Hazard Analysis Introduction

Purpose

The hazard analysis is the foundation upon which all emergency planning efforts in the community are built. In fact, preparing a good hazard analysis and community profile is the first step that the community's emergency planning team should take in building an effective emergency management program. A hazard analysis provides an understanding of the potential threats facing the community. By pinpointing the location, extent and magnitude of past disasters or emergency situations, and by examining knowledge of new or emerging risks, it is possible to determine the probability of such events occurring and the vulnerability of people and property. Coupled with relevant land use, economic and demographic information from a well prepared "community profile," Emergency Management Directors/Coordinators can make assumptions about those segments of the community that might be impacted by various types of incidents. This, in turn, allows them to set priorities and goals for resource allocation and response, recovery and mitigation activities prior to an incident occurring. Collectively, these decisions are the cornerstone of the community's emergency management program and should guide all decisions pertaining to community emergency management activities.

Hazard Analysis Development

One of the most effective methods of developing a community hazard analysis is to divide the task into three distinct, but equally important tasks. The first step is to identify those hazards to which the community is susceptible. The second step is to develop a community profile of the community's major land use, demographic and economic trends and patterns to determine which segments of the community might be impacted. The third and final step is the actual analysis of the information, that is, determining the level of community vulnerability based on the identified hazards and existing community trends and patterns. Coupling this information with the results of the community's Capability Assessment can help identify the community's strengths and weaknesses, and provides the basis for the community emergency management program.

Step 1: Hazards Identification

All local hazard analysis in the State of Michigan should be based on EMHSD PUB - 103, "Michigan Hazard Analysis." This document presents a comprehensive study of the various types of disasters and emergencies that have confronted the State of Michigan, as well as those hazards that have the potential to occur. From this document, it is possible to identify potential community hazards and gather information about the community's potential exposure and vulnerability to those hazards. Although this provides an excellent overview hazards from a statewide perspective, it is important to build upon this information to more specifically focus on the local jurisdiction. This requires local research conducted through local libraries, historical

organizations, newspapers, broadcast media, chambers of commerce, insurance companies and other community entities (even private citizens) that may be able to provide insight and information about past disaster events and local hazard areas. The Emergency Management Director/Coordinator must also review previous hazard analysis and identify changes in the community. The information should be recorded on a map or maps to provide an accurate geographic portrayal of the community's hazard base.

Step 2: Community Profile

A community profile provides information about key segments or elements of the community's makeup. It examines the land use pattern, the transportation network, demographic breakdown of the population, key industries, locations of key community facilities, major community organizations, and other information that is relevant to the community's existence. Simply put, preparing a community profile requires answers to the 5 W's of the jurisdiction. Who are we, where are we located, what do we do, and when, and why do we exist, what is the community's main "reason for being"? Answers to many of these questions have already been prepared by other community agencies, such as the planning department, chamber of commerce, economic development authority, aging office, community college or university, school district, etc. In most cases, this information can be utilized from information acquired from those organizations after adaptation into the proper format. As initially locating the information is critical, broadening the search for information also helps complete the job faster and generates support and "buy-in" for the end product from agencies assisting in the information gathering. This information is recorded on a map or maps (as per the hazard identification step outlined above) to indicate the geographic relationship of key facilities, population distributions and land use patterns to the identified hazards.

Step 3: Analysis of Hazards and Vulnerability

The third step in the process, the actual "analysis" portion of the hazard analysis, comes when the hazard identification information is combined with the community profile. At this point, it is possible to determine and "analyze" the potential impact of these hazards on the community, or vulnerability. This requires a lot of "what ifs" to be asked. It is in answering the "what ifs" that the community can determine where its strengths and weaknesses lie in its capability to respond to, recover from and mitigate the consequences of the hazards to which it is susceptible. When matched with the community's Capability Assessment this analysis allows the community to determine its strengths and weaknesses, and then design an emergency management program that is tailored to its needs and resources.

Hazard Identification

The Newaygo County Hazard Analysis has been developed by Newaygo County Emergency Services, the Local Emergency Planning Team, and community officials to provide a documented description of the community's identified hazard's, possible risk, and potential vulnerabilities to support local emergency planning and mitigation activities. The Michigan Hazard Analysis (MSP EMHDS Publication 103) was utilized as the guiding document in the development of each of the Hazard Sections. The State of Michigan Hazard Analysis is broken into three hazard classifications, Natural Hazards (updated in 2024), Technological Hazards (updated in 2020), and Human Related Hazards (updated in 2020). Newaygo County's Hazard Analysis continues to be revised from the previous editions to mirror the most current Michigan Hazard Analysis. These changes make the plan not only compliant with FEMA planning standards, but with larger Emergency Management Accreditation Program (EMAP) standards as well, with a full consideration of natural hazards, technological hazards, human-related hazards, as well as greater linkages between hazard mitigation and the other phases of emergency management—preparedness, response, and recovery.

The State of Michigan encompasses 4 major categories of natural hazards including Weather Hazards, Flooding Hazards, Ecological Hazards, and Geological Hazards. Each of these major categories are then broken down into subcategories with some having secondary categories. This mirrors local planning considerations. Although grouped slightly different than the State of Michigan, Newaygo County's existing hazards have been organized into 13 major hazard classes. This method has allowed for an effective planning approach for a variety of reasons. First, the Newaygo County Emergency Operations Plan is an all-hazard document dependent on implementation of emergency functions, not related to specific hazard response. In example, many flood hazards require similar planning, response, and mitigation measures despite their specific type. Second, Newaygo County is a moderately sized jurisdiction with its population and resources concentrated in villages and cities, creating a need to generalize hazards. Concentrating on the primary local considerations for the entire hazard class allows for a more efficient planning process than otherwise analyzing each of the individual hazards.

The following relates Newaygo County's Hazard Classes to the Michigan Hazard Analysis Document.

Newaygo County Hazard Analysis Category	Michigan Hazard Primary Category	Michigan Hazards Secondary Category
Natural Hazards: Weather Hazards		
Thunderstorm	Thunderstorm	• Lightning • Hail • Tornados
Tornados	High Winds	
Severe Winter Weather	Winter Hazards	• Snowstorms (Blizzards) • Freezing Rain and Sleet • Extreme Cold
Natural Hazards: Flooding Hazards		
Flooding	• Fluvial and Pluvial Flooding • Great Lakes Shoreline Hazards • Dam and Levee Failures	
Natural Hazards: Ecological Hazards		
Drought	• Drought • Extreme Heat	
Wildfires	Wildfires	
Invasive Species	Invasive Species	
Natural Hazards: Geologic Hazards		
Geologic Hazards	• Earthquake • Subsidence • Meteorites (Impacting objects) • Space Weather	
Technological Hazards: Industrial Hazards		
Hazardous Materials	• Hazardous Materials • Nuclear Power Plant Emergencies • Pipeline and Wellhead Incidents	• Fixed Sites (Hazmat) • Transportation (Hazmat)
Fires	Structure Fires	
Technological Hazards: Infrastructure Hazards		
Infrastructure Failure	• Built Infrastructure Failures • Nuclear Power Plant Emergencies • Pipeline and Wellhead Incidents • Energy failures and shortages	• Water, Storm sewers, bridges, communications • Transportation (Hazmat)
Transportation	Major Transportation Incidents	
Human-Related Hazards		
Criminal Incidents	• Terrorism and similar criminal incidents • Civil Disturbances • Nuclear Attack • Cyberattacks and Major Network Disruptions	
Public Health Emergencies	Public Health Emergencies	• Contagious • Food and water contamination

Non-significant Hazards

Earthquakes

In the early 1800s there were several mild earthquakes reported in Southern Lower Michigan. With limited documentation the exact number is difficult to determine, however, no severely destructive earthquakes have ever been documented in Michigan. According to the Michigan Hazard Analysis, Michigan is not located in an area subject to major earthquake activity. Although there are fault lines in the bedrock of Michigan, they are now considered relatively stable. Based on recent scientific studies, portions of southern lower Michigan could be expected to receive minor damage were such an earthquake to occur. Newaygo County is outside the earthquake threat zone.

Nuclear Power

Currently, Michigan has three operational commercial nuclear power plants which include The Enrico Fermi 2 Plant near Monroe just south of Wayne County, The Donald C. Cook plant near Bridgman in Berrien County, and the Palisades Plant near Covert in Van Buren County. A fourth plant, the Big Rock Point plant near Charlevoix, was closed in 1997 and is now decommissioned, but spent fuel is still stored on-site in dry casks which will probably remain there a while. The Davis-Besse nuclear power station near Toledo, Ohio has several Michigan Counties within its Secondary Emergency Planning Zone, requiring coordination between Michigan and Ohio. In addition, nuclear research facilities can produce / use radioactive materials, as well as other hazardous substances. Newaygo County is outside of the Emergency Planning Zone for all Nuclear Power Plants located in Michigan.

Hazard Section Organization

Each of the following hazard sections are formatted to contain similar information as described below:

Hazard Definition

This section briefly defines the hazard.

Hazard Description

This section provides a general description summary of each hazard taken from a statewide perspective. This portion has been utilized from information provided by MSP-EMHSD Pub 103 Michigan Hazard Analysis and MSP-EMD Pub207 Local Hazard Mitigation Planning Workbook.

Hazard Analysis

This section provides information on threats, h istorical occurrences, and key points of concerns as it relates to both the State of Michigan and Newaygo County. This allows for planners to focus mitigation, planning, and response efforts on specific areas of vulnerabilities, risk, resources, etc. that have been identified through the hazard analysis process.

Vulnerability Analysis

This section provides information on vulnerabilities the jurisdiction faces and the potential impacts the hazard has on each jurisdiction within Newaygo County.

2026

Newaygo County Hazard Rankings

01



INFRASTRUCTURE FAILURE

02



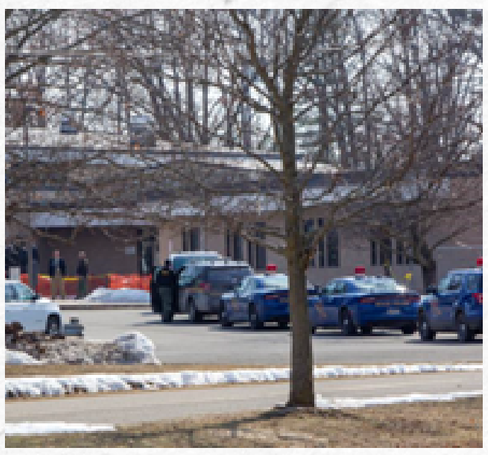
WILDFIRE

03



PUBLIC HEALTH

04



CRIMINAL

05



HAZARDOUS MATERIALS

06



FLOODING / DAM FAILURE

07



THUNDERSTORM

08



SEVERE WINTER WEATHER

09



DROUGHT / EXTREME HEAT

10



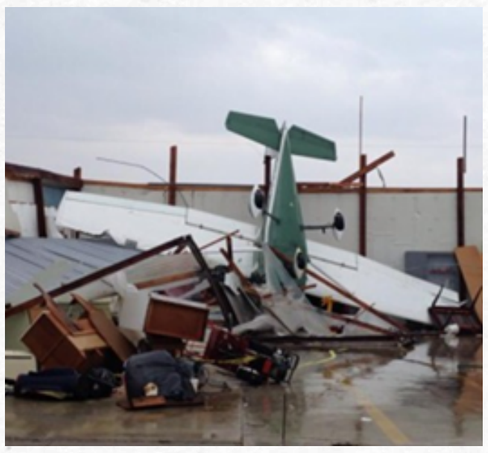
FIRES

11



TRANSPORTATION ACCIDENTS

12



TORNADO

13



GEOLOGIC HAZARDS

SEVERE THUNDERSTORM AND TORNADOES

Severe Thunderstorm and Tornadoes

Severe Thunderstorms are weather systems accompanied by strong winds (greater or equal to 58 mph), lightning, heavy rain, hail (greater than or equal to 1" diameter – quarter size), and possibly contain tornadoes. Tornados are a violently whirling column of air extending downward to the ground from a cumulonimbus cloud.

Hazard Description

Thunderstorms form when a shallow layer of warm, moist air is overrun by a deeper layer of cool, dry air. Cumulonimbus clouds, frequently called "thunderheads," are formed in these conditions. These clouds are often enormous (up to six miles or more across and 40,000 to 50,000 feet high) and may contain tremendous amounts of water and energy. That energy is often released in the form of high winds, excessive rains, lightning, and possibly hail and tornadoes.

Thunderstorms are typically short-lived (often lasting no more than 30-40 minutes) and fast moving (30-50 miles per hour). Strong frontal systems, however, may spawn one squall line after another, composed of many individual thunderstorm cells. Severe thunderstorms may also cause severe flood problems because of the torrential rains that they may bring to an area. Thunderstorms sometimes move very slowly, and can thus dump a tremendous amount of precipitation onto a location. Flooding can result, including flash floods, "urban flooding," and riverine flooding.

The following are specific thunderstorm hazards:

Hail:

A condition where atmospheric water particles from thunderstorms form into rounded or irregular lumps of ice that fall to the earth. Hail is a product of the strong thunderstorms that frequently move across the state. As one of these thunderstorms passes over, hail usually falls near the center of the storm, along with the heaviest rain. Sometimes, however, strong winds occurring at high altitudes in the thunderstorm can blow the hailstones away from the storm center, causing an unexpected hazard at places that otherwise might not appear threatened. Hailstones range in size from a pea to a golf ball, but hailstones larger than baseballs have occurred in the most severe thunderstorms. Hail is formed when strong updrafts within the storm carry water droplets above the freezing level, where they remain suspended and continue to grow larger, until their weight can no longer be supported by the winds. They finally fall to the ground, battering crops, denting autos, and injuring wildlife and people. Large hail is a characteristic of severe thunderstorms, and it often precedes the occurrence of a tornado.

Lightning:
The discharge of electricity from within a thunderstorm. Although lightning is often perceived as a minor hazard, it damages many structures and kills and injures more people in the U.S. per year, on average, than tornadoes or hurricanes. Many lightning deaths and injuries could be avoided if people would have more respect for the threat that lightning presents. Michigan ranks second in the nation in both lightning-related deaths and lightning-related injuries.

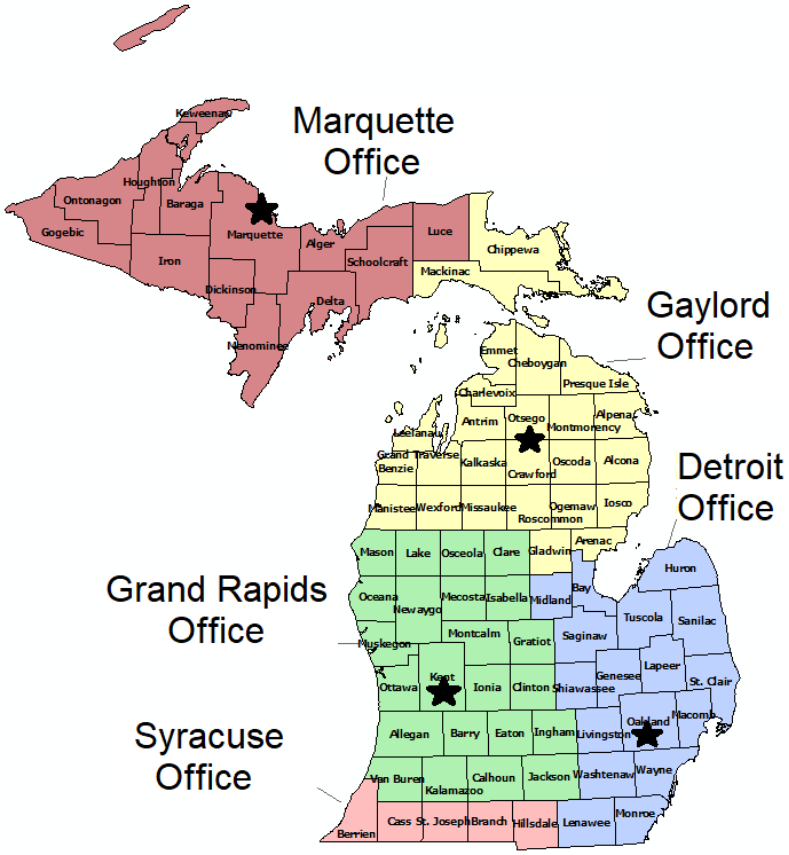
Severe Winds (Windstorms):
According to the National Weather Service, winds 58 miles per hour or greater are classified as a windstorm. Windstorms are a fairly common occurrence in many areas in Michigan. Along the Great Lakes shoreline, strong winds occur with regularity, and gusts of over 74 miles per hour (hurricane velocity) do occasionally occur in conjunction with a storm front. Severe windstorms can cause damage to homes and businesses, power lines, trees and agricultural crops, and may require temporary sheltering of individuals without power for extended periods of time. Windstorms occur in all areas of Michigan, although more often along the lakeshore and in central and southern lower Michigan.

Tornadoes
A violently whirling column of air extending downward to the ground from a cumulonimbus cloud. The funnel cloud associated with a tornado may have winds up to 300 miles per hour and an interior air pressure that is 10-20 percent below that of the surrounding atmosphere. The typical length of a tornado path is approximately 16 miles, but tracks much longer than that - some even up to 200 miles - have been reported. Tornado path widths are generally less than one-quarter mile wide. Historically, tornadoes have resulted in the greatest loss of life of any natural hazard, with the mean national annual death toll being 111 persons. Property damage from tornadoes is in the hundreds of millions of dollars every year. Michigan averages approximately 18 tornadoes per year, most occurring in the southern Lower Peninsula.

Severe Thunderstorm Hazard Analysis:
Severe thunderstorms can occur anytime in Michigan, although they are most frequent during the warm spring and summer months from April through September. Various areas in Michigan are subject to an average of at least 20 thunderstorm days per year, and up to just over 40 thunderstorm days per year in the state's southwestern corner. Severe thunderstorms have some degree of predictability and are closely monitored by the National Weather Service.

In addition to daily forecasts, which predict the probability of rainy or stormy weather, the NWS system of Watches and Warnings helps communities understand when there is a potential risk of severe thunderstorms, or if severe thunderstorms are imminent. When the NWS issues a "Severe Thunderstorm Watch," it means that thunderstorms with large hail and damaging winds are possible in your area. When the NWS issues a "Severe Thunderstorm Warning," it signifies that severe thunderstorms (with the damaging winds and hail) are in your area or are imminent.

The NWS has five offices that serve Michigan and are responsible for monitoring and providing predictions and bulletins for the entire state. The five offices are in Grand Rapids, Detroit, Gaylord, Marquette, and Syracuse (Indiana). These stations provide information on severe weather watches and warnings, but also provide useful Doppler Radar images that track the movement of thunderstorms in your area. The Syracuse office covers portions of southwest Michigan (www.weather.gov/iwx); the Grand Rapids station covers the remainder of southwest Michigan (www.weather.gov/grr); the Detroit station covers Southeast Michigan (www.weather.gov/dtx); the Gaylord station covers the north central portion of the Lower Peninsula and the eastern edge of the Upper Peninsula (www.weather.gov/apx); and the Marquette station examines the majority of the Upper Peninsula (www.weather.gov/mqt).

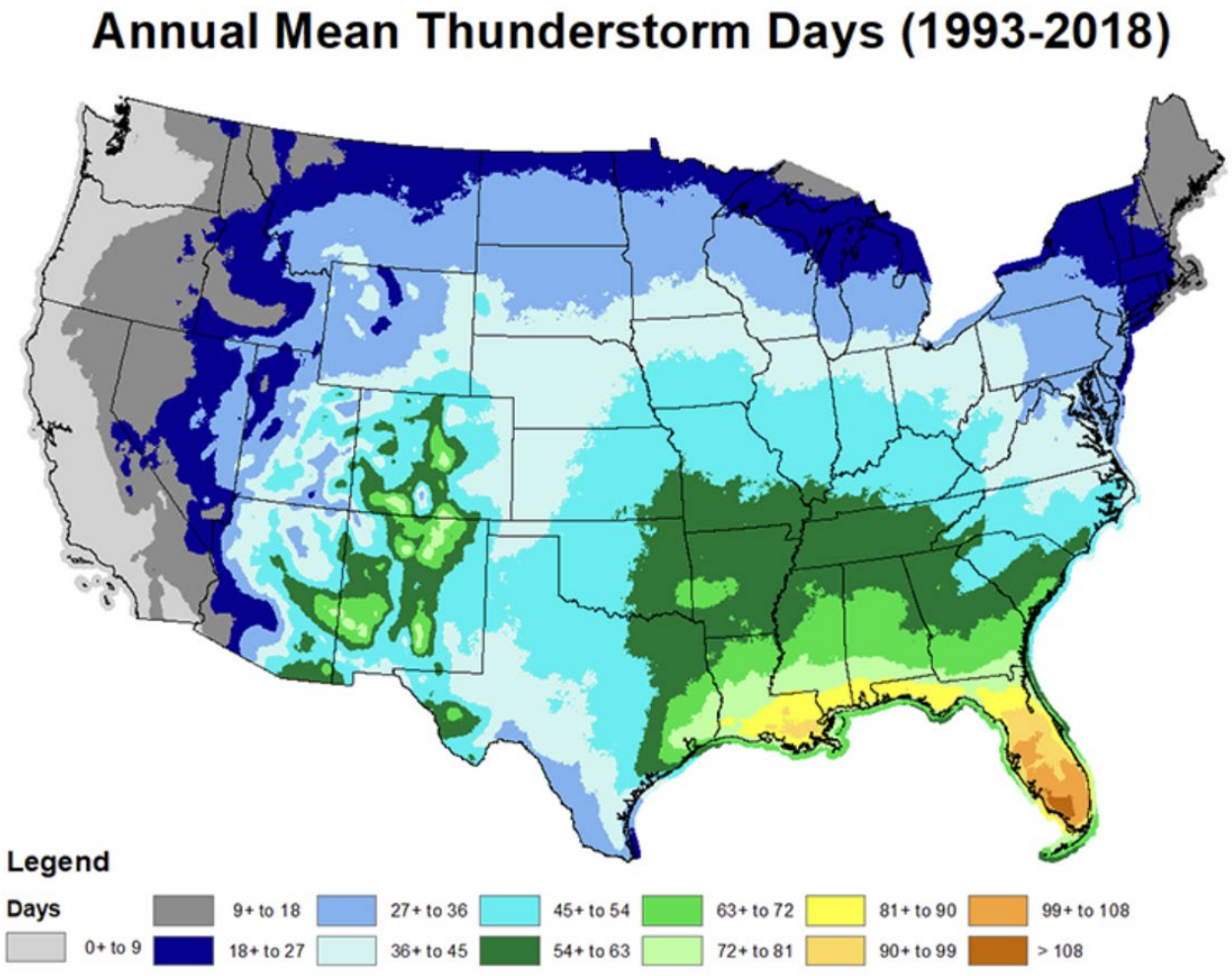


National Weather Service Doppler Weather Radar can now more easily detect severe weather events that threaten life and property—including storms that are likely to produce damaging hail. Most significantly, the lead time and specificity of warnings for severe weather have greatly improved since the early 2000s. The National Weather Service (NWS) Doppler Weather Radar Network (WSR-88D) has undergone many upgrades since 2010 in the Service Life Extension Program that will keep the system operational well into the 2030s. Upgrades include additional technology to detect atmospheric particle size and movement (dual polarization) that aids the NWS in detecting severe winds, large hail, and tornado structure. Doppler technology calculates both the speed and the direction of wind motion inside of severe storms. The system allows forecasters to identify conditions leading to severe weather, as well as information on the direction and speed of storms once they form.

Severe Thunderstorm Hazards in Michigan

The figure below from the National Oceanic and Atmospheric Administration shows the average number of thunderstorm days each year throughout the U.S. (The graphic defines a day of thunderstorms as two lightning flashes within a 10 nmi (18.5 km) radius). The most frequent occurrence is in the southeastern states, with Florida having the highest number of "thunder" days (80 to 105+ days per year). This is because warm, moist air from the Gulf of Mexico and Atlantic Ocean (which we will see later are necessary ingredients for thunderstorm development) is most readily available to fuel thunderstorm development in this part of the country.

As the map below indicates, various areas in Michigan are subject to an average of at least 18 thunderstorm days per year, and up to just over 45 days per year in the state's southwestern corner. The Lower Peninsula, in general, is subject to approximately 27-36 thunderstorm days per year, while the Upper Peninsula average is closer to 18-27 thunderstorm days per year. This map can be located here: https://www.noaa.gov/jetstream/thunderstorms



Annual number of thunderstorm days in the U.S. From: Koehler, Thomas L., 2019: Cloud-to-Ground Lightning Flash Density and Thunderstorm Day Distributions over the Contiguous United States Derived from NLDN Measurements: 1993-2018. Under review at Monthly Weather Review. Used by permission.

Since thunderstorms bring the potential for dangerous hail, lightning, straight-line winds, and tornados, it is necessary to further examine each of those hazards in the following sections of this annex.

Hail Hazards

As a product of the strong thunderstorms that frequently move across the state, the size of hail is usually proportional to the intensity of the storm cell that generates it. As a thunderstorm passes over, hail usually falls near the center of the storm, along with the heaviest rain. Sometimes, a thunderstorm's strong winds can occur at high altitudes and blow the hailstones away from the storm's center, causing an unexpected hazard at places that otherwise might not appear threatened.

Most hailstones reported in Michigan range in size from a pea (¼" diameter) to a golf ball (1¾" diameter), but hailstones larger than baseballs (2¾" diameter) have occurred with the most severe thunderstorms. The following table provides the range of sizes and historical occurrences.

Hail Size Comparison (Michigan, 1996-2021)

Relative Hail Size	Diameter	# of MI events	Description/Impacts:
Pea	¼" (6mm)	Too many to include	Minimal structural impacts, but crop damages can be severe
Marble or mothball	½" (13mm)		
Penny or dime	¾" (19mm)	Too many to include	Old threshold for severe hail, raised to 1" in 2009
Nickel	0.9" (22mm)		
Quarter	1" (25mm)	1349 (combined)	$70.12M property damage, $3.55M in crop damage
Half-dollar	1¼" (32mm)		
Walnut/ping-pong ball	1½" (38mm)	543 (combined)	$229.07M property damage, $3.83M crop damage, 3 injuries
Golf ball	1¾" (44mm)		
Hen's egg	2" (51mm)	79	$29M in property damage, $855K in crop damages, 1 injury
Tennis ball	2½" (64mm)	14	
Baseball	2¾" (70mm)	18	
Teacup	3" (76mm)	14	Damages: $12M property, $2.8M crop
Grapefruit	4" (102mm)	4	$1.8M in property damage
Softball	4½" (114mm)	1	$32.6M in property damage
	Total of Included:	2,022	$375M property, $11M crop

(sources: Adapted from NCEI Storm Events Database (2021))

Although damaging hail is much less frequent than thunderstorms, since only a fraction of all thunderstorms produce damaging hail, there is still an unusual aspect to the types of events that cause damages to occur. Hail is most likely for severe thunderstorms that also produce great amounts of precipitation, but although damaging hail has occurred in every part of Michigan, the events producing the largest-sized hail are not always reported to be damaging, and much smaller-sized hail often causes far greater negative impacts. The vast majority of reported property damage in Michigan stems from just a few events. The important thing to note is that both the Upper Peninsula and the Lower Peninsula have endured extensive damage from rare but large hail events.

Michigan Hail* Data (Arranged by Geography, 1/1/1996 – 4/30/2023)
(see Appendix A for information related to geographic groupings)

COUNTY/AREA	Reported Hail Events	Total Property Damage	Total Crop Damage	Injuries
Washtenaw	203	$10,000		
Wayne	164	$7,000		
Livingston	63			
Oakland	184	$25,011,000		
Macomb	148	$2,000		
5 County Metro Area	**152 avg.**	**$25,030,000**	**$0**	**0**
Berrien	69	$10,000	$1,300,000	
Cass	34	$12,000		
St. Joseph	53	$7,000		
Branch	55	$1,000,000		
Hillsdale	42	$2,000,000		
Lenawee	106	$2,150,000		1
Monroe	86			
Van Buren	36	$50,420,000	$305,000	
Kalamazoo	61	$130,205,000	$370,000	
Calhoun	40	$525,000	$385,000	
Jackson	39	$385,000	$225,000	
Allegan	59	$2,712,000	$402,000	
Barry	44	$1,860,000	$205,000	
Eaton	46	$510,000	$325,000	
Ingham	45	$512,000	$235,000	
Ottawa	61	$497,000	$302,000	
Kent	82	$15,112,000	$395,000	
Ionia	19	$4,680,000	$100,000	
Clinton	30	$220,000	$125,000	
Shiawassee	41	$2,800,000	$2,000,000	
Genesee	168			
Lapeer	68			
St. Clair	79	$125,000		
Muskegon	46	$965,000	$260,000	
Montcalm	36	$1,180,000	$165,000	1
Gratiot	32	$405,000	$130,000	
Saginaw	103	$300		
Tuscola	71			
Sanilac	55	$155,000	$10,000	
Mecosta	28	$575,000	$170,000	
Isabella	39	$205,000	$215,000	
Midland	98	$10,127,000		
Bay	92	$20,050,000		2
Huron	61	$5,500		
34 County Southern Lower Peninsula	**60 avg.**	**$249,409,800**	**$7,624,000**	**4**

(continued on next page)

COUNTY/AREA	Reported Hail Events	Total Property Damage	Total Crop Damage	Injuries
Oceana	32	$260,000	$175,000	
Newaygo	38	$325,000	$235,000	
Mason	18	$195,000	$40,000	
Lake	16	$135,000	$65,000	
Osceola	16	$130,000	$70,000	
Clare	32	$715,000	$110,000	
Gladwin	34			
Arenac	38	$10,000		
Manistee	33		$35,000	
Wexford	29			
Missaukee	28			
Roscommon	40			
Ogemaw	40	$32,600,000		
Iosco	52			
Benzie	15			
Grand Traverse	32			
Kalkaska	13			
Crawford	26			
Oscoda	38			
Alcona	46		$500	
Leelanau	35	$85,000	$3,055,000	
Antrim	34	$95,000	$1,030,000	
Otsego	43	$5,000		
Montmorency	33		$50,000	
Alpena	32		$100,000	
Charlevoix	31	$45,000		
Emmet	16	$100,000		
Cheboygan	17			
Presque Isle	31	$3,500,000	$300,000	1
29 County Northern Lower Peninsula	**31 avg.**	**$37,995,000**	**$5,265,500**	**1**
Gogebic	54	$750,000		
Iron	51	$4,102,000		
Ontonagon	51			
Houghton	64	$10,000		
Keweenaw	5			
Baraga	46	$10,020,000		
Marquette	175	$64,653,000		
Dickinson	75	$225,000		
Menominee	76	$600,000		
Delta	78	$19,000		
Schoolcraft	37	$100,000		
Alger	58	$5,000		
Luce	19	$1,004,000		
Mackinac	16			
Chippewa	29			
15 County Upper Peninsula	**56 avg.**	**$81,488,000**	**$0**	**0**
MICHIGAN TOTAL**	**4,508**	**$394,128,300**	**$12,889,500**	**5**
Michigan Annual Avg.	**165**	**$14,421,495**	**$471,638**	**0.2**

*Uses the NCEI Storm Data category for "Hail". **One event may take place in multiple counties. State totals may be less than the sum of all counties.

On average, Michigan counties will experience two or more hail events per year of various intensities. The vast majority of reported property damage stems from just a few events, with usually at least one severe hailstorm in the state each year causing significant damage. Hailstorm damage should be looked at similarly as to how tornado damage is experienced, in that they rarely greatly damage any one specific location but the damage those events do cause can be extremely high. All general areas of the state have historically endured extensive damage from hail events at one time or another. Severe thunderstorm forecasts from the NWS typically provide sufficient warning for residents to take appropriate action to reduce potential hail damage where possible. Statistics from the past few decades indicate that approximately 50% of the severe thunderstorms that produce hail have occurred during the months of June and July, and nearly 80% have occurred during the prime crop growing season of May through August.

Specific Impacts

Most people have experienced small and harmless hail, but injuries may occur when people underestimate the severity of a storm. Motorcyclists traveling at high speeds may be especially vulnerable, as are people on exposed watercraft such as canoes. Hail damaging airplanes while in flight is rare but possible. Most hail in general causes little property damage but can vary significantly based on size and other factors. Most damage involves outer layers of structures such as windows, skylights, siding, roofs, air-conditioning units, and outdoor lighting. Greenhouses or temporary structures may be especially vulnerable. In very unusual storms bigger infrastructure may be damaged, such as at electrical substations. An accumulation of ice on the ground can potentially clog or reduce the effectiveness of drainage grates and paths.

Although a severe hail event can do a great deal of damage to property and crops, this tends to occur within only a small area of the county for a short time. True economic hardship tends to be limited, such as with canceled or impacted outdoor events or agricultural areas that suffer extensive crop damage (e.g., potatoes, beans, tomatoes, corn, soybeans, apples, peaches, grapes, plums, cherries, and raspberries). Livestock may also be injured. Businesses with many unsheltered vehicles and planes (e.g., auto dealerships, and airports) may suffer significant damage all at one time.

Hail Hazards in Newaygo County

Within Newaygo County there has been 53 recorded hail events which have caused $325,000 in property damage and $235,000 in crop damage from January 1950 through November 2024 according to the National Centers for Environmental Information Storm Event Database located here: https://www.ncdc.noaa.gov/stormevents/

Hail Events in Newaygo County

Date	Location	Hail Size	Property Damage	Crop Damage
8/30/1958	NEWAYGO CO.	1.75 in.	0.00K	0.00K
7/31/1963	NEWAYGO CO.	1.00 in.	0.00K	0.00K
5/25/1973	NEWAYGO CO.	1.00 in.	0.00K	0.00K

Date	Location	Hail Size	Property Damage	Crop Damage
6/17/1975	NEWAYGO CO.	1.00 in.	0.00K	0.00K
7/10/1975	NEWAYGO CO.	0.75 in.	0.00K	0.00K
6/8/1985	NEWAYGO CO.	0.75 in.	0.00K	0.00K
5/17/1986	NEWAYGO CO.	0.75 in.	0.00K	0.00K
6/11/1986	NEWAYGO CO.	1.00 in.	0.00K	0.00K
8/6/1993	Ensley Center	0.75 in.	0.00K	0.00K
4/26/1994	Bridgeton	0.75 in.	0.00K	0.00K
9/25/1994	Bridgeton	0.75 in.	0.00K	0.00K
7/15/1995	Bitely	0.88 in.	0.00K	0.00K
6/20/1997	CROTON	0.88 in.	0.00K	0.00K
6/11/1999	WHITE CLOUD	0.75 in.	0.00K	0.00K
5/12/2000	BRUNSWICK	0.88 in.	40.00K	0.00K
5/12/2000	NEWAYGO	0.88 in.	30.00K	10.00K
7/22/2003	WHITE CLOUD	0.75 in.	25.00K	10.00K
5/6/2004	HESPERIA	0.88 in.	20.00K	20.00K
5/8/2004	NEWAYGO	1.00 in.	20.00K	20.00K
5/8/2004	NEWAYGO	0.88 in.	20.00K	20.00K
5/23/2004	BROHMAN	0.75 in.	15.00K	15.00K
6/23/2004	NEWAYGO	1.00 in.	10.00K	10.00K
9/3/2004	NEWAYGO	0.88 in.	5.00K	5.00K
1/12/2005	FREMONT	0.88 in.	5.00K	5.00K
4/22/2006	WHITE CLOUD	0.88 in.	5.00K	5.00K
6/28/2006	FREMONT	0.75 in.	5.00K	5.00K
6/28/2006	BITELY	0.75 in.	5.00K	5.00K
7/9/2006	WHITE CLOUD	1.00 in.	5.00K	5.00K
7/9/2006	BIG PRAIRIE	1.00 in.	5.00K	5.00K
9/6/2006	GRANT	0.75 in.	10.00K	5.00K
9/6/2006	FREMONT	0.75 in.	15.00K	5.00K
10/2/2006	BITELY	1.00 in.	10.00K	10.00K
10/2/2006	VOLNEY	0.88 in.	10.00K	10.00K
10/2/2006	NEWAYGO	1.00 in.	10.00K	10.00K
10/2/2006	GRANT	1.00 in.	10.00K	10.00K
10/2/2006	WOODVILLE	0.75 in.	10.00K	10.00K
6/2/2007	BROHMAN	0.88 in.	0.00K	0.00K
7/9/2007	ENSLEY CENTER	0.88 in.	5.00K	0.00K
1/7/2008	CROTON	0.75 in.	0.00K	0.00K
7/2/2008	NEWAYGO	1.00 in.	0.00K	0.00K
7/2/2008	CROTON	1.00 in.	0.00K	0.00K
6/21/2011	WHITE CLOUD ARPT	1.00 in.	0.00K	0.00K
5/20/2013	OXBOW	1.00 in.	0.00K	0.00K
5/30/2013	NEWAYGO	1.25 in.	0.00K	0.00K
5/2/2018	BISHOP	0.88 in.	0.00K	0.00K
8/29/2019	FREMONT MUNI ARPT	1.75 in.	10.00K	10.00K
8/29/2019	FREMONT MUNI ARPT	2.50 in.	10.00K	25.00K
09/12/2021	GRANT	1.00 in	0.00K	0.00K
09/21/2022	GRANT	1.00 in	0.00K	0.00K
06/29/2023	WHITE CLOUD	1.25 in	0.00K	0.00K
08/24/2023	GRANT	1.00 in	0.00K	0.00K
11/06/2023	NEWAYGO	1.25 in	0.00K	0.00K
TOTALS			325.00K	235.00K

Case: August 29, 2019 – Newaygo, Muskegon, Kent, and Montcalm Counties - Storms resulted in isolated wind damages. There were several reports of large hail ranging from 1.75-2.5 inches in diameter. Estimated event property damages included $20K for Newaygo County, $25K for Muskegon County, and $10K for Kent County. Both Newaygo and Kent also saw $25K in crop damages.

Specific Impacts within Newaygo County

Newaygo County is especially vulnerable to hail within the Spring, Summer, and Fall due to people on exposed watercraft including fishing boats, canoes, kayaks, and river tubes. With high recreational use of watercraft on the Muskegon River and numerous lakes throughout the County, hundreds of people can be outside at one time. Hail has the potential to cause human injury as well as damage to the watercraft.

The largest impact hail has within Newaygo County is damage to crops. According to the 2022 Census of Agriculture, Newaygo County is ranked 12th in the State of Michigan for its production of Fruits, tree nuts, and berries. Newaygo County is ranked 13th in the State of Michigan for its production of Vegetables, melons, potatoes, and sweet potatoes.

Lightning Hazards

Lightning is a random and unpredictable product of a thunderstorm's tremendous energy. The energy in the storm produces an intense electrical field like a giant battery, with the positive charge concentrated at one end and the opposite charge concentrated at the other. Most lightning stays within the clouds, but about 20% of it involves contact with the ground. Lightning strikes can generate current levels of 30,000 to 40,000 amperes, with air temperatures often superheated to higher than 50,000 degrees Fahrenheit (hotter than the surface of the sun) and speeds approaching one-third the speed of light.

Globally, there are about 2,000 thunderstorms occurring at any given time, and those thunderstorms cause approximately 100 lightning strikes upon the ground each second. In the United States, approximately 100,000 thunderstorms occur each year, and every one of those storms generates lightning. A single thunderstorm can produce hundreds or even thousands of lightning strikes. However, many persons in the general public still perceive lightning as a minor hazard. That perception lingers even though lightning damages many structures and even causes more deaths per year, on average, than tornadoes or hurricanes. Many lightning deaths and injuries could be avoided if people would have more respect for the threat lightning presents to their safety.

Lightning deaths are usually caused by the electrical force shocking the heart into cardiac arrest or throwing the heartbeat out of its usual rhythm. Lightning can also cut off breathing by paralyzing the chest muscles or damaging the respiratory center in the brain stem. It takes only about one-fiftieth of an ampere of electric current to contract chest muscles and stop breathing,

and one-hundredth of an amp can disrupt a human heartbeat. Lightning can also cause severe skin burns that can lead to death if complications from infection set in.

According to NWS records, Michigan saw 101 lightning deaths and 716 injuries from 1959-2021, ranking it near the top in the nation for this long time period. Looking specifically at 1959-1995, Michigan recorded 812 lightning-related casualties (i.e., deaths and injuries), ranking it 2nd in injuries and 12th in deaths for the nation. However, Michigan recorded only three fatalities from 2012-2021, which ranked it 22nd in lightning-related deaths, well below the highest ranked states of Florida (52 deaths) and Texas (22 deaths). This more recent rank change may be attributed to shifting population statistics compared to other states, a state decline in certain outdoor activities, or the success of educational campaigns increasing awareness for lightning-related dangers.

Lightning-Related Deaths in Michigan: 1959- 2021

	LIGHTNING DEATHS: 101	
Number of Deaths	**Location**	**Percent of Total**
29	Open fields, ball fields	29%
26	Under trees (not golf)	26%
11	Boats/water-related	11%
10	Golf course	10%
4	Near tractors/heavy equipment	4%
2	At telephone	2%
19	Other location/unknown	19%

(source: NOAA NCEI storm data)

Although Michigan's counties experience from about 27 to 36 thunderstorm days per year, there are a smaller number of known damaging lightning events per year (about 14 such events per year, on average). Michigan's average deaths from lightning are approximately 1 per year, and injuries average about 5 per year. Property damage from major events totals over $17 million since 1996 – averaging nearly $1 million per year. (Data from the National Climatic Data Center have been used to calculate these statistics.) Large outdoor gatherings (e.g., sporting events, concerts, campgrounds, fairs, festivals, etc.) are particularly vulnerable to lightning strikes that could result in many deaths and injuries.

As one might expect in a state with a high number of lightning deaths and injuries, lightning incidents involving one individual are fairly common in Michigan. However, lightning incidents involving groups of individuals also take place. Over the past 35 years, numerous lightning incidents in Michigan have resulted in multiple injuries:

Michigan Lightning* Data (Arranged by Geography, 1/1/1996 – 4/30/2023)
(see Appendix A for information related to geographic groupings)

COUNTY/AREA	Reported Lightning Events	Total Property Damage	Deaths	Injuries
Washtenaw	21	$1,820,000	2	4
Wayne	21	$857,000	3	18
Livingston	13	$1,844,000		5
Oakland	40	$2,323,000	1	5
Macomb	25	$2,927,000		7
5 County Metro Area	**24.0 avg.**	**$9,771,000**	**6**	**39**
Berrien	3	$840,000		1
Cass				
St. Joseph	6	$30,000	1	2
Branch				
Hillsdale	1		1	
Lenawee	18	$880,000	1	
Monroe	10	$180,000		2
Van Buren	2	$200,000		2
Kalamazoo	3	$20,000		10
Calhoun	1	$11,000		
Jackson				
Allegan	1	$5,000		
Barry	1			1
Eaton				
Ingham				
Ottawa	3	$60,000		1
Kent	3	$1,000,000		
Ionia	1			1
Clinton				
Shiawassee	6	$225,000		1
Genesee	15	$222,500	1	11
Lapeer	10	$1,327,000		4
St. Clair	6	$28,000		1
Muskegon	1	$40,000		
Montcalm	1			4
Gratiot				
Saginaw	7	$202,500		
Tuscola	1	$100,000		
Sanilac	5	$145,000		
Mecosta	2	$50,000		4
Isabella	1	$10,000		
Midland	6	$70,000		
Bay	5	$63,000		
Huron	5	$570,000		
34 County Southern Lower Peninsula	**3.6 avg.**	**$6,319,000**	**4**	**45**

(continued on next page)

COUNTY/AREA	Reported Lightning Events	Total Property Damage	Deaths	Injuries
Oceana				
Newaygo	1	$100,000		
Mason				
Lake				
Osceola				
Clare	1	$5,000		
Gladwin	1		1	6
Arenac	1	$500		
Manistee	2		1	
Wexford	1			
Missaukee	3	$1,000		2
Roscommon	2	$55,000		
Ogemaw	2			6
Iosco	3	$15,000		6
Benzie	1			
Grand Traverse	6	$170,000	1	1
Kalkaska	2			1
Crawford	1			1
Oscoda	2		2	1
Alcona				
Leelanau	2	$40,000		
Antrim	2	$80,000		
Otsego	4	$503,000		
Montmorency				
Alpena	1			1
Charlevoix	1			
Emmet	1	$4,000		
Cheboygan	3	$75,000		3
Presque Isle	3	$4,000	1	
29 County Northern Lower Peninsula	**1.6 avg.**	**$1,052,500**	**6**	**28**
Gogebic	2		1	1
Iron	2	$50,500		
Ontonagon				
Houghton	2	$25,000		
Keweenaw				
Baraga	1	$2,000		
Marquette	8	$78,500		
Dickinson	3	$171,000		
Menominee	1	$500,000		1
Delta	2	$130,000		
Schoolcraft				
Alger	3	$20,000	1	3
Luce	1	$70,000		
Mackinac	1	$150,000		
Chippewa	1	$2,800		
15 County Upper Peninsula	**1.8 avg.**	**$1,199,800**	**2**	**5**
MICHIGAN TOTAL**	**318**	**$18,343,000**	**18**	**117**
Michigan Annual Avg.	**11.6**	**$671,186**	**0.7**	**4.3**

Uses the NCEI Storm Data category for "Lightning". **One event may take place in multiple counties. State totals may be less than the sum of all counties.

Specific Impacts:

In addition to the casualties and damages noted in this chapter, lightning has a discouraging effect on outdoor activities (e.g., jogging, golfing, swimming). Boaters on the water may be put at risk. Exposed stadiums, such as for sporting events or concerts, may be evacuated. Struck buildings may see damaged appliances, including medical equipment. Electrical and communications infrastructure such as radio towers can be affected by lightning strikes, sometimes causing power outages, impacting cell phone coverage, or disrupting the internet. Airports, with tall control towers and fueling operations, are also at risk.

Lightning Hazards in Newaygo County

Within Newaygo County there has been 1 recorded lightning events which have caused $100,000 in property damage from 1950 through August 2019 according to the National Centers for Environmental Information Storm Event Database. This event occurred on June 5, 2008 when an isolated severe thunderstorm resulted in a report of one-inch diameter hail. In addition, a lightning strike resulted in a gas well fire in Ensley Center in Newaygo County, resulting in significant damage.



Specific Impacts Within Newaygo County:

Newaygo County has a large outdoor recreation population in the Spring, Summer, and Fall months. This includes golf courses, watercraft, canoe liveries, campgrounds, mountain biking, community festivals, and outdoor leisure activities. As most lightning victims are struck while enjoying outdoor activities, risk to this population is most common in the afternoon and on weekends when most people are outside. A list of community events and outdoor recreation areas can be found starting on page 156.

Severe Wind Hazards

Severe winds, or straight-line winds, sometimes occur during severe thunderstorms and other weather systems, and can be very damaging to communities. Often, when straight-line winds occur, the presence of the forceful winds, with velocities over 58 mph, may be confused with a tornado occurrence. Severe winds have the potential to cause loss of life from breaking and falling trees, property damage, and flying debris, but tend not to cause as many deaths as tornadoes do. However, the property damage from straight line winds can be more widespread than a tornado, usually affecting multiple counties at a time. In addition to property damage to buildings (especially less sturdy structures such as storage sheds, outbuildings, etc.), there is a risk of infrastructure damage from downed power lines due to falling limbs and trees. Large scale power failures, with hundreds of thousands of customers affected, are common during straight-line wind events.

Another dangerous aspect of straight-line winds is that they occur more frequently beyond the April to September time frame than is seen with the other thunderstorm hazards. It is not rare to see severe winds ravage parts of the state in October and November—some winter storm events in Michigan have produced wind-speeds of 60 and 70 miles per hour. Stark temperature contrasts seen in colliding air masses along swift-moving cold fronts can occur during practically any month.

Figures from the National Weather Service indicate that severe winds occur more frequently in the southern half of the Lower Peninsula than any other area of the state. On average, severe wind events can be expected 2-3 times per year in the Upper Peninsula, 3-4 times per year in the northern Lower Peninsula, and 5-7 times per year in the southern Lower Peninsula. It must be emphasized that this refers to winds from thunderstorms and other forms of severe weather, but **not** tornadoes.

The property damage from straight line winds can be just as extreme as that of a tornado, since the damage from straight line winds is more widespread and usually affects multiple counties. In addition to property damage to buildings (especially less sturdy structures such as storage sheds, outbuildings, etc.), there is a risk for infrastructure damage from downed power lines due to falling limbs and trees. Large-scale power failures, with hundreds of thousands of customers affected, are common during straight-line wind events.

Severe winds spawned by thunderstorms or other storm events have had devastating effects on Michigan, resulting in 36 deaths, about 270 injuries, and nearly $1.5 billion in damage to public and private property and agricultural crops since 1996. Severe wind events are characterized by wind velocities of 58 miles per hour or greater, with gusts sometimes exceeding 74 miles per hour (hurricane velocity), but do not include tornadoes.

Derechos are usually large-scale storm systems that travel hundreds of miles and are many counties wide. The damage path of a derecho often exceeds 250 miles in length, with damage reports typically stretching across many states. Derechos can happen any time of the year, but are most common in Michigan during the warmer half of the year. Wind speeds in derechos can exceed 100 mph at times and often result in damage that is more widespread than most other storms and tornadoes in Michigan. The following map gives an indication of the pattern of Derecho frequency across the United States.

Derecho Average Frequencies

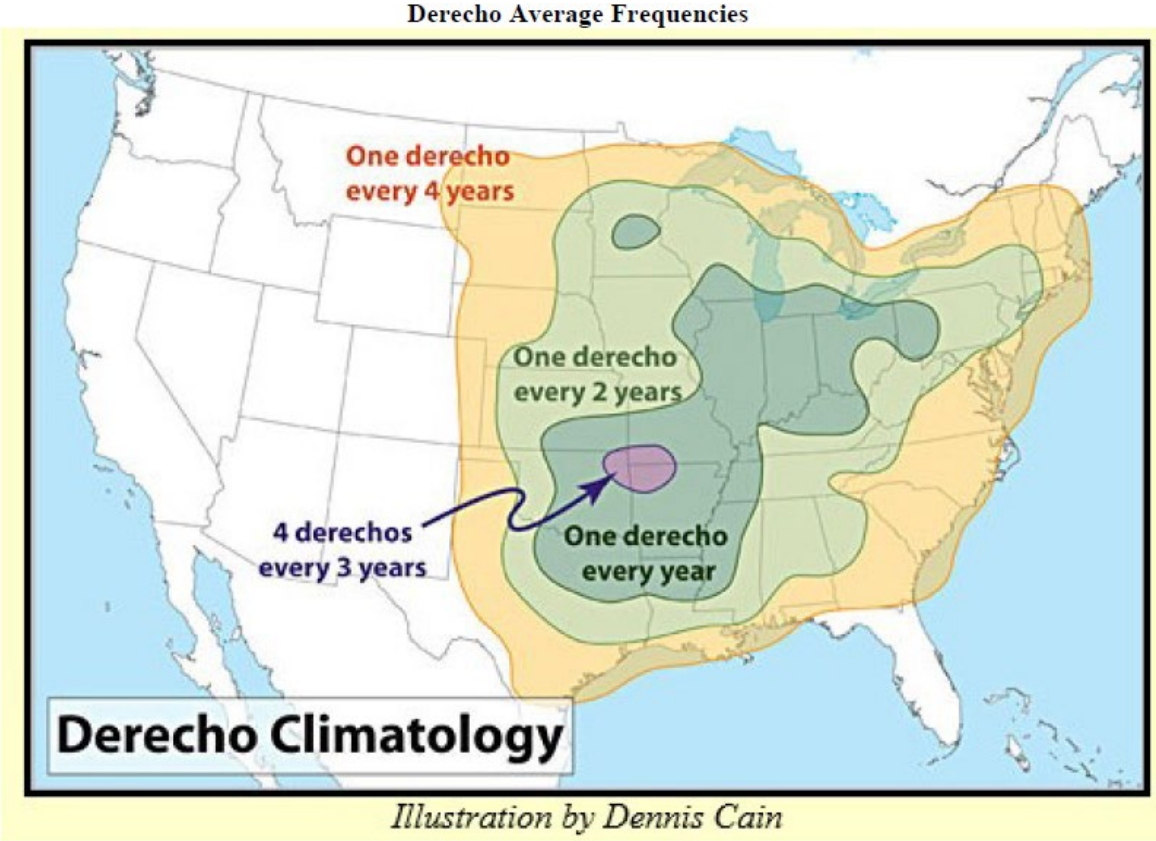


Illustration by Dennis Cain

Source: http://www.spc.noaa.gov/misc/AbtDerechos/derechofacts.htm#climatechange

High winds have had significant effects on Michigan, resulting in 42 deaths, 282 injuries, and over $1.2 billion in property and crop damages since 1996. These are a result of high winds from most non-tornadic sources and does not include damage from tornadoes

Michigan High Winds* Data (Arranged by Geography, 1/1/1996 – 4/30/2023)
(see Appendix A for information related to geographic groupings)

COUNTY/AREA	Reported High Winds Events	Total Property Damage	Total Crop Damage	Deaths	Injuries
Washtenaw	383	$49,890,000		1	4
Wayne	431	$105,851,000		8	35
Livingston	285	$35,478,000			1
Oakland	576	$75,601,000		3	10
Macomb	358	$68,662,000			2
5 County Metro Area	**407 avg.**	**$335,482,000**	**$0**	**12**	**52**
Berrien	236	$893,500	$120,000	2	9
Cass	164	$1,264,000		1	6
St. Joseph	210	$750,550		2	
Branch	188	$455,000			
Hillsdale	185	$613,000			2
Lenawee	262	$25,882,000			5
Monroe	263	$26,360,000			8
Van Buren	121	$18,854,000	$40,000	1	
Kalamazoo	138	$28,744,000	$145,000		1
Calhoun	160	$46,910,000	$235,000	1	10
Jackson	143	$14,858,000	$30,000		
Allegan	163	$17,972,000	$95,000		3
Barry	106	$15,006,000	$55,000		
Eaton	97	$17,982,000	$180,000		
Ingham	119	$18,335,000	$55,000		
Ottawa	132	$58,846,000	$10,060,000	5	21
Kent	161	$87,072,000	$20,085,000	4	60
Ionia	99	$14,994,000	$45,000		2
Clinton	105	$15,255,000	$70,000	2	
Shiawassee	160	$14,102,000			
Genesee	366	$40,714,000			3
Lapeer	228	$16,806,000		1	1
St. Clair	256	$35,893,000			
Muskegon	109	$45,850,250	$5,030,000	1	5
Montcalm	88	$28,502,000	$70,000		23
Gratiot	63	$14,757,000	$15,000		
Saginaw	267	$35,159,000			5
Tuscola	201	$13,023,950			
Sanilac	139	$12,465,500	$4,000		1
Mecosta	49	$11,549,000	$10,000		
Isabella	77	$12,011,000	$35,000		
Midland	141	$12,778,000			
Bay	150	$15,211,000		1	
Huron	186	$12,462,000		1	
34 County Southern Lower Peninsula	**163 avg.**	**$732,329,750**	**$36,379,000**	**22**	**165**

(continued on next page)

COUNTY/AREA	Reported High Winds Events	Total Property Damage	Total Crop Damage	Deaths	Injuries
Oceana	50	$15,845,000	$50,000		37
Newaygo	74	$12,797,000	$50,000	2	
Mason	71	$8,038,000	$35,000		5
Lake	43	$7,633,000			
Osceola	44	$5,932,500	$35,000		1
Clare	53	$5,943,510	$15,000	2	1
Gladwin	52	$501,000			
Arenac	40	$430,500			4
Manistee	55	$645,500			
Wexford	53	$404,500			
Missaukee	28	$532,000			
Roscommon	73	$515,500			1
Ogemaw	70	$625,500		1	2
Iosco	52	$263,000			1
Benzie	33	$236,000			
Grand Traverse	64	$13,468,000	$1,000		
Kalkaska	42	$665,000			
Crawford	40	$1,570,000			
Oscoda	35	$223,000			1
Alcona	48	$141,500			1
Leelanau	56	$24,245,000	$8,000		
Antrim	68	$960,500			1
Otsego	60	$2,041,000			1
Montmorency	45	$287,000	$5,000		1
Alpena	54	$292,000			
Charlevoix	44	$323,000			
Emmet	52	$623,000			1
Cheboygan	44	$491,500			
Presque Isle	33	$216,000			1
29 County Northern Lower Peninsula	**51 avg.**	**$105,889,010**	**$199,000**	**5**	**59**
Gogebic	120	$1,450,000	$1,000,000	1	1
Iron	79	$406,000	$2,000,000		
Ontonagon	77	$206,000	$1,060,000		
Houghton	154	$548,000	$1,000,000		
Keweenaw	58	$403,000			
Baraga	80	$619,500			
Marquette	235	$3,835,250		2	
Dickinson	105	$1,066,000			
Menominee	115	$732,000			
Delta	107	$1,308,000	$4,250,000		3
Schoolcraft	50	$734,000	$2,613,000		
Alger	71	$473,500	$1,001,000		1
Luce	47	$200,000	$1,000		
Mackinac	29	$150,000			
Chippewa	47	$454,500			1
15 County Upper Peninsula	**92 avg.**	**$12,585,750**	**$12,925,000**	**3**	**6**
MICHIGAN TOTAL**	**10,415**	**$1,163,454,097**	**$49,393,000**	**42**	**282**
Michigan Annual Avg.	**381**	**$43,407,193**	**$1,811,358**	**1.5**	**10.3**

*Combines NCEI Storm Data categories for "High Wind," "Strong Wind," and "Thunderstorm Wind".
**One event may take place in multiple counties. State totals may be less than the sum of all counties.

The

Specific Impacts:

High winds impede transportation, causing slowed traffic, flight delays, and rough waters. Property damages can be comparable to weak tornadoes but often with a more widespread area of effect. Trees/limbs frequently break, blocking roads and toppling phone and power lines. Large scale and often lengthy power outages can be anticipated, sometimes during hot or cold weather. Loss of life from falling trees and flying debris is possible, but typically less than seen with tornadoes. Facilities, homes, and garages may have roofs removed or destroyed. Mobile homes are susceptible.

Most storms will have only a moderate impact on the county, depending on location. The largest of storms may impact an entire region, hindering operations until debris can be cleared or power can be restored. Some businesses may be shuttered for safety reasons until fully repaired. Major shipping locations or airports that are damaged may impact the supply of goods. Building components may be in short supply if large areas are affected. High winds hitting the timber industry or agricultural areas may be disproportionally affected.

Severe Wind Hazards in Newaygo County

Within Newaygo County there has been 99 recorded Thunderstorm Wind and Strong Wind events which have caused $3.049 Million in property damage and $50,000 in crop damage from January 1950 through November 2024 according to the National Centers for Environmental Information Storm Event Database located here: https://www.ncdc.noaa.gov/stormevents/

Thunderstorm Wind and Strong Wind Events in Newaygo County

Date	Location	Wind Speed	Wind Speed MPH	Property Damage	Crop Damage	Deaths
8/12/1958	NEWAYGO CO.	0 kts.	0 mph	0.00K	0.00K	
10/2/1963	NEWAYGO CO.	0 kts.	0 mph	0.00K	0.00K	
7/17/1965	NEWAYGO CO.	0 kts.	0 mph	0.00K	0.00K	
1/10/1975	NEWAYGO CO.	0 kts.	0 mph	0.00K	0.00K	
6/5/1975	NEWAYGO CO.	0 kts.	0 mph	0.00K	0.00K	
7/26/1978	NEWAYGO CO.	0 kts.	0 mph	0.00K	0.00K	
5/30/1980	NEWAYGO CO.	0 kts.	0 mph	0.00K	0.00K	
4/4/1981	NEWAYGO CO.	0 kts.	0 mph	0.00K	0.00K	
8/3/1982	NEWAYGO CO.	0 kts.	0 mph	0.00K	0.00K	
10/20/1982	NEWAYGO CO.	0 kts.	0 mph	0.00K	0.00K	
7/28/1983	NEWAYGO CO.	0 kts.	0 mph	0.00K	0.00K	
7/29/1983	NEWAYGO CO.	0 kts.	0 mph	0.00K	0.00K	
7/31/1983	NEWAYGO CO.	52 kts.	60 mph	0.00K	0.00K	
7/31/1983	NEWAYGO CO.	0 kts.	0 mph	0.00K	0.00K	
7/10/1984	NEWAYGO CO.	0 kts.	0 mph	0.00K	0.00K	
7/10/1984	NEWAYGO CO.	0 kts.	0 mph	0.00K	0.00K	
6/9/1985	NEWAYGO CO.	0 kts.	0 mph	0.00K	0.00K	
5/17/1986	NEWAYGO CO.	0 kts.	0 mph	0.00K	0.00K	
6/11/1986	NEWAYGO CO.	0 kts.	0 mph	0.00K	0.00K	
7/9/1987	NEWAYGO CO.	0 kts.	0 mph	0.00K	0.00K	
8/17/1988	NEWAYGO CO.	0 kts.	0 mph	0.00K	0.00K	
6/17/1992	NEWAYGO CO.	0 kts.	0 mph	0.00K	0.00K	

Date	Location	Wind Speed	Wind Speed MPH	Property Damage	Crop Damage	Deaths
4/26/1994	GRANT	0 kts.	0 mph	5.00K	5.00K	
7/4/1994	WHITE CLOUD	0 kts.	0 mph	5.00K	5.00K	
7/20/1994	FREMONT	0 kts.	0 mph	5.00K	5.00K	
7/20/1994	BITELY	0 kts.	0 mph	5.00K	5.00K	
7/20/1994	NEWAYGO	0 kts.	0 mph	5.00K	5.00K	
7/15/1995	BITELY	52 kts.	60 mph	5.00K	5.00K	
7/15/1995	BITELY	52 kts.	60 mph	5.00K	5.00K	
4/5/1997	HESPERIA			10.00K	5.00K	
5/29/1998	BRIDGETON			15.00K	5.00K	
5/29/1998	GRANT	56 kts.	64 mph	10.00K	10.00K	
5/31/1998	FREMONT			10.00K	10.00K	
5/31/1998	WOODLAND PARK			10.00K	10.00K	
2/11/1999	HESPERIA			10.00K	10.00K	
2/11/1999	BITELY			10.00K	10.00K	
6/1/2000	NEWAYGO	53 kts. E	61 mph	0.00K	0.00K	
7/13/2000	BITELY	53 kts. E	61 mph	5.00K	0.00K	
8/22/2000	FREMONT	53 kts. E	61 mph	0.00K	0.00K	
4/11/2001	WHITE CLOUD	62 kts. E	71 mph	0.00K	0.00K	
4/11/2001	NEWAYGO	53 kts. E	61 mph	0.00K	0.00K	
8/9/2001	ENSLEY CENTER	53 kts. E	61 mph	0.00K	0.00K	
4/18/2002	GRANT	53 kts. E	61 mph	0.00K	0.00K	
4/18/2002	WHITE CLOUD	53 kts. E	61 mph	0.00K	0.00K	
8/1/2002	FREMONT	60 kts. E	69 mph	0.00K	0.00K	
8/1/2002	GRANT	60 kts. E	69 mph	10.00K	10.00K	
10/6/2002	COUNTYWIDE	60 kts. E	69 mph	10.00K	25.00K	
7/4/2003	NEWAYGO	53 kts. EG	61 mph	0.00K	0.00K	
7/4/2003	WHITE CLOUD	53 kts. EG	61 mph	0.00K	0.00K	
8/3/2003	NEWAYGO	52 kts. EG	60 mph	0.00K	0.00K	
5/9/2004	WHITE CLOUD	53 kts. EG	61 mph	0.00K	0.00K	
8/27/2004	ENSLEY CENTER	53 kts. EG	61 mph	0.00K	0.00K	
3/30/2005	ENSLEY CENTER	50 kts. EG	58 mph	5.00K	0.00K	
7/24/2005	LILLEY	53 kts. EG	61 mph	10.00K	0.00K	
7/26/2005	COUNTYWIDE	53 kts. EG	61 mph	15.00K	0.00K	
7/26/2005	FREMONT	53 kts. EG	61 mph	25.00K	0.00K	
7/17/2006	WHITE CLOUD	52 kts. EG	60 mph	10.00K	0.00K	
7/17/2006	NEWAYGO	60 kts. EG	69 mph	100.00K	10.00K	
10/4/2006	WOODLAND PARK	52 kts. EG	60 mph	30.00K	10.00K	
6/7/2007	NEWAYGO	43 kts. EG	49 mph	15.00K	0.00K	
8/22/2007	FREMONT	50 kts. EG	58 mph	10.00K	0.00K	
5/17/2008	WHITE CLOUD	52 kts. EG	60 mph	5.00K	0.00K	
6/8/2008	ENSLEY CENTER	61 kts. EG	70 mph	0.00K	0.00K	
6/8/2008	ENSLEY CENTER	61 kts. EG	70 mph	0.00K	0.00K	
7/22/2009	WOOSTER	52 kts. EG	60 mph	0.00K	0.00K	
4/15/2011	NEWAYGO	43 kts. EG	49 mph	10.00K	0.00K	
7/11/2011	NEWAYGO	52 kts. EG	60 mph	0.00K	0.00K	
9/3/2011	NEWAYGO	52 kts. EG	60 mph	0.00K	0.00K	
5/15/2012	NEWAYGO	55 kts. EG	63 mph	0.25K	0.00K	
5/28/2012	HESPERIA	56 kts. EG	64 mph	75.00K	0.00K	
7/5/2012	BIG PRAIRIE	52 kts. EG	60 mph	0.00K	0.00K	
7/17/2012	FREMONT	52 kts. EG	60 mph	0.00K	0.00K	

Date	Location	Wind Speed		Property Damage	Crop Damage	Deaths
7/30/2012	HESPERIA	52 kts. EG	60 mph	25.00K	0.00K	
7/30/2012	HESPERIA	53 kts. EG	61 mph	25.00K	0.00K	
7/30/2012	WHITE CLOUD	52 kts. EG	60 mph	50.00K	0.00K	
7/31/2012	NEWAYGO	52 kts. EG	60 mph	0.00K	0.00K	2
4/12/2014	GRANT	74 kts. EG	85 mph	200.00K	0.00K	
6/25/2014	BISHOP	52 kts. EG	60 mph	10.00K	0.00K	
5/26/2015	NEWAYGO	52 kts. EG	60 mph	10.00K	0.00K	
7/13/2015	WOODVILLE	52 kts. EG	60 mph	50.00K	0.00K	
6/10/2016	FREMONT	52 kts. EG	60 mph	2.00K	0.00K	
7/1/2018	VOLNEY	52 kts. EG	60 mph	10.00K	0.00K	
8/28/2018	BROHMAN	65 kts. EG	74 mph	50.00K	0.00K	
8/28/2018	WOODVILLE	52 kts. EG	60 mph	50.00K	0.00K	
7/20/2019	CROTON	52 kts. EG	60 mph	50.00K	0.00K	
9/11/2019	WOODVILLE	52 kts. EG	60 mph	10.00K	0.00K	
6/2/2020	AETNA	52 kts. EG	60 mph	10.00K	0.00K	
6/10/2020	CROTON	52 kts. EG	60 mph	15.00K	0.00K	
11/10/2020	GRANT	52 kts. EG	60 mph	40.00K	0.00K	
10/11/2021	OXBOW	52 kts. EG	60 mph	25.00K	0.00K	
5/11/2022	WHITE CLOUD	52 kts. EG	60 mph	10.00K	0.00K	
7/11/2022	NEWAYGO	52 kts. EG	60 mph	2.00K	0.00K	
8/3/2022	BROHMAN	52 kts. EG	60 mph	5.00K	0.00K	
8/29/2022	BIG PRIAIRIE	52 kts. EG	60 mph	25.00K	0.00K	
6/25/2023	ASHLAND CENTER	52 kts. EG	60 mph	150.00K	0.00K	
6/29/2023	WHITE CLOUD	52 kts. EG	60 mph	100.00K	0.00K	
7/20/2023	GRANT	52 kts. EG	60 mph	10.00K	0.00K	
5/20/2024	WOOSTER	52 kts. EG	60 mph	50.00K	0.00K	
6/25/2024	HESPERIA	52 kts. EG	60 mph	25.00K	0.00K	
TOTALS				3.049 M	50.00K	

Based on historical occurrence, Newaygo County experiences an estimated average of 4 or more thunderstorm events causing wind or lightning damage per year. Most severe thunderstorms within Newaygo County bring down trees, do minor damage to homes (siding, shingles, windows, etc.) and bring down power poles. However, several significant storms include:

Case: April 6, 1997

An intense early spring low pressure system moving across the Great Lakes brought gale force westerly winds to all of Lower Michigan behind a strong cold front. Winds increased to sustained speeds of 35 to 45 miles per hour out of the west shortly after a frontal passage. Frequent wind gusts of 50 to 70 miles per hour were common. Damage estimates from the storm reached $5.0 million. The winds downed trees and power lines and resulted in roof damage to area homes and businesses. Between 180,000 and 200,000 Consumers Energy customers lost power across the state Sunday evening. Nearly 70,000 customers were still without power Monday morning at 5 AM EDT.

Case: May 31, 1998

A strong line of thunderstorms moved through west and central Michigan. Michigan State Police EMD's Damage and Injury Assessment Report indicated $1,237,000 in public damage costs, 48 homes destroyed, 690 homes damaged, and 15 businesses damaged across Newaygo County. Newaygo County declared a local state of emergency and was granted a Governor's disaster declaration to activate state assistance for the county. On June 24th, President Clinton granted a Major Disaster Declaration for Newaygo County, making federal disaster assistance available. The widespread and severe damage which occurred with the fast-moving line of thunderstorms during the early morning hours of Sunday, May 31st, was caused primarily by strong straight-line winds and isolated wet microburst winds. This particular derecho, a widespread and long-lived, violent convectively induced straight-line windstorm that is associated with a fast-moving band of severe thunderstorms formed in South Dakota on the evening of Saturday, May 30th, and raced eastward at 70 mph across Minnesota, Iowa, and Wisconsin, before striking Michigan's Lower Peninsula around 4:30 am EDT Sunday morning, May 31st. The derecho event produced widespread 60 to 90 mph wind gusts, which caused extensive tree and structural damage and left over 861,000 homes and businesses without electricity across Michigan's Lower Peninsula. Consumers Energy reported the derecho event was the most destructive weather event in its history, leaving over 600,000 of its customers without power

Case: April 11, 2001

Severe thunderstorms produced extensive damage across Newaygo County including roof damage from blown off shingles on a home 5 miles north of White Cloud at 11:57 p.m. It was reported to the National Weather Service of numerous trees were blown down along M-37 between Newaygo and White Cloud. Minor roof damage to a house occurred 3 miles northeast of Fremont. In White Cloud, 8 trees were blown down, each of which was 2 feet in diameter. Overall, the storm cause $100,000 of property damage in Newaygo County.

Case: March 9, 2002

A very strong area of low pressure produced numerous reports of wind gusts over 60 m.p.h. across southern lower Michigan, with sustained winds of 30 to 40 m.p.h. High wind damage across the area ranged from downed trees and power lines to property damage. The storm caused $485,000 of property damage across 19 counties including Newaygo County.

Case: October 30, 2004

A high wind event caused scattered downed trees and power lines due to gusty winds of around 58 to 60 m.p.h. The wind knocked out power to about 100,000 people statewide. Overall, the high winds caused $1.2 M in property damage across 23 counties including Newaygo County.

Case: July 17, 2006

A Severe Thunderstorm with 60 mph winds knocked down numerous power lines and trees causing $110,000 in property damage and $10,000 in crop damage.

Case: October 4, 2006
A slow moving low pressure system and its attendant cold front brought an early October severe thunderstorms episode with numerous reports of large hail and high winds of 52 mph causing $30,000 in property damage and $10,000 in crop damage.

Case: June 8, 2008
Trained spotters reported that estimated wind gusts to 70 mph blew down many trees around the intersection of Peach and 120th.NWS storm survey teams determined that one EF1 tornado struck Osceola County. Another EF1 tornado struck Eaton County and continued into extreme western Ingham County before dissipating. Extensive damage was documented in association with both tornadoes. Severe thunderstorms also produced numerous reports of wind damage and large hail.

Case: July 11, 2011
Two separate bow echoes moved across western lower Michigan during the morning hours of July 11, producing numerous reports of wind damage. The first bow echo moved onshore north of Muskegon shortly after daybreak. The second bow echo proved to be more destructive as it raced east from northern Illinois across far southern Lake Michigan and southern lower Michigan, resulting in numerous reports of downed trees and power lines. One person lost his life in Cutlerville when a tree fell in the garage he was in. Several trees and power lines were blown down in Grant, Croton and east of White Cloud. There was a 40 mile path of intermittent downburst win damage. Winds were estimated to be from 40-70 mph.

Case: July 30, 2012
Severe thunderstorms produced several reports of damaging wing gusts across portions of Newaygo County. Large trees fell on a home. Other large trees were also blown over. Two deaths were reported with this storm.





Case: November 17, 2013
Severe thunderstorms developed in the afternoon with a cold front following the line of storms. The storm winds blew down trees and produced multiple brief EF-0 tornados along more than a 50 mile path from Muskegon County northeast through Newaygo County into Mecosta County.

This event caused numerous power outages and straight line wind damage. Most of the damage was to trees with some damage to buildings and fences amounting to around $50,000 in damage in Newaygo County.

Case: April 12, 2014

Severe thunderstorms with damaging wind gusts developed near a warm front during the mid-afternoon hours of April 12th and continued through the late afternoon and evening hours. There were numerous reports of straight line wind damage with wind gusts of up to 75 to 85 mph. Hail as large as the size of quarters was also reported. Roofs were blown off multiple structures and campers were blown over. Hundreds of trees were blown down across southern and northern Newaygo County. This storm caused damage to hundreds of homes in Ashland, Grant, Ensley, Lilley, Home, and Barton Townships.



Case: March 8, 2017 – Southern Lower Peninsula

Widespread wind peaked at 60 to 70 mph across the southern Lower Peninsula, without being a part of thunderstorm systems. These strong winds alone caused electric power failures that affected as many as 1 million Michigan residents. Numerous trees and tree limbs had fallen across power lines, and damaged homes and buildings. Two persons in Clare County were killed by a tree falling onto their vehicle while driving on M-115 near the Osceola county line in Freeman Township. Total damages amounted to about $525 million across the following counties: Allegan ($12M), Baraga ($60K), Barry ($10M), Bay ($7M), Calhoun ($10M), Clare ($5M), Clinton ($10M), Eaton ($10M), Genesee ($25M), Gratiot ($10M), Huron ($7M), Ingham ($10M), Ionia ($10M), Iron ($40K), Isabella ($10M), Jackson ($10M), Kalamazoo ($13M), Kent ($15M), Lake ($5M), Lapeer ($10M), Lenawee ($15M), Livingston ($25M), Macomb ($30M), Mason ($5M), Mecosta ($10M), Midland ($7M), Monroe ($15M), Montcalm ($10M), Muskegon ($15M), Newaygo ($10M), Oakland ($35M), Oceana ($10M), Osceola ($5M), Ottawa ($15M), Saginaw ($23M), Sanilac ($7M), Shiawassee ($7M), St. Clair ($25M), Tuscola ($7M), Van Buren ($10M), Washtenaw ($25M), and Wayne ($25M).

Case: August 28, 2018 – Newaygo County

A line of severe thunderstorms impacted lower Michigan during the evening hours of August 28th, 2018. Strong winds of 50 to 60 mph were common along the line with pockets of intense

damaging winds of 75 to 90 mph. There were also two tornadoes embedded within the strongest winds near Baldwin and Idlewild. The most extensive damage was along US-10 from Ludington to Reed City, with separate areas of intense damage near Big Rapids and Le Roy. Numerous trees were blown down across portions of Newaygo County.

Case: July 20, 2019 – Newaygo, Lake, Mason County
A round of severe storms resulted in numerous reports of downed trees and power lines. Peak wind gusts were estimated at up to around 70 to 80 mph. In addition 6 to 10 inches of rain fell across much of Mason and Lake Counties. There were several road washouts, a few culvert failures, and a couple of bridge washouts. At least 48 homes were damaged by water in Lake County. Trees were blown down county wide and Croton in Newaygo County was especially hard hit.

Case: June 25, 2023 – Newaygo County
A line of severe storms resulted in numerous reports of down trees and power lines across the County. Winds were estimated at 60 mph. The area within the County most impacted was Ensley Township and Ashland Center.



Tornado Hazards

Tornadoes in Michigan are most frequent in the spring and early summer when warm, moist air from the Gulf of Mexico collides with cold air from the polar regions to generate severe thunderstorms. These thunderstorms often produce the violently rotating columns of wind known as funnel clouds. Michigan lies at the northeastern edge of the nation's primary tornado belt, which extends from Texas and Oklahoma through Missouri, Illinois, Indiana, and Ohio. Most of a tornado's destructive force is exerted by the powerful winds that knock down walls and lift roofs from buildings in the storm's path. The violently rotating winds then carry debris aloft that can be blown through the air as dangerous missiles.

A tornado may have winds up to 200+ miles per hour and an interior air pressure that is 10-20% below that of the surrounding atmosphere. The typical length of a tornado path is approximately 16 miles, but tracks much longer than that – even up to 200 miles – have been reported. Tornado path widths are generally less than one-quarter mile wide. Typically, tornadoes last only a few minutes on the ground, but those few minutes can result in tremendous damage and devastation. Historically, tornadoes have resulted in tremendous loss of life, with the mean national annual death toll being 87 persons. Property damage from tornadoes is in the hundreds of millions of dollars every year.

Although tornadoes are most commonly reported between 3pm and 9pm, they can occur at any time. Although they generally exist at the trailing edge of a thunderstorm, it is possible for them to be present in other locations and less readily recognized weather patterns.

Tornado intensity is measured on the Enhanced Fujita Scale, which examines the damage caused by a tornado on homes, commercial buildings, and other man-made structures. The Enhanced Fujita Scale rates the intensity of a tornado based on damaged caused, not by its size. It is important to remember that the size of a tornado is not necessarily an indication of its intensity. Large tornadoes can be weak, and small tornadoes can be extremely strong, and vice versa. It is very difficult to judge the intensity and power of a tornado while it is occurring. Generally, that can only be done after the tornado has passed, using the Enhanced Fujita Scale as the measuring stick. The Enhanced Fujita Scale is presented in the table below.

The Enhanced Fujita Scale of Tornado Intensity

EF-Scale Number	Intensity Descriptor	Wind Speed (mph)	Type/Intensity of Damage
EF0	Gale tornado	65-85	Light damage. Some damage to chimneys; breaks branches off trees; pushes over shallow-rooted trees; damages sign boards.
EF1	Weak tornado	86-110	Moderate damage. The lower limit is the beginning of hurricane wind speed; peels surface off roofs; mobile homes pushed off foundations or overturned; moving autos pushed off the roads; attached garages may be destroyed.
EF2	Strong tornado	111-135	Considerable damage. Roofs torn off frame houses; mobile homes demolished; boxcars pushed over; large trees snapped or uprooted; light object missiles generated.
EF3	Severe tornado	136-165	Severe damage. Roof and some walls torn off well-constructed houses; trains overturned; most trees in forest uprooted; heavy cars lifted off ground and thrown.
EF4	Devastating tornado	166-200	Devastating damage. Well-constructed houses leveled; structures with weak foundations blown off some distance; cars thrown and large missiles generated.
EF5	Incredible tornado	Over 200	Incredible damage. Strong frame houses lifted off foundations and carried considerable distances to disintegrate; automobile-sized missiles fly through the air in excess of 100 meters; trees debarked; steel reinforced concrete structures badly damaged; incredible phenomena will occur.

NOTE: When describing tornadoes, meteorologists often classify the storms as follows:
EF0 and EF1 = weak tornado; EF2 and EF3 = strong tornado; EF4 and EF5 = violent tornado
(Source: The Tornado Project; National Climatic Data Center)

Michigan's tornado records since 1950 show approximately 67% of all Michigan tornadoes classified as weak, with 29% strong and 4% violent. About 95% of tornado-related deaths occur in the months of April, May, and June (June represents 54% of all deaths)

Tornado Related Deaths in Michigan, by Month 1950 –2022

Jan	Feb	Mar	April	May	June	July	Aug	Sept	Oct	Nov	Dec	Total
0	0	3	77	25	132	3	1	1	0	1	0	246

Source: National Climatic Data Center

The following are brief synopses significant tornados in Michigan:

Case: June 8, 1953 – Flint (Genesee County)
The June 8, 1953 Flint tornado, Michigan's worst storm to date (and classified as F5), is ranked 10th on the top ten list of single killer tornadoes that have occurred in the United States. It was also the last single tornado, until the May 2011 Joplin, MO EF5 tornado, to cause over 100 deaths in the U.S. The storm began its destructive path approximately two miles north of

Flushing, moved east-northeast and devastated the north part of Flint before ending two miles north of Lapeer. The tornado obliterated homes on both sides of Coldwater Road for about one mile. It was there that most of the deaths occurred and the damage swath was over one-half mile wide. There were multiple deaths in at least 20 families. The final death toll stood at 115 in Flint alone, along with 785 injuries and total damage estimated at $19 million. Several tornadoes touched down in other locations in Michigan on that day as well, resulting in an additional six deaths and 129 injuries statewide.

Case: April 11, 1965 - Southern and Central Michigan

The April 11, 1965 Palm Sunday tornado outbreak, which affected many other states in the Midwest, had a particularly devastating impact on Michigan. As the following table indicates, a total of 23 tornadoes touched down in 14 southern and central Michigan counties, resulting in 53 fatalities, 798 injuries, and $51 million in damage to public and private property. Many of the tornadoes were rated F3 and F4 in intensity (strong and violent tornadoes), which undoubtedly contributed to the high death and injury tolls. Across the Midwest, this storm system spawned over 50 tornadoes that collectively killed 256 people and caused an estimated $200 million in property damage. In addition to Michigan, the other states that were affected by the storms included Indiana, Illinois, Ohio and Wisconsin.

April 11, 1965 (Palm Sunday) Tornado Outbreak: Michigan Impacts

County	Number of Tornadoes	Deaths	Injuries	Tornado Intensity
Allegan	1	1	9	F1
Barry	2	0	5	F1 and F3
Bay	1	0	2	F2
Branch	2	18	400	F3 and F4
Clinton	1	1	8	F4
Gratiot	4	0	1	all F2
Hillsdale	2	6	94	F3 and F4
Kalamazoo	1	0	17	F3
Kent	2	5	142	both F4
Lenawee	2	9	83	F3 and F4
Monroe	3	13	39	F3 and F4
Montcalm	1	0	0	F2
Ottawa	1	0	0	F4
Shiawassee	1	0	0	F4
Tuscola	1	0	0	F2
STATEWIDE TOTALS:	**25**	**53**	**800**	

Source: The Tornado Project / NCEI Storm Events Online Database

Case: July 13-15, 1995 – Statewide

From July 13-15, 1995 severe thunderstorms damaged numerous areas of Michigan. These storms, which produced winds up to 100 miles per hour with damaging golf ball-sized hail and severe lightning, damaged hundreds of structures and downed thousands of trees and power lines statewide. Damage was widespread, but the impacts were not severe or extensive enough in any one location to require supplemental disaster assistance. The strong winds produced widespread power outages. More than 400,000 electrical customers in southeast Michigan lost power due to the storms. In Roscommon County, over 100,000 trees were toppled by the winds. Wind gusts in that area were estimated in the 85-100 miles per hour range. One person was killed when her pontoon boat flipped over while attempting to return to its dock. One person was killed in Huron County when a barn collapsed between Bad Axe and Harbor Beach.

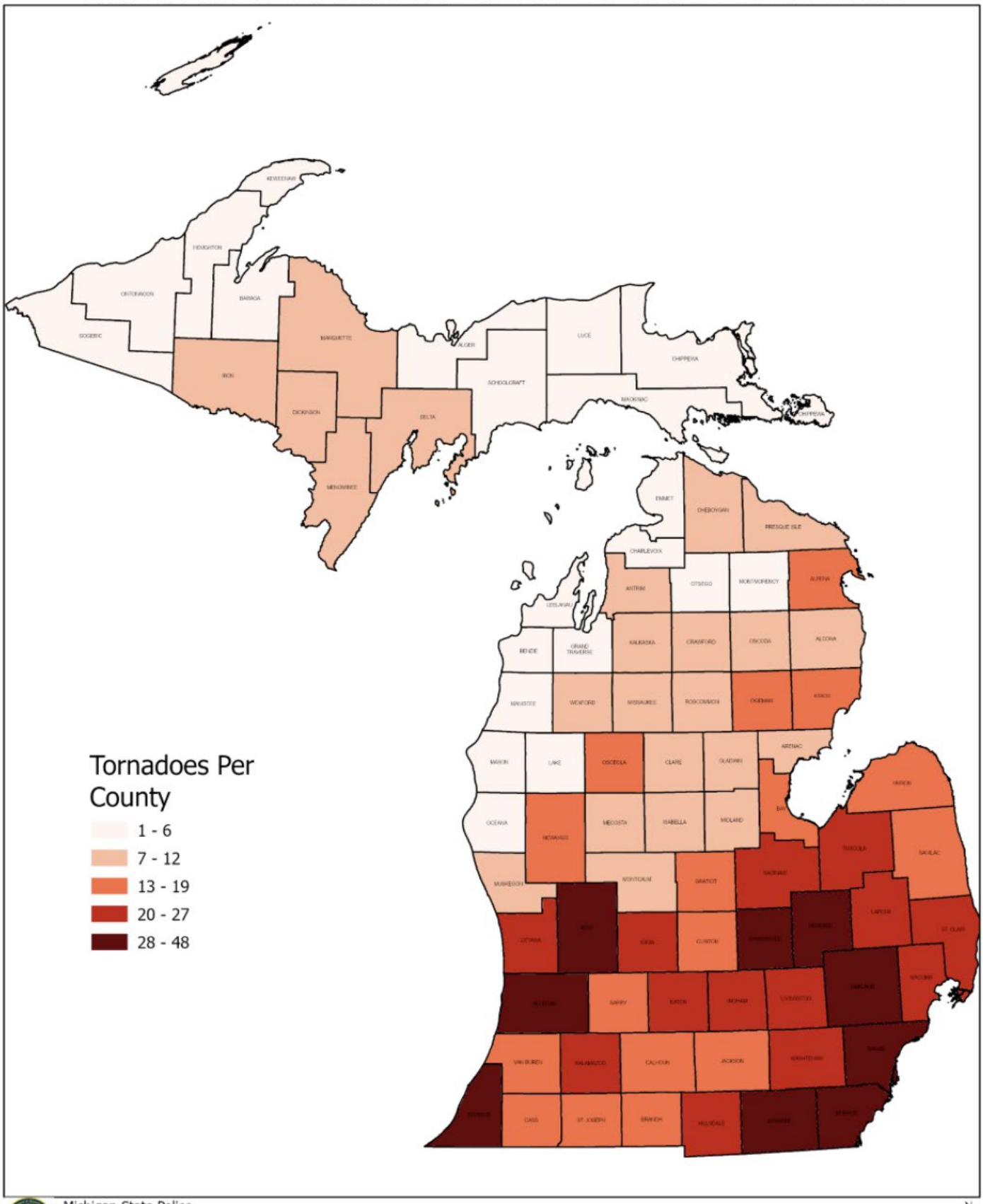
Case: May 31, 1998 – Southern Lower Peninsula

On May 31, 1998 a derecho raced across the Lower Peninsula around 4:30am, producing widespread 60 to 90 mph wind gusts that caused extensive tree and structural damage and left over 861,000 homes and businesses without electricity. Consumers Energy reported the derecho as the most destructive weather event in its history, leaving over 600,000 of its customers without power. There were four storm-related fatalities and 146 injuries (mostly minor) reported in the state. Statewide, approximately 250 homes and 34 businesses were destroyed and 12,250 homes and 829 businesses were damaged. Damage estimates totaled over $166 million. The highest wind gusts reached 120 to 130 mph in Spring Lake (Ottawa County) and Walker (Kent County), 100 mph in portions of Montcalm County (including Cody Lake and Stanton), and 90 mph in Rockford (Kent County) and Zeeland (Ottawa County). It took up to 10 days to fully restore power to certain areas, including the City of Walker and portions of Montcalm and Gratiot Counties. A Presidential Disaster Declaration was declared for 13 counties.

Case: July 13-14, 2015 – Kent and Newaygo County

Severe thunderstorms developed during the late evening hours of July 13th and continued into the early morning hours of July 14th, resulting in several reports of wind damage including downed trees and power lines. A NWS storm survey concluded that an EF-0 tornado touched down about a third of a mile southwest of 84th street and Morse Lake Road in Alto. The tornado had a maximum path width of 50 yards and was on the ground for about 2 minutes. Peak wind speeds were estimated at 75 to 85 mph. It caused roof damage to one home and snapped and uprooted several trees. The Newaygo county road commission reported that around 50 large trees were blown down across mainly the northern half of Newaygo County. There were no injuries.

MICHIGAN TORNADOES BY COUNTY: 1951-2022



Tornado Hazards in Newaygo County

Since 1950, Newaygo County has experienced 14 tornadoes causing 3 injuries and 2 deaths, $190,000 property damage, and $10,000 crop damage from tornadoes since 1950. Two significant tornados in Newaygo County include a F2 Tornado that struck Newaygo on September 26, 1951 at 2100, injuring three and killing one. On June 17, 1975 another F2 Tornado struck the County killing one person.

Other Newaygo County Tornado Events include:
F1 on 4/28/1964 at 1415 causing $25,000 of property damage
F1 on 8/10/1971 at 1410 causing $3,000 of property damage
F1 on 4/12/1979 at 1820 causing $25,000 of property damage
F1 on 5/25/1989 at 0043 causing $25,000 of property damage
F1 on 6/2/1990 at 1759 causing $25,000 of property damage
F1 pm 9/14/1990 at 0805 causing $25,000 of property damage
F0 on 3/27/1991 at 1702 causing no property damage
F0 on 7/1/1999 at 1300 causing $10,000 of property damage
F0 on 8/1/2002 at 2105 causing $2,000 of property damage in Grant
F0 on 6/29/2005 at 1620 causing $10,000 of crop damage
EF0 on 11/17/2013 at 1500 causing $50,000 of property damage
EF0 on 03/30/2025 at 1804 causing $25,000 of property damage

Case: November 17, 2013

A severe thunderstorm produced multiple brief EF-0 tornadoes along a more than 50 mile path from Muskegon county northeast through Newaygo county into Mecosta county. The tornadoes were on the ground for very short periods of time. Mostly tree damage was incurred but there was also damage to several buildings and fences.

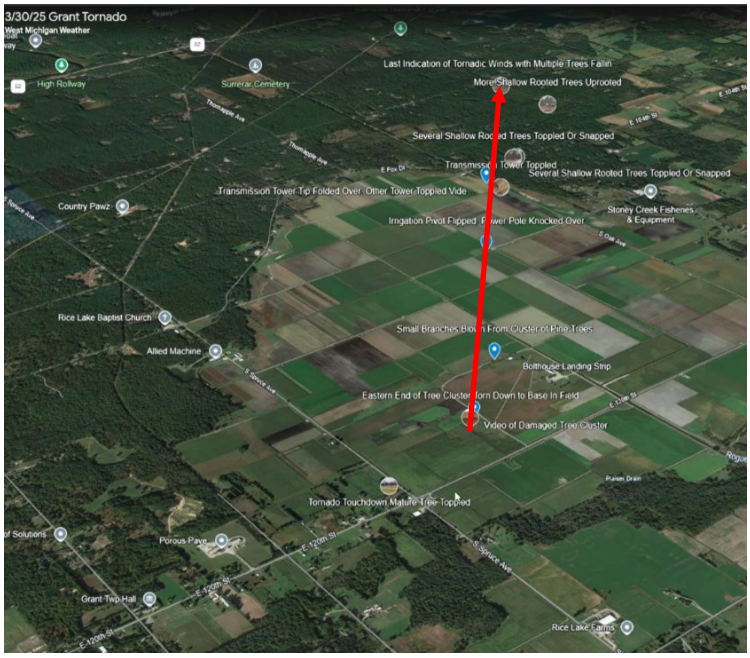


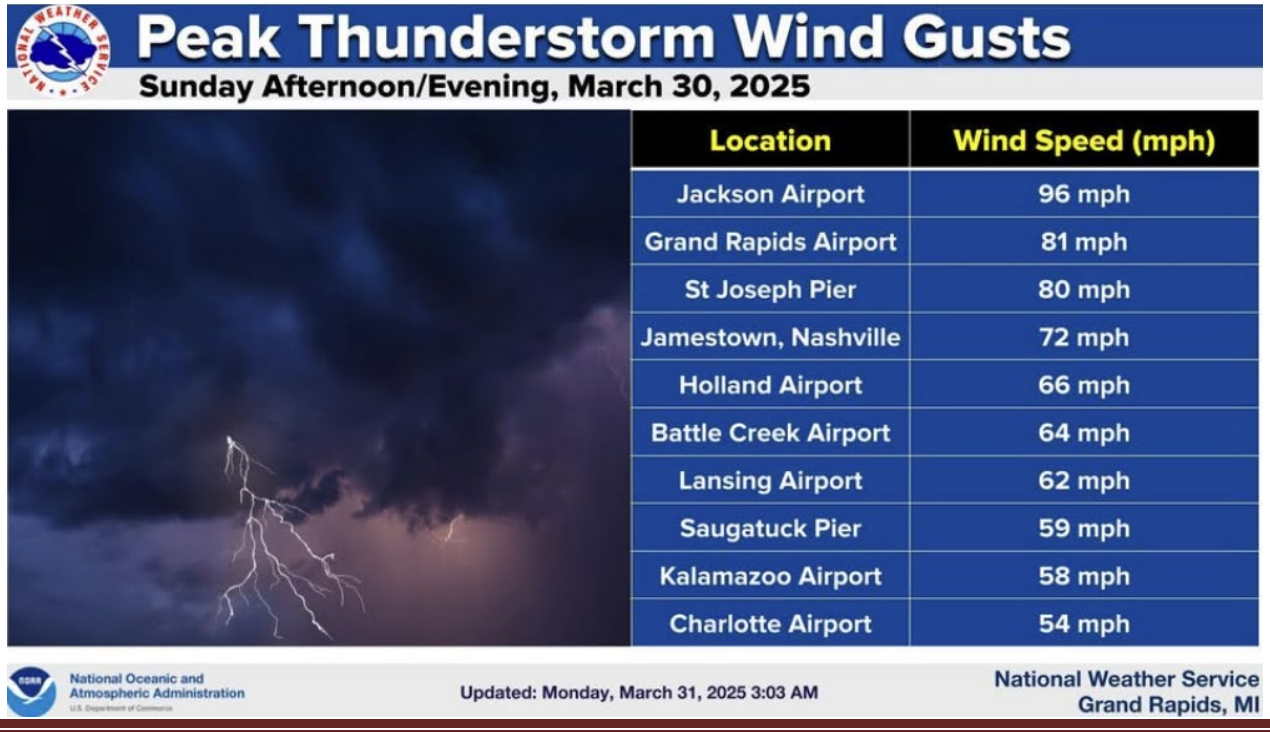



Case: March 30, 2025 EF-0 Tornado, Grant

A Severe Thunderstorm capable of producing both tornadoes and extensive straight line wind damage was located along a line extending from 5 miles southeast of Grant to near Rockford, moving northeast at 55 mph. This storm caused an EF-0 Tornado in Grant, moving through mostly open fields but did damage some trees and impacted two utility transmission towers along Oak Ave. The Tornado touched down around 6:05 pm north of E 120th Street near Poplar Ave. Its estimated max winds were 62 mph with a path length around 2.8 miles and path width around 50 yards. The tornado lifted around 6:09 pm north or E 104th Street near S Tall Oak Trail.







Warning Systems:

The most limited capability with severe thunderstorms and high winds is local warning systems. Warning systems in Newaygo County are currently very limited in their ability to alert the major populace to an emergency of widespread potential. Outdoor warning sirens are designed to warn the public of a specific hazard such as tornado. They are only designed for outdoor notification and cover a 1-2 mile radius around the siren. In Newaygo County there are eight Tornado Sirens.

NEWAYGO TORNADO SIREN LOCATIONS

Location	Address	Activation	Population
Fremont DPW	805 Oak Street, Fremont	Tornado Only	4,224
Newaygo (North)	40 Centerline Road, Newaygo	Tornado Only	1,670
Newaygo (South)	355 Clay Street, Newaygo	Tornado Only	
Grant Fire Department	62 W State Street, Grant	Fire and Tornado	**881**
Croton Township	6464 S Croton-Hardy Drive, Newaygo	Fire and Tornado	1,200
Big Prairie Fire Department	2815 S Elm Street	Fire and Tornado	600
Lilley Fire Department	10730 N Prospect, Bitely	Fire and Tornado	400
Hesperia Village Hall	33 E Michigan Street, Hesperia	Tornado Only	954

Additional systems implemented to augment warning consisting of strategically placed tone alert monitors and Nixle Alert and Notification System, similarly are of limited effectiveness. As such, the primary mass population warning system remains the media outlets of television and radio media coverage which covers a large percentage of the population, however, is limited due to requiring the target audience's to be already monitoring those channels. Adding to their limitation, these systems are reliant on fully functioning local infrastructure such as communications systems, electrical power, and telephone service.

Community Vulnerability:

Large sections of land can be flattened by tornadoes with neighborhoods reduced to piles of debris. Damage may be sporadic in an area, with completely destroyed structures next to those left relatively unscathed. Communities may see many residents without homes, areas with no electricity or natural gas, burst pipes, and long clean-up and recovery times. People may have to permanently relocate. While smaller structures, mobile homes, and automobiles are particularly vulnerable, hospitals, fire stations, schools, and virtually any building run the risk of being substantially damaged or destroyed. Roadways, airports, and other transportation modalities may be affected. Waterspouts may impact lake and shoreline areas. Fatalities or injuries are likely to occur depending on the strength and location of the tornado, how long it stays on the ground and other factors.

The combination of high population concentrations, limited warning, and temporary/unfamiliar facilities results in increased vulnerability from thunderstorm hazards to the high number of people who attend any one of Newaygo County's popular special seasonal events. It is impractical to list and detail all of

Newaygo County's facilities and resources that could significantly limit local response should they become a casualty of a severe thunderstorm effect. However, it is important to note that many of the vulnerabilities identified in other hazard sections are equally vulnerable to the effects of severe thunderstorm hazards due to its unpredictability, limited mitigation potential, and large magnitude. Three primary areas of vulnerability for Severe Thunderstorms within Newaygo County are:

1. Local Special Events
2. Campgrounds
3. Mobile Home Communities

Local Special Events within Newaygo County vulnerable for Severe Thunderstorms

City of Fremont	Month	Approximate Date	Daily Event Population
Fremont Area Home and Garden Show	March	Third weekend	750
Family Health and Safety Expo	May	Third weekend	1,000
National Baby Food Festival	July	Third week, Wednesday - Saturday	7,400
Newaygo County Agricultural Fair	August	First full week, Saturday - Saturday	5,500
Fremont Harvest Festival	October	First weekend, Saturday - Sunday	5,600
Fremont Farmers Market	June – September	Saturdays and Tuesdays	
City of Newaygo	**Month**	**Approximate Date**	
Memorial Day Festival	May	Memorial Day Weekend	5,300
Newaygo County Kids Day	June	Father's Day Weekend, Saturday	914
Newaygo Farm Market	July – October	Brooks Park	315
Logging Festival	September	Labor Day Weekend	2,600
Holiday Festival and Christmas Walk	December	First Weekend, Friday - Sunday	5,700
City White Cloud	**Month**	**Approximate Date**	
Kids Free Fishing Day	June	First Saturday	1,500
White Cloud Sky Fest	June	Father's Day	1,600
City of Grant	**Month**	**Approximate Date**	
Grant Festival	August	Third weekend, Friday - Saturday	4,400
Village of Hesperia	**Month**	**Approximate Date**	
Hesperia Family Fun Festival	July	July 4th Holiday, 4 days	16,600
Big Prairie and Croton Township	**Month**	**Approximate Date**	
Dam to Dam Ice Fishing Contest	February	DNR Free Fishing Weekend (3rd Saturday)	380
Croton Dam Freedom Festival	July	July 4th Holiday, 4 days	4,600
Hot Boat Weekend	September	First weekend after Labor Day	4,100
Lilley Township			
Bitely Homecoming Celebration	July	Third full weekend (Saturday – Sunday)	5,300
ROTATING EVENTS	Month	Approximate Date	
Gus Macker 3 on 3 Basketball Tournament	July	Third full weekend (Saturday – Sunday)	5,800

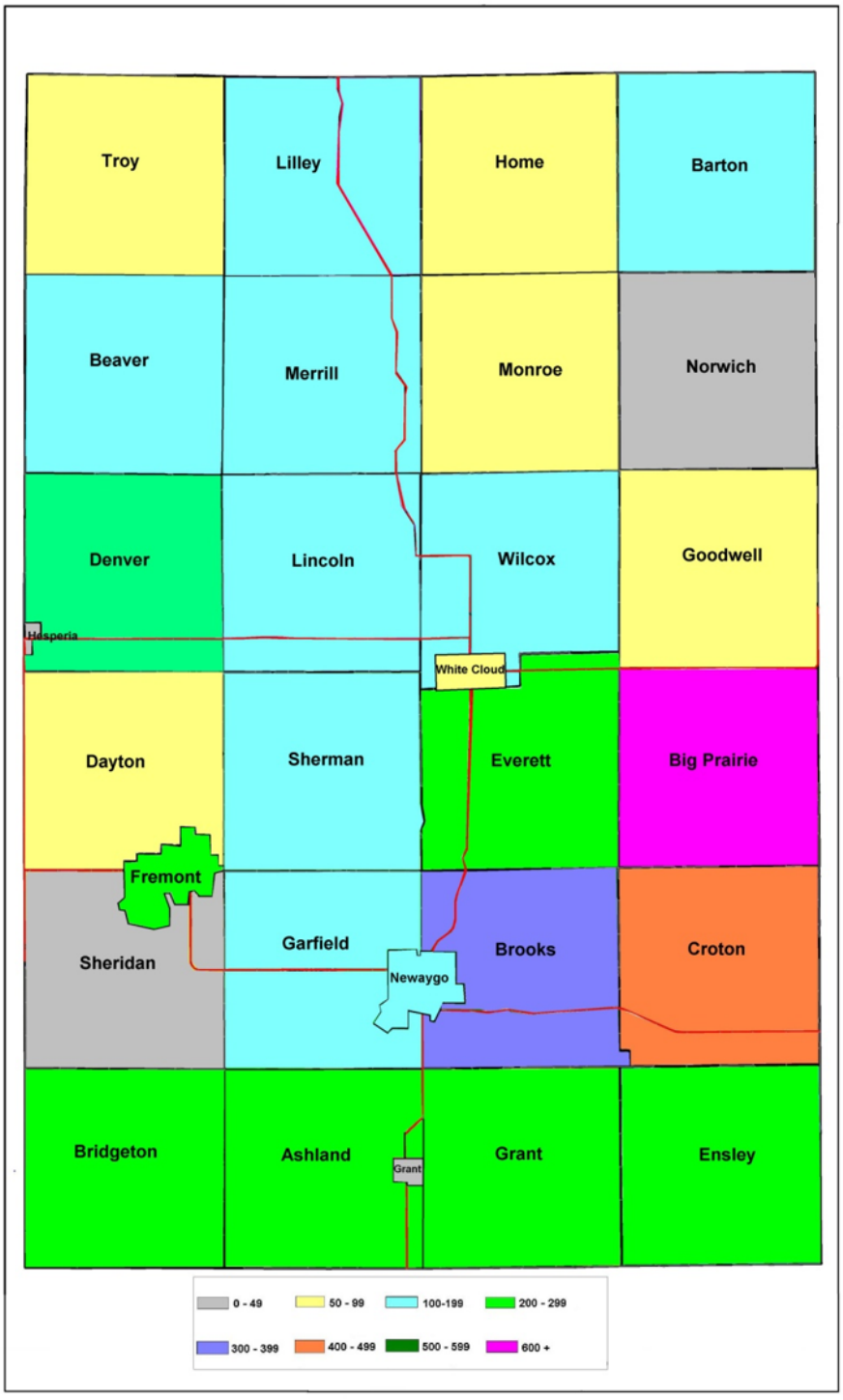
Campgrounds within Newaygo County

Name of Establishment	Address	City, State, Zip	Number of Sites
Adventure Bound Camping - Woods and Water	4495 South Spruce	White Cloud, MI 49349	375
Benton Lake Campground (NFS)	5308 Forest Road	Brohman, MI 49312	25
Big Bend Park	2000 Beech Avenue	White Cloud, MI 49349	230
Brooks Lake M.H. Club (Private)	2263 Spruell	Newaygo, MI 49337	15
Brush Lake Campground (NFS)	6 Mile (Forest Rd 5534)	White Cloud, MI 49349	7
Chapel of the Three Crosses	879 E Yoder Lane	White Cloud, MI 49349	15
Chinook Campground	5471 W 112th Street	Grant, MI 49327	168
Cindy Lou's Hide A Way	6245 N Comstock Road	Hesperia, MI 49421	22
Consumers Power Employee Hardy Dam Club (Private)	8000 16th Street	White Cloud, MI 49349	45
Croton Dam Float Trips	5355 Croton Drive	Newaygo, MI 49337	24
Croton Township Campground	7683 Croton Hardy Drive	Newaygo, MI 49337	160
Dan Raymond Park (Private)	6971 W 112th Street	Grant, MI 49327	8
Diamond Lake (aka Camp Swampy)	3351 N Mundy Road	White Cloud, MI 49349	100
Ed Henning County Park	500 Croton Drive	Newaygo, MI 49337	84
Fremont Lake Park	933 Cottage Grove	Fremont, MI 49412	94
Happy Campers Campground	5380 Croton Drive	Newaygo, MI 49337	25
Heights Hide A Way	4424 Parson Road	Fremont, MI 49412	13
Hess Lake Mobile Home	825 E 88th Street	Newaygo, MI 49337	34
Highbank Lake Campground (NFS)	Roosevelt Drive / 15 Mile	Bitely, MI 49309	9
Hungerford Lake Campground (NFS)	Forest Rt 5134	Big Rapids, MI 49307	48
Hungerford Hills Farms	7616 Hungerford Lake	Big Rapids, MI 49307	50
K and K Camping LLC (Private)	7701 Whitneyville Rd	White Cloud, MI 49349	13
Indian Lake Campground (NFS)	Nagek Drive	Brohman, MI 49312	6
Leisure Time RV Park	4799 South Spruce	White Cloud, MI 49349	94
Little Switzerland Resort	254 Pickeral Lake Drive	Newaygo, MI 49337	80
Lonesome Lake Campground	318 W 18 Mile Road	Bitely, MI 49309	50
Minnie Pond Campground (NFS)	9570 Forest Road	Hesperia, MI 49421	11
Mystery Creek Campground	9570 S Wisner Avenue	Newaygo, MI 49337	85
Newaygo State Park	2793 Beech Street	Newaygo, MI 49337	99
Nichols Lake Park South (NFS)	Forest Route 5140	Brohman, MI 49312	29
Oxbow Park	2973 Cottonwood	Newaygo, MI 49337	197
Pettibone Lake Park (NFS)	490 W Pettibone Drive	Bitely, MI 49309	16
Pickeral Lake Campground	12666 N Woodbridge	Bitely, MI 49309	46
Pint Pleasant Nesters (Private)	4424 Parson Road	Fremont, MI 49412	13
Salmon Run Campground	8845 Felch Avenue	Grant, MI 49327	94
Sandy Beach Campground	6926 30th Avenue	White Cloud, MI 49349	220
Shelley Lake Campground (NFS)	5450 Forest Road	Brohman, MI 49312	8
Shi Lo Cum- VHF (Private)	2940 N Felch Avenue	White Cloud, MI 49349	35
Sportsman Park Campground	2500 Sportsman Drive	White Cloud, MI 49349	86
Timbers Edge Campground	4345 North Warner	Hesperia, MI 49421	50
Twinwood Lake Campground (NFS)	5488 Forest Rd	White Cloud, MI 49349	5
Walkup Lake Campground (NFS)	Cleveland Drive	Bitely, MI 49309	127
White Cloud City Campground	680 Wilcox	White Cloud, MI 49349	99
		TOTAL	1,995

Newaygo County has a high volume of wind vulnerable structures such as manufactured homes, trailers, and poorly constructed homes, they are spread over a significant distance due to the jurisdiction's rural nature.

NEWAYGO COUNTY **MOBILE HOMES DISTRIBUTION**		
COMMUNITY	**# Mobile Homes**	**% Mobile Homes**
Newaygo County *	4,692	100%
City of Fremont	187	3.98%
City of Newaygo	162	3.45%
City of White Cloud	37	0.79%
City of Grant	58	1.23%
Village of Hesperia	7	
Ashland Township	113	2.40%
Barton Township	90	1.92%
Beaver Township	79	1.68%
Big Prairie Township	744	15.83%
Bridgeton Township	339	7.21%
Brooks Township	382	8.13%
Croton Township	387	8.24%
Dayton Township	50	1.06%
Denver Township	343	7.30%
Ensley Township	185	3.94%
Everett Township	178	3.79%
Garfield Township	90	1.92%
Goodwell Township	39	0.83%
Grant Township	225	4.79%
Home Township	43	0.92%
Lilley Township	122	2.60%
Lincoln Township	173	3.68%
Merrill Township	200	4.26%
Monroe Township	56	1.19%
Norwich Township	32	0.68%
Sheridan Township	32	0.68%
Sherman Township	76	1.62%
Troy Township	50	1.06%
Wilcox Township	220	4.68%
* total of cities and townships; village total already included with township totals		*source: U.S. Census Bureau*

Newaygo County
Mobile Homes Distribution Map



SEVERE WINTER WEATHER

Severe Winter Weather

A storm that generates sufficient quantities of snow, ice, or sleet to result in hazardous conditions and/or property damage. These storms are often accompanied by high winds, cold temperatures, and low visibility. Severe winter weather hazards include snowstorms, blizzards, and extreme cold, ice, and sleet storms.

Severe Winter Weather Hazard Description

While the danger from winter weather varies across the country, nearly all Americans, regardless of where they live, are likely to face some type of severe winter weather at some point in their lives. Winter storms can range from a moderate snow over a few hours to a blizzard with blinding, wind-driven snow that lasts for several days. Many winter storms are accompanied by dangerously low temperatures and sometimes by strong winds, icing, sleet and freezing rain.

Heavy snows can shut down towns and cities for a period of a few days if snow is persistent and cannot be cleared in a timely fashion. Roof failures may occur as the weight and volume of snow cause damage to homes and buildings. Urban areas are especially susceptible to outages and problems with snow removal, while rural areas may have inaccessible roads for some time but have residents that are more prepared to handle power outages and temporary isolation. Motorists and passengers in cars can be stranded in rural areas and die of exposure because of inadequate preparation for conditions. One of the primary concerns is the winter weather's ability to knock out heat, power and communications services to your home or office, sometimes for days at a time. Heavy snowfall and extreme cold can immobilize an entire region.

The following are specific severe winter weather hazards:

Snowstorms and Blizzards:

Snowstorms are defined as a period of rapid accumulation of snow often accompanied by high winds, cold temperatures, and low visibility. Blizzards are the most dramatic and perilous of all snowstorms, characterized by low temperatures and strong winds bearing enormous amounts of snow. Most of the snow accompanying a blizzard is in the form of fine, powdery particles of snow which are wind-blown in such great quantities that, at times, visibility is reduced to only a few feet. Blizzards have the potential to result in property damage and loss of life. Just the cost of clearing the snow can be enormous. As a result of being surrounded by the Great Lakes, Michigan experiences large differences in snowfall in relatively short distances. The average annual snowfall accumulation in different areas ranges from 30 to 200 inches of snow. The highest accumulations are in the northern and western parts of the Upper Peninsula. Since winter storms tend to move from west to east, the western parts of the state usually have greater amounts of snow than the eastern parts.

Ice and Sleet Storms:
An ice storm is a storm that generates sufficient quantities of ice or sleet to result in hazardous conditions and/or property damage. Ice storms are sometimes incorrectly referred to as sleet storms. Sleet is small frozen rain drops (ice pellets) that bounce when hitting the ground or other objects. Sleet does not stick to trees and wires, but sleet in sufficient depth does cause hazardous driving conditions. Ice storms are the result of cold rain that freezes on contact with a surface, coating the ground, trees, buildings, overhead wires and other exposed objects with ice, sometimes causing extensive damage. When electric lines are downed, power may be out for several days, resulting in significant economic losses and the disruption of essential services in affected communities. Often times, ice storms are accompanied by snowfall, in which the ice is camouflaged and covered up by snow, creating treacherous transportation conditions. Both storms occur when the temperature is close to 32°F but are far more severe when the temperature is in the 20s.

Extreme Cold
Prolonged periods of very low temperatures, often accompanied by other extreme meteorological conditions such as high winds, etc. Extreme temperatures - whether it be extreme heat or extreme cold - share a commonality in that they both primarily affect the most vulnerable segments of society such as the elderly, children, impoverished individuals, and people in poor health. The major threats of extreme cold are hypothermia (also a major medical emergency) and frostbite. Michigan is subject to both temperature extremes.

National Weather Service Hazard Warning Descriptions
Winter storms can happen gradually or abruptly during the Michigan winter season. Learn the terms and know what do before, during and after a winter storm emergency or disaster.

Sleet**:** Rain that turns to ice pellets before reaching the ground. Sleet also causes moisture on roads to freeze and become slippery.

Freezing Rain**:** Rain that freezes when it hits the ground, creating a coating of ice on roads, walkways, trees, and power lines. Small accumulations of ice can be a significant hazard. An inch or more of ice can paralyze a region for days to a week or more. Heavy accumulations of ice can bring down trees and topple utility poles and communication towers.

Winter Weather Advisory**:** This product is issued by the National Weather Service when a low pressure system produces a combination of winter weather (snow, freezing rain, sleet, etc.) that present a hazard, but does not meet warning criteria. Weather conditions are expected to cause significant inconveniences and may be hazardous. Caution should be used if traveling. This generally indicates in the Lower Peninsula: 4 to 5 inches are expected in a 12-hour period. In the Upper Peninsula: 4 to 7 inches of snow are anticipated in that same time period.

Winter Storm Watch**:** This product is issued by the National Weather Service when there is a potential for heavy snow or significant ice accumulations, usually at least 24 to 36 hours in advance. Conditions are favorable for severe winter weather, with the possibility of heavy sleet, heavy snow, ice storm, heavy snow and blowing snow—or a combination of events.

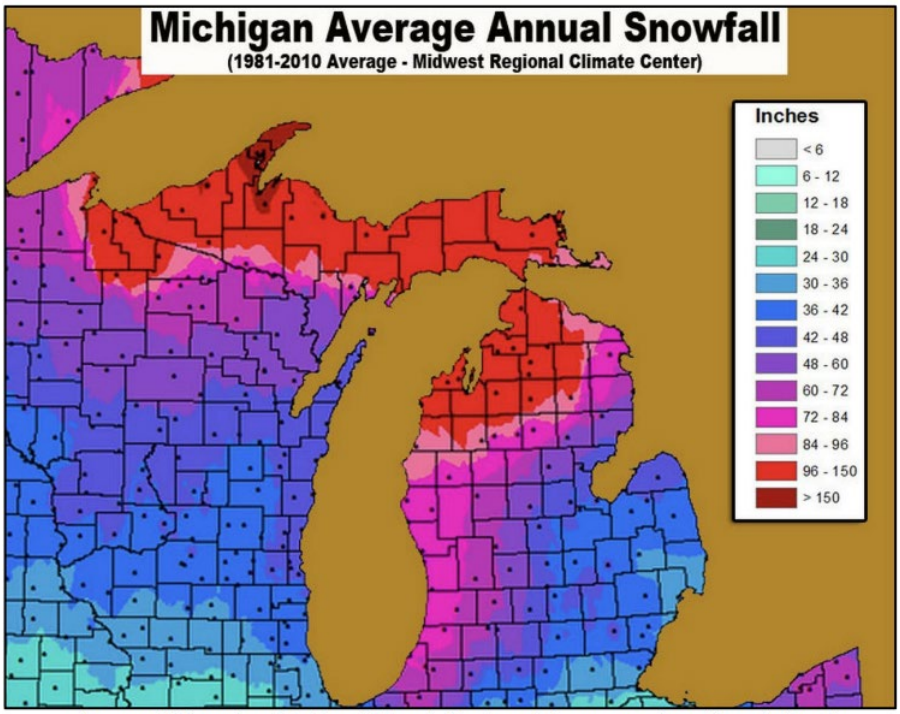
Winter Storm Warning**:** Severe winter conditions are imminent. This product is issued by the National Weather Service when a winter storm is producing or is forecast to produce heavy snow or significant ice accumulations. A winter storm warning for heavy snow generally indicates snowfalls of at least 8 inches.

Blizzard Warning**:** Issued for winter storms with sustained or frequent winds of 35 mph or higher with considerable falling and/or blowing snow that frequently reduces visibility to 1/4 of a mile or less. These conditions are expected to prevail for a minimum of 3 hours.

Severe Winter Weather Hazard Analysis

Most of the severe winter weather events that occur in Michigan have their origin as Canadian and Arctic cold fronts that move across the state from the west or northwest, although some of the most significant winter storms have their origins from the southwest, in combination with Arctic air masses. Winter storm hazards plague Michigan annually from November to March, with the state being vulnerable to snowstorms and ice and sleet storms. No area of the state is immune to severe winter conditions that can clog or paralyze the transportation network, cause widespread power outages, and slow normal daily activities to a standstill. Each community should be prepared for the harsh landscape created by snow and ice extremes.

The snowfall map that follows shows that the western Upper Peninsula experiences the most snowstorms and snowfall in Michigan each year. The western half of the Lower Peninsula also experiences heavy snowfall and a relatively large number of snowstorms. One reason for this is the "lake effect," a process by which cold winter air moving across Lakes Michigan and Superior picks up moisture from the warmer lake waters, resulting in larger snowfall amounts in the western part of the state. More detailed information can be found at the State Climatologist's web site: https://climate.geo.msu.edu/climate_mi/ .



(source: Midwestern Regional Climate Center; dots represent weather stations)

Severe Winter Weather in Michigan

Most light snowfall is relatively harmless and can even be beneficial. Severe snowstorms however can impact communities over a period of days or weeks, especially with heavy accumulations or snowfall that is difficult to clear. Blizzards are the most dangerous of snowstorms, characterized by low temperatures and strong winds containing large amounts of falling or blowing snow. The majority of significant snowfall events in Michigan are associated with regional synoptic-scale low pressure systems which are in turn linked with migrating cyclonic waves. Many of these originate in the southern Great Plains or the lower Gulf Region and lead to the large-scale transport of water vapor into the region from sub-tropical oceans. The vast majority of frozen precipitation associated with these systems falls from horizontally oriented stratiform clouds with relatively constant rates. They may impact large areas of hundreds or thousands of square miles. Sufficient atmospheric instability may however lead to the formation of vertically oriented convective clouds (stratocumulus) with showers and thunderstorms (referred to as “thundersnow”) embedded within the stratiform clouds. These may produce heavy snowfall rates (some of Michigan’s worst snowstorms have included thundersnow).

Michigan experiences some of the heaviest seasonal snowfall totals and length of snow cover durations in the Continental US east of the Rocky Mountains. Major differences in snowfall frequency and totals exist within the state. The highest average annual snowfall amounts to over 220 inches occur near parts of the Upper Peninsula. Amounts exceeding 150 inches of annual snowfall are centered in northwestern Lower Michigan. Seasonal snowfall totals decrease rapidly from northwest to southeast across the state, with totals of less than 40 inches found to the southeast.

An important factor for Michigan snowfall events is proximity to the Great Lakes (particularly those waters to the west). The relatively colder air that passes over them in the fall and winter brings moisture that, when cold enough, takes the form of snow showers or squalls generally better known as “lake effect” snow. In contrast to the snowfall of low-pressure systems, lake effect snow is typically associated with shallow convective clouds (stratocumulus) and is much more localized in geographical coverage. The bands of these snow-bearing clouds may typically be only a few miles wide and extend less than 100 miles inland but can carry intense snowfall rates (sometimes exceeding 3 inches an hour). “Lake enhanced” snowfall (which includes both synoptic and lake effect processes) may also be present. While Michigan is not a particularly mountainous state, its topography also plays a role in snowfall climatology. Winds forcing moisture-laden air over topographical obstacles cools more rapidly and leads to increased precipitation rates. This explains why the heaviest seasonal snowfall totals in the state tend to be found on relatively higher elevation sites in the upper and northern Lower Peninsulas (i.e., along the spine of the Keweenaw Peninsula).

Climate Change Considerations

The effect of climate change upon Michigan is expected to cause an increase in the amount of precipitation during the next few decades. Even though the length of Michigan winters has been decreasing, the season remains an intense one, and periods of deep freeze may actually become more likely as temperature differences narrow between the arctic, polar, and tropical air masses during the Northern Hemisphere’s winter season. During the winter months, the

increase in precipitation means that snowfall events will tend on average to be more intense. More snowfall is likely to happen at a time, in the form of significant snowstorm events (e.g. 8 or more inches, higher snowdrifts, cancelled school sessions, etc.).

Michigan meteorologist Paul Gross notes that "contrary to what most would expect, the warming climate is causing an increase in snowfall in those winters where the storm track brings more frequent winter storms to the Great Lakes. In Detroit, for example, five of the ten all-time snowiest winters have occurred since 2004, two of the top-five highest combined snowfall in back-to-back winters have occurred since 2007, the all-time snowiest start of a season through the end of January occurred in 2013-2014 and, as of the date of this report, the winter of 2013-2014 was already in the top five for most consecutive days with at least one inch of snow on the ground."

Michigan Snowstorm* Data (Arranged by Geography, 1/1/1996 – 4/30/2023)
(see Appendix A for information related to geographic groupings)

COUNTY/AREA	Reported Snowstorm Events	Total Property Damage	Total Crop Damage	Deaths	Injuries
Washtenaw	61	$6,225,000			
Wayne	56	$5,960,000			
Livingston	64	$2,129,000			3
Oakland	65	$6,400,000			3
Macomb	60	$5,170,000			
5 County Metro Area	**61 avg.**	**$25,884,000**	**$0**	**0**	**6**
Berrien	134	$20,000			
Cass	122				
St. Joseph	83				
Branch	73				
Hillsdale	69				
Lenawee	55	$505,000			
Monroe	44	$45,000			
Van Buren	135	$50,000			
Kalamazoo	91	$50,000			
Calhoun	66	$2,350,000			
Jackson	61	$1,325,000			
Allegan	154	$125,000			
Barry	76	$150,000			
Eaton	57	$1,150,000			
Ingham	57	$1,150,000			
Ottawa	145	$350,000			
Kent	105	$150,000			
Ionia	60	$125,000			
Clinton	49	$1,125,000			
Shiawassee	53	$1,010,000			
Genesee	65	$2,650,000			1
Lapeer	63	$1,010,000			
St. Clair	73	$1,045,000			
Muskegon	122	$100,000			
Montcalm	68	$180,000			
Gratiot	54	$175,000			
Saginaw	60	$2,025,000			
Tuscola	60	$1,000,000			
Sanilac	82	$1,005,000			
Mecosta	66	$240,000			
Isabella	57	$490,000			
Midland	57	$1,000,000			
Bay	56	$2,025,000			
Huron	68	$2,500,000			
34 County Southern Lower Peninsula	**78 avg.**	**$25,125,000**	**$0**	**0**	**1**

(continued on next page)

COUNTY/AREA	Reported Snowstorm Events	Total Property Damage	Total Crop Damage	Deaths	Injuries
Oceana	118	$100,000			
Newaygo	85	$125,000			
Mason	117	$150,000			
Lake	86	$525,000			
Osceola	65	$660,000			
Clare	58	$500,000			
Gladwin	44				
Arenac	47	$4,000			
Manistee	97	$350,000			
Wexford	72	$283,000			
Missaukee	79	$185,000			
Roscommon	66	$104,000			
Ogemaw	56	$55,000			
Iosco	54	$14,000			
Benzie	103	$600,000	$2,000,000		
Grand Traverse	127	$618,000	$5,000,000		
Kalkaska	135	$290,000			
Crawford	89	$255,000			
Oscoda	60	$100,000			
Alcona	50	$3,000			
Leelanau	135	$653,000	$13,000,000		
Antrim	162	$270,000			
Otsego	134	$342,000			
Montmorency	68	$165,000			
Alpena	75	$110,000			
Charlevoix	144	$295,000			
Emmet	122	$204,000			
Cheboygan	98	$206,000			
Presque Isle	75	$261,000			
29 County Northern Lower Peninsula	**90 avg.**	**$7,427,000**	**$20,000,000**	**0**	**0**
Gogebic	318	$102,000			1
Iron	144	$636,000			
Ontonagon	362	$43,000		1	2
Houghton	516	$210,000			
Keweenaw	250	$5,000			
Baraga	287	$113,000			
Marquette	374	$1,626,000		1	
Dickinson	146	$204,500			
Menominee	150	$187,000			
Delta	208	$76,000			
Schoolcraft	319	$265,000			
Alger	405	$80,000			
Luce	232	$88,500			
Mackinac	105	$50,000			
Chippewa	152	$185,000			
15 County Upper Peninsula	**265 avg.**	**$3,871,000**	**$0**	**2**	**3**
MICH. TOTAL**	**9,549**	**$62,306,500**	**$20,000,000**	**2**	**10**
Michigan Annual Avg.	**349**	**$2,279,849**	**$731,817**	**0.1**	**0.4**

* Combines NCEI Storm Data categories for "Blizzard", "Heavy Snow", "Lake-Effect Snow", "Winter Storm", and "Winter Weather". **One event may take place in multiple counties. Combined totals may be lower for the State.

Severe Winter Weather in Newaygo County

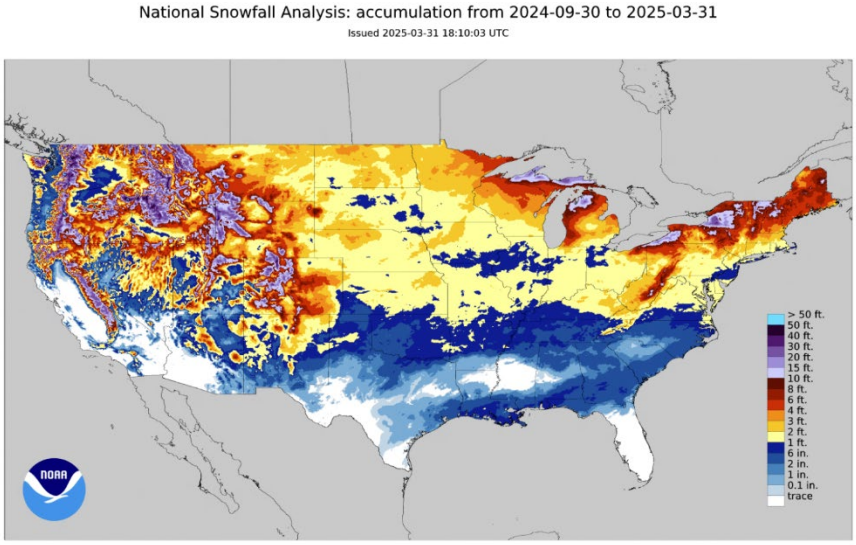
According to the US National Weather Service Office, the following chart highlights the average first accumulating snowfall dates for snowfall amounts of greater than or equal to 0.1 inches in Grand Rapids, Lansing, and Muskegon.

According to the NOAA National Centers for Environmental Information the most days a year Newaygo County will have snow is 52 days. Annual average snowfall amounts for Newaygo County is approximately 75 inches. Newaygo County can be impacted by system snow (snow storms) in addition to lake effect snow bands from Lake Michigan. Due to the geographic nature of the County (close proximity to Lake Michigan) the west side of the county near Fremont and Hesperia can see higher snowfall totals than the central or eastern part of the county near White Cloud, Newaygo, and Grant.

NOAA National Snowfall Analysis

Approximate accumulation in Inches for Newaygo County

		From	To
2024 to 2025 Season	72	9/30/2024	3/31/2025
2023 to 2024 Season	48	9/30/2023	9/30/2024
2022 to 2023 Season	72	9/30/2022	9/30/2023
2021 to 2022 Season	72	9/30/2021	9/30/2022
2020 to 2021 Season	48	9/30/2020	9/30/2021
2019 to 2020 Season	72	9/30/2019	9/30/2020
2018 to 2019 Season	96	9/30/2018	9/30/2019
2017 to 2018 Season	72	9/30/2017	9/30/2018
2016 to 2017 Season	48	9/30/2016	9/30/2017
2015 to 2016 Season	60	9/30/2015	9/30/2016
2014 to 2015 Season	84	9/30/2014	9/30/2015
2013 to 2014 Season	92	9/30/2013	9/30/2014
2012 to 2013 Season	72	9/30/2012	9/30/2013
2011 to 2012 Season	72	9/30/2011	9/30/2012
2010 to 2011 Season	96	9/30/2010	9/30/2011
2009 to 2010 Season	72	9/30/2009	9/30/2010
2008 to 2009 Season	92	9/30/2008	9/30/2009
Average	75		



The highest annual snowfall for:

- Muskegon 173.5 inches
- Grand Rapids 116.0 inches
- Lansing 86.3 inches

First Snowfall Date Statistics

Average First Accumulating Snowfall Date

Snowfall Amount	Grand Rapids Area	Lansing Area	Muskegon Area
0.1"	November 7	November 7	November 13
1"	November 20	November 21	November 25
3"	December 3	December 15	December 7

1+ Inch Snows Later Than April 26

Muskegon	
5.0	May 9, 1923
4.0	April 30, 1907
4.0	May 10, 1902
3.0	April 29, 1909
2.5	April 28, 1912
1.6	April 30, 1963
1.6	April 28, 1961
1.5	April 28, 1979

Grand Rapids	
5.5	May 9, 1923
5.5	May 10, 1902
3.6	April 30, 1963
3.0	May 2, 1929
2.2	April 29, 1909
2.1	April 30, 1907
1.7	May 3 - 4, 1954

Lansing	
11.5	May 9, 1923
4.0	April 29, 1909
4.0	May 1, 1866
3.0	May 1, 1875
2.6	May 2 - 3, 1929
2.2	April 27, 1950
2.0	May 10, 1902

Bloomingdale	
3.0	April 27, 1950
3.0	May 2, 1929
2.6	April 27, 2019
2.0	April 30, 1963
2.0	May 2, 1940
2.0	May 9, 1923

Kalamazoo	
4.5	April 27, 1950
4.0	May 2, 1929
4.0	May 9, 1923
1 - 2	April 27, 2019 (unofficial, estimated)
1.0	May 3, 1907

Hastings	
4.4	May 9, 1923
3.5	May 14, 1895
3.0	April 27, 1950
3.0	May 10, 1902
1.0	May 4, 1900

NOAA / National Weather Service

Newaygo County is frequently faced with severe snow and/or ice storms, and periods of extremely low temperatures. Based on historical occurrence, Newaygo County experiences an estimated average of 4 or more events per year. Although the majority of the population has grown accustomed to these emergencies and prepare appropriately, the hazards still pose significant risk to the jurisdiction due to its frequency, intensity, wide area effect, and long duration. The combination of these health and

economic factors have resulted in snow and ice storms emergencies and account for 4 of Newaygo County's 7 Presidential Declarations of Emergency/Disaster since 1953 and 1 Governor's Declaration of Emergency.

- March 20, 1976, Ice Storm
- January 26-31, 1977, Blizzard
- January 26-27, 1978, Blizzard
- January 2-15, 1999, Blizzard
- February 24, 2019, Blizzard

Since 2016, the US National Weather Service Grand Rapids Office classifies Winter Weather Advisories as snow accumulations under 8 inches, especially if spread out over 12-36 hours. Wind gusts 45-57 mph or sustained 30 - 40 mph, Ice for less than ¾-1 inch, and wind chills -15 to -25 degrees also fall into the advisory category. Prior to 2016, the threshold was under 6 inches of snow in 24 hours.

Since 2016, the US National Weather Service Grand Rapids Office classifies Winter Storm Warnings as snow accumulations greater than 8 inches in less than 12 hours. Wind chills less than -25 degrees, ice or more than ¾-1 inch, and wind gusts more than 58 mph or sustained 40-50 mph. Blizzards are classified as 35 mph gusts, snow, blowing snow, and visibility near zero.

The following is Newaygo County's Warning History since 2001. Data was provided by the US National Weather Service Office in Grand Rapids, Michigan.

MONTH	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	Total Average
Winter Weather Advisory		11	14	15	16	16	10	21	22	11	7	16	10	**14**
Winter Storm Warning		2	3	2	5	6	5	10	9	3	2	4	3	**5**
MONTH	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**Total Average**
Winter Weather Advisory	24	18	11	19	22	12	20	7	16	11	15	9	11	**16**
Winter Storm Warning	2	2	3	5	2	1	2	2	1	2	2	2	1	**2**

Ice Storm Warnings: None Since 2000.

Blizzard Warning: 1 in 2009, 1 in 2019 (2009 might have been a Winter Storm Warning if issued after NWS change in 2016), and 1 on December 21, 2022

From 1950 - 2024, there have been 98 total winter weather events totaling over $13,425,000 in property damage. Several significant storms include:

Case: January 12, 1993
Snow began across central Lower Michigan late in the evening of the 12th and quickly spread north across northern Lower Michigan during the early morning hours of the Wednesday the 13th. The combination of heavy snow, northeast winds of 15 to 25 mph and temperatures in the lower to mid-20s created near blizzard conditions at times most of Wednesday. The snow tapered to flurries by early evening hours of Wednesday with total snowfall ranging from six to twelve inches. The heavy snow led to downed power, telephone and cable T.V lines across this area. Almost 20,000 people lost power from the heavy snow. Numerous traffic accidents occurred with one serious injury. Most of the schools were closed over central Lower Michigan due to the heavy snowfall. This storm resulted in $50,000 in damage.

Case: April 2, 1993
A late season winter storm was tracked across central Indiana during the evening hours of March 31st and through central Ohio during the overnight hours of April 1st. This storm brought a wintry mix to Lower Michigan on April 1st and 2nd. Rain began across most of lower Michigan during the evening hours of March 31st with only flurries reported across northeastern Lower Michigan. Rain changed to freezing rain across central Lower Michigan from Bay City, Saginaw and Midland to Lansing, and Flint after midnight on the 1st. All the rain and freezing rain across east central and southeast Lower Michigan changed to snow after sunrise on the 1st as the precipitation remained all snow across northeast lower Michigan. By the time the snow ended on the 2nd, a general 4 to 7 inch snowfall occurred across the eastern one-third of Lower Michigan. The combination of wind gusts to 40 mph and ice accumulations of up to 0.25 inches caused numerous power outages in central lower Michigan in the Tri-city area of Bay City, Midland and Saginaw. Up to 57,000 customers were without power. Numerous schools also were closed across these areas due to the icy road conditions. This storm resulted in $50,000 in damage.

Case: January 29, 1994
Snow developed over southwest Lower Michigan just after Midnight on the 27th. The snow mixed with, then changed to, sleet and freezing rain. Overnight on the 27th and into the morning hours of the 28th, occasional rain continued over the southern half of Lower Michigan while occasional freezing rain continued over the north half of Lower Michigan. During the rest of the 28th, the area of freezing rain changed to snow across Lower Michigan. Over central and northern Lower Michigan the snow became heavy by mid-afternoon. Snowfalls of six to eight inches were common over the north half of Lower Michigan. As for ice accumulations over Lower Michigan during the freezing rain, around a quarter inch accumulated over the south third of lower Michigan, from 0.50 to 0.80 inches accumulated over central and northeast Lower Michigan. This resulted in numerous outages. Detroit Edison reported 50,000 people affected by power outages. Consumers Power County reported 2,000 customers without power. More than 150 schools canceled classes across the state. This storm resulted in $5 Million in damage across the State.

Case: October 26, 1997
An early season winter storm which tracked south of Michigan, across Indiana and Ohio, produced a band of heavy, wet snow across much of southwest, south central, and central Lower Michigan. This was the first measurable snowfall of the season and because of significant foliage still left on the trees, limbs and branches were more vulnerable to bending and snapping under the added weight of the

heavy snow. This resulted in numerous power outages and reports of property damage from downed trees. At the height of the storm, which occurred late Sunday evening, October 26th into early Monday morning, October 27th, power outages affected 333,000 utility customers statewide. Of these, approximately 195,000 occurred in the Grand Rapids metropolitan area alone. Total property damage was estimated at $1.2 Million area-wide. The hardest hit areas included the northwest and northeast sections of the city of Grand Rapids, northern Kent County including Sparta and Rockford, and the city of Kalamazoo. Because of widespread power outages, some of which lasted between 36 and 72 hours, the American Red Cross opened emergency shelters to take care of senior citizens and others vulnerable to the cold. The storm closed many area schools and businesses on Monday, October 27th. Many remained closed on October 28th due to power still being out. Many weather-related traffic accidents were reported during the storm, with many cars in ditches and skidding off the road. Large tree limbs falling on vehicles resulted in significant property damage, much of which was not available in damage cost estimates. No injuries were directly related to the storm, however several injuries and one fatality occurred in traffic accidents judged to be weather-related. Snowfall accumulations ranged from 2 to 8 inches. The heaviest snow fell in a band from northeast Ottawa County across northwest Kent County, western Montcalm County, eastern Mecosta County, into eastern Osceola County. This storm resulted in $1.5 Million in damage across the State.

Case: April 5, 2003

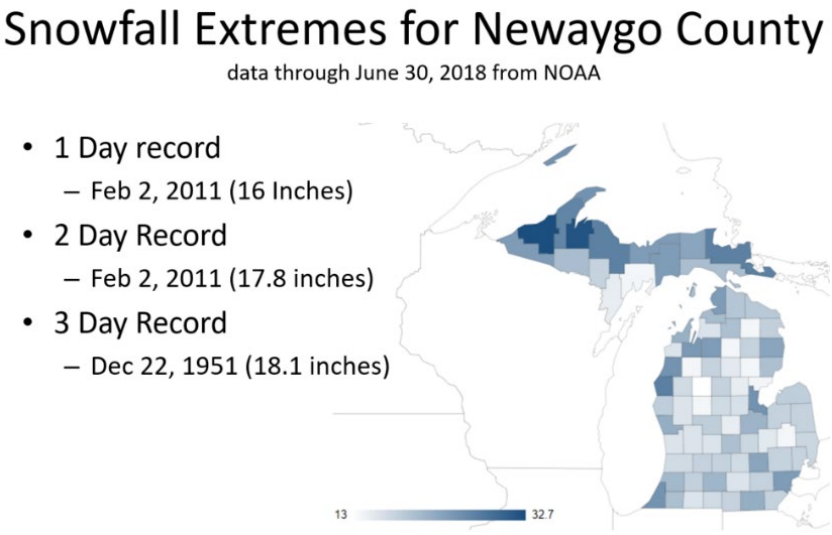
A major ice storm affected much of southern lower Michigan, causing hundreds of thousands of people to lose power. The weight of the ice brought down thousands of trees and limbs and hundreds of power lines. Many people across the area lost power for several days and some people who live in outlying areas were without power for a week. The ice storm resulted in several million dollars' worth of damage across the area. The ice storm came in three stages. The first period of freezing rain during the afternoon hours of the 3rd resulted in up to a quarter of an inch of ice across Osceola and Isabella counties, in central lower Michigan. The second period of freezing rain came during the nighttime hours of the 3rd into the morning hours of the 4th, when ice accumulations of a quarter to three quarters of an inch occurred across much of central lower Michigan, north of Grand Rapids. The heaviest period of freezing rain with thunderstorms came during the very late afternoon and evening hours, with the counties in the vicinity of I-96 receiving the heaviest ice accumulation. Up to an inch of ice was reported in the Lansing area, and numerous reports of a quarter to as much as an inch of ice were received in the vicinity of I-96. This was one of the biggest ice storms to affect lower Michigan in the last 50 years. When all was said and done with, most counties across central and southern lower Michigan ended up receiving a total of at least a half an inch of ice, with reports of total ice accumulation of an inch quite common, and even up to near an inch and a half of ice in some locations. This storm resulted in $4.9 Million in damage across the State.

Case: February 16, 2006

A major ice storm developed across much of central lower Michigan producing around a quarter to half inch of ice accumulation between Route 10 and I-96. Thousands of homes lost power from just north of Grand Rapids to Lansing north to Route 10 and many areas did not have power for three to five days. There were numerous reports of downed trees and power lines all across that area. Just north and northwest of that area precipitation mainly fell in the form of snow, and six to eight inches of snow fell across northern Mason and Lake counties. This storm resulted in $1 Million in damage across the State.

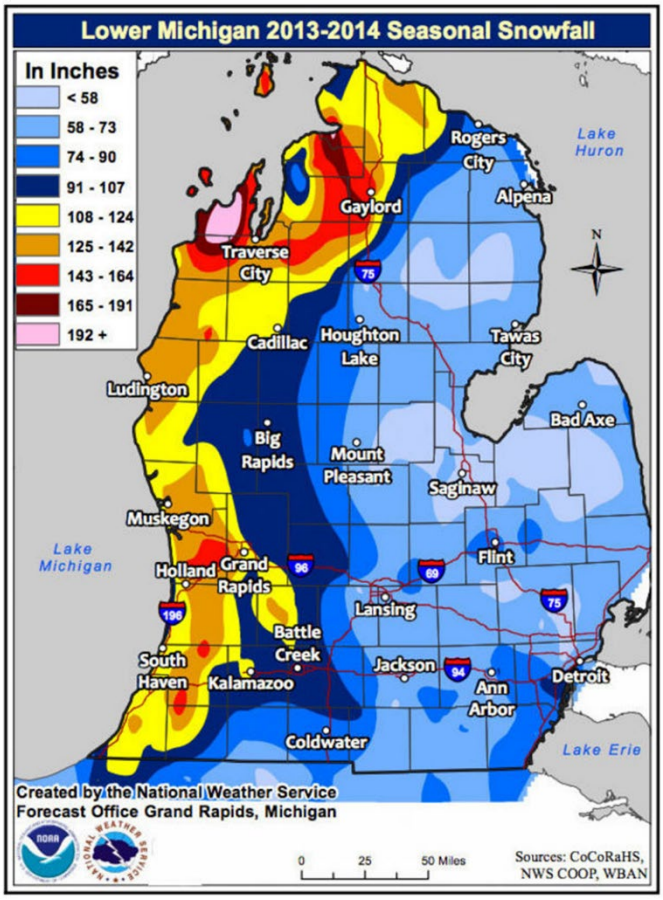
Case: Winter of 2013-2014

The winter of 2013-2014 broke many temperature and snow records for Western Michigan. Overall, Grand Rapids had its second snowiest winter in records dating back to the late 1800s with 110.7 inches of snowfall. This winter season also went down on the record books for being one of the coldest winters. According to Wikipedia the 2013–14 North American cold wave was an extreme weather event extending from December 2013 to April 2014, and was also part of an unusually cold winter affecting parts of Canada and the Eastern United States. The event consisted of 2 episodes, the first one in December 2013 and the second in early 2014, both caused by southward shifts of the North Polar Vortex. Record cold temperatures also extended well into March.



Case: November 17, 2014

The cold air and a favorable atmospheric setup for lake-effect snow led to a prolonged and record-breaking early season snowfall across much of the Great Lakes. Due to strong winds, the greatest snow amounts were recorded further inland. Synoptic and lake effect snow continued November 17-21 and the snow was heavy at times, resulting in hazardous travel conditions through the week. Total snowfall from November 13-21 reached 3 feet from north central Allegan County north to eastern Ottawa County. Total snowfall reports in excess of 2 feet were common along the US-131 corridor. Temperatures across Southwest Lower Michigan averaged well below normal, snowfall was above to well above normal. A number of daily temperature, snowfall, and precipitation records were also set. As much as two and a half feet of snow fell across southern Newaygo County from November 17-21, resulting in very hazardous travel conditions. From December 6–10, the first wave of record-breaking cold air pushed into the Eastern U.S., before the temperatures returned to a more stable range. On January 2, an Arctic cold front initially associated with a nor'easter, tracked across Canada and the United States, resulting in heavy snowfall. Temperatures fell to unprecedented levels, and low temperature records were broken across the United States. Business, school, and road closures were common, as well as mass flight cancellations. Altogether, more than 200 million people were affected, in an area ranging from the Rocky Mountains to the Atlantic Ocean and extending south to include roughly 187 million residents of the Continental United States.



Case: February 13, 2015

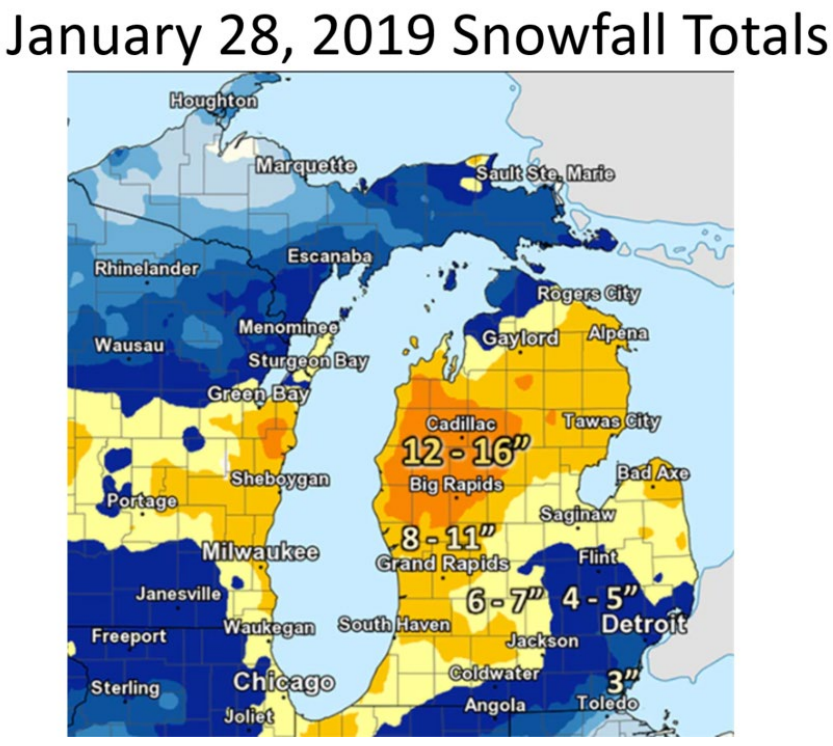
An arctic cold front moved through Southwest Michigan late in the evening on the 13th, bringing a burst of snow during the late afternoon and evening hours of the 13th. Behind the cold front during the early morning hours of the 14th, lake effect snow showers developed. The heaviest snow from this part of the storm was also west of US-131. Ludington got nearly a foot of snow from this system. Strong winds developed by mid morning on the 14th, frequently gusting to between 35 mph and 45 mph across the area. Winds gusted to over 50 mph along the Lake Michigan shoreline. The wind and snow diminished during the evening as the snow bands shifted toward the lake shore. Impacts from the storm included several roads near Lake Michigan drifting shut. Numerous accidents were reported, particularly west of US-131.

Case: March 23, 2016

A late winter storm brought around a a tenth to as much as four tenths of an inch of freezing rain and ice accumulation to central lower Michigan. In addition, heavy wet snow and sleet was also reported. Newaygo County received a quarter of an inch of ice accumulation on trees and road signs.

Case: April 14, 2018

A significant late season winter storm brought a mix of high winds, heavy rain, sleet and freezing rain. The highest wind gusts occurred on the 14th and heavy sleet and freezing rain developed during the early morning hours of the 15th through the early to mid-afternoon hours of the 15th. Numerous accidents and slide-offs were reported across the region, including on I-94 during the early afternoon hours of the 15th. Michigan State Police requested weather conditions for an investigation into a serious head on accident on M-21 that shut the road down in both directions. Medical support from AeroMed was requested from Grand Rapids but denied due to hazardous weather conditions. Road conditions were poor in the morning into the afternoon with sleet-packed roads and ice coated roads where freezing rain was prevalent. Total ice accumulations ranged from around a tenth of an inch to about half an inch. Total sleet accumulations reached 1 to 2 inches in some areas. Numerous flights were either delayed or cancelled. A total of 450,000 customers were impacted by power outages across Michigan, with 110,000 Consumers Energy Customers being impacted. Power was restored to the majority of Consumers Power customers by the evening hours of the 15th.



Case: January 28 – February 24, 2019

During this timeframe, two Winter Storm Warnings, one Ice Storm Warning, and 1 Blizzard Warning were issued. A series of heavy snowfall events began this week-long

event. On Monday, January 28, much of the state faced the start of a blizzard, with snowfall ranging up to over a foot in depth as sustained winds began (with gusts up to 40 mph) and were soon accompanied by a dangerous drop in temperatures. An extremely large number of schools throughout the state were closed as a result of the snowfall, and then remained closed for most of the week as the combination of sustained subzero temperatures and strong winds produced dangerously low wind-chill values throughout the state. Wind-chill values below -30 degrees Fahrenheit were common throughout Michigan for multiple days, and often dipped below -40. In additional to numerous local states of emergency, non-essential State Government offices were closed for more than half a day on Monday, and for the entire day on Wednesday and Thursday. Governor Gretchen Whitmer's State of Emergency declaration took effect on January 29, anticipating the dangerous impacts of the deep freeze that had been forecast by the National Weather Service.

Newaygo County also saw the Muskegon River reach a moderate flood level in Bridgeton Township and the City of Newaygo, as the result of an ice jam. In addition, some infrastructure problems also arose from water main and pipe breaks in the northern half of the City of Newaygo which was placed under a boil water advisory. From there two periods of freezing rain from February 5th through February 7th resulted in significant ice accumulation on the order of a half to three quarters of an inch across portions of central lower Michigan. This resulted in thousands of downed trees, limbs and power lines. Approximately one hundred and fifty thousand people lost power. Schools in the area were closed for days. Newaygo County experienced approximately $1,000,000 in property damage as a result of this storm. Finally, Blizzard conditions developed on Sunday February 24th with moderate to heavy snow and blowing snow due to wind gusts of 45 to 50 mph that resulted in near zero visibilities at times.

Although not as dramatic, smaller and more frequent events also cause regular concern to Newaygo County due to their immediate effects on the jurisdiction and its infrastructure.

December 21, 2022 Blizzard

A major winter storm with blizzard conditions impacted much of Lower Michigan just before the Christmas holiday weekend 2022. Conditions deteriorated rapidly on Thursday afternoon with snow moving into the area. Around 6 PM on Thursday December the 23rd, wind at the Grand Rapids NWS office was calm. Then, the arctic cold front came through resulting in 20 mph and gusty winds from the west. The worst conditions at Grand Rapids were between 3 PM and 6 PM on Friday December 23rd. This is when the wind was strongest, and visibility was lowest in blowing and drifting snow. Accidents and multi-car pile ups led to closures of some Interstates and Highways on Friday.

February 27, 2023 Heavy Icing

A major ice storm impacted much of southern Lower Michigan while areas of moderate to heavy snow impacted central Lower Michigan on February 22, 2023. Hundreds of thousands of customers lost power across southern portions of the state as freezing rain accumulated on trees and power lines, bringing branches, trees, and power lines down in many areas. In between the areas of freezing rain to the south and snow to the north, sleet (ice pellet) accumulation reached a couple of inches deep.

In order for freezing rain to occur, snowflakes that fall from the sky need to completely melt and not refreeze into ice pellets before reaching the ground. That was the case for most areas south of the I-96 corridor during this event. Along and slightly north of the I-96 corridor, ice pellets persisted for most of this event leading to 1"-2" of dense ice pellet accumulation. The environment stayed just cold enough above the surface to completely refreeze the melted snowflakes into sleet. Further north, the atmosphere was cold enough to keep precipitation all snow, where generally 2"-8" fell.

Wind gusts reached the 25-35 mph range for many locations during the height of the event. This added an additional challenge to areas that received heavy icing on trees and power lines.

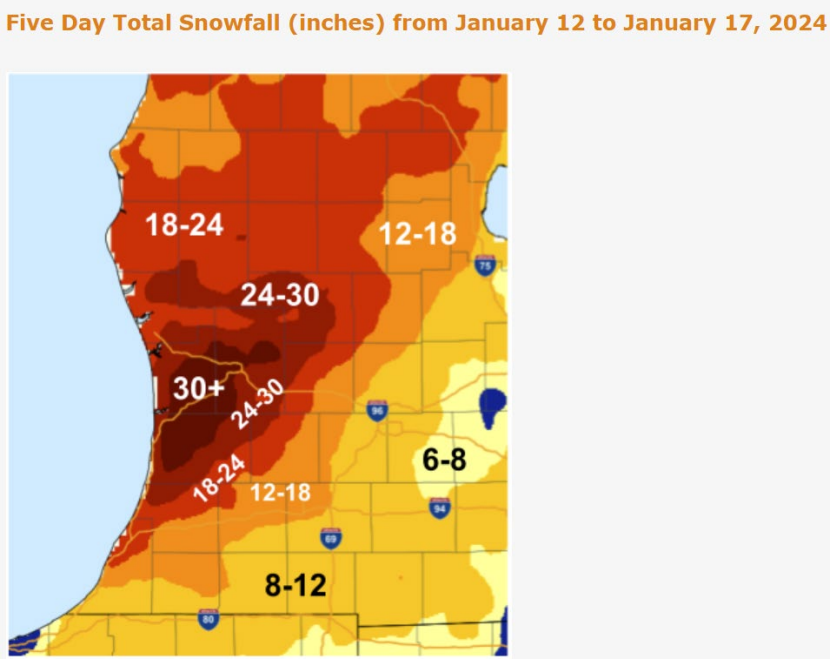






January 12 – January 17, 2024

Winter returned with a vengeance as the area experienced a winter storm associated with a low pressure system, followed by prolonged cold and windy conditions that fostered persistent lake effect snow. Significant travel impacts occurred due to a long stretch of icy conditions that resulted from temperatures remaining well below freezing and a nearly constant supply of at least light snow.



Additional Event summaries can be located here: https://www.weather.gov/grr/events

Community Vulnerability:

Land, air, and water transportation can all be substantially impacted depending on the amount of snow, winds, and other factors. Visibility may be reduced to only a few feet and many roads may become impassable. People may become stranded on roadways or in homes. Winter holiday travel is often affected. The work required to move accumulated snow, or its drifting, may overwhelm individual residents or public workers. An increase in heart attacks may occur from shoveling/strenuous activity. Roofs can be vulnerable to the weight of accumulated snow, which sometimes also migrates under shingles and creates leaks within homes. Snow may cause tree branches to bend or break across utility lines, interrupting service. Hypothermia may occur, and warming centers/sheltering may be required.

Within Newaygo County, the county's rural nature makes travel limitations an immediate and major concern. Even relatively small amounts of snow and ice can quickly limit travel on main routes, make secondary routes difficult to navigate, and render private roads virtually impassible. Emergency units such as ambulance, fire services, and law enforcement resources are often overwhelmed due to the response challenges resulting from the slower and more hazardous emergency responses to the dramatically increased number of weather related emergency calls.

M-37, M-20, and M-82 are utilized as the main trunk lines and primary traffic routes through Newaygo County by commuters and to/from its major communities by residents. These highways are heavily relied upon for routine and emergency travel. During severe winter events, it becomes even critical that these routes remain navigable for emergency services and travelers. As state highways, primary responsibility for maintenance of these roadways fall upon the Michigan Department of Transportation who has contracted with Newaygo County Road Commission to maintain these roads.

Although not primary routes for commuters, primary county roads are heavily relied upon by citizens and emergency agencies for inter-county travel and access to the primary highways. During severe winter emergencies, these become critical as many secondary roads can easily become impassible by passenger and emergency vehicles. As county roadways, the responsibility for maintenance of these routes belongs to the Newaygo County Road Commission. When severe winter weather occurs, these routes are no longer maintained and focus turns to keeping the main trunk lines open.

Secondary roads through Newaygo County provide critical traffic routes for citizens from the various communities and areas to access the primary and secondary routes. As emergency locations are unpredictable, it becomes a priority to maintain these roads during severe winter events to the best resources allow as many tertiary roads become unusable to passenger and emergency vehicle traffic.

Secondly, the nature of snow and ice storms frequently results in equally severe secondary emergencies. These include infrastructure failures, transportation accidents, and structure fires. Although these secondary effects are discussed in their independent sections, it is important to note that their response severity would be magnified by the primary existing snow and ice conditions.

Finally, the extended duration and large area of effect can easily strain the community's economic and financial resources due to travel route maintenance, loss of work and school days, and limited consumer activity. Periods of extremely low temperatures often accompany snow and ice storms, however, are also an independent hazard of unique nature. Of primary concern is the immediate health potential to lethally affect vulnerable persons such as the elderly, disabled or ill, and young children. This is complicated due to the fact, that during such periods, many fixed income families begin to rely on auxiliary and unsafe heating devices resulting in increases in residential structural fires and carbon monoxide poisonings. Longer duration events can additionally overcome local human services agencies such as the American Red Cross, Department of Health and Human Services, and local churches who provide heating assistance to needing families.

Extreme Low Temperatures

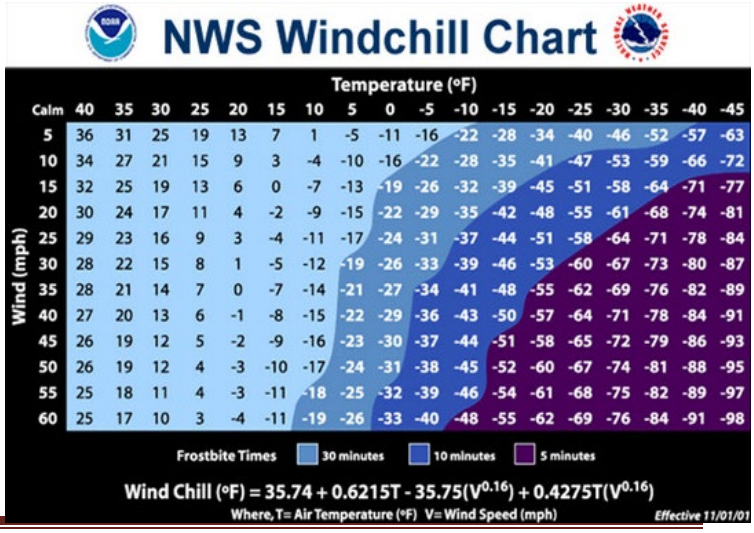
Prolonged periods of very low temperatures can last more than a week and cause loss of life among vulnerable populations, damage to infrastructure, and disruptions to schools and businesses. Vulnerabilities to extreme cold events can be elevated by lengthy power outages caused by severe winter weather. Extreme cold is primarily associated with the wintery months from November to early April, and is categorized by temperatures remaining near or below 0°F.

Although all counties in Michigan are susceptible to harsh subfreezing temperatures, counties in the North Central and Upper Peninsula of the state typically have more annual days of extreme cold than the southern portions of Michigan, and a similarly more frequent occurrence of sustained low temperatures persisting for multiple days in a row. Periods of extreme cold are risky for those in both rural and in urban areas. Frostbite and hypothermia is common in rural areas where people are trapped outdoors and cannot adjust successfully to the temperatures. Even indoors, hypothermia is a concern for individuals living in inadequately heated apartments or rooms (below 68 °F) for lengthy periods of time. Loss of life can occur with either of these situations. Damage to buildings and pipelines can also occur as a result of extreme cold, resulting in expensive repairs and possibly days of business and school shutdowns.

Extreme Low Temperature Hazard Warning Description

Wind Chill: Wind chill is the temperature it "feels like" when you are outside. The National Weather Service provides a chart to show the difference between air temperature and the perceived temperature and the amount of time until frostbite occurs.

Frost/Freeze Warning: Issued during the growing season when surface temperatures are expected to drop below freezing over a large area for an extended period of time.



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

Extreme Low Temperature Hazard Analysis

Each year in the United States, approximately 700 persons die as a result of severe cold temperature-related causes. This is substantially higher than the average of 175 heat-related deaths each year. It should be noted that a significant number of cold-related deaths are not the direct result of “freezing” conditions. Rather, many deaths are the result of illnesses and diseases that are negatively impacted by severe cold weather, such as stroke, heart disease and pneumonia. It could convincingly be argued that, were it not for the extreme cold temperatures, death would not have occurred at the time that it did due to the illness or disease alone. There are, in various parts of Michigan, an average of between 3 and 50 (or more) days per year at or below 0° Fahrenheit. Michigan also tends to have between 90 and 180 (or more) days per year in which the temperature is below the freezing point.

Hypothermia (the unintentional lowering of core body temperature), and frostbite (damage from tissue being frozen) are probably the two conditions most closely associated with cold temperature-related injury and death. Hypothermia is usually the result of over-exposure to the cold, and is generally thought to be clinically significant when core body temperature reaches 95 degrees or less. As body temperature drops, the victim may slip in and out of consciousness, and appear confused or disoriented. Treatment normally involves warming the victim (preferably performed by trained medical personnel) but frostbitten areas should not be rubbed. Although frostbite damage itself rarely results in death (which may occur due to hypothermia instead), in extreme cases it can result in the amputation of the affected body tissue.

Periods of extreme cold are risky for those in both rural and in urban areas. Frostbite and hypothermia is common in rural areas where people are trapped outdoors and do not adjust properly to the temperatures. Even indoors, hypothermia is a concern for individuals living in inadequately heated apartments or rooms. Loss of life can occur with either of these situations. Damage to buildings and pipelines can also occur in bitter cold conditions, resulting in expensive repairs and potential days of business and school shutdowns.

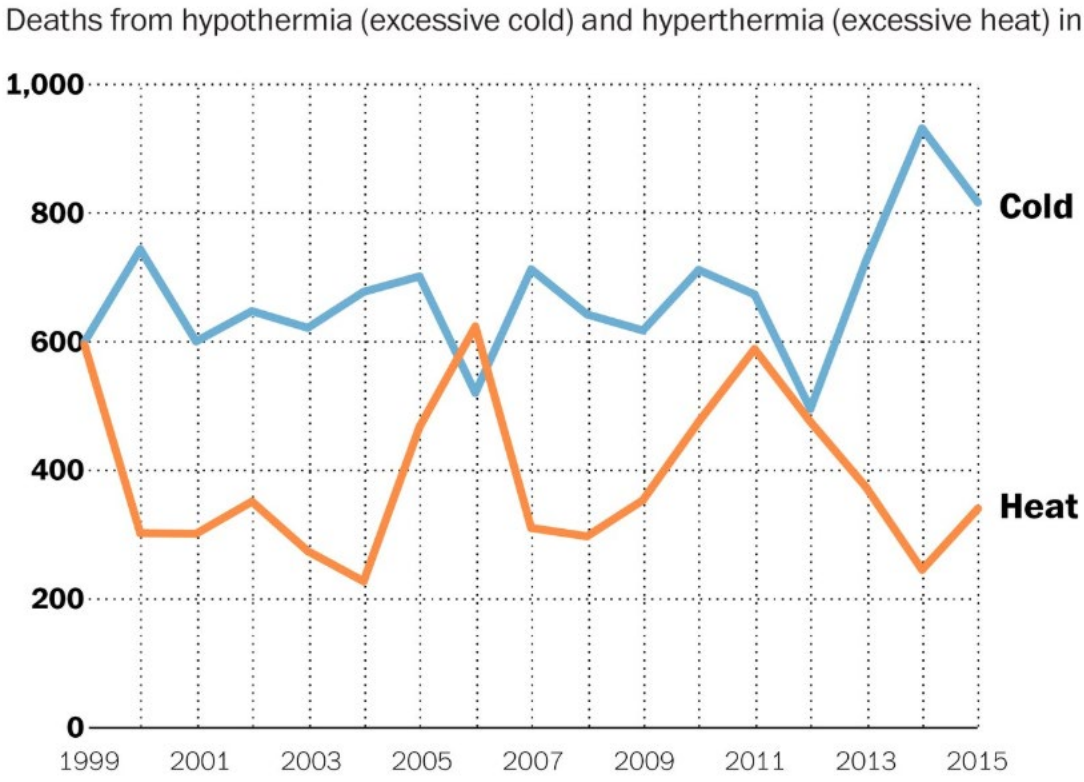
To mitigate the effects of the unfavorable cold temperatures, communities should make sure that housing codes are appropriate and that adequate furnaces are in place in apartment dwellings. Inspections of vulnerable and outdated infrastructure should be made in the fall season, before winter sets in. In addition, proper insulation of piped areas can prevent water main breaks.

In the wind chill chart, extremely low apparent temperatures can also be associated with an amount of exposure time that it takes to cause frostbite. Cells of the table that have darker shadings denote wind chill temperatures that can produce frostbite in 10 minutes or less. Cells with lighter shadings are associated with frostbite times of 30 minutes or less. Unshaded cells in the table should require longer exposure times to cause frostbite. Again, the chart displays only two factors that contribute heavily to risk, but risk can be increased for an individual in particular circumstances. For example, people should be aware that the drier air (common to winter weather) also allows a more rapid drop in temperature than is the case with warm summer air. As a cold front moves in, or as daytime high temperatures for the day change to nighttime low temperatures, the corresponding drop in temperature

can be much greater when the humidity is low. Persons who are outdoors can rapidly find themselves in danger of hypothermia.

Hypothermia usually occurs in one of two sets of circumstances. One situation involves hypothermia associated with prolonged exposure to cold while participating in outdoor sports such as skiing, hiking or camping. Most victims of this form of hypothermia tend to be young, generally healthy individuals who may lack experience in dealing with extreme cold temperatures. The second situation involves a particularly vulnerable person who is subjected to only a moderate, indoor cold stress. A common example would be that of an elderly person living in an inadequately heated home. In such circumstances, hypothermia may not occur until days or perhaps weeks after the cold stress begins. Isolated rural locations may involve difficulties in reaching a heated space, or a designated warming shelter.

Deaths due to extreme winter cold are often not associated with a particular weather event. Rather, they are the result of a one-time over-exposure to severe cold weather (a hiker lost in the woods, or car failure in a rural area), or more commonly from continuous exposure to moderate cold temperatures by vulnerable persons (such as the elderly). In some cases, hypothermia deaths can be linked to severe winter weather such as snowstorms or blizzards, where the victim is caught unprepared for the extreme cold temperatures. As mentioned earlier, many cold temperature-related deaths involve the exacerbation of an existing, serious medical condition such as heart disease or pneumonia. In Michigan, approximately 70% of weather-related fatalities (about 40 deaths per year) are attributed to exposure to the cold (according to the Michigan Department of Community Health and the National Weather Service). The following table from the CDC gives an indicator for the nation as a whole.



The special vulnerability of elderly persons to hypothermia has become apparent. Over half of the hundreds who die each year due to cold exposure are 60 years of age or older, even though this age group only represents about 20% of the country's population. This remarkable statistic may be due, in part, to an impaired perception of cold as well as the voluntarily setting of thermostats to relatively low temperatures. In addition, high energy costs and the relative poverty among some elderly people may discourage their setting thermostats high enough to maintain adequate warmth (just as it may cause others to limit their use of fans and air conditioning during summer heat waves). Because many elderly people live alone and do not have regular visitors, the cold conditions may persist for several days or weeks, thus allowing hypothermia to set in.

Extreme Cold Temperatures in Michigan

Extreme cold temperatures are a universal hazard in Michigan. Whereas heat waves tend to impact urban centers more than suburban or rural areas, cold temperatures are an "equal opportunity" killer. Every community in Michigan is vulnerable, regardless of location or size. It must also be noted that many of the agricultural sectors of Michigan are vulnerable to crop losses because of extreme cold events. A couple of severe recent events have involved unusually warm temperatures, which plant life may treat as a return of Spring, followed by a re-freeze when the plants have made themselves more vulnerable and which can therefore be devastating to them.

Historic Temperature Records at Various Michigan Locations (through 2021)

Southern Lower Peninsula	**Record Low Temperature**	**Record High Temperature**
Adrian (Lenawee County)	-26°F (1/20/1892)	108°F (7/14/1936, 7/24/1934)
Benton Harbor (Berrien County)	-21°F (1/12/1918)	104°F (7/21/2002, 7/30/1999)
Coldwater (Branch County)	-29°F (1/31/2019)	108°F (7/24/1934)
Ann Arbor (Washtenaw County)	-23°F (2/11/1885)	105°F (7/24/1934)
Bloomingdale (Van Buren Co.)	-23°F (2/3/1996)	105°F (7/5/1911, 7/13/1936)
Detroit (Wayne County)	-21°F (1/21/1984)	105°F (7/24/1934)
Jackson (Jackson County)	-20°F (1/18/1976, 1/19/1994)	103°F (7/15/1977)
Pontiac (Oakland County)	-22°F (2/5/1918)	104°F (7/6/1988, 7/8/1936, 7/16/1988, 7/24/1934)
Flint (Genesee County)	-25°F (1/18/1976, 2/20/2015)	108°F (7/8/1934, 7/13/1936)
Grand Rapids (Kent County)	-24°F (2/13-14/1899)	108°F (7/13/1936)
Port Huron (St. Clair County)	-19°F (1/19/1994)	103°F (7/9/1936)
Saginaw (Saginaw County)	-23°F (2/5/1918)	111°F (7/9/1936)
Harbor Beach (Huron County)	-22°F (2/9/1934)	105°F (7/10/1936)
Big Rapids (Mecosta County)	-36°F (2/11/1899)	103°F (7/30/1916, 7/13-14/36)
Northern Lower Peninsula	**Record Low Temperature**	**Record High Temperature**
Houghton Lake (Roscommon Co)	-34°F (2/17/1979)	103°F (6/19/1995)
Alpena (Alpena County)	-37°F (2/17/1979)	106°F (7/13/1936)
East Tawas (Iosco County)	-29°F (2/1/1918, 2/20/1929)	106°F (7/8-9/1936)
Gaylord (Otsego County)	-37°F (2/17/1979)	101°F (7/11/1921, 7/30/1916)
Gladwin (Gladwin County)	-39°F (2/20/1979)	105°F (7/13/1936)
Traverse City (Gd. Traverse Co.)	-37°F (2/17/1979)	105°F (7/7/1936)
Upper Peninsula	**Record Low Temperature**	**Record High Temperature**
Hancock (Houghton County)	-30°F (2/9/1951, 2/10/1948)	102°F (7/7/1988)
Ironwood (Gogebic County)	-41°F (1/17/1982, 2/12/1967)	104°F (7/13/1936)
Munising (Alger County)	-33°F (2/25/1928)	103°F (7/7-9/1936, 8/6/1947)
Sault Ste. Marie (Chippewa Co.)	-37°F (2/8/1934, 2/10/1899)	98°F (7/3/1921, 7/30/1916, 8/5-6/1947)

(source: NOAA NCEI)

Case: Early 2014 – Statewide

Several times during the 2013-2014 winter season, very low temperatures were felt across the state, for periods of time that placed many persons at risk. This sometimes coincided with ice storms, power failures, propane shortages, and transportation blockages that caused the effects of the extreme cold temperatures to be more pronounced. The media made the term “polar vortex” popular during these extreme temperature events. On January 5 through 9, 2014, much of the Upper Peninsula endured an air mass that was far below normal winter temperatures, with wind chill values consistently between 30 and 50 degrees below zero. The worst was at Ironwood (a wind chill reading of 54 below zero), where the highest temperature on the day of January 6 was 15 degrees below zero. Various Upper Peninsula schools were closed for two to three days during this cold spell (and later during the month and season). The deep cold reached many other Michigan counties by January 6, and although the wind chill values there were less extreme than the Upper Peninsula’s, they were still dangerously low, such as -33°F at West Branch, Houghton Lake, Cassopolis, and Hillsdale. Actual temperatures were below zero, with Detroit Metropolitan Airport bottoming out at -14°F on January 6 and 7 (both of which were record lows for that location on those dates).

Case: Mid-Late February, 2015 – Northwest Lower Peninsula, then Upper Peninsula

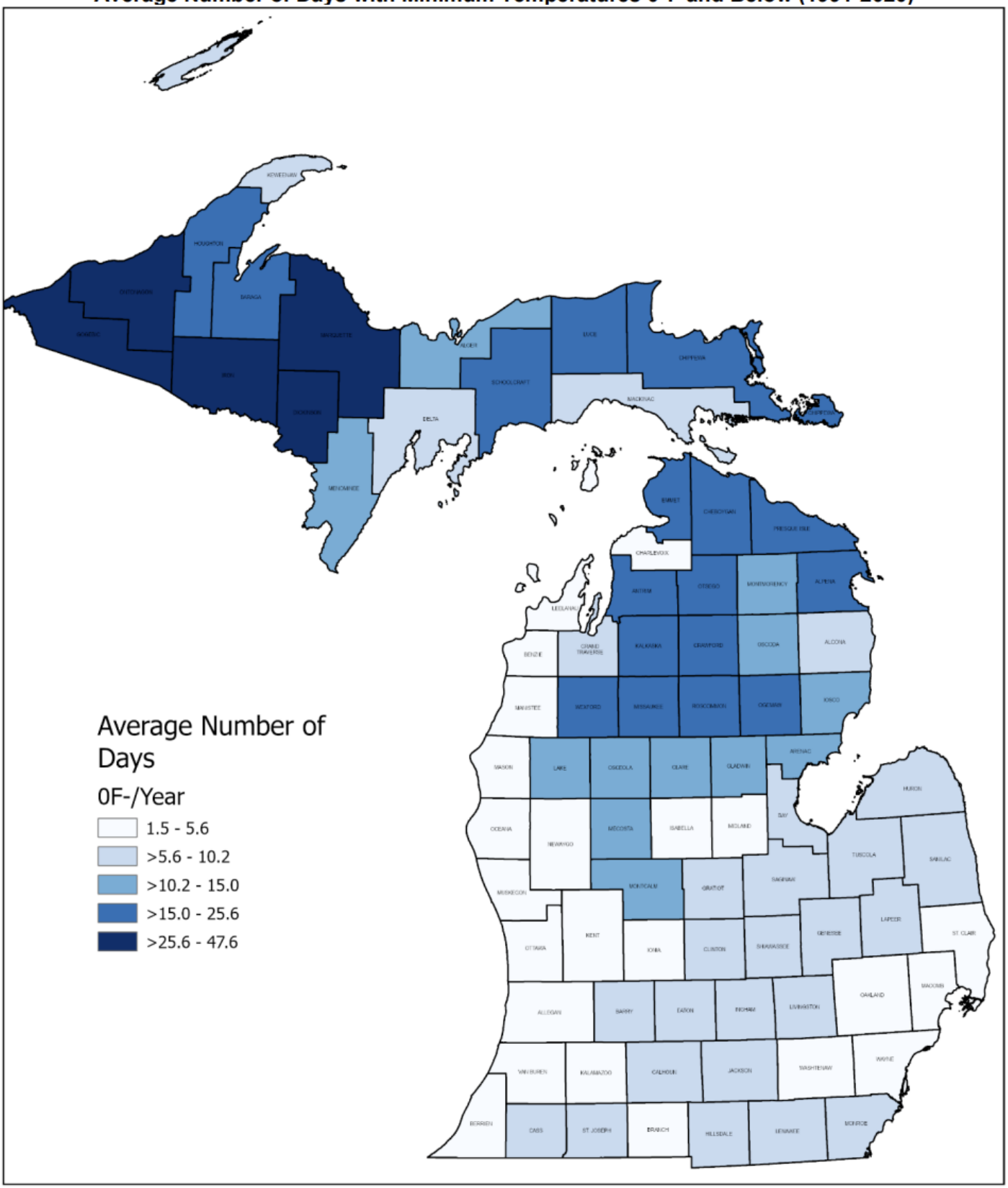
February 13 to 14 saw the coldest air of the winder entering the Traverse Bay region and causing wind chills from -30 to -40, with the Upper Peninsula going as much as 10 degrees below that. After a couple milder days, February 18 then saw a very cold Arctic air mass move in across the Upper Peninsula, causing schools to close for three days across much of the peninsula as gusty winds combined with sub-zero temperatures. Wind chill values were in the -25 to -35 range in various areas from February 18 to 20, and included many counties in the Northern Lower Peninsula on February 19, which saw even colder wind chills in the -30 to -40 range (the lowest at -43 near the City of Cadillac, in Wexford County.) Subsequent warming was felt on February 21, but similar cold returned on subsequent mornings from February 22 to 23. Arctic air returned again on the morning of February 26 and caused schools to close. The southernmost regions of the state did not feel these extremes.

Case: January 28 to February 2, 2019 – Statewide Winter Emergency

A series of heavy snowfall events began this week-long event. On Monday, January 28, much of the state faced the start of a blizzard, with snowfall ranging up to over a foot in depth as sustained winds began (with gusts up to 40 mph) and were soon accompanied by a dangerous drop in temperatures. An extremely large number of schools throughout the state were closed as a result of the snowfall, and then remained closed for most of the week as the combination of sustained subzero temperatures and strong winds produced dangerously low wind-chill values throughout the state. Wind-chill values below -30 degrees Fahrenheit were common throughout Michigan for multiple days, and often dipped below -40. In additional to numerous local states of emergency, non-essential State Government offices were closed for more than half a day on Monday, and for the entire day on Wednesday and Thursday. Governor Gretchen Whitmer’s State of Emergency declaration took effect on January 29, anticipating the dangerous impacts of the deep freeze that had been forecast by the National Weather Service. At least three deaths were attributed to weather exposure, and special shelters and over a hundred warming centers were activated at many locations around the state. Additional hospitalizations took

place, not just as a direct result of the cold, but also to treat for carbon monoxide exposures resulting from makeshift efforts to heat residents' homes. Hundreds of local and county government offices were closed for at least one or two days during the week, as well. Driving conditions were treacherous and slow. Highway M-40, southeast of Holland (Allegan County) became backed up. A 24-car pileup occurred on I-196 near Zeeland (Ottawa County), resulting in the temporary closure of that expressway. Other expressway closures occurred during the event, including I-496 and northbound US-127 in Lansing, US-131 in Allegan County, and M-37 South of White Cloud, in Newaygo County. Newaygo County also saw the Muskegon River reach a moderate flood level in Bridgeton Township and the City of Newaygo, as the result of an ice jam. Some infrastructure problems also arose from water main and pipe breaks, in places such as Lansing's Capitol Complex (Ingham County) and the northern half of the City of Newaygo (placed under a boil water advisory), and substantially lowered the water quality in Escanaba (Delta County). Many rivers experienced ice jams that threatened some areas with floods as well—Benzie County's Platte River near the Village of Honor threatened 20 homes and cottages, Berrien County near M-139 saw minor flooding near Riverfront Campground and in Niles. Excessive delays were reported at the Detroit Metropolitan Airport (Wayne County), as well as the Blue Water Transit bus system (St. Clair County) shutting down from January 30 to 31. Visibility was often a problem, with white-out conditions resulting from the blizzard. On Wednesday, January 30, at 10:33am, a fire occurred at an important Consumer's Energy facility in Armada Township (Macomb County), and when the impacts of this fire were calculated to eventually lead toward natural gas shortages, the head of that major utility, followed by the Governor, appealed to both residential and industrial customers to voluntarily reduce their use of natural gas. By voluntarily reducing thermostat levels to the recommended 65 degrees or below, until the end of the day on January 31, and temporarily scaling back production activities at certain facilities, this collective effort succeeded in preventing the complete interruption of gas delivery that otherwise was expected to occur. The problem did not involve a supply of natural gas, but only the constraints that the fire had caused in the ability to deliver that gas throughout the state's network. Temporary power failures occurred in some locations, affecting thousands of residents and businesses but fortunately not lasting very long. Other midwestern states also authorized state emergency and disaster declarations during this event. By Friday, February 1, temperatures went back above zero, and Michigan's State of Emergency expired on February 2, 2019.

Average Number of Days with Minimum Temperatures 0°F and Below (1991-2020)



Michigan State Police
Emergency Management and
Homeland Security Division

Extreme Cold Temperatures in Newaygo County

While Newaygo County is fairly insulated due to its proximity to Lake Michigan, portions of the county can still be below 0 °F between an average of 1.5 – 5.6 days per year. This can impact critical infrastructure, vulnerable populations, agriculture.

Source: Weather Underground Weather Station in Fremont, Michigan

Month	Record Low	Date	Previous Record
January	-16°F	1-3-1918	
February	-30°F	2-11-1899	
March	-11°F	3-16-1897	
April	1°F	04-07-1982	9°F (04-01-1923)
May	22°F	05-10-1974	
June	31°F	06-11-1972	34°F (06-04-1945) (06-08-1949)
July	39°F	07-2-2001	40°F (07-11-1945)
August	36°F	8-16-1979	40°F (08-15-1929)
September	27°F	09-27-1989 09-28-1991	28°F (09-25-1947) (09-26-1947)
October	19°F	10-29-1905	
November	-14°F	11-25-1950	-8°F (11-24-1950)
December	-15° F	12-31-1976	-11°F (12-30-1976)

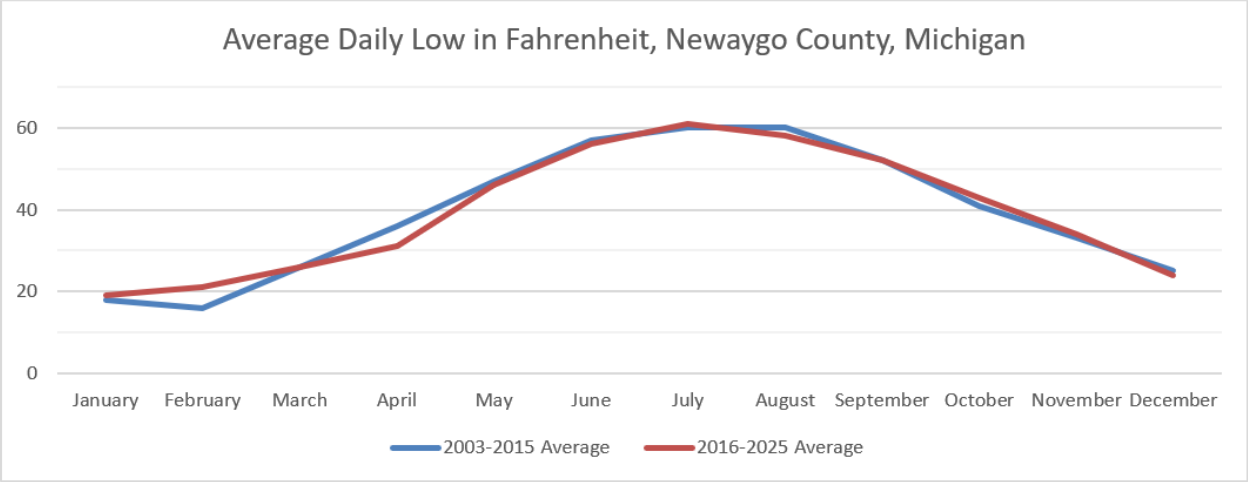


Table 3: Average Daily Low in Degrees Fahrenheit
Source: Weather Underground Weather Station in Fremont, Michigan
US Climate Data Fremont, Michigan

MONTH	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	Total Average
January	15	14	19	29	23	21	9	21	15	24	19	8	11	**18**
February	14	18	23	20	14	15	20	22	18	24	15	8	0	**16**
March	24	32	20	28	30	25	27	31	25	39	22	11	20	**26**
April	35	38	38	39	36	38	36	40	36	34	33	33	33	**36**
May	45	49	44	48	50	43	47	50	49	49	49	45	48	**47**
June	53	56	63	56	58	58	56	58	56	55	56	57	53	**57**
July	60	60	62	64	61	62	54	64	64	63	59	54	57	**60**
August	62	56	61	61	63	59	58	63	60	67	56	56	58	**60**
September	51	53	55	51	54	55	52	52	51	48	51	48	56	**52**
October	40	43	43	39	49	40	40	40	42	39	41	40	42	**41**
November	35	34	33	34	32	33	36	34	34	31	29	26	36	**33**
December	26	22	23	30	25	21	23	23	28	27	17	24	33	**25**

MONTH	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	Total Average
January	22	25	15	12	28	22	13	31	27	21				**19**
February	24	26	18	14	23	11	20	26	28	21				**21**
March	31	29	22	19	31	31	26	30	30					**26**
April	26	38	26	33	36	26	36	40	43					**31**
May	46	42	50	44	48	44	51	49	50					**46**
June	55	57	57	53	58	59	55	58	62					**56**
July	61	60	60	61	67	63	60	62	63					**61**
August	62	56	58	56	57	60	64	63	62					**58**
September	56	53	53	44	55	53	56	58	54					**52**
October	45	46	39	43	42	52	42	47	45					**43**
November	37	32	27	32	35	30	37	34	40					**34**
December	25	21	25	28	26	30	37	37	29					**24**

The following Age data is from 2020 US Census Reporter for Newaygo County at https://censusreporter.org/profiles/05000US26123-newaygo-county-mi/

Age

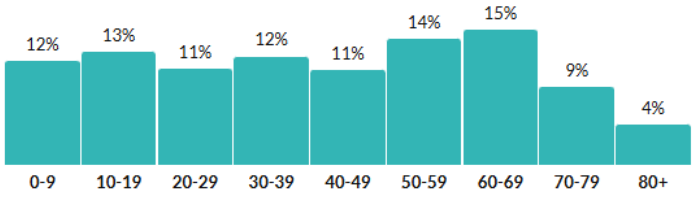
42.8

Median age

about 10 percent higher than the figure in Michigan: 40.1

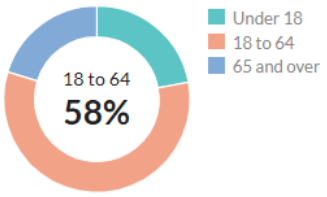
about 10 percent higher than the figure in United States: 38.7

Population by age range



Hide data / Embed

Population by age category



Show data / Embed

Population by age range (Table B01001) View table

Column	Newaygo County				Michigan				United States			
0-9	11.6%	±0%	5,856	±269.9	11.3%	±0%	1,137,655	±4,250.6	11.8%	±0%	39,042,250	±33,188.6
10-19	12.7%	±0%	6,376	±275.1	12.7%	±0%	1,278,884	±4,440.8	13.1%	±0%	43,367,691	±34,027.2
20-29	10.7%	±0%	5,404	±227.2	13.2%	±0%	1,330,315	±5,559.8	13.2%	±0%	43,983,589	±35,940.2
30-39	12.1%	±0%	6,121	±247.8	12.6%	±0%	1,268,762	±4,078.9	13.6%	±0%	45,310,101	±30,494.5
40-49	10.6%	±0%	5,331	±237	11.8%	±0%	1,180,606	±3,934	12.4%	±0%	41,291,641	±31,030.7
50-59	14.1%	±0%	7,083	±255.5	13.2%	±0%	1,321,382	±4,020.7	12.7%	±0%	42,092,439	±30,407.9
60-69	15.1%	±0%	7,599	±392.3	13.2%	±0%	1,323,482	±6,978.9	11.9%	±0%	39,670,102	±44,626.9
70-79	8.7%	±0%	4,404	±272.2	8%	±0%	802,222	±4,616.3	7.5%	±0%	24,911,038	±31,011.1
80+	4.4%	±0%	2,240	±193.5	4.1%	±0%	408,287	±3,653.3	3.8%	±0%	12,718,689	±25,070.9

VULNERABLE POPULATIONS SUMMARY

Adult Foster Care Homes and Home for the Aged
Total Homes in Newaygo County: 14
Total Capacity: 87

Adult Foster Care (AFC) homes are residential settings that provide 24-hour personal care, protection, and supervision for individuals who are developmentally disabled, mentally ill, physically handicapped, Alzheimer's Disease or other Dementia Related Disorder or aged who cannot live alone but who do not need continuous nursing care. AFC Homes are restricted to providing care to no more than 20 adults

A **Home for the Aged** (HFA) provides 24 hour room, board, and supervised personal care to:

- 21 or more unrelated, non-transient individuals 60 years of age or older.
- 20 or fewer individuals 60 years of age or older that is operated in conjunction with and as a distinct part of a licensed nursing home.

Note: HFA is restricted to providing care to persons who are 60 years of age or older

Newaygo County Day Care Providers
Total Day Care Centers in Newaygo County: 70
Total Capacity: 2,929

Newaygo County Schools
Total Schools (Buildings) in Newaygo County: 29
Total Capacity: 11,902 School Age Children

Newaygo County Community Churches
Total Churches in Newaygo County: 71
Total Capacity: 9,870

Apartment Complexes
Total Complexes in Newaygo County: 20
Total Capacity: Approximately 660

Mobile Homes Communities
Total Mobile Homes Communities in Newaygo County: 13
Total Capacity: 14,336

Campgrounds and Resorts
Total Campgrounds in Newaygo County: 38
Total Capacity: Approximately 2,536

Youth Camps
Total Youth Camps in Newaygo County: 7
Total Capacity: 1,484

Hotels and Motels
Total Hotels and Motels in Newaygo County: 19
Total Capacity: Approximately 566

Community Vulnerability:

Extreme cold can have a profound effect on public life safety. Nationwide statistics show extreme cold ranking behind only structure fires as a leading cause of fatalities. Looking beyond direct morbidity/mortality, greater energy use can also result in infrastructure failures due to the capacity limitations of utility systems. Warming centers may need to be operated. The main impacts upon facilities come from frozen pipes. These can range from small internal pipes within homes to large utility mains. Freezing can cause minor leaks or completely burst pipes with extensive water damage. Drinking water may be compromised whether on utility systems or wells. Schools and businesses are routinely impacted. Cold temperatures and thawing cycles are well known to have an impact on roadways and other infrastructure, which may become more brittle. General travel may become problematic and electric vehicles may not work as well.

Extreme cold can also have an economic impact on the state of routine businesses and organizers of outdoor events (e.g., sports, concerts) may be impacted by heating challenges, disrupted water service, or canceled events. General business productivity may be lowered. Many agricultural crops and livestock are vulnerable to losses because of extreme cold events (see the supplemental materials section of this chapter). Transportation and logistics hubs may be shut down. Deliveries may be delayed as vehicles stop working in the cold (e.g., dead batteries). Planes will need extensive deicing, and maritime traffic may be impacted by frozen waterways.

Being a rural community, there is also a large impact on responders, continuity of operations, and continued delivery of services. Freezing conditions may directly impact the health and effectiveness of responders, including the potential for dealing with impacts on overwhelmed or failed infrastructure. Special clothing and equipment maintenance is typically necessary. Frozen pipes may inhibit responders' access to water that is needed to fight fires. Some structure fires may become more common as people turn to extreme methods to heat their homes. Carbon monoxide poisoning may increase ambulance calls and hospital admissions. Schools and other governmental services may be closed.

FLOODING

Flooding

To cover or submerge a place or area with water.

Flooding Hazard Description

Flood hazards in Michigan include dam failures, riverine flooding, urban flooding, and Great Lakes shoreline flooding, and erosion. Thunderstorms, snowstorms, and ice/sleet storms produce precipitation that can cause or exacerbate flooding—either immediately or when the frozen precipitation melts. Ice can build up and block critical parts of drainage-ways and thus cause flooding. Similarly, woody debris from severe winds, wildfires, or invasive species can cause trees, utility poles, etc., to build up and jam streams or drains. Extreme cold has caused freeze events in which pipes and water mains have broken and caused floods. Human related hazards such as terrorism, sabotage, or civil disturbances may cause water-related infrastructure to be disabled and thus cause or worsen floods as well. Floods can also cause landslides and subsidence problems.

Floods cause extensive property damage each year, reduced quality of life, and even injuries and deaths. Floods can damage or destroy public and private property, disable utilities, make roads and bridges impassable, destroy crops and agricultural lands, cause disruption to emergency services, and result in fatalities. During floods, people may be stranded in their homes for several days without power or heat, or they may be unable to reach their homes at all. Long-term collateral dangers include the outbreak of disease, widespread animal death, broken sewer lines causing water supply pollution, downed power lines, broken gas lines, fires, and the release of hazardous materials.

Every year, flooding causes more than $2 billion of property damage in the U.S. Michigan flood disasters cause an average of more than $100 million in property damage annually. In a high-risk (“Special Flood Hazard”) area, a home has at least a 26% chance of being damaged by a flood during the course of a 30-year mortgage, compared to a 9% chance of being damaged by fire.

Riverine Flooding

Riverine flooding is defined as the periodic overflowing of rivers, streams, and channels—due to inadequate drainage capacity, drainage system failures, ice or log jams, accumulated sediments, erosion, or meandering—that results in nearby property damage, safety issues, disruption of infrastructure function and services, and/or decreased quality of life.. Flooding of land adjoining the normal course of a stream or river has been a natural occurrence since the beginning of recorded history. If these floodplain areas were left in their natural state, floods would not cause significant damage. Development has increased the potential for serious flooding because rainfall that used to soak into the ground or take several days to reach a river or stream via a natural drainage basin now quickly runs off streets, parking lots, and rooftops, and through man-made channels and pipes. Some developments have also encroached into flood plain areas and thus impeded the carrying capacity of the drainage area. Floods can also result when vital drainage channels become clogged with ice, logs, or debris.

Urban Flooding

Not all flooding occurs within recognized floodplain areas, or adjacent to rivers and lakes. In some cases, melting snow or other runoff waters pool in low-lying areas, damaging structures and inhibiting the function of roads and infrastructure. In other cases, some type of breakdown in an area's pumping or drainage infrastructure may result in a damaging flood. This type of flooding typically occurs in well-developed urban or suburban areas, and therefore is often called urban flooding. It tends to occur due to either (1) a breakdown in infrastructure or (2) inadequate planning and design standards on the part of builders, developers, engineers, architects, and planners.

Dam Failures:

Dam failures are defined as the collapse or failure of an impoundment that results in downstream flooding. Dam failures can result in loss of life and extensive property or natural resource damage for miles downstream from the dam. Failure of a dam does not only occur during flood events, which may cause overtopping of a dam. Failure can also result from poor operation, lack of maintenance and repair, and vandalism. Such failures can be catastrophic because they occur unexpectedly, with no time for evacuation. The Michigan Department of Environmental Quality (MDEQ) has documented approximately 302 dam failures in Michigan since 1888.

The worst recorded dam failure in U.S. history occurred in Johnstown, Pennsylvania, in 1889. More than 2,200 people were killed when a dam upstream from Johnstown failed, sending a huge wall of water downstream which completely inundated the town.

Great Lakes Shoreline Flooding

Michigan has over 3,200 miles of coastline (the longest freshwater coastline in the world), and about 4.7 million persons live in the state's 41 shoreline counties. Wind, waves, water levels, and human activities constantly affect the communities along the shores of the Great Lakes. Shoreline flooding and erosion are natural processes, occurring at high, average, and even low Great Lakes water levels. However, during periods of high water, flooding and erosion are more obvious, causing serious damage to homes and businesses, roads, water and wastewater treatment facilities, and other structures in coastal communities. Low lake levels can also pose a hazard, as cargo ships are more prone to running aground and the shorelines may also become more polluted from lake bottom debris. Long-term and seasonal variations in precipitation and evaporation rates primarily control the Great Lakes water levels and their fluctuations.

Erosion

Soil erosion is defined as the displacement of the upper layer of soil. This natural process is caused by the dynamic activity of erosive agents, that is, water, ice, snow, air, plants, animals and humans. Erosion of soil and other land may eventually cause damage to the roads, structures, and infrastructure that relies on it for stability and support. For example, occasional reports have been received of a house near a river, whose foundation has become at-risk after decades of supporting Earth that has been cut away and moved downstream by the flowing

water. Stabilization measures are required in order to keep the house's foundation from becoming destabilized, or even the entire slope of the hillside from eventually giving way in a landslide event. Such things are well-known on Michigan's Great Lakes shores, where the extensive forces of the lake waters cause erosion to occur far more rapidly and dramatically than most of Michigan's rivers (please refer to the chapter on Great Lakes Shoreline Hazards in this document, for more information). Although riverine erosion does not normally result in a community-level disaster or emergency event, structures and infrastructure that are at-risk from erosion may nevertheless benefit from the application of hazard mitigation funds for their protection. There can actually be cases in which erosion eventually makes infrastructure exposed and vulnerable, and leads to local emergency events if a road or bridge collapse eventually occurs. The most common events of this type involve the erosion of the land surrounding an undersized culvert or pipe, eventually causing the water to completely break down the integrity of the land that supports a roadway or bridge, making an important transportation route impassable and sometimes causing deaths during its collapse. There are other cases in which a water main, gas line, or underground utility cables can eventually become exposed and vulnerable to freezing weather, breakage and leaks, or the inflow of water, causing an infrastructure breakdown.

Riverine Flooding Hazard Analysis

Floodprone areas are found throughout the state, as every lake, river, stream and open drain has a floodplain. The type of development that exists within the floodplain will determine whether or not flooding will cause damage. The Michigan Department of Environmental Quality (MDEQ) estimates that about 6% of Michigan's land – roughly the size of the southeast Michigan counties of Wayne, Oakland, Macomb, Washtenaw, and Monroe combined – is floodprone, including about 200,000 buildings. The southern half of the Lower Peninsula contains the areas with the most flood damage potential. Michigan statewide expected annual losses from flooding are estimated at more than $100 million.

The primary fluvial flood sources include the connecting waters between the Great Lakes (Detroit River, St. Clair River, and St. Marys River), thousands of miles of rivers and streams, and hundreds of inland lakes. Michigan can be divided into 63 major watersheds (including 23 component watersheds for various important branches and tributaries) and lakeshed areas along the shoreline, as shown in the map at the beginning of the flood hazards section. All of these watersheds experience flooding, usually with fewer problems in the higher-elevation headwater areas and greater problems in downstream urban areas. Flooding can occur on various branches of rivers, creeks, and other water channels. The following watersheds have experienced the most extensive flooding problems or have significant damage potential: 1) Clinton River; 2) Ecorse River; 3) Grand River; 4) Huron River; 5) Kalamazoo River; 6) Muskegon River; 7) Saginaw River; 8) Rifle River; 9) River Raisin; 10) Rouge River; 11) St. Joseph River; and 12) Whitefish River. The flooding is not restricted to the main branches of these rivers.

Most riverine flooding occurs in early spring and is the result of excessive rainfall and/or the combination of rainfall and snowmelt. Ice jams are also a cause of flooding in winter and early spring. Log jams can

also cause streams and rivers to be clogged up, and the backed-up waters to overflow the stream's banks. Either ice jams or log jams can cause dangerous flash flooding to occur if the makeshift dam-effect caused by the ice or logs suddenly gives way. Severe thunderstorms may cause flooding during the summer or fall, although these are normally localized and have more impact on watercourses with smaller drainage areas.

Riverine Flooding in Michigan

In Michigan, significant flooding tends to occur each year, although the locations of flood events tend to vary with precipitation patterns. Some of Michigan's largest disaster declarations have involved flooding, although widespread urban floods have recently caused more damage than riverine flooding. Michigan has experienced 14 flood disasters since 1975 which resulted in both a Presidential Major Disaster Declaration and a Governor's Disaster Declaration (opening up the full range of federal and state supplemental disaster assistance). That averages about one major disaster every three years, but the average during the 21st Century has increased to about one every two years. A slightly lower number of additional events have resulted only in a Governor's Disaster Declaration (activating state supplemental and limited federal disaster assistance). Combined, these flood disasters have caused billions of dollars in damage to homes, businesses, personal property, and agriculture. These disasters include all types of floods.

The following brief synopses describe Michigan flood events in the past few decades in which flood impacts predominantly occurred in or near identified floodplains that surround rivers, other drainage channels, and inland lakes (or as a result of jams or failures in watershed drainage channels). Events which were predominantly pluvial or urban in nature (involving excessive runoff, ponding, and failures of urban storm sewer systems) will be emphasized within the next section. Many other damaging flood events have occurred at the local level, without qualifying for a governor's disaster declaration, and some of these are included in the following descriptions

Case: April 1975 – Southern Lower Michigan: Federal Disaster #465

A series of intense thunderstorms struck southern Lower Michigan in the last two weeks of April 1975, spawning several tornadoes and causing widespread flooding over a 21 county area. Total public and private damage was nearly $58 million. A Presidential Major Disaster Declaration was granted for the 21 affected counties.

Case: September 1975 – West Central / Central Lower Michigan: Federal Disaster #486

During the last week of August and first week of September 1975, intense thunderstorms and severe winds pounded a 16 county area in west-central and central Lower Michigan. Intense rainfall accompanying these storms caused widespread flooding, resulting in nearly $3 million in public and private damage. A Presidential Major Disaster Declaration was granted for the 16 affected counties.

Case: September 1986 – Central Lower Michigan: Federal Disaster #774

Beginning on September 10, 1986 a slow moving low-pressure system moved across the middle of the Lower Peninsula. In a 24-hour period, the intense rainstorm produced rainfall ranging from 8 to 17 inches over an area 60 miles wide and 180 miles long. In Big Rapids, 19" of rain fell from September 9

to 12. The storm resulted in thousands of people being evacuated due to flooding. Five people were killed and 89 injured. (Up to ten were killed, if indirect effects are included.) About 30,000 homes suffered basement and structural damage and 3,600 miles of roadways were impassable as a result of the failure of four primary bridges and hundreds of secondary road bridges and culverts. The heavy rainfall resulted in 11 dam failures and 19 others that threatened with failure, resulting in about 1,500 people being evacuated downstream of the dams. The failure and threatened failure of these dams was primarily the result of inadequate spillway capacity. Most of the dams were constructed without an emergency spillway, and didn't have an adequate inspection and maintenance program. The excessive rainfall resulted in the design capacity of the dam being exceeded, causing failure of the dam or intentional breaching of the embankment to save certain portions of the structure. Fortunately, no deaths or injuries were attributable to this series of dam failures. Over $300 million in damage resulted from the flood. This was the worst flood in Michigan in 50 years. Thirty (30) counties were included in the Presidential Major Disaster Declaration granted for this flood.

Case: June 1997 – West Michigan

On June 20-21, 1997 a series of intense thunderstorms passed through West Michigan, spawning heavy rainfall that flooded many areas in Allegan, Ottawa, Barry, and Van Buren counties. Flood and wind damage was particularly severe in Allegan County, which reported four injuries, five homes destroyed and 234 damaged, and 37 businesses damaged. Damage to public facilities, roads and bridges, and culverts and drainage channels totaled nearly $1.5 million. Ottawa County officials reported damage to 111 homes and five businesses, in addition to nearly $700,000 in public damages. On June 27, 1997, a Governor's Disaster Declaration was granted to Allegan and Ottawa counties to provide supplemental state assistance for the public damage. The SBA provided low-interest disaster loans to those home and business owners that suffered uninsured damage from the flooding or wind.

Case: May-June 2004 – Southern Lower Michigan

In May 2004, a stationary front over Iowa, Wisconsin, and Michigan brought severe thunderstorms and heavy rains, which caused widespread flooding over Southern Lower Michigan. Much of the rainfall occurred in saturated areas that had experienced well-above average precipitation for the month of May. Over a 36 hour period (12 am May 22nd to 8 am May 23rd), 2 to 6 inches of rain fell across Southeast Michigan. Backyards were submerged under several feet of water. About 100 homes in Macomb County had damage of about $100,000 each. Road and bridge damage was expected to cost $10 million to repair. Total rainfall over the Grand River basin from May 20th through June 3rd varied from four to as much as seven inches. It was the biggest and longest duration flooding event in the past ten to twenty years across southwestern and south central Lower Michigan. It was the wettest May on record in Lansing and Muskegon and the third wettest May on record in Grand Rapids. A Presidential Major Disaster Declaration was granted to 23 counties in Southern Lower Michigan.

Case: June 2008 – Lower Peninsula: Federal Disaster #1777

Beginning on June 6, severe weather impacted twelve counties and two major population centers in the southwest and central Lower Peninsula. The National Weather Service reported two flash floods that exceeded the "100-year" threshold, confirmed three EF1 tornadoes, and also noted severe thunderstorms with winds exceeding 100 mph. Rainfall totals were estimated between 7 and 12 inches,

exceeding the “100-year” rainfall values of 3.5 inches in less than 6 hours. Flash flooding washed out roads, flooded crops, and caused moderate flooding of rivers and streams. A large severe thunderstorm squall line affected Southwest Michigan on June 8, with four counties experiencing winds of 75 to 100 mph. Disaster declarations were requested and received in July, for 11 full counties.

April - May 2013 – Western Lower and Upper Peninsulas: Federal Disaster #4121
Record flooding occurred during the month of April, most directly caused by an accumulation of heavy rains and resulting in disaster declarations for numerous counties across the western portions of the state (plus the cities of Grand Rapids and Ionia, which were both specifically named in the Governor’s disaster declaration). Hundreds of homes were flooded, more than 300 roads were closed, and the preliminary damage assessments totaled more than 32 million dollars. The flooding was exacerbated by the melting of significant snowpack—especially in the Western and Central Upper Peninsula. According to the NCDC website in 2014, the following damage amounts were sustained by each of the following counties: $5 million in Allegan, $5 million in Barry, $5 million in Calhoun, $3 million in Clare, $5 million in Clinton, $3 million in Eaton, $1 million in Gogebic, $3 million in Gratiot, $2.9 million in Houghton, $5 million in Ingham, $7 million in Ionia, $3 million in Isabella, $3 million in Jackson, $5 million in Kalamazoo, $3 million in Lake, $625,000 in Marquette, $3 million in Mason, $3 million in Mecosta, $1.4 million in Midland, $3 million in Montcalm, $5 million in Muskegon, $5 million in Newaygo, $3 million in Oceana, $550,000 in Ontonagon, $3 million in Osceola, $5 million in Ottawa, $1.3 million in Saginaw, and $3 million in Van Buren.

April 12, 2014 – Newaygo and Osceola Counties
About 400 homes along the Muskegon River were impacted by flooding as snowfall and rainfall caused the river levels to rise greatly. About $4 million in property damage was estimated in Newaygo County, and $3 million in Osceola County. Significant road damage also resulted. A governor’s disaster declaration was proclaimed for floods in these two counties, although the storm event also involved a great deal of wind damage in and around these areas.

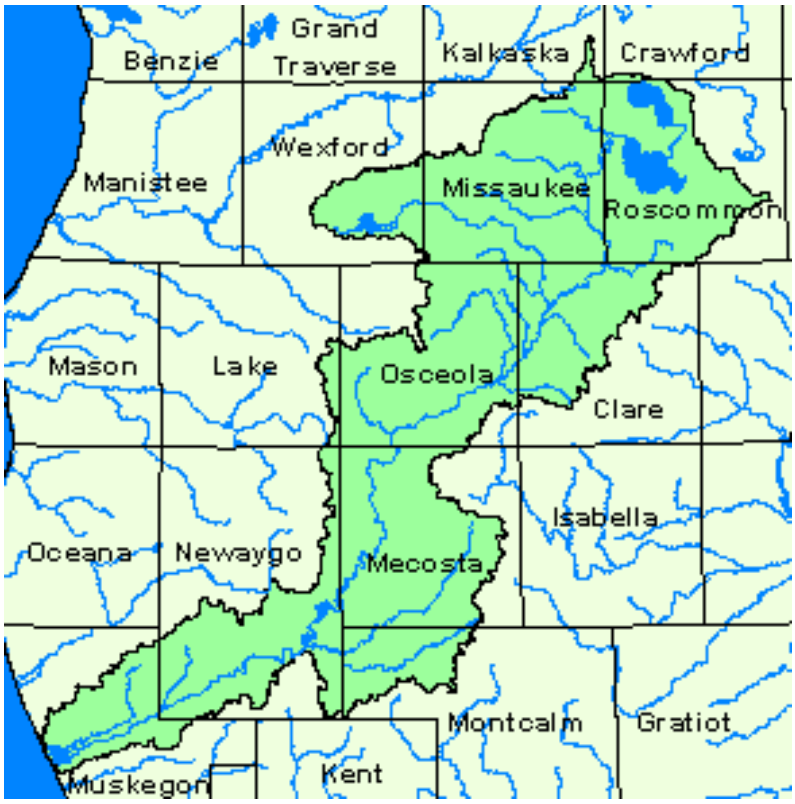
Climate Change Considerations
One of the Michigan trends connected with climate change is to experience increasing amounts of precipitation. Moreover, this precipitation is considered more likely to take the form of acute (and severe) weather events. As mentioned in the winter weather sections, a larger proportion of snow precipitation occurring in snowstorm events can cause more extensive snow accumulation which, under unlucky temperature patterns, may add to the drainage burdens of the normal melting and rainfall patterns of the spring season. In short, spring flood risks are likely to worsen, as are ice jam related winter flood risks.

Riverine Flooding in Newaygo County

Like many Michigan communities, Newaygo County is permeated with numerous lakes, rivers, and streams of varying sizes, including 234 natural lakes and ponds, 356 miles of rivers and streams covering 12,543 acres. Naturally, these have resulted in a significant amount of seasonal and permanent housing development along the scenic waterways and have added to the area's popularity in recreational activities.

Along with the role that the water base has played in the jurisdiction's development, it has also resulted in a significant flooding risk to those same areas of the population. Minor flooding occurs annually along the low lying areas of the Muskegon River and White River, which regularly affect the permanent and seasonal residences in the associated sub-divisions.

The Muskegon River

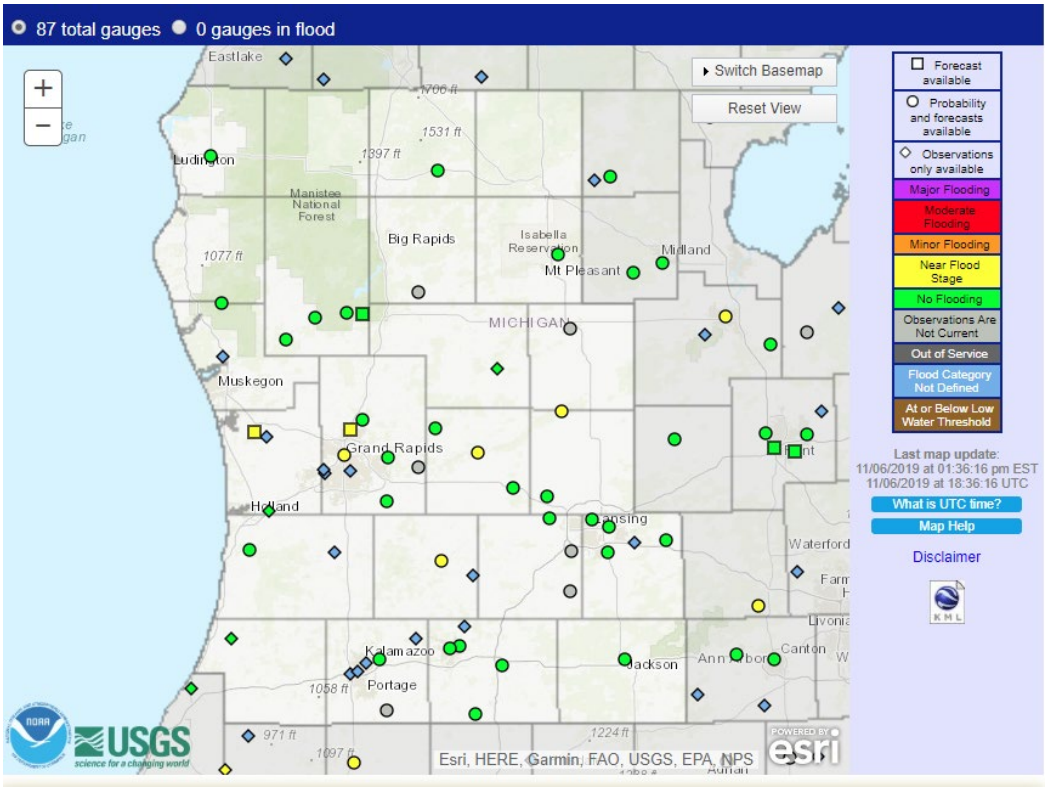


The Muskegon River Watershed begins in north-central lower Michigan, flowing from Higgins and Houghton Lakes, southwesterly to the City of Muskegon and discharging into central Lake Michigan. The watershed incorporates over 2,350 square miles of land with approximately 94 tributaries flowing directly into the Muskegon River. Most of the watershed is contained within eight counties: Roscommon, Missaukee, Clare, Osceola, Mecosta, Montcalm, Newaygo, and Muskegon. The Muskegon River is the main stem river within the Muskegon River Watershed. The river is 212 miles long and drops 575 feet in elevation between its sources and the river mouth.

There are numerous dams and impoundments in the Muskegon River watershed. Many dams are not registered with the State of Michigan and are established on tributary streams. Four dams are currently located on the Muskegon River and include Reedsburg Dam (constructed in 1940), Rogers Dam (constructed in 1906), Hardy Dam (constructed in 1931), and Croton Dam (constructed in 1907). The Hardy Dam and Croton Dams are both located within Newaygo County.

USGS River Gauges on the Muskegon River

A system of United States Geological Survey (USGS) stream gauges exists across Michigan and is linked with a real-time remote monitoring system through the internet (www.waterwatch.usgs.gov). Most gauges commonly measure the height and volume of water flowing through rivers. Live updates and old records from the gauges are available online. Local, State, and Federal agencies rely on the data for flood forecasting and issuing permits. Along the Muskegon River there are four USGS stream gauges. One is located in Osceola County in the City of Evart, and three are located in Newaygo County below the Croton Dam.

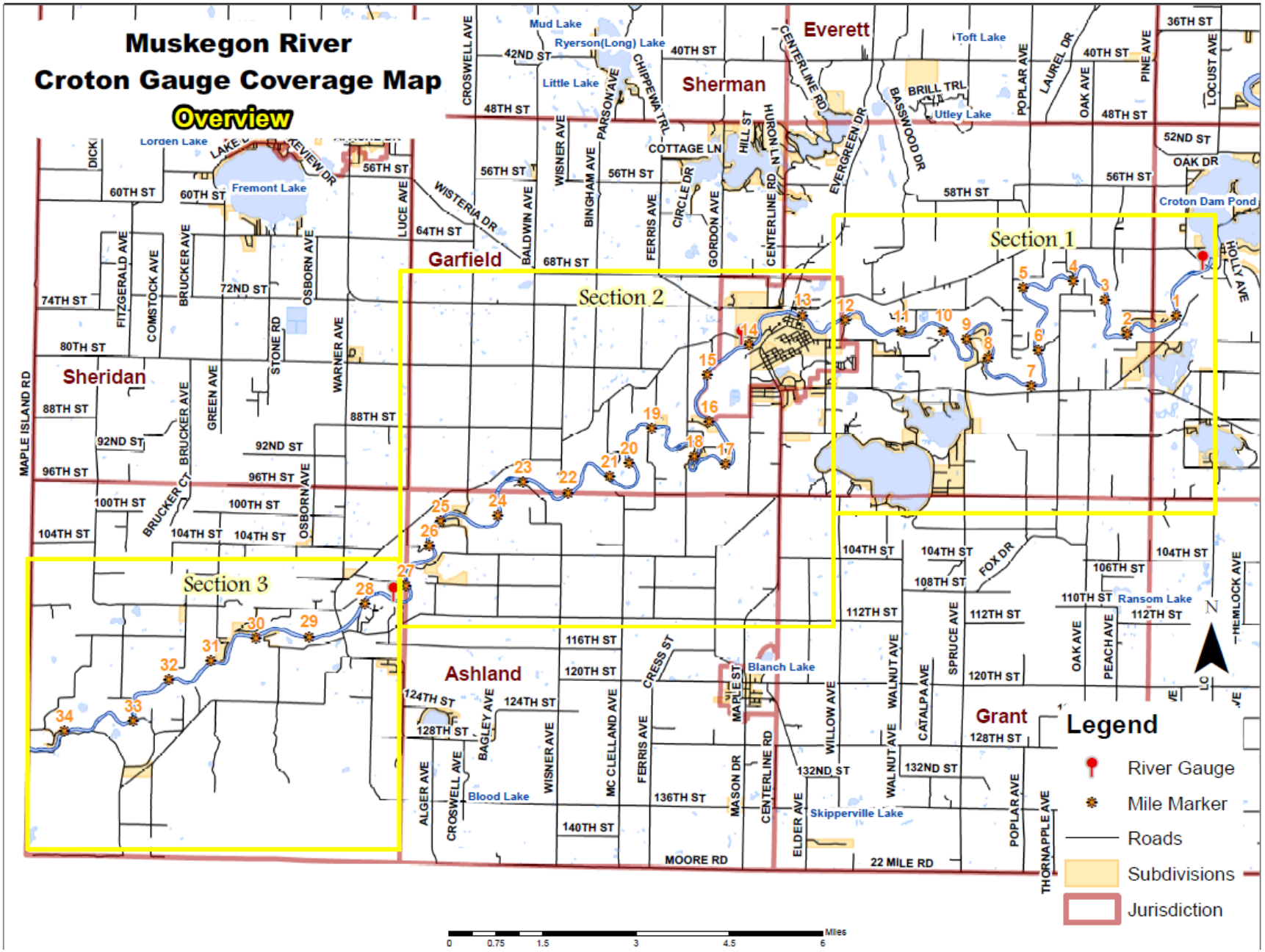


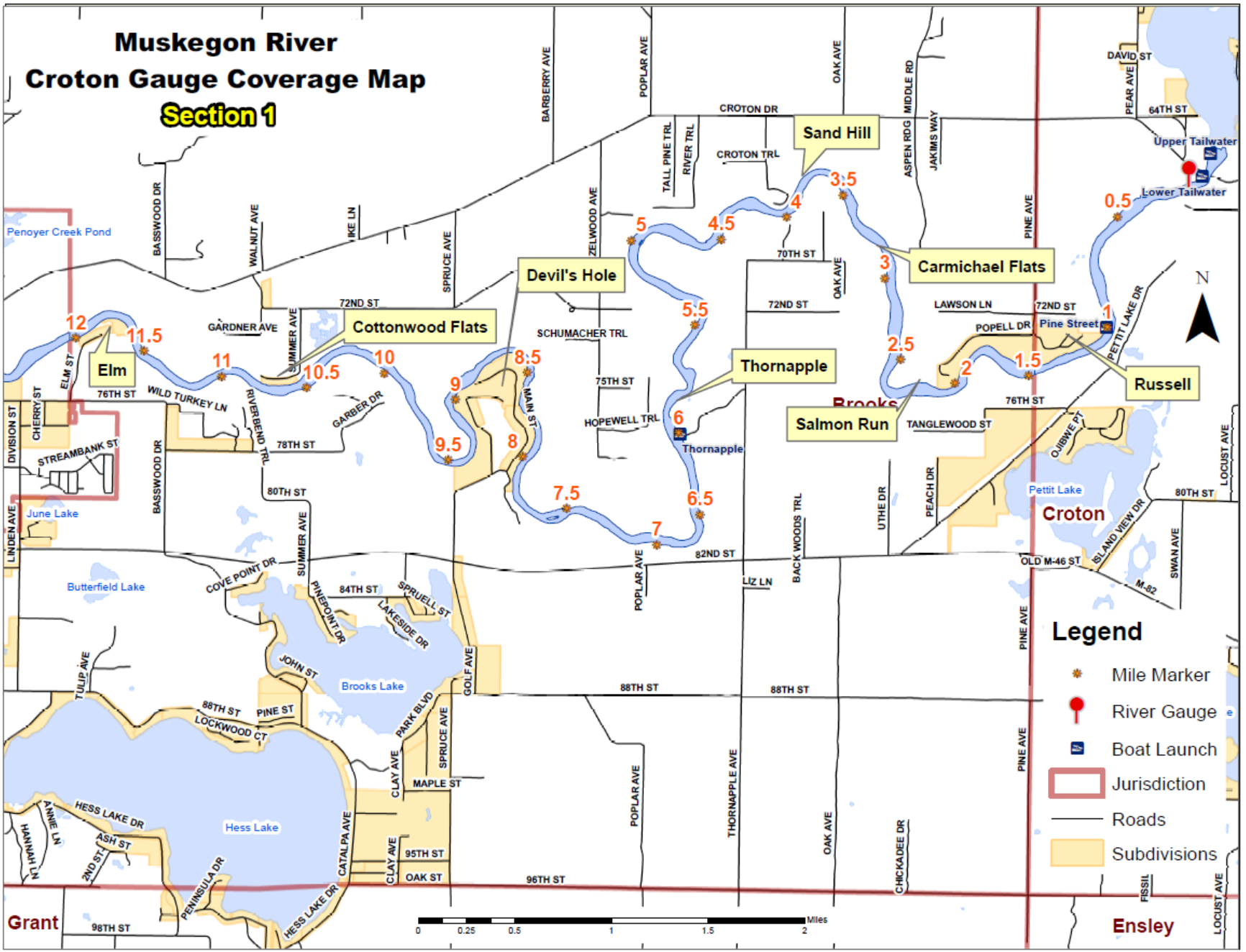
Correlation between the USGS River Gauges on the Muskegon River

During flooding conditions it takes approximately 2.5 hours for water to flow from Croton to Newaygo and approximately 13.0 hours for water to flow from Croton to Bridgeton. The Newago Gauge reads approximately 2.7 feet more than the Croton Gauge. The Bridgeton Gauge reads approximately 4.8 feet more than the Croton Gauge.

Formulas	Clear	Heavy Rain
Thornapple	= to Croton	= to Croton
Newaygo	Croton + 2.4'	Croton + 2.7
Newbridge in Newaygo	Croton + 2.4'	Croton + 2.7
Anderson Flats (Felch)	Croton + 2.4'	Croton + 3.4'
Bridgeton	Croton +3.9'	Croton +4.8'
Maple Island	Croton + 2.9'	Croton + 3.9'

The clear formulas are based on the river being held steady for over 3 days and observing the gauges. Heavy rain accounts for the rises at Croton, as well as other sources feeding into the river.

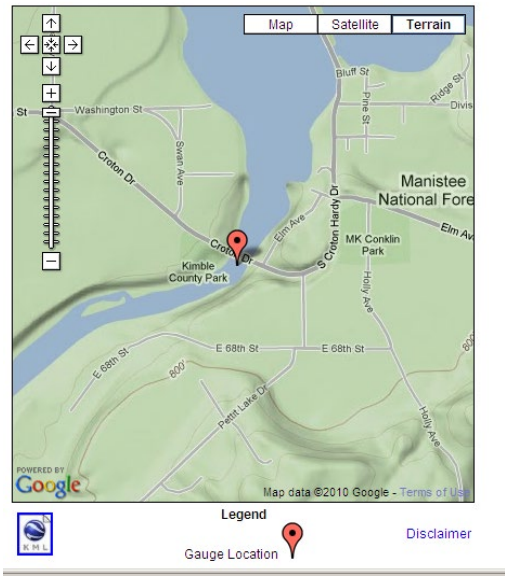

Muskegon River
Croton Gauge Coverage Map
Overview
Section 1
Section 2
Section 3
Sheridan
Garfield
Sherman
Everett
Ashland
Grant
Mud Lake
Ryerson(Long) Lake
Little Lake
Toft Lake
Utley Lake
Lorden Lake
Fremont Lake
Croton Dam Pond
Blanch Lake
Ransom Lake
Blood Lake
Skipperville Lake
Legend
River Gauge
Mile Marker
Roads
Subdivisions
Jurisdiction
Miles
0
0.75
1.5
3
4.5
6
N


Muskegon River
Croton Gauge Coverage Map
Section 1
Sand Hill
Carmichael Flats
Devil's Hole
Cottonwood Flats
Thornapple
Salmon Run
Russell
Elm
Upper Tailwater
Lower Tailwater
Pine Street
Thornapple
Penoyer Creek Pond
June Lake
Butterfield Lake
Brooks Lake
Hess Lake
Pettit Lake
Croton
Grant
Ensley
Legend
Mile Marker
River Gauge
Boat Launch
Jurisdiction
Roads
Subdivisions
Miles
0
0.25
0.5
1
1.5
2
N

USGS 04121970 Muskegon River at Croton, MI Flood Impacts (Established in 1994)

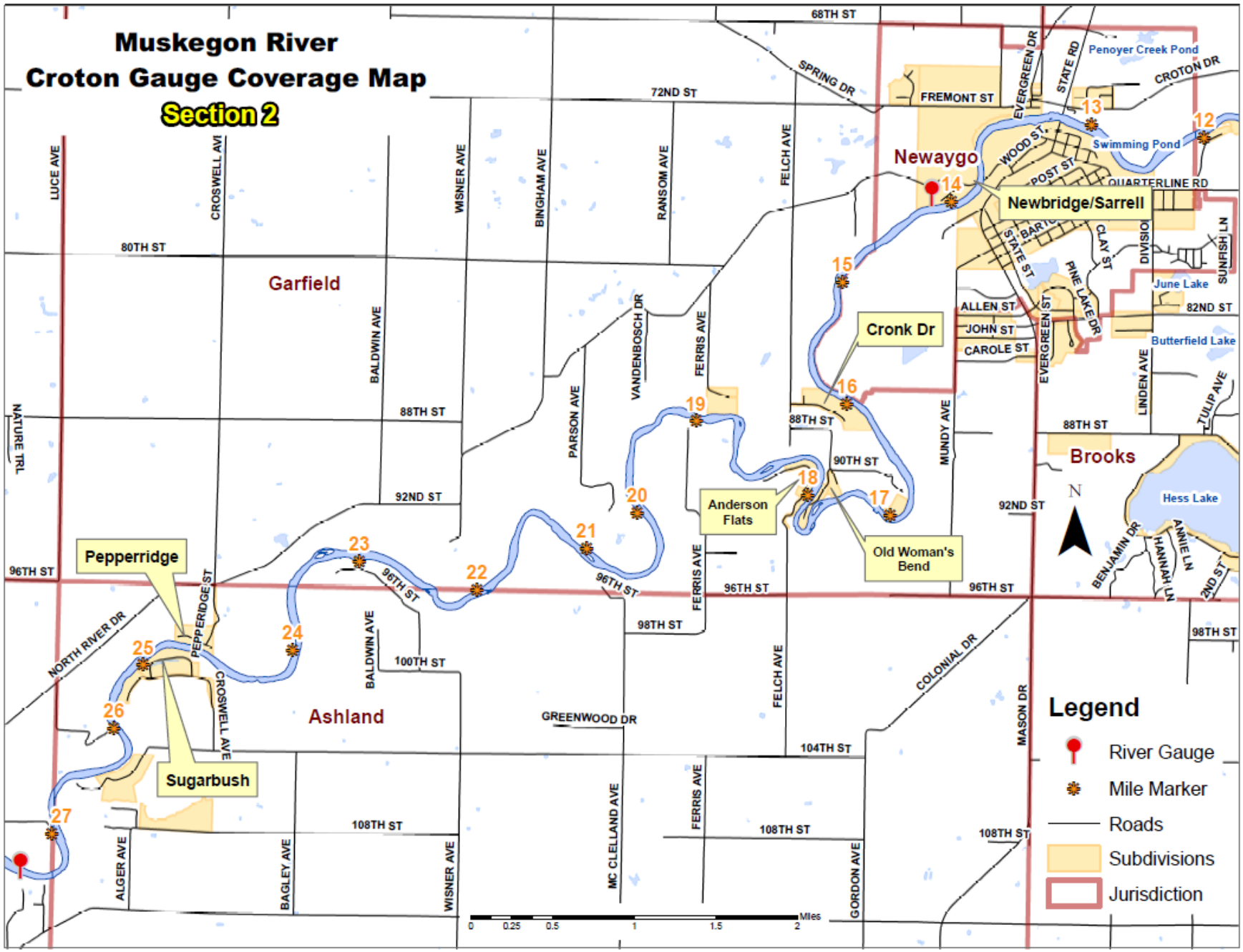
Near Flood Stage	8 Ft	
Flood Stage	9 Ft	Minor Flooding – Minimal property damage, public inconvenience
Moderate Flooding Stage	11 Ft	Moderate Flooding – Some inundation, possible evacuations
Major Flood Stage	12 Ft	Major Flooding – Extensive inundation and evacuations

13.0	Flood water begins surrounding properties on Russel Road in Croton Township… Cottonwood Flats and Gould Subdivision in Brooks Township... Expect Major flooding of cottages and homes downstream from Croton in the areas of Devil's Hole, Muskegon Blvd, 3740 and 3710 E Croton Drive, and 6812 S Thornapple Ave in Brooks Township. Expect Main Street in Brooks Township to be closed… Expect all public River Access Sites to be closed.
12.0	Expect major flooding of cottages and homes downstream from Croton in the areas of Devil's Hole, Muskegon Blvd, 3740 and 3710 E Croton Drive, and 6812 S Thornapple Ave in Brooks Township. Expect Main Street in Brooks Township to be closed. Expect minor flooding in the areas of Salmon Run in Brooks Township. Expect all public River Access Sites to be closed.
11	Expect moderate flooding of cottages and homes downstream from Croton in the areas of Devil's Hole, Muskegon Blvd, 3740 and 3710 E Croton Drive, and 6812 S Thornapple Ave in Brooks Township. Expect water to begin coming over Main Street in Brooks Township. Expect water to begin surrounding homes downstream from Croton in the areas of Salmon Run in Brooks Township. Expect all public River Access Sites to be closed.
10	Flood water begins surrounding cottages and homes downstream from Croton in the areas of Devil's Hole, Muskegon Blvd, 3740 and 3710 E Croton Drive, and 6812 S Thornapple Ave in Brooks Township. Expect all public River Access Sites to be closed.
9.0	Expect minor flooding of low lying areas along the river downstream from Croton.
8.0	River is at bankfull. River begins to exceed its banks and minor flooding begins in low lying areas along the river.



Historical Crests for the USGS Gauge at Croton

Rank	Date	Gauge Height	Stream Flow
1	9/12/1986	16.80 feet	(Calculated)
2	4/15/2014	12.87 feet	15,100 cfs
3	2/21/2018	11.55 Feet	12,300 cfs
4	4/19/2013	11.11 feet	11,000 cfs
5	4/29/2011	10.64 feet	9,970 cfs
6	5/24/2004	10.45 feet	9,580 cfs
7	5/19/2020	10.33 feet	9,680 cfs
8	3/15/2019	10.08 feet	9,180 cfs
9	3/31/2016	9.98 feet	8,660 cfs
10	1/30/2013	9.88 feet	7,100 cfs
11	2/23/2018	9.63 feet	8,010 cfs
12	5/10/2004	9.52 feet	7,810 cfs
13	3/14/2006	9.42 feet	7,630 cfs
14	10/02/2019	9.21 feet	7,530 cfs
15	4/2/1998	9.12 feet	7,130 cfs
16	4/4/2005	9.10 feet	7,080 cfs
17	10/25/2017	9.04 feet	7,230 cfs


Muskegon River
Croton Gauge Coverage Map
Section 2
Garfield
Ashland
Newaygo
Brooks
Newbridge/Sarrell
Cronk Dr
Anderson Flats
Old Woman's Bend
Pepperridge
Sugarbush
Penoyer Creek Pond
Swimming Pond
June Lake
Butterfield Lake
Hess Lake
68TH ST
72ND ST
80TH ST
88TH ST
90TH ST
92ND ST
96TH ST
98TH ST
100TH ST
104TH ST
108TH ST
FREMONT ST
QUARTERLINE RD
ALLEN ST
JOHN ST
CAROLE ST
SPRING DR
CROTON DR
LUCE AVE
CROSWELL AVE
WISNER AVE
BINGHAM AVE
RANSOM AVE
FELCH AVE
BALDWIN AVE
VANDENBOSCH DR
FERRIS AVE
PARSON AVE
MUNDY AVE
EVERGREEN DR
STATE RD
WOOD ST
POST ST
CLAY ST
PINE LAKE DR
DIVISION
SUNFISH LN
LINDEN AVE
TULIP AVE
NATURE TRL
NORTH RIVER DR
PEPPERIDGE ST
GREENWOOD DR
COLONIAL DR
MASON DR
ALGER AVE
BAGLEY AVE
MC CLELLAND AVE
GORDON AVE
BENJAMIN DR
HANNAH LN
ANNIE LN
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
N
0 0.25 0.5 1 1.5 2 Miles
Legend
River Gauge
Mile Marker
Roads
Subdivisions
Jurisdiction

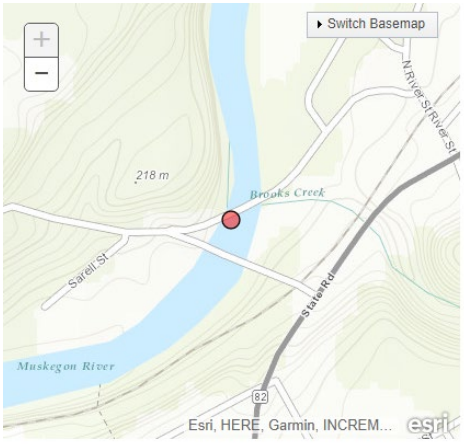
USGS 04122001 Muskegon River at Bridge Street at Newaygo, MI Flood Impacts (Functional from 1964 through 1993. Re-established in 2017)

Near Flood Stage	10 Ft	
Flood Stage	11 Ft	Minor Flooding – Minimal property damage, public inconvenience
Moderate Flooding Stage	14 Ft	Moderate Flooding – Some inundation, possible evacuations
Major Flood Stage	15 Ft	Major Flooding – Extensive inundation and evacuations

15.0	Expect the Bridge Street Bridge in the City of Newaygo to close. Expect major flooding downstream from the City of Newaygo in the areas of Anderson Flats and Old Women's Bend in Garfield Township and Sycamore Flats, 100th Ave, and Sugarbusg Lane in Ashland Township. Expect moderate flooding on Sarrell Street in the City of Newaygo. Expect Flech Ave near the Anderson Flats area to be closed. Expect all public River Access sites to be closed.
14.0	Flood water begins surrounding homes on Sarrell Street in the City of Newaygo. Moderate flooding downstream from the City of Newaygo in the areas of Anderson Flats and Old Women's Bend in Garfield Township and Sycamore Flats, 100th Ave, and Sugarbusg Lane in Ashland Township. Expect Flech Ave near the Anderson Flats area to be closed. Expect all public River Access sites to be closed.
13.0	Flood water begins surrounding cottages and homes downstream from the City of Newaygo in the areas of Sugarbush Lane and 100th Avenue in Ashland Township. Expect minor flooding in Anderson Flats and Old Women's Bend in Garfield Township and Sycamore Flats in Ashland Township. Expect water to come over Felch Ave near Salmon Run Campground and South River Lane. Expect all public River Access Sites to be closed.
12	Flood water begins surrounding cottages and homes downstream from the City of Newaygo in the areas of Sycamore Flats in Ashland Township.
11	Flood water continues to exceed its banks and minor flooding begins in low lying areas along the river.
10	River is bank full. River begins to exceed its banks and minor flooding begins in low lying areas along the river.

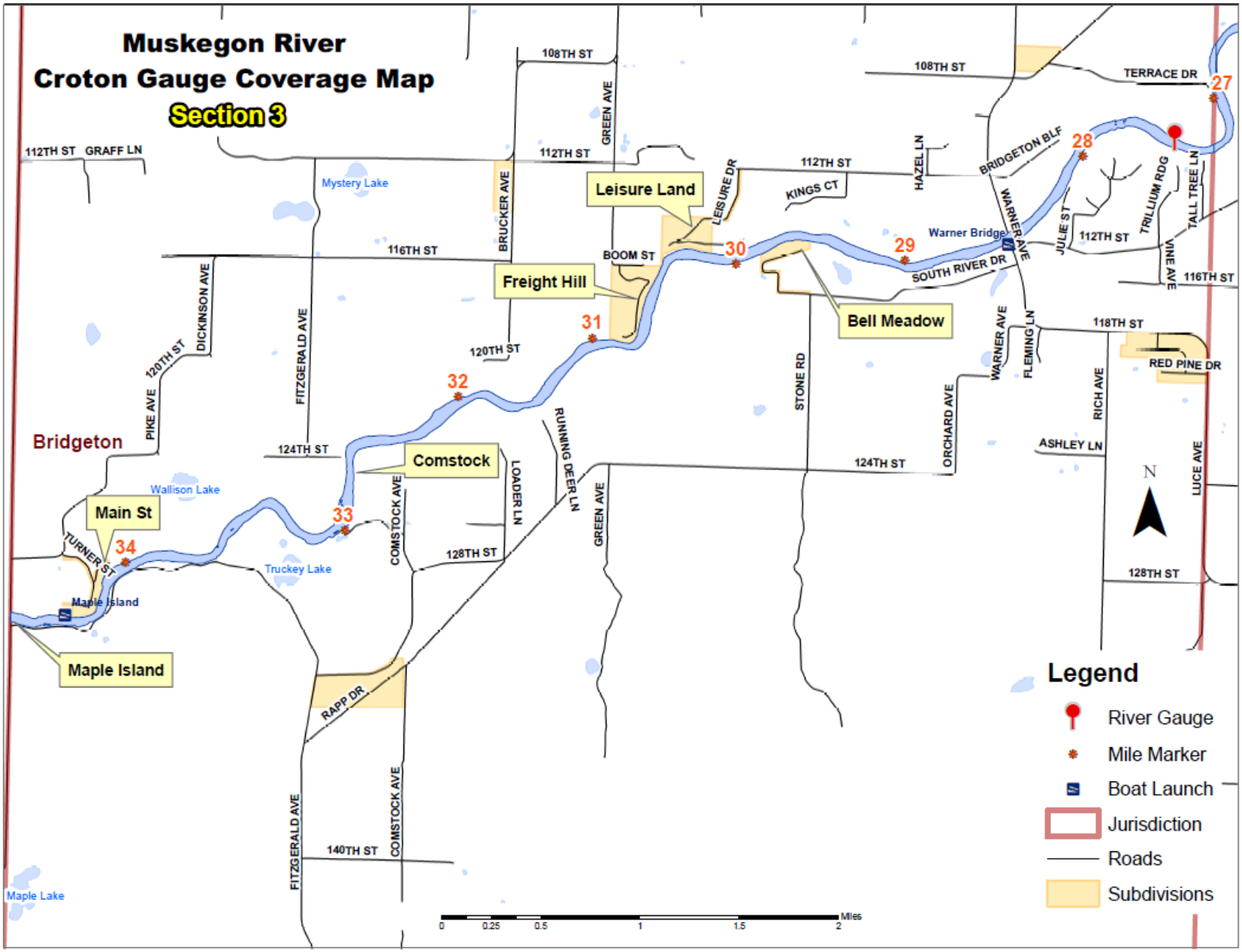
Historical Crests for the USGS Gauge at Newaygo

Rank	Date	Gauge Height	Stream Flow
1	9/12/1986	19.54 feet	23,200 cfs
2	2/21/2018	15.13 feet	10,900 cfs
3	1/31/2019	14.52 feet	N/A Ice Jam
4	7/1/1969	13.98 feet	9,550 cfs
5	5/19/2020	13.53 feet	9,280 cfs
6	3/16/2019	13.46 feet	9,220 cfs
7	3/30/1976	13.37 feet	10,800 cfs
8	10/1/1986	12.88 feet	9,940 cfs
9	9/2/1975	12.75 feet	9,800 cfs
10	4/17/1971	12.31 feet	7,220 cfs
11	10/02/2019	12.18 feet	7,680 cfs
12	6/3/1970	12.08 feet	5,900 cfs
13	10/25/2017	11.87 feet	7,510 cfs
14	4/2/1989	11.83 feet	8,290 cfs
15	6/24/2017	11.65 feet	7,170 cfs
16	4/30/2020	11.46 feet	6,880 cfs
17	12/31/2019	11.34 feet	6,730 cfs



Gauge Location Disclaimer

Latitude/Longitude Disclaimer: The gauge location shown in the above map is the approximate location based on the latitude/longitude coordinates provided to the NWS by the gauge owner.


Muskegon River
Croton Gauge Coverage Map
Section 3
Leisure Land
Freight Hill
Bell Meadow
Comstock
Main St
Maple Island
Bridgeton
Mystery Lake
Wallison Lake
Truckey Lake
Maple Lake
Warner Bridge
27
28
29
30
31
32
33
34
108TH ST
112TH ST
116TH ST
120TH ST
124TH ST
128TH ST
140TH ST
GRAFF LN
GREEN AVE
BRUCKER AVE
LEISURE DR
KINGS CT
HAZEL LN
BRIDGETON BLF
TERRACE DR
TRILLIUM RDG
TALL TREE LN
JULIE ST
WARNER AVE
SOUTH RIVER DR
VINE AVE
BOOM ST
DICKINSON AVE
PIKE AVE
FITZGERALD AVE
STONE RD
RUNNING DEER LN
LOADER LN
COMSTOCK AVE
GREEN AVE
ORCHARD AVE
FLEMING LN
RICH AVE
ASHLEY LN
RED PINE DR
LUCE AVE
TURNER ST
RAPP DR
N
Legend
River Gauge
Mile Marker
Boat Launch
Jurisdiction
Roads
Subdivisions
0
0.25
0.5
1
1.5
2
Miles

USGS 04122025 Muskegon River at Bridgeton, MI Flood Impacts (Established 2017)

Near Flood Stage	12 Ft	
Flood Stage	13 Ft	Minor Flooding – Minimal property damage, public inconvenience
Moderate Flooding Stage	16 Ft	Moderate Flooding – Some inundation, possible evacuations
Major Flood Stage	17 Ft	Major Flooding – Extensive inundation and evacuations

17.0	Expect Maple Island Bridge in Bridgeton Township to close. Expect water over Maple Island Road in Bridgeton Township. Expect Major flooding downstream from the City of Newaygo in Leisure Land Subdivision, Freight Hill Subdivision, Bell Meadow Subdivision, Bridgeton Flats, and Main Street in Bridgeton Township.
16	Expect water to be over South River Drive near Maple Island and Main Street in Bridgeton Township. Expect Moderate flooding downstream from the City of Newaygo in Leisure Land Subdivision, Freight Hill Subdivision, Bell Meadow Subdivision, Bridgeton Flats, and Main Street in Bridgeton Township.
15.5	Expect flood water to begin surrounding cottages and homes downstream from the city of Newaygo in the areas of Bell Meadow Subdivision and Main Street in Bridgeton Township. Expect minor flooding in Leisure Land Subdivision and Freight Hill Subdivision in Bridgeton Township. Expect all Public River Access Sites to be closed.
15	Flood water begins surrounding properties downstream from the City of Newaygo in the areas of Fright Hill Subdivision and 9230 Main Street in Bridgeton Township. Expect minor flooding in Leisure Land Subdivision. Expect all public River Access Sites to be closed.
14	Flood water begins surrounding cottages and homes downstream from the City of Newaygo in the areas of Leisure Land Subdivision in Bridgeton Township.
13	Flood water begins approaching cottages and homes downstream from the City of Newaygo in the areas of Leisure Land Subdivision in Bridgeton Township.
12	River is bankfull. River begins to exceed its banks and minor flooding begins in low lying areas along the river.



Gauge Location Disclaimer

Latitude/Longitude Disclaimer: The gauge location shown in the above map is the approximate location based on the latitude/longitude coordinates provided to the NWS by the gauge owner.

Historical Crests for the USGS Gauge at Bridgeton

Rank	Date	Gauge Height	Stream Flow
1	2/21/2018	16.82 feet	10,600 CFS
2	03/16/2019	15.84 feet	9,360 CFS
3	05/19/2020	15.81 feet	9,390 CFS
4	10/03/2019	14.55 feet	7,920 CFS
5	10/25/2017	14.09 feet	7,450 CFS
6	04/30/2020	14.09 feet	7,410 CFS
7	6/24/2017	13.98 feet	7,270 CFS
8	2/5/2019	13.97 feet	*ICE Jam
9	12/31/2019	13.48 feet	6,750 CFS
10	04/19/2019	13.41 feet	6,670 CFS
11	03/13/2020	12.64 feet	5,880 CFS
12			

The USGS from 1964 through 1993, the Muskegon River gauge below the Croton Dam was located within the City of Newaygo. While the gauge was at this location, the flood stage was 11.0 feet. During this 29 year period there were 12 flooding events. The following graph shows the Peak Streamflow on the Muskegon River at Newaygo, MI from the USGS:

Water Year	Date	Gage Height (Feet)	Flood Height above FS	Stream Flow (CFS)
1964	May 01, 1964	9.42		4,580
1965	April 12, 1965	11.05	0.05	7,190
1966	December 15, 1965	10.34		6,050
1967	December 10, 1966	10.97		7,060
1968	June 28, 1968	9.72		5,130
1969	July 1, 1969	13.98	2.98	9,550
1970	June 3, 1970	12.08	1.08	5,900
1971	April 17, 1971	12.31	1.31	7,220
1972	April 20, 1972	10.59		5,190
1973	March 9, 1973	10.67		6,390
1974	May 18, 1974	11.01	0.01	7,020
1975	September 2, 1975	12.75	1.75	9,800
1976	March 30, 1976	13.37	2.37	10,800
1977	March 13, 1977	9.78		5,170
1978	April 11, 1978	10.20		5,800
1979	April 2, 1979	10.40		6,100
1980	March 21, 1980	9.94		5,410
1981	February 24, 1981	9.87		5,300
1982	April 3, 1982	10.06		5,590
1983	December 4, 1982	10.50		6,720
1984	June 17, 1984	10.54		6,300
1985	December 30, 1984	11.06	0.06	7,090
1986	September 12, 1986	19.54	8.54	23,200
1987	October 1, 1986	12.88	1.88	9,940
1988	April 4, 1988	10.57		6,280
1989	April 2, 1989	11.83	0.83	8,290
1990	March 14, 1990	10.50		6,170
1991	April 16, 1991	10.95		6,870
1992	November 1, 1991	11.28	0.28	7,400
1993	April 21, 1993	10.57		6,280

When the gauge was moved to Croton in 1995, the flood stage dropped to 9.0 feet. Trends have been regularly tracked by local and state officials through various methods including a local spotting system and an electronic river gauge installed on the Muskegon River. Utilizing this information, emergency officials have been able to anticipate routine flooding activity and severity with relatively high accuracy. From 1996-2019, a 23 year period, there were 11 flooding events. The following graph shows the Peak Streamflow on the Muskegon River at Croton, MI from the USGS:

Water Year	Date	Gage Height (Feet)	Flood Height above FS	Stream Flow (CFS)
1996	June 24, 1996	8.42		5,780
1997	Jan 5, 1997	8.23		5,410
1998	April 2, 1998	9.12	0.12	7,130
1999	June 15, 1999	7.56		4,150
2000	May 19, 2000	8.33		6,080
2001	May 18, 2001	8.49		6,390
2002	March 10, 2002	8.67		6,620
2003	May 12, 2003	6.84		3,420
2004	May 24, 2004	10.45	1.45	9,580
2005	April 4, 2005	9.10	0.10	7,080
2006	March 14, 2006	9.42	0.42	7,630
2007	March 24, 2007	8.45		6,020
2008	June 9, 2008	8.78		6,550
2009	December 29, 2008	8.89		6,730
2010	October 31, 2009	8.63		6,300
2011	April 29, 2001	10.64	1.64	9,970
2012	May 5, 2012	8.49		6,150
2013	April 19, 2013	11.11	2.11	11,000
2014	April 15, 2014	12.89	3.89	15,600
2015	April 10, 2015	8.79		6,560
2016	March 31, 2016	9.98	0.98	8,660
2017	October 25, 2017	9.04	0.04	7,230
2018	February 21, 2018	11.55	2.55	12,300
2019	March 15, 2019	10.08	1.08	9,180
2020	May 19, 2020	10.33	1.33	9,680
2021	June 26, 2021	7.21		4,160
2022	April 2, 2022	8.36		5,980
2023	April 6, 2023	8.62		6,450
2024	June 25, 2024	7.11		3,990
2025	April 8, 2025	7.95		5,260

Frequency of Flooding on the Muskegon River

Raw Data shows the frequency of flooding events in Newaygo County are increasing. In a report developed by the Federal Emergency Management Agency, the 2008 ASFPM Working Group on Dams, and the 2012-13 Dam Risk Reduction Committee, "*A Strategy to Reduce the Risks and Impact of Dams on Floodplains*," identifies there are clear trends toward more heavy precipitation in a short amount of time, particularly in the Northeast and Midwest. The Muskegon River Watershed Research Partnership also released several bulletins in with projections suggesting a shifting future climate change to a warmer and wetter climate. Muskegon River models responded to the climate change with increased flows during spring flood period and also during much of the drier summer and late fall. Annual flood flows throughout the watershed show an increase in magnitude on average from 20-42% relative to 1998. In the main stem of the lower river (below Croton Dam) average increases ranged from 17-33%. Data trends also are showing an increase in average annual total precipitation. From 1971 to 2000, average annual precipitation was 33.05 inches for Fremont, Michigan.

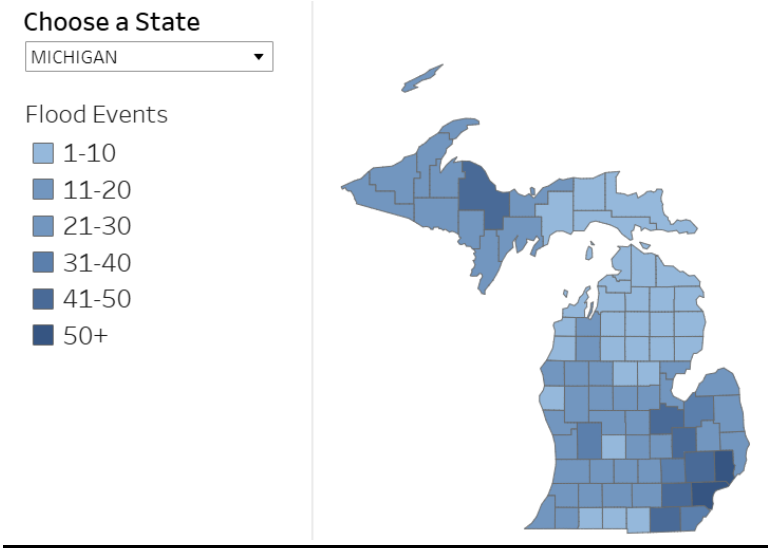
Muskegon River below Croton

Year	Events over 5,000 CFS (Bank full)	Events over 7,000 CFS (Flood Stage)	# Days 24 hour rainfall over 1 inch	Annual Total Precipitation
2000	1	0	8	
2001	3	0	9	
2002	1	0	4	
2003	0	0	4	
2004	3	2	8	
2005	2	1	5	
2006	4	1	12	
2007	2	0	3	
2008	4	0	8	
2009	6	0	10	39.91
2010	0	0	5	28.82
2011	3	1	10	36.91
2012	2	0	5	34.87
2013	4	2	12	43.69
2014	3	1	6	36.41
2015	3	0	11	39.99
2016	2	1	7	36.29
2017	5	2	6	36.44
2018	3	1	8	39.98
2019	5	4	8	45.77
2020	5	1	7	33.04
2021	0	0	5	27.11
2022	1	0	8	39.33
2023	2	0	6	35.09
2024	0	0	4	36.42
2025				4.75
Average	**3**	**Less than 1**	**7**	**36.67**

Monthly Total Precipitation for FREMONT 4 WSW, MI													
Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
2000	1.27	M	1.29	4.30	6.10	2.85	4.36	3.97	5.93	M	M	2.17	M
2001	M	3.38	0.35	4.69	7.41	2.18	M	M	2.66	6.88	2.32	1.61	M
2002	M	1.69	2.53	M	2.43	M	1.77	M	1.68	M	M	M	M
2003	M	M	1.49	M	3.29	1.67	2.19	1.58	M	M	8.39	M	M
2004	M	M	4.86	1.94	12.38	3.80	1.37	3.38	M	3.73	2.62	2.76	M
2005	3.71	M	M	M	M	0.81	1.91	M	M	M	6.48	1.56	M
2006	3.12	1.51	3.69	3.99	4.15	M	5.27	0.55	3.97	7.38	M	M	M
2007	1.60	0.75	3.83	M	2.24	M	M	3.00	1.42	M	0.79	2.58	M
2008	2.43	2.77	1.30	M	2.34	4.54	2.53	0.94	5.38	M	3.33	6.29	M
2009	1.13	3.32	3.38	4.10	4.94	2.38	1.52	5.30	2.67	7.31	1.18	2.68	39.91
2010	1.02	0.99	1.12	2.14	3.00	4.19	4.10	1.68	5.30	2.42	1.92	0.94	28.82
2011	1.97	2.21	2.98	5.55	2.03	4.79	2.58	2.63	2.70	4.09	3.59	1.79	36.91
2012	2.54	1.23	3.44	2.21	2.24	2.57	5.91	2.79	1.76	6.83	0.54	3.10	35.16
2013	5.25	2.91	1.11	7.34	4.19	3.14	2.53	2.87	3.02	3.78	5.33	2.22	43.69
2014	2.94	1.43	1.91	7.08	5.65	3.25	1.70	1.56	3.05	2.46	3.90	1.51	36.44
2015	1.40	M	1.05	5.99	4.27	4.67	4.15	2.48	3.48	2.63	4.24	4.67	M
2016	M	M	4.56	2.38	3.16	1.93	5.05	3.09	4.69	4.33	2.48	M	M
2017	2.94	1.89	2.58	4.36	M	5.05	1.52	2.11	0.67	8.69	2.18	1.74	M
2018	1.69	M	0.59	3.78	3.51	2.47	1.27	9.07	3.83	5.98	2.40	M	M
2019	3.26	M	2.96	2.73	5.64	3.65	2.00	3.87	5.67	9.20	3.23	3.56	M
2020	2.16	0.93	3.38	4.43	3.86	1.88	4.23	4.46	2.42	2.93	2.36	M	M
2021	1.15	1.53	0.75	2.81	2.10	3.79	M	5.20	2.31	3.65	1.76	2.06	M
2022	0.65	1.46	3.28	4.47	4.31	2.11	4.85	6.20	3.36	4.18	2.58	1.88	39.33
2023	2.19	3.04	3.41	4.60	0.83	3.18	6.04	1.85	1.54	4.31	2.50	1.60	35.09
2024	2.90	0.59	3.68	3.67	2.87	5.13	2.66	3.84	4.59	0.71	3.50	2.28	M
2025	1.35	0.59	2.81	M	M	M	M	M	M	M	M	M	M
Mean	2.22	1.79	2.49	4.13	4.04	3.18	3.16	3.29	3.28	4.82	3.07	2.47	36.92
Max	5.25 2013	3.38 2001	4.86 2004	7.34 2013	12.38 2004	5.13 2024	6.04 2023	9.07 2018	5.93 2000	9.20 2019	8.39 2003	6.29 2008	43.69 2013
Min	0.65 2022	0.59 2025	0.35 2001	1.94 2004	0.83 2023	0.81 2005	1.27 2018	0.55 2006	0.67 2017	0.71 2024	0.54 2012	0.94 2010	28.82 2010

Historical Flood Impact

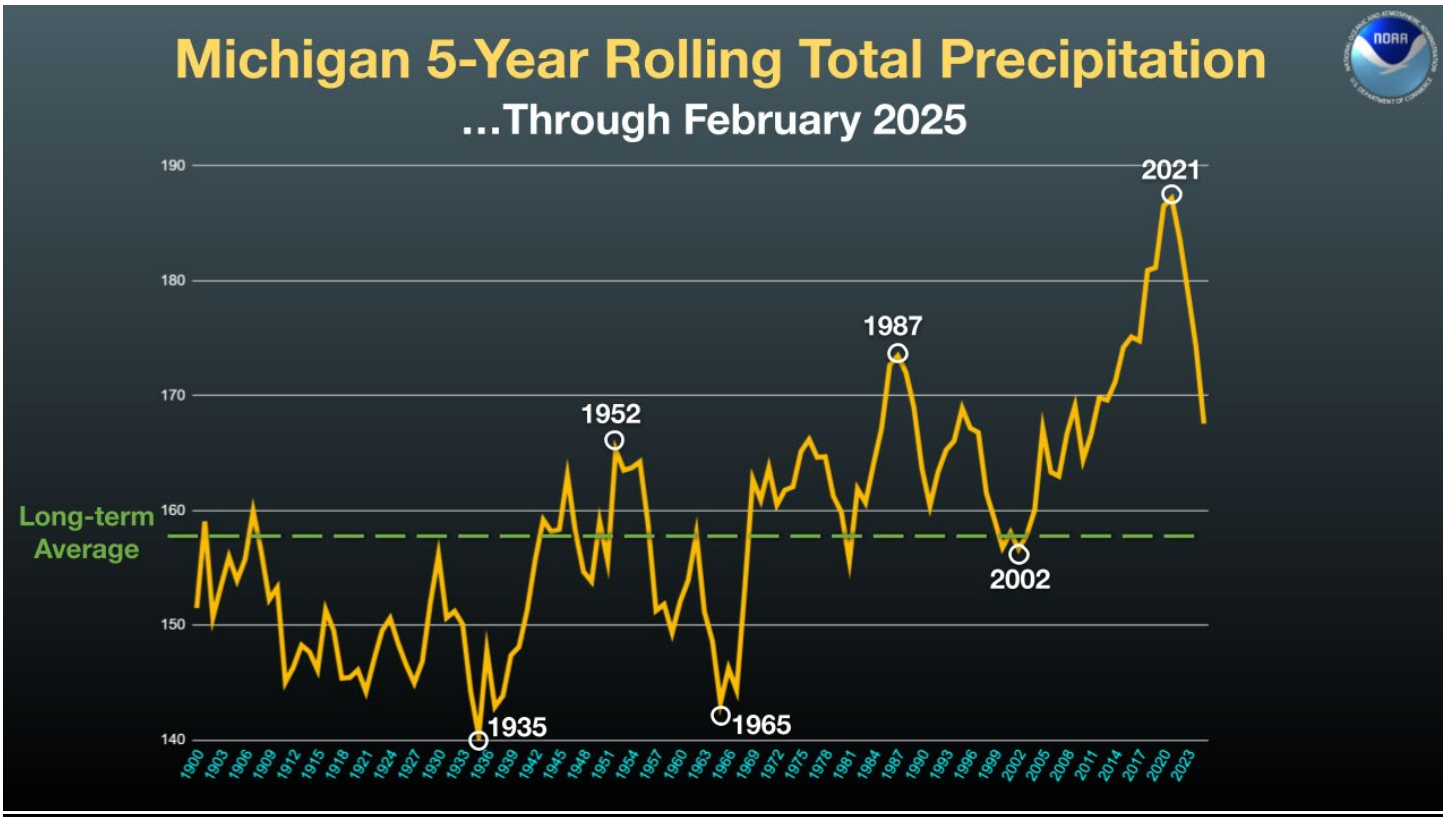
The following data is from NOAA's Storm Events Database, highlighting 14 flooding events for Newaygo County.



Frequency of Heavy Rainfall in Newaygo County

The 2014 National Climate Assessment reports in the next few decades the Midwest can expect to see an increasing scope, frequency, and intensity of weather related disasters. This includes more weather extremes such as temperature (heat and cold), heavy downpours, and flooding that will affect infrastructure, health, agriculture, forestry, transportation, air and water quality, and more. Climate change will tend to amplify existing risks climate poses to people, ecosystems, and infrastructure.

The following chart from the US National Weather Service Office in Grand Rapids, Michigan shows Michigan's 5 year Total Precipitation trends since 1900.



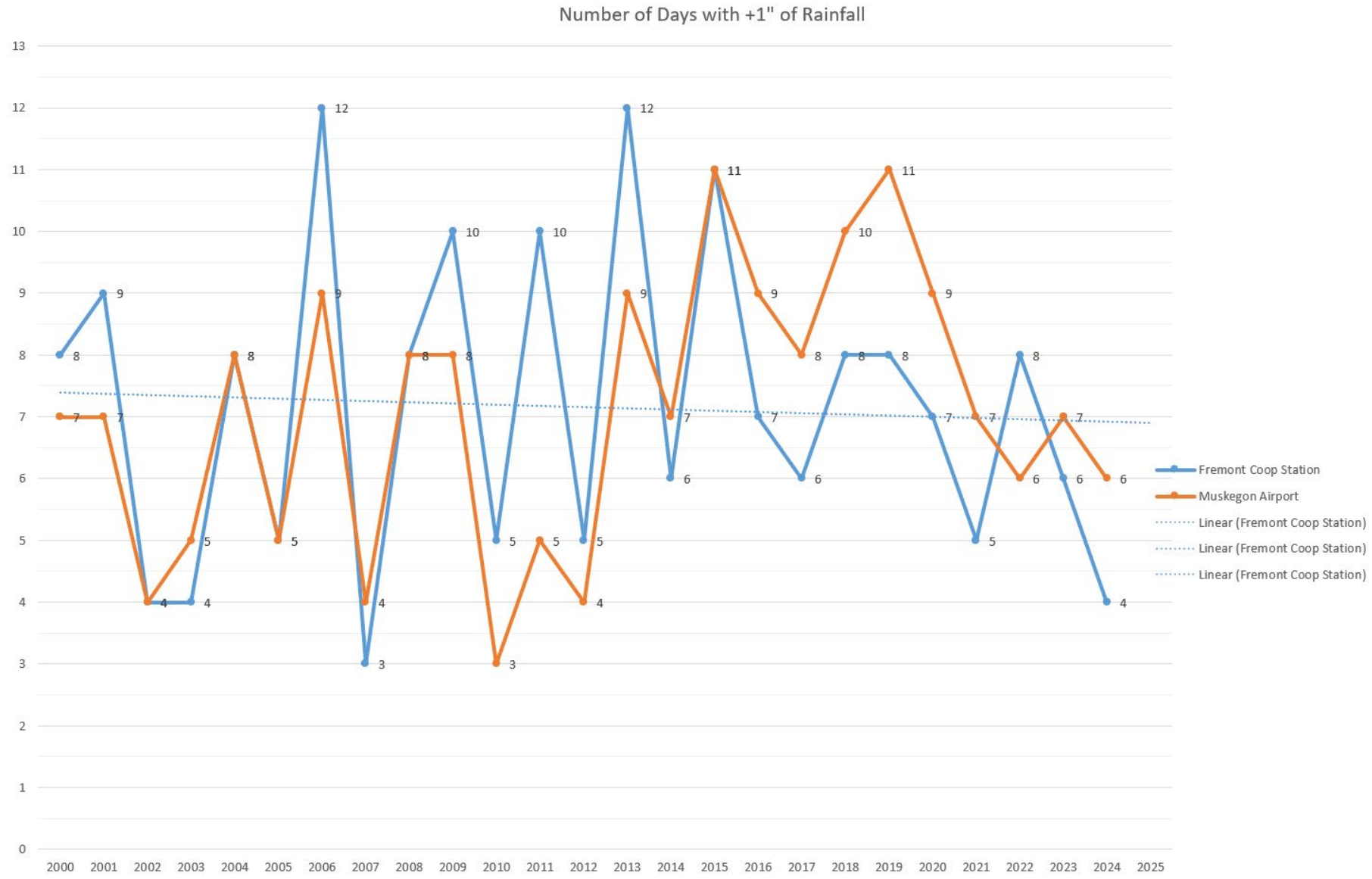
The frequency of days with very heavy precipitation (the wettest 2% of days) is projected to increase. Extreme rainfall events and flooding have already increased during the last century. These trends are expected to continue, causing erosion, declining water quality, and negative impacts on transportation, agriculture, human health, and infrastructure. The following is Highest Precipitation by day records for Fremont, Michigan.

Highest Precipitation by Day for FREMONT 4 WSW, MI

Day	Jan		Feb		Mar		Apr		May		Jun		Jul		Aug		Sep		Oct		Nov		Dec	
1	0.67	2019	0.28	2016	0.60	2012	1.32	2023	1.79	2009	0.70	2004	0.43	2016	0.44	2013	0.00	2024	0.94	2018	1.10	2013	0.70	2019
2	1.16	2005	0.79	2011	0.77	2004	0.21	2024	0.63	2019	1.41	2024	0.27	2018	1.22	2002	1.48	2018	3.98	2019	0.56	2004	0.69	2018
3	0.47	2004	1.00	2016	0.62	2002	1.46	2006	0.82	2018	0.66	2018	1.38	2008	0.70	2020	2.22	2010	2.70	2006	0.78	2003	0.17	2007
4	0.43	2015	0.42	2018	0.18	2015	1.47	2011	0.60	2016	0.76	2002	2.00	2007	0.56	2022	1.01	2022	1.48	2013	0.77	2003	0.53	2011
5	0.24	2006	0.51	2021	1.54	2004	0.60	2021	0.47	2016	0.29	2007	0.43	2003	0.38	2008	3.24	2008	0.71	2002	2.32	2003	0.33	2006
6	0.31	2022	0.49	2019	0.17	2022	0.56	2010	0.30	2003	1.00	2008	0.11	2003	0.80	2024	0.51	2018	0.74	2018	1.89	2005	0.34	2008
7	0.15	2017	0.46	2008	0.20	2004	0.64	2006	0.40	2014	0.97	2006	1.40	2015	0.50	2024	0.50	2023	0.59	2023	0.66	2013	0.38	2004
8	0.70	2019	0.74	2013	1.01	2009	1.51	2015	2.21	2004	1.19	2008	0.23	2008	1.03	2021	2.56	2016	0.70	2008	0.30	2008	1.11	2004
9	0.33	2015	1.67	2001	1.03	2009	0.85	2002	2.46	2004	1.61	2008	0.63	2002	2.54	2009	1.84	2015	1.15	2004	1.36	2005	0.66	2009
10	0.67	2024	0.71	2023	1.03	2006	2.45	2015	1.21	2004	1.55	2019	1.47	2020	2.30	2021	1.44	2013	0.36	2012	0.66	2000	0.68	2003
11	1.16	2014	0.27	2022	0.50	2013	1.21	2021	1.16	2006	0.56	2020	0.75	2020	1.36	2020	0.77	2014	1.58	2018	1.02	2006	1.03	2021
12	0.43	2018	0.61	2009	1.05	2010	2.23	2001	1.76	2022	1.35	2015	1.34	2006	0.72	2021	1.54	2000	1.09	2022	0.58	2021	0.86	2020
13	1.16	2005	0.35	2019	1.41	2006	3.85	2014	2.21	2014	1.52	2015	1.01	2023	1.15	2011	1.59	2019	0.49	2022	0.41	2005	0.33	2001
14	0.21	2024	0.61	2005	0.45	2019	1.57	2014	1.46	2009	0.82	2022	1.07	2015	2.24	2022	0.85	2008	2.80	2001	0.60	2008	1.49	2015
15	0.27	2004	0.34	2024	1.33	2019	0.85	2019	3.21	2001	0.95	2017	1.00	2010	0.86	2023	0.77	2008	0.97	2017	0.36	2005	0.56	2008
16	0.21	2021	0.38	2012	0.60	2016	0.81	2012	0.85	2001	1.03	2013	0.94	2022	1.00	2024	0.54	2010	1.23	2016	0.86	2017	0.71	2012
17	0.81	2017	1.18	2006	0.91	2023	0.42	2023	0.18	2000	0.35	2024	0.71	2015	0.67	2017	0.30	2016	0.62	2006	0.57	2000	0.42	2022
18	0.50	2006	0.65	2008	0.24	2008	1.56	2013	2.51	2020	0.68	2014	1.28	2006	0.53	2023	0.34	2012	1.08	2012	1.69	2013	0.45	2002
19	0.73	2005	0.38	2013	0.18	2013	1.13	2002	0.68	2000	1.47	2012	0.80	2015	2.92	2001	0.83	2015	0.76	2002	1.28	2003	0.42	2008
20	0.20	2000	1.34	2018	0.79	2020	1.21	2011	0.55	2004	0.54	2009	0.70	2019	0.47	2007	0.49	2002	1.21	2011	0.41	2004	0.52	2012
21	0.68	2006	1.04	2018	0.62	2011	1.63	2000	0.85	2024	0.86	2000	0.60	2019	1.67	2018	0.94	2000	0.28	2010	0.53	2023	0.60	2012
22	0.26	2008	0.32	2009	1.97	2007	0.19	2001	0.76	2004	2.07	2011	1.64	2001	2.54	2002	0.48	2010	0.54	2023	0.47	2019	0.28	2006
23	0.83	2018	0.45	2023	0.92	2011	0.88	2022	1.32	2013	1.82	2017	0.98	2021	1.75	2000	0.98	2000	1.56	2017	0.56	2010	1.13	2006
24	0.22	2024	1.02	2017	0.81	2016	0.44	2013	0.81	2004	1.18	2010	2.58	2022	0.23	2015	1.05	2006	2.60	2017	1.18	2014	0.61	2008
25	0.52	2014	0.87	2001	0.94	2016	0.55	2004	0.47	2019	0.86	2021	0.98	2016	0.31	2001	4.08	2024	0.95	2001	0.52	2014	0.39	2014
26	0.28	2024	0.26	2007	0.57	2004	2.16	2009	0.42	2011	2.35	2023	1.19	2012	0.67	2003	2.01	2005	0.89	2022	0.31	2020	0.40	2009
27	0.18	2024	1.63	2009	0.29	2024	0.89	2007	1.16	2015	0.92	2016	0.94	2023	4.03	2018	0.33	2003	1.33	2019	2.12	2015	0.34	2015
28	0.28	2004	1.13	2023	1.24	2014	1.07	2011	0.88	2021	0.84	2010	1.33	2011	1.95	2004	0.97	2009	0.49	2015	0.66	2004	1.06	2008
29	1.09	2013	0.29	2012	1.00	2009	1.54	2020	0.72	2013	1.22	2017	1.97	2023	1.51	2020	0.86	2005	0.63	2003	0.96	2016	1.27	2015
30	2.04	2013	-	-	0.39	2025	1.47	2020	0.75	2008	0.53	2005	0.87	2024	1.17	2019	0.45	2015	0.94	2009	0.95	2006	1.08	2019
31	0.29	2013	-	-	1.68	2022	-	-	0.88	2004	-	-	2.04	2012	1.51	2001	-	-	1.13	2009	-	-	0.38	2005

Period of record: 2000-01-01 to 2025-04-01

The following demonstrates the frequency of days with at least 1" of rain, broken down by calendar year, starting in 2000. Data is from a NWS observer in Fremont, as well as the airport in Muskegon. The average over the last 20 years is 7 days per year of at least an inch of rain (or equivalent snow). Both locations show an upward/increasing trend with time, on the order of 1 to 3 extra yearly occurrences over the 20 year duration.



United States Geological Survey Flood Inundation Mapper Program for the Muskegon River

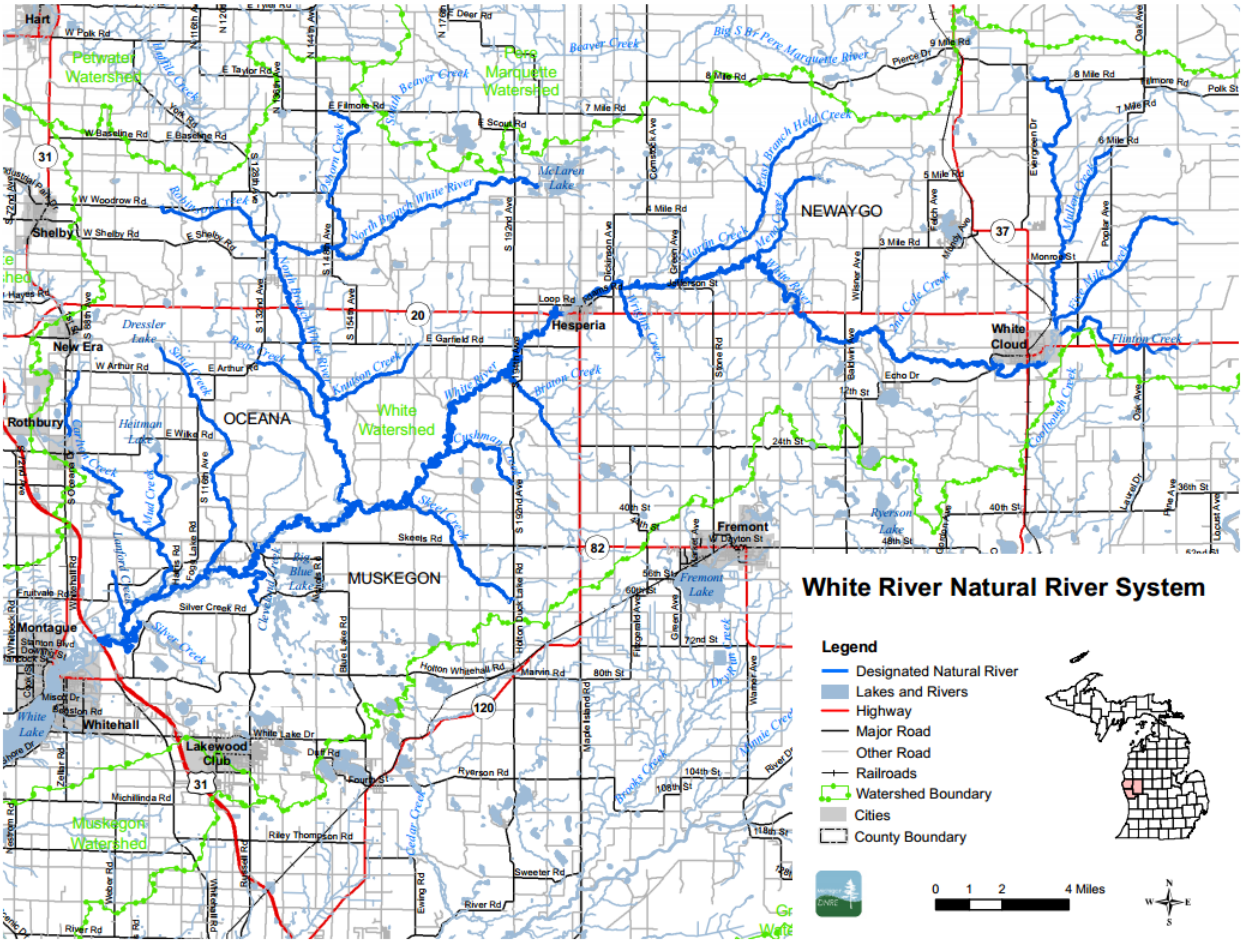
The USGS Flood Inundation Mapping (FIM) Program helps communities protect lives and property by providing tools and information to help them understand their local flood risks and make cost-effective mitigation decisions. The USGS Flood Inundation Mapping Program has two main functions. First, the USGS partners with local communities to develop a flood inundation map library. This library contains a set of maps that shows where flooding may occur over a range of water levels in the community's local stream or river. This information can be utilized for preparedness, timely response, recovery, mitigation and planning, and environmental and ecological assessments.

The second function of the Flood Inundation Mapping program is to provide online access to flood inundation maps along with real-time streamflow data, flood forecasts, and potential loss estimates. Once a community's map library is complete, it is uploaded to the USGS FIM Mapper, an online public mapping application. The FIM Mapper allows users to explore the full set of inundation maps that shows where flooding would occur given a selected stream condition. Users can also access historical flood information and potential loss estimates based on the severity of the flood. The FIM Mapper helps communities visualize potential flooding scenarios, identify areas and resources that may be at risk, and enhance their local response effort during a flooding event.

In 2016, Newaygo County received a Hazard Mitigation Grant to implement a new flood warning system for approximately 35 miles of the Muskegon River in Newaygo County utilizing the United States Geological Survey (USGS) Flood Inundation Mapper System. Through this implementation, two additional streamgages were added on the Muskegon River in 2017 and a Flood Inundation Map Library was published in 2020. Please see Flood Inundation Maps Appendix for additional information.

The White River

The White River Watershed is located in west central Michigan and is approximately 83 miles long from its start in northeastern Newaygo County to its mouth at White Lake and eventually, Lake Michigan. It covers 344,166 acres and spans three counties: Muskegon, Newaygo, and Oceana. The White River is divided into two branches, the North Branch and the South Branch. The North Branch has headwaters in central Oceana County while the South Branch originates in eastern Newaygo County.



The White River rises from the extensive Oxford Swamp in north central Newaygo County and flows in a southwesterly direction into White Lake then into Lake Michigan, near the towns of Whitehall and Montague. The White River system drains a surface area of approximately 300,000 acres and includes about 253 miles of streams. There is no USGS stream gauge monitoring in Newaygo County on the White River. Water levels are measured manually by staff gauges painted onto bridges located at M-37 bridge at the White River in White Cloud and the M-20 bridge at the White River east of Hesperia.

Based on historical occurrence, on average Newaygo County experiences and estimated 1 – 2 flooding events per year. While most of these events may be urban flooding or minor riverine flooding, the following are summaries of major flooding events in Newaygo County:

Case: September 1986 Flood

Beginning on September 10, 1986 a slow moving low-pressure system moved across the middle of the Lower Peninsula. In a 48 hour period, the intense rainstorm produced 14 inches of rainfall over a widespread area. The storm resulted in thousands of people being evacuated due to flooding. Many dams failed or threatened failure during this event including the White Cloud Dam, Croton Dam, and Hardy Dam in Newaygo County. About thousands of homes suffered basement and structural damage and hundreds of roadways were impassable as a result of the failure of bridges and culverts. Across the State, over $300 million in damage resulted from the flood. This was the worst flood in Michigan in 50 years and is still the worst flood in Newaygo County. Thirty (30) counties were included in the Presidential Major Disaster Declaration granted for this flood.

Case: February and May 2001 Flash Flooding

Extensive flooding began on the 9th of February as a result of the combination of heavy rain and melting snow. Numerous roads were closed across all of southwestern and south central lower Michigan, including portions of M-37 in Lake county. A dozen roads were washed out or closed across Newaygo County. There were also many reports of standing water in low lying areas and poor drainage areas. The event transitioned into a river flood event across the area. 10 forecast points on 8 different rivers went above flood stage. However, no lives were lost, and only minor property damage occurred. The event caused $100k in property damage.

In May, thunderstorms developed during the morning hours of the 15th, producing several reports of large hail and high winds. It was also a record rainfall event for the Grand Rapids area, and 4 to 5 inches of rain fell in less than 6 hours across much of southwestern and south central lower Michigan. Again, flash flooding became the primary problem. There were numerous reports received of flooded roads, basements, and flooding of small creeks and streams. Fortunately, however, the flash flooding and flooding did not cause any fatalities. Newaygo County was included in a Governor’s Disaster Declaration for this event.

Case: May 2004 Flood

In May 2004, a stationary front over Iowa, Wisconsin, and Michigan brought severe thunderstorms and heavy rains, which caused widespread flooding over Southern Lower Michigan. Much of the rainfall occurred in saturated areas that had experienced well-above average precipitation for the month of May. Over a 36-hour period (12 am May 22nd to 8 am May 23rd), 2 to 6 inches of rain fell across Southeast Michigan. The Muskegon River at Newaygo crested at 12.49 feet at 4 p.m. on 5/24. Flood stage is 11 feet. It was the 6th highest crest in history.

Backyards were submerged under several feet of water. Road and bridge damage was expected to cost $10 million to repair. Total rainfall over the Grand River basin from May 20th through June 3rd varied from four to as much as seven inches. It was the biggest and longest duration flooding event in the past ten to twenty years across southwestern and south central Lower Michigan. It was the wettest

May on record in Lansing and Muskegon and the third wettest May on record in Grand Rapids. A Presidential Major Disaster Declaration was granted to 23 counties in the southern Lower Peninsula. Macomb County damages were estimated at $100 million, and damages of about $1 million each were reported for the counties of Clare, Gratiot, Isabella, Lake, Mason, Mecosta, Montcalm, Newaygo, Oceana, and Osceola.

Case: April 2013 Flooding on the Muskegon River

The Muskegon River Basin received two heavy rainfall events close together in April of 2013, causing moderate to major flooding. The first rainfall event occurred on April 8 – 12, dumping 3.8 inches of rain across the state. The second event occurred on April 17-19, dumping an additional 4.45 inches of rain over an already saturated ground and swollen rivers. The Muskegon River below the Croton Dam peaked on April 19, 2013 at 11.11 feet. Hundreds of homeowners were evacuated for several days to a week. River access sites were closed for a week due to unsafe river conditions and the high flows over an extended period of time caused massive erosion and sedimentation issues, destroyed spawning beds, and caused other environmental issues. The flood caused approximately $1.5 Million in damages to 109 homes and $175,000 in damages to roads and bridges. Newaygo County was included in a Presidential Disaster Declaration along with 19 other counties for this event.

Case: April 2014 Flooding on the Muskegon River and White River

The combination of a very significant snowpack that gradually melted and multiple rounds of severe thunderstorms with heavy rainfall resulted in significant flooding in eight counties. Generally 5 to 8 inches of rainfall occurred over the Muskegon River Basin from April 12 – 14$^{th.}$ Hundreds of homeowners were evacuated for close to one week. Some homes had over 6 feet of water on the first floor living space. River access sites were closed and several parks sustained extensive damage. The flood caused over $4 million in private damages and $587,000 in public damages. Newaygo County was included in a Governor's Disaster Declaration along with 7 other counties for this event. In addition, due to the extensive home damage, Newaygo County received a disaster declaration under the Small Business Administration which opened up loan interest loans to assist homeowners with recovery.

Case: February 2018 Flood

A slow release of a snow pack, containing one to over two inches of water, occurred in the days leading to the event which started the process of river rises in many areas. Low pressure tracked from northwest Iowa into northern Lower Michigan, which ushered in a rapid warmup and equally rapid release of any remaining water in the snowpack. Several rounds of rain occurred between the 19th and 21st of February across the region. Rainfall amounts ranged from 2 to 4 inches, fed by record high precipitable water levels (by February standards) in the 1.3 to 1.5 inch range. This event was among the top 3 heaviest winter rainfall events to occur over frozen ground.

In Newaygo County, the flood caused significant rises on the White River and the Muskegon River. It was the third highest crest on record for the Muskegon River below Croton. On the White River, water flowed over the emergency spillway causing significant damage to the White Cloud and Hesperia Dams. Estimated public damages to roads and infrastructure was $177,989.00 and private damages to homes and businesses were estimated to be $456,450.00. Newaygo County received a Governor's Disaster Declaration for this event.

Urban Flooding Hazard Analysis

A combination of excessive rainfall and/or snowmelt, saturated ground, and inadequate drainage can easily result in water with no safe place to go. The water will flow downhill to find the lowest elevations available—areas that are often not in an officially recognized floodplain but that flood regularly because of this runoff. This type of flooding is increasingly common in Michigan, as development outstrips the ability of the drainage infrastructure to properly carry and disperse the water flow. Flooding also occurs due to combined storm and sanitary sewers that cannot handle the tremendous flow of water that often accompanies storm events. Typically, the result is water backing into basements, which damages mechanical systems and can create serious public health and safety concerns. Other cases involve the ponding of waters across roads or in other low-lying areas. These additional types of flooding have now been given a separate chapter within this document.

"Urban flooding" may involve low-lying areas that collect runoff waters even though they are not adjacent to drains or bodies of water. This risk varies with the topography, soil types, runoff rates, drainage basin size, drainage channel sizes, and impervious ground surfaces in each area. Other kinds of urban flooding stem from flaws or shortcomings in existing sewer infrastructure. Some flood events may come from undersized or poorly designed sewer systems that cannot always process the amounts of precipitation and runoff that affects an area. Other events may have less to do with system design than with the collective effects of land use and development trends, illegal diversion of water, or actions that plug storm drains or otherwise interfere with system function.

The drainage systems within every Michigan county, plus most of its municipalities, are limited in the amount of water that they can successfully handle within a particular time-frame. Although much water eventually soaks into the ground and is delayed by natural plant growth as it falls, the increasing amount of paved and built-up land surfaces in Michigan tends to instead cause waters to quickly drain downhill at a rate that can overwhelm the existing drain systems in many areas. Some areas never had much drainage, but as long as these low-lying areas do not contain structures or important infrastructure, they can flood or act as wetlands and thus provide a natural benefit to detain and cleanse natural water runoff. The real problem exists where waters collect across roads, in basements, and even throughout the downtown areas within cities. In some cases, this occurs at the same time as riverine and lake flooding, but there are many flood impacts that occur outside of recognized floodplain areas. Water that normally might take several days to reach a river or stream under natural drainage conditions now quickly runs off of streets, parking lots, and rooftops, and through man-made channels and pipes that in some cases are under-sized. Some developments have also encroached into flood-plain areas and have therefore impeded the water storage and carrying capacity in part of the natural drainage area. This hazard also includes inadequacies or failures in the constructed components of drainage systems, which can cause water or sewer back-ups into basements, or sewer overflows of untreated waters into the environment.

<u>Urban Flooding in Michigan</u>

Michigan’s 21st Century trends have demonstrated that it is now just as important to consider broader types of urban flooding, especially urban flood hazards which have produced two of Michigan’s most damaging natural disasters in each decade of the new century (federal disaster #1346 in September

2000 and federal disaster #4195 in August 2014), both causing widespread damage throughout Metropolitan Detroit. Similar problems occur in many other urban areas, as well as less severe impacts within rural areas of the state. It is now documented that a great amount of our country's flood damage occurs outside of NFIP-recognized floodplain areas. In other words, many flood impacts occur in places that are far from streams and lakes.

Although the most severe urban floods do not happen every year in the same locations, some of the worst events are focused upon the most central infrastructure within Michigan's largest urban areas being overwhelmed. Michigan's cities act as vital hubs in transportation, trade, communication, and other key economic functions, but large cities have historically been built adjacent to rivers and coasts, in relatively low-lying locations toward which water tends to flow during its downhill journey toward the Great Lakes. Therefore, urban floods are often inundating the very areas that serve as our most important economic hubs. Even a small city can cause large-scale shutdowns in huge industries such as the automotive sector, because many manufacturing processes rely upon the timely supply of key industrial parts from plants located in small cities.

Urban Flooding in Newaygo County

With the increase in heavy rainfall events, areas not within recognized floodplain areas, or adjacent to rivers and lakes are also experiencing an increase in flooding. In some cases, melting snow or other runoff waters pool in low-lying areas, damaging structures and inhibiting the function of roads and infrastructure. In other cases, some type of breakdown in an area's pumping or drainage infrastructure may result in a damaging flood.

Within Newaygo County, several areas experiencing urban flooding issues include the City of Fremont, The City of Newaygo, the City of Grant, the City of White Cloud, and the Village of Hesperia. In these areas, there is a risk for vehicle accidents from hydroplaning, storm water damaging businesses, and storm water seeping into basements causing damage to contents and structures. As most of these areas are not within an identified floodplain, most jurisdictions do not participate in the National Flood Insurance Program. Therefore homeowners and businesses in these areas cannot get flood insurance to cover any losses from urban flooding.

Case: March 2019 Flood

On Thursday March 14, 2019 three rounds of thunderstorms combined to drop approximately 1.5 inches of rain on much of Newaygo County. In addition, the ground was frozen and approximately 4 inches of snow water equivalent was contained in the snowpack. About 2.5 inches of this snow water melted and joined the rainfall runoff. These 3 factors all resulted in rapid and significant flooding across parts of the county that resulted in more than 50 homes and 9 businesses flooded, as well as the closure of more than 100 roads and the complete washout of more than 30 roads. A series of private dams on Penoyer Creek were also damaged. In addition, in the days after the storm, minor flooding developed along the Muskegon River that resulted in the flooding of an additional 105 homes. Damages from this storm across the county were more than $1.7 Million. The Governor declared a State of Emergency for the community as a result of this emergency.

Dam Failure Hazard Analysis

A dam is a structure that stretches across a stream or other water body in order to control its flow or to convert the energy within the water into more convenient forms, such as electricity. The impounded waters may be used for agriculture, flood-control, artificial lakes, municipal water supplies, or for energy generation. Some dams have become obsolete, and should be removed to restore the natural water flow through the area. Otherwise, neglected dams will eventually fail, and would then be likely to cause a flash flood downstream, through the sudden release of their impounded waters. Some dams are constructed by wildlife instead of humans, but can pose similar risks. Damlike obstacles can accidentally arise through the accumulation of logs, debris, or ice at a particular location, temporarily blocking waters (often causing floods nearby) but potentially vulnerable to giving way and thereby causing a flash flood downstream.

A dam failure can result in loss of life, and in extensive property or natural resource damage for miles downstream from the dam. Dam failures occur not only during flood events, which may cause overtopping of a dam, but also as a result of poor operation, lack of maintenance and repair, and vandalism. Such failures can be catastrophic because they occur unexpectedly, with no time for evacuation.

The worst recorded dam failure in U.S. history occurred in Johnstown, Pennsylvania on the afternoon of May 31, 1889. More than 2,200 persons were killed when the South Fork Dam on the Conemaugh River upstream from Johnstown failed, sending 20 million tons of water downstream in a huge wall of water (at times 60-70 feet high) moving at 40 miles per hour and laden with debris. Johnstown was completely inundated, and the Conemaugh Valley was again the site of dam failures in May of 1977 when nearly 12 inches of rain fell in a 10-hour period, causing six dams surrounding Johnstown to fail, resulting in heavy property losses and the deaths of 45 persons. The storm that caused the dam failures was said to be at least a “5,000-year” event, in terms of its intensity.

Dam Failure Hazards in Michigan

Dams in Michigan are regulated by Part 307, Inland Lake Levels, and Part 315, Dam Safety, of The Natural Resources and Environmental Protection Act, 1994 PA 451, as amended. There are 2,500 dams in the state, 813 of which are regulated by Part 315, and 235 are regulated by Part 307. Dams are regulated by Part 315 when they are over 6 feet in height and over 5 acres are impounded during the design flood. Dams are regulated by Part 307 when a circuit court issues an order establishing the level at which the lake is to be maintained. There are also 99 hydroelectric dams in Michigan that are regulated by the Federal Energy Regulatory Commission (FERC) under the Federal Power Act.

State of Michigan classifies dams into three different categories:

1. High Hazard Potential: Failure may cause serious damage to inhabited homes, agricultural buildings, campgrounds, recreational facilities, industrial or commercial buildings, public utilities, main highways or class I carrier railroads, or where environmental degradation would be significant, or where danger to individuals exists with the potential for loss of life. (Sec.31503 [11])

2. Significant Hazard: failure may cause damage limited to isolated inhabited homes, agricultural buildings, structures, secondary highways, short line railroads, or public utilities, where environmental degradation may be significant, or where and danger to individuals exists. (Sec. 31505 [5])
3. Low Hazard: failure may cause damage limited to agriculture, uninhabited buildings, township or county roads, where environmental degradation would be minimal, and danger to individuals is slight or nonexistent. (Sec. 31504 [2])

The Michigan Department of Environment, Great Lakes, and Energy (EGLE) has documented approximately 302 dam failures in Michigan since 1888.The following is a brief summary of some of the more recent incidents:

Case: 2002-2004: Upper Peninsula Flooding and Dam Failures
A pattern of flooding and dam failures occurred in the Western and Central Upper Peninsula for several years in a row. In April of 2002, several dams in Gogebic County were breached by floodwaters, with the City of Wakefield being especially affected. The city's water treatment, wastewater treatment, and electric plant were all in danger of inundation and shutdown, and the State Police Post there was evacuated due to flooding. The Wood Dam (Presque Isle Wildlife Dam) was breached and an embankment to its north partially eroded, allowing waters to flow through. In Gogebic County, 48 homes were destroyed, 91 suffered major damage, and 27 endured minor damage; 7 businesses were destroyed, and 11 were damaged. A federal Disaster Declaration was issued by the president. In Marquette County, two dams were at maximum levels, but held during that 2002 event. In May of the next year, however, Marquette County was the one to suffer from flooding, as a series of dikes and dams failed, starting with the Silver Lake dike, and caused excessive water to flood low-lying areas in the City of Marquette. Marquette County declared a local state of emergency, and damages were estimated at about $3.2 million, of which $1,000,000 was caused to the failed dike and downstream dams themselves. The Governor ordered the evacuation of persons living along waterways in the Dead River Basin area and its tributaries downstream of Silver Lake. Although the U.S. Small Business Administration issued a "Declaration of Economic Injury," no federal Disaster Declaration was approved for this event. In 2004, similar flooding threatened to occur, but did not have quite the same level of impact as had happened in the previous two years.

Case: September 13, 2008 – Berrien County
On September 11, heavy rainfall struck the area as the remnants of Hurricane Ike and Tropical Storm Lowell finally reached the southern portion of Michigan. Over the next few days, rainfall totals across Berrien and Cass Counties exceeded 12 inches, and an earthen portion of the Niles Dan suffered a breach. Downstream residents were evacuated, as a precaution. The main flood impacts were felt upon the area's roads, especially in the Niles area, through September 15.

Case: May 31, 2010 – Kent County
After severe storms and heavy rainfall battered the area, a retaining wall was washed out and caused numerous homes to flood, about one mile south of Rockford. Property damage from the storm's impact was estimated at $200,000. Various roads were also flooded over and washed out.

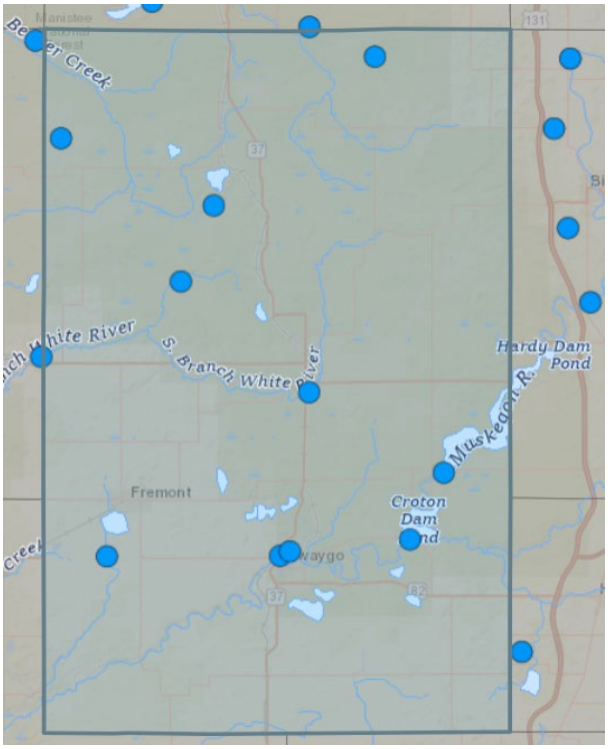
Case: October 6, 2012 – Dam Failure and Flash Flood (Grand Traverse County)
East of the town of Grawn, a temporary dam and de-watering structure had been in place alongside the Brown Bridge Dam on the Boardman River, to assist in drawing down the small lake behind the dam (Brown Bridge Pond) before the dam's permanent removal. This temporary dam failed and caused the release of all remaining water, causing road closures and home evaluations within the hour. A total of 53 homes sustained varying degrees of damage. Docks, small footbridges, and some small outbuildings were destroyed. Total damages were estimated at $1.8 million.

April 15, 2014 – Roscommon County
During the annual spring thaw, water levels were high in the area, and the Wraco Lodge Dam on Wolf Creek gave way, sending flood waters across several major roads and resulting in approximately $60,000 in property damage to them. The resulting road closures included Old 27 near the Clare County Line, Waco and Rollway Roads, Newaygo and Townline Roads, and County Road 402. Floodwaters were just inches away from reaching the level of the U.S.-127 Bridge.

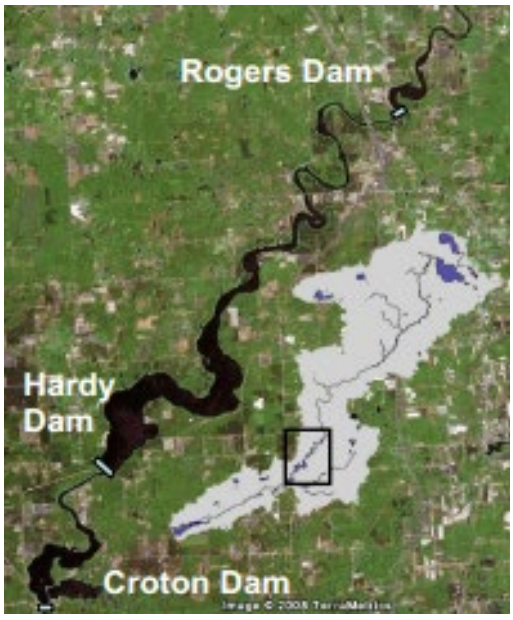
May 19, 2020 – Gladwin, Midland, and Saginaw Counties (Federal Disaster 4547-DR)
A heavy storm began on May 18, delivering up to 6-8 inches of rain in areas of the Tittabawassee River watershed. Flooding occurred in counties such as Gladwin, Midland, Saginaw, Iosco, and Arenac (which became part of state and federal emergency and disaster declarations). Run-off waters placed a heavy load upon the Secord and Smallwood Dams in Gladwin County, which were damaged but not breached. A breach occurred the next day at the downstream Edenville Dam, east of its powerhouse and spillways, resulting in an uncontrolled release into Sanford Lake. This was in turn followed by the overtopping of the downstream Sanford Dam about two hours later. The contents of Wixom Lake inundated areas as it progressed through Midland County, where floodwaters reached nine feet deep in parts of the City of Midland. Saginaw County also saw flooding, but area marshlands absorbed enough flow to blunt some effects. Serious impacts occurred in the Village of Sanford, the City of Midland, and townships along the Tittabawassee River, destroying roughly 130 homes and causing about $320M in property damage. Evacuations were complicated by multiple nursing homes in Saginaw and Midland Counties and involving hundreds of senior citizens (one Midland facility had roof damage and 18 inches of floodwater). At least 500 persons made use of temporary shelter facilities, complicated by Coronavirus 2019 (some evacuees chose to sleep in their vehicles to reduce exposure). Many evacuated persons found shelter with friends, but 280 families were put up in hotel lodging. In Saginaw County, all four bridges across the Tittabawassee River were closed. In Midland County, all major highways had flood closures, some for multiple days, with a county total of 138 closed roadway segments. Damaged community facilities included the Midland library, historic county courthouse, Northwood University, Midland Center for the Arts, Sanford Centennial Museum, and the Dow Botanical Gardens. Schools were also disrupted. Up to nine feet of flood water swept into the bottom level of Midland Hospital, closing their morgue and relocating their dispatch services. The City of Midland's wastewater infrastructure was inundated. Five sewer pump stations failed when they were completely submerged. Sixteen temporary pumps were used, and potable water stations were set up. Power failures occurred as cables were damaged, and there were additional impacts on gas, phone, and internet lines (one area network hub was completely lost). Drained lake areas created an erosion risk as former shorelines threatened to crumble.

Dam Hazards in Newaygo County

Within Newaygo County there are (2) Hydroelectric Dams owned and operated by Consumers Energy. These dams are regulated by the Federal Energy Regulatory Commission. In addition, there are 1 municipally owned dams and 8 privately owned dams as registered in the United States Army Corps of Engineers National Inventory of Dams. These dams are regulated under Part 315, Dam Safety, of The Natural Resources and Environmental Protection Act, 1994 PA 451, as amended.



Private dam owners are responsible for more than 65% of the nation's dams with the average age of dams more than 53 years old. As dams get older, deterioration increases and repair costs rise. Common problems include deteriorating metal pipes and structural components, sediment filled reservoirs, and increased volume of runoff into the reservoir upstream from a change in land use. Many private dam owners lack the financial resources necessary for adequate dam maintenance.



Hardy Dam

Located in Big Prairie Township, the Hardy Hydroelectric Dam is the third largest earthen-filled dam in the world, and the largest east of the Mississippi River. Its impoundment forms Michigan's largest inland lake with over 50 miles of shoreline and a reservoir of 3,902 acres. The average annual cubic feet per second of flow through the dam is 1,460. The Hardy Dam is capable of generating 30,000 kilowatts of electricity which is enough power to serve a community of 16,600 people.

The Hardy Dam is owned and operated by Consumers Energy. Because of its size and operation, the dam is licensed by the Federal Energy Regulatory Commission (FERC). This license governs plant operation, dam safety, and land management and recreation. The Hardy Dam is not designed and cannot operate as a flood control structure under the FERC License. The dam operates in a peaking mode, with pond levels maintained within +/- 0.5 feet of the 822.0 feet surface water level on a daily basis (except during drawdown and refill). Annually, from January until the end of April, the Hardy Dam may be drawn down up to -12 feet below 822.0 feet +/- 0.5 feet. The maximum depth of the drawdown is based on a winter snow

survey conducted with the National Weather Service. The pond must be refilled back to full levels by May 1st. Rates of drawdown and refill must not exceed 1 foot in a 24 hour period.



The Hardy Dam is listed as a High Hazard Dam by the Michigan DEQ. This dam is noteworthy not only because of the large amounts of water impounded behind it, but also because of its location upstream from the populated and agriculture areas along the Muskegon River near the City of Newaygo and in Muskegon County. A failure on this dam would likely result in loss of life and/or damage to structures, roads, utilities, crops and the environment. In addition, a failure of the Hardy Dam would cause a failure of the Croton Dam.

Croton Dam

The Croton Hydroelectric Generating Dam has been in continuous operation since 1907. Its impoundment, the Croton Pond, is 1,290 acres with a mean depth of 18 feet. The average annual cubic feet per second of flow through the dam is 1,871. The dam is capable of generating 8,800 kilowatts of electricity, enough to serve a community of about 4,900 people. The plant is located in Newaygo County's Croton Township and is the site of the great salmon migration.

The Croton Dam is owned and operated by Consumers Energy. Because of its size and operation, the dam is licensed by the Federal Energy Regulatory Commission (FERC). This license governs plant operation, dam safety, and land management and recreation. The Croton Dam is not designed and cannot operate as a flood control structure under the FERC License. The dam operates in a re-regulation mode, with pond levels maintained at 722.0 feet surface water level on a daily basis. With Hardy at full or minimum pond level, flows from Croton are to approximate the inflows from Rodgers Dam plus the Little Muskegon River. During the Hardy drawdown or refill periods, Croton is to release the projected daily average flow from Hardy plus the Little Muskegon River. Rates of drawdown and refill must not exceed 1 foot in a 24 hour period.



The Croton Dam is also listed as a High Hazard Dam by the Michigan DEQ. This dam is noteworthy not only because of the large amounts of water impounded behind it, but also because of its location upstream from the populated and agriculture areas along the Muskegon River near the City of Newaygo and in Muskegon County. A failure on this dam would likely result in loss of life and/or damage to structures, roads, utilities, crops and the environment.

White Cloud Dam

The White Cloud Dam is located at the southeast corner of the City of White Cloud on the White River. Two city parks are set on the edge of the impoundment near the Dam. The City of White Cloud Rotary Park is located at the toe of the right1 downstream embankment of the Dam. There is a public boat launch located on the right upstream embankment of the Dam, and a public beach with a dock is located North of the impoundment and accessible from James Street. The impoundment is primarily used for swimming and boating. South State Street runs along the crest of the Dam.

The dam was built in 1872 and is 18.89 foot high, 950 foot long earthen embankment with three spillways. The dam's impoundment is 475 acres. The Principal Spillway and the Secondary Spillway control the impoundment elevation and flow during normal conditions. The Emergency Spillway is an overflow structure, designed to overtop when the other spillways cannot adequately pass the flow through the dam. The dam is presently owned and operated by the City of White Cloud.

The White Cloud Dam is listed as a High Hazard Dam by the Michigan EGLE. This dam is noteworthy because of its location upstream from M-37 and the Marquette Railroad Bridge just south of the City of White Cloud. A failure on this dam would likely result in loss of life and/or damage to structures, roads, utilities, crops and the environment. It is unknown if a failure of the White Cloud Dam would cause a failure of the Hesperia Dam.

In recent years, numerous deficiencies have been identified during dam safety inspections by EGLE and structural inspections by the City's engineer (Holland Engineering, formerly OMM, Inc.). These deficiencies range from uncertainty about spillway capacity, concrete and steel deterioration, seepage on the downstream side of the embankment, and woody vegetation growing on the embankment. Additionally, there have been several recent overtopping events reported along the overflow spillway and a failure of stoplogs on the principal spillway. These deficiencies have led to the Dam receiving a poor condition rating from EGLE Dam Safety as of the latest inspection report, dated December 22, 2022.



The following are a list of known private dams in Newaygo County from the National Inventory of Dams, US Army Corps of Engineers and Michigan EGLE Dam Safety Division.

NAME	NIDID	OWNER NAME	ADDRESS	LOCATION	YEAR COMPLETE	Height (Ft)	MAX STORAGE (Acres)	MAX DISCHARGE (CFS)	HAZARD POTENTIAL
Minnie Lake Dam (Mena Creek)	MI82402	USDA FS	Alger Ave	Lincoln Township	1939	13	264	1,132	Low
Henkin Pond Dam	MI01759	Steve F Pagura	N. Dickinson Ave	Troy Township	1966	18	66	36	
Clayton Dam	MI00312	Leonard Kurello	West 9 Mile Road (Woodland	Merrill Township	1955	10	200	N/A	
Peace Creek Dam	MI00406	Grass Lake Hunting Club	13453 Pine Street	Home Township	1965	16	179	620	
Rowe Dams No. 1 (Penoyer Creek)	MI00234	Resonate Church	171 Curve Street, Newaygo	City of Newaygo	1888	13	65	400	
Rowe Dams No. 2 (Penoyer Creek)	MI00235	Resonate Church	171 Curve Street, Newaygo	City of Newaygo	1915	14	65	250	
Peterson Dam	MI02119	Thomas Merritt	7124 Robinwood	Sheridan Township	N/A	9	108	300	
Minnie Lake Dam (Mena Creek)	MI00185	Huron Manistee National Forest	W 2 Mile Road, Manistee National Forest	Lincoln Township	1939	10	264	1,000	
White Cloud Dam	MI00526	City of White Cloud	Silver Street	City of White Cloud	1872	18.9	475	2,600	High

The following brief synopses describes Newaygo County's Dam Failure Hazard Events:

Event: White Cloud Dam 1910
The White Cloud Dam was originally constructed in 1872. It was destroyed by flooding in 1910 and reconstructed the same year.

Event: White Cloud Dam September 1986
The White Cloud dam failed in September 1986 during severe flooding. The dam was reconstructed in 1990, with the addition of the roller compacted concrete overflow spillway to increase the dam's spillway capacity.

Event: Three White Cloud Dam Overtopping Incidents
During the April 2014, February 2018, March 2019, and October 2019 flooding events the White Cloud Dam overtopped resulting in overflow damage and required repairs.

Event: Rowe Dams on Penoyer Creek March 2019
Due to a heavy rainfall event and deferred maintenance, all Penoyer Creek dams sustained heavy damage. Rowe Dam#2 overtopped and an emergency drawdown was conducted to prevent complete collapse of the dam. Once the drawdown was completed, emergency stabilization took place to lessen further damage. Currently, the dam owner is working to EGLE and a Dam Engineer to determine the next course of action. The reservoir remains drawn down as the dam is no longer functioning as designed.



Great Lakes Shoreline Hazard Analysis

Shoreline flooding and erosion are natural processes, occurring at high, average, and even low Great Lakes water levels. However, during periods of high water, flooding and erosion are more obvious, causing serious damage to homes and businesses, roads, water and wastewater treatment facilities, and other structures in coastal communities. Great Lake water levels go through complicated cycles that are not easy to predict. The time between period of high and low water levels can vary widely.

The Great Lakes occupy an area of 95,000 square miles and drain an amount of land twice that size. They hold nearly one-fifth of the world's fresh surface water. Because the land draining into the Great Lakes is so vast, changes in the amount of water running into the lakes from precipitation within the basin has an enormous effect on water levels. Following long periods of above-average yearly precipitation, there is an accompanying rise in water levels. This rise is not immediately evident because of the delay between the time precipitation falls within the drainage basin and the time that runoff waters enter the lakes. The same holds true for below-average yearly precipitation. The reduced flow of runoff water eventually results in lower Great Lakes water levels.

Shoreline erosion hazards involve the loss of property as the supporting sand or soil is removed by wind and wave action. Worst-case scenarios tend to involve inhabited structures that, over the years, have had adjacent lands eroded away and now stand perilously close to lake waters or shoreline cliffs. The foundation of a structure, or underground utility pipes in the area, may become fully exposed and vulnerable to weather, extreme temperatures, water damage, or other sources of risk. Roads and structures may be just one storm away from falling into the lake when the shoreline is significantly eroded to the extent that it reaches a structure's foundation and the area's important infrastructure.

<u>Shoreline Hazards in Michigan</u>

Michigan has over 3,200 miles of coastline, the longest freshwater coastline in the world. About 4.7 million persons live in the state's 41 shoreline counties. Wind, waves, water levels, and human activities constantly affect the communities along the shores of the Great Lakes. Generally, low-lying lands along the coastline are prone to shoreline flooding during both high and low lake water periods. The Michigan Department of Environmental Quality (MDEQ) has designated 41 communities on Michigan's shoreline as flood risk areas, meaning that they have floodplain-like areas with at least a 1% annual chance of a designated flood level being exceeded. These designations allow the mapping of flood-prone areas in a manner similar to riverine flooding, but these shoreline areas may suffer from additional damages caused by the added effects of wave action and seiche activities on the Great Lakes. The MDEQ estimates that approximately 10% of Michigan's Great Lakes shoreline is flood-prone, involving lands encompassing more than 45,000 acres and located in 30 counties.

Another frequent situation in Michigan involves shoreline roadways whose banks erode and cause the road surface to crack, become unstable, or more prone to deposits of sand, snow, water and ice from nearby beaches and water bodies. The costs of delayed traffic and detours can be counted as harmful

shoreline effects. Travel on shoreline highways can also be made treacherous by sand, mists, and snow blown in by wind gusts.

Provided examples are for representative purposes and are not meant to be comprehensive. Flooding events affecting the Great Lakes shoreline also impact other areas of the State:

Case: August to September 2007 – Muskegon County Water Level Recession
Local reports described drought-related effects upon marine traffic in the Muskegon area. A super-freighter became stuck in the mouth of Muskegon Harbor and was reported as the second large ship to run aground within the space of a month, in the same location. Shipping officials stated that additional dredging was needed in Great Lakes ports because of low water levels.

October 2019 – Lakeshore Area Flooding (various Lake Michigan and Lake Huron locations)
Strong winds resulted in coastal flooding and beach erosion. Water levels rose over the docks at Northport Marina (Leelanau County). A boat house was also flooded. Part of the break wall at Empire Beach was destroyed. A previous restoration effort from earlier flooding was ruined in Glen Haven with shoreline fences ruined. High water levels and 30-40 mph winds produced large waves resulting in flooding across Bay, Tuscola, and Huron Counties. The water level at Essexville peaked at 71 inches above the chart datum. Lakeshore flooding affected homes and roads in Harbor Beach, Caseville, and Sebewaing. Shoreline erosion occurred at Port Crescent State Park and Port Hope. Significant damage to seawalls was reported in Lakeport. Extensive flooding also worked inland from Lake Michigan into New Buffalo (Berrien County). Some road closures were noted. Total property damages for the events were over $500K.

<u>Shoreline Hazards in Newaygo County</u>
Newaygo County is not a Great Lakes Shoreline community, therefore is minimally impacted by shoreline hazards. However, erosion on riverbanks of the Muskegon River and the Little Muskegon River has began impacting some homes. During the April 2013 flood, several properties along the Little Muskegon River in Croton Township experienced significant bank erosion due to sandy soils collapsing. One home was deemed no longer safe to occupy and had to be demolished. Again during the April 2014 flood, several more properties experienced bank collapse, this time on the Muskegon River in Brooks and Garfield Townships. One of the homes was deemed no longer safe to occupy and had to be demolished. Another is still actively being monitored and working on mitigating the property by relocating the structure.





Several locations continue to actively be monitored for additional erosion, which is threatening homes. A majority of these properties are located in Brooks Township along the Muskegon River's high banks. Some homeowners have attempted to work with outdoor restoration companies to stabilize the banks utilizing natural ground covers, however, additional mitigation efforts will need to be evaluated in order to protect the structures from future loss.





Community Vulnerability:

Floods can damage or destroy public/private property, including widespread residential impacts which may require evacuation and sheltering. They carry the potential to affect large portions of a community or region, making roads and bridges impassable and stranding cars. Power outages and drinking water supply/quality issues may emerge as infrastructure is damaged. Basement flooding and sewer back-ups may occur. Long-term collateral dangers include the outbreak of disease, widespread animal death, and the deposit of hazardous materials onto croplands or other areas. Fatalities and major injuries are uncommon in Michigan but possible.

Floods can also shut down businesses and services over a wide geographical area based on event severity, potentially crippling several economic components at one time (e.g., commercial, industrial, farming). Floodwaters may be slow to recede and produce lengthy/costly cleanups. Some governmental infrastructure may be directly impacted and need to be replaced, including along drains and sewer systems. Budgetary dollars that can be used for other purposes may need to be shifted to areas where flooding becomes chronic. Those who lose their homes may suffer significant financial losses, particularly among the uninsured.

Responder vehicles may have limited alternate routes available amongst flood streets. Boats or helicopters may need to be deployed. High flow rates, water depth, and hidden hazards make search and rescue dangerous. Fire stations, police stations, and other key infrastructure may themselves become flooded, some of which (e.g., hospitals) are difficult to relocate to less susceptible areas. Almost all services carry the risk of being affected, especially if important assets (e.g., generators, pumping stations) are located in basements or otherwise compromised. Winter flooding from ice jams may make cleanup especially difficult.

Water may become contaminated as it flows across a floodplain's streets, industrialized areas, or farmlands. Untreated sewage may be dumped into rivers when water systems are compromised or in localities with combined sewer systems. High bacterial counts may kill fish or create sanitary issues for communities depending upon the event. While the impact of flooding can sometimes have beneficial effects for certain types of wildlife or can recharge wetlands, many negative consequences also occur. Washed-out silt and debris may choke out the habitat as it accumulates downstream. The flow of some waterways may be permanently changed.

Floodplain Mapping and the National Flood Insurance Program

FEMA and the National Flood Insurance Program FEMA is responsible for mapping the country's flood risk through maps known as Flood Insurance Rate Maps (FIRM), one of the regulatory tools used by the NFIP. The NFIP makes flood insurance available in communities that have agreed to manage their floodplains in a manner geared towards minimizing future losses from flood damage. The NFIP is delivered directly by FEMA or through a network of companies that can write a policy under their own name (with FEMA still underwriting losses). FEMA provides information on how homeowners can understand flood zones and maps to help them decide if flood insurance is right for them. Michigan also provides information on how residents can use the program under the Department of Environment, Great Lakes, and Energy (EGLE), which can be located at https://www.michigan.gov/egle/about/organization/water-resources/floodplain-management/floodplain-mapping

As of February 2025, there were 19,629 active flood insurance policies in Michigan providing $4,458,758,800 in coverage. This figure reveals a roughly 20% decline in policies since 2010, and EGLE estimates that only 15% of all eligible flood-prone structures in Michigan have coverage. It should

be noted that only 50% of all local Michigan communities participate in the NFIP, so there are also thousands of flood-prone structures not eligible for insurance through the program.

As of March 2025, the following information was provided by the State of Michigan National Flood Insurance Program Coordinator for Newaygo County:

CID	Jurisdiction	Total premium	Policies	Rep. Losses	Total Coverage	Claims since 1978	Total Paid since 1978
	Newaygo County	**$ 73,667**	**68**	**43**	**$ 14,409,000**	**133**	**$2,970,623**
260694	Ashland Township	$ 20,138	11	6	$ 1,904,000	31	$742,825
260465	Big Prairie Township		0	0			
260466	Bridgeton Township	$ 17,047	17	21	$ 3,616,000	43	$776,295
260467	Brooks Township	$ 11,707	14	2	$ 3,367,000	19	$710,140
260468	Croton Township	$ 2,123	1	0	$ 1,050,000	1	$0
261402	Dayton Township	$ 3,846	7	0	$ 1,405,000	2	$116,369
261042	Ensley Township		0	0			
261404	Everett Township		0	0			
260167	City of Fremont	$ 1,699	2	0	$ 560,000		
260469	Garfield Township	$ 7,519	6	8	$ 1,222,000	25	$439,693
260485	Village of Hesperia	$ 843	1	0	$ 44,000	2	$12,904
261379	Lilley Township		0	0			
260828	Lincoln Township	$ 4,396	3	0	$ 615,000	0	$0
260340	City of Newaygo	$ 1,759	2	6	$ 317,000	10	$172,397
261899	Sheridan Township	$ 605	1	0	$ 280,000	0	$0
261384	Sherman Township		0	0			
260470	City of White Cloud	$ 3,684	3	0	$ 553,000	0	$0
261013	Wilcox Township		0	0			

*All Repetitive Loss properties are classified as single family residential

Newaygo County Communities NOT Participating in the National Flood Program

CID	Community Name	Init FHBM Identified	Init FIRM Identified	Current Eff. Map Date	Reg Emer Date
	Barton Township				
	Beaver Township				
	Denver Township				
	Goodwell Township				
	Grant Township				
	Home Township				
	Merrill Township				
	Monroe Township				
	Norwich Township				
	Troy Township				
	City of Grant				

As a participant in the NFIP, a community must adopt regulations that:

1) require any new residential construction and substantial improvements to existing structures, within the 100-year floodplain to have the lowest floor, including the basement, elevated above the 100-year flood elevation,
2) require non-residential structures to be elevated or dry floodproofed, and
3) require anchoring of manufactured homes in flood-prone areas.

The community must also maintain a record of all lowest floor elevations or the elevations to which buildings in flood hazard areas have been floodproofed. Flood Insurance Rate Map and the Risk MAP Program Floodplain maps, including FIRMs, typically display areas that fall within a 100-year flood boundary (the term 100-year flood indicates that the area has a 1% chance of flooding in any given year, not that a flood will occur every 100 years). The term can be misleading because a "100-year" flood may still occur several times a century, due to both random chance, inaccuracies in complex modeling, or changes to an area (e.g., new development, weather patterns) since maps were created. More information regarding digitized FIRM availability for Michigan is available in the supplemental materials section at the end of this chapter. Risk MAP, which focuses on mapping, assessment, and planning, is another flood-related FEMA program and a description of the process used to create flood maps. Its maps and other materials are generally divided between regulatory products and non-regulatory products. Regulatory products, such as FIRM, are intended to be used as the basis for official actions required by the NFIP. The FEMA Flood Map Service Center used for obtaining maps can be found HERE.

CID	Community Name	Init FHBM Identified	Init FIRM Identified	Current Eff. Map Date	Reg Emer Date	LOMCS
260694	Ashland Township	5/19/1978	09/01/1986	2/18/15	09/01/1986	7
260465	Big Prairie Township					0
260466	Bridgeton Township	10/22/1976	09/04/1986	02/18/1915	09/04/1986	9
260467	Brooks Township	07/18/1975	07/03/1986	02/15/2015	07/03/1986	9
260468	Croton Township	03/10/1978	09/30/1978	02/18/2015(M)	09/30/1988	22
261402	Dayton Township		02/18/2015	02/18/2015(M)	12/15/2015	
261042	Ensley Township		02/18/2015	(NSFHA)	02/18/2015	0
261404	Everett Township		02/18/2015	02/18/2015	02/18/2016	
260167	City of Fremont	05/31/1974	08/10/1979	02/18/2015(M)	08/10/1979	1
260469	Garfield Township	08/08/1975	09/29/1986	02/15/2015	09/29/1986	2
260485	Village of Hesperia	07/11/1975	08/01/1986	08/04/2014(M)	08/01/1986	3
261379	Lilley Township		02/18/2015	02/18/2015	02/18/2016	
260828	Lincoln Township		09/27/1991	02/18/2015	02/21/1996	16
260340	City of Newaygo	09/12/1975	02/18/2015	02/18/2018	05/25/1984	1
261899	Sheridan Township		02/18/2015	02/18/2015(M)	12/07/2015	
261384	Sherman Township		02/18/2015	02/18/2015(M)	02/18/2015	
260470	City of White Cloud	04/11/1975	09/01/1986	02/18/2015(M)	09/01/1986	6
261013	Wilcox Township		02/18/2015	02/18/2015(M)	02/18/2015	0

Federal Emergency Management Agency
Disaster Report - MICHIGAN
Flood Insurance - Detail

CID	Community	CRS Class Rating	Policies	Insurance In Force	Total Paid Losses	Total Paid Amount	Repetitive Loss Buildings	Repetitive Loss Payment	Target Rep. Loss Buildings
	**** NEWAYGO COUNTY ****								
260694A	ASHLAND, TOWNSHIP OF		11	1,940,000	31	742,825	3	198,517	0
261400#	BARTON, TOWNSHIP OF		0	0	0	0	0	0	0
261401A	BEAVER, TOWNSHIP OF		0	0	0	0	0	0	0
260465A	BIG PRAIRIE, TOWNSHIP OF		0	0	0	0	0	0	0
260466A	BRIDGETON, TOWNSHIP OF		17	3,616,000	43	776,295	10	587,044	1
260467A	BROOKS, TOWNSHIP OF	8	14	3,367,000	19	710,140	1	98,012	0
260468A	CROTON, TOWNSHIP OF		3	1,050,000	1	0	0	0	0
261402A	DAYTON, TOWNSHIP OF		7	1,405,000	2	116,369	0	0	0
261403A	DENVER, TOWNSHIP OF		0	0	0	0	0	0	0
261042A	ENSLEY, TOWNSHIP OF		0	0	0	0	0	0	0
261404A	EVERETT, TOWNSHIP OF		0	0	0	0	0	0	0
260167A	FREMONT, CITY OF		0	0	0	0	0	0	0
260469A	GARFIELD, TOWNSHIP OF		6	1,222,000	25	439,693	4	95,673	1
261375#	GOODWELL, TOWNSHIP OF		0	0	0	0	0	0	0
261376#	GRANT, CITY OF		0	0	0	0	0	0	0
261405A	GRANT, TOWNSHIP OF		0	0	0	0	0	0	0
260485B	HESPERIA, VILLAGE OF		1	44,000	2	12,904	0	0	0
261378#	HOME, TOWNSHIP OF		0	0	0	0	0	0	0
261379A	LILLEY, TOWNSHIP OF		0	0	0	0	0	0	0
260828A	LINCOLN, TOWNSHIP OF		3	615,000	0	0	0	0	0
261380A	MERRILL, TOWNSHIP OF		0	0	0	0	0	0	0
261381#	MONROE, TOWNSHIP OF		0	0	0	0	0	0	0
260340A	NEWAYGO, CITY OF		2	317,000	10	172,397	5	141,534	0
261382#	NORWICH, TOWNSHIP OF		0	0	0	0	0	0	0
261899A	SHERIDAN, CHARTER TOWNSHIP OF		1	280,000	0	0	0	0	0
261384A	SHERMAN, TOWNSHIP OF		0	0	0	0	0	0	0
261406#	TROY, TOWNSHIP OF		0	0	0	0	0	0	0
260470A	WHITE CLOUD, CITY OF		3	553,000	0	0	0	0	0
261013A	WILCOX, TOWNSHIP OF		0	0	0	0	0	0	0
	County Total :		68	14,409,000	133	2,970,623	23	1,120,780	2
	Grand Total :		**0**	**0**	**0**	**0**	**0**	**0**	**0**

Sources for NFIP Information include

- Participating Communities: http://www.fema.gov/national-flood-insurance-program/national-flood-insurance-program-community-status-book
- Policies and Coverage: http://www.fema.gov/policy-claim-statistics-flood-insurance/policy-claim-statistics-flood-insurance/policy-claim-13
- Repetitive Losses: Matt Occhipinti, NFIP Coordinator, Michigan EGLE - Water Resources Division
- FEMA Regional Flood Insurance Liaison: James Sink, FEMA Region 5 Mitigation Division Regional Flood Insurance Liaison

Community Rating System

Since 1978, about $88.4 million in claims have been paid due to flooding in Michigan. It should be remembered that officially claimed flood losses are only a small percentage of the total losses that are occurring from flood events. The flood insurance losses provide a good indication of where flooding problems currently exist, but they do not provide a good estimate of the total losses that are actually occurring.

The "Community Rating System" allows participating communities to earn discounts for their residents' flood insurance premiums. The following communities (as of October, 2010) are all CRS participants that have earned discounts of between 5% and 25% on the policy premiums for their NFIP-insured properties:

CRS Class 5 (25% discounts earned): Midland City (Midland County)

CRS Class 6 (20% discounts earned): Ann Arbor City (Washtenaw County), Vassar City (Tuscola County)

CRS Class 7 (15% discounts earned): Dearborn Heights City (Wayne County), Novi City (Wayne County), Saginaw Township (Saginaw County), Shelby Township (Macomb County), Sterling Heights City (Macomb County)

CRS Class 8 (10% discounts earned): **Brooks Township (Newaygo County)**, Detroit City (Wayne County), Gibraltar City (Wayne County), Grand Haven Township (Ottawa County), Hamburg Township (Livingston County), Luna Pier City (Monroe County),
Portage City (Kalamazoo County), Rockwood City (Wayne County), Taymouth Township (Saginaw County), Zilwaukee City (Saginaw County)

CRS Class 9 (5% discounts earned on NFIP policy premiums): Bedford Township (Monroe County), Commerce Township (Oakland County), Fraser Township (Bay County), Plainfield Township (Kent County), Richfield Township (Genesee County), Saugatuck City (Allegan County), Taylor City (Wayne County)

In addition, the following communities are in Class 10, and do not currently receive any discount:

CRS Class 10 (Rescinded) City of Farmington Hills (Oakland County), Park Township (Ottawa County), Sumpter Township (Wayne County)

Floodplain Management in Michigan

Michigan Floodplain and Flood Hazard Management Floodplain permitting review is done by the district floodplain engineer responsible for that portion of the state. Part 31, Floodplain Regulatory Authority, is intended to ensure that the flow-carrying capacity of a watercourse is not obstructed in harmful ways and that its floodway portions are not used in residential construction. It and other select governmental authorities are described below:

- Floodplain Regulatory Authority, found in Water Resources, Part 31 of the Natural Resources and Environmental Act, 1994 PA 451: Regulates occupation of the 100-year floodplain and ensures that proposed development in the floodway does not obstruct flood flows. A permit is required from EGLE for any occupation or alteration of the 100-year floodplain. In general, construction and fill may be permitted in the portions of the floodplain that are not floodway, provided local ordinances and building standards are met. Residential construction is specifically prohibited in the floodway. Non-residential construction may be permitted in the floodway if it can be demonstrated that the project will not cause increased flood stages during flooding conditions up to and including the 100-year flood.
- Inland Lakes and Streams, Part 301 of the Natural Resources and Environmental Protection Act, 1994 PA 451: Regulates all construction, excavation, and commercial marina operations on the State's inland waters. It ensures that proposed actions do not adversely affect inland lakes, streams, connecting waters, and the uses of all such waters. Structures are prohibited that interfere with the navigation and/or natural flow of an inland lake or stream.
- Land Division Act, 1996 PA 591, as amended by 1997 PA 87: The Act requires review at local, county, and state levels to ensure that subdivided land is suitable for development. A proposed subdivision is reviewed for proper drainage by the County Drain Commissioner and for floodplain impacts by EGLE. Floodplain limits must be defined and prescribe minimum standards for new residential developments in areas within or affected by a floodplain.
- Wetlands Protection, Part 303 of the Natural Resources and Environmental Protection Act, 1994 PA 451: Requires a permit from the EGLE for any dredging, filling, draining, or alteration of a wetland. This permitting process helps preserve, manage, and protect wetlands and the public functions they provide – including flood and stormwater runoff control.
- Natural Rivers Program, Part 305 of the Natural Resources and Environmental Protection Act, 1994 PA 451: Through the natural rivers designation process, a Natural River District is established (typically 400 feet on either side of the riverbank) and a zoning ordinance is adopted. Within the Natural River District, permits are required for building construction, land alteration, platting of lots, cutting of vegetation, and bridge construction. These include building setbacks (in many cases prohibiting construction in the 100-year floodplain) and vegetative strip requirements.

- Manufactured Housing Commission Act, 1987 PA 96: Provides regulation on the placement of manufactured homes and establishes construction criteria. Manufactured homes are prohibited from being placed within a floodway, as determined by EGLE. Manufactured homes sited within a floodplain must be elevated above the 100-year flood elevation and must install an approved anchoring system to prevent it from being moved from the site.
- Local River Management Act, 1964 PA 253 Provides for the coordination of planning between local units of government as related to water management programs. Watershed councils conduct studies and have the authority to develop River Management Districts for the purpose of acquisition, construction, operation, and financing of water storage and other river control facilities. The provision to allow the acquisition of land adjacent to the river, for the purpose of management, aids in regulating the development of land prone to flooding.

DROUGHT AND EXTREME TEMPREATURES (HEAT)

Drought

A period of abnormally dry weather sufficiently long enough to cause a serious hydrological imbalance

Drought Hazard Description

In contrast to hazards with well-defined thresholds, drought is a relative condition caused by a natural reduction in the amount of available water over an extended period of time (usually a season or more in length). Effects may accumulate slowly, typically without exact beginning or end points. This lack of clearly visible and universally accepted standards can make confirming drought conditions difficult. Large geographic areas may be impacted and made more severe based on location, duration, and the water needs of humans and natural/agricultural landscapes.

Droughts may be described in different ways. For example, a meteorological drought is based on the degree of dryness, or the departure of actual precipitation from an expected average or normal amount based on monthly, seasonal, or annual time scales. A hydrologic drought involves the effects of precipitation shortfalls on stream flows and reservoir, lake, and groundwater levels. An agricultural drought involves deficiencies in precipitation and soil moisture with respect to the water needs of crops.

Drought differs from other natural hazards in several ways. First, in the lack of an exact beginning and endpoint for a drought, whose effects may accumulate slowly and linger even after the event is generally thought of as being over. Second, the lack of a clear-cut definition of drought can make it difficult to confirm whether one actually exists, and if it does, its degree of severity. Third, drought impacts are often less obvious than other natural hazards, and they are typically spread over a much larger geographic area. Fourth, due primarily to the aforementioned reasons, most communities do not have in place any contingency plans for addressing drought. This lack of pre-planning can hinder support for drought mitigation capabilities that would otherwise effectively increase awareness and reduce drought impacts.

Drought may also be associated with extreme heat lasting for more than one week. Extreme heat in Michigan occurs during the warm months from May to September, and is marked by temperatures above 90°F. This can cause loss of life among vulnerable populations, damage to infrastructure, disruptions to schools and businesses, and contribute to drought conditions. Extreme heat can occur independent of drought and a drought can occur without extreme heat.

Drought Hazard Analysis

Droughts can cause many severe impacts on communities and regions, including: 1) water shortages for human consumption, industrial, business and agricultural uses, power generation, recreation and navigation; 2) a drop in the quantity and quality of agricultural crops; 3) decline of water quality in lakes, streams and other natural bodies of water; 4) malnourishment of wildlife and livestock; 5) increase in

wildfires and wildfire-related losses to timber, homes and other property; 6) declines in tourism in areas with water-related attractions and amenities; 7) declines in land values due to physical damage from the drought conditions and/or decreased economic or functional use of the property; 8) reduced tax revenue due to income losses in agriculture, retail, tourism and other economic sectors; 9) increases in insect infestations, plant disease, and wind erosion; and 10) possible loss of human life due to food shortages, extreme heat, fire, and other health-related problems such as diminished sewage flows and increased pollutant concentrations in surface water.

Although it is difficult to determine when a drought is actually occurring, once a drought is recognized it can be classified within four different categories - meteorological, hydrologic, agricultural, and socioeconomic. A **meteorological** drought is based on the degree of dryness, or the departure of actual precipitation from an expected average or normal amount based on monthly, seasonal, or annual time scales. A **hydrologic** drought involves the effects of precipitation shortfalls on stream flows and reservoir, lake, and groundwater levels. An **agricultural** drought concerns soil moisture deficiencies relative to the water demands of plant life, usually crops. A **socioeconomic** drought is when the effective demand for water exceeds the supply, as a result of weather-related shortfalls.

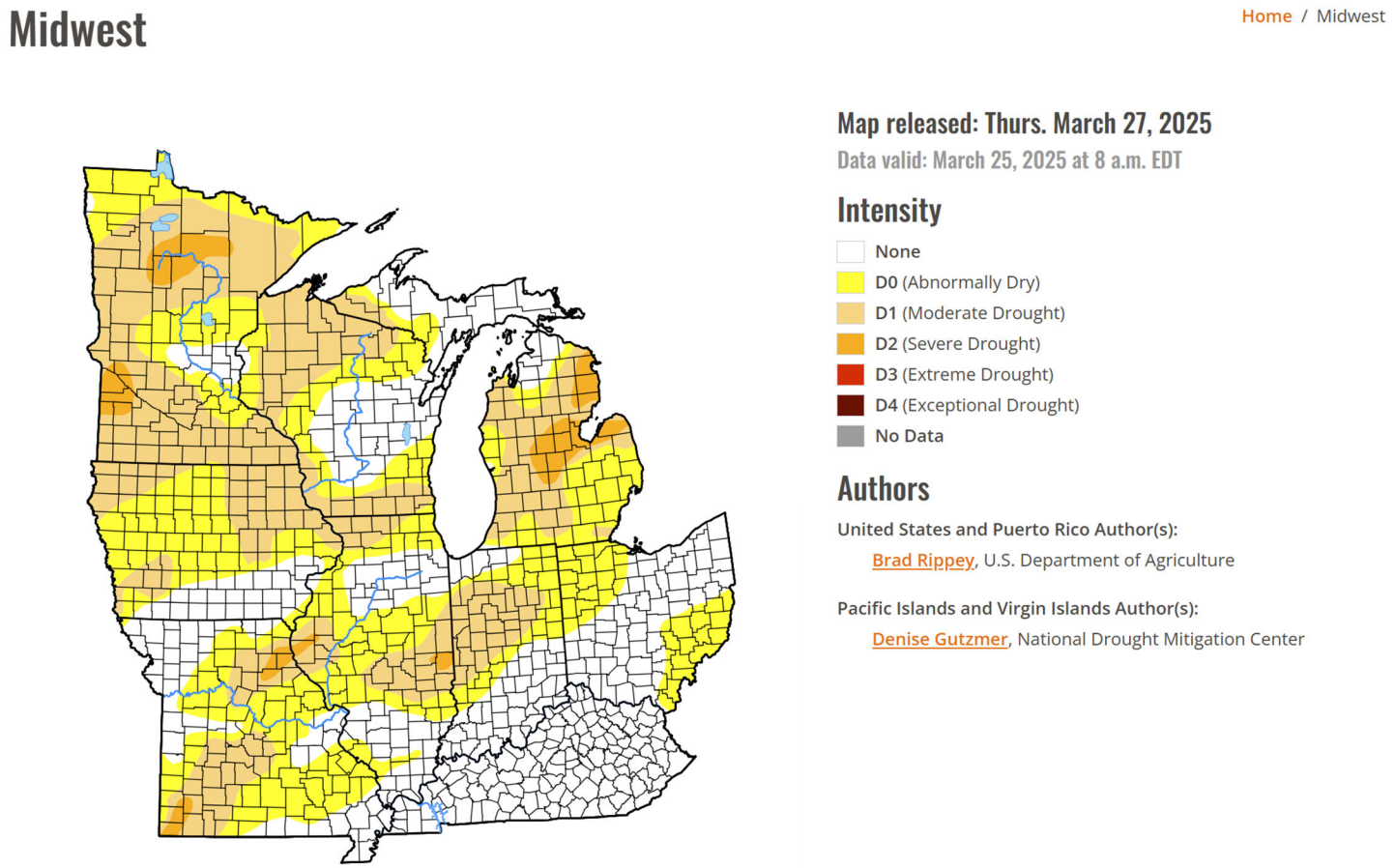
The U.S. Drought Monitor (http://www.drought.unl.edu/dm/monitor.html) uses four classifications of severity, from the least intense category (D1) to the most intense (D4), with an additional (D0) category used to designate a “drought watch” area in which long-term impacts such as low reservoir levels are probably present. The Drought Monitor summary map is available online, identifying general drought areas and labeling their intensity. While not the only way to characterize droughts, the U.S. Drought Monitor is convenient and their classification levels have recently been used in various reports and assessments of drought conditions. Short-term indicators are on the level of 1-3 months, while long-term indicators focus on a duration of 6 to 60 months.

Palmer Drought Classification Categories

Category	Description	Possible Impacts	Palmer Drought Index	CPC Soil Moisture Model, USGS Weekly Streamflow, Objective Short & Long-term Drought Indicator Blends (Percentiles)	Standardized Precipitation Index (SPI)
D0	Abnormally Dry	Going into drought: short-term dryness that slows planting, growth of crops or pastures. Coming out of drought: some lingering water deficits; pastures or crops not fully recovered.	-1.0 to -1.9	21-30	-0.5 to -0.7
D1	Moderate Drought	Some damage to crops, pastures, streams, reservoirs, or wells low; some water shortages developing or imminent; voluntary water-use restrictions requested.	-2.0 to -2.9	11-20	-0.8 to -1.2
D2	Severe Drought	Crop or pasture losses likely; water shortages common; water restrictions imposed.	-3.0 to -3.9	6-10	-1.3 to -1.5
D3	Extreme Drought	Major crop/pasture losses; widespread water shortages or restrictions.	-4.0 to -4.9	3-5	-1.6 to -1.9
D4	Exceptional Drought	Exceptional and widespread crop/pasture losses; shortages of water in reservoirs, streams, and wells creating water emergencies.	-5.0 or less	0-2	-2.0 or less

Source: U.S. Drought Monitor web site http://drought.unl.edu/dm/classify.htm

In addition, the U.S. Drought Monitor uses two general drought categories in assessing an event—an A to denote agricultural effects on crops, pastures, and grasslands, and an H to denote hydrologic effects on water supplies such as rivers, groundwater, and reservoirs.



Drought in Michigan

Despite the thousands of miles of rivers and streams in the state, Michigan has experienced occasional drought conditions. Most common are agricultural droughts, with severe soil-moisture deficits, which have had serious consequences for crop production, particularly when coupled with extreme summer temperatures. Also, various water bodies, both inland lakes and the Great Lakes themselves, cyclically go through periods of low-water levels. Michigan has emerged from its latest such period and is now experiencing high water levels. (See the section on Flooding Hazards for more information about these trends in water levels.)

Drought can be a “low-profile” hazard that does not get a lot of public attention in Michigan, compared with other parts of the United States. Nevertheless, parts of Michigan have tended to experience significant drought conditions about 20% of the time on average (depending upon how it is measured). Even if the occurrence of drought appears at first to be of lesser concern for a community, it is important to include a consideration of the drought hazard in local hazard mitigation planning, since plans are an excellent way to deal with gradual or longer-term hazards such as drought.

When a drought takes place, there are many impacts that can result from the extended dry period. These impacts can be classified as economic, social, and environmental. Of great significance is the economic loss of crop production through lower yields, poorer crop quality, and reduced productivity of the land. (Michigan's fruit production is especially vulnerable to lesser yields, as was seen in a 2001 drought event that caused the destruction of one-third of the state's fruit and vegetable crop.) Timber production is also reduced, through exacerbated risks from forest fires and tree diseases, and fisheries have lesser amounts of fish as water quality tends to degrade. Lessened production in the agricultural sector leads to income losses for farmers and industries dependent on agricultural products. Lower hydrologic levels lead to water shortages for municipalities and potential production limits or shutdowns in industries and businesses that depend on large volumes of water. Tourism becomes hampered by lower lake and river depths, due to the recreational difficulties and inconveniences that are caused. Severe and prolonged droughts could have catastrophic effects on the economy, in cases when adverse conditions lead to disruptions in the regional and national economy and when widespread economic losses affect the supply and distribution of goods and services.

Michigan drought analysis can accomplished by examining different types of drought and severity by region. Addressing agricultural droughts first, they can carry significant economic losses through lower yields and/or decreased crop quality.

Agricultural Disaster Declarations Involving Drought (Michigan, 2012-2021)

ID#	Declared	Description	Counties	In Area 4	In Area 3	In Area 2	In Area 1
S3275	7-12-2012	Drought	5	0	0	5	0
S3303	7-25-2012	Drought	10	0	0	10	0
S3332	8-08-2012	Drought	1	0	0	1	0
S3344	8-15-2012	Drought	2	0	0	2	0
S3370	8-29-2012	Drought and heat	83	15	29	34	5
S3380	9-05-2012	Heat, frost, freeze, and drought	5	0	0	5	0
S3384		Drought and heat	3	0	0	3	0
S3623	1-23-2014	Drought and colder-than-normal temperatures	5	0	5	0	0
S3636		Rain, drought, and cooler-than-normal temperatures	25	0	22	3	0
S3807	3-25-2015	Rain, drought, and colder-than-normal temperatures	19	0	19	0	0
S3936	11-25-2015	Drought, rain, hail, and high winds	24	5	19	0	0
S4132	1-09-2017	Drought	51	5	25	16	5
Total # Each Area Has Been Partially Affected by Declaration:				**3**	**6**	**9**	**2**

(source: USDA FSA; as described in Appendix A: Area 4 (Upper Peninsula), Area 3 (Northern Lower Peninsula), Area 2 (Southern Lower Peninsula minus Metropolitan Detroit), Area 1 (Metropolitan Detroit))

Information from the National Centers for Environmental Information (NCEI) is available for the current tracking and historical research of drought events in Michigan, but since dry conditions in one region may be balanced (in a statewide average) by wet conditions in another region, it is appropriate to look at specific regions rather than the state as a whole, to assess the presence and severity of drought conditions from the historical data. Following this is an overarching description of incidents and trends shown in historical drought records for Michigan.

Michigan's 10 Climate Divisions (CDs) are useful for analyzing drought. The following divisions are arranged by county:

Division 1: Baraga, Dickinson, Gogebic, Houghton, Iron, Keweenaw, Marquette, Menominee, Ontonagon
Division 2: Alger, Chippewa, Delta, Luce, Mackinac, Schoolcraft
Division 3: Antrim, Benzie, Charlevoix, Emmet, Grand Traverse, Kalkaska, Leelanau, Manistee, Missaukee, Wexford
Division 4: Alcona, Alpena, Cheboygan, Crawford, Montmorency, Iosco, Ogemaw, Oscoda, Otsego, Presque Isle, Roscommon
Division 5: Lake, Mason, Muskegon, Newaygo, Oceana
Division 6: Clare, Gladwin, Gratiot, Isabella, Mecosta, Midland, Montcalm, Osceola
Division 7: Arenac, Bay, Huron, Saginaw, Sanilac, Tuscola
Division 8: Allegan, Berrien, Cass, Kalamazoo, Kent, Van Buren, Ottawa
Division 9: Barry, Branch, Calhoun, Clinton, Eaton, Hillsdale, Ingham, Ionia, Jackson, Shiawassee, St. Joseph
Division 10: Genesee, Lapeer, Lenawee, Livingston, Macomb, Monroe, Oakland, St. Clair, Washtenaw, Wayne



The following table summarizes 127 years of drought records as expressed by the Palmer Drought Severity Index (PDSI), by month, for all 10 of Michigan's CDs.

Drought Months in Michigan, by Climate Division
Drought Severity Based Upon PDSI
Select Index Values Shown (January 1895 through December 2021)

Climate Division	Months without Drought	Months with any drought		% Months with drought	% Months with drought	% Months with drought	% Months with drought	% Months with drought	% Months with drought
PDSI:	(>=0)	(< 0)		<= -2	<= -3	<= -4	<= -5	<= -6	<= -7
1	46.3%	53.7%		19.0	8.4	3.7	1.5	0.4	0.1
2	46.2%	53.8%		18.5	9.4	2.5	0.5	0.0	0.0
3	48.2%	51.8%		18.6	6.4	2.1	0.6	0.2	0.0
4	50.7%	49.3%		19.4	10.0	4.3	1.0	0.1	0.0
5	48.7%	51.3%		18.2	6.4	1.8	0.4	0.1	0.0
6	55.4%	44.6%		15.7	6.1	2.3	0.9	0.1	0.0
7	54.5%	45.5%		14.4	6.2	2.0	0.7	0.2	0.0
8	52.8%	47.2%		16.9	6.7	2.2	0.7	0.3	0.0
9	56.8%	43.2%		14.1	6.2	3.2	1.2	0.3	0.0
10	56.1%	43.9%		15.9	8.2	3.9	2.2	1.0	0.0

Drought in Newaygo County

According to the US Geological Survey mild droughts are common in Michigan, but severe droughts are infrequent and generally of short duration. The even distribution of precipitation and moderate humidity are helpful in meeting the large demand for moisture by crops. Although rainfall is abundant during the summer, runoff is decreased because of increased evapotranspiration and absorptive capacity of soils. A majority of the severe droughts occurred in the late 1800s and early 1900s. These droughts were prolonged and statewide. In the summer of 1871, there was a prolonged drought over much of the Great Lakes Regions, and again in May through September of 1891 which devastated Michigan's Lumber industry. The most severe drought on record was during the 1930's. The recurrence interval of the 1930-37 drought was 50-70 years, depending upon locality.

More recent droughts and heat waves have caused considerable damage to agriculture and related industries in several areas of the United States. In rural agricultural areas and the heavily forested areas similar to Newaygo County, drought brings on a host of other problems to address. The agricultural areas of Newaygo County are highly vulnerable to drought conditions that impact the quantity or quality of crops, livestock, and other agricultural activities. These areas often depend heavily on agricultural production for their economic needs. A prolonged drought can seriously impact local and regional income, which in turn has a rippling effect on the other components of the economy. Drought can also cause long-term problems that can negatively affect the very viability of some agricultural operations.

Newaygo County sits in Michigan's Climate Division 5. The following are significant droughts affecting this division: The most extreme drought was in February 1931, when the Palmer drought severity index hit a record low of -6.06. Lengthy drought incidents took place in 1895-1896 (15 months), 1901-1902 (11 months), 1910-1911 (14 months), 1921-1922 (9 months), 1925-1926 (13 months), 1930-1931 (13 months), 1934 (9 months), 1956-1957 (8 months), 1963-1964 (19 months), 1971-1972 (11 months), 1976-1977 (10 months), and 2002-2003 (12 months).

Community Vulnerability:

Droughts may cause water shortages used for drinking, power generation, and recreation. A reduction in the quantity and quality of agricultural crops may lead to food shortages. Property values may be impacted by soil or water feature loss. Water restrictions and limitations among residents may change lifestyle patterns (e.g., lawn watering, and car washing). Stream flows can fall below 50% of their normal levels during moderate and severe drought conditions, reducing the navigability of waterways and altering the relationship between water levels/locations and built facilities (boardwalks, docks, fishing sites, etc.). Some municipal systems and infrastructure may find the maintenance of water quality and supply to be more difficult and expensive. Urbanized areas can be vulnerable to drought due to the sheer number of users that are competing for available water resources. Drought associated with high heat may be especially problematic in dense inner-city areas with urban heat islands. Illness from associated heat and other health-related problems may arise from diminished sewage flows and increased pollutant concentrations in surface water.

Extreme Temperatures, Heat

Prolonged periods of very high or very low temperatures, often accompanied by other extreme meteorological conditions.

Extreme Heat Hazard Description

Prolonged periods of extreme temperatures, whether extreme summer heat or extreme winter cold, can pose severe and life-threatening problems for Michigan's citizens. Although they differ in their initiating conditions, the two hazards share a commonality in that they both tend to have a special impact on the most vulnerable segments of the population—the elderly, young children and infants, impoverished individuals, and persons who are in poor health. Due to their different characteristics, extreme summer heat and extreme winter cold hazards will mostly be discussed separately in this section. For both types of temperature extremes, however, a longer hot or cold spell makes the temperature effects much more severe on vulnerable populations—a longer duration tends to produce more severe effects.

Extreme Heat Hazard Analysis

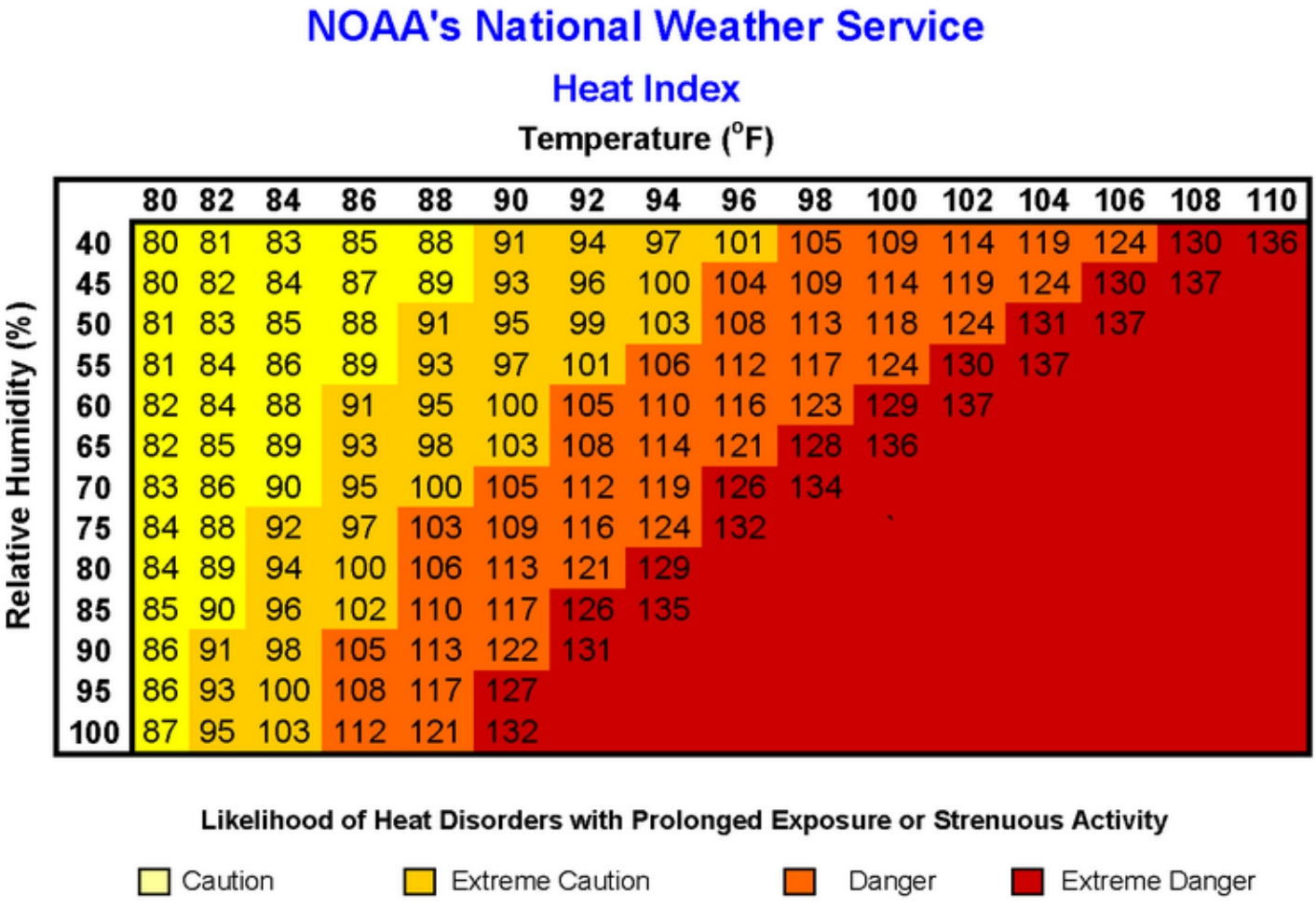
Extreme Summer Heat is characterized by a combination of very high temperatures and humid conditions. When persisting over a long period of time, this phenomenon is commonly called a heat wave. The major threats of extreme summer heat are heat exhaustion and heatstroke (a major medical emergency). Heat exhaustion is a less severe condition than heatstroke, but it causes problems involving dizziness, weakness and fatigue. Heat exhaustion is often the result of fluid imbalance due to increased perspiration in response to the intense heat. Treatment generally consists of restoring fluids and staying indoors in a cooler environment until the body returns to normal. If heat exhaustion is not addressed and treated, it can advance to heatstroke, so medical attention should be sought immediately. Heatstroke symptoms include a high body temperature (it can be 106 degrees or higher), dry skin, inadequate perspiration, paleness or reddening, confusion or irritability, and seizures. The victim may become delirious, stuporous, unconscious, or even comatose. Cooling is essential to preventing permanent neurological damage or death.

Other, less serious risks associated with extreme summer heat are often exercise-related and include heat cramps (an imbalance of fluids that occurs when people unaccustomed to heat exercise outdoors) and heat syncope (a loss of consciousness by persons not acclimated to hot weather). Periods of hot weather also entail risks of dehydration, even for those who are not engaged in demanding physical activities. Non-caffeinated fluids should be consumed to maintain adequate hydration.

A useful set of general principles to recognize is that evaporation is a cooling mechanism for our bodies. Evaporation of moisture (i.e. perspiration) doesn't occur as rapidly when the surrounding air already has a relatively high moisture content (humidity). Thus, humidity inhibits evaporation and produces a feeling of greater heat, while winds assist the evaporation of perspiration from skin and thus tend to produce a feeling of greater coolness. It can therefore be difficult for the body to precisely gauge actual outdoor temperatures—it rather senses the potential for heat gain or loss. A period of extreme heat is

more debilitating when the air humidity is high, and a period of extreme cold is similarly more dangerous when coupled with strong winds. For these reasons, temperature alone is usually only a limited indicator of the weather's likely threat to human health, and additional factors should also be considered. The additional factors of humidity and wind speed have provided the basis for two additional means of describing the extent of extreme temperatures' impact—the Heat Index (HI) and the Wind Chill Temperature Index (WCT).

The following tables indicate the way that temperature, humidity, and wind speed probably feels to the human body, and suggest the types of temperature effects relevant to Michigan's climate. Although some of the resulting heat numbers may at first seem outrageous to describe Michigan temperatures, some of the extremes are actually comparable to what is felt in a sauna, which is often set at more than 140 degrees. Like saunas, such heat should not be felt by the body for more than brief periods of time, and since one of the body's cooling reactions is to increase the rate of blood circulation, this also adds to the burden placed on the heart muscle, and can be too much strain for some persons to bear.



Extreme Temperatures, Heat in Michigan

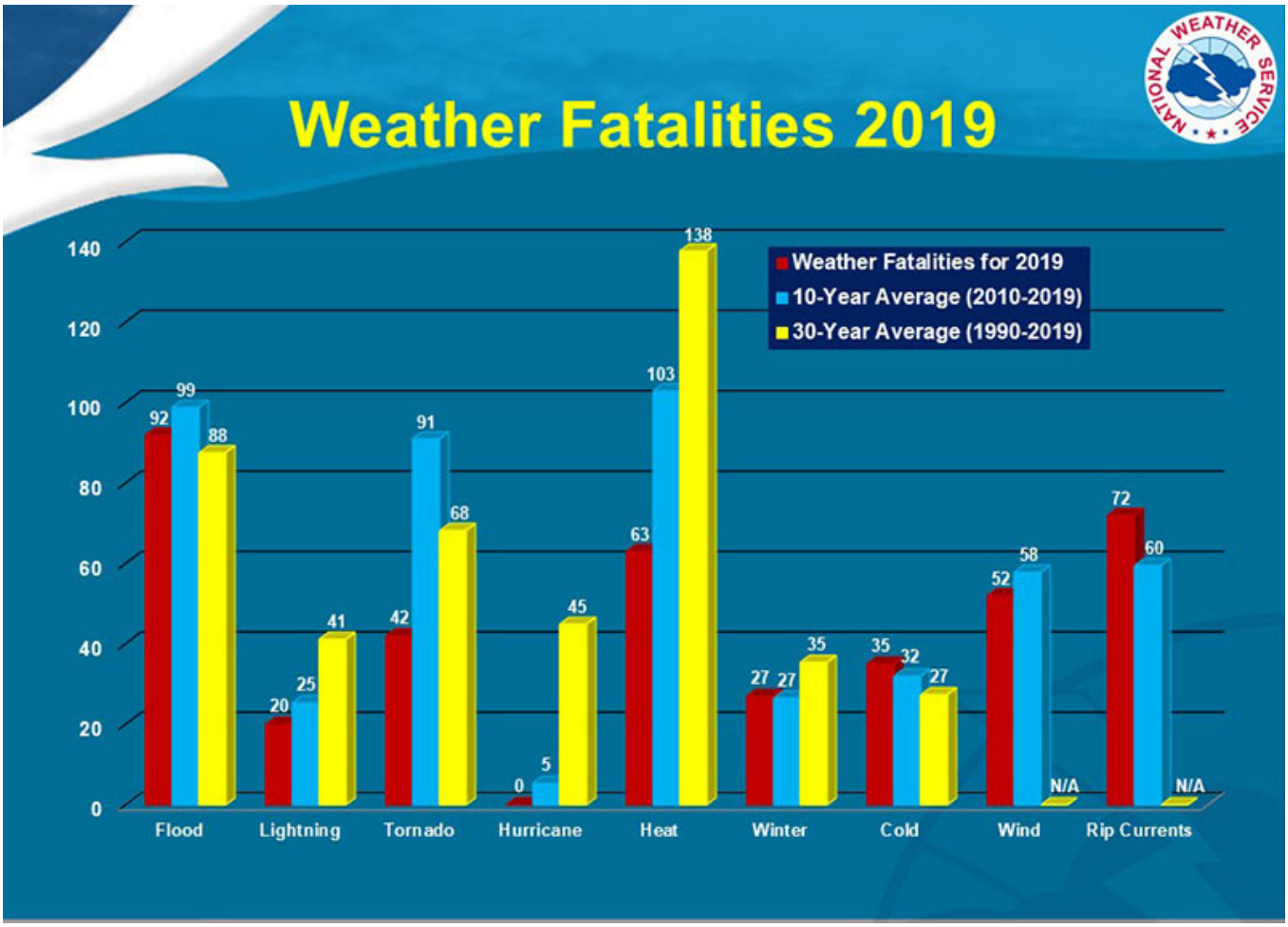
In Michigan, heat advisories will tend to be announced when the heat index is calculated to exceed 105 degrees in an area for a period of at least 3 hours in duration. It should be noted, however, that the temperature inside of vehicles without air conditioning can be dozens of degrees hotter than the outdoor temperature—an outdoor temperature might be "only" 100 degrees Fahrenheit, but people may then get into a car that exceeds 130 degrees. People vary in the conditions in which they operate (and in their capacity to tolerate extreme temperatures), and can find themselves in circumstances that threaten their health even if no official temperature advisory has been issued.

Historic Temperature Records at Various Michigan Locations (through 2021)

Southern Lower Peninsula	**Record Low Temperature**	**Record High Temperature**
Adrian (Lenawee County)	-26°F (1/20/1892)	108°F (7/14/1936, 7/24/1934)
Benton Harbor (Berrien County)	-21°F (1/12/1918)	104°F (7/21/2002, 7/30/1999)
Coldwater (Branch County)	-29°F (1/31/2019)	108°F (7/24/1934)
Ann Arbor (Washtenaw County)	-23°F (2/11/1885)	105°F (7/24/1934)
Bloomingdale (Van Buren Co.)	-23°F (2/3/1996)	105°F (7/5/1911, 7/13/1936)
Detroit (Wayne County)	-21°F (1/21/1984)	105°F (7/24/1934)
Jackson (Jackson County)	-20°F (1/18/1976, 1/19/1994)	103°F (7/15/1977)
Pontiac (Oakland County)	-22°F (2/5/1918)	104°F (7/6/1988, 7/8/1936, 7/16/1988, 7/24/1934)
Flint (Genesee County)	-25°F (1/18/1976, 2/20/2015)	108°F (7/8/1934, 7/13/1936)
Grand Rapids (Kent County)	-24°F (2/13-14/1899)	108°F (7/13/1936)
Port Huron (St. Clair County)	-19°F (1/19/1994)	103°F (7/9/1936)
Saginaw (Saginaw County)	-23°F (2/5/1918)	111°F (7/9/1936)
Harbor Beach (Huron County)	-22°F (2/9/1934)	105°F (7/10/1936)
Big Rapids (Mecosta County)	-36°F (2/11/1899)	103°F (7/30/1916, 7/13-14/36)
Northern Lower Peninsula	**Record Low Temperature**	**Record High Temperature**
Houghton Lake (Roscommon Co)	-34°F (2/17/1979)	103°F (6/19/1995)
Alpena (Alpena County)	-37°F (2/17/1979)	106°F (7/13/1936)
East Tawas (Iosco County)	-29°F (2/1/1918, 2/20/1929)	106°F (7/8-9/1936)
Gaylord (Otsego County)	-37°F (2/17/1979)	101°F (7/11/1921, 7/30/1916)
Gladwin (Gladwin County)	-39°F (2/20/1979)	105°F (7/13/1936)
Traverse City (Gd. Traverse Co.)	-37°F (2/17/1979)	105°F (7/7/1936)
Upper Peninsula	**Record Low Temperature**	**Record High Temperature**
Hancock (Houghton County)	-30°F (2/9/1951, 2/10/1948)	102°F (7/7/1988)
Ironwood (Gogebic County)	-41°F (1/17/1982, 2/12/1967)	104°F (7/13/1936)
Munising (Alger County)	-33°F (2/25/1928)	103°F (7/7-9/1936, 8/6/1947)
Sault Ste. Marie (Chippewa Co.)	-37°F (2/8/1934, 2/10/1899)	98°F (7/3/1921, 7/30/1916, 8/5-6/1947)

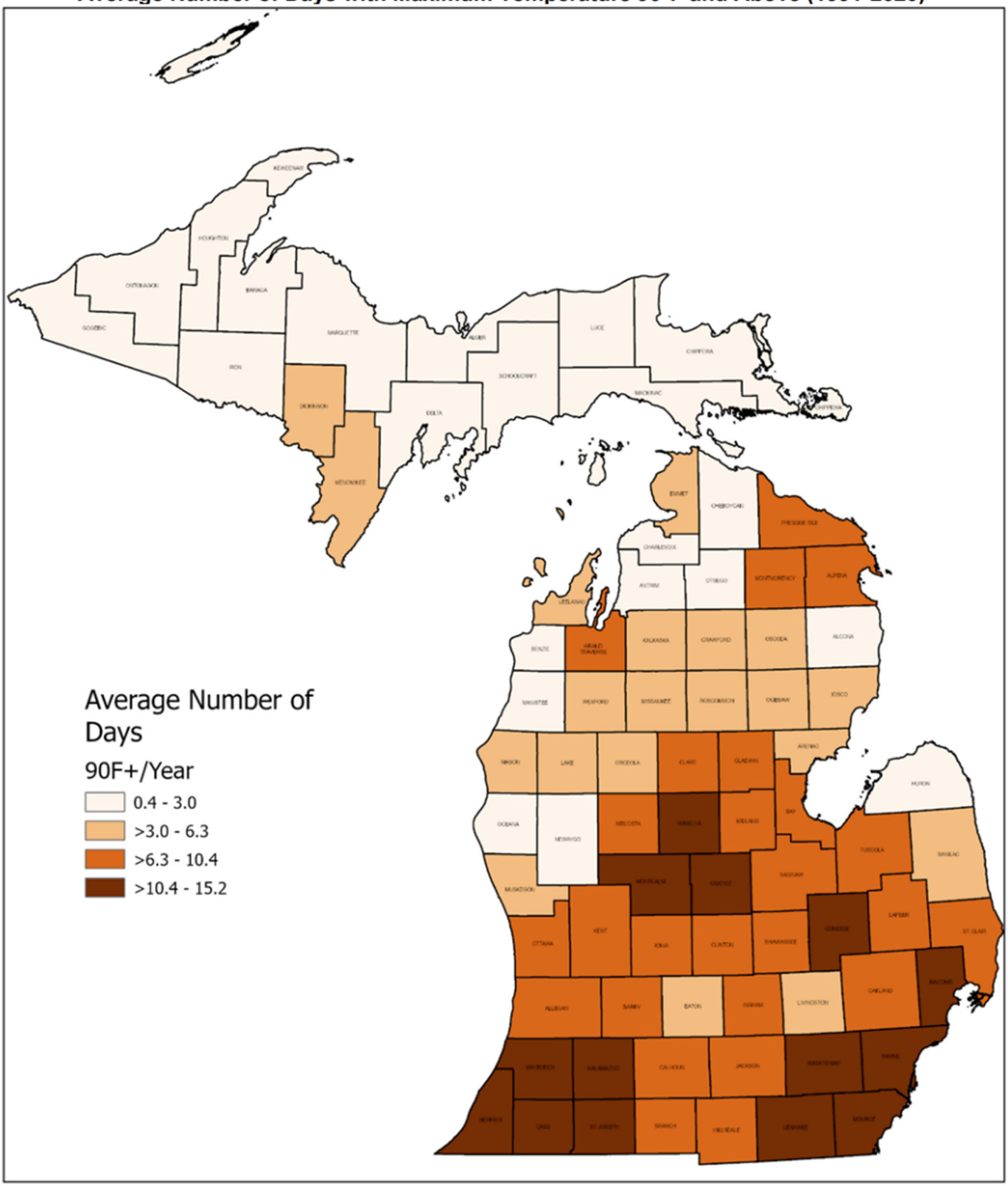
(source: NOAA NCEI)

Heat waves tend to have stagnant atmospheric conditions that trap pollutants in urban areas and thus compound the health effects faced by urban residents. Because the combined effects of high temperatures, high humidity, and trapped pollution are focused more intensely in urban centers, heatstroke and heat exhaustion are a greater problem in sizeable cities than in suburban or rural areas. Nationwide, approximately 136 deaths per year are attributed to extreme heat (a total of 2,225 from 2000 through 2018, according to (http://www.nws.noaa.gov/om/hazstats/images/70-years.pdf). Of these deaths, 8 occurred in Michigan.



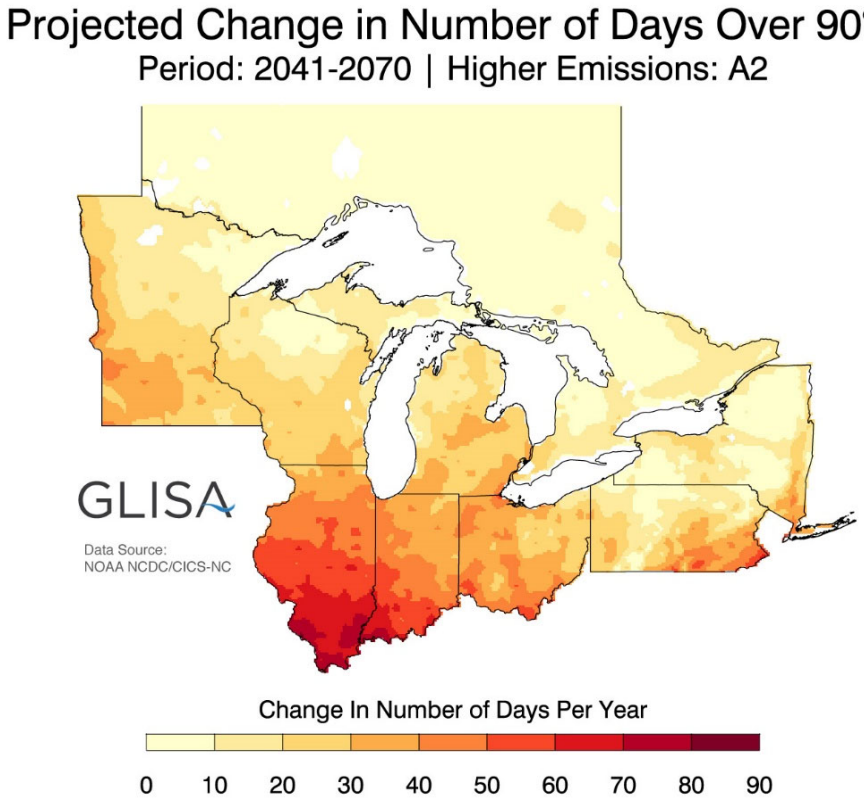
Extreme summer heat is also hazardous to livestock and agricultural crops, and it can cause water shortages, exacerbate fire hazards, and prompt excessive demands for energy. Roads, bridges, railroad tracks and other infrastructure are susceptible to damage from extreme heat (due to the effects of thermal expansion of materials). Scorching weather also puts a strain on the energy demands for an area, as the use of air conditioning increases greatly. Possible shutdowns of schools, colleges, and industries can occur during these times.

Average Number of Days with Maximum Temperature 90°F and Above (1991-2020)



The 2014 National Climate Assessment reports in the next few decades the Midwest can expect to see an increasing scope, frequency, and intensity of weather related disasters. This includes more weather extremes such as temperature (heat and cold), heavy downpours, and flooding that will affect infrastructure, health, agriculture, forestry, transportation, air and water quality, and more. Climate change will tend to amplify existing risks climate poses to people, ecosystems, and infrastructure.

Within Michigan, the frequency and intensity of heat waves are projected to increase by mid-century. Temperatures above 95°F are associated with negative human health impacts and suppressed agricultural yields. These conditions also increase humidity, degrade air quality, and reduce water quality which will increase public health risks.



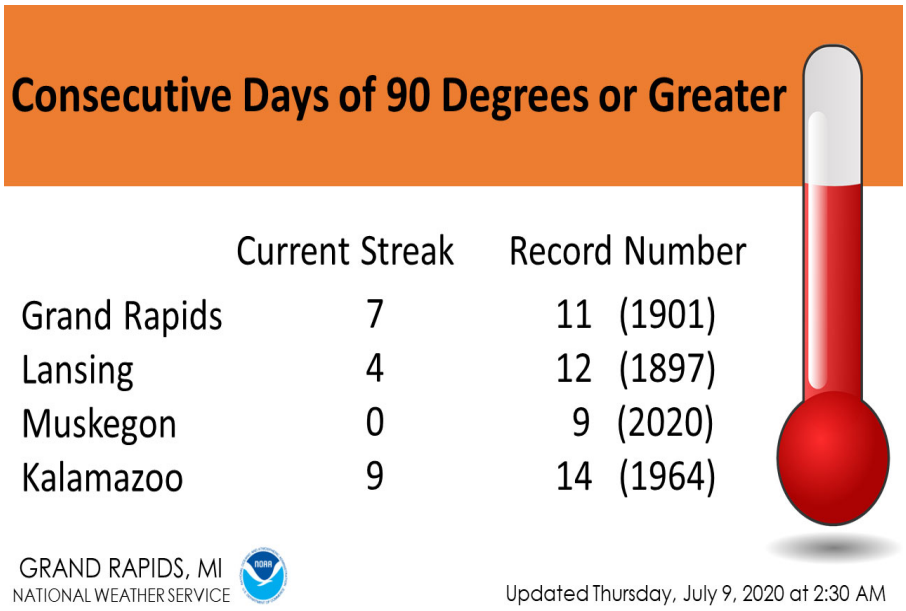
Brief synopses of recent significant historical heat waves or unusual temperature patterns that have affected Michigan. The listing is not meant to be comprehensive. Temperatures are in Fahrenheit unless otherwise noted.

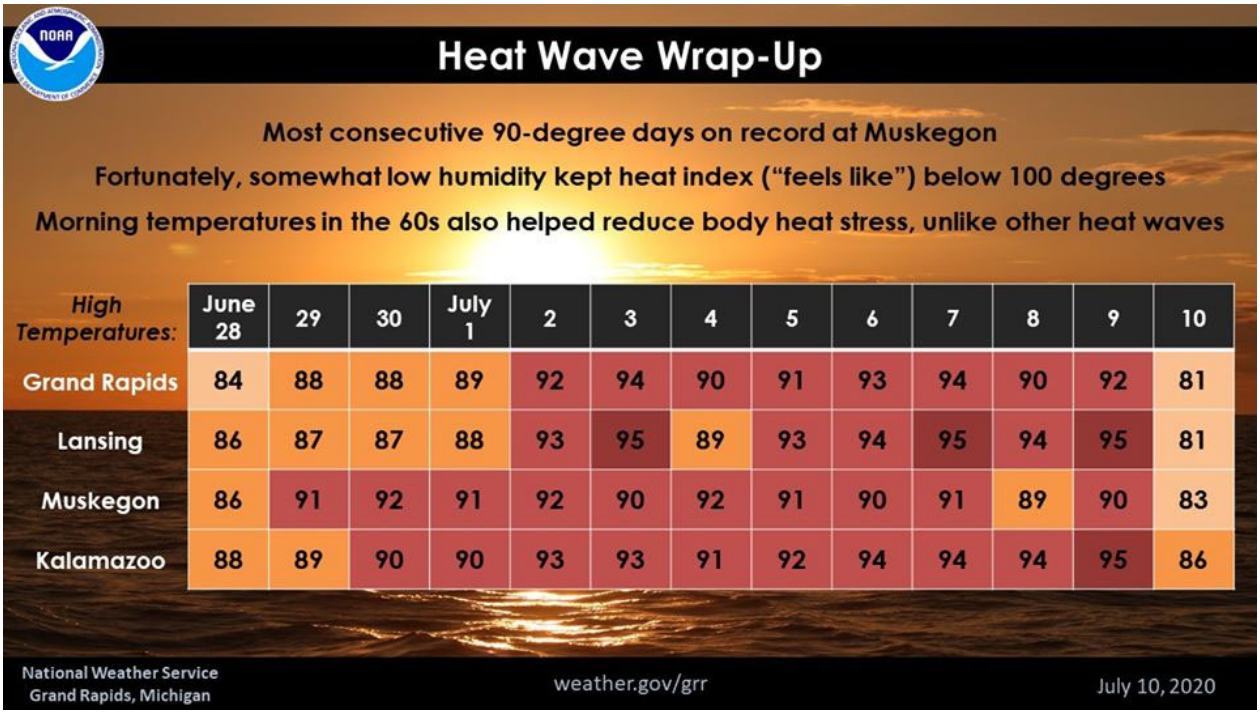
June 30-July 5, 2018 – Southeast Michigan and Northern Lower Michigan A heat wave impacted southeast Michigan. During this period, high temperatures in Detroit was between 90°F and 96°F. Heat-related emergency room visits peaked on July 1, remaining elevated through the rest of the heat wave.

June also ended hot for northern Lower Michigan. Highs were well into the 90°s, including 99°F at Alpena and 98°F at Traverse City and Gaylord. Heat indices exceeded 105°F across most of northern lower Michigan, and some locations exceeded 110°F (114°F near Indian River). An estimated 25-30 people visited local hospitals due to heat-related illnesses.

Case: June-July 2020 – Michigan

Temperatures in June and July of 2020 expect to get close to breaking records of consecutive high heat days of 90 degrees or above. Muskegon broke their record number of 90 degree days in a row, reaching nine between June 29 and July 7, 2020.





High Temperatures:	June 28	29	30	July 1	2	3	4	5	6	7	8	9	10
Grand Rapids	84	88	88	89	92	94	90	91	93	94	90	92	81
Lansing	86	87	87	88	93	95	89	93	94	95	94	95	81
Muskegon	86	91	92	91	92	90	92	91	90	91	89	90	83
Kalamazoo	88	89	90	90	93	93	91	92	94	94	94	95	86

Spring, 2023 – Lower Peninsula and Western Lower Peninsula A spring heat wave brought early high temperatures to many areas of the state, with nearly the entire lower peninsula hitting near or above 90°F on June 1. Conditions were also extremely dry. The western side of the state saw the highest temperatures, with Muskegon breaking time of year records several days in a row. Kalamazoo had at least five days in a row between 90°F and 93°F. Holland also hit 93°F during this time, and Mt. Pleasant 92°F. Average temperatures for early June would typically have been in the middle 70°s.

Extreme Temperatures, Heat in Newaygo County

While Newaygo County does not have a large history of extreme heat, data from the Midwestern Region Climatic Center from 1971 to 2001 show Newaygo County has a medium risk for the average number of days with maximum temperatures at or above 90°F to be between 5 and 9.

Record Monthly Temperatures in Degrees Fahrenheit
Source: Weather Underground Weather Station in Fremont, Michigan

Month	Record High	Date	Previous Record
January	63°F	01-25-1950	59°F (1-24-1950)
February	67°F	02-11-1999	58°F (02-21-1930)
March	82°F	03-20-2012 03-21-2012	77°F (03-27-1967) (03-30-1967)
April	86°F	04-29-1970	85°F (04-27-1899)
May	93°F	05-29-1962	90°F (05-10-1930)
June	98°F	06-20-1995	94°F (06-11-1956) (06-24-1901)
July	99°F	07-07-2012 07-30-1913	
August	99°F	08-03-1964	96°F (08-24-1947)
September	95°F	09-1-1953 09-06-1957	94°F (09-02-1913) (09-03-1953)
October	89°F	10-18-1910	
November	76°F	11-2-1961 11-20-1930	74°F (11-19-1930) (11-01-1935)
December	64°F	12-02-1982	63°F (12-06-1951) (12-05-2001)

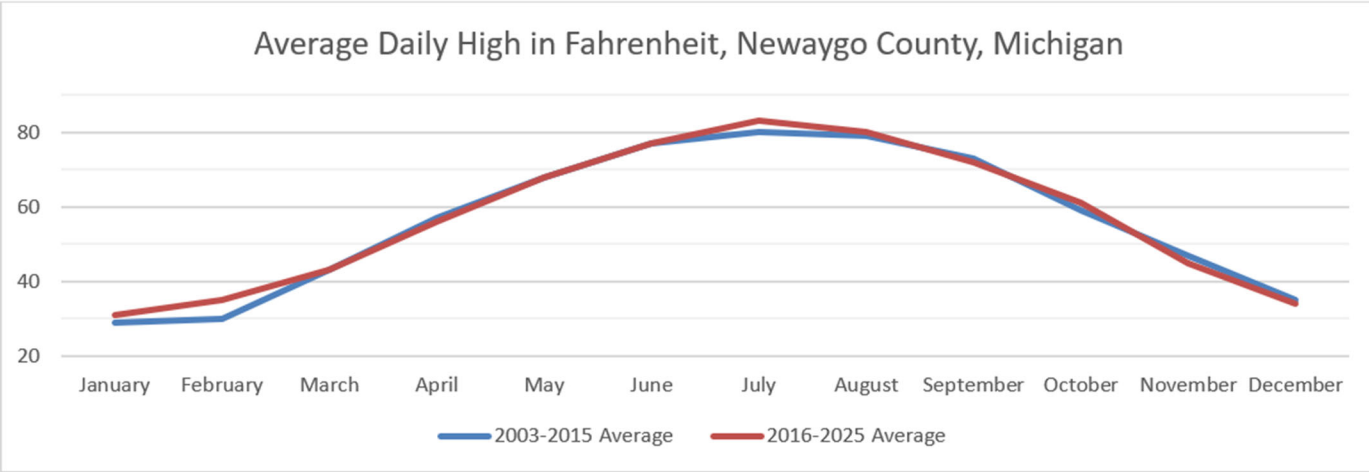


Table 2: Average Daily High in Degrees Fahrenheit
Source: Weather Underground Weather Station in Fremont, Michigan
US Climate Data Fremont, Michigan

MONTH	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	Total Average
January	27	27	29	39	34	32	24	30	26	36	32	21	25	**29**
February	28	34	35	33	25	30	33	32	31	36	30	22	19	**30**
March	42	46	39	45	49	40	43	52	38	56	36	32	37	**43**
April	56	60	62	61	54	61	55	62	54	56	50	53	56	**57**
May	65	68	64	67	73	66	67	70	68	71	71	65	68	**68**
June	76	73	83	77	81	77	75	76	76	78	76	77	74	**77**
July	80	79	82	84	82	66	75	82	84	90	79	74	77	**80**
August	82	75	81	81	81	81	75	83	79	78	78	77	78	**79**
September	72	77	77	69	77	74	73	68	70	71	71	70	75	**73**
October	59	60	62	56	66	60	53	61	62	56	59	56	61	**59**
November	48	47	49	48	46	46	50	48	47	46	42	38	53	**47**
December	38	35	30	41	35	33	32	31	37	38	28	35	44	**35**
MONTH	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**Total Average**
January	32	35	31	26	36	32	27	38	34	31				**31**
February	36	42	32	29	34	28	33	39	46	32				**35**
March	49	45	41	38	46	50	43	44	49					**43**
April	55	58	56	54	53	47	52	59	60					**56**
May	70	62	74	64	65	68	71	71	73					**68**
June	79	78	78	74	80	80	78	80	79					**77**
July	83	82	84	84	85	80	81	81	80					**83**
August	83	78	78	79	81	83	81	80	80					**80**
September	76	78	74	59	71	74	74	75	78					**72**
October	64	64	55	57	58	65	62	61	66					**61**
November	54	45	37	40	50	45	51	49	51					**45**
December	34	32	35	39	36	43	37	46	39					**34**

Monthly Highest Max Temperature for FREMONT 4 WSW, MI

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
2000	53	65	72	70	83	86	84	84	89	77	68	38	89
2001	41	52	57	77	80	89	91	95	83	74	63	65	95
2002	51	57	55	85	82	89	90	92	90	77	59	52	92
2003	48	46	67	78	75	88	88	88	86	78	66	48	88
2004	57	48	68	78	81	85	86	85	85	73	61	51	86
2005	59	50	71	79	80	93	93	92	89	83	64	41	93
2006	51	45	66	76	90	89	92	93	81	75	61	52	93
2007	49	42	75	78	87	91	91	94	89	85	59	50	94
2008	59	45	53	78	79	85	88	86	91	78	69	53	91
2009	31	55	65	78	77	92	80	84	81	65	68	49	92
2010	44	40	64	81	91	85	89	88	86	76	67	49	91
2011	55	53	59	78	86	90	90	85	88	81	62	52	90
2012	53	50	84	69	88	92	96	88	87	76	67	65	96
2013	54	42	52	69	83	83	91	85	86	74	62	55	91
2014	40	42	48	72	83	86	83	82	80	72	57	47	86
2015	39	36	57	73	83	79	88	87	86	71	72	60	88
2016	43	56	67	81	84	89	94	89	87	77	70	50	94
2017	53	65	67	77	81	89	89	86	93	80	59	61	93
2018	55	59	61	73	93	90	91	91	89	81	58	51	93
2019	47	47	60	78	76	86	91	85	83	81	51	56	91
2020	48	45	55	68	89	89	94	89	M	M	M	M	94
2021	M	M	M	M	M	M	M	M	M	78	62	62	78
2022	41	46	67	78	87	90	87	88	84	75	72	54	90
2023	44	54	53	82	89	91	89	90	89	84	63	56	91
2024	40	69	68	75	84	89	85	89	88	81	68	52	89
2025	47	50	75	38	M	M	M	M	M	M	M	M	75
Mean	48	50	63	75	84	88	89	88	87	77	64	53	90
Max	59 2008	69 2024	84 2012	85 2002	93 2018	93 2005	96 2012	95 2001	93 2017	85 2007	72 2022	65 2012	96 2012
Min	31 2009	36 2015	48 2014	38 2025	75 2003	79 2015	80 2009	82 2014	80 2014	65 2009	51 2019	38 2000	75 2025

Community Vulnerability:

Urban areas often contain vulnerable populations with special considerations, such as lack of air conditioning amidst heat island effects. Any required stair use will become difficult due to physical mobility limitations or trapped stairwell heat. Some foods and medicines require refrigeration. The elderly and children may be especially susceptible, as are workers who must be outside (e.g., farming, construction). Cooling centers may be needed, including those allowing for pets. Increased use of air conditioning may result in electric brownouts or system failures. Backup generators may be lacking. Water use may be regulated if drought is also present. Athletic events, parades, and festivals may be affected. Although not as widely reported compared to southern states, extreme heat can have a damaging impact on Michigan infrastructure such as roads and airport runways. Climate-related migration may occur, both within and into the state, affecting population distribution and housing.

Although Newaygo County is more rural than urban, the population impacts of extreme heat are similar to those of extreme cold. Small children, the elderly, and certain other groups including people with chronic diseases, low-income populations, and outdoor workers have higher risk for heat-related illness. Extreme heat events can trigger a variety of heat stress conditions, such as heat stroke. Heat stroke is the most serious heat-related disorder. It occurs when the body becomes unable to control its temperature. Body temperature rises rapidly, the sweating mechanism fails, and the body cannot cool down. This condition can cause death or permanent disability if emergency treatment is not given. https://www.cdc.gov/climateandhealth/pubs/extreme-heat-final_508.pdf

The following highlights the demographics of the groups that are most susceptible to extreme heat and drought:

The following Age data is from 2020 US Census Reporter for Newaygo County at https://censusreporter.org/profiles/05000US26123-newaygo-county-mi/

Age

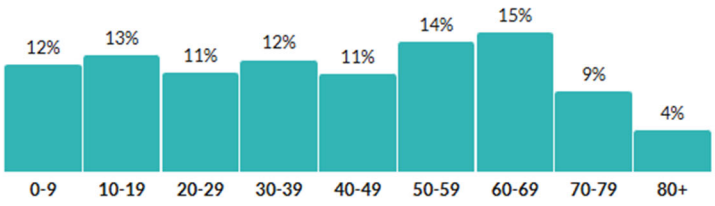
42.8

Median age

about 10 percent higher than the figure in Michigan: 40.1

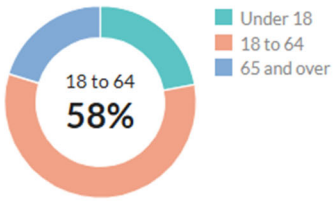
about 10 percent higher than the figure in United States: 38.7

Population by age range



Hide data / Embed

Population by age category



Show data / Embed

Population by age range (Table B01001) View table

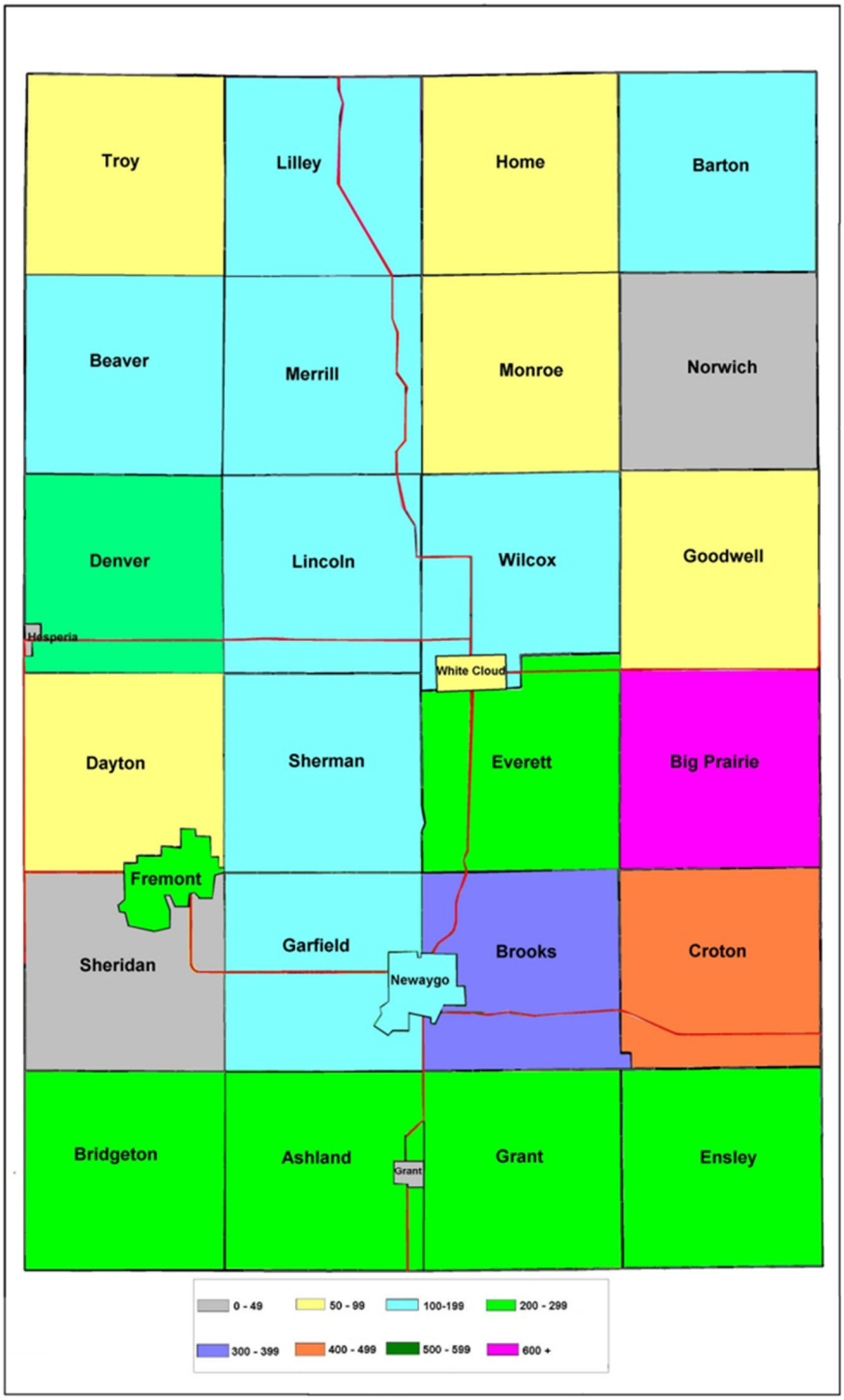
Column	Newaygo County				Michigan				United States			
0-9	11.6%	±0%	5,856	±269.9	11.3%	±0%	1,137,655	±4,250.6	11.8%	±0%	39,042,250	±33,188.6
10-19	12.7%	±0%	6,376	±275.1	12.7%	±0%	1,278,884	±4,440.8	13.1%	±0%	43,367,691	±34,027.2
20-29	10.7%	±0%	5,404	±227.2	13.2%	±0%	1,330,315	±5,559.8	13.2%	±0%	43,983,589	±35,940.2
30-39	12.1%	±0%	6,121	±247.8	12.6%	±0%	1,268,762	±4,078.9	13.6%	±0%	45,310,101	±30,494.5
40-49	10.6%	±0%	5,331	±237	11.8%	±0%	1,180,606	±3,934	12.4%	±0%	41,291,641	±31,030.7
50-59	14.1%	±0%	7,083	±255.5	13.2%	±0%	1,321,382	±4,020.7	12.7%	±0%	42,092,439	±30,407.9
60-69	15.1%	±0%	7,599	±392.3	13.2%	±0%	1,323,482	±6,978.9	11.9%	±0%	39,670,102	±44,626.9
70-79	8.7%	±0%	4,404	±272.2	8%	±0%	802,222	±4,616.3	7.5%	±0%	24,911,038	±31,011.1
80+	4.4%	±0%	2,240	±193.5	4.1%	±0%	408,287	±3,653.3	3.8%	±0%	12,718,689	±25,070.9

VULNERABLE POPULATIONS SUMMARY	
Adult Foster Care Homes and Home for the Aged **Total Homes in Newaygo County: 14** **Total Capacity: 87** **Adult Foster Care** (AFC) homes are residential settings that provide 24-hour personal care, protection, and supervision for individuals who are developmentally disabled, mentally ill, physically handicapped, Alzheimer's Disease or other Dementia Related Disorder or aged who cannot live alone but who do not need continuous nursing care. AFC Homes are restricted to providing care to no more than 20 adults A **Home for the Aged** (HFA) provides 24 hour room, board, and supervised personal care to: • 21 or more unrelated, non-transient individuals 60 years of age or older. • 20 or fewer individuals 60 years of age or older that is operated in conjunction with and as a distinct part of a licensed nursing home. **Note:** HFA is restricted to providing care to persons who are 60 years of age or older	**Newaygo County Day Care Providers** **Total Day Care Centers in Newaygo County: 70** **Total Capacity: 2,929** **Newaygo County Schools** **Total Schools (Buildings) in Newaygo County: 29** **Total Capacity: 11,902 School Age Children** **Newaygo County Community Churches** **Total Churches in Newaygo County: 71** **Total Capacity: 9,870**
Apartment Complexes **Total Complexes in Newaygo County: 20** **Total Capacity: Approximately 660** **Mobile Homes Communities** **Total Mobile Homes Communities in Newaygo County: 13** **Total Capacity: 14,336**	**Campgrounds and Resorts** **Total Campgrounds in Newaygo County: 38** **Total Capacity: Approximately 2,536** **Youth Camps** **Total Youth Camps in Newaygo County: 7** **Total Capacity: 1,484** **Hotels and Motels** **Total Hotels and Motels in Newaygo County: 19** **Total Capacity: Approximately 566**

Newaygo County has a high volume of heat vulnerable structures such as manufactured homes, trailers, and poorly constructed homes, they are spread over a significant distance due to the jurisdiction's rural nature.

NEWAYGO COUNTY MOBILE HOMES DISTRIBUTION		
COMMUNITY	**# Mobile Homes**	**% Mobile Homes**
Newaygo County *	4,692	100%
City of Fremont	187	3.98%
City of Newaygo	162	3.45%
City of White Cloud	37	0.79%
City of Grant	58	1.23%
Village of Hesperia	7	
Ashland Township	113	2.40%
Barton Township	90	1.92%
Beaver Township	79	1.68%
Big Prairie Township	744	15.83%
Bridgeton Township	339	7.21%
Brooks Township	382	8.13%
Croton Township	387	8.24%
Dayton Township	50	1.06%
Denver Township	343	7.30%
Ensley Township	185	3.94%
Everett Township	178	3.79%
Garfield Township	90	1.92%
Goodwell Township	39	0.83%
Grant Township	225	4.79%
Home Township	43	0.92%
Lilley Township	122	2.60%
Lincoln Township	173	3.68%
Merrill Township	200	4.26%
Monroe Township	56	1.19%
Norwich Township	32	0.68%
Sheridan Township	32	0.68%
Sherman Township	76	1.62%
Troy Township	50	1.06%
Wilcox Township	220	4.68%
* total of cities and townships; village total already included with township totals		*source: U.S. Census Bureau*

Newaygo County
Mobile Homes Distribution Map



Local Special Events within Newaygo County vulnerable for Extreme Heat

City of Fremont	Month	Approximate Date	Daily Event Population
Fremont Area Home and Garden Show	March	Third weekend	750
Family Health and Safety Expo	May	Third weekend	1,000
National Baby Food Festival	July	Third week, Wednesday - Saturday	7,400
Newaygo County Agricultural Fair	August	First full week, Saturday - Saturday	5,500
Fremont Harvest Festival	October	First weekend, Saturday - Sunday	5,600
Fremont Farmers Market	June – September	Saturdays and Tuesdays	
City of Newaygo	**Month**	**Approximate Date**	
Memorial Day Festival	May	Memorial Day Weekend	5,300
Newaygo County Kids Day	June	Father's Day Weekend, Saturday	914
Newaygo Farm Market	July – October	Brooks Park	315
Logging Festival	September	Labor Day Weekend	2,600
Holiday Festival and Christmas Walk	December	First Weekend, Friday - Sunday	5,700
City White Cloud	**Month**	**Approximate Date**	
Kids Free Fishing Day	June	First Saturday	1,500
White Cloud Sky Fest	June	Father's Day	1,600
City of Grant	**Month**	**Approximate Date**	
Grant Festival	August	Third weekend, Friday - Saturday	4,400
Village of Hesperia	**Month**	**Approximate Date**	
Hesperia Family Fun Festival	July	July 4th Holiday, 4 days	16,600
Big Prairie and Croton Township	**Month**	**Approximate Date**	
Dam to Dam Ice Fishing Contest	February	DNR Free Fishing Weekend (3rd Saturday)	380
Croton Dam Freedom Festival	July	July 4th Holiday, 4 days	4,600
Hot Boat Weekend	September	First weekend after Labor Day	4,100
Lilley Township			
Bitely Homecoming Celebration	July	Third full weekend (Saturday – Sunday)	5,300
ROTATING EVENTS	Month	Approximate Date	
Gus Macker 3 on 3 Basketball Tournament	July	Third full weekend (Saturday – Sunday)	5,800

Campgrounds within Newaygo County

Name of Establishment	Address	City, State, Zip	Number of Sites
Adventure Bound Camping - Woods and Water	4495 South Spruce	White Cloud, MI 49349	375
Benton Lake Campground (NFS)	5308 Forest Road	Brohman, MI 49312	25
Big Bend Park	2000 Beech Avenue	White Cloud, MI 49349	230
Brooks Lake M.H. Club (Private)	2263 Spruell	Newaygo, MI 49337	15
Brush Lake Campground (NFS)	6 Mile (Forest Rd 5534)	White Cloud, MI 49349	7
Chapel of the Three Crosses	879 E Yoder Lane	White Cloud, MI 49349	15
Chinook Campground	5471 W 112th Street	Grant, MI 49327	168
Cindy Lou's Hide A Way	6245 N Comstock Road	Hesperia, MI 49421	22
Consumers Power Employee Hardy Dam Club (Private)	8000 16th Street	White Cloud, MI 49349	45
Croton Dam Float Trips	5355 Croton Drive	Newaygo, MI 49337	24
Croton Township Campground	7683 Croton Hardy Drive	Newaygo, MI 49337	160
Dan Raymond Park (Private)	6971 W 112th Street	Grant, MI 49327	8
Diamond Lake (aka Camp Swampy)	3351 N Mundy Road	White Cloud, MI 49349	100
Ed Henning County Park	500 Croton Drive	Newaygo, MI 49337	84
Fremont Lake Park	933 Cottage Grove	Fremont, MI 49412	94
Happy Campers Campground	5380 Croton Drive	Newaygo, MI 49337	25
Heights Hide A Way	4424 Parson Road	Fremont, MI 49412	13
Hess Lake Mobile Home	825 E 88th Street	Newaygo, MI 49337	34
Highbank Lake Campground (NFS)	Roosevelt Drive / 15 Mile	Bitely, MI 49309	9
Hungerford Lake Campground (NFS)	Forest Rt 5134	Big Rapids, MI 49307	48
Hungerford Hills Farms	7616 Hungerford Lake	Big Rapids, MI 49307	50
K and K Camping LLC (Private)	7701 Whitneyville Rd	White Cloud, MI 49349	13
Indian Lake Campground (NFS)	Nagek Drive	Brohman, MI 49312	6
Leisure Time RV Park	4799 South Spruce	White Cloud, MI 49349	94
Little Switzerland Resort	254 Pickeral Lake Drive	Newaygo, MI 49337	80
Lonesome Lake Campground	318 W 18 Mile Road	Bitely, MI 49309	50
Minnie Pond Campground (NFS)	9570 Forest Road	Hesperia, MI 49421	11
Mystery Creek Campground	9570 S Wisner Avenue	Newaygo, MI 49337	85
Newaygo State Park	2793 Beech Street	Newaygo, MI 49337	99
Nichols Lake Park South (NFS)	Forest Route 5140	Brohman, MI 49312	29
Oxbow Park	2973 Cottonwood	Newaygo, MI 49337	197
Pettibone Lake Park (NFS)	490 W Pettibone Drive	Bitely, MI 49309	16
Pickeral Lake Campground	12666 N Woodbridge	Bitely, MI 49309	46
Pint Pleasant Nesters (Private)	4424 Parson Road	Fremont, MI 49412	13
Salmon Run Campground	8845 Felch Avenue	Grant, MI 49327	94
Sandy Beach Campground	6926 30th Avenue	White Cloud, MI 49349	220
Shelley Lake Campground (NFS)	5450 Forest Road	Brohman, MI 49312	8
Shi Lo Cum- VHF (Private)	2940 N Felch Avenue	White Cloud, MI 49349	35
Sportsman Park Campground	2500 Sportsman Drive	White Cloud, MI 49349	86
Timbers Edge Campground	4345 North Warner	Hesperia, MI 49421	50
Twinwood Lake Campground (NFS)	5488 Forest Rd	White Cloud, MI 49349	5
Walkup Lake Campground (NFS)	Cleveland Drive	Bitely, MI 49309	127
White Cloud City Campground	680 Wilcox	White Cloud, MI 49349	99
		TOTAL	1,995

Table 8: Change in Agriculture-Farmstead Land Use and Farm Size
Source: 2022 Census of Agriculture

AGRICULTURE-FARMSTEAD LAND USE	2022	2017	2012	2007	2002	1997	% Change
Total Number of Farms	795	850	*923*	*951*	*902*	787	8%
Total Number of Acres	*115,914*	*136,232*	*125,663*	*133,403*	135,422	131,779	3.4%
Total Cropland (Farms)		704	757	812	813	739	-4.7%
Total Cropland (Acres)	80,534	96,749	83,384	89,457	93,491	94,890	2.0%
Total Harvested Cropland (Farms)		620	670	649	689	663	-6.5%
Total Harvested Cropland (Acres)		86,982	76,076	74,516	72,732	74,140	17.3%
Total Grazing Land (Farms)		98	81	206	364	372	-73.7%
Total Grazing Land (Acres)	6,215	11,982	1,632	4,907	9,607	11,257	6.4%
Average Size of Farm in Acres	**146**	**160**	**136**	**140**	**150**	**167**	-4.2%

Table 9: Agriculture-Farmstead Land Use and Farm Size
Source: 2022 Census of Agriculture

Farms by Value of Sales

	Number	Percent of Total [b]
Less than $2,500	324	41
$2,500 to $4,999	90	11
$5,000 to $9,999	98	12
$10,000 to $24,999	83	10
$25,000 to $49,999	45	6
$50,000 to $99,999	37	5
$100,000 or more	118	15

Farms by Size

	Number	Percent of Total [b]
1 to 9 acres	77	10
10 to 49 acres	354	45
50 to 179 acres	237	30
180 to 499 acres	71	9
500 to 999 acres	31	4
1,000+ acres	25	3

USDA United States Department of Agriculture
National Agricultural Statistics Service www.nass.usda.gov/AgCensus

Percent of farms that:

Have internet access	79
Farm organically	1
Sell directly to consumers	14
Hire farm labor	18
Are family farms	96

Top Crops in Acres [e]

Forage (hay/haylage), all	22,248
Corn for grain	19,478
Soybeans for beans	9,156
Corn for silage/greenchop	8,989
Wheat for grain, all	4,679

Livestock Inventory (Dec 31, 2022)

Broilers and other meat-type chickens	2,872
Cattle and calves	34,607
Goats	1,198
Hogs and pigs	974
Horses and ponies	1,166
Layers	4,866
Pullets	482
Sheep and lambs	680
Turkeys	258

Market Value of Agricultural Products Sold

	Sales ($1,000)	Rank in State [c]	Counties Producing Item	Rank in U.S. [c]	Counties Producing Item
Total	**190,663**	**24**	**83**	**866**	**3,078**
Crops	**78,566**	**33**	**83**	**1,009**	**3,074**
Grains, oilseeds, dry beans, dry peas	29,287	37	80	1,160	2,917
Tobacco	-	-	-	-	267
Cotton and cottonseed	-	-	-	-	647
Vegetables, melons, potatoes, sweet potatoes	22,156	13	81	154	2,831
Fruits, tree nuts, berries	20,271	12	82	122	2,711
Nursery, greenhouse, floriculture, sod	1,561	41	80	805	2,660
Cultivated Christmas trees, short rotation woody crops	142	31	75	264	1,274
Other crops and hay	5,149	22	82	665	3,035
Livestock, poultry, and products	**112,097**	**12**	**83**	**616**	**3,076**
Poultry and eggs	(D)	36	82	1,031	3,027
Cattle and calves	22,450	11	82	772	3,047
Milk from cows	86,399	10	71	140	1,770
Hogs and pigs	331	30	82	668	2,814
Sheep, goats, wool, mohair, milk	331	17	80	601	2,967
Horses, ponies, mules, burros, donkeys	333	27	73	800	2,907
Aquaculture	(D)	12	30	(D)	1,190
Other animals and animal products	1,880	5	83	140	2,909

WILDFIRES

Wildfires

An uncontrolled fire in grasslands, brushlands, or forested areas.

Hazard Description

Annually the Federal Government spends billions of dollars to suppress wildfires. The most immediate dangers from wildfires are the destruction of homes and timber, wildlife, and injury or loss of life to persons who live in the affected area or who are using recreational facilities in the area. Impacts from wildfires include the increased potential for flooding, debris flows, and landslides and smoke and other emissions contain pollutants that can cause significant health problems. Short term effects include destruction of timber, forage, wildlife habitats, scenic vistas, and watersheds. Long term effects include reduced access to recreational areas, destruction of community infrastructure and cultural and economic resources. Forests cover approximately one-half of Michigan's total land bases. As a result, much of the state is vulnerable to wildfire. In addition, development in and around forests and grasslands is increasing rapidly, making public safety a primary consideration in wildfire mitigation and suppression efforts.

Wildfire statistics help to illustrate past U.S. wildfire activity. Nationwide data compiled by the National Interagency Fire Center (NFIC) indicate that the number of annual wildfires is variable but has decreased slightly over the last 30 years and that the number of acres burned annually, while also variable, generally has increased. Every year since 2000, and average of 72,400 wildfires burned an average of 7.0 million acres. This figure is nearly double the average annual acreage burned in the 1990s (3.3 million acres), although a greater number of fires occurred annually in the 1990s (78,600 on average).

According to the National Interagency Fire Center:

- More land has been affected by wildfires in recent years than at any time since the 1960's.

Current National Statistics



11 Incidents
Total Number of Large Fires Being Suppressed



1 Total
New Large Fires



16,177 Incidents
Year-to-date Wildfires



161,526 Acres
Acres Burned on Large Fires



2,172
Personnel Assigned to Wildfires



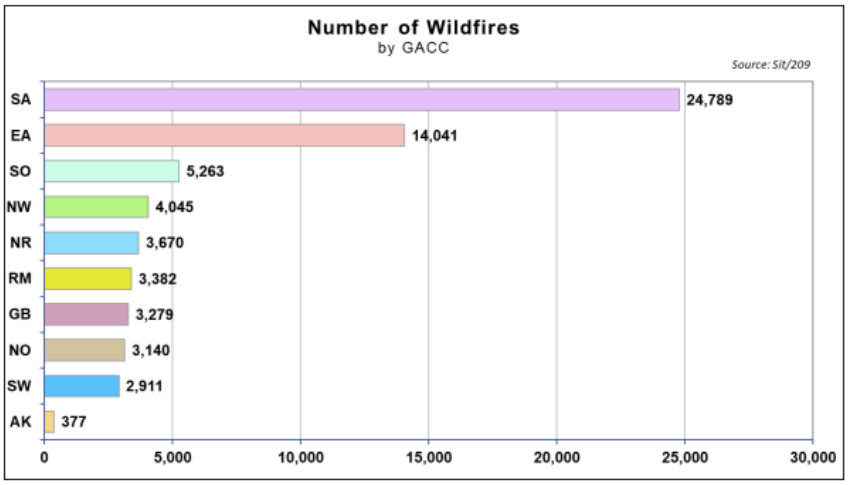
803,349 Acres
Year-to-date Acres Burned

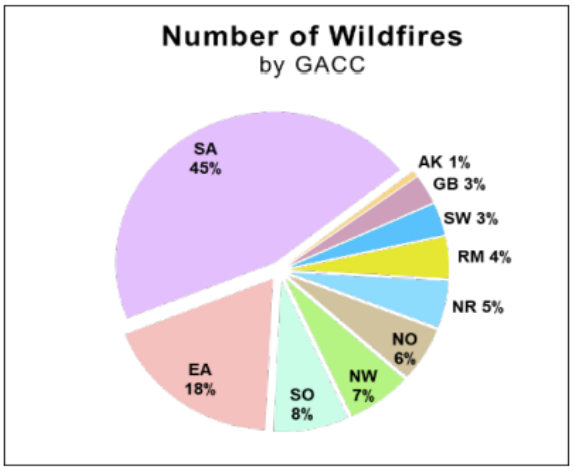
Last Updated: Thursday, April 3, 2025 - 06:45

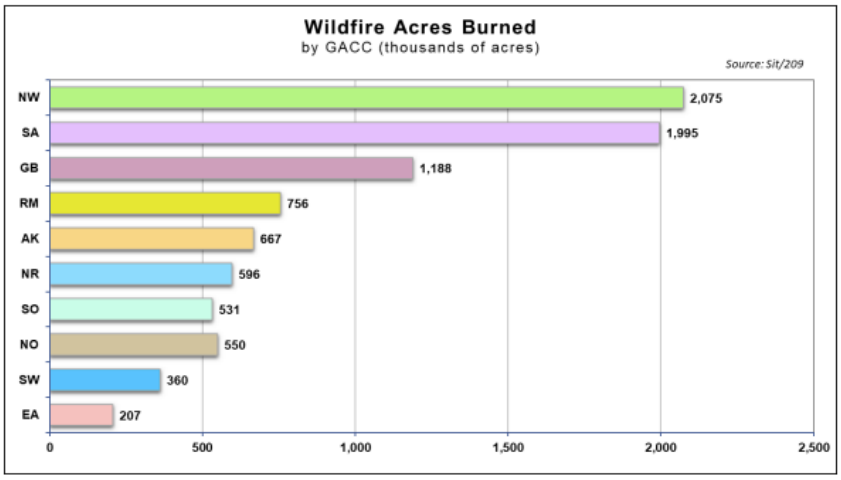
* Source for statistics is the Incident Management Situation Report published by the National Interagency Coordination Center.

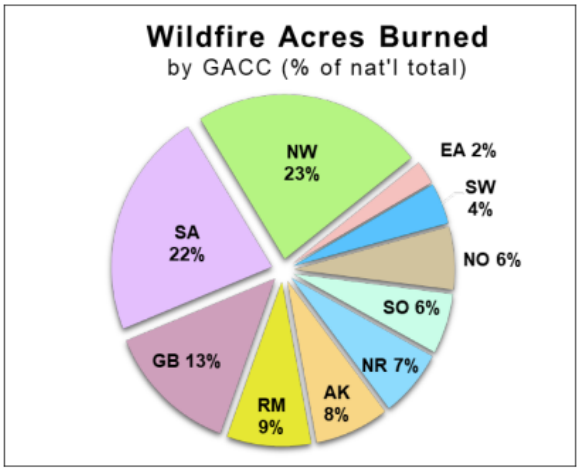
Wildfires by Geographic Area

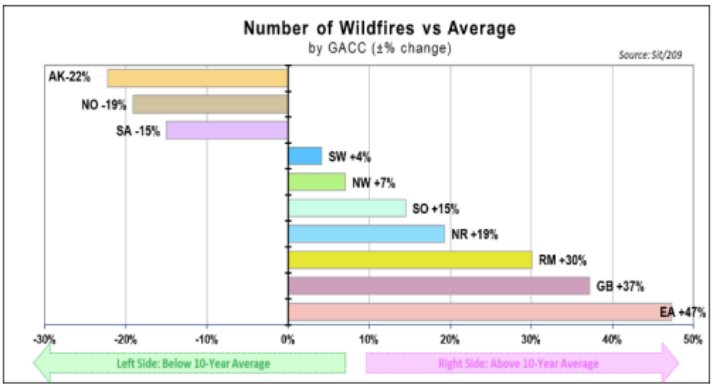
In 2024, the Southern Area accounted for just over a third of the overall distribution of wildfires, while the Northwest Area had the largest proportion of acres burned in the United States.

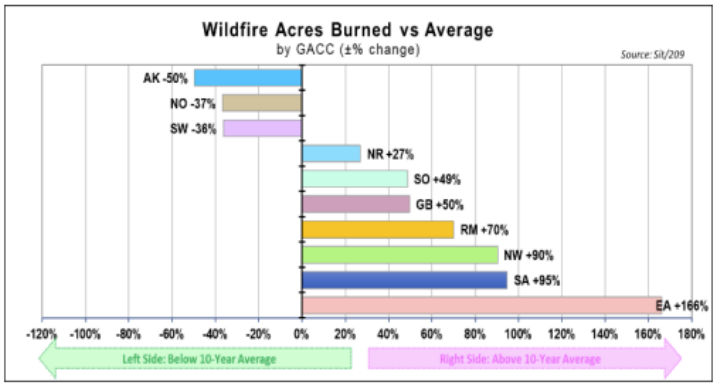


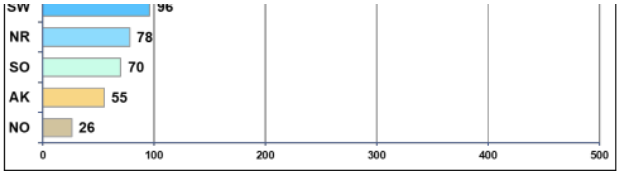


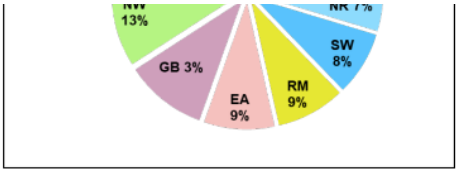












Michigan is a part of the Eastern Area (EA) fire coverage district.

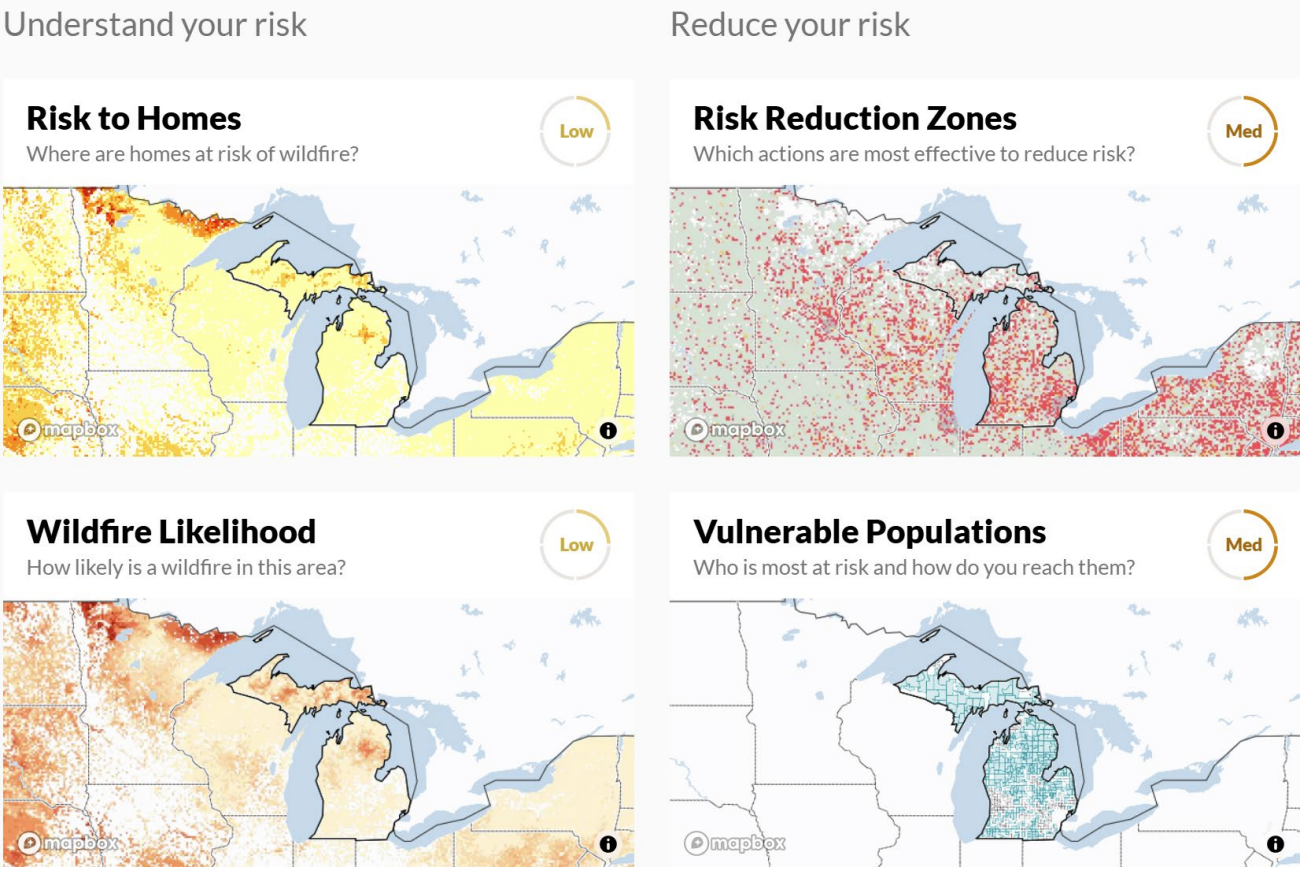
The National Interagency Coordination Center annual reports and historical year-end fire statistics are available to download from https://www.nifc.gov/fire-information/statistics

Hazard Analysis

Michigan was roughly 95% forested prior to Euro-American settlement, with forests now still covering roughly 53% of the State's total land area (roughly 20 million acres). Michigan has nearly 4 million acres of official state forest land that sees management practices such as harvesting and replanting. Forests may be described based on a predominant species, ecological classification, or resource use (e.g., timberlands). This vast forest system is a boon for the environment, recreation, and industry. Despite these benefits, every forest holds the potential for wildfire.

This danger is particularly relevant to many rural/remote areas of development outside of city cores, although urban forestry and city park systems should also be properly managed. Some plants are particularly flammable due to high resin and other factors (e.g., junipers, pines, firs, spruces). The National Wildfire Coordinating Group (NWCG) (and others) utilize highly detailed modeling to predict how different types of land may burn under specific scenarios.

Wildfire Risk to Communities is a free, easy-to-use website with interactive maps, charts, and resources to help communities understand, explore, and reduce wildfire risk. It was created by the USDA Forest Service under the direction of Congress and is designed to help community leaders, such as elected officials, community planners, and fire managers. It was first launched in 2020 and completely updated in May of 2024. This tool can be found here https://wildfirerisk.org/



Wildfire Hazards in Michigan

Michigan has experienced many destructive wildfires. Thousands of homes (during Michigan's first century) and millions of acres of forest have been destroyed by wildfires. According to Michigan Department of Natural Resources (MDNR) and U.S. Forest Service records, over 5.8 million acres of forest in Michigan were burned between 1910 and 1949, an average of 145,000 acres per year. By comparison, it was reported that between 1950 and 1996, the MDNR and U.S. Forest Service were involved in suppressing over 46,100 wildfires that burned 390,000 acres of forest, which averages only 8,300 acres burned per year. In 2018, there were 431 wildland fires, burning 3,786 acres. This drastic reduction in the acres of timber burned was largely the result of (1) increased use of specialized equipment to suppress the fires, and (2) intensified efforts toward fire prevention.

Conditions that make areas susceptible to wildfire mean nearby regions may see multiple fires at one time or in quick succession. Areas of poor tree health, including insect infestation or disease, may result in standing dead timber. Some fires may take several days to completely extinguish, which may complicate sheltering even for those whose homes remain untouched. Monitoring operations are frequently required to ensure fires are not rekindled.

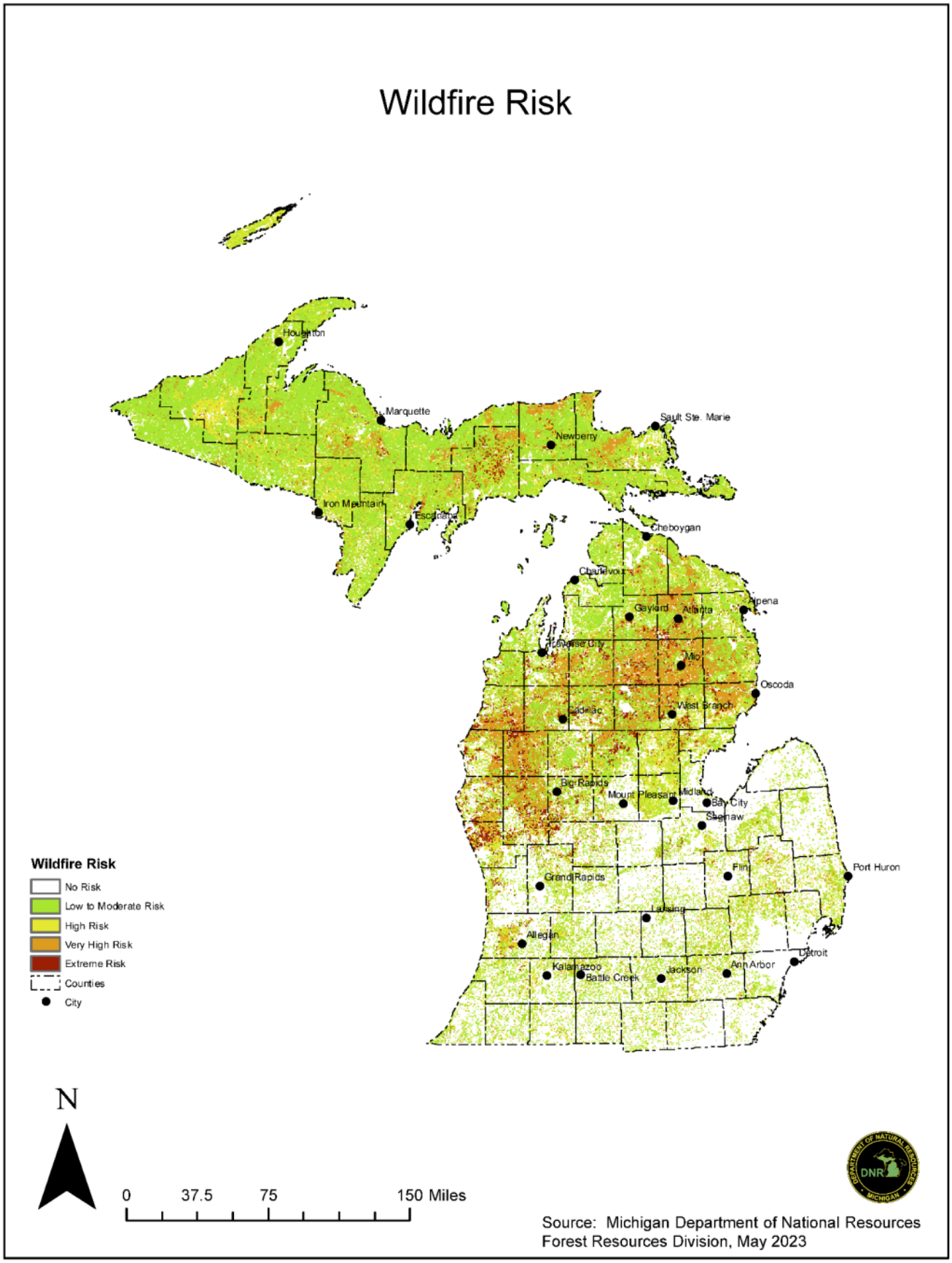
Debris burning is the leading cause of DNR response to wildfires. Lightning strikes caused fewer fires but were associated with the greatest number of acres burned (potentially because they may start in difficult to access remote areas). Equipment such as vehicles may start fires from hot/sparky exhaust or engine blocks hovering over grass and leaves.

DNR Responded Wildfires (Attributable Cause)

Number of Michigan Events & Acres Burned (2006-2021)

Activity/Cause	By # of Events	By Acres Burned
Debris burning	**30.1%**	20.3%
Undetermined / Misc.	25.7%	17.4%
Equipment	13.7%	4.2%
Campfires	8.5%	2.1%
Lightning	5.1%	**52.1%**
Powerline	4.9%	< 1%
Arson	4.0%	1.6%
Children Fires	2.6%	< 1%
Railroad Fires	2.1%	< 1%
Structural fires	1.4%	< 1%
Smoking	1.3%	< 1%
Fireworks	< 1%	< 1%

(source: Michigan DNR, 2022)


Wildfire Risk
Houghton
Marquette
Sault Ste. Marie
Newberry
Iron Mountain
Escanaba
Cheboygan
Charlevoix
Gaylord
Atlanta
Alpena
Traverse City
Mio
Oscoda
Cadillac
West Branch
Big Rapids
Mount Pleasant
Midland
Bay City
Saginaw
Flint
Port Huron
Grand Rapids
Lansing
Allegan
Kalamazoo
Battle Creek
Jackson
Ann Arbor
Detroit
Wildfire Risk
No Risk
Low to Moderate Risk
High Risk
Very High Risk
Extreme Risk
Counties
City
N
0
37.5
75
150 Miles
Source: Michigan Department of National Resources
Forest Resources Division, May 2023

The authority to respond to Wildfires in the State of Michigan is broken down to three response agencies:

Michigan Department of Natural Resources

Within Michigan, the Department of Natural Resources maintains a nationally recognized wildfire program that is charged with the prevention and suppression of forest fires on state and private land. Under the Natural Resources and Environmental Protection Act 451 of 1994, Part 515 Prevention and Suppression of Forest Fires, it described the roles and responsibilities of the Department of Natural Resources within Michigan.

National Forest Service

Within Newaygo County, a large portion of the public land is federally owned and managed by the United States Forest Service. Seventeen of the twenty-four townships within Newaygo County have national forest property within them and are a part of the Huron-Manistee National Forest. Under the Weeks Act of 1911, the Clarke-McNary Act of 1924, and United States Code Title 16 Chapter 3, it defines a wide range of law governing how the Forest Service and other agencies manage public lands and fire suppression on those lands.

Local Volunteer Fire Departments

Locally, volunteer fire departments maintain the authority under Act 207 Fire Prevention Code of 1941 to provide for the prevention and protection of persons and property from exposure to the dangers of fire or explosion. Under this law, it allows the fire department to work together with the National Forest Service and Michigan Department of Natural Resources to respond to a wildfire.

The following list summarizes some of the largest and most severe wildfires that have occurred in Michigan to date.

Case: April 24, 2008 – Crawford County

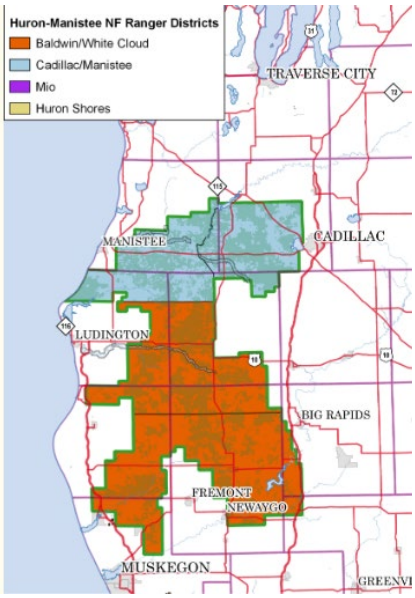
Called the “Four Mile Road Fire,” the cause may have been some sparks from a passing train. A Red Flag warning had been in effect when the fire started a few miles south-southeast of Grayling. The weather was warm, dry, and windy, and the fire quickly expanded to the northwest, crossing I-75 (which was closed for several hours) and eventually burning 1,300 acres. On the far south side of Grayling, a gas station and motel were threatened, but spared damage. About a half-dozen cabins near Simpson Lakes were lost (about two miles south of downtown Grayling), and $287,000 in damage was sustained by the Grayling Game Club. Total property damages from the event were estimated at $750,000, and MDNR response costs and timber damages were about $619,000. Fifty homes were evacuated, and power was lost in Grayling. By the evening, winds and temperatures went down and several periods of rain during the night helped the fire to be extinguished.

Case: May 18 to 26, 2010 – Crawford and Kalkaska Counties

A debris fire expanded out of control and resulted in the “Meridian Boundary Fire” by about 1:30pm on May 18. A total of 8,800 acres were eventually burned by this fire, which took until May 26 to reach 95% containment. Twelve residences were destroyed, six were damaged, and 36 outbuildings were

either destroyed or damaged, resulting in total property damages of about $825,000. Also on May 18, in adjacent Kalkaska County, the “Range 9 Fire” started when a controlled burn on an artillery range became uncontrolled as winds increased through the area. The Range 9 Fire burned 1,100 acres of mostly grassy areas on the Camp Grayling grounds, but also crossed over the boundary line at one point and destroyed 4 seasonal homes in Blue Lake Township, resulting in an estimated $125,000 in property damage. By late evening on the same date, that smaller fire was under control.

May 1, 2018 – Crawford, Wexford, and Newaygo Counties



The Michigan Department of Natural Resources sent fire crews to respond to wildfires overnight on May 1st, including three major blazes in Crawford, Wexford, and Newaygo counties. The fire in Crawford County occurred at approximately 4pm along I-75, about 7 miles south of Grayling. The fire was estimated to be just over 44 acres in size, and a stretch of I-75 was shut down for about an hour and a half. The fire in Wexford County occurred at approximately 5pm in Haring Township, about 5 miles north/northwest of Cadillac. Called the “Bond Mill Pond Fire,” it was estimated to be about 79 acres, mostly involving state forest lands. The fire caused the evacuation of 79 residents, who were all allowed to return that same evening. The U.S. Forest Service provided helicopter support for the fire suppression efforts and dumped 1,600 gallons of water before being grounded due to high winds. The fire in Newaygo County occurred at approximately 6:45pm, just over 6 miles east of Newaygo, south of M-82. This “Oak Fire” was located primarily on federal lands and estimated at 105 acres in size. It was contained by around 1am. Two residents were evacuated and 15 structures were threatened, but excellent work by 11 local volunteer fire departments, U.S. Forest Service crews, and MDNR fire crews resulted in all the structures being saved.

Wildfire Hazards in Newaygo County

Sixty-one percent of Newaygo County’s 537 thousand acres of land is forested (MSU Extension 2006). Of this 62% is in private ownership, almost all owned by small, non-industrial owners. Of the 38% in public ownership, the vast majority is part of the Manistee National Forest managed by the US Forest Service. Oak-hickory, beech-maple and lowland hardwoods make up 79% of the forestland in the county. Pine types (white, red and jack) are predominant on 15% of the forested acreage.

The forests of northern Michigan are rich in history. In the late 1800s logging was at its peak and these forests were quickly cut and cleared. In 1909, the Huron National Forest was established and the Manistee National Forest was formed in 1938. In 1945, these two National Forests were administratively combined. Working hand in hand with the Michigan Department of Natural Resources and other partners, the Forest Service has changed the "lands that nobody wanted" to healthy forests again.

The Huron-Manistee National Forest strives to maintain an excellent fire management program. Working with local volunteer fire departments, the Michigan Department of Natural Resources and other National Forests, Forest Fire Crews work hard at suppressing wildfires. But fire suppression is only one

part of Forest Service fire management. In coordination with local communities' forest fire personnel have used the Fire Wise program, educating homeowners on how to protect their homes from urban interface fires. Forest employees also work with media on updating the public about current fires, burn permits, and any burning bans that may be in effect.

The threat of wildfire is a key challenge of spring, especially in the northern part of the county where the vegetation (red, white and jack pine and oak) is on dry, sandy sites. There is danger prior to and at the beginning of spring green up. Recreation areas are in direct contact with vegetation and need to be especially careful with sources of ignition such as cigarettes, motorized recreational equipment and campfires.

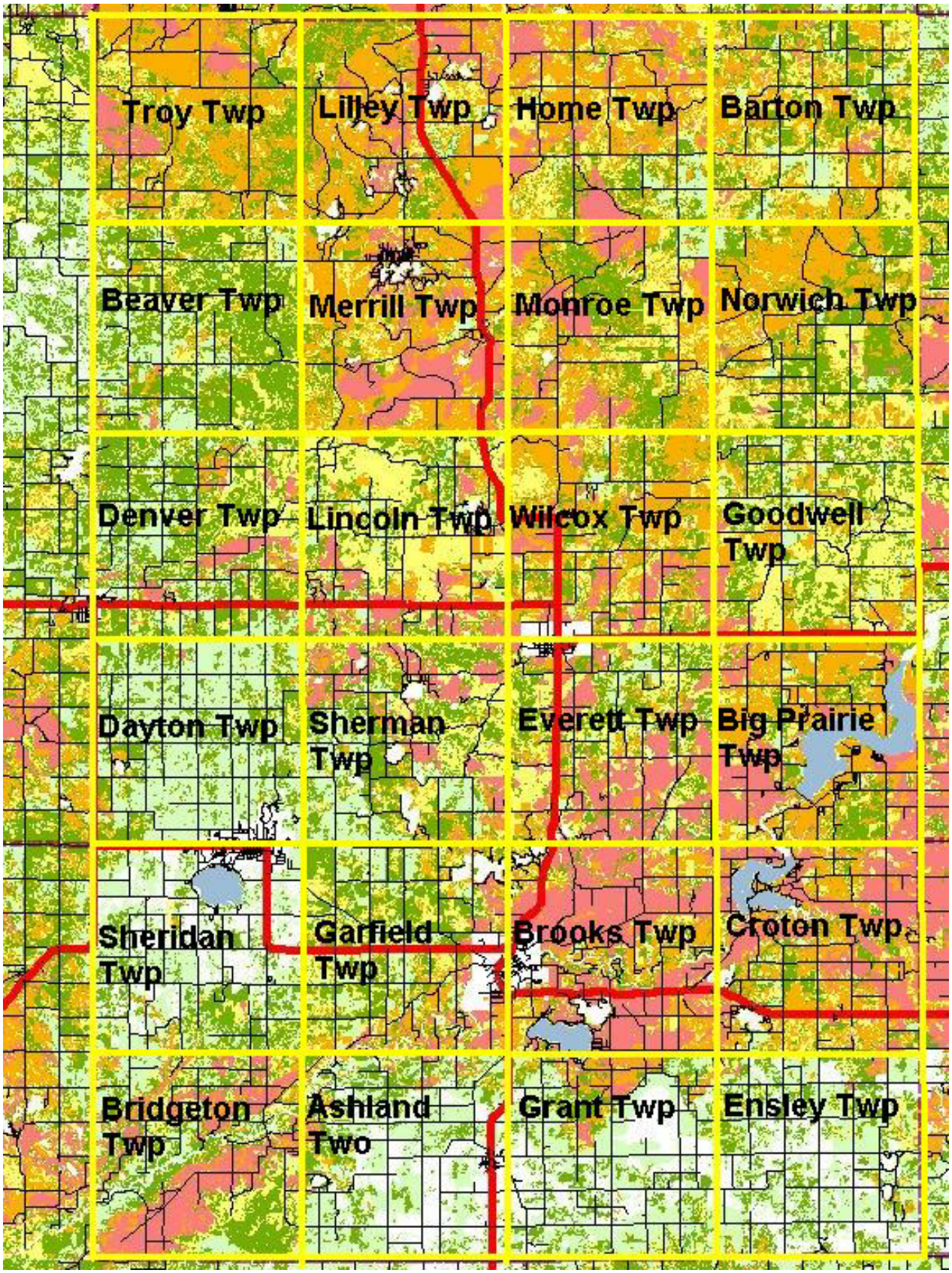
Based on historical occurrence, on average an estimated 2 – 3 smaller wildfire events occur annually. The following data came from the Fuels Management Specialist with the Huron Manistee National Forest.

The types of wildfire behavior of greatest concern in Newaygo County are crown fires and high-intensity surface fires. Crown fires are characterized by sustained burning through the forest canopy, often independent of a surface fire. Crown fires burn primarily the needles and small branches of trees. Crown fires are able to move very swiftly, spot long distances, and release large amounts of heat energy, and therefore are very difficult to control.

High-intensity surface fires are different from a crown fire in that the greatest amount of burning is taking place on the forest floor and lower shrub layers, with occasional torching of individual or small clumps of trees. Like crown fires, high-intensity surface fires have the potential to move swiftly, spot long distances, and release large amounts of heat energy. However, since the heat energy comes primarily from larger surface fuels spread across the forest floor, this energy is spread over a wider area and is sustained for a longer period of time. This type of surface fire is also very difficult to control.

The forest types of greatest concern in Newaygo County are: jack pine, Scotch pine, jack pine-oak, red pine, and oak. The forest types are listed with the most hazardous type first and so on to the least hazardous of the species of concern. The jack pine-dominated stands have the greatest potential for high-intensity wildfire, and are considered one of the most volatile fuel types occurring in the United States or Canada. Contained on the following is a fuels map from the National Forest Service:

Newaygo County Fuels Map



History of Wildland Fire Occurrence for Newaygo County

(Grass, Woods, and Illegal Burn Fire Starts)

Township	Fire Dept	2013	2014	2015	2016	2017	NFS	Total
Ashland	Station 13 – Grant Fire	3	2	12	6	3	0	**26**
Barton	Big Rapids City Fire	0	1	2	3	0	1	**7**
Beaver	Station 19 – Hesperia Fire Walkerville Fire	6	2	1	1	1	3	**14**
Big Prairie	Station 15 – Big Prairie Fire	8	3	16	3	5	12	**47**
Bridgeton	Station 11 – Fremont Fire Station 13 - Grant Fire	4	1	4	0	5	0	**14**
Brooks	Station 12 – Newaygo Fire	4	7	11	8	3	24	**57**
Croton	Station 14 – Croton Fire	12	4	21	5	8	15	**65**
Dayton	Station 11 – Fremont Fire Station 19 – Hesperia Fire	5	1	8	1	5	0	**20**
Denver	Station 19 – Hesperia Fire	4	2	4	3	2	6	**21**
Ensley	Sand Lake Fire	3	1	2	3	6	0	**15**
Everett	Station 18 – White Cloud Fire	9	7	6	6	0	11	**39**
Garfield	Station 11 –Fremont Fire Station 12 – Newaygo Fire	1	5	6	5	2	1	**17**
Goodwell	Station 15 – Big Prairie Fire	1	3	3	0	1	3	**14**
Grant	Station 13 – Grant Fire	3	1	4	7	7	6	**28**
Home	Station 17 – Lilley Fire	1	0	2	2	0	2	**7**
Lilley	Station 17 – Lilley Fire	5	1	2	2	5	7	**22**
Lincoln	Station 18 – White Cloud Fire	3	1	3	1	1	8	**19**
Merrill	Station 17 – Lilley Fire	0	1	1	0	5	4	**11**
Monroe	Station 17 – Lilley Fire	0	0	0	3	1	4	**8**
Norwich	Big Rapids City Fire	2	1	4	1	1	1	**10**
Sheridan	Station 11 – Fremont Fire	1	3	0	0	3	0	**7**
Sherman	Station 11 – Fremont Fire Station 18 – White Cloud Fire	5	2	5	1	7	1	**21**
Troy	Walkerville Fire Station 17 – Lilley Fire	5	0	1	2	0	6	**14**
Wilcox	Station 18 – White Cloud Fire	5	1	9	3	1	9	**28**

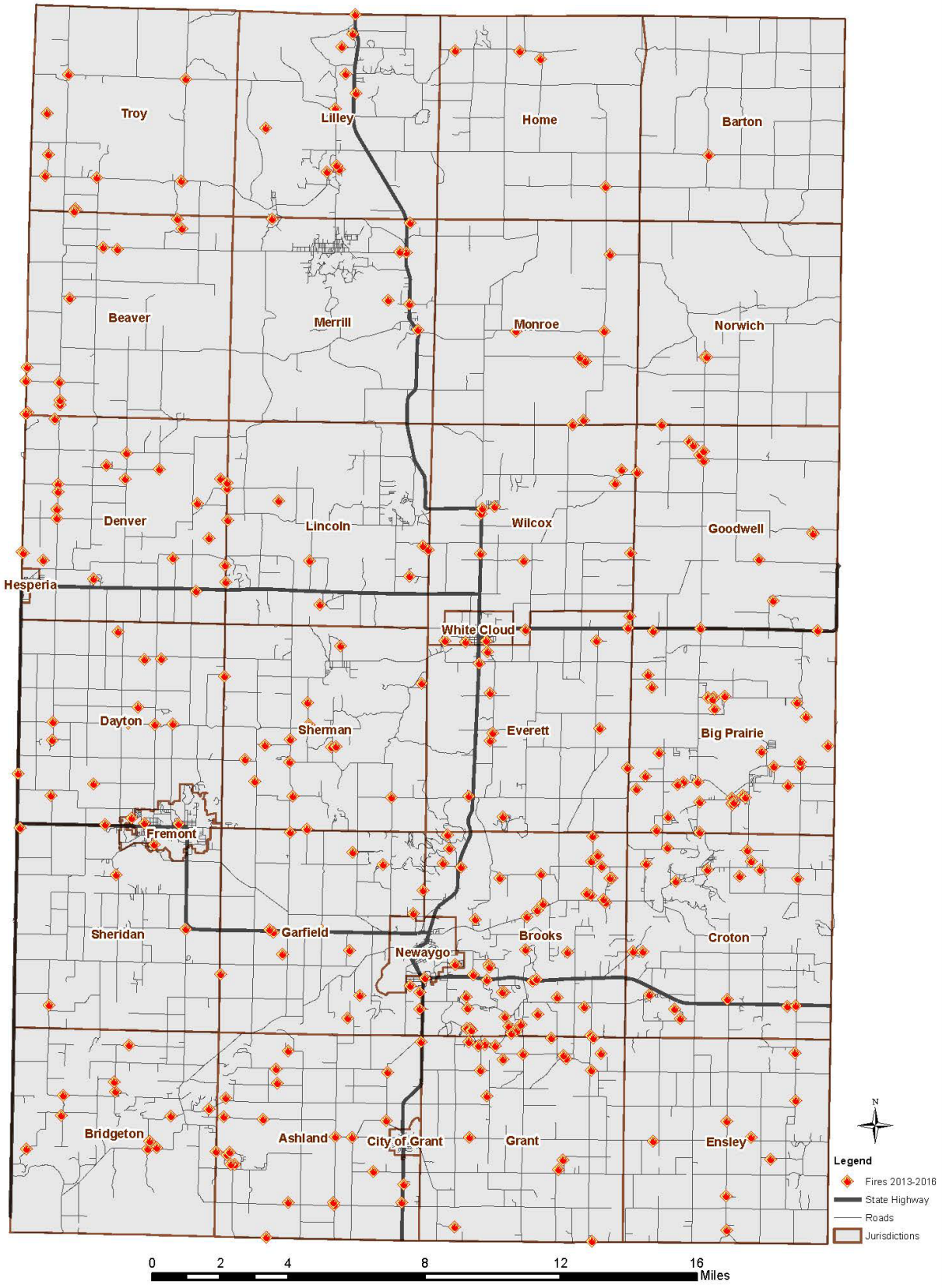
(Grass, Woods, and Illegal Burn Fire Starts)

Township	*Fire Dept*	*2018*	*2019*	*2020*	*2021*	*2022*	*NFS 20-22*	*Total*
Ashland	Station 13 – Grant Fire	7	5		2	2	0	**16**
Barton	Big Rapids City Fire	1	0		3	5	1	**10**
Beaver	Station 19 – Hesperia Fire	1	2		1	0	3	**7**
Big Prairie	Station 15 – Big Prairie Fire	1	4		7	5	9	**26**
Bridgeton	Station 11 – Fremont Fire Station 13 - Grant Fire	2	7		3	4	0	**16**
Brooks	Station 12 – Newaygo Fire	4	6	16	3	9	12	**50**
Croton	Station 14 – Croton Fire	2	2		6	6	14	**30**
Dayton	Station 11 – Fremont Fire Station 19 – Hesperia Fire	7	0		1	2	0	**10**
Denver	Station 19 – Hesperia Fire	2	0		3	4	1	**10**
Ensley	Sand Lake Fire	4	2		3	3	0	**12**
Everett	Station 18 – White Cloud Fire	0	0		6	5	10	**21**
Fremont City	Station 11 –Fremont Fire	0	0		1	1	0	**2**
Garfield	Station 11 –Fremont Fire Station 12 – Newaygo Fire	4	3	6	3	7	0	**23**
Goodwell	Station 15 – Big Prairie Fire	1	1		1	1	3	**7**
Grant City	Station 13 – Grant Fire	0	0		0	3	0	**3**
Grant	Station 13 – Grant Fire	7	1		7	6	0	**21**
Home	Station 17 – Lilley Fire	1	2		0	3	5	**11**
Lilley	Station 17 – Lilley Fire	0	4		0	5	11	**20**
Lincoln	Station 18 – White Cloud Fire	3	4		2	5	6	**20**
Merrill	Station 17 – Lilley Fire	1	2		3	2	3	**11**
Monroe	Station 17 – Lilley Fire	1	0		0	0	4	**5**
Newaygo City	Station 12 – Newaygo Fire	0	0	1	3	2	1	**7**
Norwich	Big Rapids City Fire	2	1		1	1	5	**10**
Sheridan	Station 11 – Fremont Fire	1	2		5	7	0	**15**
Sherman	Station 11 – Fremont Fire Station 18 – White Cloud Fire	7	3		4	3	1	**18**
Troy	Station 17 – Lilley Fire	1	0		0	0	1	**2**
White Cloud City	Station 18 – White Cloud Fire	0	0		1	3	2	**6**
Wilcox	Station 18 – White Cloud Fire	6	3		0	0	6	**15**

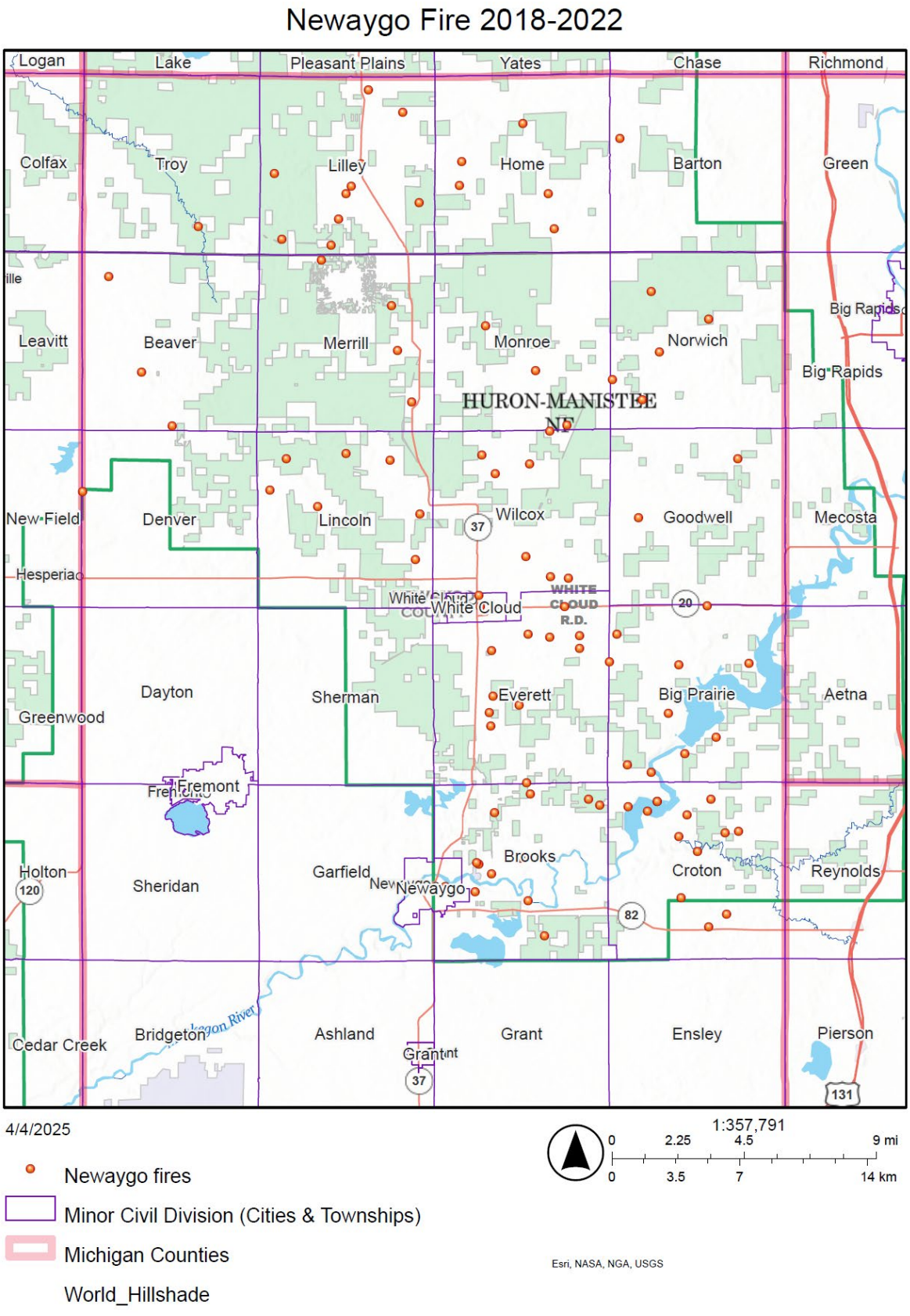
(Grass, Woods, and Illegal Burn Fire Starts)

Township	Fire Dept	2023	2024	2025	2026	2027	NFS 23-3/2025	Total
Ashland	Station 13 – Grant Fire	9	13	15			0	**37**
Barton	Big Rapids City Fire	10		1			3	**14**
Beaver	Station 19 – Hesperia Fire	1	1	4			3	**9**
Big Prairie	Station 15 – Big Prairie Fire	17	13	9			5	**44**
Bridgeton	Station 11 – Fremont Fire Station 13 - Grant Fire	12	10	10			0	**32**
Brooks	Station 12 – Newaygo Fire	11	26	9			5	**51**
Croton	Station 14 – Croton Fire	11	13	10			5	**39**
Dayton	Station 11 – Fremont Fire Station 19 – Hesperia Fire	5	6	7			0	**18**
Denver	Station 19 – Hesperia Fire	3	7	4			3	**17**
Ensley	Sand Lake Fire	8	7	5			0	**20**
Everett	Station 18 – White Cloud Fire	8	14	9			10	**41**
Fremont City	Station 11 –Fremont Fire	2	4	4			0	**10**
Garfield	Station 11 –Fremont Fire Station 12 – Newaygo Fire	9	11	19			1	**40**
Goodwell	Station 15 – Big Prairie Fire	1	1	5			4	**11**
Grant City	Station 13 – Grant Fire	2	2	0			0	**4**
Grant	Station 13 – Grant Fire	5	11	13			0	**29**
Home	Station 17 – Lilley Fire	3	1	1			5	**10**
Lilley	Station 17 – Lilley Fire	1	4	8			3	**16**
Lincoln	Station 18 – White Cloud Fire	7	5	6			4	**22**
Merrill	Station 17 – Lilley Fire	12	7	5			4	**28**
Monroe	Station 17 – Lilley Fire	1	3	1			3	**8**
Newaygo City	Station 12 – Newaygo Fire	5	1	5			2	**13**
Norwich	Big Rapids City Fire	4	3	2			3	**12**
Sheridan	Station 11 – Fremont Fire	4	9	10			0	**23**
Sherman	Station 11 – Fremont Fire Station 18 – White Cloud Fire	4	11	3			0	**18**
Troy	Station 17 – Lilley Fire	7	4	1			2	**14**
White Cloud City	Station 18 – White Cloud Fire	3	4	2			0	**9**
Wilcox	Station 18 – White Cloud Fire	10	5	3			6	**24**

Fire Starts (2013-2016)

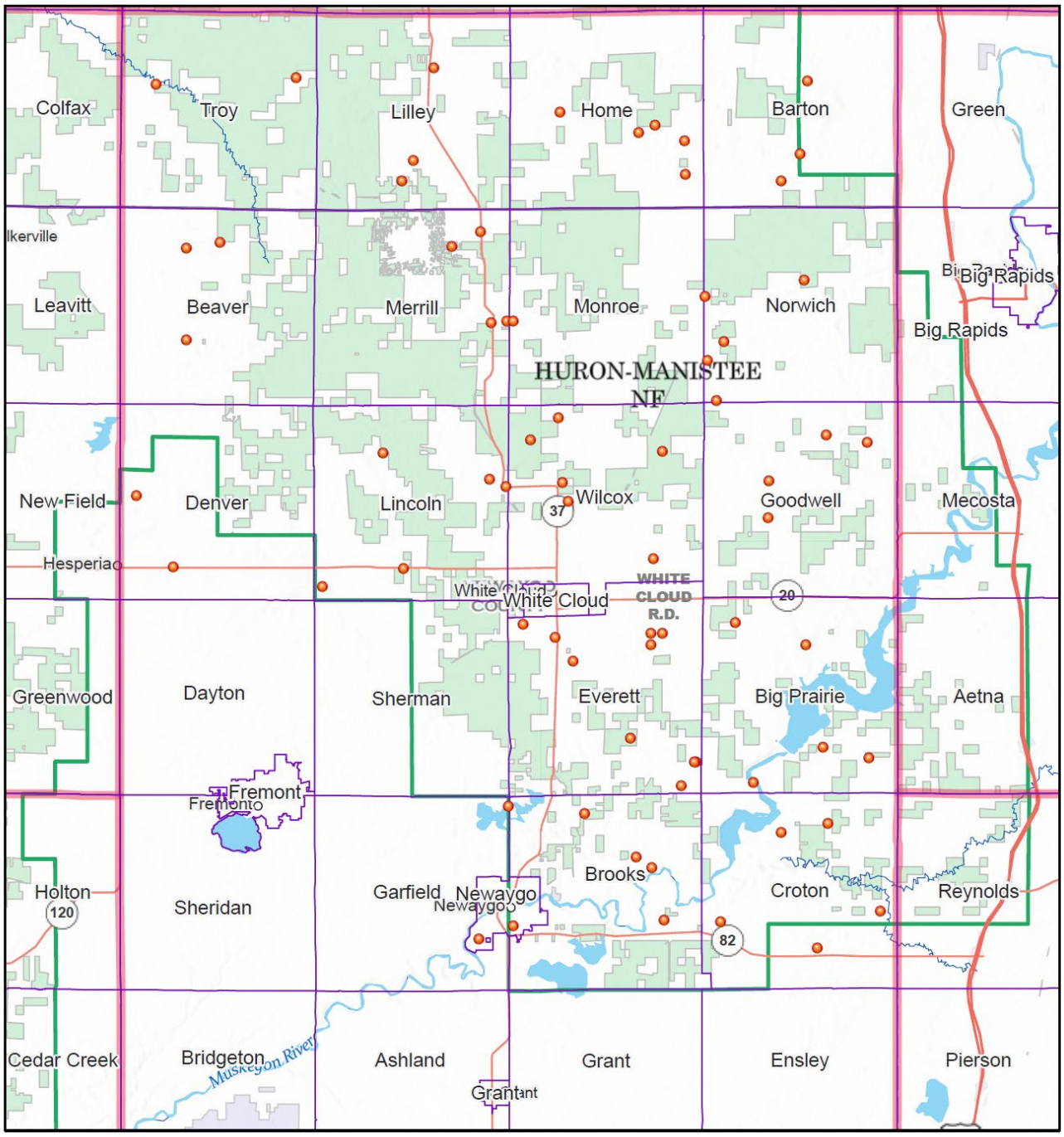


Data from the US National Forest Service for Fire Calls in Newaygo County



Data from the US National Forest Service for Fire Calls in Newaygo County

Newaygo Fires 2023-2025



4/4/2025

1:377,791

0 2.25 4.5 9 mi

0 3.75 7.5 15 km

Esri, NASA, NGA, USGS

- Newaygo fires23 _25
- Minor Civil Division (Cities & Townships)
- Michigan Counties
- World_Hillshade

Wildland Urban Interface Areas in Newaygo County

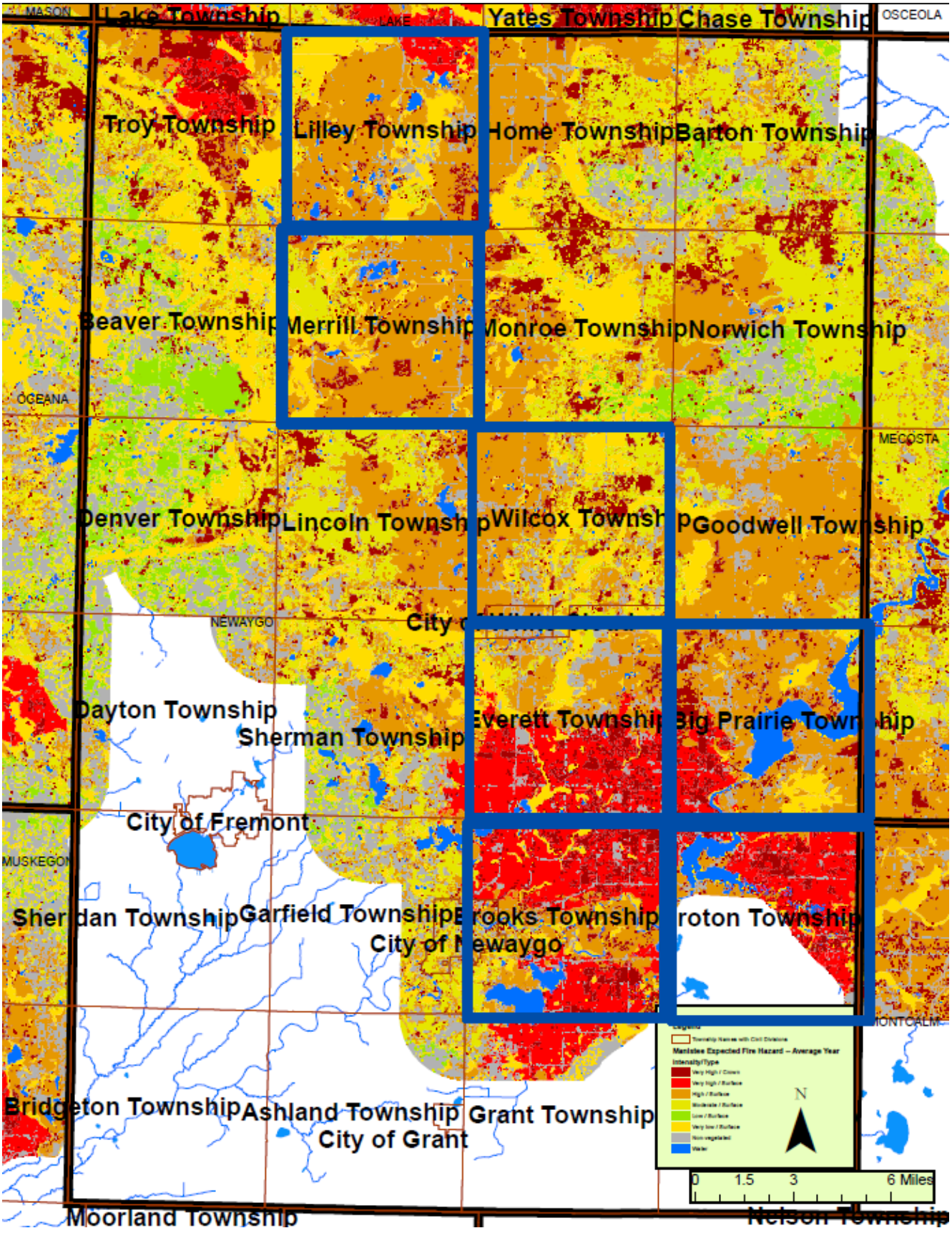
Wildland Urban Interface areas are broadly defined as areas where homes are built near or among lands prone to wildfire. These lands include forests, grasslands, shrub lands, and other natural areas that have not been significantly modified by agriculture or human development. More specifically, Wildland Urban Interface areas are lands with a higher housing density, more than one housing unit per 40 acers, which are adjacent to natural areas or where wildlands dominate the landscape.

Within Newaygo County, seven Wildland Urban Interface (WUI) areas have been identified. Utilizing townships as a geographical boundary for a Wildland Urban Interface Community allowed the local communities latitude in setting local priorities and activities related to fire risk reduction and buffer zones. These activities include; fire protection and preparedness, hazardous fuels reduction, restoration of healthy forests, fire prevention and ecosystem based planning. Each Wildland Urban Interface (WUI) community will serve as a planning area boundary for implementation of the Newaygo County Wildland Fire Protection Plan. Projects can overlap between Wildland Urban Interface (WUI) communities and cross different jurisdictions where agreements are in place. The map below shows Newaygo Counties' six Wildland Urban Interface (WUI) areas and boundaries. Detailed descriptions of each Wildland Urban Interface community can be found starting on page 118.

One significant benefit for Newaygo County communities is establishing localized definitions and boundaries for their specific Wildland Urban Interface areas (WUI). Without a written Community Wildfire Protection Plan, the Wildland Urban Interface is limited by statute to within ½ mile of a community's boundary or within 1 ½ miles when mitigating circumstances exist, such as sustained steep slopes or geographic features aiding in creating a fire break. Another benefit is expedited National Environmental Policy Act (NEPA) procedures for federal agencies implementing fuel reduction projects identified in a Community Wildfire Protection Plan fuels treatments can occur along evacuation routes regardless of their distance from the community. At least 50 percent of funds when appropriated under the Healthy Forest Restoration Act must be used within Wildland Urban Interface areas (WUI) as defined by a Community Wildfire Protection Plan or by the limited definition provided by the Healthy Forests Restoration Act when no Community Wildfire Protection Plan exists. Community Wildfire Protection Plans provide a context for prioritizing fuel treatments projects in a cross-boundary, landscape-scale manner that was envisioned in the National Fire Plan and 10-Year Comprehensive Strategy.

Another important reason for completion of a Community Wildfire Protection Plan is that federal agencies must give specific consideration to fuel reduction project implementation plans identified in the Newaygo County Community Wildfire Protection Plan. If a federal agency proposes fuel treatment methods in an area addressed by this community plan, but the community identifies a different treatment method, the federal agencies must also evaluate the community's recommendation as part of the federal agencies environmental assessment process

Newaygo County Wildland Urban Interface areas (WUI) Map with Fire Hazard



The following list summarizes some of the largest and most severe wildfires that have occurred in Newaygo County to date.

Case: April 1994: County Line Fire. USFS mobilized a Type I Incident Management Team. Eight mobile homes and 820 acres burned in Lake County near the Newaygo County border.

Case: May 1, 2018 Oak/M-82 wildfire. This105-acre fire was primarily on federal land, contained at around 1 a.m. on May 2, but not before it engulfed many mature pine and oak trees. Two homes were evacuated, and 15 structures were threatened, but all structures were saved. The fire caused a short closure of M-82 between Elm and Spruce.

Case: April 26, 2020 Creedmore Fire. This 22 acre fire was located in Lilley Township

Case: May 9, 2021 W Barry Drive and W 32nd Street in Sherman Township. This 80 acre fire was located in Sherman Township and required 5 local paid-on-call fire departments to respond and contain the fire. Due to the location of this fire, it was extremely challenging to gain access and locate the point of origin. This fire was also supported by Newaygo County Sheriff's Office and Life EMS.

Case: May 7, 2022 Pine Ave Fire. This 14.5 acre fire was located across private land in between 12th street and 24th street on Pine Ave in Big Prairie Township. 40+ personnel from multiple departments responded to the fire. A U.S. Forest Service Incident Command team was deployed to wildfire, including members from a West Virginia taskforce.

Case: April 14, 2023 City of Newaygo DPW Garage Wildfire. This 11 acre fire was located in the City of Newaygo behind the DPW garage. The wildfire occurred during a Red Flag Warning and was reported around 5pm near Mundy Ave. The fire started from railroad operations and maintenance sparking a large fire within the City.



Warnings in Newaygo County

In Michigan, Red Flag Warnings are issued by the US National Weather Service Office when there is a high risk of wildfires due to critical weather conditions. Parameters for issuance of these warnings include sustained winds of 15 mph or greater, relative humidity of 25% or less, and temperatures of 75°F or greater. Because of these parameters, Red Flag Warnings in Michigan are rare. However, in recent years because of drought conditions, warmer temperatures, and lower humidity in the Spring and Fall, Red Flag Warnings have become more common. Since 2014, the following are dates Red Flag Warnings have been issued for Newaygo County:

2018 (2)	**2018 Wildfires Responded to (local VFD Only)**
○ 04/30/2018	66
○ 05/01/2018	
2019 (1)	**2019 Wildfires Responded to (local VFD Only)**
○ 04/22/2019	54
2020 (0)	**2020 Wildfires Responded to (local VFD and NFS)**
	74
2021 (3)	**2021 Wildfires Responded to (local VFD and NFS)**
○ 06/05/2021	92
○ 06/06/2021	
○ 06/17/2021	
2022 (1)	**2022 Wildfires Responded to (local VFD and NFS)**
○ 05/09/2022	116
2023 (9)	**2023 Wildfires Responded to (local VFD and NFS)**
○ 04/12/2023	213
○ 04/13/2023	
○ 04/14/2023	
○ 05/16/2023	
○ 05/18/2023	
○ 06/04/2023	
○ 06/06/2023	
○ 06/07/2023	
○ 06/08/2023	
2024 (3)	**2024 Wildfires Responded to (local VFD and NFS)**
○ 04/16/2024	211
○ 04/22/2024	
○ 10/11/2024	
2025 (1)	**2025 Wildfires Responded to (local VFD and NFS)**
○ 04/28/2025	174

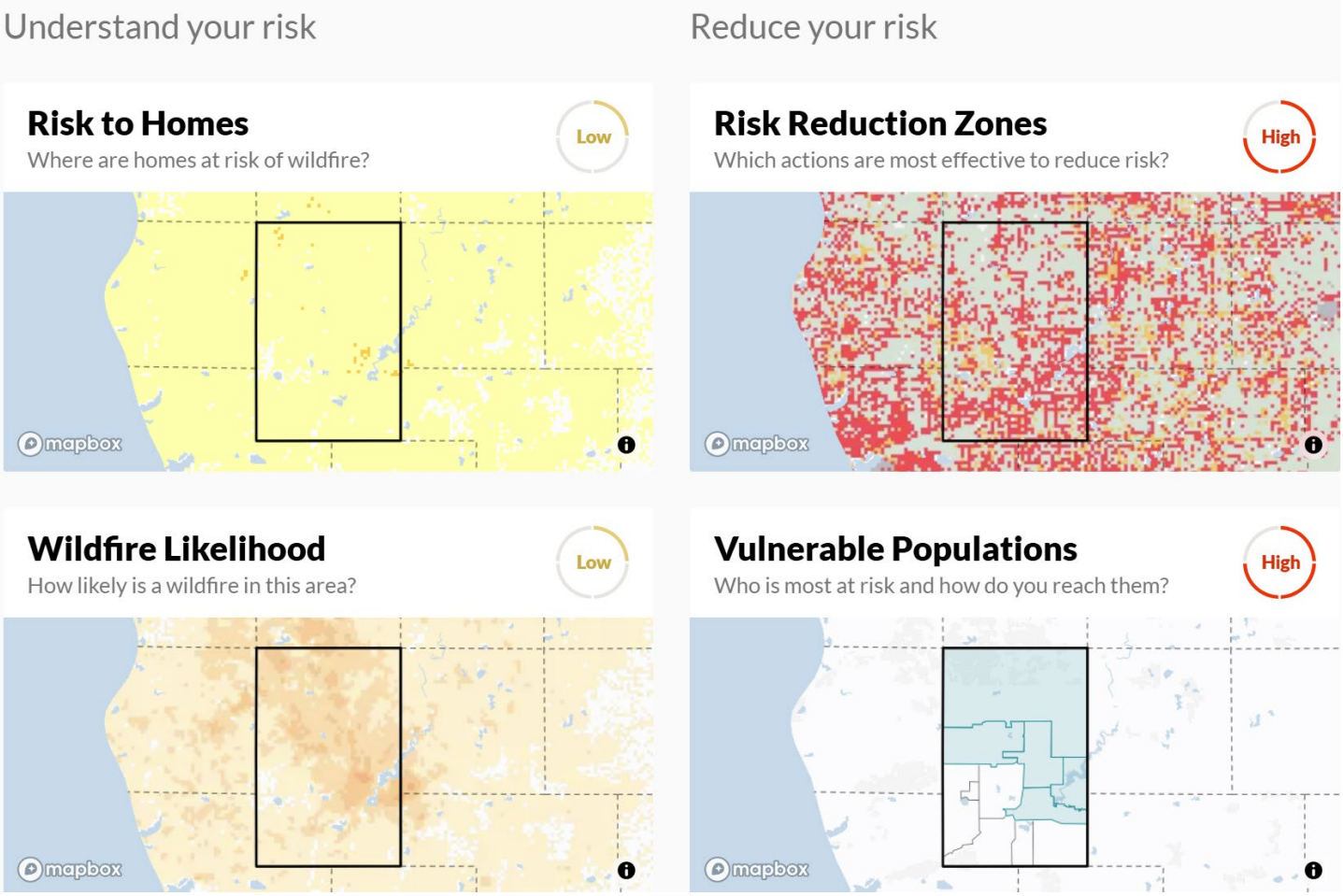
Community Vulnerability

The destructive properties of wildfire are described in the historical examples (below). Isolated structures or entire towns may be put at risk. Sheltering may be required. Fires may close roadways and air travel due to flames or smoke. Electric power may be impacted, sometimes intentionally (to protect firefighters). Property damages are largely driven by the amount of developed areas affected. Michigan events in recent decades have not resulted in human deaths but have done so in the past. Impacts can also be widespread from smoke, ash, and debris that may travel far away via air and water. Exposure to smoke may be especially problematic for certain cohorts (e.g., people with asthma, the elderly).

The county economy as a whole is typically not affected, with the timber industry being a notable exception. Agriculture and tourism can also see moderate localized impacts. Smaller communities in rural areas may see more significant or longer-lasting effects. Costs for successfully responding to fires can still be significant, especially for areas where they are common and budgets need to be shifted.

Wildfires involve special training and equipment. Heat, smoke, and remote locations present risks that may make areas inaccessible or ground planes and helicopters used in operations. Equipment staging, coordination, and communications may be impacted by multiple fires over large areas. Normal services are typically restored within a few days unless specific governmental structures catch fire or are part of an evacuation area.

Large tracts of vegetative land may be completely destroyed and take years to recover. The extent of tree damage will vary based on factors such as time of exposure, bark thickness, prior tree health, and whether fires remained on the ground or reached treetops. Wildfires may also cause dramatic changes to the ecosystem, permanently altering the prevalence of some species while allowing for the rapid introduction of new ones. It is worth noting that many Michigan plants were historically dependent on natural fire cycles. The jack pine and mesic prairies are examples, some of which face challenges due to a lack of routine fires. All forms of wildlife may be impacted, through injury, death, or loss of habitat (some animals likewise rely on ecosystems with cyclical fires). Wildfires can be a significant source of particulates in the atmosphere that absorb and scatter solar radiation. They also produce many gases, including carbon monoxide, carbon dioxide, and methane. Both factors have various impacts on animal health, plant growth, and climate conditions.



https://wildfirerisk.org/explore/overview/26/26123/

FIRES

Structural Fires

A fire, of any origin, that ignites one or more structures, causing loss of life and/or property.

Hazard Description

Structure fires are any instance of an uncontrolled burning which results in structural damage to residential, commercial, industrial, or other properties in developed areas. Structural fires can be started by cooking accidents, electrical faults, fuel leaks, children playing with lighters or matches, and accidents involved an open flame from candles, cigarettes, etc. The leading cause of home fires and home injuries is unattended cooking. The leading cause of fire deaths is structural fires originating from smoking material starting upholstered furniture or mattress/bedding on fire.

Hazard Analysis

In terms of average annual loss of life and property, structural fires—often referred to as the "universal hazard" because they occur in virtually every community—are by far the most common hazard facing most communities in Michigan and across the country. Each year in the United States, fires result in approximately 5,000 deaths and 25,000 injuries requiring medical treatment. According to some sources, structural fires cause more property damage and loss of life than all types of natural disasters combined. Direct property losses due to fire exceed $9 billion per year, and much of that figure is the result of structural fires.

According to the National Fire Protection Association Fire Analysis and Research Division, the following are fire loss statistics in the United States during 2018:

- 1,318,500 fires were responded to by public fire departments
- 379,600 fires occurred in residential structures (30%)
- 3,655 civilian fire deaths occurred
- 2,790 civilian fire deaths occurred in residences (76%).
- 15,200 civilian injuries occurred as the result of fire
- An estimated $25.6 billion in property damage occurred as a result of fire.
- $13.2 billion of property damage occurred in structure fires
- An estimated 26,000 fires were intentionally set resulting in 180 civilian deaths
- Intentionally set structure fires resulted in an estimated $480 million in property damage.

Unfortunately, although the United States has made great strides in lessening deaths and injuries caused by other types of disasters, structural fires are worse problems in this country than in many

other industrialized countries (even those with a more densely developed population pattern). Overall trends for residential building fires and losses for the 10-year period of 2009 to 2018 show the following:

- A 4% increase in fires
- A 13% increase in deaths
- A 19% decrease in injuries
- A 0.04% decrease in dollar loss
- Cooking is the leading cause of residential building fires for the 10-year period
- An 18% increase in residential cooking fires (2018 there were 192,700 cooking fires)
- A 30% decrease in residential heating fires (2018 there were 35,700 heating fires)
- A 17% increase in residential other unintentionally or carelessly set fires (2018 there were 28,600 unintentionally or carelessly set fires)
- A 2% decrease in residential electrical malfunction fires (2018 there were 25,700 electrical fires)

The United States Centers for Disease Control (CDC) figures indicate that fire-associated mortality rates in the United States are approximately 2-3 times greater than those in many other developed countries. According to the Federal Emergency Management Agency's National Fire Data Center, overall trends in the leading fire death causes for the 10-year period of 2009 to 2018 show the following:

- Other unintentional, careless was the leading cause of residential fire deaths in nine years out of the 10-year period, and there was a 33% increase in residential other unintentionally or carelessly set fire deaths. In 2018, 16 reported multi-fatality fire incidents (resulting in two, four or five deaths each) may have contributed to the increase in the estimate of fire deaths.
- Smoking was the second leading cause of residential fire deaths in 2018, and there was a 4% increase in residential smoking fire deaths. In 2018, seven reported multi-fatality fire incidents (including one resulting in six deaths) may have contributed to the increase in the estimate of fire deaths.
- A 58% increase in residential cause-under-investigation fire deaths.

Structure Fires in Michigan

Michigan's fire experience generally mirrors the national fire situation. According to statistics compiled by the Fire Marshal Division of the Michigan Department of Licensing and Regulatory Affairs for 2003, nearly 19,000 structural fires occurred in Michigan, resulting in 161 deaths and 624 injuries. The dollar loss for all fires was estimated at over $230 million. The Fire Marshal Division estimated that a structural fire occurred in Michigan about every 28 minutes in 2003. Michigan's fire death rate of 15.4 persons per million puts it toward the middle of all states in the nation in 2006. Michigan's fire death rate is ranked third in the Midwest, behind Missouri and Indiana as of 2007.

During the period from 1975-2009, the number of reported fires in Michigan (both structural and nonstructural) has trended downwards from a high of just over 80,000 to the current low of around

40,000, with yearly numbers fluctuating within this range. The number of structural fires represents approximately 35-40% of those yearly totals. Although fire risks are clearly a major concern, most of the incidents are of a limited scale and do not threaten or harm an entire community. This analysis will focus on major fires that do cause a severe impact to local communities—as disaster events.

Unfortunately, Michigan has not been immune to large structural fires that resulted in a significant loss of life. Michigan has not had a catastrophic structural fire disaster in recent years that resulted in a significant loss of human life or significant injury. However, in any given year it is not uncommon for several multiple-casualty residential structural fires to occur throughout the state. Despite the best efforts of fire officials in fire safety education and prevention, deadly residential fires continue to occur year after year.

Case: State Office Building Fire 1951

February 8, 1951: Although it did not result in any loss of life, the arson fire at the State Office Building in Lansing was another significant structural fire that had a profound impact on Michigan. That fire, which caused close to $7 million in damage and burned for a week—destroyed thousands of irreplaceable state records and archives, including the Michigan Library. The fire was started by a young employee who thought having a criminal record would prevent him from being drafted into the Korean War.

Case: Herbruck's Poultry Ranch Fire 2005

August 2005: Another example of a catastrophic fire that did not result in any loss of human life is the blaze at a poultry farm in Berlin Township, Ionia County. The fire destroyed an egg-production building at one of the state's largest poultry farms, causing the death of over 250,000 chickens and $5 million in damage. Sixteen fire departments from four counties responded to the fire that destroyed the 150- by 600-foot building, which housed egg-laying hens.

Case: Grand Rapids Condominium Fire 2008

On January 20, 2008 a massive structural fire in Grand Rapids resulted in the destruction of over 100 condominium units in two adjacent buildings. Around 200 individuals escaped the building, and although nobody was injured, four persons had to be rescued.

Structure Fires in Newaygo County

Newaygo County is served with fire suppression services from 11 local fire departments funded by townships and cities. Each is staffed by paid on-call personnel who are activated on a per call basis to respond to emergencies as required. Fire chiefs' association meetings have contributed to fostering inter-department coordination, mutual aid, and cooperative efforts. Although the volunteer nature of the system has posed a continual challenge in several aspects of fire suppression capabilities in key areas of administration, personnel, training, and pre-planning, the system has served the jurisdiction with a high level of pride and professionalism since its establishment.

Despite the independent multi-department system, Newaygo County's fire hazards remain a primary countywide concern. Based on historical occurrence, on average each jurisdiction within Newaygo

County has an estimated four or more structure fires annually. As a small community, Newaygo County's major fire hazard concerns lies in critical economic, societal, and/or historic sites such as large businesses, downtown areas, and service facilities (i.e. schools, hospital, etc.)

Historically, when Newaygo County was first established, large fires plagued it. In 1867, the first serious fire in the history of the county occurred and the Newaygo Company's Mill burned; this was called The Big Red Mill. It was rebuilt in 1869 at a cost of $40,000. In 1883 a massive fire destroyed The City Newaygo, leaving only two buildings standing and completely relocating the County Seat from Newaygo to White Cloud. More recently, most structural fires are residences and can be handled by one two three departments and do not require a lot of outside mutual aid support.

Case: Northern Trails Bar and Grill Fire 2007



On, Monday July 16, 2007 Northern Trails Bar and Grill was destroyed by fire. The fire was spotted around 6:15 am by a Newaygo County Sheriff's Deputy patrolling the area. Fire departments from Kent County, Mecosta County, Montcalm County, and Newaygo County responded to the fire. The fire was ruled as arson. This fire was connected to a second restaurant fire in Croton (Mr. Pibs) the following week.

Case: Pine Lake Village Apartment Complex Fire 2010

On Sunday, August 15, 2010, a medical oxygen tank exploded around 8pm in a unit of Pine Lake Village Apartments in the 100 block of West Pine Lake in Newaygo. The explosion ignited a fire which heavily damaged 4 units within the apartment complex. Through response efforts from the local fire department, the building was saved along with the exposure buildings. Newaygo Fire Department, Fremont Fire Department, White Cloud Fire Department, and Grant Fire Department responded to the fire.

Case: July 3rd, 2018

An orchard warehouse and cider processing building in Grant (Newaygo County) was destroyed by fire. 20 Fire departments along with local, state and federal resources responded to assist.

Case: October 1, 2018

Morley Fire Department responded to a structure fire in northern Deerfield Township around 4:30 a.m. Monday, Oct. 1. While firefighters responded to that fire, two other fires were reported in the area, with another in northern Montcalm County. Firefighters from Lakeview, Mecosta Township, Morton

Township, Big Rapids Township, Big Rapids Department of Public Safety, Big Prairie Township in Newaygo County and Maple Valley in Montcalm County responded to assist.

Case: January 30, 2019, 140-year-old Smugglers Cove Restaurant caught on fire. 4 fire departments responded. The building was deemed unsalvageable and was torn down.



Photo by Ryan Pendergast

Case: February 7, 2019 Ensley Township, Mobile home fire, Occupant escaped and survived with 2nd degree burns and two pets lost.

Case: November 29, 2019 East 128th St Structure Fire, Ensley Township, homeowner killed.

Case: January 18, 2022, Cottonwood Ave in Norwich Township. A single family structure became fully engulfed in flames just before 5am. Upon arrival of the fire department, fire was going through the whole house when it collapsed upon itself. An 80 year old man and his 68 year old wife were later located deceased inside the home.

Case: March 18, 2023, The Charlie's Family Grill at 276 S. Charles Street in White Cloud was destroyed by a fire. During investigation, Investigators found multiple points of origin for the fire in the attic and basement, which, along with a lack of food and cooking equipment, raised suspicion of arson. In October 2023, the owners, Ryan and David Robinson, were charged with arson. A jury trial took place in August 2025 finding the pair guilty of arson of an insured real property. Ryan Robinson was also found guilty of two counts of false pretenses for insurance fraud related to the restaurant fire and a previous garage fire.



*Case: December 8, 2024, s*everal fire departments and police agencies helped extinguish a deadly fire that started early Sunday morning. They were called just before 4:30 a.m. to a home on 7 Mile Rd near Maple Island Rd. Newaygo Central Dispatch confirmed 1 person died, and Newaygo County Sheriff's Office later posted details on social media saying a 69-year-old man was pulled from the home—despite life-saving measures, he was pronounced dead. A 69-year-old woman was also in the home, but was able to get out without being hurt.

Case: February 6, 2025, Dan's Excavating Services on 120th Street west of Sycamore Street, immediately adjacent to the Grant High School in Grant Township, was fully engulfed in flames. When firefighters arrived, the fire was fully involved from one end of the building to the other. Strong winds, which were blowing at speeds of up to 45 mph, helped spread the fire quickly. 16 Fire Departments responded to the fire. 8 departments assisted from Newaygo County with the remaining 8 departments responding from Muskegon County, Kent County, and Montcalm County. No one was injured during the fire, but the building was a total loss. It was not clear what caused the fire.



Photo by WZZM13

Case: May 4, 2025, around 8:15 p.m., firefighters were called to South Fitzgerald Avenue in Sheridan Township. The roof collapsed while the fire was ongoing. No one was injured in the fire, and it's not clear what caused it. Crews from Fremont, Newaygo, Holton and Grant responded.

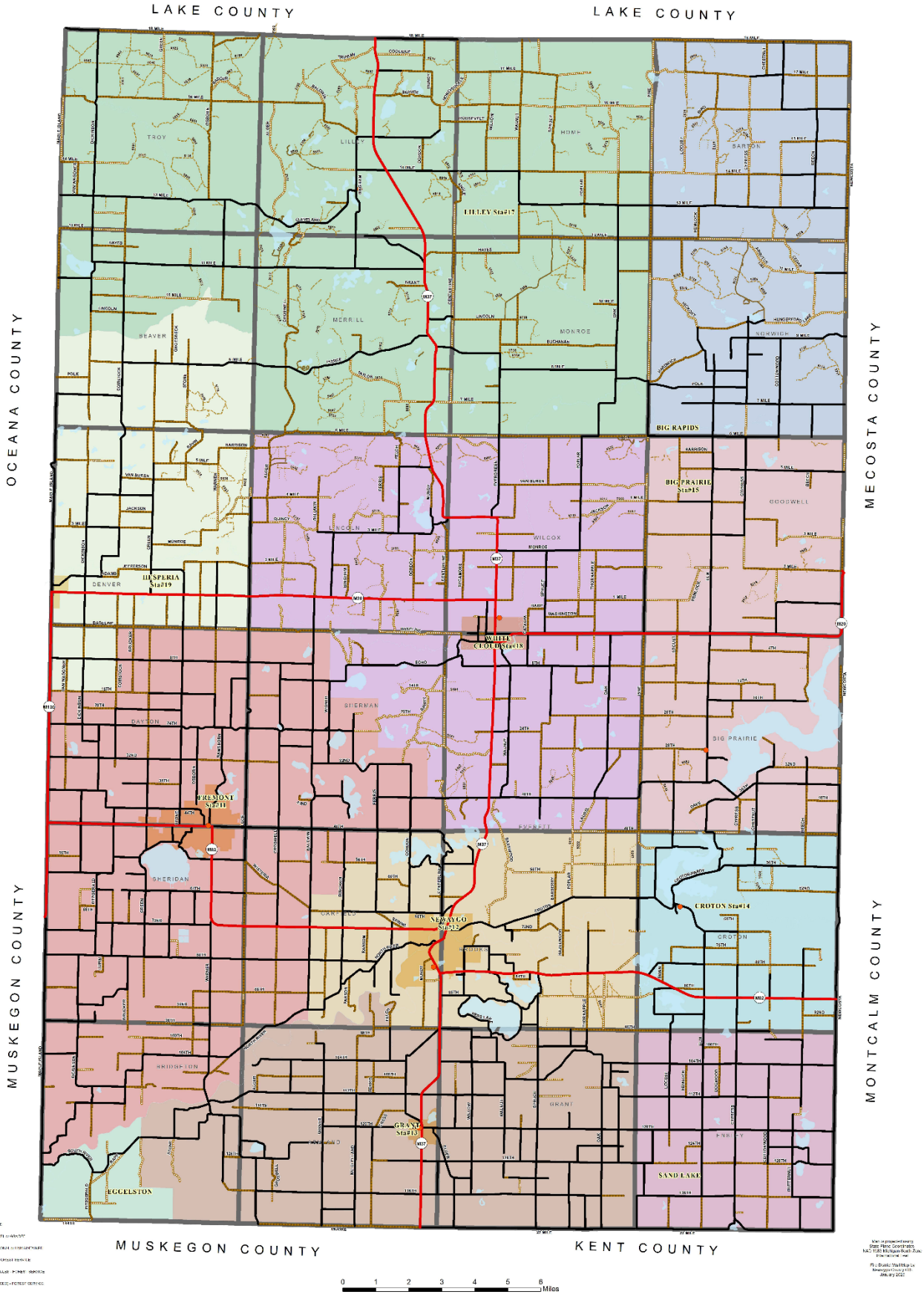
History of Structure Fires in Newaygo County 2017-July 2020

Jurisdiction	Fire Dept	2017	2018	2019	2020	Total
City of Fremont	Station 11- Fremont Fire	10	2	9	3	24
City of Grant	Station 13 - Grant Fire	0	0	1	0	1
City of Newaygo	Station 12 - Newaygo Fire	2	2	1	1	6
City of White Cloud	Station 18 - White Cloud Fire	0	0	0	0	0
Ashland Township	Station 13 - Grant Fire	3	8	4	1	16
Barton Township	Big Rapids City Fire	0	1	0	1	2
Beaver Township	Station 19 - Hesperia Fire Walkerville Fire	2	1	1	2	6
Big Prairie Township	Station 15 - Big Prairie Fire	7	3	1	2	13
Bridgeton Township	Station 11 - Fremont Fire Station 13 - Grant Fire	3	3	3	3	12
Brooks Township	Station - 12 Newaygo Fire	2	7	5	2	16
Croton Township	Station 14 - Croton Fire	5	10	4	0	19
Dayton Township	Station 11- Fremont Fire Station 19 - Hesperia Fire	2	2	2	1	7
Denver Township	Station 19 - Hesperia Fire	3	1	5	1	10
Ensley Township	Sand Lake Fire	3	2	5	5	15
Everett Township	Station 18 - White Cloud Fire	0	0	0	2	2
Garfield Township	Station 11- Fremont Fire Station 12 - Newaygo Fire	5	4	5	0	14
Goodwell Township	Station 15 - Big Prairie Fire	0	2	0	0	2
Grant Township	Station 13 - Grant Fire	1	5	2	0	8
Home Township	Station 17 - Lilley Fire	1	1	0	1	3
Lilley Township	Station 17 - Lilley Fire	2	1	2	3	8
Lincoln Township	Station 18 - White Cloud Fire	3	0	1	4	8
Merrill Township	Station 17 - Lilley Fire	1	2	0	0	3
Monroe Township	Station 17 - Lilley Fire	2	1	1	0	4
Norwich Township	Big Rapids City Fire	0	3	0	0	3
Sheridan Township	Station 11 - Fremont Fire	2	7	4	2	15
Sherman Township	Station 11 - Fremont Fire Station 18 - White Cloud Fire	2	2	6	0	10
Troy Township	Station 17 - Lilley Fire	4	1	1	0	6
Wilcox Township	Station 18 - White Cloud Fire	6	0	4	0	10
Total		**71**	**71**	**67**	**34**	**61 AVG**

History of Structure Fires in Newaygo County 2021-September 2025

Jurisdiction	Fire Dept	2021	2022	2023	2024	2025	Total
City of Fremont	Station 11- Fremont Fire	3	5	2	5	4	19
City of Grant	Station 13 - Grant Fire	1	1	1	2	2	7
City of Newaygo	Station 12 - Newaygo Fire	0	2	2	1	2	7
City of White Cloud	Station 18 - White Cloud Fire	0	0	5	0	4	9
Ashland Township	Station 13 - Grant Fire	4	6	3	8	7	28
Barton Township	Big Rapids City Fire	0	2	0	0	0	2
Beaver Township	Station 19 - Hesperia Fire Walkerville Fire	0	2	0	1	2	5
Big Prairie Township	Station 15 - Big Prairie Fire	3	4	5	4	5	21
Bridgeton Township	Station 11 - Fremont Fire Station 13 - Grant Fire	4	6	2	3	5	20
Brooks Township	Station - 12 Newaygo Fire	3	3	3	1	4	14
Croton Township	Station 14 - Croton Fire	5	4	8	9	1	27
Dayton Township	Station 11- Fremont Fire Station 19 - Hesperia Fire	1	1	2	0	2	6
Denver Township	Station 19 - Hesperia Fire	1	0	3	1	2	7
Ensley Township	Sand Lake Fire	2	7	3	5	4	21
Everett Township	Station 18 - White Cloud Fire	1	4	2	4	6	17
Garfield Township	Station 11- Fremont Fire Station 12 - Newaygo Fire	0	2	5	5	4	16
Goodwell Township	Station 15 - Big Prairie Fire	0	1	3	0	3	7
Grant Township	Station 13 - Grant Fire	3	8	3	4	5	23
Home Township	Station 17 - Lilley Fire	0	3	0	0	0	3
Lilley Township	Station 17 - Lilley Fire	0	0	1	1	3	5
Lincoln Township	Station 18 - White Cloud Fire	2	2	5	4	2	15
Merrill Township	Station 17 - Lilley Fire	2	2	1	6	1	12
Monroe Township	Station 17 - Lilley Fire	0	0	0	0	3	3
Norwich Township	Big Rapids City Fire	2	2	0	1	1	6
Sheridan Township	Station 11 - Fremont Fire	4	6	4	5	3	22
Sherman Township	Station 11 - Fremont Fire Station 18 - White Cloud Fire	1	3	3	2	2	11
Troy Township	Station 17 - Lilley Fire	0	3	0	0	3	6
Wilcox Township	Station 18 - White Cloud Fire	1	3	3	1	1	9
Total		**43**	**82**	**69**	**73**	**81**	**70 AVG**

NEWAYGO COUNTY FIRE DISTRICTS

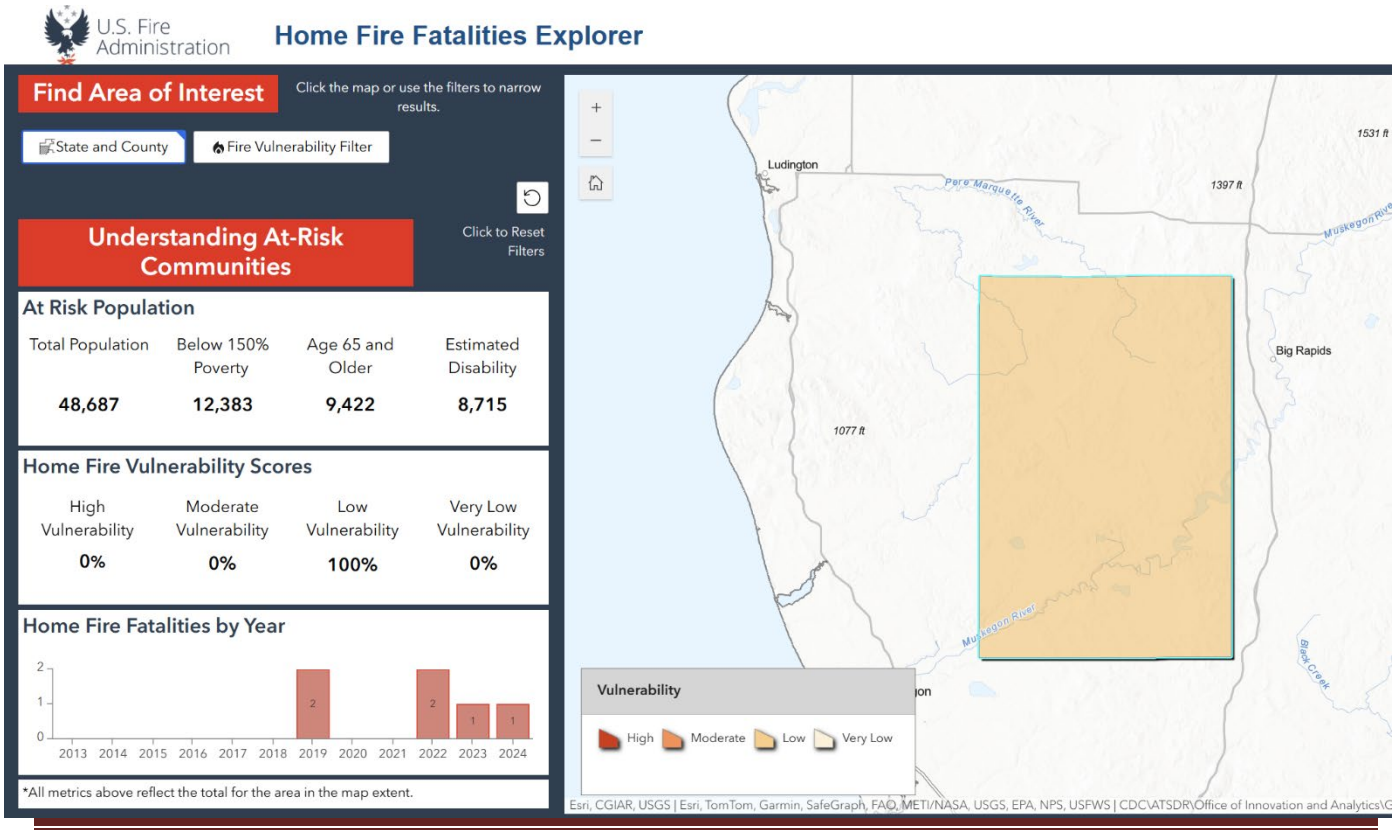


Community Vulnerability

Structure fire health impacts include smoke inhalation, which can cause respiratory problems and even death due to inhaling smoke and toxic gases produced by the fire. Direct exposure to flames, hot gases, and hot surfaces can cause severe burns and other injuries to firefighters and occupants of a burning structure. Responding to and fighting fires can also be emotionally and physically challenging, leading to trauma and stress among firefighters and other emergency responders. Next, structural fires can weaken or collapse buildings and other structures, which can lead to injury or death among firefighters and occupants. Structural fires can also release toxic chemicals, such as asbestos and lead, into the environment, posing health risks to nearby residents and the environment. Lastly, firefighting efforts can lead to significant water damage to buildings and other structures, resulting in property damage and mold growth.

Structural fires can also cause extensive damage to nearby buildings and roads and lead to water damage resulting in property damage and mold growth. Structural fires can damage electrical systems, leading to power outages and other disruptions to daily life. They can also weaken or collapse buildings and other structures, posing a risk of injury or death to firefighters and other occupants.

Historical incidents have shown the cost of extinguishing fires, property damages, business interruption cost, and the cost of rebuilding or repairing damaged structures to be significantly high. The following is information from the US Fire Administration Home Fire Fatalities Explorer:



Scrap Tire Fires

A large fire that burns scrap tires being stored for recycling or reuse.

Hazard Description

Tire fires are described as any instance of uncontrolled burning at scrap tire storage or recycling site. Each year in the U.S., an estimated 290 million vehicle tires have to be disposed of. Michigan alone generates 10 million scrap tires annually. Many of these scrap tires end up in disposal sites (legal or illegal), some of which may have several hundred thousand tires. Although responsible means of storage and disposal have become more common, tire dumps of the last forty years still present environmental and safety hazards.

Tire disposal sites can be fire hazards due to the large quantity of "fuel" onsite, coupled with the fact that the shape of a tire allows air to flow into the interior of a tire pile, rendering standard firefighting practices nearly useless. Flowing burning oil released by the burning tires spreads the fire to adjacent areas. Some scrap tire fires have burned for months, creating acrid smoke and an oily residue, which can leach into the soil, creating long-term environmental problems.

Scrap tire fires differ from conventional fires in several respects: 1) even relatively small scrap tire fires can require significant resources to control and extinguish; 2) the costs of fire management are often far beyond that which local government can absorb; 3) the environmental consequences of a major tire fire can be significant; and 4) the extreme heat from the fire converts a standard passenger vehicle tire into about two gallons of oily residue, which can then leach into the soil or migrate to streams.

Hazard Analysis

In May 2020, the State of Michigan has identified a total of 55 non-compliant scrap tire collection sites containing a total of about 550,000 tire equivalents (unburied ones that pose the greatest fire danger) in outdoor stockpiles scattered around the state. Since the MDEQ Michigan Scrap Tire Program began in 1991, the total amount of Michigan's scrap tire stockpile has gone from 31 million to about 2.2 million. The department estimates that most of the remaining tires could be disposed of before the program's ending date in December 2015.

Scrap Tire Fires in Michigan

Scrap tire fires have occurred in Michigan in the past. Over the past several years, there has been a decrease in both the frequency and severity of fires at scrap tire disposal sites due to the cleanup of existing stockpiles and an increase in compliance at collection sites. Unfortunately, fire departments are generally ill-equipped and untrained to handle these incidents when they do occur. This is especially true in rural areas where many scrap tire disposal sites are located. Scrap tire fires occur often enough to present a major concern to those communities that have quantities of tires stored at disposal sites within or adjacent to their borders. Given the right set of circumstances, the potential is always there for a major fire that may require evacuation, sheltering, large amounts of fire suppression assistance, and both short and long-term environmental monitoring. Large scrap tire fires can also be very costly

for the owner/operator and the affected local jurisdiction(s), as the fires are difficult to extinguish and typically require a large emergency response personnel presence at the fire scene (often for an extended period of time).

Scrap Tire Disposal Sites in Michigan: November 2009

County	Sites	Tires	County	Sites	Tires
Alpena	2	100,250	Livingston	1	1,000
Arenac	1	37,341	Marquette	1	3,000
Bay	1	700	Mecosta	1	8,000
Benzie	1	10,000	Menominee	1	2,000
Calhoun	2	5,700	Midland	2	121,100
Cass	1	37,000	Monroe	2	7,500
Chippewa	1	500	Montcalm	1	2,000
Clare	1	700	Newaygo	2	27,000
Crawford	1	10,000	Oakland	2	20,633
Dickinson	1	499	Oceana	1	11,000
Eaton	1	300	Osceola	2	2,385,000
Genesee	2	152,000	Ottawa	1	100,000
Grand Traverse	1	1,499	St. Clair	3	9,400
Gratiot	1	2,500	St. Joseph	2	48,000
Hillsdale	1	1,300	Sanilac	2	11,000
Houghton	2	117,500	Shiawassee	1	1,000
Ingham	1	500	Tuscola	2	12,700
Iosco	1	4,800	Wayne	22	168,977
Ionia	1	3,000	Van Buren	2	3,000
Jackson	2	6,600	**Total**	**76**	**3,435,499**

Source: Department of Environmental Quality, Waste and Hazardous Materials Division.

NOTE: Inventory totals compiled for tire quantities are approximated and will vary from year to year, as new tires are brought in and others are recycled or otherwise disposed of.

In recent history, the following incidents stand out as examples of the adverse impacts that can occur when fire breaks out at a scrap tire disposal site.

Case: October 30, 1987 – Kent County
A large fire broke out at a scrap tire disposal site in Kent County containing over one million tires. It was estimated that the blaze was contained to about a fifth of the ten-acre site and a fire break was established with bulldozers. Firefighters ultimately concluded that the best course of action was to allow the contained portion of the fire to burn, and that applying water would add no benefit. Nearby residents were evacuated during the early stages of the fire.

Case: *December 29, 1995 to January 20, 1996 – Grand Traverse County*
A tire fire burned at a re-treading facility in Grawn near Traverse City. Initial fire response was delayed due to attempts by employees at the recycling center to extinguish the blaze without outside assistance. Over the course of the event, surrounding subdivisions were evacuated. The fire engulfed 100,000 tires spread over a three-acre site. Personnel from numerous area fire departments, as well as the U. S. Environmental Protection Agency (EPA) and U. S. Coast Guard, were involved in the containment and suppression effort. In all, 451 responders from 30 separate agencies assisted with the fire over its 22-

day duration. The long duration of this fire was testimony to the difficulty of extinguishing fires of this nature.

Case: *July 30, 1996 – Clare County*
A fire broke out at a scrap tire storage facility located in Redding Township in Clare County. Over the course of the fire, 14 fire departments responded, along with representatives from the EPA and Michigan Department of Environmental Quality (MDEQ). Fortunately, the fire was contained to 250,000 of the 4.2 million tires on the ten-acre site, and was extinguished the following day, some 32 hours after it began.

Case: *April 16, 1997 – Osceola County*
The worst tire fire ever in Michigan occurred in Osceola County. The salvage yard where the blaze started contained over 6 million tires. All of the fire departments in a five county area were contacted. Residents within a three-mile radius were evacuated. The fire was extinguished in about two and one-half days by digging a trench around the perimeter of the fire to prevent its spread, and capping the fire with sand. In all, 478 firefighters from 34 different departments fought the blaze. The final cost of putting the fire out came to approximately $300,000. Over 1.5 million tires, two buildings and some trailers were lost in the fire.

Case: *February 24, 2000 – Mecosta County*
A fire broke out at a tire recycling plant located in Hinton Township in Mecosta County. The fire had started in a pole barn that contained approximately 50,000 shredded tires. Nearby structures that also contained scrap tires were in danger of catching fire as well. Approximately 150 fire personnel from 13 local fire departments fought the blaze. Eventually, sand was brought in by a local contracting firm to smother the flames. Investigators determined that the apparent cause of the fire was a machine that had caught fire earlier and had not been adequately extinguished. The fire had then spread from the machine to the tires.

Case: *June 13, 2003 – Clare County*
A large fire broke out at a scrap tire disposal site in Clare County. It was estimated that 135,000 of the 850,000 tires at the site had caught on fire. The fire response and pollution control efforts would have been much more difficult without the $250,000 in funds awarded to Clare County through the DEQ Scrap Tire Grant Program in 2002. The lanes constructed between the tire piles had bought firefighters enough time to prevent the fire from spreading into the remaining piles. Otherwise, they would have been dealing with a much larger fire. This fire occurred at the same location as the scrap tire fire of 1996, when 250,000 tires were involved.

Case: *July 23, 2008 – Ottawa County*
A scrap yard fire, fueled by 1,000 tires, kept fire departments from Spring Lake Township, Coopersville, Fruitport, Ferrysburg, Ottawa County, Marne and Grand Haven Township busy for several hours and sent thick plumes of black smoke over the area. This fire in Nunica was first reported at around 3:45

pm and was caused by sparks from workers who were cutting off an automobile's catalytic converter. The blaze was confined to roughly a 50-by-50-foot area. Because the nearest hydrant was about 2,000 feet away, water had to be trucked in. In all, 70,000 gallons of water were poured onto the fire before it was brought under control after 90 minutes. No structures were damaged by the fire and no injuries occurred. Because of possible oil contamination from melting tires, the Department of Environmental Quality was notified.

Case: *December 31, 2010 – Muskegon County*
An early morning fire destroyed a Twin Lake tire business on December 31, 2010 with damage estimates over $325,000. The fire started on the west end of a100-by-60 foot pole barn construction building. The building had several tires inside it which provided extra fuel for the fire after it started. City water was not available on the scene so responding fire crews set up water reservoirs at three sites and used tanker trucks to shuttle water in from other areas. A tanker task force involving 10 area fire departments was used to battle the blaze. Assisting Dalton Township were fire departments from the townships of Muskegon, Blue Lake, Holton, Fruitport, and Egelston, along with the North Muskegon and Fremont city departments, the White Lake Fire Authority and Montague Fire District.

Local Structural Scrap Fire Analysis:

With strong zoning and ordinances in all townships, scrap tire piles and junkyards have not been a significant fire and blight concerns. The State Department of Environmental Quality Waste Division has addressed many problems associated with these hazards by providing for grants to clean up Scrap Tire Sites. To date, Newaygo County has received several grants totaling over $85,000 to clean up two sites. There are, however, three known sites within the County which have around a combined total of an estimated 27,000 tires.

HAZARDOUS MATERIALS

Hazardous Material Incidents

Any solid, liquid, or gas that can cause harm to humans and other living organisms due to its being radioactive, flammable, explosive, toxic, corrosive, a biohazard, an oxidizer, an asphyxiant, or capable of causing severe allergic reactions.

Hazard Description

Hazardous materials are highly regulated by the government to reduce risk to the general public, property and the environment. Despite precautions taken to ensure careful handling during the manufacture, transport, storage, use and disposal of these materials, accidental releases are bound to occur. A reportable hazardous material incident is one in which all three of the following conditions apply: 1) a material is present that is suspected to be something other than ordinary combustible by-product material; 2) the material is in such a state, quantity or circumstance that, if left unattended, it is presumed to pose a threat to life, health, property or the environment; and 3) special hazardous material resources were dispatched or used, or should have been dispatched or used, for assessing, mitigating or managing the situation.

The following are specific types of hazardous materials incidents:

Fixed Site:

An uncontrolled release of hazardous materials from a fixed site is capable of posing a risk to health, safety, property and the environment. Hazardous materials are present in quantities of concern in business and industry, agriculture, universities, hospitals, utilities, and other community facilities. Hazardous materials are materials or substances, which, because of their chemical, physical, or biological nature, pose a potential threat to life, health, property and the environment if they are released. Examples of hazardous materials include corrosives, explosives, flammable materials, radioactive materials, poisons, oxidizers, and dangerous gases.

Industrial Accidents

Industrial accidents differ from hazardous material incidents in the scope and magnitude of offsite impacts. An industrial accident is a fire, explosion, or other severe accident (especially if it involves hazardous materials) at an industrial facility that results in serious damage, injury, or loss of life. Whereas hazardous material incidents typically involve an uncontrolled release of material into the surrounding community and environment that may require evacuations or in-place sheltering of the affected population, the impacts from industrial accidents are often confined to the site or facility itself, with minimal physical outside impacts. Nonetheless, industrial accidents, such as fires, explosions, and excessive exposure to hazardous materials, may cause injury or loss of life to workers at the facility, and significant property damage. In addition,

industrial accidents can cause severe economic disruption to the facility and surrounding community, as well as significant long-term impacts on the families of the workers injured or killed.

Transportation Incidents:
An uncontrolled release of hazardous materials that during transport is capable of posing a risk to health, safety, property or the environment. All modes of transportation - highway, railroad, seaway, airway, and pipeline - are carrying thousands of hazardous material shipments on a daily basis through local communities. A transportation accident involving any one of those hazardous material shipments could cause a local emergency affecting many people. The U.S. Department of Transportation regulates the transportation and shipping of over 18,000 different materials. Areas most at risk are within a 1-5 mile radius of a major transportation route along which hazardous material shipments move. All areas in Michigan are potentially vulnerable to a hazardous material transportation incident, although the heavily urbanized and industrialized areas in southern Michigan are particularly vulnerable due to the highly concentrated population, the large number of transportation routes that criss-cross the area, and the large number of hazardous material shipments that occur on a daily basis.

Petroleum and Natural Gas Pipeline Accidents:
Petroleum and Natural Gas Pipeline Accidents are an uncontrolled release of petroleum or natural gas, or the poisonous by-product hydrogen sulfide, from a pipeline. As a major petroleum and natural gas consumer in the United States, vast quantities of petroleum and natural gas are transported through and stored in Michigan. Though often overlooked as a threat because much of the petroleum and gas infrastructure in the state is located underground, petroleum and gas pipelines can leak, erupt or explode, causing property damage, environmental contamination, injuries and loss of life. In addition to these hazards, there is also a danger of hydrogen sulfide release. Hydrogen sulfide is an extremely poisonous gas that is also explosive when mixed with air temperatures of 500 degrees or above. In addition to pipelines, these dangers can be found around oil and gas wells, pipeline terminals, storage facilities, and transportation facilities where the gas or oil has high sulfur content.

Oil and Natural Gas Well Accidents:
Oil and Gas Well Accidents are defined as an uncontrolled release of oil or natural gas, or the poisonous by-product hydrogen sulfide, from production wells. Oil and natural gas are produced from fields across 63 counties in the Lower Peninsula. From 1927 to January 2009, there have been 56,525 oil and natural gas wells drilled in Michigan, of which roughly half have produced oil and gas. To date, Michigan wells have produced over 1.4 billion barrels of crude oil and 6 trillion cubic feet of gas.

In addition to these hazards, many of Michigan's oil and gas wells contain extremely poisonous hydrogen sulfide (H2S) gas. Hydrogen sulfide is a naturally occurring gas mixed with natural gas or dissolved in the oil or brine and released upon exposure to atmospheric conditions. Over 1,300 wells in Michigan have been identified as having H2S levels exceeding 300 parts per million (ppm).

As the table below indicates, at concentrations of 700 ppm, as little as one breath of hydrogen sulfide can kill. Although hydrogen sulfide can be detected by a "rotten egg" odor in concentrations from .03 ppm to 150 ppm, larger concentrations paralyze a person's olfactory nerves so that odor is no longer an indicator of the hazard. Within humans, small concentrations can cause coughing, nausea, severe headaches, irritation of mucous membranes, vertigo, and loss of consciousness. Hydrogen sulfide forms explosive mixtures with air at temperatures of 500 degrees Fahrenheit or above, and is dangerously reactive with powerful oxidizing materials. Hydrogen sulfide can also cause the failure of high-strength steels and other metals. This requires that all company and government responders be familiar not only with emergency procedures for the well site, but also with the kinds of materials that are safe for use in sour gas well response.

Physiological Response to H_2S

10 ppm	Beginning eye irritation
50-100 ppm	Slight conjunctivitis and respiratory tract irritation after 1 hour exposure
100 ppm	Coughing, eye irritation, loss of sense of smell after 2-15 minutes. Altered respiration, pain in the eyes and drowsiness after 15-30 minutes, followed by throat irritation after 1 hour. Several hours of exposure results in gradual increase in severity of these symptoms and death may occur within the next 48 hours.
200-300 ppm	Marked conjunctivitis and respiratory tract irritation after 1 hour of exposure.
500-700 ppm	**Loss of consciousness and possibly death in 30 minutes to 1 hour.**
700-1000 ppm	**Rapid unconsciousness, cessation of respiration, and death.**
1000-2000 ppm	**Immediate unconsciousness, with early cessation of respiration and death following within a few minutes. Death may occur even if the individual is removed to fresh air at once.**

Source: American National Standards Institute, Standard: 237.2-1972

An unplugged abandoned well, also known as an orphan well, can be a hazard to the health and safety of the surrounding people and environment. There are many situations where an unplugged well can become dangerous. For example, a rusted-out casing in a gas well can let natural gas flow underground and accumulate in the basement of a nearby building, possibly causing an explosion. Occasionally, gas leaking from an old well can contaminate a nearby water well. An old well might also be a conduit for salt brine from deeper formations to pollute fresh groundwater, or to discharge at the surface. In some cases, oil leaks from abandoned wells, polluting soil and water. In the vicinity of a coal mine, an old well can be a conduit for explosive gas to enter the mine, a serious

mine safety problem. Also, where coal mining has occurred, an old well can allow acidic mine water to discharge at the surface.

Hazard Analysis

Both fixed site and transport-related hazardous material incidents involve the potential for evacuation (or sheltering in place), with significant problems possible for special populations in hospitals, schools, nursing homes, and other critical facilities. Areas at most risks are within a 1-5 mile radius of identified hazardous material sites. Many communities have detailed plans and procedures in place for responding to incidents at fixed sites, but releases can still cause severe harm to people, property and the environment if proper mitigation actions are not taken in a timely manner.

Certain types of extremely hazardous substances may result in a public health emergency, and a resulting need for triage, mass treatment, and congregate care. In addition to the direct impacts of the hazardous material event itself, transportation incidents may directly affect the transportation infrastructure in the area and cause extensive delays in travel and the conduct of business.

The world's deadliest hazardous material incident occurred on December 4, 1984 in Bhopal, India. A cloud of methyl isocyanate gas, an extremely toxic chemical, escaped from a Union Carbide chemical plant, killing 2,500 people and injuring tens of thousands more. This incident triggered historical Federal legislation intended to minimize such disasters from occurring in the United States.

Though often overlooked, petroleum and natural gas pipelines pose a real threat in many Michigan communities. Petroleum and natural gas pipelines can leak or fracture and cause property damage, environmental contamination, injuries, and even loss of life. The vast majority of pipeline accidents that occur in Michigan are caused by third party damage to the pipeline, often due to construction or some other activity that involves trenching or digging operations. Many structures are located right next to pipelines and thus may be at risk. Pipelines can also cross through rivers, streams, and wetlands, thus posing the possibility of extensive environmental damage in the event of a major failure.

While it is true that the petroleum and natural gas industries have historically had a fine safety record, and that pipelines are by far the safest form of transportation for these products, the threat of fires, explosions, ruptures, and spills nevertheless exists. In addition to these hazards, there is the danger of hydrogen sulfide (H2S) release. These dangers (fully explained in the Oil and Natural Gas Well Accidents section) can be found around oil and gas wells, pipeline terminals, storage facilities, and transportation facilities where the gas or oil has a high sulfur content. Hydrogen sulfide is not only an extremely poisonous gas, but is also explosive when mixed with air at temperatures of 500 degrees Fahrenheit or above.

Hazardous Materials Incidents in Michigan

Michigan has not experienced such a large-scale hazardous material release involving mass casualties as that which occurred in Bhopal, India. This can be attributed, in large part, to the steps taken by government and private industry to carefully regulate those processes and practices that could cause an accidental hazardous material release. Michigan's population density is also lower, and its zoning and planning personnel tend to separate conflicting land uses from each other. Bhopal's 2001 population density was 12,655 persons per square mile, whereas Michigan's highest population density (according to the 2010 census) is the city of Hamtramck, at 10,751 persons per square mile. Bhopal's population was reported as totaling 1.5 million in 2001—Michigan's smaller and more widely spaced urban developments tend to make it less vulnerable to the most severe types of impacts, as do the regulations it currently has in place to oversee the handling of extremely hazardous substances.

Michigan has also been fortunate not to have a large-scale, serious hazardous material transportation incident. However, Michigan has had numerous smaller-scale hazardous material transportation incidents that required a response by local fire departments and hazardous material teams, and many events also required evacuations and other protective actions. Those types of incidents, while problematic for the affected community, are fairly commonplace. They are effectively dealt with by local and state emergency responders and hazardous material response teams. Larger incidents, however, pose a whole new set of problems and concerns for the affected community. Large-scale or serious hazardous material transportation incidents that involve a widespread release of harmful material (or have the potential for such a release) can adversely impact the life safety and/or health and well-being of those in the area surrounding the accident site, as well as those who come in contact with the spill or airborne plume. In addition, damage to property and the environment can be severe as well.

Statistics show that almost all hazardous material transportation incidents are the result of an accident or other human error. Rarely are they caused simply by mechanical failure of the carrying vessel. As a major manufacturer, user, and transporter of hazardous materials, Michigan will always be vulnerable to the threat of a serious hazardous material transportation incident.

However, Michigan has had numerous petroleum or natural gas pipeline accidents in recent years that resulted in injury, loss of life, or significant property damage. Since 1996, the MPSC has investigated over 100 incidents involving pipelines, and at least half of those incidents involved injury, loss of life, or significant property damage. A majority of the state's major natural gas storage facilities are located in the central part of the Lower Peninsula. Natural gas is piped into those storage facilities from Michigan wells, and from large transmission pipelines that originate in Canada, the southwestern United States, and the Gulf of Mexico area.

Michigan is both a major consumer and producer of natural gas and petroleum products. According to the federal Energy Information Administration, Michigan's consumption of petroleum products, particularly liquefied petroleum gases (LPG) is high; Michigan is the largest residential LPG market in the nation, due mostly to high residential and commercial propane consumption. The state has a single petroleum refinery but a large network of product pipelines. More than 78% of the overall home heating market uses natural gas as its primary fuel. With over one-tenth of U.S. capacity, Michigan has the greatest underground natural gas storage capacity in the nation and supplies natural gas to neighboring states during high-demand winter months. Driven largely by the residential sector, Michigan's natural gas consumption is high. Nearly four-fifths of Michigan households use natural gas as their primary energy source for home heating.

Following are brief synopses of the more significant accidents and their impacts as highlighted in the 2012 Michigan Hazard Analysis:

Case: September 7, 1950 Big Rapids (Mecosta County)
A newly installed natural gas pipeline exploded near Big Rapids because of a flaw in the line. Two barns were destroyed and many windows were shaken. The ensuing fire was seen from 50 miles away.

Case: February 22, 1986 Muskegon (Muskegon County)
A Muskegon County pipeline break occurred when an 8-inch high-pressure Marathon Oil pipeline ruptured, spilling thousands of gallons of gas into streams feeding Ruddiman Creek. Gas vapors also caused some minor house explosions that forced dozens of Lakeside-Glenside residents to flee. No one was injured in the incident, although the environment suffered damage.

Case: April 22, 1990 – Egelston Twp. (Muskegon County)
A release of phosphorus oxychloride from a plant created a toxic plume that covered a two-mile area, forcing the evacuation of 1,000 people from two mobile home parks.

Case: December 2006 Mecosta County
In December, 2006 a gas well burst into an explosion in Mecosta County, resulting in the evacuation of several nearby residents. The issue was later resolved, with no additional threat to public safety.

Case: July 26, 2010 Calhoun & Kalamazoo Counties Enbridge Pipeline Disaster
On July 26, 2010, an oil spill was discovered by the owners of an oil pipeline, Enbridge Energy Partners L.P., during a maintenance activity at a pumping station located on the south edge of the City of Marshall. The 30-inch pipeline normally transported 190,000 barrels per day from Griffith, Indiana, to Sarnia, Ontario, and passes through Calhoun County and several other Michigan counties. Oil from the pipeline leaked into the Talmadge Creek and then into the Kalamazoo River and began to flow downstream toward Lake Michigan. Enbridge Energy officials shut down the pipeline pumps and closed valves located upstream and downstream from the leak site to stem the flow of additional oil and try to contain the spill. Based on company estimates, up to 19,500 barrels of crude oil had leaked from the pipeline (approximately 800,000 gallons).

Calhoun County declared a local state of emergency and several downstream communities, including Kalamazoo County, took emergency response actions in coordination with Calhoun County. The State Emergency Operations Center in Lansing was activated and a number of state departments and support organizations convened there to monitor the incident and coordinate state response activities with involved governmental agencies and company officials. Representatives of the U.S. Environmental Protection Agency, U.S. Fish and Wildlife Service, National Transportation Safety Board, U.S. Department of Transportation and other federal agencies quickly convened at the incident site and began working with company, local and state officials (under a Unified Command structure) to develop and implement a spill containment, recovery, and clean-up plan and protection strategy for the environment and affected local residents.

A coordination facility was established in the City of Marshall and contractors where brought in for environmental restoration and product recovery. Aggressive product recovery efforts were instituted to expedite oil containment and environmental clean-up. Wildlife rescue and rehabilitation operations were also implemented to aid in protecting animals and aquatic life from harm, and saving wildlife that had been adversely impacted by the spill. Health advisories were issued to protect the public from harm, and some of the nearby residents were evacuated for a time until the air quality improved within the area. A number of contracted cleanup crews were brought in to perform clean-up and product recovery work.

On September 27, the repaired oil pipeline was restarted by company officials, with the approval of the U.S. Department of Transportation. New oil again flowed through the pipeline, initially at a reduced pressure level but then at full capacity again. Clean-up and product recovery efforts are still ongoing. The unified command center remained operational for an extended period of time, due to the long-term nature of product recovery and environmental clean-up operations.

Hazardous Materials Incidents in Newaygo County

Regardless of their type or classification, it is a fact that every Newaygo County citizen could potentially be affected by a hazardous materials incident, whether they live or work in a rural or urban community. This obviously results in a high level of risk.

Newaygo County's primary vulnerability concern for hazardous materials incidents directly results from the lack of local hazardous materials response capability. Although local emergency services expend great efforts to plan and train in such emergencies to the best of their abilities, the fact remains that there is no quantifiable level of hazardous materials response team within the jurisdiction. Lack of this essential equipment in detection, personal protection, containment, and decontamination, etc. has resulted in the need to call contracted hazmat teams from nearby Counties for response and cleanup, requiring 1 ½ to 2 ½ hour response time.

Although virtually every business, industry, and household contains some levels of hazardous materials, of primary concern in Newaygo County are identified sites that are required to meet regulatory requirements of the Superfund Amendment and Reauthorization Act (SARA) due to their quantity and type of extremely hazardous substances (EHS). Facilities identified by the Michigan Department of Environmental Quality (MDEQ) as containing Extremely Hazardous Substances (EHS) above identified Threshold Planning Quantities (TPQ) are classified as SARAIII 302 sites. Facilities identified by the Michigan Department of Environmental Quality (MDEQ) as containing Extremely Hazardous Substances (EHS) at established reporting quantities are classified as SARAIII 312 sites. Although less than identified SARAIII 302 sites, these facilities still pose a significant level of risk to their communities.

The following facilities have been identified as containing Extremely Hazardous Substances (EHS) at or above established reporting quantities as identified by the Environmental Protection Association (EPA). As such, off-site response plans have been developed and are annually revised by the Emergency Management Department, Emergency Planning Committee, Site Coordinator, and local fire department. These plans are additionally designed to meet Firefighter Right to Know and MIOSHA HAZWOPER requirements.

- KEYSTONE COOPERATIVE formerly known as CERES Solutions (FREMONT)
- GOODWELL COMPRESSOR STATION – ANR (WHITE CLOUD)
- NESTLE GERBER PRODUCTS (FREMONT)
- MAGNA MIRRORS (NEWAYGO)
- AT&T (GRANT)
- AT&T (NEWAYGO)
- AT&T (FREMONT)
- AT&T (WHITE CLOUD)
- FRONTEER COMMUNCATIONS (HESPERIA)

- HARBISON WALKER INTERNATIONAL - NORTH AMERICAN REFACTORIES (WHITE CLOUD)
- WILBUR-ELLIS (GRANT)
- CEDAR VALLEY PACKING (GRANT)- Closed as of July 2024.
- RICE LAKE FARMS (GRANT)

It is unknown how many more businesses and farms throughout the county utilize, store, or transport reportable quantities of Extremely Hazardous Substances (EHS) and who are not reporting under the Community Right-to-Know law, therefore, the above list is not all inclusive.

Naturally, hazardous materials utilized at local fixed sites don't just magically appear and disappear. They simply must arrive and leave the community through some method. As such, regular shipments of hazardous materials travel through Newaygo County on primary and secondary local transportation routes on a regular, daily basis. Primary highways such as M-37, M-20, and M-82 are not only utilized for transportation of shipments to and from local business/industry, but are also heavily utilized for transportation of shipments to statewide and neighboring jurisdiction facilities. Secondary routes, such as local county roads, provide concern, as they are necessary to transport shipments either to or from local businesses to the main highways. Although these routes are secondary roads, many of these are located in populated or vulnerable areas.

In addition, several hazardous materials are shipped through the southwestern portion of the County by Marquette Railway on a daily basis. This includes Calcium Carbonate, Hot Asphalt, and other petroleum products. The line is one of the busiest in the state of Michigan traveling through the Cities of Grant, Newaygo, and White Cloud. The other line is a C&O Railway ending at the City of Fremont in Gerber Products.

Newaygo County also has natural gas and petroleum pipeline infrastructure running through the County. Large compressor stations, pipelines, and other resources make the jurisdiction's pipeline emergencies a concern on a statewide basis. The 200,000 miles of oil pipelines traversing this country represents an estimated $200 to $400 billion investment in an infrastructure that is vital to our economy, safety, and standard of living. The nation's pipelines are a transportation system that enables the safe movement of extraordinary quantities of energy products to industry and consumers, literally fueling our economy and way of life. The arteries of the Nation's energy infrastructure, as well as the safest and least costly ways to transport energy products, our oil and gas pipelines provide the resources needed for national defense, heat and cool our homes, generate power for business and fuel an unparalleled transportation system. The United States has the largest network of energy pipelines – both oil and natural gas -- of any nation in the world. The oil pipeline network alone in the U.S. is more than 10 times larger than that in Europe.



Based on historical occurrences, Newaygo County experiences a hazardous materials incident on average, approximately once every two to three years. The following are hazardous materials incidents which have occurred in Newaygo County:

Case: February 4, 1978 Woodland Park (Newaygo County)
A Dow Chemical train derailed caused a chemical spill of approximately 30,000 gallons of ethylene oxide, carbolic acid, methylene chloride, and phropheline oxide. A total of 50 persons were evacuated from the vicinity of the accident scene. According to the Merrill Township Master Plan, recent tests conducted by 24 Hour News 8 in the area show chemical levels of the potential carcinogen 1,1-DCE (used to make plastics and flame-retardant coatings) to be more than twice the level for safe drinking water and that the chemical has spread to the southwest, toward East Lake. Additional tests conducted by a consultant hired by CSX have found traces of vinyl chloride in East Lake. Vinyl chloride is a known carcinogen and is created when 1,1-DCE breaks down in the environment. The Environmental Protection Agency (EPA) says 1,1-DCE might cause cancer in humans. This chemical can damage the nervous system, liver, and lungs. Unconfirmed anecdotal evidence shows that many people who lived around the train derailment site died of cancer within a few years of the derailment.

The biggest concern for Merrill Township is human exposure through drinking the groundwater. Clean-up efforts on the groundwater were stopped in 1998 after it became apparent that they were not working. Since this time, monitoring wells are showing chemical levels up to 137 times higher than the safe level for drinking. Another investigation several years ago indicated that the contamination had spread uphill and upstream to the north, crossing 11 Mile Road.

Case: June 22, 1979 Newaygo (Newaygo County)
A freight train derailment caused a chlorine leak that eventually sealed itself. A total of 300 persons were evacuated as a precautionary measure.

Case: May 1990, City of Grant (Newaygo County)
In May 1990, the Newaygo County Health Department investigated a complaint of a taste and odor problem associated with a private water supply well in Grant, Michigan. Laboratory results of a sample collected from the well indicated the presence of several volatile organic compounds (VOCs). The presence of contaminants in the well prompted the health department to sample other wells in the area. The sampling results identified over 40 residential wells contaminated with various VOCs. The primary contaminant in the area was determined to be tetrachloroethylene (PCE), a known human carcinogen that is a common solvent often utilized in dry cleaning operations. The results of a limited investigation by the state in 1990 identified a potential source. Further investigation revealed that a garage at the rear of the source property had formerly been used for dry cleaning operations where spent PCE was discharged

to a floor drain for disposal. Sampling confirmed the presence of PCE in soils surrounding and beneath. The DEQ installed and operated a soil vapor extraction (SVE) remediation system from December 1995 to July 1999 and removed over 500 pounds of PCE from the soils to eliminate the direct contact and indoor air inhalation hazards and minimize additional groundwater impacts. In May and October 2017, a return to the site areas for monitoring revealed additional properties affected by the plume. The DEQ installed soil vapor extraction (SVE) remediation systems at those properties also. The operation and maintenance of the mitigation systems, as well as the annual sampling performed to assess the effectiveness of the systems operations, will be performed under the statewide vapor mitigation contract. The need for additional activities to address the vapor intrusion pathway associated with this site will be assessed on a continuous basis to ensure that unacceptable exposure will not occur to potential receptors.

Case: October 21, 2000 Woodland Park (Newaygo County)
A propane explosion on October 21, 2000, demolished a summer home in Woodland Park and killed 4 members of a family, just minutes after they had arrived at the home for a weekend visit. Two other family members survived the blast, which may have originated in the basement of the home.

Case: May 24, 2007 (Wesco Tanker Truck)
A tanker truck carrying 13,000 gallons of gasoline and ethanol turned onto its side while swerving to miss a deer on 80th Street west of Warner Ave. The tanker truck rolled into a ditch spilling gasoline and ethanol contaminating soil and a nearby stream. No one was hurt during the accident or response.





Case: June 5, 2008 (Dart Oil Fire)
Lightning from a Severe Thunderstorm hit a pole nearby the Dart Oil natural gas well located at South Cypress Ave and 96th Street in Ensley Township igniting the tank on fire. Flames leaped 60 feet into the air after the strike, but the oil eventually burned itself out. The tank is used to capture sludge that drips off from a natural gas well.

Case: May 2012 Oil Well Head Leak (Beaver Township)

An oil well head located at approximately 9552 E Filmore Rd, Hesperia MI was found to be leaking crude oil. There was a 12 foot by 15 foot pool of oil around the well head, approximately 80 yards from a creek. The owner and installer of the well is Well Masters out of Rothberg, Michigan. DEQ worked with the EPA and Newaygo County Emergency Services to clean up the spill.

Case: 2000 and 2014 Campbell, Wyatt, and Cannon Pipeline Leak (Bridgeton Township)



In 2000, the DEQ and Grant Fire Department responded to a crude petroleum leak in the Muskegon River near Bell Meadow Subdivision. The leak was coming from a decommissioned 6-8 inch pipe that was once a transmission line owned by Campbell, Wyatt, and Cannon running from near Big Rapids to the Muskegon Refinery. The line crosses the Muskegon River in Section 14 of Bridgeton Township, and is exposed on the bottom of the river. As the pipe is no longer in service, it only contained residual crude oil. In an attempt to stop the leak, the DEQ contracted with Northern A-1 to cap the line and suction off any remaining crude oil.

Case: June 29th 2014

A property owner on Bell Meadow Subdivision contacted Newaygo County Emergency Services reporting an oil leak going into the river. After further investigation, the DEQ believes the leak is residual oil from contaminated ground and is being seeped into the river because of high ground water and deteriorating condition of the transmission line. With the assistance of Grant Fire Department and DNR Officer Ginn, absorbent booms and pads were placed to keep the sheen from spreading. The DEQ is currently working to resolve the leak permanently by removing any contaminated soil in addition to the section of the pipe running along the bottom of the Muskegon River.

Case: July 22, 2018 and October 9 2018

First occurrence- Owner of refrigerated food packing facility called 911 to report a fire in the compressor room and an ammonia leak from the refrigeration system. The hazmat team responded, refrigeration contractor and consumers energy responded. The system was shut down, leak repaired. Second occurrence – a small ammonia leak. Fire responded, and owner contacted engineering contract service. It was repaired. Both unintentional releases no injuries.

Newaygo County Hazardous Materials Incidents - Recent Cases



- April 2021 - PEAS 26199 (9988 Maple Island, Walkerville) Person reported a small creek has a large oil sheen and a noticeable fish kill on it. Spill was resulting from Arbre Farms sewage release which impacted the Pere Marquette River in 3 Counties (Oceana, Mason, and Newaygo).
- April 26, 2021 – PEAS 26211 White River Sewage Spill. Sewer truck crash. 75 yards of roadway covered in waste draining into White River. (Everett Twp)
- August 9 – 10, 2021 - PEAS 27199 (5544 Ferris, Newaygo) Strong chemical smell with foam on the roadway.
- December 14, 2021 4084 E Croton Drive (Brooks Township). Abandoned drums and waste burn pile. Soil sampling took place April 21, 2022, per the request of the Township Zoning Official.
- April 11, 2022 NCR#1333014 Hydraulic Fluid Release in Brohman.
- May 2022 – Brooks Creek and Muskegon River Diesel Spill (City of Newaygo)
- May 17, 2022 – PEAS 24208 Liquid Manure release to ground drain. Semi trailer had a malfunction and had to empty the load causing to run across the road and ditches. Corner of 22 Mile Road and Poplar Ave (Grant Township)
- July 2022 – PEAS 24858 Tanker truck roll over (Ensley Twp)





- August 1, 2022 – PEAS 24955, EPA 1343982VARRATI. Holland Special Delivery Diesel Release from two vehicle accident at 120th Ave and Locust (Ensley Twp)



- April 5, 2023 - PEAS 26529 2500 gallons of liquid nitrogen into storm drain. About 1500 gallons of a 28% solution of anhydrous ammonia was discharged Tuesday evening to the storm sewer at Ceres Solutions in Fremont due to a pump in the secondary containment area accidentally left on, in addition to a leak from a holding tank labelled “Liquid Nitrogen”. Due to heavy rain, the ammonia was not volatized or evaporated, and instead washed to the storm sewer. Chief Hettinger reported seeing no environmental impacts, primarily due to the high volume of rainwater that the area was receiving. The EQLE Water Resources Division (WRD) staff took a pH reading at the site of the discharge, 7.4, and at the mouth of the lake receiving the storm water, 8.0. No dead fish or other impacts were noted. (City of Fremont)
- June 2, 2023 – PEAS 27038 8,000 gallon manure release (transport truck incident) to Brooks Creek on 80th Ave and S Sleeper Ave (Sheridan Charter Township)
- June 2023 to April 1, 2024 – 11442 N Bingham Ave, Bitely DISC0079 55 Gallon Drums (qty 13) abandoned on property containing various hazardous contents. Multiple samplings and field work took place over the course of a 10 month period cleaning up the property (Lilley Township)
- July 8, 2023 PEAS 27381 Plane crashed and is submerged in Hardy Dam Pond. No hazardous fluids to the water were identified. (Big Prairie Township)
- August 1, 2023 – PEAS 27638 S Warner and W 112th Street (Bridgeton Township)
- August 7, 2023 – NRC#1375427, 5 gallon motor oil released onto ground
- May 6, 2024 – PEAS 30044 Overturned Calcium Chloride Tanker into wetland with 3,000 gallons of calcium chloride spilled at 5 Mile road and Maple Island (Denver Township).
- August 20, 2024 – 13 Mile at Walnut Diesel Release (Home Township)
- December 16 – 18, 2024 – 4198 S Osborn ethylene and propylene glycol inspection and sampling (Dayton Township)
- September 9, 2025 – PEAS 34717 Five Gallon buckets filled with unknown liquid near drainage ditch. Suspected to be a type of fuel. Located on 14 Mile Road east of Walnut (Home Township).





Newaygo County Hazardous Materials Incidents Fire Department Response

Township	Fire Dept	2017	2018	2019	2020	2021
Ashland	Station 13 - Grant Fire	1	0	0	0	0
Barton	Big Rapids City Fire	0	0	0	0	0
Beaver	Station 19 - Hesperia Fire Walkerville Fire	1	0	0	0	0
Big Prairie	Station 15 - Big Prairie Fire	7	0	0	0	0
Bridgeton	Station 11 - Fremont Fire Station 13 - Grant Fire	4	0	0	0	0
Brooks	Station - 12 Newaygo Fire	6	1	0	0	0
Croton	Station 14 - Croton Fire	6	0	0	0	0
Dayton	Station 11- Fremont Fire Station 19 - Hesperia Fire	1	1	0	0	0
Denver	Station 19 - Hesperia Fire	0	0	0	0	0
Ensley	Sand Lake Fire	1	1	0	0	0
Everett	Station 18 - White Cloud Fire	0	0	0	0	1
Fremont	Station 11- Fremont Fire	17	4	0	0	0
Garfield	Station 11- Fremont Fire Station 12 - Newaygo Fire	5	0	0	0	0
Goodwell	Station 15 - Big Prairie Fire	1	0	0	0	0
Grant	Station 13 - Grant Fire	2	0	0	0	0
Grant City	Station 13 - Grant Fire	0	0	0	0	0
Home	Station 17 - Lilley Fire	0	0	0	0	0
Lilley	Station 17 - Lilley Fire	2	1	0	0	0
Lincoln	Station 18 - White Cloud Fire	0	0	0	0	0
Merrill	Station 17 - Lilley Fire	1	0	0	0	0
Monroe	Station 17 - Lilley Fire	0	0	0	0	0
Newaygo	Station 12 - Newaygo Fire	2	0	0	0	0
Norwich	Big Rapids City Fire	0	0	0	0	0
Sheridan	Station 11 - Fremont Fire	2	0	0	0	1
Sherman	Station 11 - Fremont Fire Station 18 - White Cloud Fire	5	0	0	0	0
Troy	Station 17 - Lilley Fire	0	0	0	0	0
White Cloud	Station 18 - White Cloud Fire	0	0	0	0	0
Wilcox	Station 18 - White Cloud Fire	4	0	0	0	0

Newaygo County Hazardous Materials Incidents Fire Department Response Continued

Township	Fire Dept	2022	2023	2024	2025	Total
Ashland	Station 13 - Grant Fire	0	0	0	0	**1**
Barton	Big Rapids City Fire	0	0	0	0	**0**
Beaver	Station 19 - Hesperia Fire Walkerville Fire	1	0	0	0	**2**
Big Prairie	Station 15 - Big Prairie Fire	0	0	0	0	**7**
Bridgeton	Station 11 - Fremont Fire Station 13 - Grant Fire	0	0	0	0	**4**
Brooks	Station - 12 Newaygo Fire	0	0	0	0	**7**
Croton	Station 14 - Croton Fire	0	0	0	0	**6**
Dayton	Station 11- Fremont Fire Station 19 - Hesperia Fire	0	0	0	0	**2**
Denver	Station 19 - Hesperia Fire	0	0	1	0	**1**
Ensley	Sand Lake Fire	0	0	0	0	**2**
Everett	Station 18 - White Cloud Fire	0	0	0	0	**1**
Fremont	Station 11- Fremont Fire	0	1	0	0	**22**
Garfield	Station 11- Fremont Fire Station 12 - Newaygo Fire	0	0	0	0	**5**
Goodwell	Station 15 - Big Prairie Fire	0	0	0	0	**1**
Grant	Station 13 - Grant Fire	0	0	0	0	**2**
Grant City	Station 13 - Grant Fire	0	0	0	0	**0**
Home	Station 17 - Lilley Fire	0	0	0	0	**0**
Lilley	Station 17 - Lilley Fire	0	0	0	0	**3**
Lincoln	Station 18 - White Cloud Fire	0	0	0	0	**0**
Merrill	Station 17 - Lilley Fire	0	0	0	0	**1**
Monroe	Station 17 - Lilley Fire	0	0	0	0	**0**
Newaygo	Station 12 - Newaygo Fire	0	1	0	1	**4**
Norwich	Big Rapids City Fire	0	0	0	0	**0**
Sheridan	Station 11 - Fremont Fire	0	0	0	0	**3**
Sherman	Station 11 - Fremont Fire Station 18 - White Cloud Fire	0	0	0	0	**5**
Troy	Station 17 - Lilley Fire	0	0	0	0	**0**
White Cloud	Station 18 - White Cloud Fire	0	0	0	1	**1**
Wilcox	Station 18 - White Cloud Fire	0	0	0	0	**4**

Community Vulnerability

One of the most significant risks to health and safety is exposure, which can cause health effects from minor irritations to severe injuries or illnesses. Evacuations or sheltering in place orders may be necessary to protect the public from exposure to hazardous materials. Additionally, hazardous materials can pose fire or explosion hazards, either alone or in combination with other substances, posing risks of injury or death to responders and nearby individuals. Lastly, hazardous materials released into the environment can contaminate soil, air, and water, which can have long-term effects on human health and the environment.

Both a fixed-site or transportation/rail HAZMAT release can physically damage property, such as structures and vehicles, in the vicinity of the release. Hazardous materials released into the environment can also contaminate buildings and facilities, necessitating decontamination or even demolition in some cases. Lastly, a HAZMAT release can cause damage to critical infrastructure such as bridges, roads, and utility systems, disrupting essential services like water and power, which can impact the ability of residents and businesses to carry out daily activities.

The economic impact of this hazard can vary, especially when including the cost of environmental remediation. According to the U.S. EPA Hazmat Response Team, the costs for responding to a hazmat incident can range from $1,000 to $100,000. In addition, some property damage from this type of event can be expected, especially if the release results in a fire or explosion. Another impact in the form of lost business revenue can result if the incident causes a business to close.

Although major fixed-site hazmat incidents are not common in Newaygo County, there is a potential for such an incident. A significant incident would likely involve response efforts from multiple agencies and departments. The additional impact could result from environmental remediation and restoring public confidence in the environmental health of the County.

Response Resources

Due to the rural nature of Newaygo County, all local fire departments are paid on call. In addition, these departments only have personnel trained and equipped to respond to a hazardous materials release at an Operations Level. This means personnel perform defensive operations without entering the hot zone. This includes the ability to analyze the incident, implement containment and control measures from a distance, perform basic decontamination, assist with evacuations, and use appropriate defensive techniques to protect people and the environment. Newaygo County does not have the capacity nor capability to provide a technician level response (conduct operations within the hot zone). In order to fill the capability gap, Newaygo County has maintained a County to County Mutual Aid Agreement with Muskegon County to provide technical hazardous materials response capability since 2008.

INFRASTRUCTURE FAILURE

Infrastructure Failure

The failure of critical public or private utility infrastructure that results in a temporary loss of essential functions and/or services.

Hazard Description

Public and private utility infrastructure provides essential life supporting services such as electric power, heating and air conditioning, water, sewage disposal and treatment, storm drainage, communications, and transportation. When one or more of these independent, yet inter-related systems fails due to disaster or other cause - even for a short period of time - it can have devastating consequences. For example, when power is lost during periods of extreme heat or cold, people can literally die in their homes. When the water or wastewater treatment systems in a community are inoperable, serious public health problems arise that must be addressed immediately to prevent outbreaks of disease. When storm drainage systems fail due to damage or an overload of capacity, serious flooding can occur.

All of these situations can lead to disastrous public health and safety consequences if immediate actions are not taken. Typically, it is the most vulnerable segments of society - the elderly, children, ill or frail individuals, etc., that are most heavily impacted by an infrastructure failure. If the failure involves more than one system, or is large enough in scope and magnitude, whole communities and even regions can be negatively impacted.

Hazard Analysis

Infrastructure failures can occur at any time and in any place in the state of Michigan and have the potential to affect hundreds of thousands of people. The risk of failure grows each year, as physical and technological infrastructure gets steadily more complex, and the interdependency between various facets of infrastructure (like pipelines, telecommunications lines, and roads) becomes more intertwined. Additionally, more vulnerable and aging infrastructure (rail lines, electrical components, bridges, roads, sewers, etc.) is in need of repair. Because of these reasons, large-scale disruptions in various components of infrastructure are likely. Major disruptions could lead to widespread economic losses, limit security, and altered ways of life.

As the Nation’s public and private utility infrastructure systems continue to age, infrastructure disasters will undoubtedly become more common. Because many of these systems were developed decades ago, the costs of repairing and replacing aging sections and/or components have greatly increased. As a result, many communities cannot afford to do the maintenance work necessary to keep the system in ideal operational mode. Increasing demands on the systems also lead to increased deterioration, and many components have far exceeded their useful service life. This creates a situation of increasing risk from infrastructure-related disasters, either as a primary event, or as a secondary event from floods, windstorms,

snow and ice storms, or other natural or technological hazards. When those disasters do occur, they cause great inconvenience to the affected population and they can also create severe public health and safety concerns.

Infrastructure Failure in Michigan

As the nation's oldest engineering society, representing more than 160,000 civil engineers who serve as stewards of infrastructure here in the U.S. and around the globe, The American Society of Civil Engineers (ASCE) is a leading advocate for infrastructure improvements. As part of this advocacy, every four years since 1998, ASCE has prepared a comprehensive assessment of the nation's major infrastructure systems in its *Report Card for America's Infrastructure*. The Report Card assigns easily understandable letter grades for each category and uses a concise but replicable methodology to analyze all aspects of system performance.

The number of Report Card categories has grown from ten in 1998 to 18 in 2025, offering a more comprehensive and robust appraisal of American infrastructure. Report Card editions have headed new research making it clear that infrastructure is a network of interdependent systems with broad scope. Infrastructure serves people and the Report Card grew based on usage trends: adding Ports as e-commerce boomed, adding Stormwater as development patterns and extreme weather threatened, and including Broadband with 2025 as reliable internet connectivity became essential to American homes and businesses. Simultaneously, ASCE's state Report Card program has grown since 1998, with over 40 state report cards providing an assessment of local infrastructure conditions and trends.

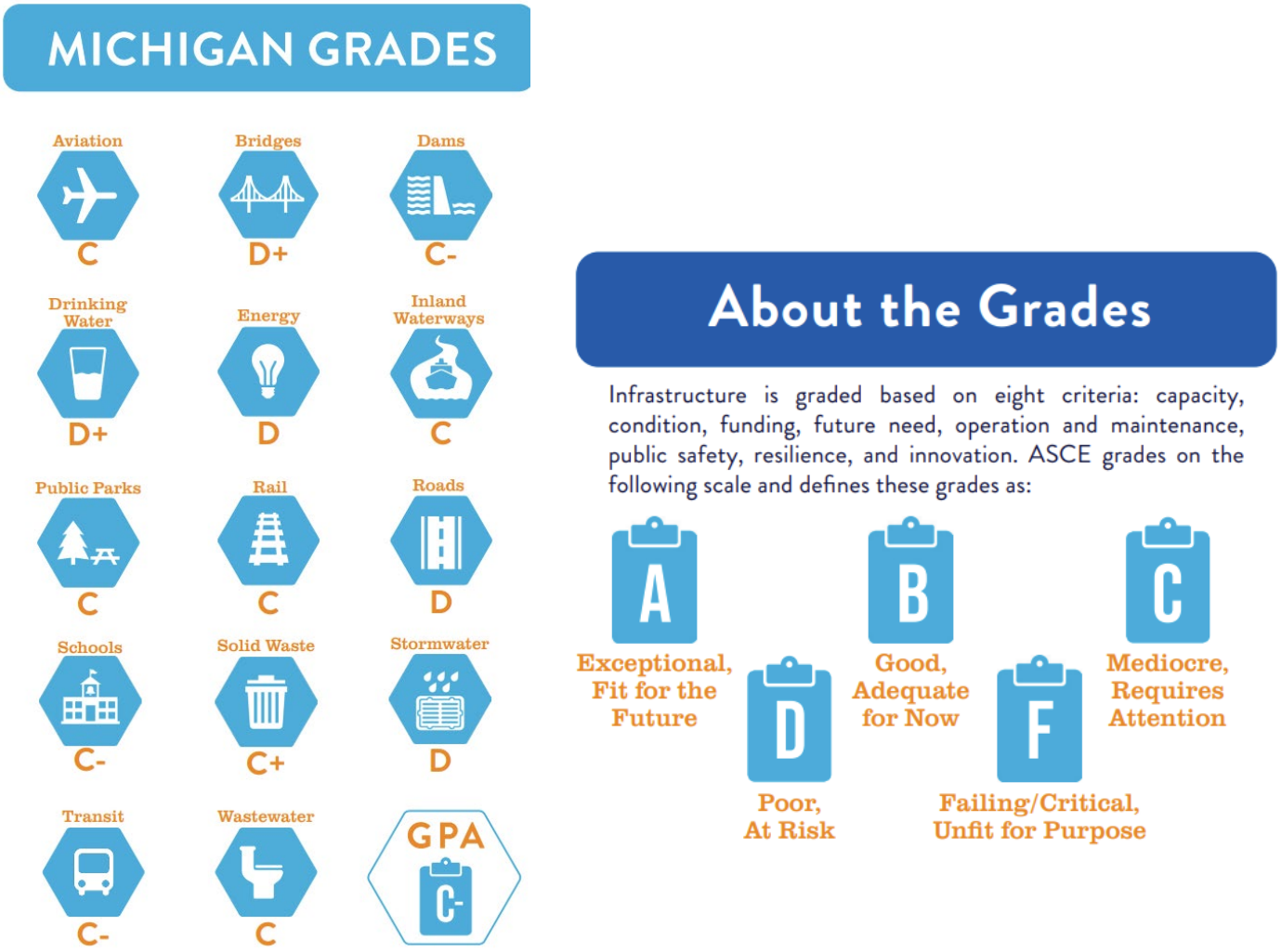
Decision-makers have also adopted many of the policy recommendations in the early editions, making the Report Card a key resource for federal, state, and local policymakers working to improve our vital infrastructure networks. However, some of the first recommendations from the Report Card remain as relevant in 2025 as in 1998, but positive momentum is clear. https://infrastructurereportcard.org/making-the-grade/report-card-history/

The American Society of Civil Engineers 2023 Michigan Infrastructure Report Card had a score of C-. Highlights from the Executive Summary include:

> "Quality infrastructure is necessary for Michigan's economic success, public health, and social prosperity. Our transportation system allows Michiganders to take essential and recreational trips. Water systems deliver drinking water to homes and offices, collect and treat wastewater from growing communities, and convey stormwater from dangerous flooding. Ports and inland waterways provide routes from farm to market. And the state – home to Edison's private residence, the first in America to utilize electricity – relies heavily on the power grid to charge electronics and keep the lights on."
>
> "For too long, Michigan's infrastructure suffered the impacts of chronic underinvestment. Fortunately, progress has been made over the past five years thanks to investments

from the state and federal lawmakers. These included $3.5 billion in bond funding from the "Rebuilding Michigan Program" and $4.7 billion from the "Building Michigan Together" plan. Michigan is also set to to receive $11 billion over the next five years from the 2021 Bipartisan Infrastructure Law for much needed projects in the systems assessed by this report card."

"To sustain recent improvements to Michigan's infrastructure, close investment gaps, and expand system services, decisionmakers must implement sustainable, dedicated, longterm funding solutions, address workforce challenges, and prioritize resilience and reliability. The 2023 Report Card for Michigan's Infrastructure can help residents, elected officials, and decisionmakers easily understand the state of our infrastructure and how to make strategic decisions to continue the forward progress."
https://infrastructurereportcard.org/wp-content/uploads/2024/12/Brochure-2023-MI-IRC-Final-Print.pdf



The ASCE study found a common thread nationwide of an increase in demands on public infrastructure without a corresponding increase in funding to perform the necessary maintenance and repairs on facilities, and to re build aging or dilapidated facilities.

Unfortunately, Michigan has had its share of infrastructure failures, mostly due to the effects of natural disasters such as snow and ice storms, severe cold, windstorms, tornadoes, and floods. Michigan has had numerous widespread and severe electrical power outages, caused mostly by severe weather such as windstorms or ice and sleet storms. In addition, Michigan has had several power outages in recent years that left upwards of 500,000 people (roughly 5% of the State's population) without power for periods lasting from several hours to several days at a time. Fortunately, most of those occurred during months when severe cold temperatures were not a problem. If they had occurred during the cold winter months, there certainly would have been a potential for loss of life – especially among the elderly and other more vulnerable members of society. The following are incidents highlighted in the Michigan Hazard Analysis.

Case: January 1, 2000 Statewide Y2K – Electric Power Infrastructure Failure
The most anticipated electric power failure in the history of humankind never actually occurred. The much-celebrated year 2000 (commonly known as Y2K) computer conversion crisis was considered by many to be the biggest "non-event" ever. Actually, several years of mitigation and preparedness efforts had paid off on the morning of January 1, 2000, when the electric power grid and other critical public utility systems remained operational – stemming fears that there would be widespread power outages, resource shortages, and economic and social chaos. The electrical grid in Michigan and across the country continued to operate on January 1 and beyond, without so much as a hiccup – a testament to the proactive efforts of the electric power industry.

Case: August 2003 Northeastern United States Electrical Blackout
On Aug. 14, 2003, most residents of the northeast United States and Ontario were hit by the largest blackout in North America's history. Electricity was cut to 50 million people, bringing darkness to customers from New York to Michigan. Some essential services remained in operation in most of these areas, although backup generation in some cities was not up to the task. The phone systems remained operational in most areas; however, the increased demand by people phoning home left many circuits overloaded. Water systems in several cities lost pressure, forcing boil-water advisories. Cellular telephones experienced significant service disruptions as their transmission towers were overloaded with a sudden increase in the volume of calls. Television and radio stations mostly remained on the air, with the help of backup generators, or by relaying their broadcasts through the Grimsby transmission towers, which were online throughout the blackout. Most interstate rail transportation in the United States was shut down, and the power outage's impact on international air transportation and financial markets was widespread. Meanwhile, the reliability and vulnerability of all electrical power grids were called into question. Total costs of the blackout have been estimated at between 4 and 10 billion dollars.

Case: Flint Water Crisis – Lead and other contaminants

In 2013 the city changed five-decade practice of piping treated water for its residents from Detroit in favor of a cheaper alternative: temporarily pumping water from the Flint River until a new water pipeline from Lake Huron was built. Although the river water was highly corrosive, Flint officials failed to treat it, and lead leached out from aging pipes into thousands of homes. Soon after residents started complaining that the water from their taps looked, smelled, and tasted foul. Despite protests by residents lugging jugs of discolored water, officials maintained that the water was safe. Water samples collected from 252 homes through a resident-organized effort indicated citywide lead levels had spiked, with nearly 17 percent of samples registering above the federal "action level" of 15 parts per billion (ppb), the level at which corrective action must be taken. More than 40 percent measured above 5 ppb of lead, which the researchers considered an indication of a "very serious" problem.September 2015 a Flint pediatrician, found The incidence of elevated blood-lead levels in children citywide had nearly doubled since 2014—and nearly tripled in certain neighborhoods. In Flint, nearly 9,000 children were supplied lead-contaminated water for 18 months.

The city's switch from Detroit water to the Flint River coincided with an outbreak of Legionnaires' disease (a severe form of pneumonia) that killed 12 and sickened at least 87 people between June 2014 and October 2015. The third-largest outbreak of Legionnaires' disease recorded in U.S. history—as well as the discovery in 2014 of fecal coliform bacteria in city water—was likely a result of the city's failure to maintain sufficient chlorine in its water mains to disinfect the water. Ironically, the city's corrective measure—adding more chlorine without addressing other underlying issues—created a new problem: elevated levels of total trihalomethanes (TTHM), cancer-causing chemicals that are by-products of the chlorination of water.

In early 2016, a coalition of citizens and groups - Concerned Pastors for Social Action, NRDC, and the ACLU of Michigan—sued the city and state officials in order to secure safe drinking water for Flint residents. In November 2016, a federal judge ordered the implementation of door-to-door delivery of bottled water to every home without a properly installed and maintained faucet filter. In March of 2017 aspart of a major settlement, the city was required to replace the city's thousands of lead pipes with funding from the state, and guaranteeing further funding for comprehensive tap water testing, a faucet filter installation and education program, free bottled water through the following summer, and continued health programs to help residents deal with the residual effects of Flint's tainted water.

Modern science shows that even low levels of lead can impair the brain development of fetuses, infants, and young children. The damage can reverberate for a lifetime, reducing IQ and physical growth and contributing to anemia, hearing impairment, cardiovascular disease, and behavioral problems. Large doses of lead exposure in adults has been linked to high blood pressure, heart and kidney disease, and reduced fertility.

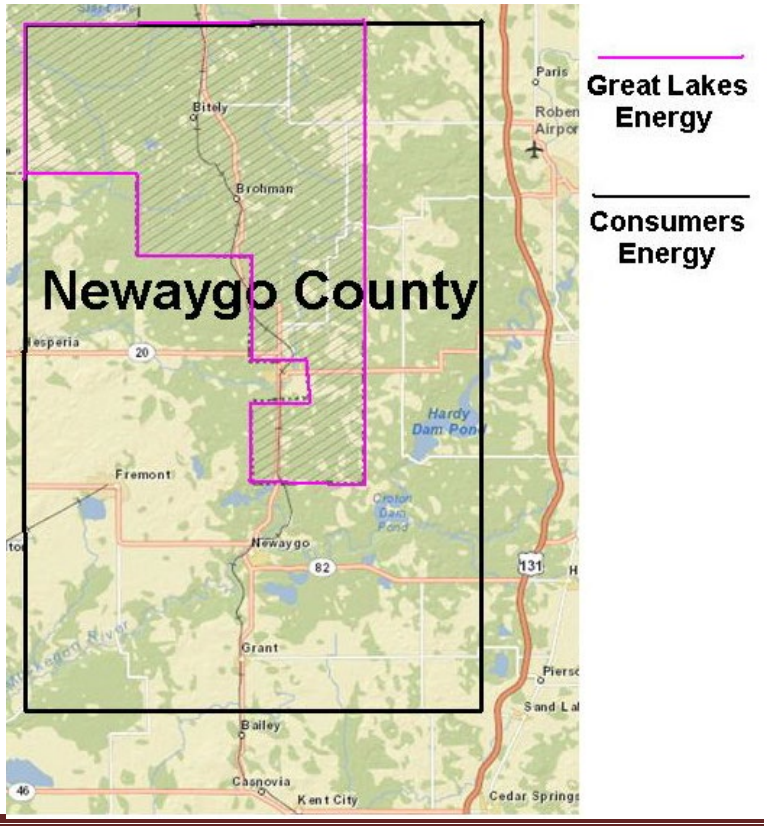
Pure lead pipes, solder, and fittings were banned from U.S. water systems in 1986 (it was only in 2014 that allowable lead levels in plumbing and fixtures dropped to 0.25 percent), and national regulations for lead testing and treatment of public water supplies were established in 1991 with the Lead and Copper Rule. While action by the water utility is required once the level of lead in public water supplies reaches 15 ppb (as measured at the 90th percentile of samples collected), the EPA acknowledges that "there is no safe level of exposure to lead." Independent tests conducted in fall 2015 revealed that nearly 17 percent of samples from hundreds of Flint homes measured above the 15 ppb federal lead action level, with several samples registering above 100 ppb.

Infrastructure Failure in Newaygo County

Due to older utility systems, Newaygo County has historically been affected by localized infrastructure failures of critical electrical, telephone, and public safety communications services. Based on historical occurrence, Newaygo County on average, experiences hundreds of infrastructure failures annually. Despite the majority of these occurrences being brief in nature and of limited effects, they have clearly demonstrated the potential of significant public safety and economic concerns posed by larger magnitude incidents. Primary concern for this hazard focuses on the lack of critical back-up systems to facilitate an effective response to such incidents.

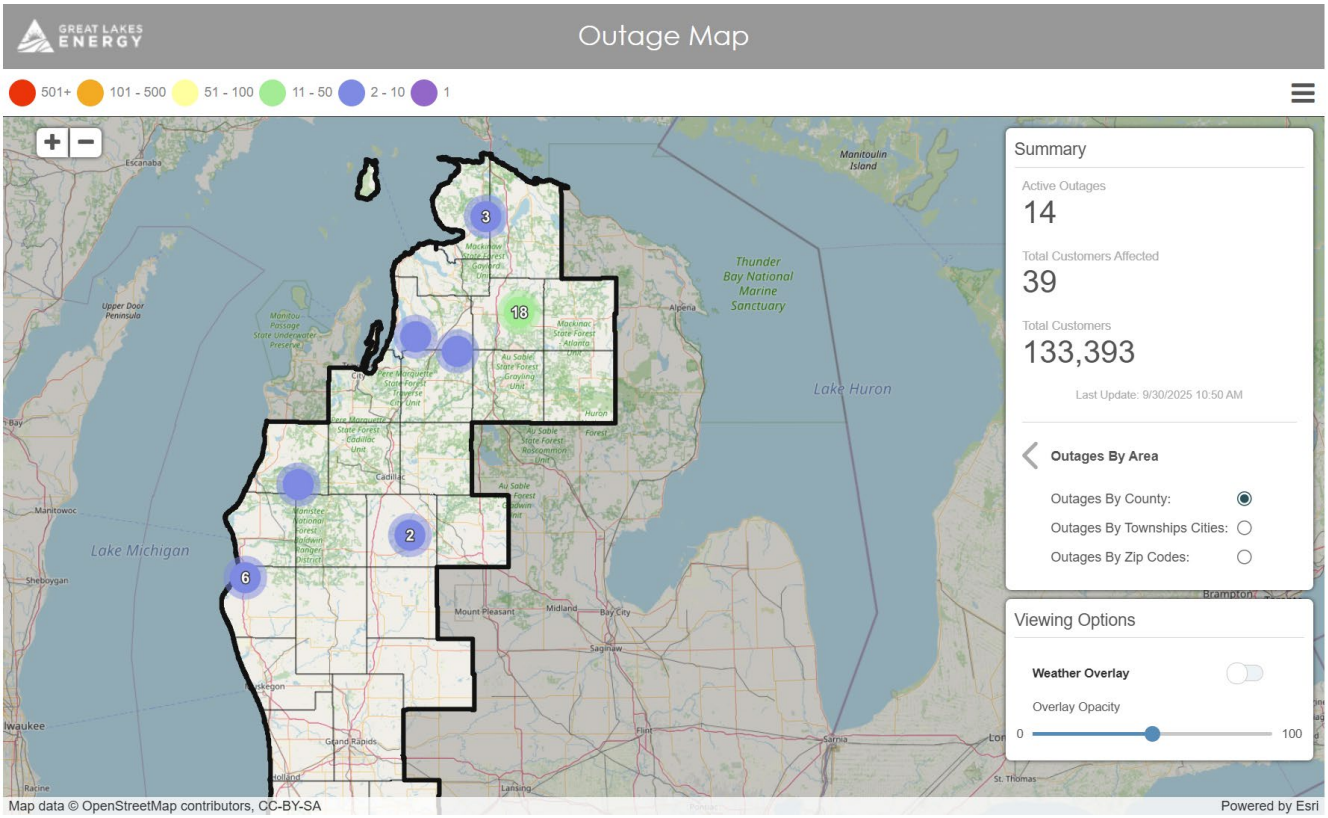
Electrical infrastructure failure is not only a common occurrence in Newaygo County but is also an identified consequence of many other local hazards. This has resulted in intense concerns by emergency management and response officials focused on the lack of generator capability at critical facilities identified as shelters (primarily schools).

Newaygo County is serviced by two private electric companies, Great Lakes Energy and Consumers Energy. These companies own the distribution lines and infrastructure to provide electricity to the public. ITC Transmission is also a private company that owns a majority of the transmission lines and electrical substations within Newaygo County. Great Lakes Energy and Consumers Energy utilize ITC Transmissions' infrastructure to distribute power to end users.

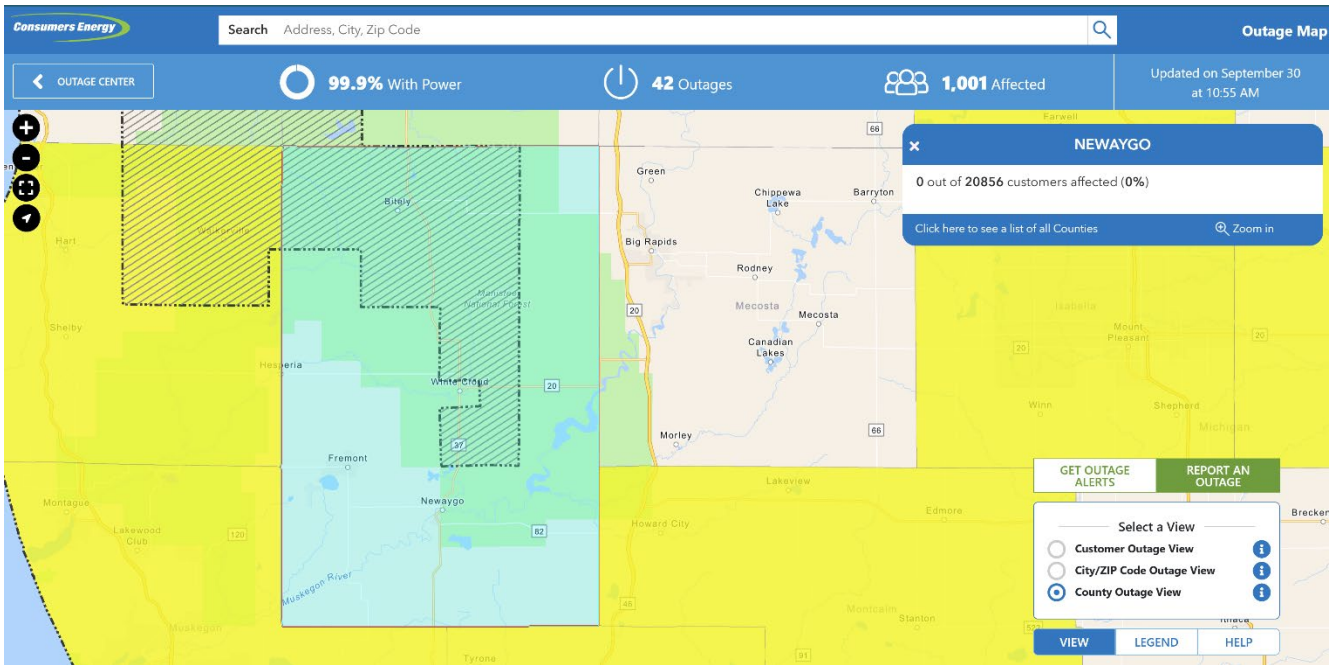


Both Great Lakes Energy and Consumers Energy maintain online outage maps where the public can access information on current outages. Outage information can be sorted by County, by townships and cities, by zip code, or by customer's affected. Additional outage specific information is also available including number of customers affected, estimated restoration time, outage cause, and crew status. .

Great Lakes Energy - https://www.gtlakes.com/power-outages/



Consumers Energy - https://www.consumersenergy.com/outagemap



Newaygo County Outages and Customer Count by Month (Consumers Energy)

Year	Month	# Incidents	# Customers	County Name
2009	January	26	325	NEWAYGO
2009	February	15	344	NEWAYGO
2009	March	43	1,039	NEWAYGO
2009	April	37	545	NEWAYGO
2009	May	35	564	NEWAYGO
2009	June	48	936	NEWAYGO
2009	July	46	304	NEWAYGO
2009	August	107	6,473	NEWAYGO
2009	September	49	1,987	NEWAYGO
2009	October	134	3,851	NEWAYGO
2009	November	27	263	NEWAYGO
2009	December	42	1,889	NEWAYGO
2009 Totals		**609**	**18,520**	
Year	**Month**	**# Incidents**	**# Customers**	**County Name**
2010	January	18	203	NEWAYGO
2010	February	15	4,580	NEWAYGO
2010	March	33	2,028	NEWAYGO
2010	April	42	1,647	NEWAYGO
2010	May	62	2,573	NEWAYGO
2010	June	55	1,930	NEWAYGO
2010	July	81	2,302	NEWAYGO
2010	August	66	1,606	NEWAYGO
2010	September	243	10,344	NEWAYGO
2010	October	185	6,630	NEWAYGO
2010	November	47	5,197	NEWAYGO
2010	December	49	1,174	NEWAYGO
2010 Totals		**896**	**40,214**	
Year	**Month**	**# Incidents**	**# Customers**	**County Name**
2011	January	16	146	NEWAYGO
2011	February	54	5,569	NEWAYGO
2011	March	149	8,522	NEWAYGO
2011	April	64	1,315	NEWAYGO
2011	May	39	1,882	NEWAYGO
2011	June	131	5,670	NEWAYGO
2011	July	261	13,535	NEWAYGO
2011	August	136	6,674	NEWAYGO
2011	September	276	18,904	NEWAYGO
2011	October	49	6,847	NEWAYGO
2011	November	49	2,053	NEWAYGO
2011	December	27	474	NEWAYGO
2011 Totals		**1251**	**71,591**	

Newaygo County Outages and Customer Count by Month (Consumers Energy)

Year	Month	# Incidents	# Customers	County Name
2012	January	43	741	NEWAYGO
2012	February	15	384	NEWAYGO
2012	March	135	7,015	NEWAYGO
2012	April	63	3,907	NEWAYGO
2012	May	118	3,125	NEWAYGO
2012	June	62	1,831	NEWAYGO
2012	July	293	13,521	NEWAYGO
2012	August	50	4,010	NEWAYGO
2012	September	63	304	NEWAYGO
2012	October	55	1,311	NEWAYGO
2012	November	20	1,217	NEWAYGO
2012	December	39	2,752	NEWAYGO
2012 Totals		**956**	**40,118**	
Year	**Month**	**# Incidents**	**# Customers**	**County Name**
2013	January	73	5,950	NEWAYGO
2013	February	17	175	NEWAYGO
2013	March	14	91	NEWAYGO
2013	April	77	4,488	NEWAYGO
2013	May	68	9,786	NEWAYGO
2013	June	45	929	NEWAYGO
2013	July	67	1,936	NEWAYGO
2013	August	70	1,556	NEWAYGO
2013	September	43	602	NEWAYGO
2013	October	60	1,259	NEWAYGO
2013	November	152	4,179	NEWAYGO
2013	December	38	332	NEWAYGO
2013 Totals		**724**	**31,283**	
Year	**Month**	**# Incidents**	**# Customers**	**County Name**
2014	January	53	7,609	NEWAYGO
2014	February	30	1,516	NEWAYGO
2014	March	23	1,298	NEWAYGO
2014	April	213	7,785	NEWAYGO
2014	May	77	816	NEWAYGO
2014	June	119	1,575	NEWAYGO
2014	July	44	1,033	NEWAYGO
2014	August	43	645	NEWAYGO

Consumers Energy is no longer able to provide the data as listed above. However, the Michigan Public Service Commission began reporting large utility outages for the State of Michigan in 2019 at: https://www.michigan.gov/mpsc/consumer/electricity/customer-outage-history

2019 Utility Outages		
Start Date of Event	**Utility**	**Total Outages**
2/6/2019	CE	250,000
2/7/2019	DTE	34,238
2/12/2019	DTE	43,103
2/24/2019	I&M	7,650
2/24/2019	DTE	128,513
5/23/2019	DTE	50,080
6/1/2019	DTE	40,440
6/2/2019	CE	53,430
6/28/2019	DTE	186,158
7/2/2019	DTE	118,077
7/19/2019	DTE	402,457
7/19/2019	CE	231,684
7/26/2019	DTE	97,178
8/18/2019	DTE	41,059
8/26/2019	DTE	40,849
9/11/2019	DTE	59,069
9/13/2019	DTE	28,886
9/12/2019	CE	80,815
10/21/2019	CE	50,319
10/21/2019	I&M	12,000
10/27/2019	DTE	44,480
11/27/2019	DTE	74,388
12/30/2019	CE	40,328
12/30/2019	DTE	30,883

2020 Utility Outages		
Start Date of Event	**Utility**	**Total Outages**
1/12/2020	DTE	35,717
1/12/2020	CE	41,383
3/29/2020	DTE	31,287
5/18/2020	CE	32,519
6/3/2020	DTE	30,384
6/9/2020	CE	304,638
6/9/2020	DTE	187,824
6/9/2020	UPPCO	3,077
6/9/2020	I&M	3,293
6/23/2020	DTE	34,978
6/26/2020	DTE	51,598
7/7/2020	DTE	143,875
7/19/2020	DTE	184,726
8/2/2020	DTE	41,510
8/11/2020	I&M	22,811
8/27/2020	DTE	48,785
8/30/2020	CE	51,687
10/23/2020	DTE	38,762
11/2/2020	CE	50,155
11/2/2020	DTE	47,311
11/14/2020	DTE	203,919
11/18/2020	CE	95,895
12/12/2020	CE	53,031

2021 Utility Outages		
Start Date of Event	**Utility**	**Total Outages**
6/22/2021	CE	57,433
6/21/2021	DTE	131,000
6/27/2021	CE	20,000
7/1/2021	DTE	237,000
6/27/2021	I&M	3,000
7/12/2021	DTE	213,000
7/24/2021	DTE	151,000
7/24/2021	CE	20,000
7/25/2021	CE	30,000
7/26/2021	NSP/XCEL	7,149
7/29/2021	CE	9,000
8/9/2021	DTE	498,346
8/10/2021	DTE	700,000
8/10/2021	CE	372,000
8/10/2021	I&M	20,000
8/24/2021	CE	26,318
8/24/2021	DTE	59,565
8/27/2021	DTE	47,329
8/29/2021	DTE	28,662
9/7/2021	CE	78,000
9/7/2021	DTE	80,000
12/11/2021	CE	150,000
12/11/2021	DTE	160,000
12/11/2021	I&M	200
12/15/2021	CE	142,000
12/15/2021	DTE	12,400
12/15/2021	UPPCO	5,261

2022 Utility Outages		
Start Date of Event	**Utility**	**Total Outages**
3/22/2022	UMERC	6,000
3/23/2022	UPPCO	3,700
3/31/2022	CE	44,000
3/31/2022	DTE	50,000
4/14/2022	CE	62,983
5/9/2022	UMERC	6,008
5/9/2022	UPPCO	5,000
5/20/2022	CE	28,000
6/6/2022	NSP/XCEL	3,199
6/13/2022	I&M	10,200
6/15/2022	CE	67,000
6/21/2022	NSP/XCEL	709
7/23/2022	CE	94,000
8/4/2022	CE	84,000
8/4/2022	DTE	40,000
8/4/2022	I&M	2,000
8/29/2022	CE	197,000
8/29/2022	DTE	265,000
11/5/2022	CE	146,239
11/5/2022	DTE	36,093

2023 Utility Outages		
Start Date of Event	**Utility**	**Cumulative Outages**
12/19/2023	CE	27,100
12/9/2023	CE	55,608
10/31/2023	CE	58,118
8/24/2023	CE	280,925
8/23/2023	DTE	462,108
8/15/2023	I&M	9,000
7/29/2023	CE	22,916
7/26/2023	CE	57,304
7/26/2023	DTE	364,968
7/26/2023	UMERC	7,500
7/20/2023	CE	38,131
7/20/2023	DTE	177,427
6/25/2023	CE	47,166
6/29/2023	CE	24,459
6/25/2023	DTE	161,244
5/1/2023	UMERC	7,513
5/1/2023	UPPCO	23,359
4/5/2023	CE	27,116
4/1/2023	CE	10,247
3/25/2023	DTE	56,808
2/22/2023	DTE	866,257
2/22/2023	CE	484,557
2/15/2023	DTE	41,506
2/15/2023	CE	33,372

2024 Utility Outages		
Start Date of Event	**Utility**	**Cumulative Outages**
8/27/2024	DTE	378,232
8/27/2024	CE	217,820
8/27/2024	I&M	7,650
7/15/2024	I&M	11,000
7/9/2024	CE	44,968
6/25/2024	CE	185,497
6/19/2024	DTE	125,128
6/16/2024	CE	87,334
6/5/2024	DTE	71,603
5/20/2024	CE	34,988
4/12/2024	CE	93,060
2/28/2024	CE	45,704
1/12/2024	DTE	190,235
1/9/2024	CE	293,020
*Initial Report - Will Be Updated With Final Numbers		

2025 Utility Outages

Start Date of Event	Utility	Total Outages
2/6/2025	CE	31,597
3/15/2025	CE	98,226
3/29/2025	Alpena	16,774
3/29/2025*	Cloverland	10,137
3/29/2025	CE	380,064
3/29/2025*	Great Lakes Energy	43,900
3/29/2025	I&M	26,173
3/29/2025*	Presque Isle	31,655
3/29/2025	UMERC	23,746
3/29/2025*	Midwest	9,300
3/29/2025	DTE	84,711
4/29/2025	CE	52,788
5/15/2025	CE	321,747
5/15/2025*	I&M	33,000
5/15/2025	UMERC	2,680
6/18/2025*	DTE	38,837
6/18/2025	CE	25,723
6/19/2025	CE	46,104
6/21/2025	UMERC	2,011
6/25/2025	DTE	88,038
7/24/2025*	CE	58,638

* Initial Report - Will be updated with final numbers

The next U-21122 filings are due November 15, 2025

Community Vulnerability:

Several public health and safety impacts can result from electrical system failure. One impact is the increased risk of fire hazards. Electrical system failures can lead to electrical fires that can threaten life, property, and the environment. Additionally, electrical system failures can create hazardous conditions that can result in electrocution, electric shock, and other injuries. Finally, electrical system failures can disrupt critical services such as hospitals, emergency response services, and water and wastewater treatment facilities. This can lead to serious public health and safety consequences, especially during emergencies.

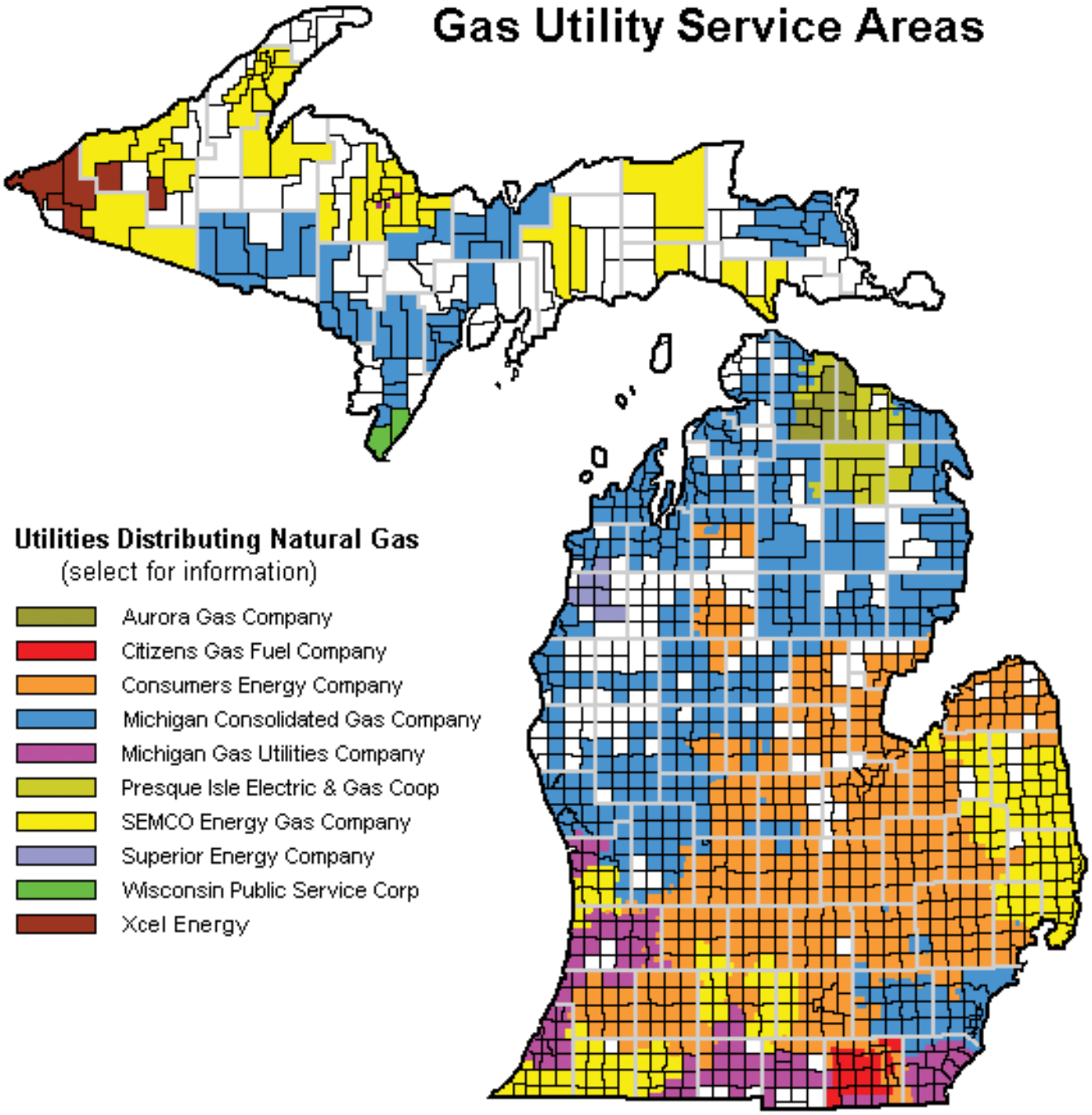
In addition to health and safety, there are several different vulnerabilities and impacts from electrical failures, including damaged equipment such as appliances, electronics, and machinery, resulting in costly repairs or replacements. Another impact is structural damage, where electrical system failures can cause structural damage to buildings, bridges, and other infrastructure, posing safety risks and requiring significant repair costs. Electrical system failures can also disrupt transportation systems, including traffic lights, train signals, and airport systems, leading to accidents and congestion. Lastly, they can impact utilities such as power grids, water systems, and gas pipelines, resulting in outages and other issues.

Electricity is a vital component to operating businesses and county services. Information regarding the economic impact of electrical outages is not available. It is anticipated that an outage can be extremely costly, depending on the number of affected customers and duration of the event.

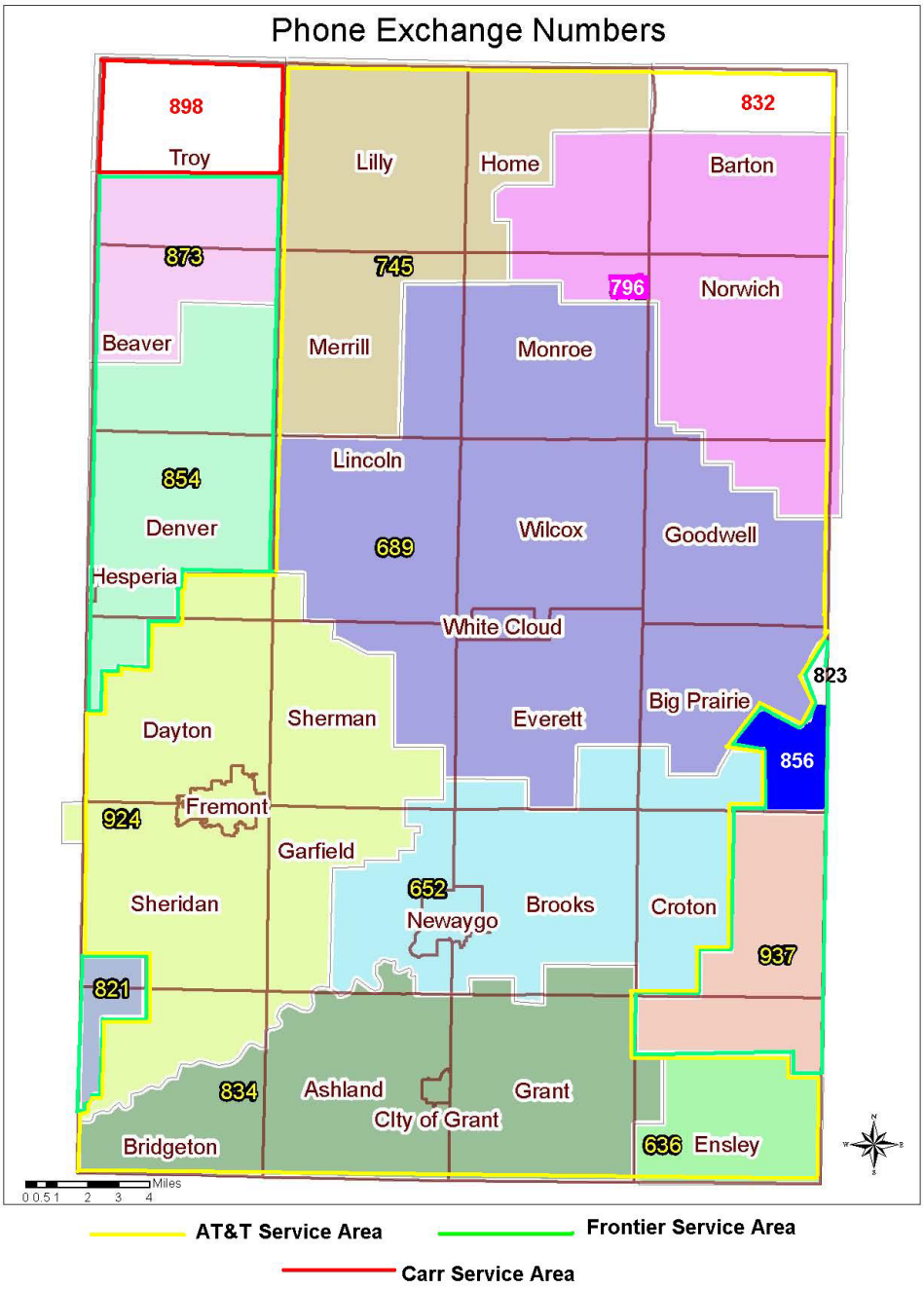
Newaygo County – FEMA Hazards National Risk Index – Social Vulnerability
Relatively Moderate Score (49.97)
https://hazards.fema.gov/nri/map



As many areas within Newaygo County are rural in nature, a majority of the homes are heated using propane or wood. Residences in these areas rely on local distributors to provide them services. In more populated areas of Newaygo County, Michigan Consolidated Gas Company (MichCON) is the natural gas distributor servicing the area.



Local telephone service within Newaygo County is provided by three private companies, AT&T, Frontier Communications, and CAAR. Although many residences are choosing to no longer maintain local telephone service and are reliant on cell phones, most of the vulnerable populations still maintain landline communications. During a telephone outage or power outage, it becomes increasingly difficult to alert and notify the public of emergencies and hazards within their area. This requires local emergency officials to utilize more direct and labor intensive warning and public information mechanisms such as door-to-door notification.



Being rural in nature, many residences within Newaygo County rely on privately owned well and septic systems for water and waste water. However, there are six municipal water and waste water systems within Newaygo County maintained by city or local authority boards. The City of Fremont maintains 3 water towers and 8 well houses as a part of their Water Supply and Treatment to the City of Fremont. The City of Grant and the City of Newaygo both maintain a single water tower and treatment facility. The City of White Cloud maintains three wells and two water towers. The Sherman Twp/White Cloud Sewer Authority manages the 1.1 million gallon per year waste water treatment facility just west of the City of White Cloud. The Chain of Lakes also maintains a Sewer Authority serving portions of Everett, Brooks, and Garfield Townships around Sylvan, Emerald, Pickerel, and Kimball Lakes.

It is rare to have a water or sewer interruption, however, in the spring of 2014, both the City of White Cloud and the City of Newaygo experienced water main breaks due to extreme winter weather causing a disruption in service to both communities.



Water Quality in Newaygo County

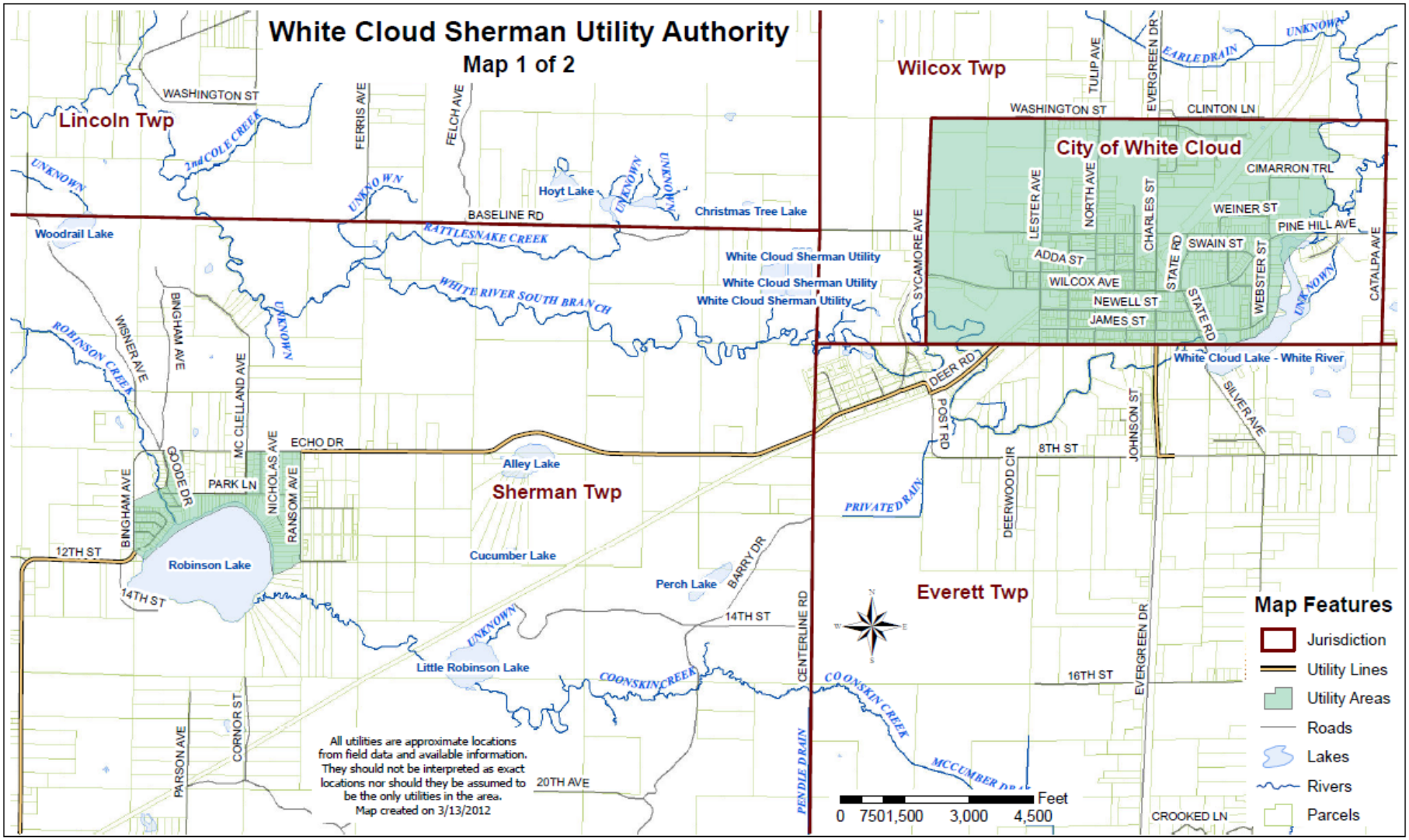
Changes to the Michigan Safe Drinking Water Act were approved in 2018. The rule now requires:

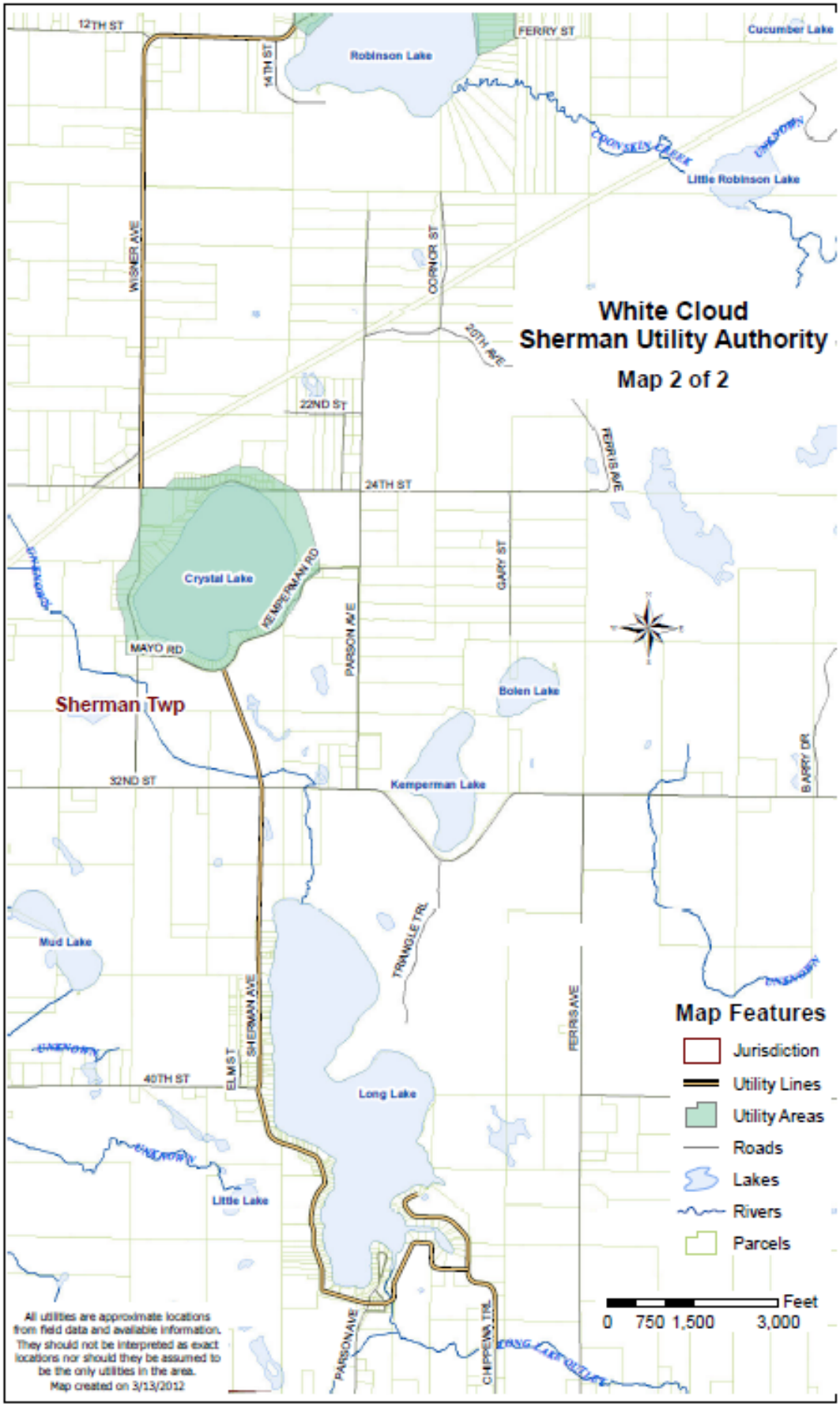
- The removal of all lead service lines in Michigan. Water supplies are required to replace an average of 5 percent of their lead services line every year for the next 20 years unless an alternative schedule is approved by EGLE.
- Communities locate and prioritize lead service lines for removal.
- The Action Level for lead in drinking water be lowered from the current level of 15 parts per billion (ppb) to 12 ppb on January 1, 2025.
- The banning of partial lead service line replacements.
- Complete service line material inventories be submitted to EGLE by January 1, 2025.

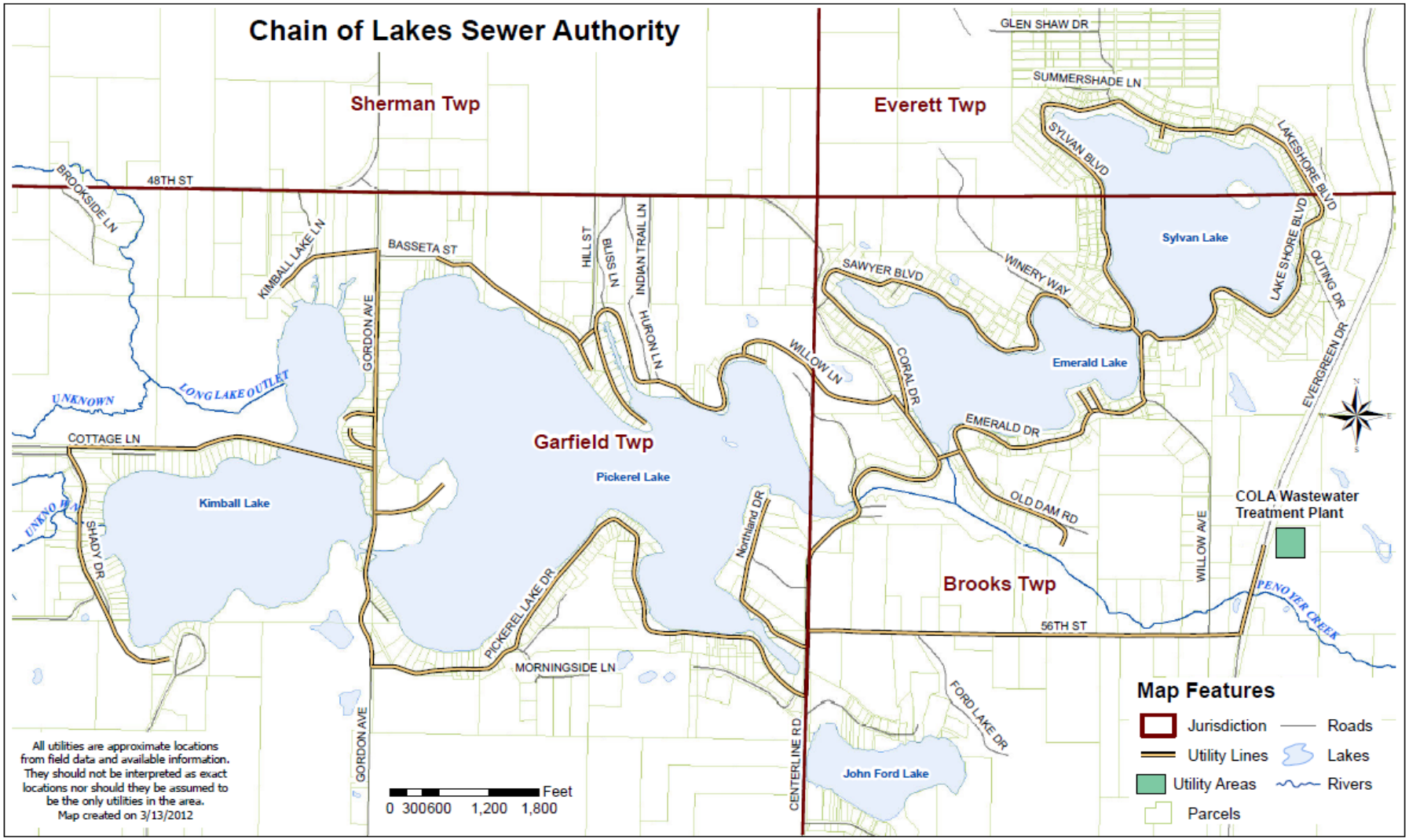
The testing changes also now require that lead sampling must be taken from both the first liter and fifth liter water draw. By testing that fifth liter of water, it shows lead results that might be farther upstream in the water supply that is coming into homes.

Public Water Supply ID	System Name	County	Population	Last Monitoring Period End	Lead 90th Percentile (ppb)	Includes 5th liter?	Sampling Next Due (subject to change)
MI0002490	FREMONT	NEWAYGO	4,081	2018-12-31	2	N	2020-09-30
MI0002823	GRANT	NEWAYGO	894	2019-12-31	2	N	2022-09-30
MI0003130	HESPERIA	NEWAYGO	954	2017-12-31	2	N	2020-09-30
MI0004710	NEWAYGO	NEWAYGO	1,976	2018-12-31	5	N	2021-09-30
MI0007060	WHITE CLOUD	NEWAYGO	1,408	2018-12-31	4	N	2021-09-30
MI0040368	LAKE FOREST PARK	NEWAYGO	185	2017-12-31	0	N	2020-09-30
MI0040369	FOUR SEASONS TRAILER PARK	NEWAYGO	140	2017-12-31	1	N	2020-09-30
MI0040370	HESS LAKE RV AND MOBILE HOME PARK	NEWAYGO	160	2018-12-31	0	N	2021-09-30
MI0040587	EVERGREEN VILLAGE MH PARK	NEWAYGO	248	2017-12-31	2	N	2020-09-30

Public Water Supply ID	System Name	County	Population	Last Monitoring Period End	Lead 90th Percentile (ppb)	Includes 5th liter?	Sampling Next Due (subject to change)
MI0002490	FREMONT	NEWAYGO	4,516	2023-12-31	1	N	2026-09-30
MI0002823	GRANT	NEWAYGO	894	2022-12-31	2	N	2025-09-30
MI0003130	HESPERIA	NEWAYGO	954	2023-12-31	4	N	2026-09-30
MI0004710	NEWAYGO	NEWAYGO	2,571	2024-12-31	3	N	2027-09-30
MI0007060	WHITE CLOUD	NEWAYGO	1,408	2022-12-31	2	Y	2025-09-30
MI0040368	LAKE FOREST PARK	NEWAYGO	185	2023-12-31	2	N	2026-09-30
MI0040369	HARDY PARK	NEWAYGO	140	2023-12-31	1	N	2026-09-30
MI0040370	HESS LAKE RV AND MOBILE HOME PARK	NEWAYGO	160	2025-06-30	0	N	2025-12-31
MI0040587	HESPERIA MHP LLC	NEWAYGO	248	2023-12-31	2	N	2026-09-30


White Cloud Sherman Utility Authority
Map 1 of 2
Lincoln Twp
Wilcox Twp
Sherman Twp
Everett Twp
City of White Cloud
WASHINGTON ST
BASELINE RD
ECHO DR
DEER RD
8TH ST
12TH ST
14TH ST
16TH ST
20TH AVE
CROOKED LN
CLINTON LN
CIMARRON TRL
WEINER ST
PINE HILL AVE
SWAIN ST
ADDA ST
WILCOX AVE
NEWELL ST
JAMES ST
PARK LN
GOODE DR
Woodrail Lake
Hoyt Lake
Christmas Tree Lake
Alley Lake
Cucumber Lake
Perch Lake
Robinson Lake
Little Robinson Lake
White Cloud Lake - White River
2nd COLE CREEK
RATTLESNAKE CREEK
WHITE RIVER SOUTH BRANCH
ROBINSON CREEK
COONSKIN CREEK
EARLE DRAIN
PRIVATE DRAIN
PENDLE DRAIN
MCCUMBER DR
UNKNOWN
White Cloud Sherman Utility
White Cloud Sherman Utility
White Cloud Sherman Utility
FERRIS AVE
FELCH AVE
SYCAMORE AVE
LESTER AVE
NORTH AVE
CHARLES ST
STATE RD
WEBSTER ST
CATALPA AVE
TULIP AVE
EVERGREEN DR
POST RD
JOHNSON ST
SILVER AVE
DEERWOOD CIR
BARRY DR
CENTERLINE RD
WISNER AVE
BINGHAM AVE
MC CLELLAND AVE
NICHOLAS AVE
RANSOM AVE
CORNOR ST
PARSON AVE
All utilities are approximate locations from field data and available information. They should not be interpreted as exact locations nor should they be assumed to be the only utilities in the area.
Map created on 3/13/2012
Feet
0 7501,500 3,000 4,500
Map Features
Jurisdiction
Utility Lines
Utility Areas
Roads
Lakes
Rivers
Parcels


White Cloud
Sherman Utility Authority
Map 2 of 2
Sherman Twp
12TH ST
14TH ST
FERRY ST
Cucumber Lake
Robinson Lake
Little Robinson Lake
WISNER AVE
CORNOR ST
20TH AVE
22ND ST
24TH ST
FERRIS AVE
GARY ST
Crystal Lake
KEMPERMAN RD
PARSON AVE
MAYO RD
Bolen Lake
32ND ST
Kemperman Lake
BARRY DR
TRIANGLE TRL
Mud Lake
SHERMAN AVE
ELM ST
40TH ST
Long Lake
Little Lake
PARSON AVE
CHIPPEWA TRL
Map Features
Jurisdiction
Utility Lines
Utility Areas
Roads
Lakes
Rivers
Parcels
Feet
0 750 1,500 3,000
All utilities are approximate locations from field data and available information. They should not be interpreted as exact locations nor should they be assumed to be the only utilities in the area.
Map created on 3/13/2012


Chain of Lakes Sewer Authority
Sherman Twp
Everett Twp
Garfield Twp
Brooks Twp
48TH ST
BROOKSIDE LN
KIMBALL LAKE LN
BASSETA ST
GORDON AVE
HILL ST
BLISS LN
INDIAN TRAIL LN
HURON LN
GLEN SHAW DR
SUMMERSHADE LN
SYLVAN BLVD
LAKESHORE BLVD
Sylvan Lake
LAKE SHORE BLVD
OUTING DR
EVERGREEN DR
SAWYER BLVD
WINERY WAY
WILLOW LN
CORAL DR
Emerald Lake
EMERALD DR
OLD DAM RD
UNKNOWN
LONG LAKE OUTLET
COTTAGE LN
Kimball Lake
SHADY DR
Pickerel Lake
Northland DR
PICKERELL LAKE DR
MORNINGSIDE LN
COLA Wastewater Treatment Plant
WILLOW AVE
PENOYER CREEK
56TH ST
FORD LAKE DR
CENTERLINE RD
John Ford Lake
All utilities are approximate locations from field data and available information. They should not be interpreted as exact locations nor should they be assumed to be the only utilities in the area.
Map created on 3/13/2012
Feet
0 300600 1,200 1,800
Map Features
Jurisdiction
Roads
Utility Lines
Lakes
Utility Areas
Rivers
Parcels

TRANSPORTATION ACCIDENTS / MASS CASUALTY INCIDENTS

Transportation Mass Casualty Accidents

A crash or accident involving an air, land, or water-based commercial passenger carrier causing a situation that stresses the emergency medical services resources and health care system.

Hazard Description and Analysis

A mass casualty incident (MCI) is any event, natural or man-made, where the number and severity of casualties overwhelm local emergency medical services and healthcare resources, requiring external assistance to manage the patient surge and restore normal community function. This inability to cope with the demand for health care due to insufficient personnel, equipment, or facilities is the defining characteristic of an MCI. Transportation accidents are the most common hazard to cause a mass casualty incident.

According to the Bureau of Transportation Statistics 2024 Transportation Statistics Annual Report, in 2023, the US transportation system served 335 million US residents residing in 145 million households, including people who may not own a vehicle or rarely travel, plus millions of foreign visitors. Transportation is used to commute to work, obtain goods and services, visit with family and friends, and travel for leisure and work. It also drives the economy, connecting 8.3 million business establishments with customers, supplies, and workers.

Table 1-1 Public Roads, Streets, and Bridges: 2010 and 2018–2022

Road/street/bridge	2010	2018	2019	2020	2021	2022
Public road and street mileage by functional type (miles)	4,067,076	4,176,915	4,171,125	4,172,562	4,187,440	4,197,446
Interstate	46,900	48,440	48,481	48,472	48,519	48,605
Other freeway and expressways	14,619	18,603	18,631	18,656	18,712	18,804
Other principal arterial	157,194	156,614	156,680	157,210	157,398	157,844
Minor arterial	242,815	246,214	246,831	246,539	246,303	246,314
Collectors	799,226	814,585	815,118	819,025	820,343	821,283
Local	2,806,322	2,892,459	2,885,384	2,882,660	2,896,165	2,904,596
TOTAL lane-miles	**8,582,261**	**8,794,569**	**8,785,398**	**8,790,746**	**8,823,515**	**8,844,304**
TOTAL bridges	**604,460**	**616,096**	**617,084**	**618,456**	**619,622**	**620,669**
TOTAL registered vehicles	**250,070,048**	**273,602,100**	**276,491,174**	**275,936,367**	**282,214,578**	**283,400,986**
Vehicle-miles of travel (millions)	2,967,266	3,240,327	3,261,772	2,903,622	3,132,411	3,196,191

Source: U.S. Department of Transportation (USDOT), Federal Highway Administration (FHWA), Highway Statistics (multiple years), as cited in the USDOT. Bureau of Transportation Statistics (BTS). National Transportation Statistics (NTS). Tables 1-5, 1-6, 1-11, 1-28, and 1-35. Available at http://www.bts.gov/ as of October 2024.

Note: Lane-miles are the centerline length in miles multiplied by the number of lanes.

In the United States, transportation is facilitated by road, air, rail, and waterways. According to the Bureau of Transportation Statistics, 78.18% of passenger mode of transportation to work is by passenger vehicles including cars, trucks, vans, and motorcycles while 7.98% was

handled by public transportation, taxicab, and other means. 8.99% of people carpooled with 2 or more persons in the car.

Table 2-2 Mode of Transportation to Work Change: 2019 and 2021–2023

	2019 (prepandemic)		2021 (first pandemic year)		2022 (second pandemic year)		2023 (postpandemic year)		Change from 2019 to 2023
Mode	Commutes	Share (%)	Commutes	Share (%)	Commutes	Share (%)	Commutes	Share (%)	
TOTAL	**156,941,346**	**100.00**	**154,314,179**	**100.00**	**160,577,736**	**100.00**	**162,434,675**	**100.00**	**5,493,329**
Worked from home	8,970,800	5.72	27,568,098	17.86	24,381,732	15.18	22,486,510	13.84	13,515,710
Car, truck, or van	133,054,328	84.78	116,668,475	75.60	124,126,435	77.30	126,985,709	78.18	−6,068,619
Drove alone	119,153,349	75.92	104,650,121	67.82	110,245,368	68.66	112,376,082	69.18	−6,777,267
Carpooled	13,900,979	8.86	12,018,354	7.79	13,881,067	8.64	14,609,627	8.99	708,648
In 2-person carpool	10,469,892	6.67	9,050,049	5.86	10,240,427	6.38	10,696,703	6.59	226,811
In 3-person carpool	1,982,471	1.26	1,776,397	1.15	2,173,594	1.35	2,325,425	1.43	342,954
In 4-or-more-person carpool	1,448,616	0.92	1,191,908	0.77	1,467,046	0.91	1,587,499	0.98	138,883
Public transportation	7,778,444	4.96	3,793,329	2.46	5,013,135	3.12	5,735,258	3.53	−2,043,186
Bus	3,601,403	2.29	1,971,235	1.28	2,401,748	1.50	2,636,607	1.62	−964,796
Subway or elevated rail	2,935,633	1.87	1,400,185	0.91	1,952,645	1.22	2,242,806	1.38	−692,827
Long-distance train or commuter rail	921,391	0.59	294,566	0.19	466,508	0.29	626,481	0.39	−294,910
Light rail, streetcar, or trolley	242,776	0.15	82,915	0.05	129,309	0.08	155,455	0.10	−87,321
Ferryboat	77,241	0.05	44,428	0.03	62,925	0.04	73,909	0.05	−3,332
Taxicab	385,756	0.25	296,457	0.19	382,417	0.24	405,531	0.25	19,775
Motorcycle	221,923	0.14	166,676	0.11	217,325	0.14	215,105	0.13	−6,818
Bicycle	805,722	0.51	616,153	0.40	731,272	0.46	761,757	0.47	−43,965
Walked	4,153,050	2.65	3,399,405	2.20	3,855,075	2.40	3,966,159	2.44	−186,891
Other means	1,571,323	1.00	1,805,586	1.17	1,870,345	1.16	1,878,646	1.16	307,323

Source: U.S. Department of Commerce, Census Bureau, 2019, 2021-2023 American Community Survey, Table B08301, available at https://data.census.gov/cedsci/ as of November 2024.
Note: The ACS was not conducted in 2020.

Transportation incidents across the United States for all modes claimed 44,546 lives in 2022, of which all byt 2,032 involved highway motor vehicles. In 2022, 38 percent of speeding drivers in fatal crashes were alcohol-impaired compared to just 18 percent of nonspeeding drivers. Fatal crashes for speeding passenger vehicles not wearing seat belts were 52 percent, whereas only 22 percent for the nonspeeding passenger vehicle drivers. NHTSA data also suggested that these risky behaviors may be abating somewhat as the pandemic recedes.

- More than 7,500 pedestrians died in traffic incidents in 2022, which is the most since 1980.
- Transportation injuries in 2022 fell by about 120,000 to 2.4 million, with nearly all (i.e., 99.6 percent) involving highway motor vehicles.

- In 2022, 891 people died in work zones, down from 961 in 2021, a 15-year high.

Among the more than 2,000 deaths in nonhighway modes in 2023:

- Railroad deaths were just under 1,000 (998) and the highest number since 1998, with trespasser deaths at 718, the highest since at least 1975.
- Boating deaths jumped in the first year of the pandemic but have fallen in each subsequent year to 564 in 2023.
- There were no deaths from crashes on large commercial airlines in 2023, but several hundred deaths occurred in crashes in general aviation, commuter air, and air taxi services.

The following are specific types of transportation accidents and background according to the US Transportation Statistics 2024 Annual Report:

Roadway Transportation Accidents

Highway, motor vehicles are involved in more than 94% of US transportation fatalities and about 99% of the people injured in transportation crashes and incidents. A major roadway transportation accident has the potential to create a local emergency event, or to seriously strain or overwhelm local response and medical services. It would involve a commercial passenger bus, a local public transit bus, a school bus or a church van. Although these modes of transportation have good safety records, an accident has a high potential of creating numerous injuries and shutting down portions of major roadways for an extended period of time.

Railway Transportation Accidents

Railroad-related fatalities (including grade crossing and trespasser deaths) were just under 1,000 in 2023, the highest number since 1998. The increase reflects a 28 percent increase in trespasser deaths from 2022. As with transit, most fatalities associated with railroad operations occur outside the train and mostly include people struck by trains while on track rights-of-way (called “trespassers” in railroad reporting parlance) or people in motor vehicles struck at highway rail-grade crossings. Very few train passengers or crew members die in train accidents in most years. Of the people who died in railroad-related accidents in 2023, FRA attributes about 26 percent of the fatalities to passenger train operations

Air Transportation Accidents

Air transportation fatalities totaled 358 in 2022, with all but 19 of those fatalities involving general aviation, such as recreational flying. In most years, general aviation deaths greatly exceed those in commercial aviation (which includes large freight and passenger air carriers, commuter air services carrying 10 or fewer passengers, and air taxis). In recent years, there have been very few fatal crashes on large U.S. commercial passenger carriers. However, there have been numerous close calls, such as runway

incursions, hull breaches, equipment failures and near misses involving commercial carriers as well as other aircraft.
Almost any accident occurring during flight results in multiple fatalities of passengers, fire, and issues with protection of evidence.

Waterway Transportation Accidents

Fatalities in water transportation, both commercial and recreational boating (also called boating below), totaled 715 in 2021 and 686 in 2022. Many boating fatalities occur on calm, protected waters; in light winds; or with good visibility. Alcohol use, operator distraction, failure to wear life jackets, and lack of operator training continue to play key roles in fatal recreational boating accidents.

As for commercial waterborne transportation, such as excursion boats, freighters, and fishing vessels, there were 86 vessel-related fatalities in 2020, which was a decrease from 94 in 2019. This number continued to decrease to 57 in 2021 and 50 in 2022.8 Large vessels in collisions can inflict damage to other vessels and to on-land facilities, resulting in property damage and fatalities or injuries. Over the years, there have been many vessels colliding with bridges, most notably in the March 2024 collapse of the Francis Scott Key Bridge in Baltimore Harbor due to a container ship striking a bridge pier. Six maintenance workers on the bridge drowned as a result of the collision, and another worker was critically injured.

Table 5-1 Transportation Fatalities by Mode: 2016–2023

Category	Mode	2016	2017	2018	2019	2020	2021	2022	2023	Change from 2022 to 2023
Fatalities	**TOTAL**	**39,753**	**39,364**	**38,755**	**38,424**	**41,038**	**45,250**	**44,546**	—	—
	Air	413	347	396	454	355	373	358	—	—
	Highway	37,806	37,473	36,835	36,355	39,007	43,230	42,514	40,990*	↓
	Railroad[1]	631	677	661	723	632	724	760	876	↑
	Transit rail[2]	150	151	174	173	176	197	223	210	↓
	Water	737	709	682	707	853	715	686	—	—
	Pipeline	16	6	7	11	15	11	5	15	↑
Other counts, redundant with modal counts	U.S. air carrier[3]	0	0	1	4	0	0	1	—	—
	On-demand air taxi and commuter carrier	27	16	16	34	26	27	18	—	—
	General aviation	386	331	379	416	329	346	339	—	—
	Railroad, trespasser deaths not at highway–rail crossing	468	505	499	533	504	578	605	718	↑
	Railroad, killed at public crossing with motor vehicle	130	140	132	129	94	128	146	122	↓
	Rail, passenger operations	254	307	254	262	188	200	280	272	↓
	Rail, freight operations	507	510	539	589	539	647	626	726	↑
	Transit, nonrail	109	98	86	95	113	124	117	117	→
	Recreational boating	701	658	633	613	767	658	636	564	↓
	Commercial waterborne	36	51	49	94	86	57	50	—	—

Source: Various sources as cited by the U.S. Department of Transportation, Bureau of Transportation Statistics, National Transportation Statistics, table 2-1, available at www.bts.gov as of August 2024. Highway-2023: U.S. Department of Transportation, National Highway Traffic Safety Administration, Early Estimate of Motor Vehicle Traffic Fatalities in 2023, DOT HS 813 561, availabe at https://crashstats.nhtsa.dot.gov as of August 2024.

Michigan Hazard Analysis

The one commonality all transportation accidents share, whether air, land, or water-based, is that they can result in mass casualties. Air transportation accidents, in particular, can result in tremendous numbers of deaths and injuries, and major victim identification and crash scene management problems. Water transportation accidents, on the other hand, may require a significant underwater rescue and recovery effort that few local jurisdictions may be equipped or trained to handle.

Roadway Transportation Accidents

The Michigan State Police Criminal Justice Information Center provides Traffic Crash statics that have occurred in Michigan. Utilizing the Michigan Trash Crash Analysis Tool Website, users can query crash locations, view dashboards, create visualizations, and more.

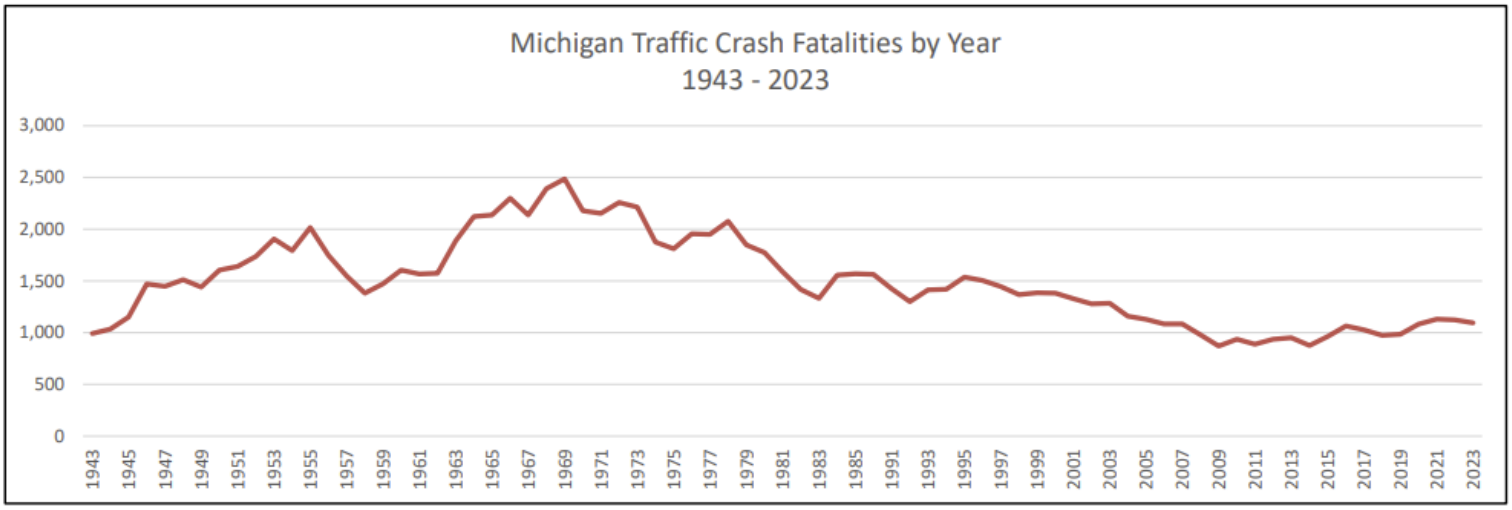
MICHIGAN STATE POLICE
CRIMINAL JUSTICE INFORMATION CENTER
TCRU TRAFFIC CRASH REPORTING UNIT

MICHIGAN TRAFFIC CRASH DECADE AT-A-GLANCE

	2023	2022	2021	2020	2019	2018	2017	2016	2015	2014
Total Crashes	287,953	293,341	282,640	245,432	314,377	312,798	314,921	312,172	297,023	298,699
Total Injuries	71,085	70,281	71,246	60,986	74,963	75,838	78,394	79,724	74,157	71,378
Total A Injuries	5,816	5,782	5,979	5,433	5,629	5,586	6,084	5,634	4,865	4,909
Total Fatalities	1,095	1,123	1,131	1,083	985	974	1,028	1,064	963	876
Fatal Crashes	1,021	1,053	1,068	1,010	902	905	937	980	893	806
Fatality Rate per 100m VMT**		1.2	1.2	1.3	1.0	1.0	1.0	1.1	1.0	0.9
Fatal Crash Rate per 100m VMT**		1.1	1.1	1.2	0.9	0.9	0.9	1.0	0.9	0.8
Fatality Restraint Use*	49.7%	47.8%	45.3%	43.2%	51.7%	54.7%	53.0%	52.3%	52.5%	50.7%
Alcohol/Drug Involved Fatal Crashes	404	420	475	422	378	394	421	378	346	291
% of Alcohol/Drug Involved Fatal Crashes to Total Fatal Crashes	39.6%	39.9%	44.5%	41.8%	41.9%	43.5%	44.9%	38.6%	38.7%	36.1%
Alcohol/Drug Involved Fatalities	445	454	505	453	419	434	470	412	384	319
% of Alcohol/Drug Involved Fatalities to Total Fatalities	40.6%	40.4%	44.7%	41.8%	42.5%	44.6%	45.7%	38.7%	39.9%	36.4%
Alcohol Involved Fatal Crashes	272	301	336	303	266	287	320	251	271	222
Alcohol Involved Fatalities	297	322	357	326	295	315	359	271	303	236
Drug Involved Fatal Crashes	230	229	259	250	214	220	221	213	159	131
Drug Involved Fatalities	256	249	275	267	237	247	246	236	179	150
OUIL Arrests *(all agencies)*	26,408	26,707	27,506	25,820	30,626	31,856	32,474	32,610	33,720	35,060
Registered Vehicles *(Millions)*	9.79	9.39	9.54	9.00	9.10	8.43	8.48	8.38	8.26	8.19
MVMT *(Billions)***		96.7	96.7	86.3	102.1	102.3	101.7	99	98.1	98.1
Population *(Millions)*	10.03	10.12	10.05	9.99	9.99	9.99	9.96	9.93	9.92	9.9

*Restraint use by deceased occupants of motor vehicles equipped with safety belts.
**The current year VMT will be updated after it is published later in the summer.

Date Created: 5/3/2024
For questions, please contact the Traffic Crash Reporting Unit at 517-241-1699.



2023

School bus-related crashes include situations where the school bus was involved or other units crashed due to the presence and influence of a school bus.

There were 988 school bus-related crashes, five of which resulted in fatalities.

Of the 988 school bus-related crashes, 352 (35.6%) took place between 6:00-8:59 AM and 371 (37.6%) occurred between 3:00-5:59 PM. The remaining 265 (26.8%) crashes occurred during other times of the day.

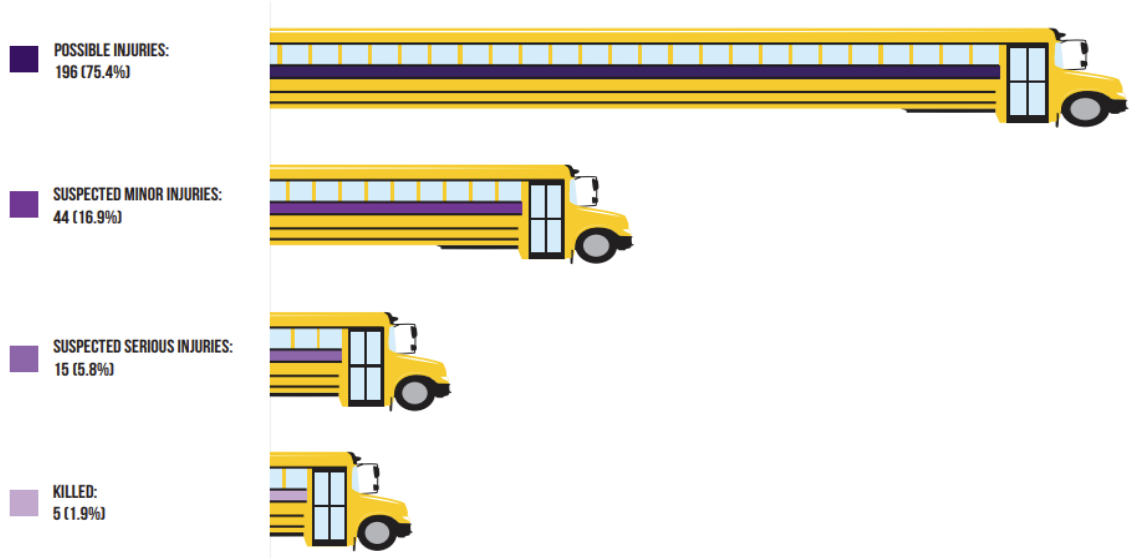
Of the 988 school bus-related crashes, 395 (40.0%) occurred at an intersection.

There were 1,717 people involved and no people killed on school buses.

Two people on a school bus received suspected serious injuries, three people received suspected minor injuries, and 59 people received possible injuries.

There were eight pedestrians and six bicyclists involved in school bus-related crashes.

INJURY SEVERITY IN CRASHES WHERE SCHOOL BUSES WERE INVOLVED

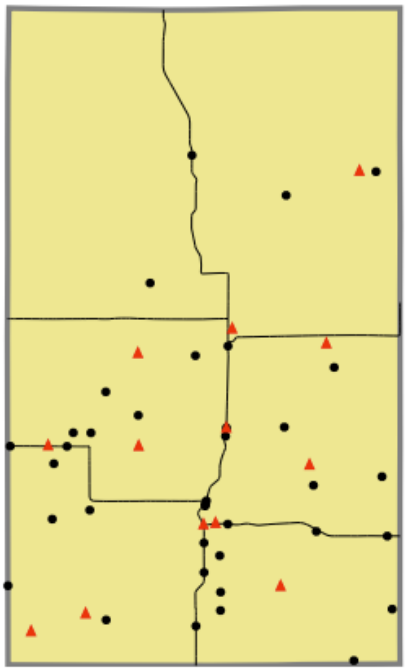


https://publications.michigantrafficcrashfacts.org/2023/2023SchoolBuses.pdf

Roadway Transportation Accidents in Newaygo County

As Newaygo County is not an urban population center, located near a major transportation route or airport, or located near a marine passenger ferry service, the probability of a transportation accident involving an air, land, or water-based commercial passenger carrier is limited. However, Newaygo County does have five public school systems operating transportation services for students, two municipal airports, a freight train railway system, and four state highways (M-20, M-120, M-37, and M-82) within the jurisdiction increasing the risk of a localized transportation accident. Based on historical occurrence, Newaygo County, on average experience approximately 2 – 3 transportation accidents causing a mass casualty incident annually.

In 2024 the Michigan Office of Highway Safety Planning produced a 2020 – 2024 5 Year Traffic Crash Data Trends report, which can be located here: https://www.michigantrafficcrashfacts.org/doc/county-profiles/newaygo The crashes in this report occurred on public roadways in Michigan and resulted in injuries, fatalities, or property damage (with $1,000 as a reporting threshold). The information was gathered from Michigan Traffic Crash Report Forms (UD-10) submitted by local police departments, sheriff's offices, and the Michigan State Police. Other related information was obtained from the departments of Transportation, State, and Community Health. Based on this report, the following information was highlighted:



Crashes by most severe injury (mapped/actual)
▲ K - Fatal (13/13)
● A - Suspected Serious (38/38)

2024 - Crashes and Injury by Month

Month	Crashes				People	
	Total	Fatal	Injury	Property Damage Only (PDO)	Fatalities	Injuries
January	142	0	13	129	0	19
February	106	0	16	90	0	21
March	73	1	3	69	1	9
April	99	1	18	80	1	26
May	106	4	17	85	4	25
June	114	1	23	90	2	30
July	116	2	21	93	2	26
August	80	2	13	65	2	23
September	117	0	12	105	0	17
October	182	0	16	166	0	22
November	204	0	22	182	0	30
December	197	2	20	175	2	33
Total	**1,536**	**13**	**194**	**1,329**	**14**	**281**

2024 - Reported Motor Vehicle Crashes by Municipality

Municipality	Crashes												
	Total	Fatal	Injury	Property Damage	Inter-State	US Route	State Route	Local Street	Alcohol-Involved	Drug-Involved	Deer-Involved	Pedestrian-Involved	Bicyclist-Involved
Ashland Twp.	105	0	15	90	0	0	36	69	1	0	53	0	0
Barton Twp.	31	0	1	30	0	0	0	31	0	0	26	0	0
Beaver Twp.	23	0	4	19	0	0	0	23	1	1	13	0	0
Big Prairie Twp.	45	1	9	35	0	0	0	45	5	1	15	0	1
Bridgeton Twp.	80	2	14	64	0	0	0	80	4	1	41	0	0
Brooks Twp.	63	1	7	55	0	0	26	37	1	0	27	0	0
Croton Twp.	86	1	7	78	0	0	26	60	6	1	42	0	0
Dayton Twp.	99	0	9	90	0	0	28	70	1	0	67	0	0
Denver Twp.	72	0	5	67	0	0	32	40	1	0	51	0	0
Ensley Twp.	50	0	6	44	0	0	0	50	3	0	26	0	0
Everett Twp.	73	1	14	58	0	0	25	48	3	0	22	0	1
Fremont	103	0	22	81	0	0	74	28	4	0	4	0	2
Garfield Twp.	72	0	8	64	0	0	40	32	0	0	43	0	0
Goodwell Twp.	29	0	0	29	0	0	16	13	3	0	22	0	0
Grant	14	0	0	14	0	0	8	6	0	0	0	0	0
Grant Twp.	80	1	13	66	0	0	15	65	6	2	45	0	0
Hesperia	6	0	0	6	0	0	5	1	0	0	0	0	0
Home Twp.	11	0	1	10	0	0	0	11	0	0	6	0	0
Lilley Twp.	21	0	1	20	0	0	11	10	0	0	10	0	0
Lincoln Twp.	35	0	2	33	0	0	18	17	1	1	22	0	0
Merrill Twp.	23	0	4	19	0	0	13	10	0	0	14	0	0
Monroe Twp.	14	0	2	12	0	0	0	14	2	0	7	0	0
Newaygo	94	1	13	80	0	0	70	24	3	1	8	0	1
Norwich Twp.	19	1	3	15	0	0	0	19	1	2	10	0	0
Sheridan Twp.	165	1	18	146	0	0	74	91	3	3	72	0	1
Sherman Twp.	76	2	6	68	0	0	0	76	4	1	46	1	0
Troy Twp.	11	0	2	9	0	0	0	11	0	0	6	0	0
White Cloud	20	1	5	14	0	0	13	7	1	1	4	0	0
Wilcox Twp.	16	0	3	13	0	0	8	8	0	0	8	0	0
Total	**1,536**	**13**	**194**	**1,329**	**0**	**0**	**538**	**996**	**54**	**15**	**710**	**1**	**6**

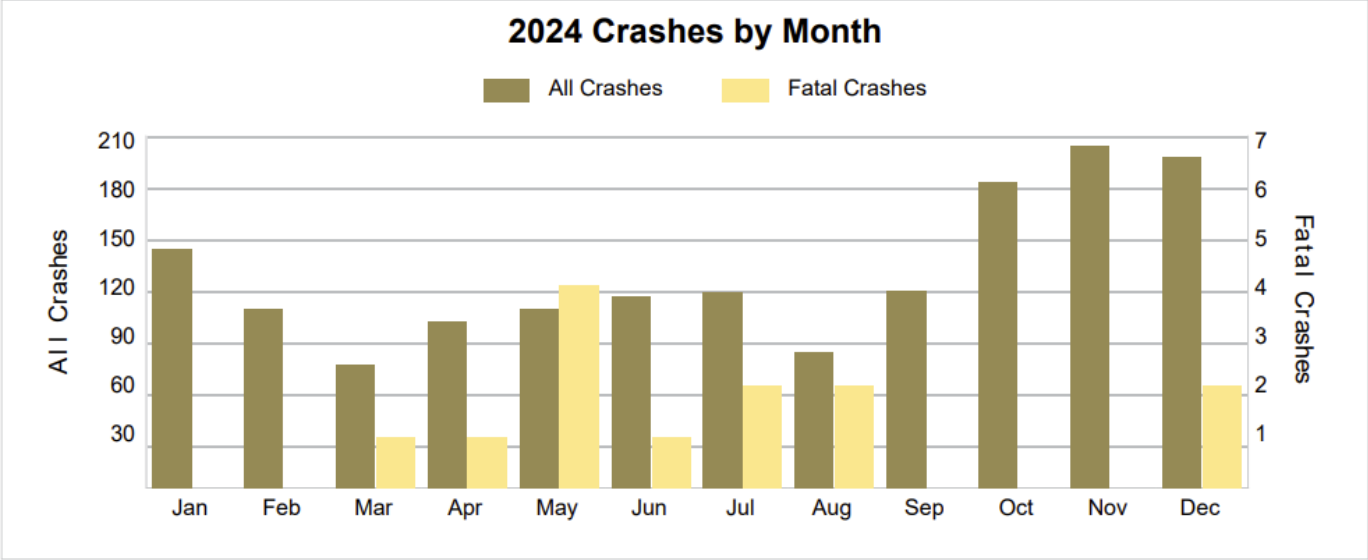
5-Year Trend - Crashes by Month

Month	2020		2021		2022		2023		2024	
	Total Crashes	Fatal Crashes	Total Crashes	Fatal Crashes	Total Crashes	Fatal Crashes	Total Crashes	Fatal Crashes	Total Crashes	Fatal Crashes
January	175	1	127	0	138	2	114	1	142	0
February	128	0	109	1	99	0	126	1	106	0
March	72	1	85	0	106	0	115	0	73	1
April	49	0	83	0	82	0	79	4	99	1
May	94	0	84	0	114	2	102	1	106	4
June	121	1	107	1	130	0	132	1	114	1
July	106	3	110	1	128	1	98	0	116	2
August	103	3	122	1	109	1	99	1	80	2
September	123	2	138	0	105	0	115	0	117	0
October	171	1	158	0	185	0	190	1	182	0
November	201 †	1	182 †	1	207 †	0	216 †	0	204 †	0
December	157	0	155	1	146	1	131	0	197	2
Total	**1,500**	**13**	**1,460**	**6**	**1,549**	**7**	**1,517**	**10**	**1,536**	**13**

Note: † Indicates that the highest number of total crashes reported in the 5-year period occurred in the same month.

5-Year Trend - Crashes by Day of Week

Day	2020		2021		2022		2023		2024	
	Total Crashes	Fatal Crashes	Total Crashes	Fatal Crashes	Total Crashes	Fatal Crashes	Total Crashes	Fatal Crashes	Total Crashes	Fatal Crashes
Monday	190	2	192	1	205	1	247	2	207	0
Tuesday	205	2	204	1	207	2	227	1	221	0
Wednesday	229	2	213	1	213	0	196	0	235	0
Thursday	227	2	201	1	248	1	218	0	234	2
Friday	239	1	251	1	249	2	247	3	255	6
Saturday	224	2	205	1	227	1	212	3	214	4
Sunday	186	2	194	0	200	0	170	1	170	1
Total	**1,500**	**13**	**1,460**	**6**	**1,549**	**7**	**1,517**	**10**	**1,536**	**13**



Mass Casualty Impacts within Newaygo County

The major concern with transportation and mass casualty incidents in the jurisdiction results directly from limited ambulance and medical resources. Within Newaygo County, Life EMS is a provider of ambulance and paramedic emergency medical services. Life EMS provides Advanced Life Support Services to Newaygo County residents under a non-subsidized contract maintained by the Newaygo County Board of Commissioners, as authorized by MCL Section 41.711. Life EMS maintains (3) 24-hour crews stationed out of Grant, Fremont, and White Cloud and (1) 14 hour crew is stationed in Fremont but may move to the Newaygo Respite Facility when 1 or 2 ambulances are available in order to maintain coverage. All crews are staffed with (1) Emergency Medical Technician (EMT)-Basic and (1) Paramedic as licensed by the Michigan Department of Community Health Emergency Medical Services Section.

Medical First Responder personnel from (8) local Fire Departments are utilized to assist Life EMS on Priority 1 calls with initial assessment, patient care, and extrication. Priority 1 calls are critically ill or injured patients with an immediate life-threatening condition. This includes a patient with unstable or deteriorating vital signs, a compromised airway, severe respiratory distress / failure, cardiac arrest or post cardiac arrest, stroke or STEMI, Severe Head Injuries, significant blunt or penetrating trauma, and actively seizing. Medical First Responders are utilized to manage these life threatening emergencies until an ambulance arrives and maintain a safe environment for patient care to be rendered. In addition, Medical First Responders help life, move, position, and extricate a patient needing transport.

Medical First Responder services are provided by the following departments

Station11: Fremont Fire Department
101 E. Main St., Fremont, MI 49412

Station 12: Newaygo Fire Department
177 Cooperative Drive, Newaygo, MI 49337

Station 13: Grant Fire Department
62 W State Rd, Grant, MI 49327

Station 14: Croton Township Fire Department
6431 S Elm Ave, Newaygo 49337

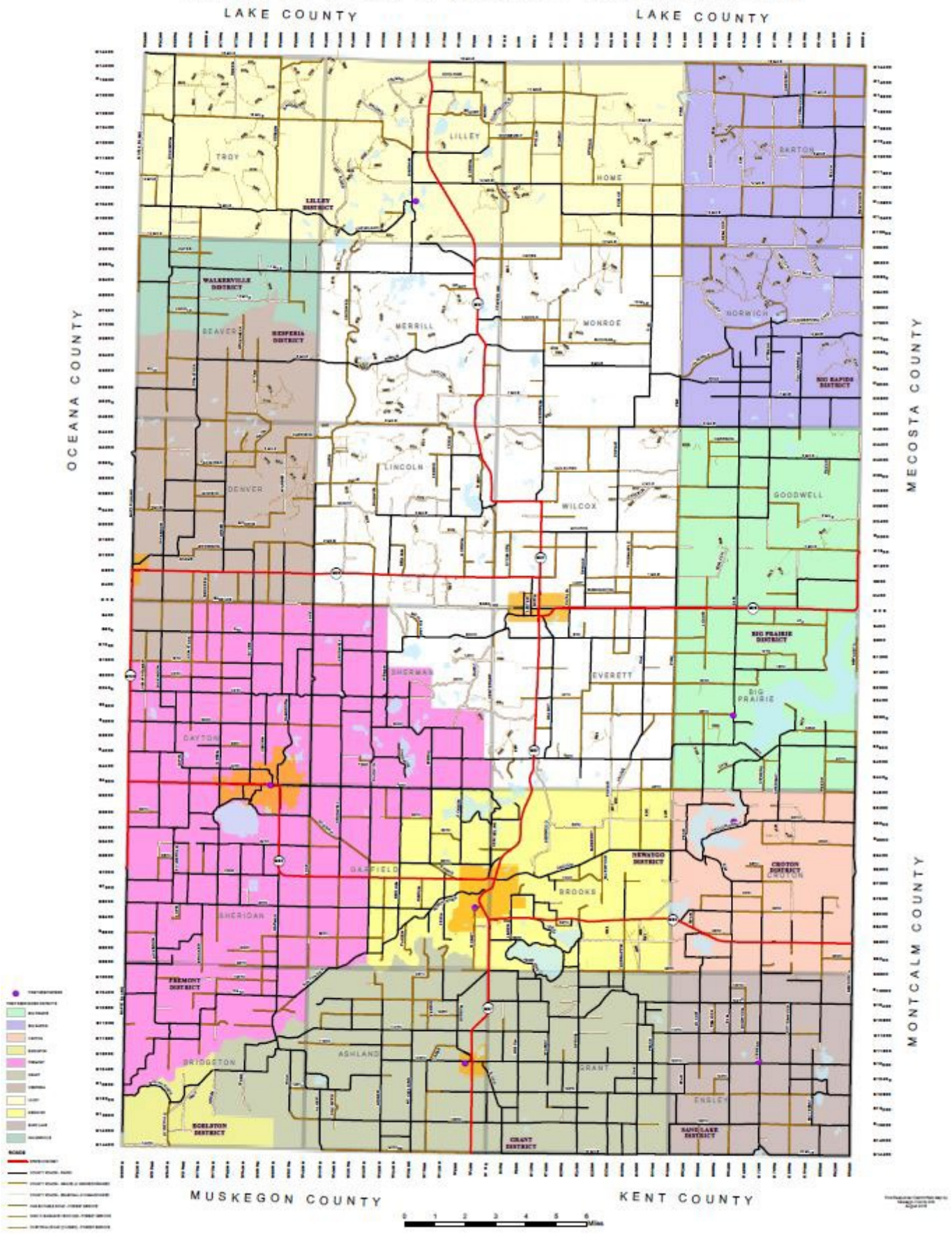
Station 15: Big Prairie Twp Fire Department
2815 S Elm Street, White Cloud MI 49349

Station 17: Lilley Township Fire Department
10730 Prospect Ave, Bitely MI 49309

Station 19: Hesperia Fire Department
8320 E M-20, Hesperia MI 49421

Sand Lake Fire Department
2 Maple Street, Sand Lake MI 49343

NEWAYGO COUNTY FIRST RESPONDER DISTRICTS



Corewell Health Gerber Hospital, the only hospital in Newaygo County, is a Level IV Trauma Center. A Level IV trauma center provides advanced trauma life support and initial evaluation for injured patients, but it is not designed to handle severe trauma. These centers are typically found in rural areas and focus on stabilizing and preparing patients for transfer to a higher-level facility, such as a Level I or Level II trauma center. A key function of a Level IV center is to ensure that a patient receives prompt and appropriate care, including crucial diagnostic and stabilization services, to maximize their chances of survival during the critical first hours after an injury.

County	Hospital Name	ED Beds	ICU Beds	Med Surg.	All Hosp Beds	Obstetrical Unit Beds	Pediatric Beds	Vents	Morgue Beds
Newaygo	Corewell Health Gerber Hospital	21	11	24	68	12	Yes	9	2

Trinity Health Muskegon is a 67 bed Level II Trauma Center located approximately 30 minutes from Newaygo County. Corewell Health Butterworth is a 65 ED Bed Level I Trauma Center located in Grand Rapids, Michigan – approximately 45 minutes away from Newaygo County.

A mass casualty incident (MCI) is any event, natural or man-made, where the number and severity of casualties overwhelm local emergency medical services and healthcare resources, requiring external assistance to manage the patient surge and restore normal community function. This inability to cope with the demand for health care due to insufficient personnel, equipment, or facilities is the defining characteristic of an MCI. Transportation accidents are the most common hazard to cause a mass casualty incident. In Michigan Region 6, the following defines the level and number of patients to meet a mass casualty alert. This number can be decreased if it involved pediatric patients (children under the age of 17).

EMS Plan 1	EMS Plan 2	EMS Plan 3
4 – 9 Patients	10 – 24 Patients	25+ Patients

There are Historical areas of concern for producing mass casualty incidents stem mainly from major transportation routes and special events. The following are highlighted examples of several mass causality incidents resulting from transportation accidents within Newaygo County.

Case: October 2006 Amish Buggy MCI
In October of 2006, there was an Amish Buggy accident at 48 St and Wisner Avenue east of the City of Fremont. An Intoxicated driver hit an Amish Buggy carrying a family of seven. All 7 people in the buggy were injured and 1 of them died from their injuries.

Case: October 2, 2007 Grant Public Schools Bus Accident
Two Grant Public School buses collided in front of the Grant High School on 120th Ave after school. 12 Patients of High School Age were transported to Gerber Memorial Hospital for treatment of minor injuries.

Case: Friday, November 7, 2008 Newaygo Public Schools Bus Accident
Six children suffered minor injuries and were treated at Gerber Memorial Hospital after a Newaygo Public Schools bus and a truck collided at the corner of M-37 and M-82 in the city of Newaygo. The truck was heading southbound on M-37 and approached a traffic light on westbound M-82. The school bus, which had the right-of-way, was westbound on Croton Drive and turned south on to M-37 causing the accident.
Newaygo County contains no divided freeways and 3 Michigan State highways (M-20, M-37, and M-82). Additionally, many additional county and side roads have equal potential for producing a vehicle incident of significant magnitude to warrant a mass casualty response, especially during hazardous weather.

Case: July 26, 2014 Fatal Two Vehicle Head on Collision in Garfield Township
An 18 year old driver traveling on 48th Street crossed into incoming traffic and hit another vehicle head on near Wisner Ave. The diver of the first vehicle was transported to Spectrum Health Butterworth in Grand Rapids in stable condition. The driver of the second vehicle died from his injuries. His female passenger was transported to Spectrum Health Butterworth Hospital in Grand Rapids in critical condition. Four children passengers in the second vehicle were in stable condition, and a fifth child passenger was treated and released at Spectrum Health Gerber Memorial Hospital.

Case: May 13, 2017 Rollover crash 104th/Cypress in Ensley Township
One of the vehicles ran the stop sign hitting the other. Three people were sent to the hospital, one with a serious head injury after being ejected.

Case: November 5, 2017 Rollover Party Bus at the intersection of 22 Mile and Peach Ridge Ave, Grant Township
18 people were injured after a crash involving a party bus. The bus contained 30 people and was northbound on Peach Ridge when the driver failed to stop for the stop sign at the T intersection, the bus left the roadway on the north side of 22 Mile Road, hit a sign and then went into the ditch. Twelve people were transported to Spectrum Health Butterworth Hospital in Grand Rapids, where all 12 were listed in stable condition, and six people were transported to Mary's Hospital, where all six were treated and released.

Case: March 9, 2019 2 vehicle crash East Baseline Rd/South Elm
A pick-up truck collided with an SUV the 18 year old driver and 14 year old passenger were not injured. 5 people in the SUV were transported to the hospital with one of them, a 2 year old girl, pronounced dead at the scene.

Case: April 3, 2019, 128th Ave Ashland Township car pedestrian crash
3 children injured and their dog killed.

Case: June 29, 2019 Vehicle rear-ends tractor South Stone Road/W 24th St., Fremont
A 44 year old driver rear-ended a tractor pulling farm equipment. The driver was taken to the hospital with injuries along with the 43 old passenger who was pronounced dead. The driver of the tractor also suffered minor injuries. 2 injured 1 killed

Case: August 19, 2019 Dayton Township head on crash, 32nd steet near Fremont
31 year old Muskegon man crossed the center line striking an oncoming vehicle. His pregnant passenger was injured and suffered a miscarriage. The occupants in the other vehicle were not injured. 2 injured 1 killed.

Case: March 4, 2020 Newaygo County M-20 at Locust Avenue
Two vehicle crash, three people injured and transported to hospitals one sent via AeroMed. Resulted in significant traffic issues/back up due to the road being closed for a time.

Case: July 29, 2020 Newaygo County Dayton Township West 24th Street at South Dickinson Ave: An SUV with five people inside ran a stop sign and hit another car with four people inside. The driver of the SUV was airlifted and listed in critical condition at Spectrum Health Butterworth Hospital, police say. Investigators say five other people were treated and released from area hospitals. An infant, who was fastened in a child safety seat, was unharmed. This event triggered a MCI alert.

Case: February 12, 2021 E 40th Street and S Evergreen (M-37)
A multi car vehicle accident occurred at the intersection of E 40th Street and S Evergreen injuring 7 people. 3 EMS units transported 6 patients to Gerber Hospital and 1 patient to Butterworth Hospital. This event triggered a MCI alert.

Case: February 20, 2021 M-37 and 120th Ave, Grant
A man died after a crash involving three vehicles. A Chevrolet Silverado, driven by a 75-year-old man of Sparta, was driving north on M-37 when he crossed the centerline. The vehicle hit a Toyota pickup truck, driven by a 52-year-old man of Grant, head on. A third vehicle, a Ford pickup truck heading south, could not stop and crashed into the two initial vehicles. This resulted in 4 patients, 2 of which were transported to the hospital. Alcohol is believed to be a factor in this accident.

Case: September 13, 2023 S Green Ave and W 44th Street, Fremont
A multi car vehicle accident occurred injuring 7 people. All 7 priority 3 patients were transported to Gerber Hospital by 3 EMS Units. This event triggered a MCI alert.

Case: July 12, 2024 685 S Bingham Drive, White Cloud
An ATV collision resulted in 5 pediatric patients. 3 Patients were transported non-emergency to Gerber, while the remaining 2 patients with non-critical injuries waited on scene for their guardians to arrive. This event triggered a MCI alert.

Case: October 19, 2024 N Woodbridge Drive and W Coolidge Street, Bitely
Vehicle accident injured 4 people. After initial assessment, 3 patients refused transport while 1 was transported to Big Rapids.

Case: December 19, 2024 50 Car Pile up Warner Ave, Bridgeton Township
During the evening commute, weather caused a crash involving 50 cars near the Muskegon River bridge on Warner Ave, south of Fremont. The roadway was temporarily closed (approximately 2 hours) while vehicles were being cleared from the bridge. No one was injured during the pile up due to low speeds from the snow and ice.

Case: December 21, 2024 E 82nd Street at Mason Drive, Newaygo
1 dead, 4 others hospitalized after a multi-vehicle accident. A 62-year-old Newaygo man was driving northbound on M-37 when he turned westbound into the path of a southbound vehicle driven by a 23-year-old Grant man. One passenger in the southbound vehicle, a 42-year-old Newaygo woman, died at the scene. This resulted in 2 priority 2 patients being transported to Butterworth, 1 pediatric patient being transported to Devos, and 1 priority 3 patient being transported to Gerber Hospital.
The driver of the northbound vehicle and two other occupants, including a child, were also taken to a hospital with serious injuries. Preliminary investigation suggests that alcohol may have been a contributing factor in the crash. This event triggered a MCI alert

Case: December 28, 2024 S. Orchard Avenue and W. 120th Street, Bridgeton Township
On December 27, 2024, at approximately 11:14 PM, deputies from the Newaygo County Sheriff's Office were dispatched for a reported single-vehicle accident. Upon arrival, deputies determined that the driver of the vehicle, a 53-year-old male from Grant, was deceased at the scene. The passenger, a 48-year-old female also from Grant, sustained injuries and was transported to Gerber Memorial Hospital for treatment. Preliminary investigation suggests that alcohol may have been a contributing factor in the crash.

Case: March 9, 2025 S Warner Ave and W 56th Street, Fremont
A serious 2 car vehicle accident resulted in 5 total people being injured. 1 pediatric patient was transported by AeroMed to Devos Children's Hospital. Another pediatric patient was transported by EMD to Devos. 1 patient was transported by EMS to Butterworth. The remaining patients were transported by EMS to Gerber Hospital. This event triggered a MCI alert.

Case: April 17, 2025 E Croton Drive and S Oak Ave, Newaygo
7 patient motor vehicle accident resulted in 4 patients being transported by 2 EMS units to Gerber Hospital. This event triggered a MCI alert.

Case: April 27, 2025 N Stewart Ave and E Main Street, Fremont
A stolen vehicle carrying four young people crashed at the intersection of Stewart Ave. and Main Street. This accident resulted in 4 patients being transported to the hospital. 1 priority 2 patient was transported to Muskegon, 1 priority 1 patient transported to Butterworth by AeroMed, 1 priority 1 patient was transported to Butterworth by EMS, and 1 priority 2 patient was transported to Gerber Hospital. This event triggered a MCI alert.

Case: May 8, 2025 Mason Drive and W 112th Street, Grant
A multi car vehicle accident resulted in 4 people being injured and transported to Butterworth by 3 EMS units. This event triggered a MCI alert.

Case: June 19, 2025 3970 W 48th Street, Fremont
6 people were taken to the hospital after a four-vehicle crash that knocked down power lines. 1 patient was transported to Butterworth via AeroMed who later died from his injuries. 4 priority 2 patients, and 1 priority 3 patient were transported to Gerber. The accident occurred when a 26-year-old Pierson man was heading north on Croswell Avenue and did not stop at a stop sign. He crashed into an 80-year-old Florida man driving west, resulting in nearby power lines falling. Shortly after, an 81-year-old man from Fremont was driving west and swerved to avoid the downed lines, before crashing head-on with a husband and wife from Fremont, deputies say. This event triggered a MCI alert

Case: July 22, 2025 S Basswood Drive and E 40th Street, Newaygo
4 patients with head injuries (3 adults, 1 pediatric). 3 patients transported to Butterworth. This event triggered a MCI alert

Case: October 6, 2025 E 8th Street and S Oak Street, White Cloud
From the Newaygo County Sheriff's Office Media Release: On October 6, 2025, at 6:19pm, the Newaygo County Sheriff's Office, was dispatched to E 8th St and S Oak Ave, Everett Township for a two-vehicle crash. Deputies arrived on scene and determined the crash occurred with a passenger car and a White Cloud Public Schools school bus. The passenger car was driven by a 25-year-old female from Fremont. The school bus was driven by a 46-year-old female from White Cloud. There were no passengers in either vehicle. Preliminary investigation found that the passenger car was traveling westbound on E 8th St and failed to stop for a stop sign at S Oak Ave. The school bus was traveling north on S Oak Ave and struck the passenger car when it failed to stop at the stop sign. The driver of the passenger car was pronounced deceased at

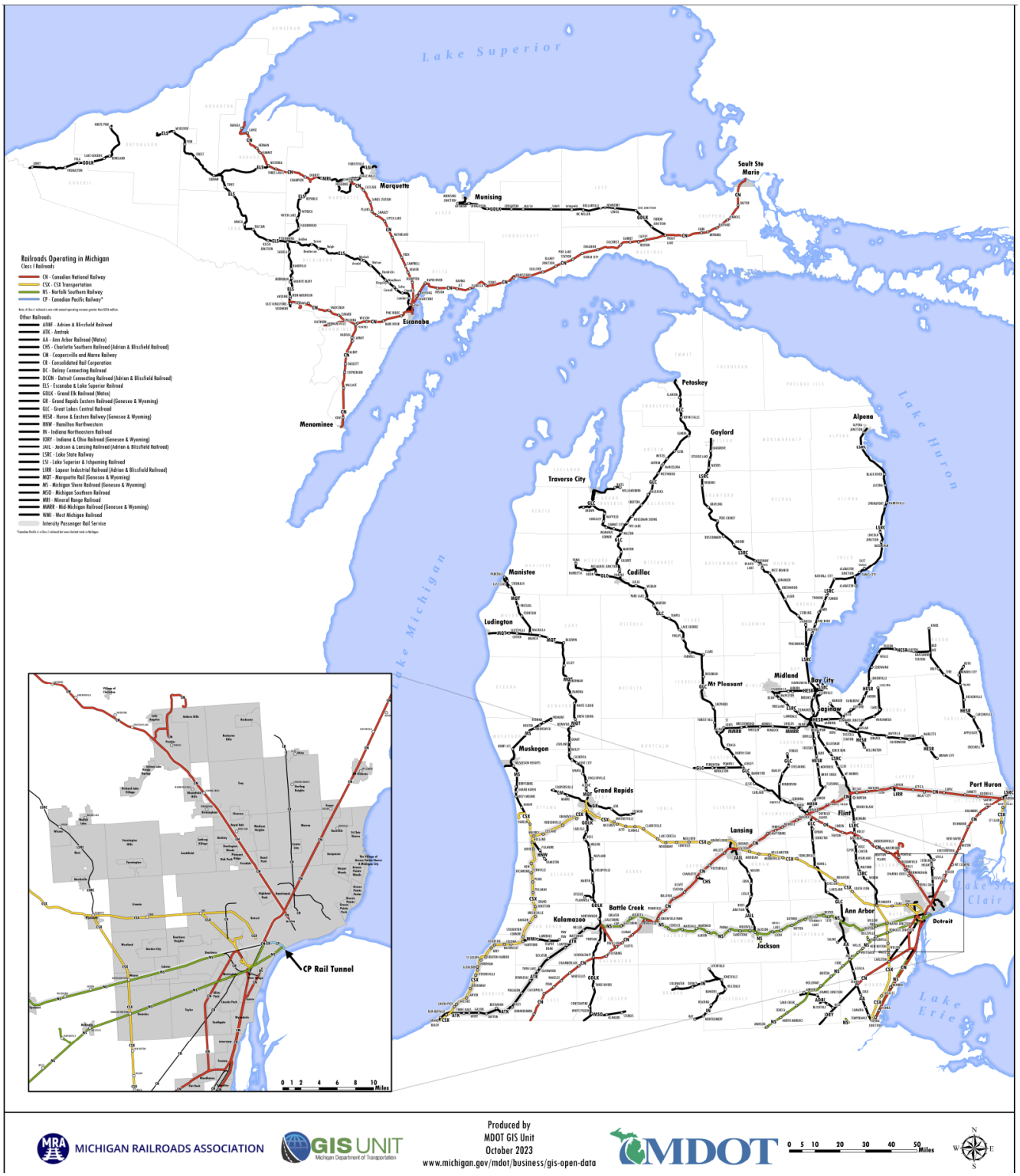
the scene. The driver of the school bus was transported to a local hospital in stable condition.

Case October 21, 2025 Elder Ave and 128th Street, Grant Township
A vehicle collided with a Newaygo Child Development Center bus, resulting in 1 adult priority 1 being transported to Butterworth and 3 pediatric patients being treated and released on scene to parents. Newaygo Child Development Center is a preschool, located in Croton Township, which houses children 4 – 6 years old. This event triggered a MCI alert.

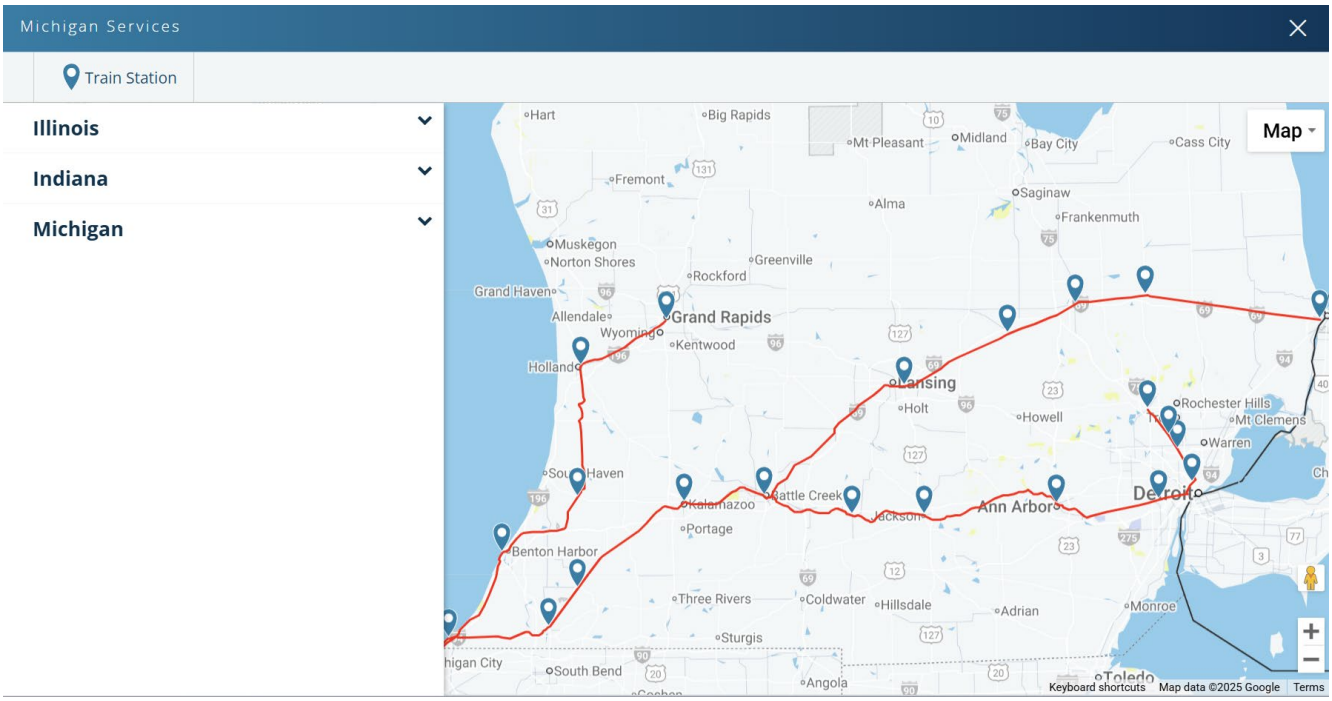


Railway Transportation Accidents in Michigan

There are 29 railroads operating in Michigan, including four Class I railroads that handle a significant portion of the state's freight. This network includes freight and passenger-rail services over approximately 3,600 miles of rail corridors. Although the rail system is almost exclusively privately owned and financed, the system carries about 17% of the state's freight tonnage.



Michigan is corrected to the National Railroad Passenger Corporation (branded as Amtrak), which is a limited intercity rail passenger service in most parts of the country. Amtrak serves most major cities but, outside of the Northeast, California, and Illinois, often by only few trains per day. Amtrak has stations in Michigan in the following cities: Albion, Ann Arbor, Bangor, Battle Creek, Dearborn, Detroit, Dowagiac, Durand, Flint, Grand Rapids, Holland, Jackson, Kalamazoo, East Lansing, Lapeer, New Buffalo, Niles, Pontiac, Port Huron, Royal Oak, St Joseph, and Troy.



At the end of FY 2023, Amtrak operated 10 trains per day in Michigan, as a part of the following routes:

- ***Blue Water*** – daily Chicago-East Lansing-Port Huron
- ***Pere Marquette*** – daily Chicago-Grand Rapids
- ***Wolverine*** – daily Chicago-Detroit-Pontiac

These trains operate at top speeds of 100 to 110 mph with a capacity of approximately 300 passengers. During FY 2023, Amtrak serviced 746,698 total passengers within Michigan.

The U.S. Department of Transportation, through the Federal Railroad Administration, regulates the speed at which trains operate over highway/railroad at-grade crossings. These regulations allow trains to operate at up to 110 miles per hour over highway-railroad at-grade crossings with conventional warning devices only (cross buck signs, side of street and/or overhead flashing lights, and/or gates). At speeds between 110 and 125 miles per hour, positive barriers must be installed at highway-railroad crossings. At speeds above 125 miles per hour, all highways and railroads must be grade separated.

These regulations were developed by evaluating the risk of accident damage, using the following philosophy:

- Up to 110 miles per hour: The highway vehicle occupant is most at-risk.
- 110 to 125 miles per hour: Possible injury to the train's occupants, due to rapid deceleration.
- Above 125 miles per hour:

Greater likelihood of injury to train occupants, and the train may be derailed. Amtrak, and high speed train manufacturers, have done computer simulations of accidents that could cause a significant rapid deceleration (similar to a highway vehicle-train accident). These simulations predict only minor injuries to the train's occupants. Based on the passenger train accident history in the state, the FRA regulations, and the computer simulations, the likelihood of a serious passenger rail transportation accident that results in significant casualties appears to be low. However, any collision between a train and a vehicle could result in casualties.

Railway accidents include vehicle-train collisions, passenger train incidents, and general railway accidents including but not limited to derailment, obstruction, other impacts, etc. The Federal Railroad Administration Office of Safety Analysis provides a public database dating back to 1975. The following are All Collisions in Michigan from 2022 to 2025

County	Multi-Year Total		Total CY Counts			Month To Month Counts Jan - Dec	
	Cases	Pct of Total	CY 2022	CY 2023	CY 2024	CY 2024	CY 2025
GRAND TOTAL....	10	100.0	1	2	6	6	1
CALHOUN	2	20.0	.	1	.	.	1
GENESEE	2	20.0	.	.	2	2	.
KENT	2	20.0	1	1	.	.	.
WAYNE	2	20.0	.	.	2	2	.
BARAGA	1	10.0	.	.	1	1	.
LENAWEE	1	10.0	.	.	1	1	.

Case: November 16, 2023 Amtrak Derailment, Berrien County
An Amtrak train carrying 200 passengers in Berrien County hit a vehicle in the process of being towed off the tracks and a tow truck on November 16, 2023. The truck then burst into flames and the train derailed. 11 people were injured during this incident.

Case: September 27, 2024 Amtrak Collision with Vehicle, Lapeer County
An Amtrak train moving at 65 mph collided at a railroad-highway crossing when a driver of a vehicle failed to stop at the railroad crossing. Both driver and passenger were transported to local hospitals where they passed away from their injuries.

Railway Transportation Accidents in Newaygo County

Two rail lines still traverse Newaygo County, Marquette Rail (Genesee and Wyoming) and Michigan Shore (Genesee and Wyoming). Marquette Rail runs trains Sunday through Thursday and is through the State and River crossing within the City of Newaygo anywhere between 2100 and 2300 daily for their northbound run. Their southbound run comes back through anywhere between 0100-0500, but could be as late as 0800. For the most part, this train is just a through train and does not stop. However, they do pickup grain from MAC in the City of Newaygo about once a month and this would be loading and offloading cars, which could affect the crossing in that area.



In addition, several hazardous materials are shipped through the southwestern portion of the County by Marquette Railway on a daily basis. This includes Calcium Carbonate, Hot Asphalt, and other petroleum products. The line is one of the busiest in the state of Michigan traveling through the Cities of Grant, Newaygo, and White Cloud. The other line is a Michigan Shore Railway ending at the City of Fremont in Gerber Products.

Case: February 4, 1978 Woodland Park

A Dow Chemical train derailed caused a chemical spill of approximately 30,000 gallons of ethylene oxide, carbolic acid, methylene chloride, and phropheline oxide. A total of



50 persons were evacuated from the vicinity of the accident scene. According to the Merrill Township Master Plan, recent tests conducted by 24 Hour News 8 in the area show chemical levels of the potential carcinogen 1,1-DCE (used to make plastics and flame-retardant coatings) to be more than twice the level for safe drinking water and that the chemical has spread to the southwest, toward East Lake. Additional tests conducted by a consultant hired by CSX have found traces of vinyl chloride in East Lake. Vinyl chloride is a known carcinogen and is created when 1,1-DCE breaks down in the environment. The Environmental Protection Agency (EPA) says 1,1-DCE might cause cancer in humans. This chemical can damage the nervous system, liver, and lungs. Unconfirmed anecdotal evidence shows that many people who lived around the train derailment site died of cancer within a few years of the derailment.

Case: June 22, 1979 Newaygo
A freight train derailment caused a chlorine leak that eventually sealed itself. A total of 300 persons were evacuated as a precautionary measure.

Case: July 8, 2013 Pere Marquette Rail Derailment, White Cloud
A cargo train derailed at the Foss Road crossing just north of White Cloud early Monday morning, according to the Newaygo County Sheriff's Department.

Case: April 26, 2018 Marquette Rail Locomotive Failure, Grant
Incident Number: MQT645818H – at the TURN-26, the crew taxied to their train at MP 30.76 on the Grand Rapids Sub at approximately 0745 and noticed a large amount of oil on the ground under locomotive IMRR 81. The train crew notified TM WOOTTON about the issue. Following a mechanical inspection, it was determined that the rod bearing basket broke causing loss of piston, causing oil to run out of the locomotive and onto the ground. Estimate would be 75-100 gallons of oil spilled. Youngs Environmental was contacted to clean up the spill. Damage to the locomotive includes rod bearing backet broke, oil lines broke, piston, damage to the block. No injuries. Closest to DOT# 235139J, but not at grade crossing.

Case: December 5, 2018 Marquette Rail Derailment, Brohman
Incident Number: MQT875018D – Train derailed at the 43rd car of a cut of 44 on a broken rail, near the crossing of 2 mile road at MP49.86. The derailed car traveled almost two miles in distance. No one was injured and no hazardous materials were spilled.

Case: October 22, 2021 Genessee Wyoming Rail Derailment, Brohman

Incident Number: MQT913721D - MQT TURN-22 crew had just made a double at KOPJE SIDING and started south with 66L X 18E moving at 19 mph. They felt a tug and the train went into emergency. Upon walking the train, the conductor discovered that CARS60-65 were derailed (2 cars on their side, 3 sideways, and 1 partially derailed). Cause is head-weather separation on the low side of the curve. No one was hurt and there were no hazardous materials spilled. This cause $70,552 in equipment damage and $44,000 in track damage.





Air Transportation Accidents

According to the 2025 Michigan Airport Directory, the following are aviation facts for Michigan:

- 212 licensed public use landing sites
  - 88 private owned
  - 126 public owned
  - 18 public-owned airports support scheduled air carrier service
- Over 38 million passengers travel through Michigan's 18 air carrier airports
- Over 490 million pounds of air cargo travel through Michigan's airports
- Over 13,000 active pilots (private pilot certificate or higher)
- Approximately 5,012 aircraft based in Michigan
- 41 licensed aircraft dealers
- 71 licensed flight schools
- Home to 5 aircraft manufacturers
  - Cameron Balloons U.S.
  - Enstrom Helicopters
  - Midwest Sky Sports
  - Phantom Aeronautics
  - Waco Classic Aircraft

CONTROL TOWER TRAFFIC
TOTAL OPERATIONS BY FISCAL YEAR

AIRPORT	2022	2023	2024
Ann Arbor (ARB)	83,956	81,776	85,059
Battle Creek (BTL)	99,276	88,385	79,260
Detroit (DET)	60,156	56,632	64,405
Detroit (DTW)	287,510	293,157	306,351
Detroit (YIP)	88,705	69,788	81,435
Flint (FNT)	48,752	46,572	51,132
Grand Rapids (GRR)	75,196	77,215	80,861
Jackson (JXN)	33,850	38,965	46,016
Kalamazoo (AZO)	53,866	48,830	51,089
Lansing (LAN)	30,289	32,529	38,097
Marquette (SAW)	18,544	18,140	17,654
Muskegon (MKG)	30,932	31,210	30,588
Pontiac (PTK)	145,898	148,567	159,635
Saginaw (MBS)	17,797	18,222	19,688
Traverse City (TVC)	86,361	88,942	95,254
Total	**1,161,088**	**1,138,930**	**1,206,524**

Statistics from the NTSB and the airline industry show that the majority (over 75%) of airplane crashes and accidents occur during the takeoff or landing phases of a flight. As a result, developed areas that are adjacent to major airports, and along airport flight paths, are particularly vulnerable to this hazard. Accordingly, the greater the number of

landings and takeoffs, the greater the probability of a crash or accident. The challenge for jurisdictions with a passenger air carrier airport is to develop adequate procedures to handle a mass casualty incident that could result from an airplane crash or accident.

Case: March 4, 1987 Detroit (Wayne County) Passenger Airplane Crash
On March 4, 1987, a plane bound from Cleveland to Detroit crashed and skidded into three ground vehicles and caught fire. The cause of the accident was the captain's inability to control the airplane while descending on the final approach for landing. Nine of the 22 passengers died from a post-crash fire, lack of fire-blocking material, and poorly designed aircraft components.

Case: August 16, 1987 Romulus (Wayne County) Passenger Airplane Crash
Michigan's worst commercial passenger airplane crash, and the seventh worst in U.S. aviation history occurred on August 16, 1987, at Detroit Metropolitan Airport. In that incident, Northwest Airlines Flight 255 was unable to gain sufficient altitude at takeoff and crashed into nearby highway I-94, killing 156 passengers and crew. A small child was the lone survivor. A Governor's Disaster Declaration was granted to the City of Romulus and numerous state resources were mobilized to assist in the recovery.

Case: June 4, 2007 Lake Michigan Passenger Airplane Crash
An unfortunate incident occurred when a plane carrying a team of surgeons and technicians from Milwaukee to Ann Arbor crashed into Lake Michigan. All six passengers died in the incident, including the two pilots, two University of Michigan surgeons, and two technicians due to prepare an organ for transplant surgery at the University of Michigan Health System hospital in Ann Arbor that same afternoon. The National Transportation Safety Board said that one of the pilots had reported severe difficulty steering the plane because of trouble with its trim system, which controls bank and pitch.

Since 1962, NTSB has recorded 4,683 aviation accidents in Michigan. 666 of these accidents were fatal. 17 of these fatal accidents have occurred since 2020. These accidents include:

- 07/21/2025 Lowell, Michigan
- 06/29/2025 Zeeland, Michigan
- 08/03/2024 Napoleon, Michigan
- 06/10/2024 Clinton, Michigan
- 11/26/2023 Ludington, Michigan
- 09/10/2023 Dowagiac, Michigan
- 06/23/2023 Beaver Island, Michigan
- 08/02/2022 South Haven Charter Township, Michigan
- 07/15/2022 Shelby Michigan
- 11/15/2021 Boyne City, Michigan

- 11/13/2021 Beaver Island, Michigan
- 11/05/2021 Harrison, Michigan
- 05/17/2021 St Louis, Michigan
- 01/02/2021 New Hudson, Michigan
- 09/19/2020 Zeeland, Michigan
- 09/01/2020 Midland, Michigan
- 07/11/2020 Grosse Ile, Michigan

Air Transportation Accidents in Newaygo County

The Newaygo County has two airports within the County. The White Cloud Airport is located just 1 Mile north of the City of White Cloud on M-37 and is owned and operated by the City of White Cloud. The airport is primarily used for business, flight school, and industry and does not have scheduled flights. The airport has one runway: Runway 18/36. Runway 18/36 is an asphalt runway 2917 ft. by 60 ft. at an elevation of 915.0 ft. lighted by medium intensity runway edge lights. 100 Low Lead Aviation Fuel is available at the airport as well as hangars and tie-downs for parking.

The Fremont Municipal Airport is 3 miles south west of the City of Fremont and is owned and operated by the City of Fremont. The airport is primarily used for business, glider operations, and industry and does not have scheduled flights. The airport has two asphalt runways, runway 18/36 and runway 9/27. Runway 18/36 is 6,498 feet by 100 feet at an elevation of 769.7 ft. with a weight bearing capacity of 30,000 lbs. and is marked with runway lights. Runway 9/27 is 3502 feet by 75 feet at an elevation of 766.9 feet with a weight bearing capacity of 16,000 lbs. on a single wheel and is marked with medium intensity runway edge lights. 100 Low Lead Aviation Fuel and Jet A Fuel are both available along with hangars and tie-downs for parking.

There are six major airports that are located within two hours of Newaygo County.

Airport Name	Distance from County
Muskegon County Airport	15 Miles
Gerald R. Ford International Airport	25 Miles
Traverse City Cherry Capital Airport	75 Miles
MBS International Airport	83 Miles
Kalamazoo Battle Creek International Airport	85 Miles
Lansing Capital Region International Airport	85 Miles
Bishop (Flint) International Airport	135 Miles
Detroit Metropolitan International Airport	185 Miles

The following is a list of airplane emergencies occurring in Newaygo County from the NTSB:

Ntsb No	Event Date	City	Highest Injury Level	Fatal Injury Count	Serious Injury Count	Minor Injury Count	Probable Cause
CHI66F0196	1965-09-14T04:00:00Z	White Cloud	None	0	0	0	
CHI66F0328	1965-09-23T04:00:00Z	White Cloud	Serious	0	1	1	
CHI66A0031	1965-09-30T04:00:00Z	White Cloud	Fatal	3	0	0	
CHI69D0219	1968-09-02T04:00:00Z	Newaygo	None	0	0	0	
CHI71DBJ35	1970-10-27T05:00:00Z	Newaygo	None	0	0	0	
CHI72DEM25	1971-09-04T04:00:00Z	Fremont	None	0	0	0	
CHI74DEM30	1973-12-16T05:00:00Z	Newaygo	Minor	0	0	1	
CHI74DEM42	1974-03-19T05:00:00Z	Grant	Minor	0	0	2	
CHI74DEM50	1974-03-31T05:00:00Z	White Cloud	None	0	0	0	
CHI75FEM38	1975-05-11T04:00:00Z	Fremont	Serious	0	1	0	
CHI77FEM25	1977-05-17T04:00:00Z	Grant	None	0	0	0	
CHI80FEM25	1980-05-19T04:00:00Z	Grant	Fatal	1	0	0	
CHI81FA006	1980-11-13T05:00:00Z	Fremont	Fatal	2	0	0	
CHI81FEM06	1981-01-22T05:00:00Z	Newaygo	None	0	0	0	
CHI82DA182	1982-05-24T18:00:00Z	White Cloud	None	0	0	0	
CHI85FA156	1985-04-05T05:00:00Z	White Cloud	Fatal	3	0	0	
CHI88DEM09	1988-08-15T10:30:00Z	White Cloud	None	0	0	0	Unauthorized pilot failed to maintain adequate control of the homebuilt aircraft during landing roll. The aircraft veered off the right side of the runway, and left wing struck the ground.
CHI88LA241	1988-09-22T09:30:00Z	Fremont	None	0	0	0	
CHI90LA135	1990-05-28T15:29:00Z	White Cloud	None	0	0	0	Failure of the pilot to maintain control of the airplane during a landing flare and touchdown. The pilots lack of total aviation experience is a factor in the accident.
CHI90DEM06	1990-07-08T12:38:00Z	White Cloud	Serious	0	1	0	The passengers disregard of the pilot's instructions and her failure to maintain clearance from the propeller.

Ntsb No	Event Date	City	Highest Injury Level	Fatal Injury Count	Serious Injury Count	Minor Injury Count	Probable Cause
CHI90LA255	1990-09-05T20:50:00Z	Newaygo	Minor	0	0	1	The student pilot's improper level off and recovery from a bounced landing which resulted in loss of control. In addition, and unqualified person was coaching the student from the ground.
CHI95LA092	1995-02-23T12:15:00Z	Grant	None	0	0	0	The student pilot's decision to intentionally land downwind and his failure to maintain directional control of the aircraft during landing roll. The pilot's lack of experience and the tailwind were contributing factors.
CHI96LA058	1995-12-16T15:30:00Z	Grant	None	0	0	0	the pilot's selection of unsuitable terrain and the weak ice-covered runway.
CHI97LA289	1997-09-07T19:00:00Z	Grant	Minor	0	0	3	the pilot's fixation on the end of the runway, his failure to place the airplane in an attitude to land (flare) which resulted in a hard landing, and the pilot's failure to recover from the subsequent bounced landing.
CHI97FA300	1997-09-25T13:25:00Z	Fremont	Fatal	2	0	0	The pilot's failure to maintain adequate airspeed which resulted in a stall. Also causal was the pilot's ostentatious display.
CHI99LA134	1999-04-26T16:30:00Z	Fremont	Minor	0	0	1	the seizure of the powerplant.
CHI00LA174	2000-06-26T12:15:00Z	Grant	Minor	0	0	3	the pilot's failure to maintain control of the airplane which resulted in a stall/mush condition. Factors associated with the accident were the trees and gusty wind conditions which resulted in turbulence on takeoff.
CHI01FA290	2001-08-23T19:40:00Z	Newaygo	Fatal	1	0	0	The pilot inadvertently positioning the fuel selector in an intermediate position, resulting in a loss of engine power. An additional cause was the pilot's failure to verify the fuel selector position during the engine restart attempt. Factors to the accident include the restricted fuel flow, fuel starvation, and the presence of trees during the forced landing.
CHI02LA139	2002-05-20T19:50:00Z	Grant	None	0	0	0	The disregarded replacement of the airplane's fuel lines, the operation of the aircraft with known deficiencies, and the turn back to the departure airport by the owner/pilot. The inadequate condition inspection by the mechanic, the cracked fuel line, the trees, and the pilot's lack of experience in the airplane type were contributing factors.

Ntsb No	Event Date	City	Highest Injury Level	Fatal Injury Count	Serious Injury Count	Minor Injury Count	Probable Cause
CHI02FA262	2002-08-28T19:49:00Z	Newaygo	Fatal	3	0	0	The altitude/clearance disregarded by the pilot and his ostentatious display. The wire and low altitude flight were a contributing factor.
CHI05LA190	2005-07-15T14:54:00Z	White Cloud	None	0	0	0	A loss of engine power during cruise flight due to the mechanic's improper maintenance, the disconnected oil line, the oil leak from the disconnected line, and the unsuitable terrain the pilot encountered during the forced landing. Factors were the outside pressures on the maintenance personnel and the uneven terrain.
CEN11CA191	2011-01-30T15:00:00Z	Newaygo	None	0	0	0	The pilot's loss of directional control during takeoff from a frozen lake.
CEN13LA286	2013-05-18T15:00:00Z	Fremont	None	0	0	0	The pilot's improper preflight planning, which resulted in a loss of engine power due to fuel exhaustion while in the traffic pattern.
CEN21LA046	2020-11-05T15:15:00Z	Fremont	Minor	0	0	1	The pilot’s improper positioning of the fuel selector during takeoff, which was not in accordance with the preflight checklist and resulted in fuel starvation, a subsequent total loss of engine power, and an aerodynamic stall during an attempted forced landing.
CEN23LA287	2023-07-08T09:10	Big Prairie	Minor	0	0	2	The flight instructor and pilot receiving instruction were completing water landings in the amphibious airplane. They had already completed several landings on the same pond without incident. During the accident landing, upon touchdown the airplane impacted a submerged log, which punctured a large hole in the hull. The pilots egressed without further incident and the airplane sank. The pilot reported no preimpact mechanical malfunctions or failures with the airplane that would have precluded normal operation.

CEN25LA239	2025-07-05T09:31:00Z	Newaygo	None	0	0	0	
				Total	Total	Total	
				15	**3**	**15**	

Case: July 5, 2025 Plane Crash, Garfield Township

On July 5th, at 0931am, a single engine plane attempted to make an emergency landing in a field on the south east corner of M-82 and Felch Avenue in Garfield Twp. The plane was piloted by a 67 year old man out of Lake City Michigan. The flight plan was to leave Lake City and head to South Haven. During the flight, the plane ran out of gas and the pilot attempted to make an emergency landing in a field. The plane made a hard landing which caused landing gear damage and the plane eventually flipped onto its roof. The pilot was able to exit the plane uninjured.



An investigation determined that the pilot misread the fuel gauge on his preflight inspection. Finding from the investigation were turned over to the FAA and NTSB. The Sheriff's Office was assisted at the scene by the Newaygo Fire Department and Central Dispatch.



Waterway Transportation Accidents

Within Michigan there are 18 marine passenger ferry services. These services have a good safety record, having never suffered a serious accident that resulted in loss of life or property in recent history. Nonetheless, given the large number of trips that are made over Great Lakes waters every year, the possibility of a water transportation accident involving one of these vessels is still a possibility. Furthermore, should such an accident occur, the often-turbulent Great Lakes waters, coupled with the potentially large number of passengers on board, could pose tremendous obstacles to carrying out an effective water rescue and recovery operation.

The U.S. Coast Guard, local law enforcement marine safety units, and the ferry operator would provide primary rescue response to a Great Lakes marine passenger ferry accident. These agencies are highly trained and skilled in water rescue operations, but their resources may not be sufficient or their efforts timely enough to save everyone should a fully loaded ferry sink. Even with on-board life-saving equipment, some loss of life might be inevitable—especially in inclement weather and/or rough lake waters. In addition, hypothermia is a real concern—even in balmy Great Lakes waters in the middle of summer.

Drowning is the cause of death in 79% of all boating-related fatalities**.**
In 2020, there were 181 Michigan boating accidents reported, including:

- 33 fatalities - only 21% of people were wearing a life jacket.
- 20 drownings.
- $2,188,237 of property damage.

Newaygo County Waterway Transportation Accidents

While Newaygo County does not have any marine passenger ferry services, ports, or commercial cruise lines, the county is home to 234 natural lakes and 356 miles of rivers and streams. The following are recent fatal boat related accidents:

- **September 11, 2024:** A 66-year-old man from Hastings died from a medical emergency after his boat capsized on Frey Lake in Ensley Township. Both passengers were able to make it to shore, but the man collapsed afterward. The second passenger was treated at the scene.
- **August 12, 2018:** A woman from White Cloud was killed and a man was critically injured when a pontoon boat fell off its trailer while being towed in Lincoln Township. The driver was later arrested for operating under the influence causing death.

Transportation Accidents Vulnerability and Impacts:

Transportation accidents can have significant public health and life safety impacts, including loss of life, injuries and trauma, public safety concerns, and community impact. Fatalities resulting from transportation accidents can include passengers, transportation crew members, and by standards near the accident. Depending on the scope of the accident, the loss of life can profoundly affect the families and loved ones of the victims and the broader community affected by the accident. Survivors of transportation accidents may suffer various injuries, ranging from minor to severe, which can have long-lasting physical and psychological effects, requiring medical treatment, rehabilitation, and support services.

Transportation accidents also pose public safety concerns due to the potential for collateral damage or injuries to people near the accident. Depending on the circumstances and location of the accident, nearby communities may be exposed to risks such as fires, fuel spills, or debris hazards. Emergency responders and authorities work to mitigate these risks and ensure the public's safety in the aftermath of an accident. In addition, the emotional toll, economic consequences, and recovery efforts following an accident can affect the overall well-being and resilience of the community, leading to a profound impact on the communities in which they occur.

PUBLIC HEALTH

Public Health Emergencies

A widespread and/or severe epidemic, incident of contamination, or other situation that presents a danger to or otherwise negatively impacts the general health and well-being of the public.

Hazard Description

Public health emergencies can take many forms - disease epidemics, large-scale incidents of food or water contamination, extended periods without adequate water and sewer services, harmful exposure to chemical, radiological or biological agents, or large-scale infestations of disease-carrying insects or rodents. Public health emergencies can occur as primary events by themselves, or they may be secondary events another disaster or emergency, such as a flood, tornado, or hazardous material incident. The common characteristic of most public health emergencies is that they adversely impact, or have the potential to adversely impact, a large number of people. Public health emergencies can be statewide, regional, or localized in scope and magnitude.

Perhaps the greatest emerging public health threat would be the intentional release of a radiological, chemical or biological agent with the potential to adversely impact a large number of people. Such a release would most likely be an act of sabotage aimed at the government or a specific organization or segment of the population. Fortunately, to date Michigan has not experienced such a release aimed at mass destruction. However, Michigan has experienced hoaxes and it is probably only a matter of time before an actual incident of that nature and magnitude does occur. If and when it does, the public health implications – under the right set of circumstances – could be staggering.

Hazard Analysis

The primary types of public health impacts involve the threat or presence of either disease, contamination, or sanitation problems. Disease epidemics or pandemics have the potential to cause widespread debilitation or loss of life, associated medical expenditures, and decreases in productivity and quality of life. Contamination can at least temporarily lower property values, as well. Sanitation problems require effort and expense to resolve. Contamination and sanitation issues increase the probability and variety of diseases that may affect the population. Facilities may be shut down, as a means of preventing disease transmission or of containing contamination, and thus cause a loss of the services being provided to the public (by schools, for example).

Communicable disease outbreaks or epidemics have the potential to rapidly overwhelm the local healthcare system. Medical resources may become overwhelmed and unable to deal with any

additional needs. As traditional medical services become increasingly difficult to access (or if their quality declines due to overwork or understaffing) then increasing numbers may turn to less responsible and effective alternative means of treatment (or may forego treatment entirely).

Influenza is an example of a potential public health emergency of very large proportions. No one knows when the influenza virus might “shift” its structure to produce a virus to which no one will be immune. Influenza can exact a terrible toll on communities. During a typical influenza season, approximately 1,188 deaths in Michigan are expected. However, during the next influenza pandemic (a worldwide epidemic), as many as 10 to 100 times that many might die, without an adequate and well-organized public/community health care system to combat the disease. As hard as the world public health community is trying to conduct influenza surveillance in order to provide the most advance notice possible, if pandemic influenza were to strike it would likely do so very early in the season and spread so rapidly that preparation would need to be done on an emergency basis.

In the northern hemisphere, the normal flu season starts in November and ends in May. Flu viruses are amenable to chilly weather, and therefore predominate around the winter season in temperate climates. (Contagion may also be assisted by persons spending more time in indoor areas with less ventilation from outside.)

The world’s worst influenza pandemic—the “Spanish flu” of 1918-19—resulted in 500,000 to 675,000 deaths in the United States and 20 to 40 million worldwide. More than 25 million Americans—nearly one quarter of the population at the time—fell ill. Scientists speculate that the virus that caused that pandemic may have percolated for several years within humans, or possibly pigs, until it grew strong enough to kill millions worldwide. The virus spread rapidly—moving around the world in a matter of a few months—in a time period in which there was much less movement of people than there is today. The virus reached Michigan in the fall of 1918. Over 8,000 of the 2.8 million state residents fell ill and half of those eventually succumbed to the disease. In retrospect, the spread of the illness was felt to be exacerbated by behavior of important officials who had misguided concerns that the effects of “panic” might be more harmful than the disease itself—a notion that proved disastrous. The pandemic had an unusual aspect, however, in that many of those who died were persons who had been young and healthy, whereas the normal pattern for influenza deaths is to take a higher toll among those who are elderly or have compromised immune systems. (Note: As a sheer numerical comparison, the 1918-19 influenza pandemic worldwide death tolls came close to equaling the death tolls of the medieval Black [Bubonic] Plague that struck in the 6th, 14th, and 17th centuries. The number of U.S. deaths from the pandemic exceeded the number of U.S. soldiers killed on the battlefield in World Wars I and II, the Korean War, and the Vietnam War combined).

Two other major influenza pandemics occurred during the 20th century—the 1957-58 **“Asian flu”** that killed 70,000 in the United States, and the 1968-69 **“Hong-Kong flu”** that resulted in 34,000 U.S. deaths—each spreading with the same rapidness as the 1918-19 pandemic. The possibility is always there that another pandemic could occur at any time. The speed and frequency of modern global travel could greatly exacerbate the spread and potential impacts of future pandemics, forcing public health officials to race against the clock to prevent the death tolls experienced in past pandemics.

Influenza viruses are designated with letters and numbers. Three main groups exist (A, B, and C), and Influenza A contains those viruses that have the capacity to cause human pandemics. Within that main classification are more specific letter-number designations that specify two types of proteins on the outer part of the virus— hemagglutinin (H) and neuraminidase (N). There are 16 known types of H and 9 known varieties of N, and combinations of these protein types distinguish various strains of the Influenza A virus from each other. As of 2009, only three combinations—H1N1, H2N2, and H3N2—have been involved in viruses confirmed to spread directly from person to person. However, it is possible for other virus strains, such as those found in birds or swine, to change and become capable of infecting other species. In 1976, a swine flu outbreak occurred among humans stationed at the Fort Dix military facility in New Jersey, and was addressed with a mass vaccination program, although the vaccine itself was found to have a small (1 in 100,000) risk of causing the serious Guillain-Barré syndrome.

In 2005, an outbreak of influenza A (H5N1), also known as **"avian flu"** or **"bird flu,"** was reported in several countries throughout Asia. First identified in 1997 Hong Kong, cases of avian influenza A (H5N1) in birds were later confirmed in Cambodia, China, Hong Kong, Indonesia, Japan, Laos, Pakistan, South Korea, Thailand, and Vietnam. Human cases of avian influenza were reported in Thailand and Vietnam. In an investigation, it was not determined that the avian flu was spread from person to person. The outbreak of avian influenza prompted the killing of more than 25 million birds in Asia. This strain of avian influenza A (H5N1) was not found in the United States. However, in February 2004, different strains of avian flu were detected among several flocks of birds in the U.S., and state officials ordered the destruction of hundreds of thousands of birds. The avian influenza strain found in Delaware was H7N2, in Pennsylvania the strain was H2N2, and the H5N2 strain was found in Texas. The strain found in Texas was determined to be "highly pathogenic" to birds. However, the strain of avian influenza in Texas was not the same as the strain in Asia.

The World Health Organization (WHO) announced a substantial risk of an influenza epidemic in the near future. One of the primary concerns is that the virus could quickly spread across the World. In response, many countries have begun planning in anticipation of an outbreak. During the spring of

2009, a new influenza virus was identified. Studies showed that this new virus was different from what had normally circulated throughout the world. Humans are especially vulnerable because their immune systems had not been previously exposed to this virus, therefore allowing limited immune response. H1N1 (also called “swine flu,” in this case) has exhibited atypical presentation in human populations.

Over 90% of detected cases are in persons under 65 years of age. In comparison to other flu viruses, hospitalizations and deaths associated with H1N1 are dramatically higher in children and young adults. Also of concern, the virus has demonstrated the ability to develop resistance to antiviral medications. Thousands of cases of influenza-like illness were reported in Michigan during the last week of October 2009 alone. However, according to an Associated Press wire report (of September 29, 2010) regarding CDC recent studies, that strain of the “swine flu” no longer represented a major threat in the United States because most citizens came to show signs of immunity.

In addition to Influenza another outbreak occurred in 2014-2016 of Ebola. Ebola Virus Disease (EVD) is a rare and deadly disease in people and nonhuman primates. The viruses that cause EVD are located mainly in sub-Saharan Africa. People can get EVD through direct contact with an infected animal (bat or nonhuman primate) or a sick or dead person infected with Ebola virus. In The 2014–2016 outbreak in West Africa was the largest and most complex Ebola outbreak since the virus was first discovered in 1976. There were more cases and deaths in this outbreak than all others combined. It also spread between countries, starting in Guinea then moving across land borders to Sierra Leone and Liberia. A total of 28,616 cases of EVD and 11,310 deaths were reported in Guinea, Liberia, and Sierra Leone. There were an additional 36 cases and 15 deaths that occurred when the outbreak spread outside of these three countries. Overall, eleven people were treated for Ebola in the United States during the 2014-2016 epidemic.

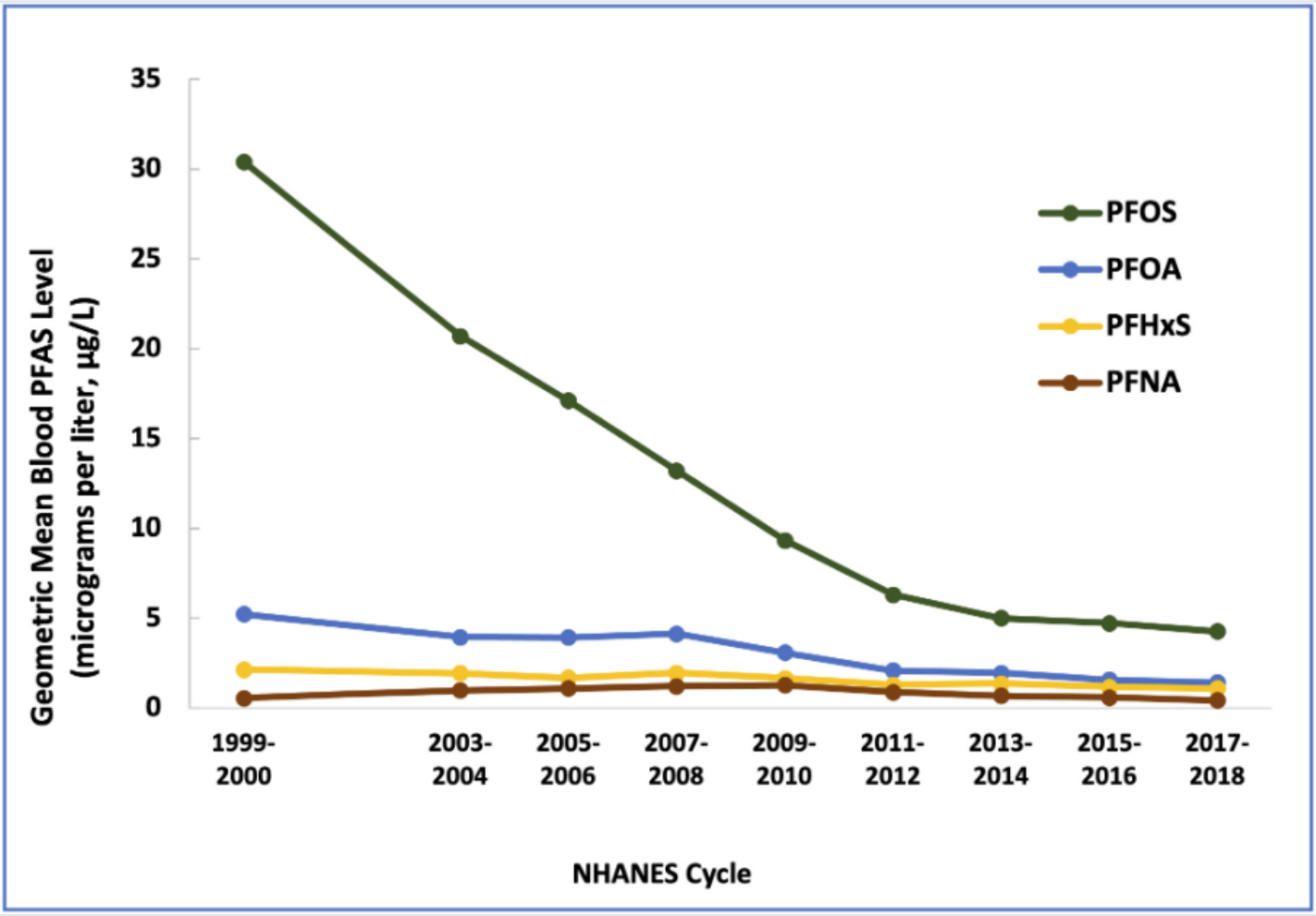
PFAS

According to the Centers For Disease Control, PFAS are man-made chemicals that have been used in industry and consumer products worldwide since the 1940s. They have been used to make nonstick cookware, water-repellent clothing, stain resistant fabrics and carpets, some cosmetics, some firefighting foams, and products that resist grease, water, and oil.
https://www.atsdr.cdc.gov/pfas/health-effects/index.html

Many scientific articles have been published about PFAS exposure and health effects. While it is difficult to show that substances directly cause health conditions in humans, scientific studies have shown that exposure to some PFAS in the environment may be linked to harmful health effects in humans and animals. More research is needed to better understand the health effects of PFAS exposure.

PFAS Monitoring

The NHANES program of studies was designed by the Centers for Disease Control and Prevention (CDC). It has measured the blood PFAS in the U.S. population since 1999-2000. The purpose of NHANES is to evaluate the health and nutrition of adults and children in the U.S. These data are publicly released in 2-year cycles.

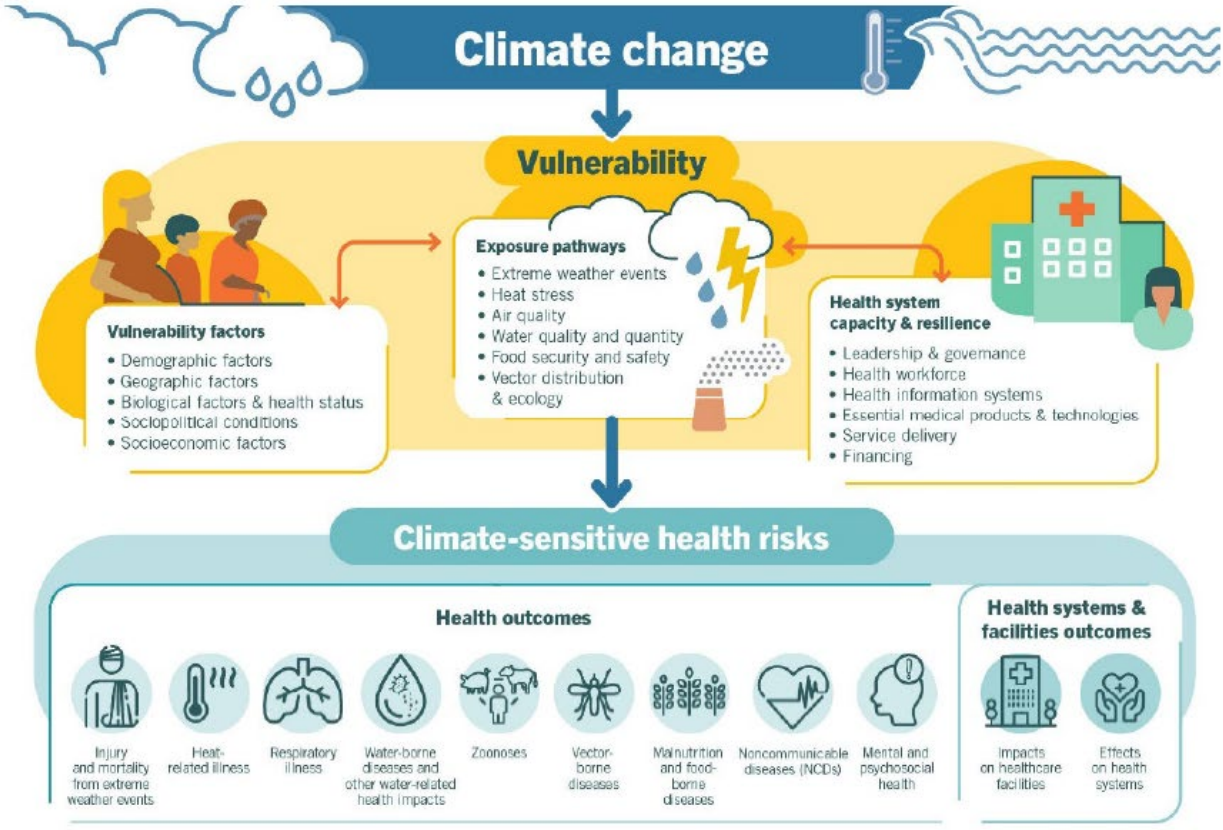


https://www.atsdr.cdc.gov/pfas/data-research/facts-stats/index.html

Climate Change

According to the World Health Organization, Climate change is the single biggest health threat facing humanity, and health professionals worldwide are already responding to the health harms caused by this unfolding crisis. Climate change is already impacting health in a myriad of ways, including by leading to death and illness from increasingly frequent extreme weather events, such as heatwaves, storms and floods, the disruption of food systems, increases in zoonoses and food-, water- and vectorborne diseases, and mental health issues. Furthermore, climate change is undermining many of the social determinants for good health, such as livelihoods, equality and access to health care and

social support structures. These climate-sensitive health risks are disproportionately felt by the most vulnerable and disadvantaged, including women, children, ethnic minorities, poor communities, migrants or displaced persons, older populations, and those with underlying health conditions.



https://cdn.who.int/media/images/default-source/health-and-climate-change/risk-pathways-climate-health.jpg?sfvrsn=3ba050b0_5&Status=Master

Public Health Emergencies within Michigan

Michigan has had several large-scale public health emergencies in recent history, but fortunately nothing that caused widespread severe injury or death. The 1973 PBB contamination incident is unprecedented in U.S. history, but the long-term implications of contamination may be less than was feared. Similarly, the northern Michigan water and sewer infrastructure disaster of 1994 is also unprecedented in scope, magnitude, and public health and safety implications for the affected communities. These events, though unusual, have heightened awareness of the broad nature of threats that can result in a public health emergency. Such emergencies no longer simply involve the spread of disease, but rather can arise out of a variety of situations and circumstances.

In 2001, Michigan health officials were introduced to the emerging health threats posed by **foot-and-mouth disease** and the **West Nile encephalitis virus**. Although foot-and-mouth disease is a highly contagious disease that only affects animals, a widespread outbreak such as that which occurred in parts of the United Kingdom in the spring of 2001 could have significant public health implications for humans as well, due to the potentially large numbers of dead animal carcasses that would have to be disposed of to prevent disease outbreaks. The Michigan Department of Agriculture and Rural Development, in conjunction with numerous other federal, state and local agencies and the agriculture industry, continues to monitor the foot-and-mouth disease situation and take the necessary steps to prevent the introduction and spread of the disease in the United States.

The West Nile encephalitis virus, which arrived in Michigan in August 2001, presents an equally challenging scenario for public health officials. Transmitted to humans by the bite of an infected mosquito, the West Nile virus is commonly found in Africa, West and Central Asia, and the Middle East. Health officials do not know how the virus was introduced to the United States. However, in 1999 and 2000, it caused an outbreak of human encephalitis in and around New York City that created a national stir and raised fears across the country that it would cause a full-blown public health emergency. The virus eventually spread to Michigan in 2001. It peaked in Michigan in 2002 with 644 reported cases, including 51 deaths. There has been a decline in reported cases every year since then.

Although no area in Michigan (or elsewhere) is immune to public health emergencies, areas with high population concentrations will always be more vulnerable to the threat. In addition, the more vulnerable members of society—the elderly, children, impoverished individuals, and persons in poor health—are also more at risk than the general population.

Michigan is fortunate in that it has an excellent public health system that constantly monitors the threats that could lead to a widespread or significant public health emergency. However, even the best monitoring and surveillance programs cannot always prevent such incidents from occurring. When they do occur, Michigan’s public health agencies have shown the ability to effectively muster the resources necessary to identify and isolate the problem, and mitigate its effects on the population. In addition, if the problem is such that a multi-agency and multi-jurisdictional response is required, the emergency management system in Michigan can be utilized to enhance coordination and effectiveness of the response and recovery effort.

The following are brief synopses of some of the more significant public health emergencies that have occurred in Michigan and other parts of the United States in recent years as highlighted in the 2012 Michigan Hazard Analysis:

Case: 1973 Chemical Contamination (Polybrominated Biphenyl Contamination)

One of Michigan's most serious statewide public health emergencies occurred in 1973 when a chemical company inadvertently sent bags of a fire retardant containing polybrominated biphenyl (PBB), a highly toxic chemical, along with a shipment of livestock feed supplement to Michigan Farm Bureau Services. After being mixed with the livestock feed, the contaminated mixture was distributed statewide for use by farmers in feeding livestock herds. The result was an environmental and public health disaster of unprecedented magnitude in Michigan. Thousands of cattle and other animals died from the poisoning and serious questions were raised regarding the long-term effects of this contamination on all Michigan residents.

Case: Spring 1997 Michigan Foodborne Pathogenic Contamination (Hepatitis A Outbreak)

In the spring of 1997, almost 300 cases of hepatitis A occurred in at least four Michigan school districts. A rapid epidemiological investigation by local, state and federal epidemiologists linked this outbreak to frozen strawberries distributed through the national school lunch program. Tracing of the implicated strawberries identified 13 different lots sent to several states in addition to Michigan. Several hundred Michigan schools were potentially affected. A massive program was instituted to evaluate risk at schools that received the frozen strawberries, to inform parents about immune globulin prophylaxis, and to provide it to recently exposed children. The prompt and insightful epidemiological investigation and rapid, well-organized response of the Michigan local health department system helped to prevent the occurrence of additional illnesses and to reduce community anxiety.

Case: November 2008 Holland, MI Norovirus Outbreak

About 420 Hope College students, faculty, and staff reported coming down with an illness from a noro-like virus in November 2008. Symptoms included diarrhea, nausea, and vomiting for 24 to 48 hours. The outbreak prompted the school and county health officials to close the campus and cancel activities starting November 7th, with students who stayed on campus restricted from gathering. Campus security and Holland police were asked to break up any parties or other student gatherings both on and off campus. The campus reopened four days later on November 11th and students were given a bag with plastic gloves, disposable wipes and bleach-based cleaning spray for sanitizing their rooms. Hand sanitizer dispensers were placed in about 40 locations on the Hope College campus to aid in the attempt to stop the spread of the norovirus outbreak.

Case: 2008 Multiple States Foodborne Pathogenic Contamination (Salmonella Outbreak)

In November 2008, Michigan joined a rapidly expanding investigation of a nationwide outbreak of Salmonella Typhimurium, which ultimately exceeded 700 cases from 46 U.S. States and from Canada. A total of 38 confirmed cases with onset dates between October 2008 and February 2009 were

identified in Michigan from 15 widely dispersed counties in the lower peninsula of the State. Of these, there were 12 reported hospitalizations. Two unusual features of both the Michigan and nationwide outbreak were noted very early in the investigation—the predominantly young distribution of the cases and the high frequency of exposure in institutional settings such as elementary schools, colleges, long term care facilities, and correctional centers. https://www.michigan.gov/documents/mdch/2009-2010_Influenza_Season_Summary_331957_7.pdf

Case: H1N1 Flu 2009-2010

From April 26, 2009 to May 29, 2010, 11,599 individual cases were reported into the Michigan Disease Surveillance System (MDSS). These cases occurred in two "waves" of activity, the first from the beginning of May 2009 through the beginning of July 2009 and the second during mid-September 2009 to mid-December 2009 (Figure 3). By comparison, 1557 cases were reported during the 2008-2009 influenza season. Five pediatric influenza-associated mortalities were reported to MDCH for the 2009-2010 influenza season; 84 adult mortalities were reported

Case: Lyme Disease 2016-2017

Lyme disease is caused by the bacterium Borrelia burgdorferi and is transmitted by the blacklegged/deer tick. It is the most commonly reported vector-borne disease in the United States and it is spreading across the state of Michigan. Typical clinical signs include flu-like symptoms however, if left untreated may spread to joints, the heart, and/or the nervous system. The majority of cases can be treated successfully with antibiotics. Finding and removing ticks promptly can prevent Lyme disease. In 2016, there were 164 reported cases of Lyme disease in humans in Michigan. In 2017, there were more than 300 human cases of Lyme disease reported, and approximately two out of three cases reported exposure in Michigan. http://www.mcgi.state.mi.us/midiseasemapper

Case: Statewide Hepatitis A outbreak 2016-2019

August of 2016 – July 2019, 865 people in Michigan contracted a Hepatitis A strain that passes from person to person. 700 were hospitalized and 27 died. Cases by Area: Detroit 172, Wayne County 145, Macomb County 221, Oakland County 119. St. Clair County 33, Ingham County 26, Genesee 24, Washtenaw and Monroe 18, and 15 in Shiawassee County.

Case: Eastern Equine Encephalitis 2019

EEE is a rare disease that is caused by a virus spread by infected mosquitoes. The EEE virus can cause inflammation of the brain encephalitis). In the United States, approximately 5-10 EEE cases in humans are reported annually. It is one of the most severe mosquito-borne diseases in the United States. According to the Centers for Disease Control and Prevention (CDC), approximately one-third

of the human cases of EEE are fatal. Michigan experienced its largest-ever outbreak of Eastern Equine Encephalitis (EEE), Eastern Equine encephalitis virus (EEE) infected 10 Michigan residents (1 Barry, 2 Berrien, 1 Calhoun, 2 Cass, 3 Kalamazoo, and 1 Van Buren) with 6 fatalities. EEE has also infected 49 animals (2 Allegan, 5 Barry, 1 Berrien, 3 Calhoun, 4 Cass, 1 Genesee, 1 Eaton, 1 Houghton, 5 Jackson, 9 Kalamazoo, 2 Kent, 1 Lapeer, 1 Leelanau, 1 Livingston, 1 Montcalm, 1 Newaygo, 7 St. Joseph, 1 Tuscola, and 2 Van Buren).https://www.mmdhd.org/eee/

Case: West Nile virus (WNV) 2019

has sickened 12 Michigan residents (1 Bay, 2 City of Detroit, 1 Genesee, 1 Kent, 2 Macomb, 1 Marquette, 1 Oakland, 1 Presque Isle and 2 Wayne) and routine testing of the blood supply identified WNV in 5 Michigan blood donors. https://www.michigan.gov/emergingdiseases/0,4579,7-186-76711_76752---,00.html

Case: Influenza 2019-2020

The flu season in the United States started in September 2019 and projected to be the worst in a decade. At least 250,000 people have been hospitalized with flu complications with 26 million Americans infected with a mortality of 14,000 (includes an unprecedented number of deaths of 105 Children) as of February 2020. https://www.cnn.com/2020/01/30/health/flu-deadly-virus-15-million-infected-trnd/index.html

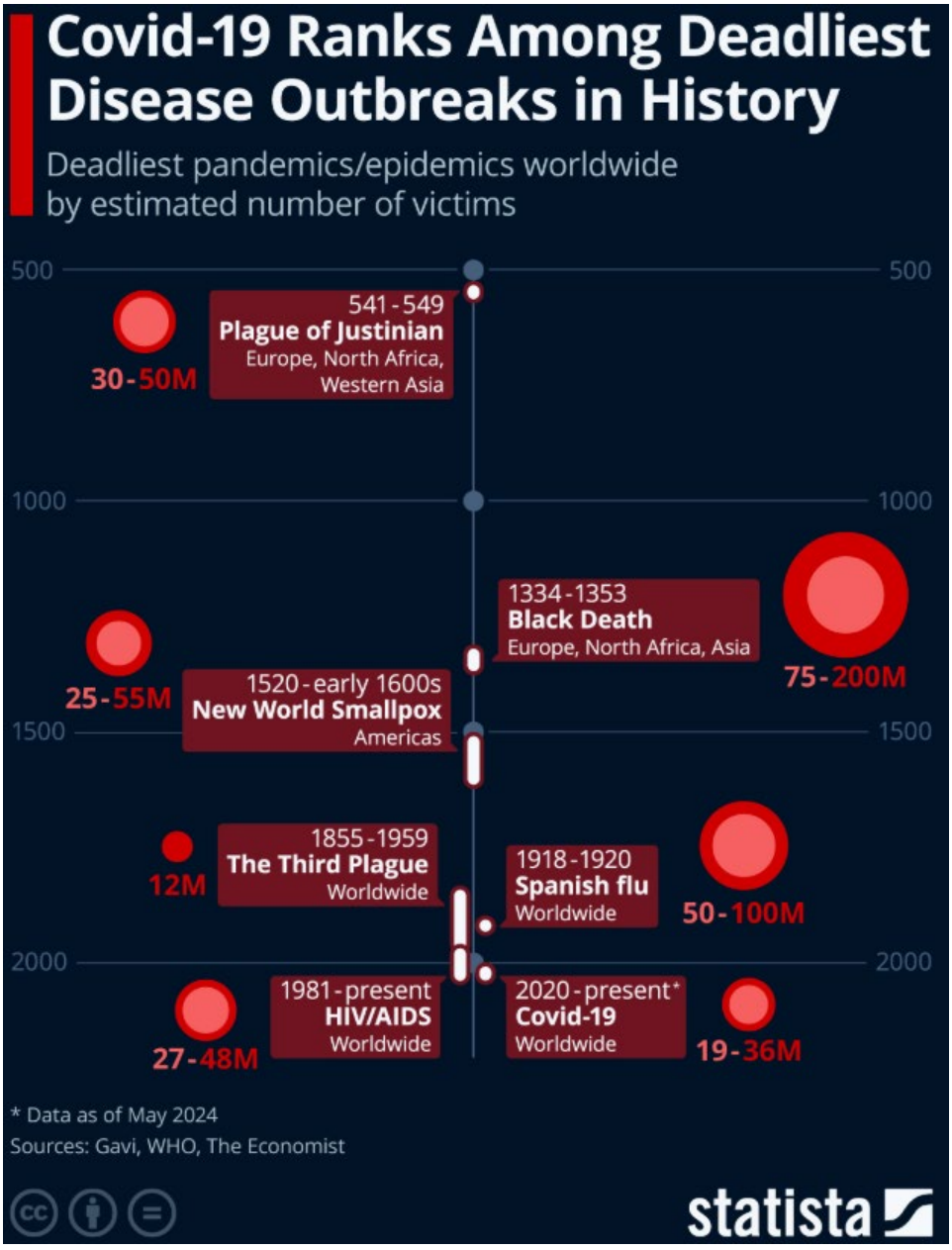
Case: Coronavirus (2019-nCoV) 2019-2023

First detected in December in central Chinese city of Wuhan linked to a food market with live animals. Coronaviruses are a group of viruses that can cause a range of symptoms including a runny nose, cough, sore throat and fever. Some are mild, while others are more likely to lead to pneumonia. They're usually spread through direct contact with an infected person. The coronavirus gets its name from the crown-like spikes on its surface, according to the Centers for Disease Control and Prevention. (Corona is Latin for crown.) Including the newly identified form of the virus, there are a total of seven coronaviruses that can infect humans, the CDC says. There is no specific treatment for the new virus, and no vaccine to prevent it.

The outbreak is coinciding with massive travel in and out of China in advance of the Lunar New Year on Jan. 25, and prompted the CDC last week to start screening passengers arriving from Wuhan at New York's John F. Kennedy International Airport, the San Francisco International Airport and Los Angeles' LAX. On Tuesday, the CDC announced that it would be screening passengers at two additional airports: Atlanta's Hartsfield–Jackson and Chicago's O'Hare. All passengers whose flights originate in Wuhan will be rerouted to one of these five airports. https://www.nbcnews.com/health/health-news/1st-case-coronavirus-china-confirmed-u-s-n1119486

Five years after the virus was declared a pandemic on March 11, 2025, worldwide deaths from Covid-19 are estimated at 19-36 million by sources like the World Health Organization and The Economist. This death count places the coronavirus among the deadliest disease outbreaks in recorded history. Epidemics and pandemics have taken their toll on humanity throughout the centuries and even though much has changed in the modern age, the devastation from the loss of life in disease outbreaks has remained the same.

Gavi, the global vaccine alliance, published data on the seven deadliest disease outbreaks in history in 2021 and even then, estimates of the extrapolated Covid-19 death toll already placed the pandemic among them. While Covid-19 might be more similar from an outbreak perspective to the Spanish flu pandemic of 1918-1920, another one is actually closer in time to it: The HIV/AIDS pandemic. First reported in 1981, the disease spread rapidly around the world and peaked at 1.6 million annual deaths in 2004. Since then this number has halved and experts believe that the pandemic as a public health threat can be ended by 2030 due to advanced medications and public health campaigns limiting the disease's spread. While fewer people die of AIDS today, the disease has claimed 27-48 million lives globally.



Wuhan coronavirus compared to other major viruses

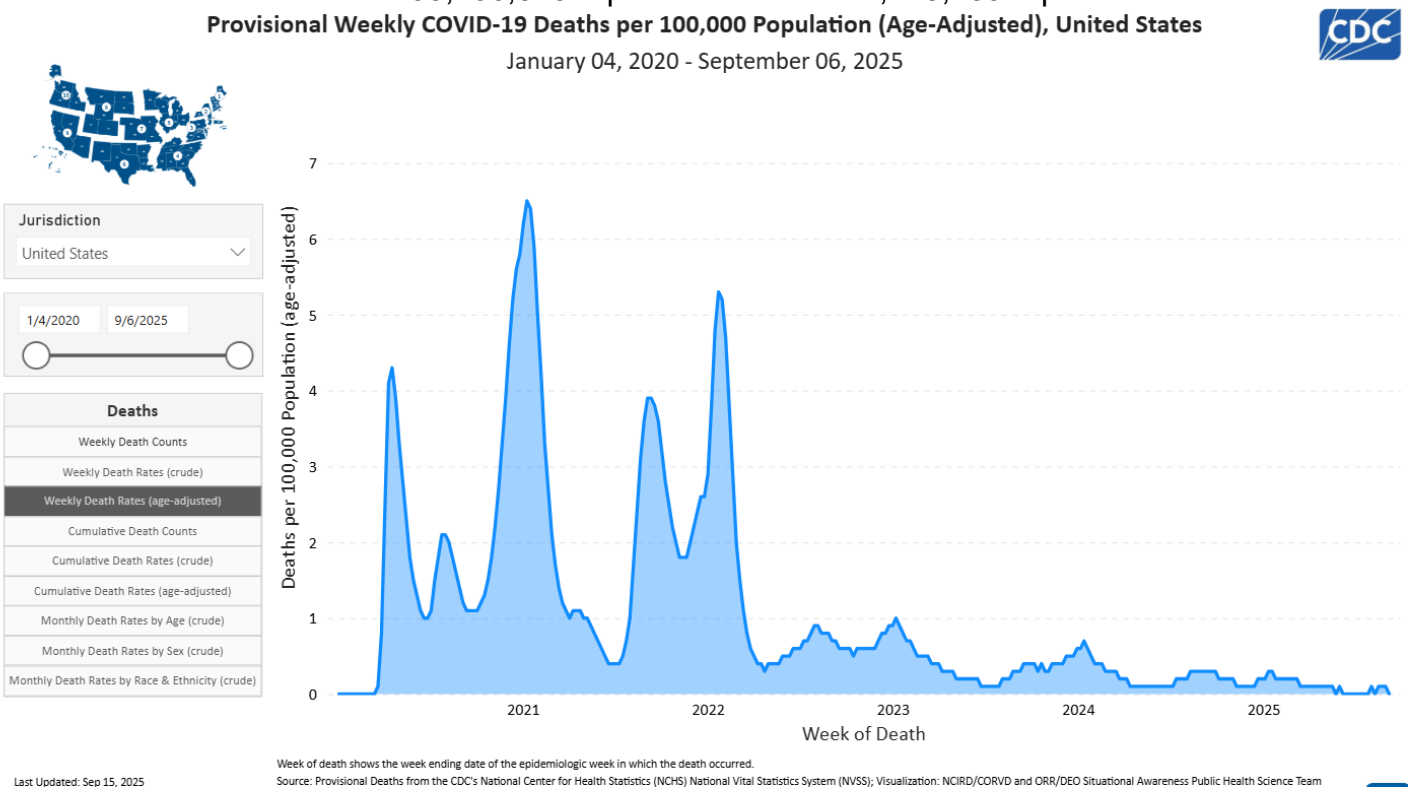
VIRUS	YEAR IDENTIFIED	CASES	DEATHS	FATALITY RATE	NUMBER OF COUNTRIES
Ebola**	1976	33,577	13,562	40.4%	9
Nipah	1998	513	398	77.6%	2
SARS	2002	8,096	774	9.6%	29
MERS*	2012	2,494	858	34.4%	28
COVID-19**	2020	60,349	1,370	2.2%	26

Sources: CDC; World Health Organization; New England Journal of Medicine; Malaysian Journal of Pathology

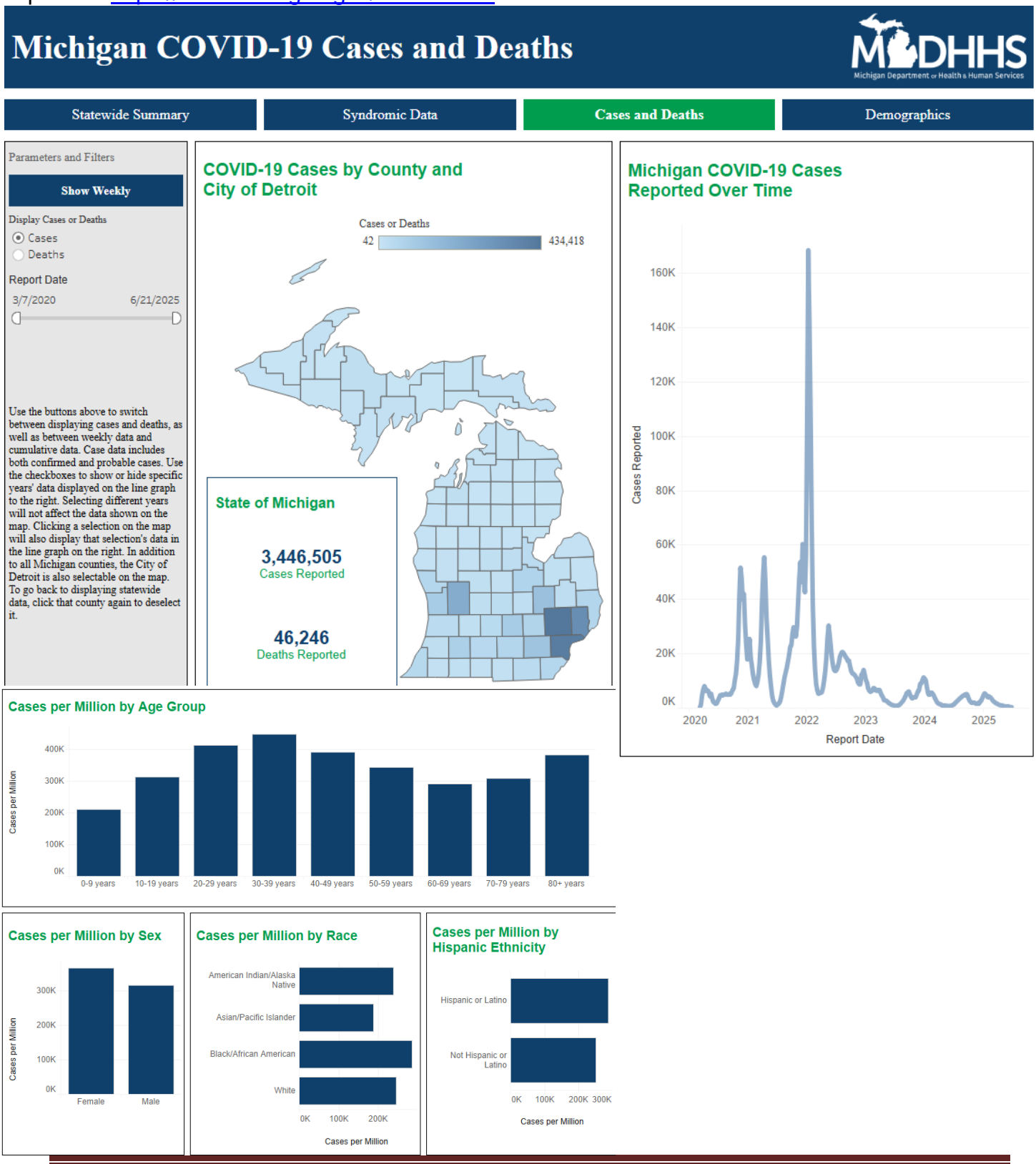
*As of November 2019 **As of Feburary 13, 2020

BUSINESS INSIDER

According to the World Health Organization COVID-19 dashboard, to date (as of October 7, 2025) there has been 778,691,725 reported cases across the World resulting in 7,102,530 reported deaths. In the United States there has been 103,436,829 reported cases and 1,228,289 reported deaths.



The Michigan Department of Health and Human Services (MDHHS) ceased updating its COVID-19 dashboard on June 30, 2025. The data and dashboard have been archived but will no longer be updated. https://www.michigan.gov/coronavirus



Case: Candida Auris 2021-2023

The fungus first emerged in the state in 2021. The state health department in Michigan reported about 199 patients have contracted Candida auris, an emerging fungus that the CDC says, "presents a serious global health threat" because it is difficult to identify with standard laboratory procedures, is resistant to anti-fungal drugs and causes outbreaks in hospitals and can lead to "severe illness." The fungus, a type of yeast, is usually found in health care facilities and has led to severe illness and sometimes death in hospitalized patients. Most of the cases are in Detroit and Wayne County, according to the Michigan Department of Health and Human Services. Other areas with confirmed infections include Oakland, Ingham, Livingston and Washtenaw counties, according to state data.

Case: Highly Pathogenic Avian Influenza 2022-2024

Highly pathogenic avian influenza (HPAI), commonly called “bird flu,” is a virus found among various species of birds. HPAI viruses can infect domestic poultry, which includes chickens, turkeys, pheasants, quail, ducks, geese, and guinea fowl. The virus also infects a wide variety of other birds, including wild migratory waterfowl. HPAI has even been detected in various species of mammals—presumably after the animals come into contact with infected wild birds. For more information on current detections in domestic poultry, livestock, and wildlife across the U.S., please visit the U.S. Department of Agriculture’s webpage.

The Centers for Disease Control (CDC) considers the risk to people from these HPAI infections in wild and domestic birds to be low. In 2022, widespread outbreaks occurred across the nation and Michigan. Multiple flocks were affected in Macomb, Menominee, Livingston, Washtenaw, Saginaw, Wexford, Branch, Oakland, Ingham, Tuscola, Lapeer, Genessee, Sanilac and Eaton counties. Approximately 35,100 turkeys were affected.

Current Status in Michigan’s Domestic Animals

As detections of highly pathogenic avian influenza continue to be discovered throughout Michigan, it remains vital for every producer to take steps to protect their animals. Cases of the disease continue to be found in Michigan’s wildlife and domestic animals. In March 2024, the virus was also detected in Michigan dairy cattle. Regardless of the species, biosecurity remains the best tool to combat HPAI. MDARD continues to diligently work with local, state, and federal partners to quickly respond to reports of HPAI, mitigate the spread of the disease, and provide additional outreach to producers, industry, and other key stakeholders

In 2024, due to an increased number of cases, MDARD established a weekly briefing call to provide an ongoing time to brief Local Emergency Managers and Local Health Departments on

the state's response to Highly Pathogenic Avian Influenza, to answer questions and flag issues EMs has at the local level, and identify items that need additional follow up or coordination. These calls continued through October 2024.

County	Record County	Animal	Facility Type	Year
Ionia	9	Dairy and Poultry	Backyard and Commercial	2024
Ottawa	9	Dairy and Poultry	Commercial	2024 – 2025
Gratiot	8	Dairy and Poultry	Commercial	2024
Clinton	6	Dairy		2024
Lapeer	4	Poultry	Backyard and Hunting Preserve	2022 - 2023
Menominee	4	Poultry	Backyard	2022
Ingham	3	Dairy and Poultry	Backyard	2022, 2024-2025
Macomb	3	Poultry	Backyard	2022
Monroe	3	Poultry	Backyard	2025
Muskegon	3	Poultry	Commercial	2022-2023
Allegan	2	Dairy and Poultry	Backyard	2024-2025
Isabella	2	Dairy		2024
Montcalm	2	Dairy		2024
Oakland	2	Poultry	Backyard	2022, 2025
Van Buren	2	Dairy		2024
Alpena	1	Poultry	Backyard	2025
Barry	1	Dairy		2024
Bay	1	Poultry	Backyard	2023
Branch	1	Poultry	Backyard	2022
Calhoun	1	Dairy		2024
Cass	1	Poultry	Backyard	2023
Eaton	1	Poultry	Backyard	2023
Genesee	1	Poultry	Backyard	2022
Jackson	1	Poultry	Backyard	2024
Kalamazoo	1	Poultry	Backyard	2022
Livingston	1	Poultry	Backyard	2022
Missaukee	1	Dairy		2024
Montmorency	1	Poultry	Backyard	2023
Newaygo	1	Poultry	Commercial	2024
Saginaw	1	Poultry	Backyard	2022
Sanilac	1	Poultry	Backyard	2022
Shiawassee	1	Dairy		2024
Tuscola	1	Poultry	Backyard	2022
Wayne	1	Poultry	Backyard	2025
Wexford	1	Poultry	Backyard	2022

https://www.michigan.gov/mdard/animals/diseases/avian/avian-influenza#current-status

Public Health Emergencies within Newaygo County

Newaygo County's concerns with Public Health emergencies result from a moderately low economic profile of the community and limited public health resources. Newaygo County contains extremely limited health care facilities including 1 rural hospital, 5 ambulances, less than 20 physician centers, and a public health department with limited resources and manpower. During even "usual" outbreaks of common illnesses, these resources become stretched to their maximum capabilities.

A contributing factor to this hazard lies in Newaygo County's position as a relatively moderate to low-income community with many families who are unable to take all steps necessary to insure primary health. This results in many citizens without current vaccinations, living in less than primary health conditions, and other factors (such as being unable to repair critical sanitary systems upon malfunction). In addition to Public Health emergencies, these factors are considered during planning other hazards that could be affected as a result of disease outbreaks, such as Mass Fatality Incidents and CBRNE Terrorism.

Most Public Health Emergencies will not be isolated to Newaygo County, but impact the entire state or Country as well. District Health Department 10 is committed to providing timely, accurate, and practical information to the citizens to assist them in taking appropriate precautions and actions to protect self and family in a public health emergency. The following table is a list of diseases that may soon reach pandemic proportions.

Possible Future Pandemics (diseases that may possibly attain pandemic proportions)	
Disease	**Description**
Lassa fever	The infection is endemic in West African countries, causing many deaths. Outbreaks of the disease have been observed in Nigeria, Liberia, Sierra Leone, Guinea, and Central African Republic.
Rift Valley fever	Rift Valley fever is a viral zoonosis causing fever. It is spread by the bite of infected mosquitoes. Approximately 1% of human sufferers die of the disease. Among livestock the fatality level is significantly higher.
Ebola virus	Ebola hemorrhagic fever is a very rare, but severe, mostly fatal infectious disease occurring in humans and other primates, caused by the Ebola virus. It was first discovered in 1976. Epidemics with 50 to 80% mortality have occurred in the Democratic Republic of the Congo, Gabon, Uganda and Sudan.
Marburg virus	The Marburg virus is the causative agent of Marburg hemorrhagic fever. Both the disease and virus are related to Ebola and originate in the same part of Africa (Uganda and Eastern Congo). The zoonosis is of unknown origin, but some scientists believe it may be hosted by bats.
Bolivian haemorrhagic fever	The Bolivian haemorrhagic fever, also known as black typhus, is a hemorrhagic fever and zoonotic infectious disease occurring in Bolivia. First identified in 1959, black typhus is caused by the machupo virus.
Avian flu	In November 2004 the director for the western region of the World Health Organization said that an influenza pandemic was inevitable and called for urgent plans to combat the virus. The Centers for Disease Control (CDC) claims that a flu pandemic could kill more than 200,000 people in the United States.

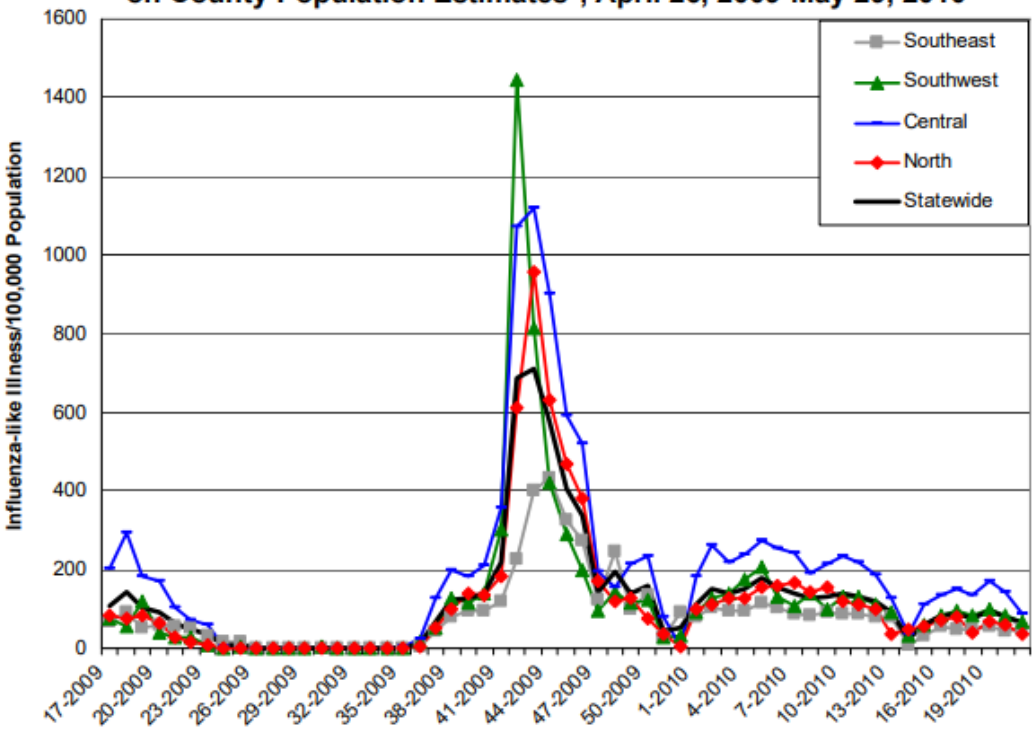
Source: Wikipedia online encyclopedia

Case: 2009-2010 H1N1 in Newaygo County

The 2009-2010 influenza season (defined as April 26, 2009 to May 29, 2010) saw the emergence and progression of a worldwide pandemic due to an influenza A (H1N1) virus. This virus was originally labeled as swine origin, but it is a human-adapted triple re-assortant virus, consisting of swine, avian and human influenza genes. The 2009 influenza A (H1N1) pandemic was the first influenza pandemic in 40 years.

The 2009-2010 influenza season had a markedly elevated level of activity compared to not only the 2008-2009 influenza season, but any previous influenza seasons in which similar surveillance methods were in place. The first pandemic influenza A (H1N1) virus isolated at the Michigan Department of Community Health (MDCH) Bureau of Laboratories was announced on April 27, 2009. While a small peak of pandemic influenza A (H1N1) activity was seen at the end of May during the first pandemic wave, the true peak of the season occurred in late October during the second pandemic wave. Pandemic influenza A (H1N1) viruses predominated during this season; other influenza virus subtypes were virtually nonexistent. Michigan reported “widespread” statewide influenza activity, the highest level of reporting to the Centers for Disease Control and Prevention (CDC), for seven straight weeks from the week ending October 17, 2009 through the week ending November 28, 2009. Peak activity in Michigan during fall 2009 occurred slightly later than most other states.

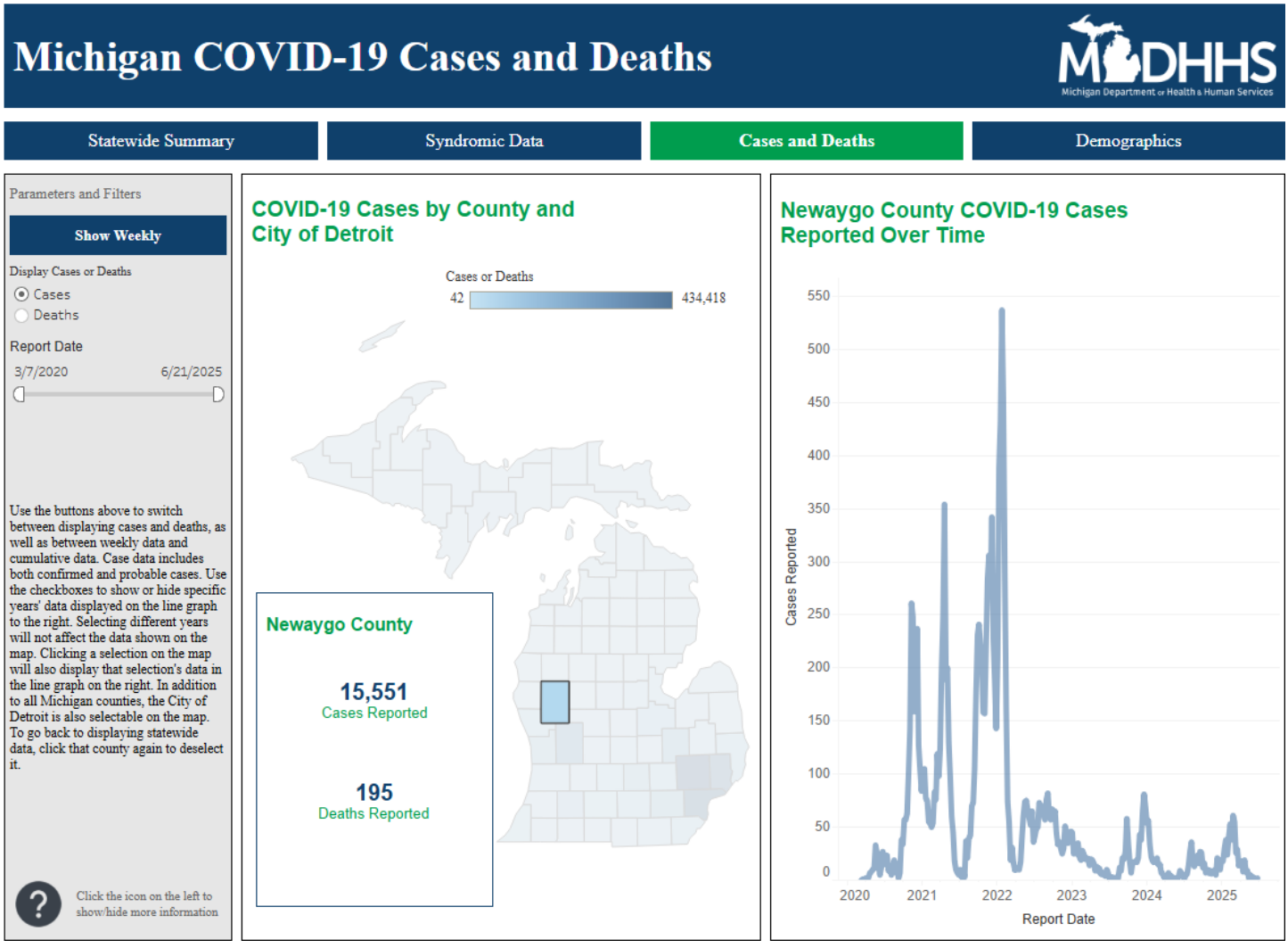
Figure 4. Rates of Aggregate Influenza-like Illness per 100,000 Population, Based on County Population Estimates*, April 26, 2009-May 29, 2010



Case: 2019 Eastern Equine Encephalitis 2019

Eastern Equine Encephalitis is a rare disease that is caused by a virus spread by infected mosquitoes. The EEE virus can cause inflammation of the brain encephalitis). In the United States, approximately 5-10 EEE cases in humans are reported annually. It is one of the most severe mosquito-borne diseases in the United States. According to the Centers for Disease Control and Prevention (CDC), approximately one-third of the human cases of EEE are fatal. Michigan experienced its largest-ever outbreak of Eastern Equine Encephalitis (EEE), Eastern Equine encephalitis virus (EEE) infected 10 Michigan residents (1 Barry, 2 Berrien, 1 Calhoun, 2 Cass, 3 Kalamazoo, and 1 Van Buren) with 6 fatalities. EEE has also infected 49 animals (2 Allegan, 5 Barry, 1 Berrien, 3 Calhoun, 4 Cass, 1 Genesee, 1 Eaton, 1 Houghton, 5 Jackson, 9 Kalamazoo, 2 Kent, 1 Lapeer, 1 Leelanau, 1 Livingston, 1 Montcalm, 1 Newaygo, 7 St. Joseph, 1 Tuscola, and 2 Van Buren).https://www.mmdhd.org/eee/

Case: Coronavirus Disease 2019



Total Positive Lab Confirmed Cases

The total positive lab confirmed cases represent the number of individuals who have received a positive COVID-19 lab test. While it is expected more individuals have had the virus but were not officially diagnosed, this number still helps us understand throughout the pandemic how many were confirmed with having COVID-19 and the trajectory of positive cases. Michigan's first confirmed case was on March 9, 2020. Newaygo County's first lab confirmed case was on March 23, 2020.

Hospital System Capacity

Being a critical access hospital - a designation given to eligible rural hospitals by the Centers for Medicare and Medicaid Services for facilities designed to reduce the financial vulnerability of rural hospitals and improve access to healthcare by keeping essential services in rural communities, Corewell Health Gerber Memorial has 24 inpatient beds (Med/Surg), 11 Intensive Care Unit beds, and 9 ventilators.

Case: Highly Pathogenic Avian Influenza April 16, 2024

Following a report to the Michigan Department of Agriculture and Rural Development (MDARD), the Michigan State University Veterinary Diagnostic Laboratory has detected the presence of highly pathogenic avian influenza (HPAI) in a commercial poultry facility from Newaygo County. From the MDARD press release, "Since the disease was first detected in Michigan in 2022, this is the seventh detection of HPAI in a commercial facility, and the first detection in Newaygo County. As wild birds complete their spring migration, it is crucial for every producer to protect their animals from wild birds and the germs they could be carrying."

Emerging Public Health Concerns - The Opioid Crisis, Vaping and Mental Health

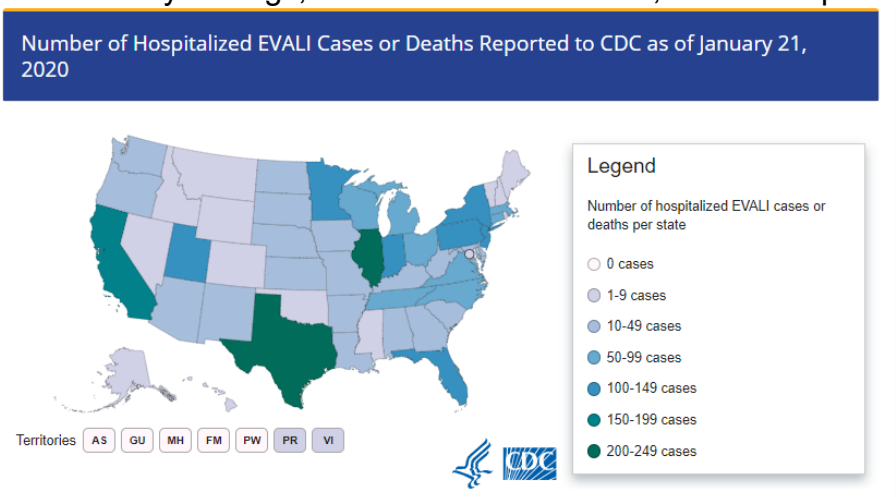
The Opioid Crisis 1990-2020

Every day, more than 130 people in the United States die after overdosing on opioids. The misuse of and addiction to opioids—including prescription pain relievers, heroin, and synthetic opioids such as fentanyl—is a serious national crisis that affects public health as well as social and economic welfare. The Centers for Disease Control and Prevention estimates that the total "economic burden" of prescription opioid misuse alone in the United States is $78.5 billion a year, including the costs of healthcare, lost productivity, addiction treatment, and criminal justice involvement. https://www.drugabuse.gov/drugs-abuse/opioids/opioid-overdose-crisis. Also, according to the Michigan Department of Health and Human Services, Opioid overdoses surged during the COVID-19 pandemic. Dr. Joneigh S. Khaldun, chief deputy for health and chief medical executive for the State of Michigan said, "Opioid overdoses kill far too many Michiganders, and it's a double tragedy that the pandemic has

exacerbated this crisis." COVID-19 resulted in these patients declining transport to the emergency department of hospitals. Press release July 29, 2020. Michigan.gov/Opioids

Outbreak of Lung Injury due to Vaping/E-Cigarette/related products 2019-2020

National outbreak of vaping, e-cigarette product use resulting in lung injury peaked August-September 2019. A total of 2,807 hospitalized cases or deaths have been reported to CDC from all 50 states, the District of Columbia, and two U.S. territories (Puerto Rico and U.S. Virgin Islands). 68 deaths have been confirmed in 29 states and the District of Columbia (as of February 18, 2020). The age range for deaths is 15-75 years of age. All patients have reported using e-cigarette products. Based on reports from several states, patients have experienced respiratory symptoms (cough, shortness of breath, or chest pain), and some have also experienced gastrointestinal symptoms (nausea, vomiting, or diarrhea) or non-specific constitutional symptoms (fatigue, fever, or weight loss). Symptoms typically develop over a period of days but sometimes can manifest over several weeks. Gastrointestinal symptoms sometimes preceded respiratory symptoms. Fever, tachycardia, and elevated white blood cell count have been reported in the absence of an identifiable infectious disease. Many patients have sought initial care in ambulatory settings, some with several visits, before hospital admission.



https://www.cdc.gov/tobacco/basic_information/e-cigarettes/severe-lung-disease.html#what-is-new

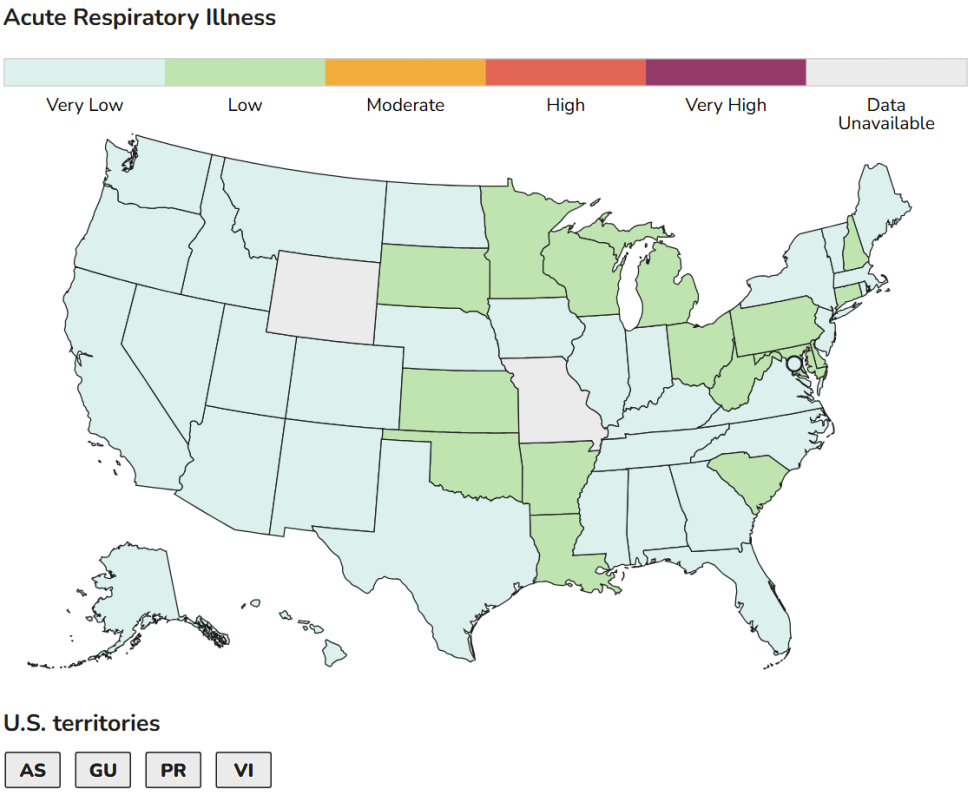
Seasonal respiratory Syncytial Virus (RSV)

In the United States, the timing of seasonal respiratory syncytial virus (RSV) epidemics (October– April) was disrupted during the COVID-19 pandemic. In the United States, respiratory syncytial virus (RSV) infections cause an estimated 58,000–80,000 hospitalizations among children aged <5 years and 60,000–160,000 hospitalizations among adults aged ≥65 years each year. U.S. RSV epidemics typically follow seasonal patterns, peaking in December or January but the COVID-19 pandemic disrupted RSV seasonality during 2020–2022.

https://www.cdc.gov/mmwr/volumes/72/wr/mm7214a1.htm

In April of 2023 the FDA approved vaccines for children and in May of 2023 the FDA approved Abrysvo (Pfizer) a vaccine for RSV for individuals 60 years and older that may help prevent the spread of the virus https://www.immunize.org/timeline/

The CDC tracks acute respiratory illness across the United States. Respiratory illness activity is monitored using the acute respiratory illness (ARI) metric. ARI captures a broad range of diagnoses from emergency department visits for respiratory illnesses, from the common cold to severe infections like influenza, RSV and COVID-19. It captures illnesses that may not present with fever, offering a more complete picture than the previous influenza-like illness (ILI) metric. https://www.cdc.gov/respiratory-viruses/data/activity-levels.html



Mental Health

New mental health issues have emerged among some special populations, such as:

- Veterans who have experienced physical and mental trauma

- People in communities with large-scale psychological trauma caused by natural disasters
- Older adults, as the understanding and treatment of dementia and mood disorders continues to improve
- For more info: https://www.healthypeople.gov/2020/topics-objectives/topic/mental-health-and-mental-disorders

According to the World Health Organization, 1 in 4 people are affected by a mental disorder at some point in their lives. By 2030 depression will be the leading cause of disease burden globally. **900,000 people commit suicide each year**. Suicide is the second most common cause of death among young people. 3 out of 4 people with severe mental disorders receive no treatment. On May 27, 2013, the World Health Assembly adopted the Comprehensive Mental Health Action Plan 2013–2020 that has great potential to change the direction of mental health in countries around the world in the next 8 years. This action plan and the accompanying resolution—a first in the history of WHO—represent a formal recognition of the importance of mental health for WHO's 194 member states. It is also a commitment by all member states to take specified actions to improve mental health and to contribute to the attainment of a set of agreed global targets. https://www.thelancet.com/journals/lancet/article/PIIS0140-6736(13)61139-3/fulltext

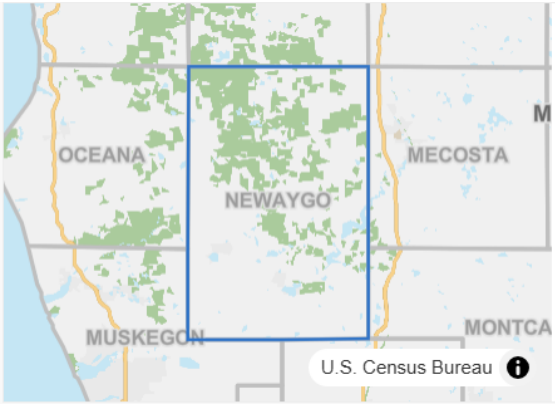
Public Health Incidents Vulnerability and Impacts:

Public health emergencies significantly impact health and safety. These emergencies often result in increased morbidity and mortality rates, posing a threat to the wellbeing of individuals and communities. They can lead to the rapid spread of infectious diseases, causing widespread illness and potentially overwhelming healthcare systems. Public health emergencies may also disrupt routine healthcare services, delay access to necessary treatments, and hinder the management of chronic conditions. Additionally, these emergencies can result in psychological distress, fear, and social disruption within affected populations.

Public health emergencies can disrupt essential services and infrastructure systems critical for public health and safety. For instance, healthcare facilities may experience increased demands and strains on resources, potentially affecting their capacity to provide adequate care. In addition, transportation networks, including airports and roadways, may face disruptions, impacting the movement of supplies, personnel, and patients. Public health emergencies can also affect the functioning of utilities such as water and wastewater systems, power grids, and communication networks.

Public health emergencies can often lead to disruptions in various sectors of the economy. For instance, lockdowns, travel restrictions, and social distancing guidelines can result in business closures, reduced

consumer spending, and job losses. Industries directly impacted by public health emergencies, such as hospitality, tourism, and retail, may experience a decline in revenue and profitability. Additionally, healthcare systems and public health agencies may face increased financial burdens due to the surge in service demand and the need to invest in emergency response capabilities.



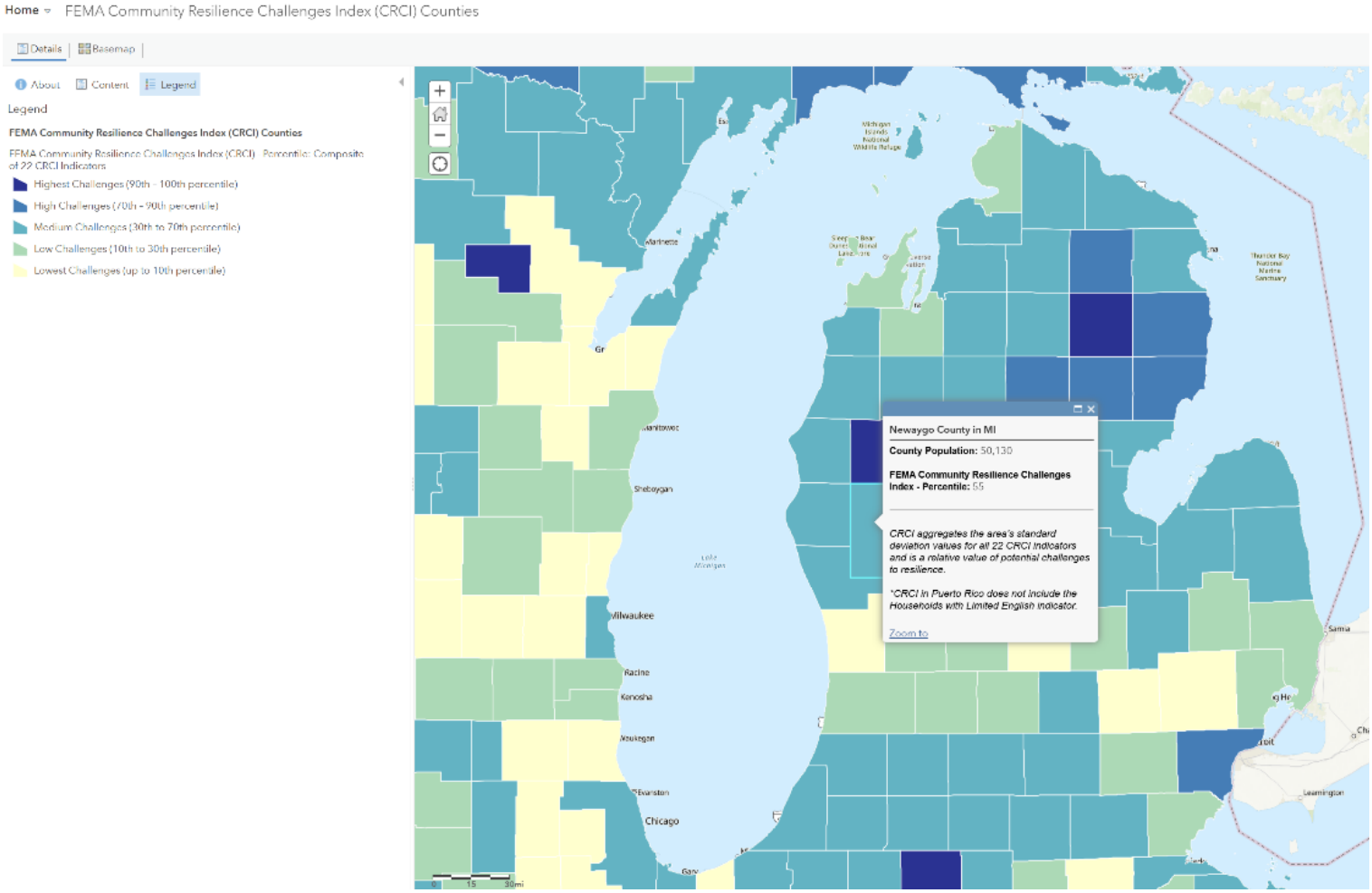
County

Newaygo County, Michigan

Newaygo County, Michigan has 838.9 square miles of land area and is the 17th largest county in Michigan by total area.

Total Population: 49,978
Median Household Income: $61,931
Bachelor's Degree or Higher: 18.4%
Employment Rate: 53.7%
Total Housing Units: 24,542
Without Health Care Coverage: 6.9%
Total Employer Establishments: 827
Total Households: 19,428
Hispanic or Latino (of any race): 2,969

View Profile



CRIMINAL INCIDENTS

Mass Violence and Terrorism

There is no universal definition of mass violence in the United States. The Federal Bureau of Investigation defines "mass violence" as a multiple homicide incident in which four or more victims are murdered, within one event, and in one or more locations in close geographical proximity. Note: the FBI definition appears to be designed on the basis of trying to identify profiles of perpetrators, so it excludes cases in which perpetrators kill family members unless large numbers of the general public are also killed. Likewise, cases in which killings occur as a part of another crime are excluded.

Terrorism: "…activities that involve violent…or life-threatening acts…that are a violation of the criminal laws of the United States or of any State and…appear to be intended (i) to intimidate or coerce a civilian population; (ii) to influence the policy of a government by intimidation or coercion; or (iii) to affect the conduct of a government by mass destruction, assassination, or kidnapping" Federal criminal code. 18 U.S.C. §2331

Mass Violence and Terrorism Hazard Description

Terrorism is a subset of mass violence. All terroristic acts that result in mass casualties can be classified as mass violence. However, not all mass violence is terrorism. The main difference between Terrorism and Mass Violence is that terrorism is specifically defined by its political or ideological motive, whereas mass violence is a broader term that can encompass terrorism but is primarily defined by the act of killing or injuring many people. While both use violence against civilians, terrorism's core purpose is to instill fear and coerce a population or government to achieve political or ideological goals, while mass violence doesn't always have this political component and can be driven by other motives like personal crises or mental health issues.

Feature	Terrorism	Mass Violence
Defining Motive	Primarily political, religious, ideological, or social.	Motives can be varied, including political, but also personal, psychological, or criminal.
Primary Goal	To intimidate or coerce a civilian population or influence government policy.	To harm or kill multiple victims, often in a public and indiscriminate way.
Scope	Acts are a specific type of mass violence.	A broader category that includes terrorism, mass shootings, and other incidents with multiple victims.
Examples	The 2016 Pulse nightclub shooting and the 2014 Charleston church shooting are often cited as examples of terrorism due to their ideological motives, as explained by VOA - Voice of America English News.	Mass shootings, acts of terrorism, and mass riots can all be considered forms of mass violence, notes the Missouri Department of Mental Health.

The distinction is important for law enforcement, policymakers, and researchers to understand the motivations behind an attack and to develop appropriate prevention and intervention strategies.

Terrorism Hazard Analysis

In April of 2019, Michigan State Police released this statement "It is important, however, for everyone to remain vigilant as we go about our daily lives. First and always, if you see something, say something", along with a list of Seven Signs of Terrorism to look out for:

1) Surveillance: Someone recording or monitoring activities. The use of cameras (either still or video), note taking, drawing diagrams, annotating on maps, or using binoculars or other vision-enhancing devices.
2) Elicitation: Attempts to gain information about military operations, capabilities, or people. Elicitation attempts may be made by mail, fax, telephone, or in person. This also includes the comings and goings of private business, places of worship or public buildings. Questions may be about security alarms, which doors are locked or deliveries both packages and U.S. Mail.
3) Tests of security: Any attempts to measure reaction times to security breaches or to penetrate physical security barriers or procedures in order to assess strengths and weaknesses. This includes private security or the police.
4) Acquiring supplies: Purchasing or stealing explosives, weapons, ammunition, etc. Acquiring military or other uniforms, decals, flight manuals, passes or badges (or the equipment to manufacture such items) or other controlled items.
5) Suspicious persons out of place: People who don't seem to belong in the workplace, neighborhood, business establishment, or anywhere else. Includes suspicious border crossings and stowaways aboard ship or people jumping ship in port.
6) Dry run/trial run: Putting people into position and moving them around according to their plan without actually committing the terrorist act. This is especially true when planning a kidnapping, but it can also pertain to bombings. An element of this activity could also include mapping out routes and determining the timing of traffic lights and flow.
7) Deploying assets: People and supplies getting into position to commit the act. This is a person's last chance to alert authorities before the terrorist act occurs. https://www.tctimes.com/news/michigan-state-police-tweet-warning-signs-for-terrorism/article_65d7c0fc-653c-11e9-904c-bb92d94c6056.html

Terrorism in the United States

Terrorism has been used for thousands of years, but modern terrorism developed in the 19th Century. The United States has suffered from terrorist attacks for more than a century: U.S. President William McKinley was assassinated by an anarchist terrorist in 1901, the Los Angeles Times building was destroyed in 1910, and Wall Street was bombed in 1920. Racial and religiously-motivated terrorism continued throughout the 20th century. A new wave of terrorism was instigated in the 1960s by left-wing radicals. This was followed by right-wing extremist terrorism in the 1980s and 1990s. All of these attacks were conducted by American domestic terrorists against other Americans.

The United States has also been the target of terrorists from other countries. Conflict in the Middle East led to many attacks on American targets overseas, primarily by Palestinian nationalist terrorists, as well as groups supported by Libya and Iran. Hijackings, kidnappings, and bombings of Americans occurred

throughout the 1970s and 1980s, and into the 1990s. By the mid-Nineties the danger had shifted toward attacks by violent Islamic extremist groups such as al-Qaeda. Al-Qaeda successfully moved their terrorist campaign inside of the United States homeland with the World Trade Center bombing in 1993 and the devastating 9/11 attacks in 2001.

The following case examples are highlighted from incidents which occurred across the Unites States as they influenced or changed public safety training and response protocols across the country.

Case: Oklahoma City Federal Building Bombing (1995)
On April 19, 1995, the Alfred P. Murrah Federal Building in Oklahoma City, Oklahoma, was attacked by a large truck bomb. The attack killed 168, injured more than 680, destroyed the building, and caused widespread destruction over a sixteen-block area. Although initially suspected of being carried out by international terrorists, the attackers were in fact anti-government domestic terrorists, one of whom had extensive Michigan connections. This attack is an example of right-wing anti-government terrorism. It also demonstrates the extensive destruction that can be caused to large buildings which lack adequate target hardening and security measures.

Case: April 20, 1999 Columbine High School Mass Shooting
The Columbine High School massacre was a school shooting and attempted bombing that killed 14 people and injured 20 others. The Columbine massacre was the deadliest mass shooting at a K-12 school in US history until December 14, 2012. It is still considered one of the most infamous massacres in the United States, and it is known for inspiring many other school shootings and bombings.

Case: September – November 2001 "Amerithrax"
Soon after the terrorist attacks of 9/11, letters laced with anthrax began appearing in the U.S. mail. Five Americans were killed and 17 were sickened in what became the worst biological attacks in U.S. history. The Amerithrax Task Force—which consisted of roughly 25 to 30 full-time investigators from the FBI, the U.S. Postal Inspection Service, and other law enforcement agencies, as well as federal prosecutors from the District of Columbia and the Justice Department's Counterterrorism Section—expended hundreds of thousands of investigator work hours on this case. Their efforts involved more than 10,000 witness interviews on six different continents, the execution of 80 searches, and the recovery of more than 6,000 items of potential evidence during the course of the investigation.

https://www.fbi.gov/history/famous-cases/amerithrax-or-anthrax-investigation.

Case: April 16, 2007 Virginia Tech Shooting
A student killed 32 people and injured 23 in two separate attacks on the campus of Virginia Tech.

Case: May 1, 2010 New York City Times Square Car Bombing Attempt
A car bomb was placed at Time Square but failed to detonate. Several days later, a Pakistani-American male was arrested in connection with the bombing attempt. He also had ties with the Taliban.

Case: December 14, 2012 Sandy Hook Elementary School Newtown, Connecticut

A gunman attacked Sandy Hook Elementary School and killed 26 people. The victims were 20 children between six and seven years old along with six adult staff members. The incident is the deadliest mass shooting incident at an elementary school in US history.

Case: April 15, 2013 Boston Marathon Bombing
Two bombs were detonated near the finish line of the 2013 Boston Marathon, killing at least three people, and leaving more than 180 others injured. Two suspects were identified. 1 was killed during a shootout with police in Watertown, Massachusetts in the early hours of April 19, and the other arrested nearby about 18 hours later. The two also shot and killed a police officer in Cambridge prior to the police chase.

Case: December 2, 2015 San Bernadino CA
A married couple, stormed a county health department's holiday banquet, fatally shooting 14 people and injuring 22 others while leaving a failed pipe bomb at the scene. Both perpetrators were shot and killed four hours later in a shootout with police forces. The pair pledged allegiance to Islamic State of Iraq and the Levant on the day of the shooting.

Case: June 12 2016 Orlando Pulse Nightclub
49 people were killed when an alleged lone-wolf gunman entered the Pulse gay nightclub. Hostages were taken and the perpetrator, was killed by local SWAT units. The FBI classified the attack as an act of "domestic terrorism" motivated by "Islamic leanings".

Case: October 1, 2017 Route 91 Harvest Music Festival, Las Vegas Mass Shooting
On October 1, 2017, a mass shooting occurred when the suspect opened fire on the crowd attending the Route 91 Harvest Music Festival on the Las Vegas Strip in Nevada from his 32nd-floor suites in the Mandalay Bay Hotel. The suspect fired more than 1,000 rounds, killing 60 people and wounding at least 413 others. The ensuing panic brought the total number of injured to approximately 867. This incident is the deadliest mass shooting by a lone gunman in American history.

Case: October 31, 2017 New York, NY
Motor Vehicle attack A pickup truck rammed into pedestrians near the World Trade center in New York, killing eight people and injuring 11 others. An ISIS flag and a note that read "Islamic State lives forever" in Arabic were found near the truck. The attacker was self-radicalized, and he had followed the Islamic State group's advice on social media on how to carry out vehicular attacks.

Case: November 5, 2017 Sutherland Springs Church Shooting, Texas
A gunman opened fire on parishioners during a Sunday service at the First Baptist Church in Sutherland Springs, Texas. The suspect killed 26 people and injured 22 others.

Case: October 1 - November 2018
United States A registered Republican Party member from Aventura, Florida sent mail bombs to various Democratic Party politicians and liberal media Biological Agents personalities and individuals including the CNN Headquarters across the United States. The perpetrator was arrested on October 26, 2018 and one year later in 2019 plead guilty to 65 felony counts such as using weapons of mass destruction in a terrorist attack.

Case: June 17, 2019 Dallas, TX
A gunman attacked the Earle Cabell Federal Building and Courthouse in Dallas, Texas, United States. No law enforcement officers, or civilians were injured in the shooting, though one person sustained a superficial injury when she was taking cover; the only casualty was the shooter who was killed by security. The gunman appears to have self-radicalized online, posting memes from an extremist far right organization including ideas about the Confederate States and Nazism, combining eco-friendly and libertarian ideas with far-right authoritarianism.

Case: August 3, 2019 El Paso, TX
A mass shooting took place at a Walmart store. Twenty-two people were killed, and 24 others were injured. A single gunman is suspected of committing the shooting. He was apprehended by police shortly afterward and arrested. The FBI is investigating the shooting as an act of domestic terrorism and a possible hate crime. The attacker released a manifesto before the attack, expressing support for and inspiration by the Christchurch mosque shootings, along with worry about Hispanic invasion, automation, large corporations, and environmental degradation. He quoted that "Hispanics will take control of the local and state government of my beloved Texas, changing policy to better suit their needs.

Case: May 24, 2022 Robb Elementary School Uvalde, Texas
A gunman attacked Robb Elementary School, killing 21 people and injuring 17 others. The victims were 19 children and two adult staff members. The suspect remained in the classrooms for 1 hour and 14 minutes before a tactical team breached the classroom and engaged the suspect, fatally shooting him. The incident is the third deadliest mass shooting incident at a K-12 school in US history.

Case: October 25, 2023 Lewiston, Maine Mass Shooting
An Army reservist carried out a shooting spree in Lewiston, Maine, killing 18 people and injuring 13 others. The initial attack occurred at the Just-In-Time Recreation bowling alley during a youth league event, followed shortly by a second shooting at the Schemengees Bar & Grille Restaurant. Following these events, the suspect escaped, prompting the Androscoggin Sheriff's Office to release his photograph identifying him as the suspect and the Maine State Police to initiate a homicide investigation and the most extensive manhunt in state history. Forty-nine hours later, on October 27, Maine State Police located him deceased from a self-inflicted wound.

Mass Violence and Terrorism in Michigan

The following are case examples of major mass violence incidents in Michigan.

Case: Bath School Disaster (1927)

On May 18, 1927, the Bath Consolidated School in Bath, Michigan, was the target of an attack with explosives. The bomber was probably motivated by personal revenge against the local school district (stemming from a taxation issue), and so this event is classified as criminal, rather than as a terrorist attack. Although many of the explosives failed to detonate, the bombs in the school killed dozens of students and teachers. The bomber also destroyed his home and farm with explosives. Immediately after the school attack, the bomber approached the rescue operations scene and detonated an explosive device carried in his vehicle, killing himself, local officials, and several bystanders. The final death toll was 45, with 58 additional persons injured. The Bath Disaster remains the second most deadly U.S. bombing attack, after the Oklahoma City Bombing, as well as the most lethal attack on an American school. This case also provides early examples of such tactics now in common use by terrorists, including a secondary device, suicide bombing, and car bomb.

Case: Michigan State University Agriculture Building Arson (1999)

On December 31, 1999, environmental terrorists affiliated with the Earth Liberation Front (ELF) set fire to the Agriculture Biotechnology Support Project, located in a classroom and office building at Michigan State University. The university was targeted because of its work on genetically modified crops. The fire was set when there were few people in the building. Damages to the building and research equipment totaled approximately $1 million. Four domestic terrorists from Michigan and Ohio were later tried and convicted in federal court for carrying out this attack. This attack, a similar attack against Michigan State in 1992, and an attempted attack against the Michigan Technological University Forestry Center in 2001 are all typical of attacks by environmental terrorist groups. These attacks generally are designed to cause property damage but few deaths and injuries. These attacks also demonstrate the vulnerability of universities and research centers to terrorist attack.

Case: Northwest Airlines Flight 253 Bombing Attempt (2009)

On Christmas Day 2009, Umar Farouk Abdulmutallab attempted to destroy Northwest Airlines Flight 253, approaching Detroit Metropolitan Airport. The weapon used was an explosive device provided by the “al-Qaeda in the Arabian Peninsula” terrorist group and hidden in his underwear. The device was small and easy to conceal, but was capable of damaging or destroying the airliner. The explosive failed to detonate properly and instead ignited and burned Mr. Abdulmutallab, who was then subdued by the plane’s passengers and crew. This attack demonstrates the potential effectiveness of even small bombs when used against vulnerable targets such as aircraft. It also demonstrates that international terrorism may be directed at targets in Michigan.

Case: Highway Shootings (2012)

During October 2012, a man shot at cars as they drove along and near a Michigan highway corridor in Oakland, Ingham, Shiawassee, and Livingston counties, over the span of several days. The first car was shot in Commerce Township on October 16th. On that same day, four more shootings occurred in Wixom. On the next day, another Commerce Township shooting took place near the same location as the first day. The northernmost shooting occurred in Perry on October 18th. On that same day, there were eight shootings

near the I-96 exit in Webberville. There was also an October 18th shooting in Howell, and six shootings in Wixom. About a week later, on October 27th, two shootings occurred along Grand River and I-96 in the area of Fowlerville, and a driver on I-96 reported being injured by a bullet (the only such instance reported). During his trial, the shooter claimed that shooting at vehicles was connected to a condition of mental illness. Investigators connected him with 24 shooting incidents in the area. In 2014, a Livingston County jury convicted him of terrorism and he was sentenced to 16 to 40 years. This was in addition to a sentence of at least 6 years received in Oakland County. It is possible that additional charges may be sought in Ingham and Shiawassee County. NOTE: Media headlines often simplified these incidents by referring to them as involving "The I-96 Shooter," even though most incidents did not involve Interstate traffic.

Case: Grocery Store Attacks May 2016

A man in Ann Arbor was arrested after spraying a liquid mixture of animal poison, water and hand cleaner on self-serve food bars in grocery stores. Over two weeks' time he targeted a number of grocery stores in the Ann Arbor Area as well as a dozen or more stores in Flint. He was arrested and charged with two counts of poisoning drink, medicine, or water supply. In spite of being found fit for trial he was not guilty by reason of insanity and involuntarily committed to a treatment facility.

Case: Stabbing attack at Flint Airport June 2017

A 51 year old Montreal man, a native of Tunisia, had a mission to kill and be killed. He researched "Gay Clubs" and "Baker College in Flint" and "Aeroport" on his laptop. He drove into the US via Champlain, New York and arrived in Flint five days later. He tried to buy a gun but failed. Instead he went to Bishop International Airport in Flint, spent some time wandering around outside of the security checkpoints, He then used a knife he had brought with him, to stab Lieutenant Jeff Neville with the plan to take the officer's gun and start shooting. Lt Neville was injured but continued to fight and was aided by a maintenance employee and other officers who coincidentally were in a law enforcement meeting in a nearby conference room. The attacker only succeeded in injuring the officer who was hospitalized, had surgery and has since recovered. The suspect admitted to planning the attack due to his hatred of the United States. During his trial he told the judge he wants to commit another act of terrorism, only do it "better" by killing people. He regrets not killing Jeff Neville during the attack and not having a machine gun to kill more people. He was convicted of committing violence at an international airport, interfering with airport security and committing an act of terrorism transcending national boundaries and will spend the rest of his life in prison. https://www.abc12.com/content/news/Amor-Ftouhi-gets-prison-for-Bishop-International-Airport-stabbing-508751021.html

Case December 30, 2018

A 32 year old White Cloud, MI man entered St. Patrick-St Anthony Catholic Parish Church in Grand Haven, MI and assaulted a parishioner that was setting up for Mass. The suspect broke a chair and used pieces of it to assault the victim. The victim fought back and called police. When police arrived and arrested him, they found he had placed Jumbo fireworks in multiple locations inside and outside the building. He had not lit them. Services were cancelled for that day.

Case: Kidnapping Plot November 2020
Nine individuals are accused of aiding with conspiring to kidnap Whitmer before the November 2020 Election. They are accused of providing materials to support terrorist acts, attempting to commit a felony as an associate or member of gang, and gun charges. Investigators have described three of the accused as anti-government extremists who were angry over coronavirus policies and restrictions imposed by the governor during the first year of the COVID-19 pandemic. Two of the suspects are founding members of the Wolverine Watchmen, which authorities described as “an anti-government, anti-law enforcement militia group.”

Case: November 30, 2021 Oxford High School Shooting
A 15 year old student shot and killed four classmates and injured seven other people at Oxford High School on November 30, 2021. The shooter pleaded guilty and was sentenced to life in prison. In a landmark ruling, his parents were also charged and convicted of involuntary manslaughter for failing to address warning signs and allowing their son access to a gun.

Case: February 13, 2023 Michigan State University Shooting, East Lansing
On February 13, 2023, a mass shooting occurred in two buildings on the campus of Michigan State University in East Lansing. Three students were killed, and five were injured.

Case: June 15, 2024 Rochester Hills Brooklands Plaza Splash Pad Shooting
On June 15, 2024, nine people, including two children, were shot at the Brooklands Plaza Splash Pad in Rochester Hills. The shooter fired multiple rounds at random into the splash pad before fleeing the scene in his vehicle. He was later discovered dead from a self-inflicted gunshot wound after a standoff with local law enforcement at his mother’s home, a half mile from the scene.

Case: September 28, 2025 Grand Blanc Church of Jesus Christ of Latter-day Saints Attack
On September 28, 2025, a gunman rammed his truck into a Church of Jesus Christ of Latter-day Saints in Grand Blanc Township, opening fire on the congregation and setting the building on fire. The attack left four people dead, including two from gunshot wounds and two from the fire. Eight others were injured, with ages ranging from 6 to 78. The suspect was an Iraq War veteran. He was killed by the police in a shootout outside the church.



Mass Violence and Terrorism in Newaygo County

Although Newaygo County has had limited history and experience with major criminal incidents, recent trends in school and workplace violence, domestic and international terrorism, and other man-made criminal actions have resulted in a new hazard concern for local officials. Local issues regarding such events have generally resulted from high profile national events and focused on the following potential: 1) school violence; 2) workplace violence; 3) sabotage/arson; 4) Prison Uprisings; 5) domestic/international terrorism. Based on historical occurrence, Newaygo County experiences a terrorism incident approximately once every decade.

In the late 1990's, high profile school violence events in Jonesboro, Arkansas and Columbine, Colorado resulted in a nationwide epidemic of school emergencies causing significant social, political, and economic issues throughout the United States. Locally, Newaygo County's largest schools of Fremont, Grant, Newaygo, White Cloud, and Hesperia experienced bomb threats and resulted in dramatic local efforts at school safety. Despite national attention on school violence diminishing, this hazard remains a primary aspect of the emergency management environment and local planning efforts focused on all-hazards safety for such public facilities.

Case: Gerber Products Mailroom Incident (2007)

Since Gerber Products was founded in the early 1920's, it has become Newaygo County's largest employer with close to 1,500 employees between the administrative building, the plant, bank, and insurance company. Gerber offers about 300 food products for babies, toddlers and infants as well as a baby care line, wellness products and life insurance. Gerber is active in more than 50 countries. In 2006, Gerber had un-audited net sales of USD $1.6 billion and operating income of USD $307 million. The Gerber Plant in Fremont supplies product throughout the United States and Canada.



In 1994, Gerber merged with Sandoz Laboratories. In 1996, Sandoz merged with CIBA-Geigy to form Novartis, one of the largest pharmaceutical companies in the world. When Novartis merged Gerber in 1996 it moved Gerber's corporate office to Parsippany, New Jersey. Since 1994 when Gerber Products merged with Sandoz Laboratories, big corporations have controlled a majority of all employment decisions from a remote location for the Fremont facility causing tension amongst local employees unsure if there would be layoffs or other changes in job status locally.

On April 12, 2007 Novartis announced that it would sell Gerber to Nestle, the world's largest food and drink company for $5.5 billion, giving Nestle Corporation the largest share of the global baby food market. Gerber Products is the largest employer in Newaygo County and it dominates the United States baby food market with a 70 percent share according to Morgan Stanley.

The same day as the sale to Nestle, an employee opening mail reported having a reaction, burning eyes and skin and a scratchy throat, to an unknown powdery substance contained in one envelope with a threatening note and no return address. Based on the conditions surrounding the threat, the Regional

Response Teams from Muskegon and Grand Rapids who are specially trained to deal with Chemical, Biological, Radiological, Nuclear or energetic devices related to potential terrorist activities, were activated along with the F.B.I. to respond to the scene to assist first responders with the Incident. 12-15 employees exposed to the unknown substance, later identified by the Michigan State Police Crime Lab in July as Capsaicin, which is a brown powder that is used in pepper spray, were decontaminated and given courses of Ciprofloxacin and Doxycycline were given as a precautionary measure. After further investigation, it is believed the sale of Gerber Products to Nestle and the letter mailed from Boston containing the Capsaicin were not related. The investigation was turned over to the FBI.

Case: March 8, 2021 Newaygo High School Explosion

On 3/08/2021 at 8:52 AM Newaygo Police Department Officers were dispatched to the Newaygo High School for an explosion inside a classroom. Preliminary investigation determined that a 16-year-old student accidently detonated a homemade explosive device he brought to the school. The device detonated in the classroom, injuring the 16-year-old and four additional classmates.

High School Administration dialed 911 and emergency services arrived on scene. The 16-year-old was taken to the hospital for moderate-severe injuries while four others were sent to the hospital for minor injuries. The four students with minor injuries were transported to the hospital by their parents. The classroom teacher also sought treatment at the hospital.

The school was immediately evacuated and students were transferred to the bus garage. All Newaygo County Schools went into lockdown according to county emergency operations plan until information was obtained that there were no further threats to students. Due to the smoke from the explosion, a need by our investigative partners to be in the building, and student safety, a collaborative decision was made to dismiss high school students for the day and a family reunification plan was released. K-8 students remain in session and there is no threat in these buildings.

This incident was an activation of the Newaygo County Critical Incident Policy with 66 different responders involved from over 20 agencies.

Case: December 8, 2021 Newaygo Public Schools

On November 30, 2021, Michigan experienced its first mass shooting inside a school. This incident took place at Oxford High School located in Oakland County on the east side of the state. After this incident, districts across the state experienced a statewide epidemic of school threats. All districts in Newaygo County began experiencing bomb threats, threats of violence, and other hoaxes.

On Monday, December 6, 2021, Newaygo Police Department took a bomb threat complaint at the High School. The threat was rapidly identified, contained, and isolated by the Newaygo Police Department School Resource Office. A visual inspection of the classrooms, hallways, and lockers was made by school administrators and law enforcement. After further investigation, the threat was deemed non-credible, and school continued under normal operations. A juvenile, age 15, was removed from the school building and charged with making a threat of terrorism against Newaygo High School by the Newaygo County prosecutor. The following day school was closed for a Snow Day.

On Wednesday, 12/08/2021 at 8:49 AM Newaygo Police Department School Resource Officer was notified of a threat of violence in the High School. The Officer quickly coordinated with the building principals and began implementing the School's Emergency Plan. At 9:06 AM a student located in the High School made a bomb threat and at 9:07 AM a student located in the Middle School made a bomb threat. Based on the situation and unknown location of one of the suspects, the Newaygo Police Chief placed the Newaygo High School and Newaygo Middle School in Lockdown and the Newaygo Elementary School was placed in Secure Mode.

As the situation progressed, Unified Command was established at Newaygo City Hall and a parent holding area was established at Resonate Church in Newaygo. All schools within Newaygo County were placed in Secure Mode until the suspect who made the verbal threat of violence was located and secured. Secure Mode was lifted for the neighboring schools at 10:45 AM. Out of an abundance of caution, the Michigan State police Bomb Dog did sweep the Newaygo Middle School and Newaygo High School. This sweep took place just after 1pm and did not locate anything. Two juveniles were removed from the school and taken into custody around 12:50 PM. While all these threats were eventually found to be not credible, one of the juveniles, age 12, was charged with threatening to commit an act of violence against the Newaygo Middle School. All Newaygo Public Schools were released from Secure Mode at 1:50 PM and students were dismissed at their normally scheduled time.

This incident was an activation of the Newaygo County Critical Incident Policy with 66 different responders involved from 19 agencies.

Case: October 31, 2024 Grant Public Schools Swatting Incident

At 11:53 AM Newaygo County Central Dispatch received a phone call from the Veteran's Crisis Line reporting they received a threat from a Mark Pulla stating he was walking into Grant High School with a loaded AR-15. At 11:58 AM the Grant Police Department School Resource Officer reported Grant High School was in Secure Mode and no unusual activity was taking place at the school. As a precaution all schools within Grant Public School District were placed into Secure Mode and Law Enforcement conducted a rapid sweep of the buildings. Newaygo County Central Dispatch received a follow up phone call from Special Agent reporting there were 15 open cases across the country from the same IP address originating in France. The calls all reported "Grant High School" and they were going into the school with an AR15 and shooting. All calls were saying slightly different things and using different names. At 12:33 PM Grant Police Chief Patterson declares the incident a Swatting and releases the schools from Secure Mode as there is no threat.

Civil Disturbances

Collective behavior that results in a significant level of lawbreaking, perceived threat to public order, or disruption of essential functions and quality of life.

Civil Disturbances Hazard Description

Civil disturbances can be separated into several sub-categories of disturbance that could affect a community. Since most of these types of disturbance share similarities with each other, and the classifications presented here are not absolute and mutually exclusive, it is recommended that this entire section be studied as a whole. The descriptions that follow, while roughly organized by type of disturbance, provide information of interest in evaluating and understanding all types of civil disturbance, and therefore should not be treated as independent subsections or read in isolation from each other.

1. Disturbances that center around a particular facility: the facility could be a prison, a courthouse or other center of government, a stadium or other public meeting place, where large numbers of people may at some point gather in a disruptive fashion that is threatening to the community, its businesses, residents, or quality of life. Typically, a risk assessment would examine the history of the facility, and similar facilities in other communities. Such historical information might identify particular conditions that may cause collective behavior to get out of hand. The degree to which a community contains facilities and conditions that have been associated with civil disturbances will indicate the amount of risk that it faces from civil disturbances.

2. Disturbances that arise in general areas experiencing conflict and hardship: This refers to neighborhoods or regions that have experienced one or more economic, social, or political stresses such as poverty, ethnic intimidation, corruption, and/or the notable presence of illegal activities. These ongoing conflicts and challenges may sometimes flare up into more widespread and blatant conflicts and unrest. The important things to recall about these sorts of civil disturbances is that it is the presence of these conflicts and problems (rather than a particular ethnic or demographic composition) that eventually generates broader disturbances. Care must be taken not to inappropriately "profile" areas based on the characteristics of their residents.

3. Disturbances that interfere with normal business functions: Sometimes, protests are organized in a way that is deliberately designed to disrupt the normal operations of one or more businesses and may also happen to disrupt surrounding business operations or traffic flows nearby. Many such incidents are political, and eventually addressed through court actions or legislative proceedings. Labor negotiations may have associated employee unrest, including strikes. Protesters may object to the existence of specific facilities or businesses, or their location in a specific area, and while seeking to make such a business or its associated activities illegal, may attempt to take more direct action against its employees or patrons. Typically, the perceived harm from such businesses are either from environmental impacts or injury to persons, or social impacts concerning the image or moral standards associated with an area. In other cases, a political demonstration may not have anything to do with the sorts of facilities or businesses in an area, but merely seeks the most crowded and inconvenient location so as to maximize the attention that it receives.

There is no specific "formula" recommended here for analyzing civil disturbance hazards, but it is probably helpful to include a historical approach that specifically addresses the social conflicts and political controversies affecting disturbance-prone areas of a community. The various costs of past events (crowd control, vandalism, arson, business disruption and closures, injuries, diverted traffic, negative economic impacts) can be estimated along with their past frequency (e.g. three times in the past hundred years) so as to produce an estimated annual cost. The history of cities with similar conditions can also be analyzed in this way, because the risk of a disturbance may be present even though there have not yet been any historic local events. This is particularly true for communities with newly-developed facilities, in rapidly growing areas, or experiencing significant social and economic changes. Their risk of civil disturbance may be increasing but there is not yet a local history of incidents that can be generalized from.

Impact on the Public

Civil disturbance impacts may include deaths and injuries, disruption of services, and short- and long-term damage to a community's tranquility and reputation (which may also affect its property values). Temporary or permanent business closures may be caused by broken windows, looting, arson, etc. Fear (and its associated security costs) may discourage visitors, shoppers, and tourists, and further cause economic impacts on the area (and associated declines in its property values). Direct property damage can be expected to cause inconvenience, at the very least, to area residents and businesses, and there is a further problem of impeded access to the area's services, and to residents' own personal property.

Impact on Public Confidence in State Government

If discontent underlies a disturbance, some persons may generalize, displace, or attribute the source of their discontent to local or state governments. Some discontent may actually be aimed toward government policies involving the environment, housing, land use, wealth distribution, taxation, military conscription, foreign affairs, labor issues, infrastructure provision, civil rights, or other issues. Although government programs often exist that attempt to address these types of concerns and to ensure that particular values (e.g. civil rights) are respected and supported throughout the jurisdiction, widespread or widely publicized disturbances or demonstrations may undermine the effectiveness of governmental programs and thus weaken public confidence in government. Other types of civil disturbance, such as wild festivities after a sporting event, may undermine public confidence in government if a pattern develops in which illegal behaviors become repetitive and widespread.

Impact on Responders

Frustration and anger may be displaced toward responders, and many citizens may not understand the nature of the motivations, rights, or responsibilities involved in either protest or policing actions. Responders may face unwarranted hostility from citizens, for many reasons, and response activities may be impeded by disruptions taking place. Response, medical facilities, communications, or transport capabilities may be overwhelmed. Psychological impacts on responders may arise from role conflicts and the nature of some of the participants involved in the disturbance (which has some differences when compared with "ordinary crime").

Impact on the Environment

Civil disturbances that stem from labor unrest (or other problems with industrial relations) may involve sabotage that causes the release of harmful substances or otherwise damages the ecosystem in an area. Civil disturbances that involve disruptive forms of collective behavior may include the lighting of fires that release toxins, especially when non-traditional manufactured items are used as fuels. Damage to property may, accidentally or deliberately, include sites that contain hazardous materials. Unruly crowds may disrupt or prevent needed maintenance activities by utility repairmen or industrial workers and thus inadvertently cause environmental problems to occur because of resulting infrastructure failures.

Civil Disturbances Hazard Analysis

Violent protests, disturbances, and riots have occurred throughout our nation's history. The Stamp Act Riots in the American Colonies in the 1760s, the "Boston Tea Party," and the Revolution itself involved riots and insurrection, as discontent escalated into organized international conflict. Though these events have occurred in the past, they are not considered an acceptable part of ordinary modern life. Although destructive civil disturbances are rare, the potential is always there for an incident to occur. It is possible that risks for future disturbances may be exacerbated today by the ability of modern mass media (television, radio, the Internet, and various wireless communication devices) to instantly relay information (factual or not), in real time, to large numbers of people. That coverage may help to spread awareness of protests, discontent, riots, disorderly "parties," or other incidents to other areas or interested groups and persons, potentially exacerbating an already difficult situation. For example, media coverage of certain events has, in the past, spurred uprisings inside prisons. Communications technologies were also important in swelling the numbers of "Cedar Fest" revelers in recent East Lansing disturbances. Real-time media coverage of unfolding events is a fact of modern life that is inescapable. As a result, law enforcement officials must be skilled in monitoring all forms of media coverage to anticipate public and perpetrator actions and event progression.

<u>Civil Disturbance in Michigan</u>

Case: Detroit Connor's Creek Labor Strike and uprising (April 18, 1894)

During the depression of the 1890s, an excavation project for a water main, just east of the city's boundary at the time, was manned by some 300 workers, who revolted at the conditions for wage reimbursement that the city Water Board had set (estimated at only about one-third of already established wage rates). The workers demanded a higher wage, and stayed on the site throughout that day and the next, to prevent any other workers from being brought in to replace them. On the third day, men arrived from the Wayne County Sheriff's Office, but only succeeded in annoying the workers. A project foreman was attacked by a worker, and the scene quickly exploded into violent chaos when gunshots followed the attack. The mob of workers with picks and shovels surged around the armed lawmen and the project's foremen. Although the violence lasted only a few minutes (resulting in the beating of the foremen and law enforcement officers), there were about 20 serious injuries, and a total of three persons ended up dead from gunshot wounds. By the end of the day, 21
persons had been arrested. Mass meetings took place on April 22, at which many thousands of ethnic workers gathered to press for policy changes.

Case: 1981 Jackson, Marquette, and Ionia Counties Prison Uprising

The second major prison uprising in Michigan occurred over the Memorial Day weekend in 1981 at the State Prison of Southern Michigan in Jackson, Marquette Branch Prison in Marquette, and the Michigan Reformatory in Ionia. The uprisings, which occurred on May 22 at Jackson and Ionia, and again on May 26 at Jackson and Marquette, were thought to be related. Although all three facilities were damaged, the State Prison of Southern Michigan incurred the worst damage.

The disturbances began when officials from the Michigan Corrections Organization at the State Prison of Southern Michigan attempted to take administrative control of the prison and lock down prisoners over the Memorial Day weekend. Rioting broke out at the facility, which then spread to the Michigan Reformatory in Ionia later in the day. The situation temporarily settled over the weekend, but rioting began again on May 26 at the State Prison of Southern Michigan, which then spread to Marquette Branch Prison. Both disturbances were quelled later in the evening, but only after major physical damage had been inflicted on the facilities.

The final damage figures for the two days of rioting were significant. The May 22 disturbances at the State Prison of Southern Michigan and the Michigan Reformatory resulted in 67 inmates and 27 staff members being injured, many requiring hospitalization. The May 26 disturbances saw an additional 44 staff members injured, along with 42 inmates. Fortunately, no lives were lost in either disturbance. The physical damage to the three facilities totaled $5 million, with another $4.1 million in riot-related costs incurred. Damages at the State Prison of Southern Michigan included fire and smoke damage to eight cell blocks, destruction of eight modular units, and damage to the academic vocational building, the inmate store, and the food service facility. The master key system also had to be replaced.

At the Michigan Reformatory, two cell blocks were damaged, in addition to the prison chapel, the food service building, and the school. The master key system also had to be replaced at this facility as well. At the Marquette Branch Prison, two vocational education buildings were destroyed, and the industries building, service building, and six cell blocks were damaged. It took many months for the damage at the three facilities to be totally repaired and services brought back to normal. In the end, legal and disciplinary actions were taken against 19 corrections personnel and numerous inmates for their roles in the two disturbances.

Case: 1980s-early 1990s East Lansing and Mt. Pleasant Civil Disturbances
Several clashes between large groups of students and police occurred in East Lansing in the late 1980s over an annual street party known as “Cedarfest.” Injuries and property damage resulted from these disturbances, which also involved the use of tear gas to try to disperse rowdy and hostile crowds. Central Michigan University in Mt. Pleasant was also witness to a series of similar parties turned into riots in the 1980s and early 1990s, with the resulting clashes often involving hundreds of students and police.

Case: June 16-17, 2003 Benton Harbor Riot
The city of Benton Harbor erupted into riots on June 16-17, 2003, after a motorcyclist being chased by police crashed into an abandoned house and died. Two nights of violence brought hundreds of police to the area to calm the citizens who felt exasperated with community conditions and circumstances. Rioters roamed a six to eight block area, setting fires and attacking passers-by, police officers, and firefighters. One person was shot in the shoulder and others were beaten and stabbed. In all, about 15 people were injured.

It was estimated that about 23 homes were damaged or destroyed by fire. A total of about 10 people were arrested.

Case: April-May 2020, Michigan
In response to Governor Whitmer's stay at home orders to prevent the spread of **COVID-19**. April 15th operation gridlock involved 4000 cars that blocked the traffic areas around the Capitol in Lansing. On April 30th another demonstration occurred where armed protestors entered the Capital building. On May 20th, hairdressers and barbers descended upon the capitol lawn to give free haircuts, protesting the continued closures of their businesses. 300 people participated in the demonstration; seven protestors were cited for disorderly conduct. Officials across the country had ruled hair salons, barbershops, and other personal care services to be non-essential, and experts have cautioned that services like haircuts cannot be performed without the type of close contact that could risk spreading the virus.

Case: May 25th, 2020, Michigan
The death of George Floyd, a black man at the hands of a white Minneapolis police officer, spurred protests across the country. Some of these protests led to violence and rioting. Protests occurred in Ann Arbor, Bad Axe, Cassopolis, Dearborn, Detroit, Flint, Grand Rapids, Kalamazoo, Lansing and East Lansing, Lincoln park and Allen park, Mount Pleasant, Pittsfield Township, Port Huron, Saginaw, Sterling Heights, Traverse City, troy, Warren, Ypsilanti, Houghton, Marquette, Sault Ste. Marie.

Police violence
At a protest in Grand Rapids, a viral video showed Grand Rapids Police pepper spraying a protester and then immediately firing a tear gas canister into their head. The Grand Rapids Police Department announced on June 2 that they would conduct an internal investigation on the incident. At a June 2 protest in Grand Rapids, some water bottles were thrown at police, with police later shooting one man with a non-lethal projectile in the arm, chokeslamming one protester and then slammed the head of another protester against the road after they were arrested.

Protester violence
Protestors in Detroit smashed police cruiser windows along Michigan Avenue on May 29. More than 100 buildings were damaged in Grand Rapids on May 30 and 31, while fires were set to several cars. Protests in Lansing resulted in thousands of dollars in damage on May 31.
https://en.wikipedia.org/wiki/George_Floyd_protests_in_Michigan

May 30th two peaceful protests occurred, in Kalamazoo. On June 2nd, 25 downtown businesses were damaged, two patrol cars were burned, an officer was injured, and six people were arrested.

Civil Disturbance in Newaygo County

Although, Newaygo County is mostly rural in nature and the history of civil unrest is minimal, the potential for a civil unrest event is still there. Local risk consists of: 1) major employers with a moderate amount of employees to cause a labor dispute; 2) large county jail housing over 250 inmates both federal and local 3) a moderate court size with the potential for high profile judicial proceedings; 4) a moderately diverse population with moderate potential for disagreements between special interest groups; 5) close proximity to college universities including Ferris State University and Grand Valley State University. Local vulnerability focuses on political and religious organizations which have strong ties in Newaygo County and have created dispute among residence in the past.

Case: Scott Allen Woodring July 7, 2003



According to Wickipedia Encyclopedia, the Michigan Militia was a loosely organized paramilitary organization founded by Norman Olson of Alanson, Michigan. The organization formed around 1994 in response to perceived encroachments by the Federal Government on the rights of citizens during the early Clinton Administration. The organization declined during the late 1990's and in the years after the Oklahoma City Bombing, the MMC slowly declined and the leadership fell into infighting. The organization was essentially defunct on a statewide basis by 2000 breaking up into smaller, more radical groups.

On July 7, 2003 the Michigan State Police found itself in a 14-hour standoff with a barricaded gunman, who had an affiliation to the Michigan Militia in Newaygo County. The standoff began the previous day when officers attempted to serve a solicitation of prostitution warrant on a male. The suspect indicated he had a gun and held officers at bay. The Michigan State Police Emergency Response Unit was called to assist at the scene and attempted an entry after deploying tear gas inside the home. Trooper Kevin M. Marshall and seven other members of the Emergency Support (ES) Team entered the home in an attempt to arrest the suspect. Upon entry, the ES Team members were met by heavy rifle fire grazing one officer and striking Trooper Kevin Marshall four times. One of the rounds penetrated his bullet proof vest and one of the others struck him just below the vest.

Although the house was surrounded by dozens of law enforcement officers, the suspect was able to escape undetected after the shooting. A cache of weapons and survival gear was found in the rubble of his house, which caught fire and burned during the raid. The suspect was shot and killed one week later after police received information on his whereabouts. The Michigan State Police Emergency Response Team arrived at the scene and located the suspect in a car. They ordered the man to stay inside the car but he exited with a semi-automatic rifle. He was shot and killed when he pointed the rifle at the officers. This standoff received national media attention and created a firestorm of dispute and dissension among Michigan Militia Members. **For additional information, please see the Officer Down Memorial Page for Trooper Kevin Michael Marshall at http://www.odmp.org/officer/16910-trooper-kevin-michael-marshall**

Violent Crimes

Crime of violence means an offense that has an element the use, attempted use, or threatened use of physical force against the person or property of another or any other offense that is a felony and that, by its nature, involves a substantial risk that physical force against the person or property of another may be used in the course of committing the offense. 18 U.S. Code §16 – Crime of violence defined.

Violent Crimes Hazard Description

Violent crime is composed of four offenses: murder and non-negligent manslaughter, forcible rape, robbery, and aggravated assault. Violent crimes are defined in the Uniform Crime Reporting (UCR) Program as those offenses which involve force or threat of force. The data presented in *Crime in the United States* reflect the Hierarchy Rule, which requires that only the most serious offense in a multiple-offense criminal incident be counted. The descending order of UCR violent crimes are: murder and non-negligent manslaughter, forcible rape, robbery, and aggravated assault.

The cause of violent crimes many be attributed to many factors. According to a Police Executive Research forum document from 2009, police chiefs from across the country believe the following are the top ten factors contributing to violent crime:

1. Gangs 82 %
2. Juveniles / youth crime 80 %
3. Economy / poverty / unemployment 74 %
4. Impulsive violence / disrespect issues 74 %
5. Release of offenders from correctional institutions 69 %
6. Drugs-Cocaine 67 %
7. Poor parenting 63 %
8. Increased availability of guns 55 %
9. Reduced cooperation from witnesses / victims (not in top 10 last year) 37 %
10. Educational system-increasing dropout rates (not in top 10 last year) 36 %

Source: http://www.policeforum.org/library/critical-issues-in-policing-series/VCrime&EconomyI.pdf

Violent Crimes Hazard Analysis

The following information and statistics are from the United States Department of Justice and Federal Bureau of Investigation Criminal Justice Information Services Division Violent Crime Data Explorer 2018 Crime in the United States Data available at http://www.fbi.gov/stats-services/crimestats.

- An estimated 1,206,836 violent crimes reported to law enforcement, including:
  - 16,214 murders
  - 101,151 forcible rapes
  - 282,061 robberies
  - 807,410 aggravated assaults.
  - Violent Crimes increased 4.7 percent over 2014 figures.
- 36.9 percent of robberies occurred on streets or highways. 1.6 percent occurred at banks.
- Aggravated assaults accounted for 62.6 percent of reported violent crimes
- Firearms were used in 69.3 percent of the murders reported

Crime in the United States

Year	**Violent crime**	Murder and nonnegligent manslaughter	Forcible rape	Robbery	Aggravated assault
1993	1,926,017	24,526	106,014	659,870	1,135,607
1994	1,857,670	23,326	102,216	618,949	1,113,179
1995	1,798,792	21,606	97,470	580,509	1,099,207
1996	1,688,540	19,645	96,252	535,594	1,037,049
1997	1,636,096	18,208	96,153	498,534	1,023,201
1998	1,533,887	16,974	93,144	447,186	976,583
1999	1,426,044	15,522	89,411	409,371	911,740
2000	1,425,486	15,586	90,178	408,016	911,706
2001[2]	1,439,480	16,037	90,863	423,557	909,023
2002	1,423,677	16,229	95,235	420,806	891,407
2003	1,383,676	16,528	93,883	414,235	859,030
2004	1,360,088	16,148	95,089	401,470	847,381
2005	1,390,745	16,740	94,347	417,438	862,220
2006	1,435,123	17,309	94,472	449,246	874,096
2007	1,422,970	17,128	92,160	447,324	866,358
2008	1,394,461	16,465	90,750	443,563	843,683
2009	1,325,896	15,399	89,241	408,742	812,514
2010	1,251,248	14,722	85,593	369,089	781,844
2011[3]	1,206,005	14,661	84,175	354,746	752,423
2012	1,214,462	14,827	*84,376	354,520	760,739
2013	1,168,298	14,319	*113,695	345,093	726,777
2014	1,153,022	14,164	118,027	322,905	731,089
2015	1,199,310	15,883	126,134	328,109	764,057
2016	1,250,162	17,413	132,414	332,797	802,982
2017	1,247,917	17,294	135,666	320,596	810,319
2018	1,206,836	16,214	139,380	282,061	807,410
2019	1,213,299	16,694	142,404	262,843	791,358
2020	1,272,167	21,587	129,926	235,984	884,670
2021	931,400	17,909	113,139	138,452	661,900
2022	1,257,034	21,868	126,545	222,162	886,459
2023	1,246,319	19,713	131,603	220,365	874,638
2024	1,191,030	16,991	126,888	201,915	845,236
2025	!340,059	!5,140	!45,841	!61,071	!288,007

Source: United States Department of Justice and Federal Bureau of Investigation Crime Data Explorer
https://cde.ucr.cjis.gov/LATEST/webapp/#/pages/explorer/crime/crime-trend
*Change in numbers due to change in definition
!Data for 2025 through May 2025

Violent Crimes in Michigan

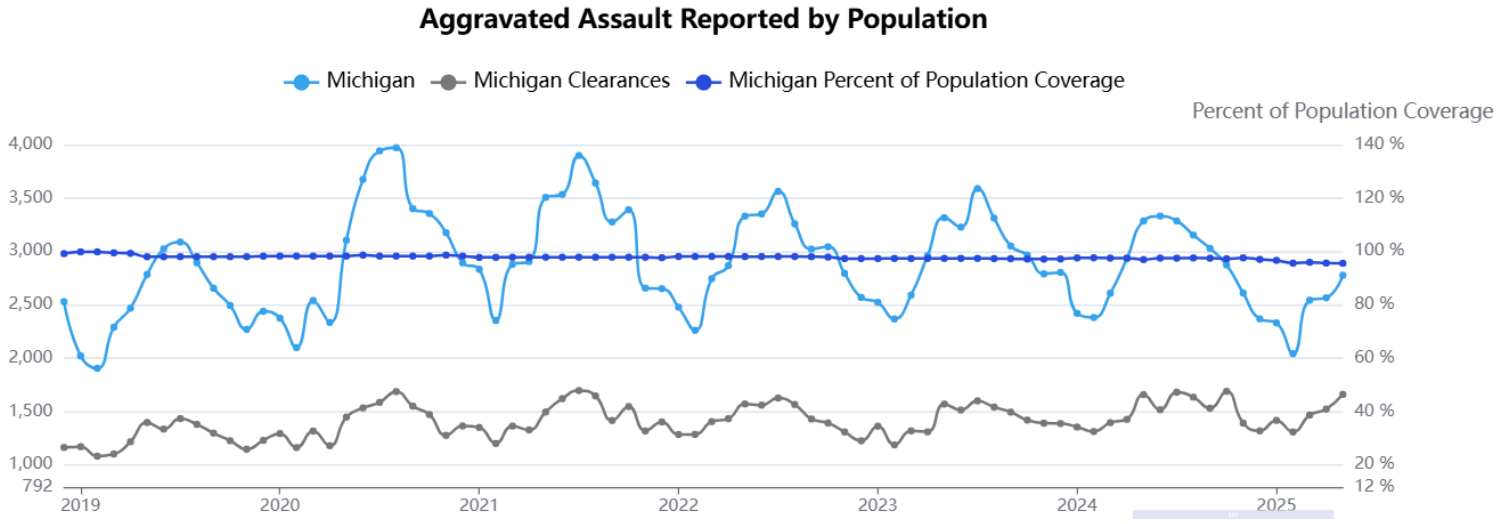
The following information and statistics are from the United States Department of Justice and Federal Bureau of Investigation Crime Data Explorer available at http://www.fbi.gov/stats-services/crimestats. Although year to year stays fairly consistent, since 2019 Aggravated Assault Reported by Population shows the highest assaults occur in June, July, and August while the lowest number of assaults occur in December, January, and February.

Crime in Michigan

Year	**Violent crime**	Murder and non-negligent manslaughter	Forcible rape	Robbery	Aggravated assault
2011	43,731	617	4,344	10,263	28,507
2012	44,922	689	4,589*	10,434	29,210
2013	41,241	631	3,236*	10,241	27,133
2014	38,956	532	3,016	8,206	27,202
2015	37,369	572	3,024	7,821	25,952
2016	40,851	586	3,173	7,116	29,976
2017	41,123	567	3,333	6,486	30,737
2018	40,929	550	3,670	5,652	31,057
2019	43,662	578	7,421	5,344	30,319
2020	48,410	764	5,941	4,585	36,850
2021	49,090	760	6,803	4,021	37,506
2022	46,220	686	6,594	3,672	35,268
2023	45,732	571	5,973	3,708	35,480
2024	43,535	500	5,610	3,163	34,262
2025	!5,541	!182	!2,129	!972	!12,258

*Change in numbers due to change in definition

!Data for 2025 through May 2025



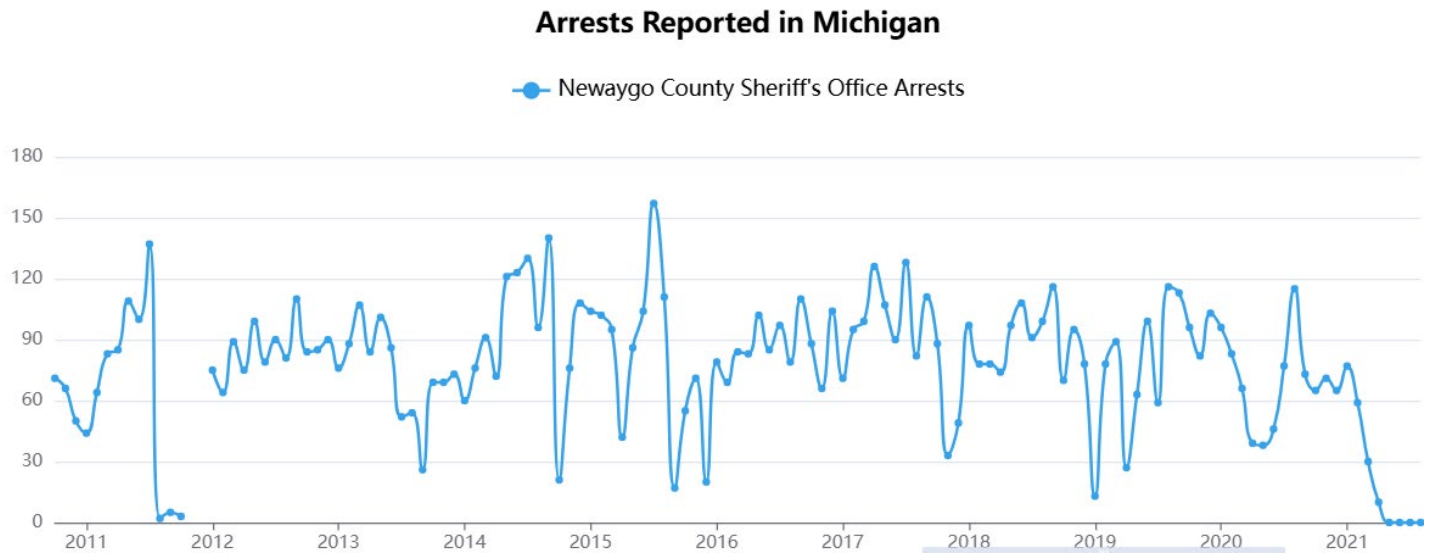
Violent Crimes in Newaygo County

The following information and statistics are from the Newaygo County Sheriff's Office Reporting Database from 2012 to May 2021. This data only includes reports taken by the Newaygo County Sheriff's Office. It does not cover the cities of Fremont, Newaygo, Grant, and White Cloud which maintain their own police department. In addition, Crimes are not necessarily cleared in the year they occur. Little or no data may be the result of an agency not participating, reporting zero incidents, changes in reporting, or being "covered by" another agency. In addition, classification, organization, and the hierarchy of agencies can vary by state. To learn more, please see agency-level data in the Crime in the United States publications. Source: Reported National Incident-Based Reporting System (NIBRS) data from Newaygo County Sheriff's Office

Crime in Newaygo County (As reported by the Newaygo County Sheriff's Office)

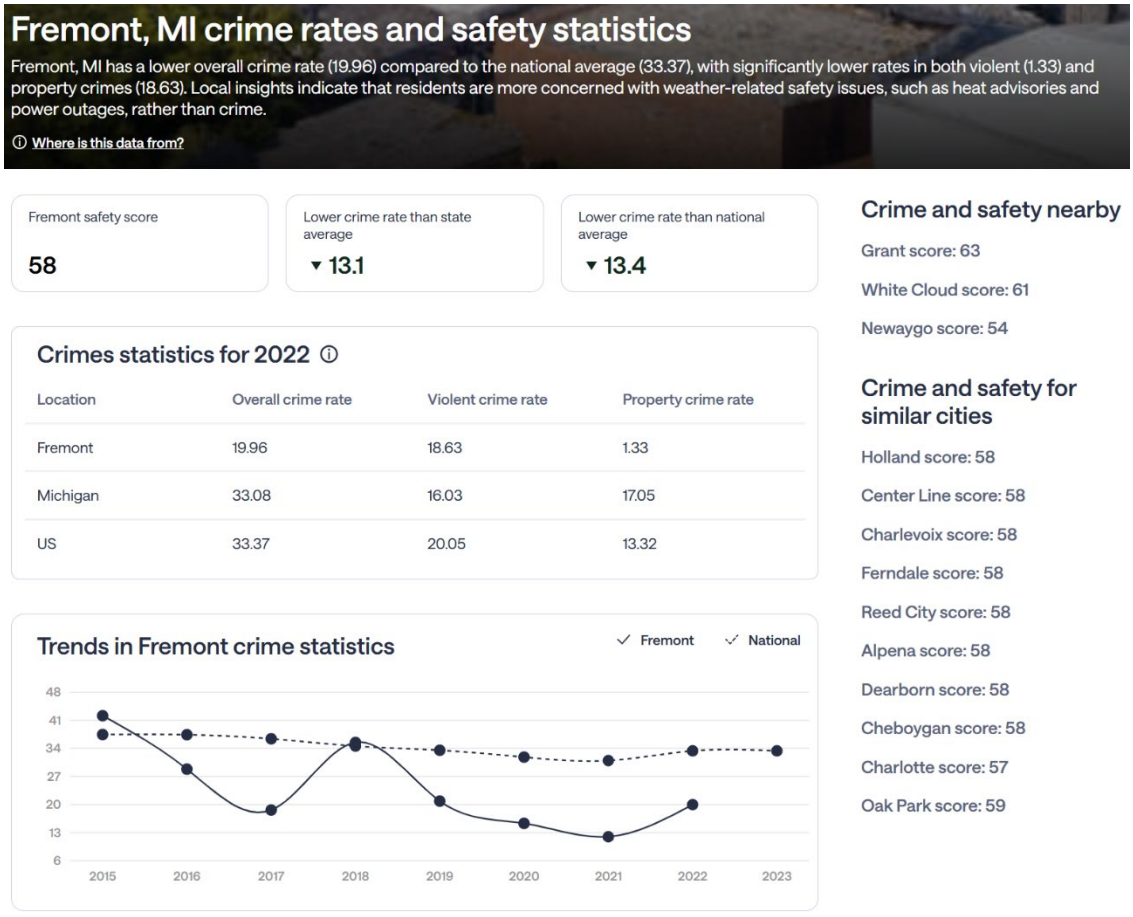
Year	**Violent crime**	Murder and non-negligent manslaughter	Forcible rape	Robbery	Aggravated assault
2012	53	2	16	0	35
2013	66	1	14	3	48
2014	84	1	31	2	50
2015	50	0	20	0	30
2016	55	0	18	0	37
2017	81	1	40	2	38
2018	55	0	18	0	37
2019	46	0	12	0	34
2020	64	0	17	0	47
2021	11*	0	5*	0	6*

*Newaygo County Sheriff's Office stopped reporting in May of 2021 to this database



Crime in the City of Fremont (As reported by the Fremont Police Department)
Source: United States Department of Justice and Federal Bureau of Investigation Crime Data Explorer
https://cde.ucr.cjis.gov/LATEST/webapp/#/pages/explorer/crime/crime-trend

Year	**Violent crime**	Murder and non-negligent manslaughter	Forcible rape	Robbery	Aggravated assault
2011	NR				
2012	3	0	1	0	1
2013	5	0	2	1	2
2014	9	0	5	0	4
2015	12	0	4	0	8
2016	12	0	6	2	4
2017	7	0	2	0	5
2018	7	0	1	1	5
2019	11	0	5	0	6
2020	7	0	2	1	4
2021	6	0	5	0	1
2022	6	0	1	0	5
2023	9	1	5	0	3
2024	7	0	3	0	4



Crime in the City of Newaygo (As reported by the Newaygo Police Department)
Source: United States Department of Justice and Federal Bureau of Investigation Crime Data Explorer
https://cde.ucr.cjis.gov/LATEST/webapp/#/pages/explorer/crime/crime-trend

Year	**Violent crime**	Murder and non-negligent manslaughter	Forcible rape	Robbery	Aggravated assault
2011	19	2	1	0	16
2012	4	0	2	0	2
2013	18	0	11	0	7
2014	10	0	1	1	8
2015	4	0	2	0	2
2016	12	0	5	0	7
2017	6	0	5	0	1
2018	7	0	4	0	3
2019	7	0	1	0	6
2020	14	0	4	0	10
2021	3	0	1	0	2
2022	5	0	0	0	5
2023	9	0	2	0	7
2024	7	0	0	0	7



Crime in the City of White Cloud (As reported by the White Cloud Police Department)
Source: United States Department of Justice and Federal Bureau of Investigation Crime Data Explorer
https://cde.ucr.cjis.gov/LATEST/webapp/#/pages/explorer/crime/crime-trend

Year	**Violent crime**	Murder and nonnegligent manslaughter	Forcible rape	Robbery	Aggravated assault
2011	5	1	1	0	3
2012	8	0	2	0	6
2013	8	0	3	0	5
2014	9	0	3	0	6
2015	6	0	1	0	5
2016	8	0	3	0	5
2017	6	0	4	0	2
2018	7	0	2	0	5
2019	11	0	7	0	4
2020	3	0	2	0	1
2021	1	0	0*	0	1*

*White Cloud Police Department stopped reporting in May of 2021 to this database



The following are violent crimes of note in Newaygo County:

Case: August 10, 1983 Richard Atwood Murder
Richard Atwood, who was 25 at the time, was last seen on Aug. 10, 1983, in White Cloud, Michigan. His 1975 Pontiac Trans-Am was found in the Grand Rapids area two months later. Roy Snell was reported as the last person to be seen with Atwood and stated he wanted to rob Atwood shortly before his disappearance. Richard Atwood's body has never been found.

In 2020, Snell was arrested in Minneapolis by the Minneapolis Violent Criminal Apprehension Unit. He was in custody in the Hennepin County Jail in Minnesota before being extradited to Michigan. On November 18, 2022, nearly 39 years after Richard Atwood disappeared from Newaygo County, Michigan Attorney General Dana Nessel and Newaygo County Prosecutor Worth Stay today announced that Roy Snell has been found guilty of murdering Atwood. Snell was found guilty on one count of homicide and once count of weapons.

Case: July 1989 Shannon Siders Murder
Shannon Sider was 18 years old when she was murdered. A hunter found her mutilated, decomposing body in the Manistee National Forest near Newaygo three months after her death. The case was deemed an "unsolvable" cold case.

In 2011, a cold case team of investigators revisited the case resulting in two convictions in May of 2015. A Newaygo County jury convicted Matthew Wayne Jones, 46, of first-degree murder. His younger brother, 44-year-old Paul Michael Jones, was found guilty of second-degree murder. They were still teens when they killed Siders. On the night Siders disappeared, investigators say the brothers spent several hours driving around "partying'' with Siders and several other teens. The brothers eventually drove her to a secluded location and sought sexual favors from her. The pair became enraged when she declined their advances. They took turns raping and beating her and eventually beat her to death, court records show.

Case: August 16, 2012 B&E Armed Robbery
3 people wearing masks broke into a Newaygo County Home, assaulted the occupants and stole money and property. 1 Victim was treated at the hospital and released.

Case: May 28th 2013 B&E Armed Robbery
3 individuals in masks broke into the home and assaulted 2 occupants with a metal pipe and tied them up.

Case: September 2, 2014 Home Explosion during Search Warrant
On 9/2/2014, the Michigan State Police, Central Michigan Enforcement Team, and Newaygo County Emergency Response Team was preparing to serve a search warrant at a suspected methamphetamine cooking operation in Sheridan Township on 96th street between Dickinson and Maple Island Roads. Officers attempted to communicate with the suspect inside the home and ordered him to exit. While trying to make contact with the suspect, the home burst into flames following an explosion inside the home. The suspect was found conscious in the debris and taken to the hospital. No officers were injured during this incident.

Case: August 4, 2017 D'Anthony Keenan Murder
Anthony Blamer of Fremont was found guilty of second degree murder in connection with the shooting death of D'Anthony Keenan of Muskegon on August 4, 2017. Blamer was also found guilty of felony firearm – committing a felony while in possession of a firearm. Investigators say the murder happened after Blamer and Keenan met in North Muskegon so Blamer could install a stereo system in the other man's SUV. Detectives said Blamer claimed he and Keenan argued over money, at which point Keenan drew a gun. Blamer reportedly said the gun went off as the men struggled and Keenan was accidentally shot in the head. Authorities said Blamer added that the gun was fired repeatedly and Keenan was shot multiple times inside the SUV.

Blamer then allegedly drove the SUV and Keenan's body to the Fremont area, where he left them at a carpool lot. Detectives say he returned the next day with a chainsaw and removed Keenan's head and hands. His motive, authorities said, was to slow the identification of the victim. Keenan's body, without the head and hands, was discovered on August 5, 2017 along a two-track in the Manistee National Forest by two men scouting duck hunting areas. Blamer, later led law enforcement to the head and hands in Oceana County.

Case: January 7, 2020 Multi State Crime Case
On 01/07/20, White Cloud Police Department Officers arrested 25 year old, Sam Nabil Al-Qadhi of Dearborn, MI. and 22 year old, Seth Reuben Goldgrab of Detroit, MI. Both are suspected of multi-county crime sprees where it's alleged they used fraudulent credit cards and stolen identities to purchase alcohol, large quantities of cigarettes, and other tobacco related items.

In November of 2019, White Cloud Police Department took a report of (at that time an unknown) suspect using what's been confirmed as stolen credit card information to purchase alcohol and large quantities of cigarettes. In that case they identified two separate victims from the State of Iowa that had their identities and credit card information stolen. They identified Sam Nabil Al-Qadhi as the suspect in the November case.

White Cloud Police Department's investigation shows that in the early morning hours of 01/07/20 the two suspects went to three gas station/convenience stores in Kent County and then traveled into Newaygo County. They confirmed that the suspects used what's suspected to be stolen credit cards and identities to purchase large quantities of cigarettes in the Cities of Grant and Newaygo. A Wesco employee in White Cloud refused sales to the suspects and contacted White Cloud Police Department. The officers located the suspects and started an investigation.

Suspects Sam Nabil Al-Qadhi and Seth Reuben Goldgrab were lodged at the Newaygo County Jail. At the scene of the traffic stop we were assisted by the Newaygo County Sheriff's Office and the Michigan State Police. On 01/09/20, Sam Nabil Al-Qadhi was arraigned on multiple counts of the following charges: Computers – using to commit a crime, identity theft, and illegal sale/use/possession of financial transaction devices. Seth Reuben Goldgrab was arraigned on multiple counts of the following charges: Computers – using to commit a crime, identity theft, illegal sale/use/possession of financial transaction devices, and controlled substance possession Oxycodone, Dextroamphetamine, Hydrocodone.

Case: December 27, 2021 Joshua Dakan Murder
At around 7:15 pm, Newaygo County Sheriff's Office Deputies were dispatched to the 800 block of E. Pierce Road in Monroe Township for a complaint of shots fired, according to the sheriff's office. They found Joshua on the ground with a gunshot wound when they arrived. He was pronounced dead on the scene. On December 7, 2022, Joshua's father, Darrell Dakan, was found guilty of second degree murder in the shooting of his son.

Case: March 2, 2022 Home Invasion and Assault with a Knife
Around 7pm on Wednesday, March 2, 2022, Deion Hanna broke into an apartment, laid in wait, then assaulted two people with a knife. The victims were taken to the hospital with life threatening injuries, but the suspect was able to run away from the scene. He was arrested Thursday morning at a home on Croswell Avenue, near M-82, in Fremont. The suspect was charged with two counts of assault with intent to murder, first-degree home invasion, armed robbery, mayhem, unlawful imprisonment and carrying a dangerous weapon with unlawful intent.

On May 19, 2023, the suspect pleaded to two counts of assault with murderous intent as well as one count of first-degree home invasion.

Case: May 8, 2024, Barricaded Gunman in City of Fremont
Around 2am on May 8, 2024 a neighbor dispute resulted in A 40-year-old man allegedly threatening the neighbor with a firearm and then went inside his house. The suspect barricaded himself inside the home and refused to come out for close to 6 hours. A shelter-in-place order was issued, and nearby Fremont Public Schools were placed on a two-hour delay. Officers negotiated with the suspect over the telephone for several hours before he was taken into custody without incident.

Case: October 14, 2025 Big Prairie Township Standoff
On October 14, 2025, at approximately 8:33 p.m., deputies from the Newaygo County Sheriff's Office were dispatched to a residence on First Street in Big Prairie Township for a report of a drunk and disorderly individual. The caller reported that the suspect was acting belligerent, making threats toward the homeowner, and insinuating he was in possession of a firearm.

Upon arrival, deputies located the individual at the scene. As deputies attempted to make contact, the suspect fled to his personal vehicle parked in the driveway. Deputies attempted a traffic stop; however, the suspect fled the scene, and a vehicle pursuit ensued. The pursuit concluded at a residence on Second Street in Big Prairie Township.

After stopping at the Second Street residence, the suspect exited his vehicle and fled on foot into the home. Deputies pursued but halted entry due to safety concerns and established a perimeter. Deputies made multiple attempts to communicate with the suspect, who refused to exit and shouted threats from inside the residence. At one point, the suspect threatened to release a dog to attack deputies.

During the investigation, deputies learned that the suspect, a 46-year-old male from Big Prairie Township, was wanted on felony charges out of Mecosta County, including contempt of court related to original charges of fleeing and eluding, and resisting and obstructing police. Based on this information, deputies obtained a

search warrant for the residence. A threat assessment led to activation of the Newaygo County Emergency Response Team (ERT), which responded to assist. Negotiators attempted repeated verbal contact, but the suspect refused to cooperate.
ERT deployed distraction techniques and later breached the front entry but found that the doors had been barricaded. Robotic technology was used to safely clear sections of the home, and the suspect was eventually located barricaded in a rear bedroom with his wife and three young children.

Negotiations continued, and after approximately a three-hour standoff, the suspect surrendered peacefully and was taken into custody without further incident. The suspect's wife and three children were safely secured and were not injured. The suspect was transported to the Newaygo County Jail, where he is currently lodged pending arraignment. He faces multiple felony charge and the case remains under investigation. No deputies or civilians were injured during this incident. The Newaygo County Sheriff's Office was assisted by the Newaygo County Emergency Response Team, White Cloud Police Department, Michigan State Police, Central Dispatch, and LIFE EMS Tac Medics.

Criminal Incidents Vulnerability and Impacts

Criminal incidents can significantly impact public health and safety with physical and emotional injuries, including death, trauma, and long-term psychological effects on survivors, witnesses, and the wider community. In addition to the immediate physical and emotional impacts, criminal incidents can have broader societal impacts, including increased fear and anxiety, decreased sense of safety and security, and adverse effects on mental health and well-being.

Criminal incidents can cause significant property damage and disrupt critical infrastructure. Depending on the location and circumstances of the shooting, property damage may include damage to buildings, vehicles, or other physical assets. In some cases, shootings may cause fires or explosions, further exacerbating the damage. In addition to physical property damage, criminal incidents can disrupt critical infrastructure, such as transportation systems, utilities, and communication networks. For example, a shooting in or near a transportation hub could cause delays or closures of train or bus lines, while a shooting near a utility facility could disrupt power or water supplies.

Criminal incidents can have significant economic impacts, both short and long-term. In the short term, the cost of responding to and investigating a criminal incident can be substantial and may strain local and state budgets. In addition, businesses and tourism in the affected area may suffer, resulting in decreased economic activity and job losses. For example, a shooting in a tourist destination may lead to cancellations of trips and events, which can have a ripple effect on local businesses. In the long term, property values in the affected area may decline, making it more difficult for homeowners and businesses to sell or lease their properties.



Celestial Impacts (Space Weather)

Celestial Impacts

An impact or threatened impact from solar geomagnetic storms, coronal mass ejections, or similar phenomena that may damage or destroy Earth's electronic satellite systems, interfere with radio communications and navigation systems, create health risks for air travelers, and disrupt electrical utility and pipeline systems.

Space Weather and Celestial Impacts Hazard Description

Space weather is a term that describes the patterns of emissions from our Sun. Ordinary radiation emissions can be considered calm "weather," but there are periodic flare-ups and blasts of much greater energies that send charged particles that impact upon the Earth's atmosphere and magnetosphere. These solar geomagnetic storms can cause widespread failures of important satellite, electronic, communication, navigation, guidance and electric power systems—which have all formed a very important part of our modern technology and lifestyles. This hazard is considered fairly likely in the near term to cause notable disruptive effects, large economic impacts, and even some direct health risks to persons who are flying in aircraft in the far northern or southern areas of the planet, where the exposure to charged particles occurs in greater quantities.

A sunspot cycle exists, in which sunspot activity periodically shifts between a minimum and maximum level. As with our Earthly seasons, however, it cannot be known in advance exactly how turbulent or calm things will be at a given moment during the sunspot cycle—only that calmer periods regularly give way to more turbulent periods. As to the regularity of the sunspot cycle itself, although it has been found that the average amount of time between a solar minimum and a solar maximum is about 11 years, the actual length varies quite a bit within each cycle. Within the documented cycles so far, the time interval between a minimum and maximum has been as long as 14 years and as short as 8 years.

The Earth's atmosphere serves as a shield for us against many types of particles and radiation zipping across space, and Earth is also surrounded by a magnetosphere that similarly provides protection against most of the charged particles traveling through space. There are some weak spots in the Earth's magnetic field, however, that exist near its two magnetic poles and allow many ions to penetrate, where they collide with atoms in the Earth's upper atmosphere and glow to produce the beautiful auroras in the skies of the arctic regions of the north and south. In addition, the Earth is surrounded by "belts" of charged particles (called Van Allen belts) which are hazardous to spacecraft and astronauts. These are known and predictable conditions of calm space weather, however, and the actual hazard is the turbulence that is generated by large solar flares, causing problems with radio communications, damage to satellites, and even disruptions in power delivery networks on the Earth. Currently, as of early 2019, sunspot cycle number 24 (since a starting point in 1755) is almost over, having started in a solar minimum reached in December 2008, proceeded through a solar maximum that was reached in

April 2014, and now reaching a new minimum again as the count of observed sunspots has dropped to nearly zero.

Another type of solar disturbance is a coronal mass ejection (CME), in which built-up pressures cause a sudden outward burst of gases (and accompanying magnetic fields) at tremendous speeds, with impacts that reach far across interplanetary space. Like solar flares, CME events are a cause of geomagnetic storm events on Earth (usually 1 to 4 days after the solar event), and they occur more frequently during periods with more sunspots. One of the additional effects of space weather involves increased exposure to ionizing radiation (e.g. harmful x-rays), especially among those in aircraft at high altitudes and along polar flight paths. Extra costs, in fuel and delays, are imposed upon airlines during periods of harmful space weather.

An important type of impact involves the interference or disruption of modern electronic and communications systems, including those upon which our modern aviation networks rely. Solar flares and storms are important because of their potential impacts and possible disruption of these complex modern communication systems—satellites, television, radio, GPS, power supply networks, and the extensive human and technological infrastructure that relies upon those communication and utility networks.

On the ground, disrupted power systems can result in widespread power failures, and the movement of the mass of charged particles in geomagnetic storms can cause induced currents to flow within pipelines, unless special design features have inhibited such currents. An increase in ions (charged particles) that interact with the Earth's magnetosphere and then strike our upper atmosphere can cause a glow within the evening skies (which, in the northern hemisphere, includes the famous aurora borealis). Such "northern lights" become increasingly prominent, and extend farther to the south, during the most active solar storms. Government agencies actively monitor space weather, but for those who have not heard any government reports, their warning of solar storm activity may come from noticing these brighter glows in the night sky—especially in most Michigan locations where such "northern lights" are not normally seen.

Space Weather and Celestial Impacts Hazard Analysis

Space weather can be very expensive for those who use or rely upon satellites. Electronic circuits can malfunction and cause interruptions or complete losses in operational capacity. Space missions may also need to be delayed, in order to ensure their safety and success. Communication disruptions can inhibit navigation and hinder the safe management of air and sea traffic.

Induced electric currents occur within conductive materials when magnetized material of sufficient moves nearby and has a sufficiently powerful charge. The induced currents from space weather can affect electrical utility systems and pipeline infrastructure, potentially weakening and damaging these systems as well increasing the chance of electronic malfunctions.

Three space weather scales are in use by NOAA/NWS to summarize the intensity and estimated potential impacts of three different types of space weather effects. Each uses a 5-category classification scheme, and the three scales denote: (1) geomagnetic storm intensity (G-scale), (2) solar radiation storms (S-scale), (3) radio blackouts (Rscale). Weaker events are given a number of 1 on the scale, and extreme events are rated as a 5. In this document, selected material is summarized below. For more detailed information, please refer to the NOAA web site at http://www.swpc.noaa.gov/NOAAscales/.

The space weather hazard appears likely to cause one or more serious infrastructure failures in the near future, due to the extent of our reliance on complicated electronic and satellite systems that are vulnerable to disruption. In addition to power failures and phone communication breakdowns, it is also quite possible for the disruption of radio and navigational systems to cause risks for air and marine traffic.

Even if cautious transportation providers are diligent about maintaining safety during such events, considerable economic impacts and delays can result from the electronic breakdowns caused by solar geomagnetic storm events. Geomagnetic storm impacts tend last 1 to 2 days, and to occur between 15 and 90 hours after a coronal mass ejection event, which can allow a little bit of warning time, as spacecraft such as the Advanced Composition Explorer (ACE) can now measure the strength of an event and report back in time for notification to allow perhaps 15 to 20 minutes of advance warning time for protective response actions to occur.

Impact on the Public, Property, Facilities, and Infrastructure

Space weather impacts can result in transportation delays and communication interference, and some cases may result in fatal transportation accidents, large economic losses, and widespread power supply interruptions. Key facilities for electrical infrastructure have been affected in the past, but the industry has reported many improvements during the past 30 years, to reduce the chance of a widespread blackout as a result of a major solar storm. Most personal property is not damaged by these events, although radio function and digital communications may often be temporarily impaired. The key built infrastructure that is most at-risk in Michigan appears to be some of its pipelines and power grids.

Impact on the Economic Condition of the State

Although Michigan would not be expected to feel space weather impacts by itself, in isolation from other states, there is the possibility that particular infrastructure failures might happen to occur specifically within Michigan. Thus, although temporary communication disruptions might be felt throughout the entire continent at the same time, particular utility systems might happen to fail within Michigan and have a disproportionate impact within the state. This would be a likely source of economic impact. Although an event like Quebec's massive 1989 power loss is reportedly less likely now, as a result of precautions taken by electric utilities, some disruption in plane flight schedules, utility function, and communication systems is likely to have an economic impact. Although the level of impact is too difficult to predict, the particular timing of the disruption

might happen to have an unusually negative effect on some particular industry within Michigan. If high-technology Michigan companies have their satellites taken out of service by the effects of a very severe event, the effects might be too expensive for such businesses to bear, while the other businesses they serve could similarly find that key processes are interrupted and therefore result in costs far more than had been planned (or budgeted to accommodate). Important tourist attractions might rely upon digital communications technologies that are then disrupted by space weather. Some pipeline services might be impacted and cause other types of cascading effects, if there is an unexpected gap in the supply of fuel for energy, industrial production, or digital information processing (although the latter should allow more potential for running off of back-up power systems. Many high-technology economic sectors rely upon efficient satellite relays for their operation. Airline scheduled and flight paths would also be disrupted during a major event. The longest impacts would involve the replacement of satellites and vulnerable utility system components. The potential for extensive power outages and electronic system disruptions could make this one of the least well-known but potentially most economically damaging types of hazards that might occur in the near future. A limited general awareness of this hazard, as well as the relative scarcity of its most extreme events (the standard having been set in 1859), may explain why advance planning and hazard mitigation activities have rarely been seen.

Impact on the Environment

It has been speculated that space weather may be connected with global climate, but this is primarily due to the possibly coincidental occurrence of a “Little Ice Age” (lower average temperatures in America and Europe) during the same time that the Maunder minimum in solar activity was observed. The specific mechanisms that would underlie such a connection have not yet been figured out and therefore such a link should probably still be considered to be purely speculative. On the favorable side, solar activity helps to shield us from some of the biologically damaging cosmic rays that come from elsewhere in the universe.

Impact on Responders, Continuity of Operations, and Continued Delivery of Services

The impacts of space weather include interruptions in the function of radios, satellites, electronics, and even power supply systems that may be needed for emergency response. Response activities that involve electronic navigation technologies and Global Positioning Systems may need to fall back upon the use of less technologically advanced means to accomplish their mission, but in most cases, such “legacy systems” either no longer exist or are simply unable to handle the operations of the newer technology. In a severe event, it is likely that some sort of service interruptions would occur within sectors that rely upon radio or satellite communication, transportation, and navigation systems. Although this might potentially include numerous types of businesses that cannot all be listed here, FEMA has noted that these systems are vital for emergency response activities. Impact on Public Confidence in State Governance The potential impacts of space weather will require greater public awareness in order to build an understanding about existing weaknesses and the expense that might be involved in correcting those weaknesses, where possible. If a major event does bring down one or more important

systems (for example, satellite communications), some might question whether it was wise to have placed so much reliance upon any particular system that was revealed to be vulnerable.

Celestial Impacts in Michigan

NOTE: Although many of the events listed here occurred out of state, some of them were nevertheless large enough to have direct impacts upon Michigan, due to the sheer magnitude of the impacts. A couple of events date back to the 19th Century, to give an indication of the magnitude of what is possible. One event describes a "close call" whose impact could have been very large if it had occurred one week earlier than it had. Thus, some of these events are included because they help to indicate the range of threat posed by the hazard—events outside of Michigan usually represent the largest known events or threats, while events involving Michigan tend to represent the typical level of recorded impacts in the state.

Case: March through October, 1847 – United Kingdom

Twelve years prior to the Carrington Event (see below), an "anomalous current" had been reported on British telegraph lines in the vicinity of Derby, Rugby, and Birmingham, which may have been the first detected effect from geomagnetic storms upon electronic infrastructure. It occurred in conjunction with a brilliant aurora that was observed on March 19 of that year. Other disturbances were reported, one on September 24 being reported as nation-wide, from South Devon up to Scotland.

Case: August 28 to September 2, 1859 – International, "Carrington Event"

After a couple days of visibly expanded auroras in the sky, telegraph disruptions were also noted in diverse parts of the world. On September 1, a large solar flare was briefly observed by astronomer Richard Carrington, and also independently recorded by Richard Hodgson. Just before dawn of the next day, however, brilliant auroras were visible in skies around the world, telegraph systems severely malfunctioned, and various damages (and minor injuries) resulted from sparks and equipment failures. This was the first solar flare observation and it was also clearly seen that the phenomenon was connected with malfunctions in electronic communications systems on Earth. No solar flare of this magnitude has been seen in the 150 years since this occurred. Based upon evidence from arctic ice, it was estimated that the 1859 solar geomagnetic storm was the most intense in the past 500 years, nearly twice as much as the second-largest event. (Even though certain intensities have since been matched, no storm since has been able to simultaneously match this one, on all types of intensity measures.) Were such an event to happen again today, it has been estimated that tens of billions of dollars in damage would be done to more than 1,000 satellites that orbit the Earth. These satellites are essential for the safe and smooth operation of airlines, spacecraft, and various communications systems.

Case: May 16, 1921 – International, "Great Storm"

An extremely strong geomagnetic storm occurred—the strongest such storm since 1859. According to one study, if a storm of this magnitude were to occur today, it could result in large-scale electrical blackouts that would affect more than 130 million persons across the northwestern U.S. (including Michigan) and the Pacific Northwest. These figures were based upon estimates of regions susceptible

to power grid collapse, and the 1921 storm was considered to be about 10 times as strong as the one that did cause power failures in 1989. Extra-high-voltage transformers were considered to be a particular vulnerability in these projected blackout areas, with places like New Hampshire, New Jersey, and Pennsylvania at particularly high risk in the interconnected grid. This has been estimated as a level of event that has a 1% annual chance of occurring in an average year.

Case: August 4, 1972 – Illinois

A huge solar flare ended up causing the failure of long-distance telephone communications across Illinois. AT&T redesigned its power system for transatlantic cables as a result of this event. Electric grid disturbances were also reported in widespread locations around North America. This event involved the fastest "transit time" of ejected solar material that had been measured. Recently, a paper reported that these storms had an effect upon U.S. military operations, including the unintended detonation of many of its DST mines within the wartime Southeast Asian operational area (Knipp, Fraser, Shea, and Smart, 2018). In some ways, this may have been the most severe event seen during the space age. Had astronauts been in space at the time, it would have been dangerous for them.

Case: March 13, 1989 – Canada and Eastern United States

Geomagnetic storms caused by a huge solar flare involved various disruptions in the transmission of electrical power, causing a widespread blackout across most of Quebec and affecting 6 million persons for a period of up to 9 hours. Specifically, when five transmission lines went down, the system was unable to withstand the loss of their 21,350-megawatt load, and collapsed within the subsequent 90 seconds. The blackout closed schools and businesses, shut down the Montreal Metro Airport, and delayed flights from other airports. Street traffic backups took place, since traffic signals and traffic control systems no longer functioned smoothly. Workers in downtown Montreal were stranded in dark offices, stairwells, and elevators. Elsewhere, power surges caused by the geomagnetic storm (geomagnetically induced currents, or GICs) caused power transformers in New Jersey to be overloaded and damaged. The functioning of long-distance telephone cables were also affected by auroral currents, major power substations experienced voltage swings, generators went offline, and the U.S. Air Force temporarily lost its ability to track satellites. Costs from the loss of power exceeded $100 million, including stalled production processes, idled workers, and spoiled products. This was considered to be the strongest geomagnetic storm of the space age, and it has been reported that the broader power grid covering the Northeastern and Midwestern U.S. was "within seconds of collapse."

Case: January 1994 – Canada

Inclement space weather caused electric charges to build up and then discharge within the electronic components of two expensive communications satellites. One satellite was disabled for about 7 hours, due to damage to its control electronics. A second satellite went out of service entirely, when its backup systems also became damaged, requiring 6 months of service before its functions were restored. The satellite disruptions prevented news information from being electronically delivered to 100 newspapers and 450 radio stations. Television and data services to more than 1,600 remote communities broke down with the second satellite failure. Telephone service in 40 communities was also interrupted. Total costs of the event were estimated at between 50 and 70 million U.S. dollars.

Case: January 11, 1997 – International
A satellite that had cost $200 million was incapacitated by the impact of a coronal mass ejection. After efforts to restore the satellite's function failed, it was officially decommissioned.

Case: April-May, 1998 – International
The failure of the attitude control system of an expensive Galaxy IV satellite (the cost of such satellites is usually on the order of $200 to $250 million) disrupted the function of about 45 million electronic paging devices. Various other satellite problems were noted, and researchers eventually concluded that these problems were "caused, or at least exacerbated by" the impacts of geomagnetic conditions originating from "highly disturbed" solar conditions. Although the satellite problems occurred in May, weeks of problematic space weather that had started back in April was considered to have eventually led up to May's events.

Case: October 19 to November 7, 2003 – International, "Halloween Storms"
Geomagnetic storms took place in late October and November, and although power grid operators had learned from the March 1989 event and were better able to withstand the storms' effects, there were some heavy impacts upon the aviation sector from this event. The Federal Aviation Administration had implemented a WAAS (Wide Area Augmentation System) to better guide navigation and aviation system control, and a part of what WAAS supports is the ability of air traffic to maintain safe distances from each other. The vertical navigation component of WAAS was disabled for approximately 30 hours across most of the United States during the late October storms. These "Halloween storms" interrupted GPS function, blocked high-frequency radio, damaged power transformers in South Africa, and forced emergency procedures to be implemented at nuclear plants in Canada and the northeastern United States.

Case: January 2005 – International
Space weather at this time included solar radiation storms. In addition to the loss of HF radio communications, such storms can cause elevated radiation exposure to persons in aircraft flying at high latitudes (e.g. across polar regions). The use of polar routes has increased dramatically since the 1990s, since such routes can reduce travel time and fuel costs (by avoiding strong wintertime headwinds). Aircraft must divert to lower-latitude routes during such radiation events, resulting in delays, increased flight times, missed connections, higher costs, and greater fuel consumption.

Case: December 2005 – International
A geomagnetic storm caused the disruption of satellite-to-ground communications and GPS (Global Positioning System) navigational signals. Although this disruption only lasted about 10 minutes, it threatened the safety of commercial air flights and marine traffic during that time.

Case: December 6, 2006 – International

A burst of solar radio wave energy caused a disruption in the function of GPS units across the entire sunlit side of the Earth (the Western hemisphere in this case). Some users of navigation systems found their capacities disrupted for many minutes, which was of particular significance for military aircraft.

Case: July 23, 2012 – International

The STEREO solar observatory (see below) detected and measured one of the largest solar storms ever recorded. The trajectory of the emissions were fortunately not directed at Earth during the time of the event, or it would have resulted in the type of extreme storm that has here been estimated as a "worst-case scenario." It has been calculated that if the solar eruption had taken place just one week earlier, then the Earth would have been aligned to receive the impacts, and the results would have been equivalent to another "Carrington Event" (see 1859 entry, above) but with far more extensive electronic systems and investments at risk than had been true in the past.

Celestial Impacts in Newaygo County

Many of the events occurred out of state, but some of them were large enough to have direct impacts upon Michigan, due to the sheer magnitude of the impacts. Although there are no recorded impacts in Newaygo County, there is an indication of the magnitude of what is possible. One event describes a "close call" whose impact could have been very large if it had occurred one week earlier than it had. Thus, these events help to indicate the range of threat posed by the hazard.

METEORITES AND OTHER IMPACTING OBJECTS

Impacting Objects

An impact or threatened impact from a meteorite, asteroid, comet, satellite, space vehicle, space debris, or similar objects that may cause physical damages or other disruptions.

Impacting Objects Hazard Description

Among the potential celestial impact hazards are the potential the effects of large masses impacting upon the Earth's atmosphere or surface. Most such forces are extraterrestrial in origin—meteors or meteorites that were originally asteroids or comets from elsewhere in the solar system—but consideration also needs to be given to the crashing of human space vehicles and artificial satellites. First, natural objects will be considered, that can forcefully explode in the atmosphere as meteors, or that reach the ground to impact as meteorites.

Meteors

Meteors burn up in the atmosphere, but in the process may cause strong winds and explosive blast forces to then strike the Earth's surface. It must be emphasized that even in cases where a large meteor does not actually strike our planet's surface, the explosive energies from its impact upon the many layers of atmosphere can create an intense heat and blast area, along with very strong winds, and can release more energy than even the largest nuclear bombs. This was demonstrated in the 2013 event in Chelyabinsk, Russia, in which about 1,000 persons throughout the metro area were injured, primarily as a result of glass windows that were shattered by the meteor's shock wave.

Meteorites are physical objects that have at least partially survived their plunge through the atmosphere and then actually strike the ground or sea at the Earth's surface. Any massive, fast-moving objects that impact upon either the ground, the oceans, or the atmosphere can cause widespread destruction and disruption of both human and natural systems, including secondary hazards such as earthquakes, shoreline floods, severe winds, and infrastructure failures. Fortunately, events of that magnitude are extremely rare, and highly unlikely to occur within the time-frame of this plan. However, an extensive discussion of impacting physical objects is given here to inform readers about the full range of potential impacts, from the trivial to the catastrophic. In the unlikely event that a very serious incident does occur, or threaten to occur, readers can have some background knowledge to better understand the hazard.

Then there is a set of cases involving unusual events such as which loud sonic booms or flaming fireballs are seen in the sky and reported to law enforcement and emergency management agencies. This chapter seeks to assist such agencies (and the general public) in better understanding and recognizing these events, and being able to explain them to others. Trivial meteor events are observed routinely during every year's well-studied meteor showers, when

Earth is passing through parts of its orbit in which numerous small particles had been left by passing comets, and which then harmlessly burn up in the atmosphere, visible as small points of moving light that are often referred to as “shooting stars.” But less frequent bolide events, in which a larger meteor hits the atmosphere with such force that it violently flares up, often with an accompanying sonic boom, and literally appears as a giant fireball, explosion, or bright pulse of light as it continues to plunge toward the ground. In Michigan, this occurred most recently in January 2018, and eventually was confirmed to be a small meteorite whose rocky and fragmented remains were found (the area of which is called a strewn field), scattered within Livingston County near Hamburg.

Although it has been estimated that a serious impact from a physical body upon the Earth occurs approximately once every 50 to 100 years, the fact that much more of the Earth has been covered by human developments within the recent past has caused increasing concern over this hazard. When Earth’s population was much smaller, events had tended to occur in areas with few if any inhabitants, so that it was very difficult to find any confirmed cases of an injury directly caused by a meteorite. However, the well-known theoretical risk of impacts became reality across the Chelyabinsk (Russia) metropolitan area on February 15, 2013, in which the force of the blast wave from a meteor caused shattered windows, and more than 1,500 injuries. One of the lessons learned from Chelyabinsk is that even though the type of damage was mostly minor (since windows are easy to replace), many of the injuries might have been prevented if there had been a greater public awareness of the concept of a blast wave.

Upon seeing a huge flash of light in the sky, an informed observer could potentially recognize that the observed light may really just be an initial warning indicator of the full event. Light travels faster than any massive objects, and so a flash of light from a distant explosion will necessarily be seen before the arrival of the impact forces of a blast wave and its accompanying strong winds. For this is effectively what happens during a large meteor event—an explosive blast occurs in the atmosphere as a meteor plunges through it. When traveling at supersonic speed through the atmosphere, a meteor will generate a loud “sonic boom” just like a fast jet plane. But if the meteor is large enough, then the force of the displaced air from that blast may continue to travel to the Earth’s surface, to strike those who are still watching the meteor. Even though most visible meteors are harmless because they are relatively small and far away, the actual size and distance of the meteor is often too difficult for ordinary observers to determine. Therefore, those who witness a sizeable blast in the sky should be aware of the potential for the light to be followed by a sonic boom and also potentially by an explosive blast wave and strong winds. Instead of staying near windows or in the open, gazing upward, some injuries could have been prevented by people going into interior rooms away from windows that face the event. The same protective principle also applies to any large explosive event, whether an industrial accident, natural gas pipeline blast, tanker explosion, or a detonated bomb. Distant observers might only experience a moment’s delay before being struck with blast force, heat, and winds from the explosion, and might have been able to use that moment to take cover to protect themselves.

Since most of the Earth's surface is covered by ocean waters, most meteorites would be expected to strike an ocean rather than a continent. However, there is still the potential for a large-enough ocean strike to be widely damaging, if the meteorite is fast and massive enough to create tsunamis and seismic activities as a result of its impact. Fortunately, this kind of event is also extremely rare, but is something that those who live in coastal areas should be aware of. For example, a strong impact on one side of Lake Michigan could cause waters to eventually swell over the property on the other side of the lake.

Extensive evidence of previous celestial impacts upon Earth has been discovered, including evidence of an ancient large crater site located in southwest Michigan, but the vast majority of Earth's past impacts have had their evidence erased from normal observation by the ongoing geological processes that take place over time. Even the largest of impact sites would no longer be evident to normal observation after a period of about 200 million years (usually much, much less). Such an amount of time is less than 5% of the Earth's overall age, but it has been found that impacts used to occur much more frequently during the earlier periods in Earth's history (i.e. nearer to the period of planetary formation) than they do in recent geological periods.

The vast majority of meteorites began as either asteroids or comets before striking the Earth. Each type of body has different characteristics and risks associated with it, described in the following paragraphs. An unknown quantity of other objects might also be able to strike the Earth, originating from beyond the solar system, but the risks from such impacts cannot readily be known and are probably very low within the near future. One example, however, was seen in October 2017. Named Oumuamua, it was the first and only known interstellar object to be detected and measured as it passed through the solar system. Its closest approach to the Sun (about 24 million miles) had occurred on September 9, 2017, and the dimensions of its elongated shape included a length that was initially estimated at 800 meters long, but a later study reached a dissenting conclusion involving a length of no more than 440 meters. Nevertheless, that magnitude is more than enough to have posed a serious threat if it were to strike the Earth or its atmosphere. Such objects were then estimated to pass through the solar system perhaps once or twice per year, most of which would have gone by completely undetected.

Asteroids

Most asteroids are located in the main asteroid belt and have well-defined orbits there between 200 and 310 million miles from the Sun, but thousands of asteroids also exist in other parts of the solar system. There are groups of "Trojan" asteroids that share an orbit with Jupiter, for example, located 60 degrees both ahead of and behind that planet in its orbit around the Sun. Asteroids that have paths located near enough to Earth's orbit are classified as Near-Earth Objects (NEOs). Four major types of NEOs have been defined (Amors, Apollos, Atens, and Altiras), two of which (Apollos and Atens) have paths that cross over Earth's orbit. As of early 2019, there were nearly 20,000 NEOs identified. Of these identified NEOs, nearly 2,000 were classified as Potentially Hazardous Asteroids (PHAs—having the potential to come within

466,000 miles of the Earth's orbit; by comparison, the average distance of the moon is 238,900 miles).

NASA's NEO discovery and tracking program had originally sought to identify all nearby objects that have a dimeter of 1 kilometer or larger. As of February 16, 2019, nearly 900 such objects had been identified. The NASA mandate was later expanded to try to document 90% of all NEOs that have a diameter of at least 140 meters (459 feet), and the tally of those objects has just exceeded 8,500. For current figures, please refer to the Discovery Statistics site at https://cneos.jpl.nasa.gov/stats/totals.html.) Fortunately, the vast majority of these objects pose no near-term risk to the Earth. Those that have even a minor chance of eventually striking Earth (i.e. within the next several decades) receive further study to better pinpoint the precise trajectory of the object over time. The results of such additional study eventually confirms that there is no impact expected, although surprises still arise from as-yet unclassified NEOs that are suddenly detected nearby ("near misses").

One near-Earth asteroid that had been identified as meriting careful monitoring is 101955 Bennu (1999 RQ36). It was made the target of a space mission and has recently been reached by the NASA spacecraft OSIRIS-Rex, which has begun scouting the asteroid for the best locations where it can land and collect information about the asteroid's composition and structure. This project will provide new information expected to help inform any future asteroid impact mitigation activities that might become necessary in the future. For up-to-date information on this mission, please refer to the website at https://www.asteroidmission.org/.

Comets

More than 99% of all meteorites come from asteroids, but some comet impacts have also been confirmed (9 are known, constituting less than 0.03% of all meteorites). The main difference between comets and asteroids is that comets tend to have elliptical orbits that carry them out beyond the "nebular frost line" (located about 700 million miles from the Sun, and well beyond the main asteroid belt) and thus their composition includes a substantial amount of icy and frozen matter. Comets usually lose about 0.1% of this matter each time they pass by the sun, due to the effects of warming and the pressure of solar radiation, and this matter trails behind them in their long "tails," which include charged particles (with associated magnetic fields) and can stretch across many tens of millions of miles of space. Where such tails cross the Earth's orbit, this matter (typically small and harmless to us) generates sometimes spectacular "meteor showers" as it periodically burns up in the Earth's atmosphere at regular times during the year. After a certain number of orbits, however, the comet simply breaks apart. Even though comets are less dense than the average asteroid, a comet's heavy nucleus can be sizeable (from several hundred meters to over 40km in diameter), and a comet impact upon the Earth would typically occur at a speed of 31 miles per second—about three times as fast as the average asteroid, with a proportionally larger momentum of destructive energy if the amount of mass is the same. It is worth noting here that the maximum impact velocity upon the Earth for any object orbiting the Sun would be no more than 44.5 miles per second—160,000 miles per hour—but that the

maximum measured velocity of any known meteorite so far was 64,000 miles per hour (seen as a fireball across the western U.S. on April 22, 2012 and later named the Sutter's Mill meteorite).

Comets are classifiable by their orbital period, with long-period comets taking more than 200 years to travel around the Sun, and short period comets taking less than that.

Impacting Objects Hazard Analysis

A couple of scales have been developed to numerically summarize the extent of risk associated with comets and asteroids. One scale is called the Palermo scale, but since that is tricky to interpret, the Torino Scale has instead been featured in media reports since its initial presentation at a United Nations conference in 1995, and it was adopted by the International Astronomical Union in 1999. Both scales take into consideration the amount of destructive energy that an impact could cause, and the probability of such an impact occurring. It is common for newly discovered objects to have their initial classifications on these scales subsequently downgraded, as additional information is collected that more precisely defines the exact path of the object. In other words, an object that is initially classified as having some potential of an impact, and thus being worthy of closer study, is usually later reclassified as additional information reveals that little or no significant impact potential exists. Objects with lower numbers on the Torino scale indicate little or no concern. Within the past 20 years, only one object (99942 Apophis) had temporarily been classified as high as a 4 on the Torino scale. Being an asteroid large enough to cause regional devastation if it struck, Apophis had initially been estimated to have a 1-in-45,000 chance of striking the Earth on April 13, 2036, but as more information was obtained about its trajectory, that estimate was downgraded to only a 0.000009 probability, as is currently classified as 0 on the Torino scale. The asteroid's approach will eventually be spectacular to observe, though, as it is predicted to come as close as 18,300 miles away from the Earth's surface as it passes. (In Celestial terms, this is a very near miss, because that distance is smaller than the circumference of the Earth.) Below is the official explanation of Torino Scale ratings, which only apply to potential impacts up to 100 years in the future. In addition to numerical categories from 0 to 10, the scale is also color-coded in five categories, from white to red.

<u>THE TORINO IMPACT HAZARD SCALE:</u>

No Hazard (White Zone)

0: The likelihood of a collision is zero, or is so low as to be effectively zero. Also applies to small objects such as meteors and bodies that burn up in the atmosphere, as well as infrequent meteorite falls that rarely cause damage.

Normal (Green Zone)

1: A routine discovery in which a pass near the Earth is predicted that poses no unusual level of danger. Current calculations show the chance of collision is extremely unlikely with no cause for public attention or public concern. New telescopic observations very likely will lead to re-assignment to Level 0.

Meriting Attention by Astronomers (Yellow Zone)

2: A discovery, which may become routine with expanded searches, of an object making a somewhat close but not highly unusual pass near the Earth. While meriting attention by astronomers, there is no cause for public attention or public concern as an actual collision is very unlikely. New telescopic observations very likely will lead to reassignment to Level 0.

3: A close encounter, meriting attention by astronomers. Current calculations give a 1% or greater chance of collision capable of localized destruction. Most likely, new telescopic observations will lead to re-assignment to Level 0. Attention by the public and by public officials is merited if the encounter is less than a decade away.

4: A close encounter, meriting attention by astronomers. Current calculations give a 1% or greater chance of collision capable of regional devastation. Most likely, new telescopic observations will lead to re-assignment to Level 0. Attention by the public and by public officials is merited if the encounter is less than a decade away.

Threatening (Orange Zone)

5: A close encounter posing a serious but still uncertain threat of regional devastation. Critical attention by astronomers is needed to determine conclusively whether or not a collision will occur. If the encounter is less than a decade away, governmental contingency planning may be warranted.

6: A close encounter by a large object posing a serious but still uncertain threat of a global catastrophe. Critical attention by astronomers is needed to determine conclusively whether or not a collision will occur. If the encounter is less than three decades away, governmental contingency planning may be warranted.

7: A very close encounter by a large object, which if occurring this century, poses an unprecedented but still uncertain threat of a global catastrophe. For such a threat in this century, international contingency planning is warranted, especially to determine urgently and conclusively whether or not a collision will occur.

Certain Collisions (Red Zone)

8: A collision is certain, capable of causing localized destruction for an impact over land or possibly a tsunami if close offshore. Such events occur on average between once per 50 years and once per several 1000 years.

9: A collision is certain, capable of causing unprecedented regional devastation for a land impact or the threat of a major tsunami for an ocean impact. Such events occur on average between once per 10,000 years and once per 100,000 years.

10: A collision is certain, capable of causing global climatic catastrophe that may threaten the future of civilization as we know it, whether impacting land or ocean. Such events occur on average once per 100,000 years, or less often.

Note: A color graphic of the current Torino Scale is available at https://cneos.jpl.nasa.gov/sentry/torino_scale.html.

The Palermo Technical Impact Hazard Scale is a bit different, with values less than -2 reflecting events for which no consequences are likely, values between -2 and 0 indicating situations that merit careful monitoring, and values above zero indicating situations that merit some level of concern. This document presents only the Torino scale in its entirety, since that scale was developed for general public-information uses.

About 40,000 to 60,000 tons of extraterrestrial material falls onto the Earth each year, but most of it is mere dust. Slightly larger materials fall during regular cycles called meteor showers, but again most of it is small enough to harmlessly burn up (through ablation) as it hits the Earth's atmosphere at high speeds. During meteor showers, the material is typically leftover debris from comets that had crossed the Earth's orbit in the past, and most such material is very small and harmless to us. Material that does survive ablation in the atmosphere and strike the Earth's surface will land in random locations, and since 70% of the Earth's surface is water, these meteorites mostly go unnoticed by ordinary people. The general risk to Michigan is actually statistically calculable, by considering the proportion of the Earth's total surface area that is occupied by Michigan's land area. This is approximately 2.9 x 10-4, or 0.00029. The frequency of global impact events can then be multiplied by this factor to estimate the frequency of impact events directly upon Michigan's land area. This results in the following estimates, on average, for different sizes of impacts upon Michigan's land itself:

- About 1 to 5 impacts per year that are larger than 100 grams (golf-ball size) – This may kill an individual that is struck, but since most space is not occupied by a person at any particular moment, such a thing is exceptionally rare, and (until the 2013 Chelyabinsk event) there have only been a couple of confirmed meteorite injuries worldwide. Instead, such incidents are more likely to simply cause limited property damage to a car or home, although their appearance in the sky can appear impressive and be accompanied by a sonic boom. Example: the Washtenaw County strike of 1997 (described in the "Significant Events" section).

- About one impact per century involving an object of more than 100kg (220 pounds), and about one impact every 1700 years involving an object of more than 1000kg (about 2200 pounds) – These types of events would result in loud sounds and bright flare-ups in the sky, leaving a field of fragments strewn across an area that is miles across, but actual damages are likely to be only moderate unless a dense urban area or critical facility happens to be struck. Example: The Park Forest, IL event of 2003. 312 Natural Hazards – Geological (Meteorites and Other Impacting Objects)

- About one impact every 350,000 years involving an object of more than 100,000kg (about 220,000 pounds) – This is the type of impact that resembles an atomic blast, exploding brightly in the sky and producing a very strong blast wave and severe winds that would cause extensive

building damages and collapse at ground level, and would flatten forest lands. Example: the Tunguska, USSR event of 1908.

Although that last type of event is so rare that it need not be of general concern for Michigan, the probability of such an event affecting some part of the U.S. and potentially causing a national emergency is a bit larger, but still remote. It is most probable that the next such event will occur elsewhere in the world (on the order of about one or two events per century) and, although potentially devastating to that area, Michigan's role would probably only involve the voluntary donation of humanitarian aid to the disaster area. One foreseeable scenario could involve an asteroid impact in the ocean, which causes tsunami impacts upon a nearby coastline of the U.S. Waves could be more than 100 feet high from the impact of an asteroid with a diameter of 1300 feet, although that scale of event would only be expected about once in 80,000 years. These types of large events—the kind that would actually form sizeable craters and cause catastrophic national or global impacts (including major seismic and volcanic effects and global cooling from gaseous effects and dust, smoke, and particulates deposited into the atmosphere)—are rare enough that no extensive description will be provided here.

Since meteors flare up brightly in the sky, some persons have speculated about whether meteorites could then cause wildfires to start up. As it turns out, this is generally not the case. The flaring fireballs are caused by ablation, as the very fast meteors encounter the atmosphere and friction generates heat, but a great amount of material typically burns away very quickly during this process, followed by miles of additional falling before ground impact, during which time the contact with blowing air exerts a cooling effect. The vast majority of meteorites are actually cool when they strike the ground. In general, wildfires will not be caused by meteorites, and in view of these principles, the weight of evidence goes against the hypothesis that any of Michigan's historic wildfires were of meteoritic origin.

In cases involving an official alert about an impending impact or potential impact, many persons would need information that allows them to understand the nature of the threat, and the techniques that may be used to prevent or mitigate its impacts. For example, there is an enormous difference between an alert that provides only a few weeks of notification, and one that has identified a need for action over the course of several decades. A National Near-Earth Object Preparedness Strategy and Action Plan was published in June 2018 as a result of extensive coordination between NASA, FEMA, and many other agencies. It calls for the development of communications plans and processes, to be implemented at the federal level. For more details within this document itself, please see https://www.whitehouse.gov/wp-content/uploads/2018/06/National-Near-Earth-Object-Preparedness-Strategy-and-Action-Plan-23-pages-1MB.pdf.

It should be realized that although the atmosphere and air around us seems to be "light" and only a small obstacle to movement under normal conditions, that air nevertheless has enough substance to sustain heavy aircraft in flight, to hold aloft huge thunderstorm clouds full of rain, allow fast-moving winds to cause damage, and so on. A meteor crashing into our atmosphere thus encounters enormous physical resistance, and releases tremendous amounts of energy as the result of the friction and impacts of plunging through large quantities of ever-thickening air layers at enormous speeds. This

energy can result in large (and loud) blast waves, even if the meteor's trajectory is oblique enough to cause it to "bounce off" the atmosphere, rather than plunging through it and hitting the ground.

It is likely that the next major meteorite impact will occur somewhere in the world other than Michigan, and that Michigan's role as part of the United States would at most involve the provision of support to the impacted area and its surroundings. If a major impact happens to occur in North America, then state-level mutual aid may result, and possibly even the intake of evacuees, as had taken place during the Katrina and Rita hurricane disasters of 2005. Several recent bolide events have been documented in the Great Lakes area, but have caused no known damage to the state's area during its European historical era over the past four centuries. It is possible that certain unexplained seismic events reported in the Upper Peninsula more than two centuries ago may have been caused by celestial impacts. For the most part, however, the meteorite hazard is important to know about mainly for preparedness and informational usefulness, rather than due to an actual pattern of severe damaging effects upon Michigan.

Impacting Objects in Michigan

NOTE: Although many of the events listed here had occurred outside of Michigan, some of them were nevertheless large enough to have direct impacts upon Michigan, due either to the sheer magnitude of the impacts or to the widespread nature of an alert. Some of the listed events occurred an extremely long time ago, while some are extremely small but recent events within Michigan, to give an indication of the range and magnitude of what is possible. Some events merely describe "close calls" and events whose limited impact at the time would have been much greater had occurred at a slightly different time or location. (Our current development density is much greater and involves much larger populations than had been present in the past.)

Case: Approximately 1.8 billion years ago – Sudbury, Ontario

One of the largest known impacts took place around Sudbury, Ontario, leaving impact effects that measure 155 miles in diameter. The impact site's geological structure had been discovered in 1883 but not fully explained until 1964. Debris ejected from the impact site was thrown as far as the Midwestern U.S., including Michigan. This was an impact of global significance. The heat directly generated by this cataclysmic impact would have killed any humans within at least 500 miles from the impact site (which includes all of Michigan), if humans had been living in the area at the time.

Case: Approximately 450 million years ago – Cass County

An impacting object struck what is now southeastern Cass County (Calvin Township), and left effects that are still geologically detectable today. The event is known as the Calvin 28 crypto-explosive disturbance, and the Calvin impact area is about 5 miles in diameter, located mid-way between the Village of Vandalia and the Michigan-Indiana State Line. About the same time (in geologic terms), a much larger impact occurred on what is now the northern coast of Lake Superior (the Slate Islands in Ontario) and formed an impact structure about 19 miles in diameter. The map above shows the Cass County impact area (Source: University of New Brunswick's Earth Impact Database website).

Case: Approximately 65 million years ago – Global

A large impact on the Yucatan peninsula of Mexico took place at the end of the Cretaceous (geological) period. The impact area is known as Chicxulub, and although it is not evident to ordinary observers today, the ancient impact structure was geologically measured at approximately 100 miles in diameter. The Chicxulub impact has been considered to be a direct or contributing cause of the extinction of many prominent species of life on Earth at the time, including the large reptilian dinosaurs. There may be galactic cycles that make major, species-threatening impacts more likely during certain periods of time than others, with mass extinctions seeming to correlate with intervals of between 26 and 32 million years in length (over the past 250 million years), perhaps caused by some celestial event that sweeps Oort Cloud or Kuiper Belt objects from the outer parts of the Solar System toward Earth, or by the effects of a nearby star going supernova. Certain regions of the Milky Way Galaxy, which the Sun passes through on a grand cycle that repeats every 225 to 250 million years as it orbits the galaxy's center, may expose the Earth to more celestial bodies than are normally seen in the Solar System during the more stable, intervening time periods. Since the most recent mass extinction period was about 11 million years ago, there is no expected threat of this type during our lifetimes. Recently, evidence has been claimed for an even larger impact site, at around the same time, off the west coast of India. A surge in volcanic activity took place in the same geological time frame as the impact events and thus may have been a result of them.

Case: July 1, 1770 – International, "Lexell's Comet" Lexell's comet (D/1770 L1) was computed by astronomers as having passed only about 1.4 million miles from Earth (less than 6 times the average distance of the Moon, or about 1.5% of the distance to the Sun). This was the nearest such Earth encounter to be measured astronomically rather than in terms of its actual impact effects as a meteorite (until the very recent tracking of smaller and slower objects). Now considered to be a "lost comet," its orbital period had been calculated at the time (by Lexell) to be 5.6 years, eventually leading to the idea that space objects may be propelled toward Earth by a gravitational encounter with Jupiter—a circumstance that is one of the potential sources of comet and asteroid impact threats that would provide little or no advance warning. The comet was initially observed on June 15, 1770, and was last observed moving away from the Sun on October 3 of the same year.

Case: September 17, 1966 – Lake Huron Bolide

A bolide event occurred over Lake Huron, Michigan, involving an air blast estimated as the equivalent of 1/3 ton of TNT, approximately 8 miles above the surface of the water. Although no material from a meteorite was found to help determine more information about the size and characteristics of this meteor, this is not surprising since the location of the event probably placed any meteorite remnants at the bottom of Lake Huron. The bolide illuminated the whole of south-western Ontario and adjacent regions at about 8:48 pm, as it was seen traveling northwest across Lake Erie and the tip of Ontario, toward Lake Huron. At least a dozen loud "detonations" were reported from the Ontario area near the lake a few minutes after the fireball's passage. Astronomers later calculated that the meteor was about 8 miles up as it crossed over Lake Huron, and probably reached the lake's surface fewer than 18 miles west of the city of Kincardine, Ontario. The meteor was traveling about 10.6 miles per second (38,000 miles per hour) and was brightly luminous for at least 10 seconds.

Case: January 1978 – International, "Cosmos 954" Satellite Crash
A Soviet satellite, Cosmos 954, which had been launched in September of 1977, was being monitored by U.S. agencies and by November was found to have a decaying orbit. By January, it had become apparent that the satellite had lost its attitude stabilization system. Such satellites were known to be powered by small nuclear reactors, using fuel that was 90 percent enriched Uranium-235. Thus, whenever and wherever this satellite fell to Earth, it had the potential to contaminate things and persons coming into contact with it. The U.S. National Security Council arrived at an estimate that there was only about a 1 in 10,000 chance that a human would be injured in the crash, but because of the political aspects of an enemy nation's nuclear satellite crashing onto friendly territory, it became important to treat the incident with more weight than what that small risk might normally be credited with. Operation Morning Light was thus created, in December of 1977, with the Department of Energy given lead responsibility for the possibility of a domestic crash site. Even though a crash site for the projected landing orbit was only supposed to have an 8% chance of being on land, plans were made for such a contingency, which would involve the finding of radioactive debris, decontamination of affected land areas, and the treatment of any persons within an unsafe distance of such debris. After about 10 days of careful inquiries with the Soviet government, various types of confirmation were received about the satellite's nature and condition. On January 24, the satellite entered the atmosphere over Queen Charlotte Island, British Columbia, and at 6:53 am, finally crashed near the Great Slave Lake, just north of the Province of Alberta, in Canada. Aircraft and Nuclear Energy Search Teams were then dispatched to Canada, to assist with clean-up operations.

Case: September 1, 1997 – Salem Township (Washtenaw County), Meteorite After numerous persons reported a bright daylight meteor and sonic booms, the meteoric object broke up into at least three parts. One meteorite (called the "Worden Meteorite") then struck a residential garage roof (in Salem Township, midway between the villages of Salem and Brookville), as the family was nearby working in their back yard. They had heard a whistling sound passing overhead, and then investigated a boom and crash, finding the garage full of plaster dust, pieces of drywall, and insulation. There was a dent in the roof of a car that was parked in the garage, and the meteorite itself was found on the floor nearby, along with a couple of associated fragments. The large meteorite weighed about 1.5kg, and its dimensions were about 6 inches long, 4 inches wide, and an inch thick.

Case: Feb 1, 2003 – National, Space Shuttle Columbia Explosion Debris Fields
The Space Shuttle Columbia broke apart violently when returning from a mission, causing a widespread alert about the potential for falling debris across the southwestern United States. More than 2,000 debris impact sites were eventually reported, but fortunately these were predominantly in sparsely populated areas. NASA issued warnings that the shuttle debris could contain hazardous materials and that it should remain untouched (and instead be reported to authorities upon discovery).

Case: March 26, 2003 – "Park Forest Meteorites" in Suburban Chicago, Illinois
Hundreds of small meteorites fell across residential areas in the suburbs of Chicago. Although meteors were visible from Michigan and the meteorites landed fairly close to Michigan territory, it must be noted

that this event is highly unusual, having been described as “the most densely populated region to be hit by a meteorite shower in modern times.” The original meteoroid was calculated to have been between 1 and 7 thousand kilograms (possibly more) before it broke apart in the atmosphere. About 30 kilograms of meteorite fragments were recovered, the largest of them weighing 5.26kg. Numerous holes were punched through windows, roofs, and ceilings in homes, and also a fire station. One roof hole was caused by a meteorite that weighed only 545 grams. There were about 18 documented fragments comparable to that size, or larger, across a couple of square miles of neighborhoods.

Case: June 27, 2011 – International, Near-Earth Object

An asteroid designated as 2011 MD passed only 7,600 miles above the Earth’s surface. It was discovered by LINEAR and its size was less than 20 meters in diameter. The object was close enough to markedly change its trajectory as it passed.

Case: November 1, 2016 – International, Near-Earth Object

This was another “near miss” event, involving asteroid 2016 VA, which was discovered only the day that it approached Earth. It passed by at a distance of about 48,000 miles, four times closer than the moon. The size of that Aten asteroid was estimated as similar to the one that landed near Chelyabinsk in 2013.

Case: January 16, 2018 – Southern Michigan Bolide and Meteorites

A meteor flared up very visibly within the early night sky. In some places, loud sonic booms were reported. Five miles southwest of New Haven (Macomb County), a seismic measurement of magnitude 2.0 was reported at approximately the same time as the meteor passed by, which might indicate the loudness of the sounds from the sonic booms (although a 2.0 seismic event is very weak, as described in the chapter on Earthquakes, q.v.). Although the bolide had been reported by hundreds of persons from seven states, this was predominantly a Michigan event. A strewn field with multiple meteorite fragments was soon found within Hamburg Township (Livingston County), and the meteorite samples found there are named Hamburg, after that community. All meteorite fragments were quite small, the largest of them weighing 102 grams. Twenty meteorite pieces were found, with an estimated total mass of 1 kilogram. No known damage resulted from this event.

Case: March-April, 2018 – Tiangong-1 Space Station Alert

In March, the orbit of a Chinese space station, Tiangong-1, had decayed enough that it was clear that it was plummeting into the atmosphere and that some of its debris could survive the re-entry process, posing a hazard if it struck one of Earth’s land areas. In addition to the problems of life and property damage from any large metal components as they landed, Tiangong’s corrosive fuel, hydrazine, would have posed a contamination risk if tainted fragments fell in populated areas. The likeliest paths for Tiangong’s decaying orbits had been calculated and showed that there was a higher chance of debris falling within particular mid-latitude zones of the Earth, which included the most heavily populated parts of southern Michigan. It was estimated that some parts of the space station might weigh as much as 220 pounds when crashing to Earth. Therefore, the State Emergency Operations Center went into a monitoring mode to be ready to coordinate activities if Tiangong’s impact area did turn out to involve

Michigan. The Michigan Satellite Reentry Response and Recovery Plan was utilized and updated in March, and fortunately it became clear by early April that the actual crash site would not be in Michigan. The remains of the Tiangong-1 space station all landed safely in the South Pacific Ocean on April 2.

Case: December 18, 2018 – Bering Sea Bolide

The most powerful meteor since the 2013 Chelyabinsk event occurred above the Bering Sea. A meteor exploded into a large fireball and unleashed energy that was calculated to be 10 times that of the 1945 atomic bomb detonation at Hiroshima. The uninhabited area meant that no harmful effects occurred to persons or property. The event was documented by two NASA instruments on a satellite, and these images were widely distributed in media reports and at NASA's website.

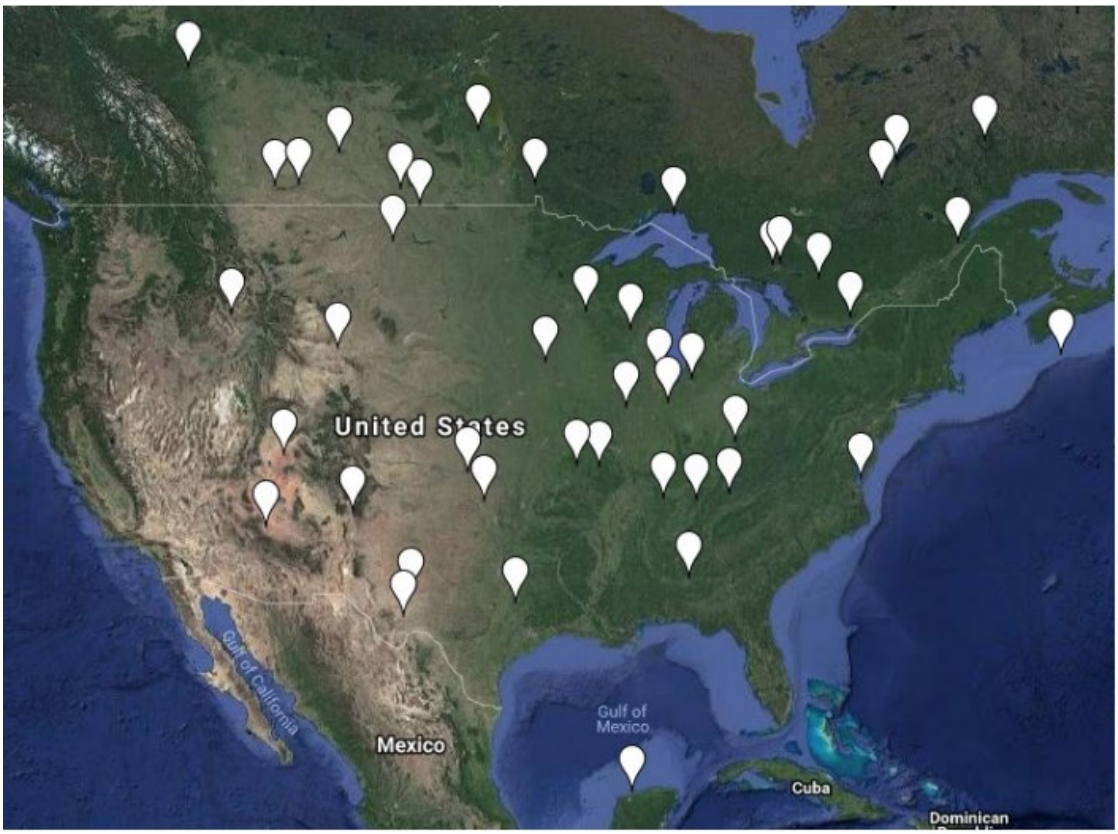


Image showing identified impact crater sites across a portion of North America Source: The Earth Impact Database website: http://www.passc.net/EarthImpactDatabase/New%20website_05-2018/NorthAmerica.html)

Impacting Objects in Newaygo County

Many of the events occurred out of state, but some of them were large enough to have direct impacts upon Michigan, due to the sheer magnitude of the impacts. Although there are no recorded impacts in Newaygo County, there is an indication of the magnitude of what is possible. One event describes a "close call" whose impact could have been very large if it had occurred one week earlier than it had. Thus, these events help to indicate the range of threat posed by the hazard.

INVASIVE SPECIES

Invasive Species

A species whose introduction to Michigan causes or is likely to cause economic or environmental harm, or harm to human health, to an extent that outweighs the species' known benefits. This chapter includes a consideration of harmful contagious diseases that may have similar impacts.

Hazard Description

An invasive species is defined as a species that is (1) non-native (alien) to the ecosystem under consideration and (2) whose introduction causes or is likely to cause economic or environmental harm, or harm to human health. Invasive species can be plants, animals, and other organisms (e.g., microbes). This chapter includes a consideration of harmful contagious diseases that may have similar levels of impact upon Michigan's ecology or economy. Invasive species typically fall into two broad categories—**terrestrial** (able to live in Michigan's land area) and **aquatic** (able to live within Michigan's water bodies).

Human actions have been an important consideration as a means of invasive species' sudden introduction (thus distinguishing the situation from natural shifts in the distribution of species), but a human-related cause may not be relevant to the extent of impact that results. Nationally, the current environmental, economic, and health costs of invasive species have been estimated as exceeding the costs of all other natural disasters combined, and Michigan's own potential costs have been estimated as extremely serious.

Invasive species can be transported in many ways, such as on animals, vehicles, ships, commercial goods, produce, and clothing. Although non-native species are the foundation of U.S. agriculture, and also are used to prevent erosion, to provide fishing and hunting opportunities, and as ornamental plants and pets, occasionally a non-native organism flourishes too well and causes unwanted economic, ecological, or human health impacts. The terms "invasive" or "nuisance" are used to describe such species. After its arrival, an invasive species becomes capable of establishing a breeding population in its new location and becomes a pest by threatening local biodiversity and causing or threatening human health impacts, significant economic costs, and/or harmful ecological effects to an extent that outweighs its known benefits. New environments may affect rates of reproduction, susceptibility to disease, and other features that affect a species' success. Consequently, a plant or animal that causes little damage to agriculture or natural ecosystems in one area may cause significant problems in another. Certain non-native species are very successful in their new habitats because they out-compete native plants or animals and have no natural controls (predators, diseases, etc.) in the new area. At least 200 well-known, high-impact, non-native species presently occur in the United States. They range from the European gypsy moth and emerald ash borer to crabgrass, dandelions, and German cockroaches, annually costing well over a billion dollars to control. Some even pose human health risks. Others, like the zebra mussel, threaten widespread disruption of ecosystems and the displacement or loss of native plants and animals.

Hazard Analysis

Hundreds of new species from other countries are introduced intentionally or accidentally into the United States each year. These invasive species may arrive on our shores in a variety of ways. Transportation efficiencies that make it possible to travel around the globe in hours rather than weeks make it possible for organisms to survive transportation from one continent to another.

As more adaptable and generalized species are introduced to environments already impacted adversely by human activities, native species are often at a disadvantage to survive in what was previously a balanced ecosystem. There are many examples of decreased biodiversity in such areas. One of the primary threats to biodiversity is the spread of humanity into what were once isolated areas, with land clearance and habitation putting significant pressure on local species. Agriculture, livestock, and fishing can also introduce changes to local populations of indigenous species and may result in a previously innocuous native species becoming a pest, due to a reduction of natural predators. This threat intensifies the need for scientists, managers, and stakeholders to cooperate to build better systems to prevent invasion, improve early detection of invaders, track established invaders, and to coordinate containment, control, and effective habitat restoration.

Although invasive species, in most cases, primarily cause environmental damage and degradation, there are situations in which serious threats to public health, safety, and well-being can occur due to animal disease or plant and animal infestations. For example, certain diseases could wipe out large segments of an animal population, creating a potentially serious agricultural disaster and a potential public health emergency (often with a need to properly and rapidly dispose of many animal carcasses).

Similarly, a widespread insect infestation, such as that of the Emerald Ash Borer, has created serious public safety threats (especially in densely populated urban areas) due to dead and dying trees being fire prone (because of their dry, brittle nature) and subject to damaging collapses, especially during high wind events or periods with ice and snow accumulation. Falling trees or limbs can bring down power lines, cause damage to public and private structures, and cause injuries or even death.

Impact on the Public, Property, Facilities, and Infrastructure

The emerald ash borer had caused extensive damage to trees in Michigan, and those weakened trees have often (1) collapsed and caused property damage, including utility line impacts, and (2) required removal, at considerable expense. A disaster declaration request had been sent to FEMA, but the request was not accepted by that agency, leaving state and local budgets, residents, and insurance companies to try to cover the considerable expenses and efforts involved in dealing with the problem. Similar terrestrial species include the Asian Long-Horned Beetle and the Cedar Long-Horned Beetle, although aquatic species and some microbes are also of concern, since they may disrupt or impede forestry, horticulture, and fishing for Michigan residents, tourists, and industries. The most severe potential impact is now estimated to be posed by the invasion of Asian Carp into the Great Lakes. It has been reported that entire summer tourist industries could go into serious decline as a result of such an event, including fishing, swimming, and boating-related activities. Property damage had occurred as a result of the Emerald Ash Borer impacts, and lessened property values may eventually result from a

full-scale Asian Carp problem. Some facilities have been affected by Zebra Mussels, but a greater impact has probably now been seen from the return of cyanobacteria problems (i.e. harmful algal blooms) within Lake Erie, which caused a temporary shutdown of the Toledo drinking water supply.

Impact on the Economic Condition of the State

An Asian Carp invasion into the Great Lakes is expected to cause a serious and dramatic decline in Michigan's major summer tourism sector, to the degree that such an invasive species is expected to interfere with swimming, boating, and water-skiing activities, and to proliferate at the expense of valuable Great Lakes fisheries. The Emerald Ash Borer had caused a regional impact without any of the compensation that had been requested of FEMA. A quarantine area needed to be imposed and enforced, with regard to the transport of firewood and similar lumber that could pose risks of spreading the insect to harm new areas, but this only slowed the spread of infestation, and the quarantine was repealed by the director of MDARD on October 1, 2018.

Impact on Responders, Continuity of Operations, and Continued Delivery of Services

The invasive species hazard is a less familiar one for the general public, generally long-term and insidious in its effects, and rooted in an understanding of the biological sciences. Most emergency management training does not focus on the topic. Emergency management consideration of invasive species is recent and therefore needs to be increased. MSP/EMHSD has recently been strengthening coordination with the U.S. Geological Survey, which has specialized offices dealing with this hazard. An Ann Arbor USGS office deals with Great Lakes aquatic species, and a separate USGS office in Fort Collins, Colorado, deals with terrestrial species. The most damaging Emerald Ash Borer event probably affected some operations and services as a result of damages from falling trees, but such effects were generally minor compared with the direct physical damages.

Impact on the Environment

Terrestrial and aquatic forms of invasive species both pose problems for the ecosystems in which they are introduced. Whether invasive species are brought to an area on purpose or by accident, these non-native life forms can alter the existing ecosystem and decrease an area's biodiversity. Like many hazards that affect Michigan's environment, invasive species have both direct and indirect impacts. The Zebra Mussel, for example, has been invading Michigan's water bodies since the mid 1980's and is responsible for eating the microscopic food supply that is vital to the existing ecosystem. Further, the Zebra Mussel attaches to water intake pipes and screens used for drinking water and industrial plants. Not only do these pests cause environmental problems, but they cause secondary economic impacts to a community as well. Similarly, the Emerald Ash Borer, a non-native insect, is responsible for killing millions of Ash Trees in Michigan, which changes the biodiversity of the forest and diminishes wildlife habitats. Dead trees pose problems for the human-built environment, as well, pulling down nearby wires and damaging structures.

Impact on Public Confidence in State Governance

Terrestrial species are likely to have more general public awareness than aquatic ones, and thus more likely to be a cause for dissatisfaction or loss of public confidence in government. Although there have

been well-publicized aquatic species of concern (e.g. zebra mussels, Asian carp), people tend to be more aware of the impacts of terrestrial species, unless their recreational or business activities are more heavily curtailed by aquatic ones. The most recent widespread terrestrial species of concern has been the emerald ash borer insect—trees killed by these insects are prone to collapse, causing property damage, blocked roads, broken utility lines, etc. Citizens and businesses that are more heavily connected with agriculture and tourist industries are more likely to be aware of the impact of invasive species, and thus more likely to express doubts about government policies.

Climate Change Considerations

Different patterns of wildlife have already been concerned as a result of the lengthening average growing season in Michigan. Species that had previously been found only in warmer areas to the south have started to appear in Michigan. Although the definition of invasive species specifically refers to human species introduction, to distinguish these patterns from naturally occurring ones, species transported by human action can be more likely to survive (and thus to become invasive) as climatic changes occur.

NOTE: The following lists and descriptions provide examples of invasive species that pose some threat to Michigan, or have already affected Michigan. For each of these categories, at least several other species could have been included. Some of these species, such as the Gypsy Moth, are already well-established throughout the state, but the text provides information about the kinds of impacts that can result from the invasive species hazard.

Much additional information can be found at https://www.misin.msu.edu/ and http://www.invasive.org/.

A Michigan watch list has been established, and can be found at online at the following web site: https://www.michigan.gov/invasives/0,5664,7-324-68002_74188---,00.html. Species on the watch list have been identified as posing an immediate and significant threat to Michigan's natural resources. The species have either not been confirmed in the wild in Michigan, or have just a limited known distribution. Any occurrence of these species should be reported.

Examples of Potentially Threatening Terrestrial Invasive Species
(Note: These are just a few of the species that are currently on a Michigan watch list.)

Asian Long-Horned Beetle (Anoplophora glabripennis)

Hosts: Several species of hardwood trees found in Michigan. Its favorite host is the Norway maple, although it has been found in other maple species, horse chestnut, elm, box elder, mulberry and poplar trees.

Symptoms: Dark, wet areas on branches and trunks or white foamy sap are often the first symptoms seen in infested trees. The sap often attracts bees, wasps and hornets.

Damage: Trees infested are first weakened, and then die. Damage from these insects and secondary pests will kill a tree within a few years.

Control/Treatment: Prohibited in Michigan. The only known way to eradicate the beetle is to cut down and burn infested trees.

Balsam Woolly Adelgid (Adelges piceae)
Hosts: All true firs.
Symptoms: Small white masses on tree, stunted shoots, formation of galls, tree crown turns red.
Damage: Feeding on the branches of the crown and main stem, causing mortality in 2-6 years.
Control/Treatment: Spraying of individual trees from the ground with lindane has proved effective for control. The spray, prepared by mixing 2.5 pints of 10% emulsifiable concentrate per 100 gallons of water, is applied as a bark drench with a hydraulic sprayer from May through June and September through October to control crawlers. Treatment will reduce populations to below the tree-killing level, and some treated trees may remain generally free from aphids for at least 2 years. Spraying is warranted only in accessible areas supporting relatively high-value trees.

Hemlock Woolly Adelgid (Adelges tsugae)
Hosts: Eastern Hemlocks.
Symptoms: Small white cottony masses at the base of the needles. Needles turn grayish green and drop off. There is a lack of new buds, and low vigor.
Damage: Feeding on twigs by nymphs cause the trees to die within 1-4 years.
Control/Treatment: Horticulture oils that smother the insects have been the best insecticidal treatment. The oils are non-toxic to the trees, as opposed to soap, which is an otherwise effective treatment. However, the least harmful cure may be the introduction of Japanese ladybugs.

Thousand Canker Disease of Walnut (Pityophthorus juglandis and Geosmithia morbida)
Hosts: Black walnut and other walnut species.
Symptoms: Infected trees show wilting, curling, and yellowing of leaves on one or more branches in their upper portions, as a fungus from the walnut twig beetles progressively affects the tree's health.
Damage: Causes thousands of small cankers on and under the bark, disrupting the flow of nutrients to the branches. Tree mortality is directly proportional to the number of feeding sites present on the tree.
Control/Treatment: There is no practical treatment, once infected. Landowners should remove affected trees to prevent spread to nearby trees.

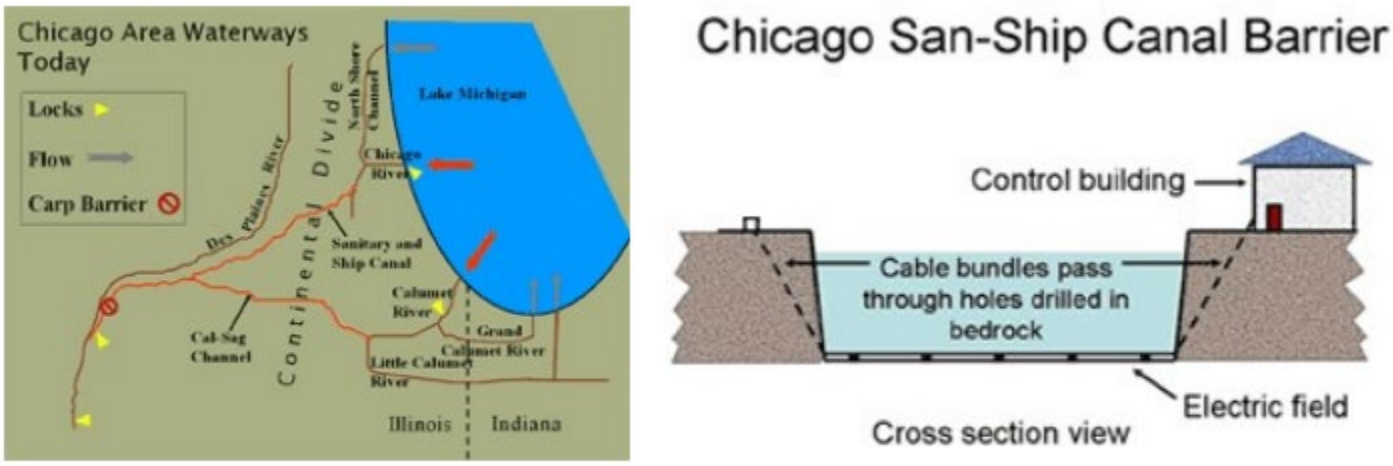
Examples of Potentially Threatening Aquatic Invasive Species

Asian Carp (Ctenopharyngodon Idella Grass Carp, Hypophthalmichthys nobilis Bighead Carp, Mylopharyngodon piceus Black Carp, and Hypophthalmichthys molitrix Silver Carp)
Hosts: Asian carp made their way into the Mississippi River from Arkansas fish farms in the 1970s as a result of flooding and have steadily swum upstream for years at a pace of 40 to 50 miles a year. Asian carp are currently in the Illinois River and only miles away from entering the Great Lakes. **Symptoms:** Decline in native fish species. There are four different species of Asian carp that have invaded the

Mississippi River: grass (Ctenopharyngodon idella), bighead (Hypophthalmichthys nobilis), black (Mylopharyngodon piceus), and silver (Hypophthalmichthys molitrix). All three species of Asian carp pose a problem to the waterways by devastating habitats and destroying water quality. However, the bighead and silver carp are of the greatest concern, due to their size. These fish can each grow to be 50 to 100 pounds. Although great attention has been focused on these fish recently, dreissenid mussels have already invaded the Great Lakes and caused extensive impacts. (A description of mussels also appears in this section.)

Damage: Researchers expect that Asian carp would disrupt the food chain that supports the native fish of the Great Lakes. Due to their large size, ravenous appetites, and rapid rate of reproduction, these fish could pose a significant risk to the Great Lakes Ecosystem. If bighead or silver carp enter the great lakes, the economic impacts on the fishing industry would be devastating, putting the Midwest's multi-billion dollar-a-year fishing industry at risk. Also, silver carp have been known to cause injuries to boaters, as they jump out of the water.

Control/Treatment: Prohibited in Michigan. To prevent the species from entering the Great Lakes, the U.S. Army Corps of Engineers, U.S. EPA, State of Illinois, International Joint Commission, Great Lakes Fishery Commission, and U.S. Fish and Wildlife Service constructed a temporary electronic dispersal barrier on the Chicago Sanitary and Ship Canal near Romeoville, Illinois, which was activated in April 2002. In late October 2004, construction began on a second, more permanent barrier. The new barrier, completed in February 2005, stretches two rows of electrodes across the canal approximately 220 feet apart. The electrodes pulse DC current into the water, causing fish to turn back rather than pass through the electric current. The electric current poses no threat to humans. A model of the Chicago Canal Barrier can be seen below. In November 2009, evidence of the presence of Asian carp was detected beyond the electric barrier, which left only a single lock/dam on the Calumet River between the carp's detected location and Lake Michigan. Due to the major ecological threat to Lake Michigan and to recreational boaters, the U.S. Army Corps of Engineers shut down one of the electric barriers for maintenance in December 2009. The Illinois Department of Natural Resources responded to the situation by dumping 2,200 gallons of the toxin rotenone into the canal. Rotenone is deadly for fish but not harmful to humans, animals, or most other aquatic life. The intentional fish kill cost $3 million and produced about 90 total tons of dead fish, but only one carp was found in the Lockport Lock and Dam area. In June 2010, a 19-pound Asian carp was found near the shore of Lake Michigan, in Lake Calumet, about six miles downstream from Lake Michigan, by a commercial fisherman hired by the state of Illinois to do routine fish sampling in the area. The fish confirmed existing DNA evidence suggesting that the Asian carp had indeed breached the electric barrier on the Chicago Sanitary and Ship Canal, which had been considered the last line of defense for Lake Michigan. One type of Asian Carp was recently found within the Great Lakes watershed area, but as grass carp, it was not of the type whose impact is of such widespread concern.



Chicago Sanitary and Ship Canal Dispersal Barrier System (Source: U.S. Geological Survey)

Many other species exist that could become harmfully invasive if they reached Michigan. Although the watch list assesses the most likely risks, any other threatening species must also be identified and reported, so that proper preventive or response activities can occur as quickly as possible.

Significant Invasive Species Incidents and Threats

Example of Risks from a non-Watch List Species
Khapra Beetle (Trogoderma granarium)
Hosts: The beetle prefers hot, dry conditions and can be found in areas where grain and other potential food is stored, such as pantries, malthouses, grain and fodder processing plants, and stores of used grain sacks or crates.
Symptoms: Destruction of grains and seeds. They can multiply quickly in stored items such as crackers, wheat, flour and baby cereal and rapidly spread to warehouses, storage bins, and mills.
Damage: The beetles can potentially cause severe harm to the agriculture crop industry such as grains and seeds including wheat, soybean, barley, corn and rice.
Control/Treatment: Fumigation with methyl bromide in containers to quarantining shipments until treatment. Powdered neem has been used to control the beetle in wheat stores in India. On November 23, 2018, agricultural specialists found these beetles infesting a bag of seeds that a woman was attempting to bring into the state when traveling by plane from Iraq. There was no indication that the woman was aware of the seed infestation, as she planned to sow her garden with them, but the resulting agricultural damage from such an oversight could have been severe.

Examples of Recent and Active Problems within Michigan

Dreissenid Mussels (including Zebra Mussels and Quagga Mussels) (family Dreissenidae)

Hosts: Freshwater lakes and streams

Symptoms: By firmly attaching to hard surfaces, dreissenid mussels have clogged water-intake pipes and fouled hard-shelled animals such as clams and snails. In addition, zebra mussels have reduced plankton populations, as colonies of mussels filter large volumes of water for food, potentially depleting food resources of larval and planktivorous fishes such as smelt, chub, and alewife. Transfer of suspended material to the lake bottom in mussel waste products also leads to increased water clarity and increased growth of aquatic plants. Although clear water is often considered aesthetically pleasing, this clarity indicates that drastic changes have occurred at the base of the food web and that energy flows through the ecosystem has been altered. The mass media has given a great deal of attention to the zebra mussel, but quagga mussel infestations are actually far more extensive in the Great Lakes. Both zebra and quagga mussels belong to the same genus, dreissenid mussels, but quagga mussels are more tolerant of colder and deeper waters than zebra mussels are. Quagga mussels were first spotted in the Great Lakes around 1990, and have devoured so much plankton that the food web is being altered.

Damage: Communities along the affected lakes and rivers rely on these waters for drinking, industrial water supplies, transportation, commercial fishing and shelling, and recreation. Rapidly expanding populations of dreissenid mussels could ultimately affect many of these activities, in addition to changing the structure of the ecosystem.

Control/Treatment: Restricted in Michigan. Applications of hot water and bleach have been used for control. A new method involving bacteria is being refined.

Dutch Elm Disease

Hosts: Elm trees

Symptoms: Trees infected by elm bark beetles first show wilting, curling, and yellowing of leaves on one or more branches in the upper portion of the tree, as a fungus from the beetles progressively affects the tree's health.

Damage: Large trees may survive and show progressively more symptoms for one or more years. Trees infected through root grafts wilt and die rapidly; this frequently occurs in the spring, soon after the trees have leafed out, and progresses from the base of the tree upward.

Control/Treatment: Dutch elm disease control has involved two different but related programs: (1) community-wide sanitation programs designed to reduce the level of elm bark beetles (principal carriers of the Dutch elm disease fungus); and (2) prevention of the spread of the disease through natural root grafts from infected trees to adjacent healthy trees. There are probably no community-wide programs being used any more, with a shift toward disease management involving the planting of different species of trees. There is no way to eliminate Dutch elm disease once it begins, but different species such as Siberian elms are resistant to the disease. This disease is still active in Michigan Elm Trees.

Emerald Ash Borer (EAB) (Agrilus planipennis)

Hosts: White, black, and green ash trees.
Symptoms: Typically the upper third of a tree will die back first, followed by the rest during the next year. This is often followed by a large number of shoots or sprouts arising below the dead portions of the trunk. The adult beetles typically make a D-shaped exit hole when they emerge. Tissue produced by the tree in response to larval feeding may also cause vertical splits to occur in the bark. Distinct S-shaped tunnels may also be apparent under the bark. Adults are dark metallic green in color, 1/2 inch in length and 1/16 to 1/8 of an inch wide and are only present from mid-May until late July. Larvae are creamy white in color and are found under the bark.
Damage: The adult beetles feed on ash foliage but cause little damage. The larvae feed on the inner bark of ash trees, disrupting the tree's ability to transport water and nutrients. Many trees appear to lose about 30 to 50 percent of their canopy in one year and the tree is often killed after 2-3 years of infestation. Most of the devastation in Michigan has occurred in the southeastern Lower Peninsula, where about 20 million trees have been killed. Fallen trees have caused extensive property damage. A quarantine area had been imposed by state government in 2002, in an effort to slow the spread of this pest, but by 2018, EAB had spread to 79 of Michigan's 83 counties, and suspected to be present to some degree in the remaining four. Therefore, the quarantine was lifted by Governor Snyder on October 1, 2018.
Control/Treatment: Treatment options for controlling infected or at-risk trees include systemic insecticides applied as soil injections, systemic insecticides applied as trunk injections, noninvasive systemic sprays, and protective cover sprays. If properly applied, these treatment options can prevent EAB larvae from taking over the ash tree about 70% of the time. Treatment also proves to be successful when managing at-risk trees in areas where EAB has been identified. More information on the EAB can be found on the MDARD's website: www.michigan.gov/eab.

Gypsy Moth (Lymantria dispar)
Hosts: Tree foliage.
Symptoms: The egg mass is usually laid within a few feet of the female pupa casing. They are covered by a dense coating of hairs.
Damage: During high population levels, total defoliation can occur. During the months of June and July, defoliating populations cover sidewalks, homes, children's play equipment and other objects, making outdoor activity in residential and recreational areas almost impossible. For Michigan's nursery industry, additional expense and pesticide use are required. For the forest products industry, high gypsy moth populations mean the potential loss of wood fiber from reduced production (due to tree stress or mortality).
Control/Treatment: Counties may get involved in the Michigan Cooperative Suppression Program. The only pesticide used in the Cooperative Suppression Program is Bacillus thuringiensis, most commonly referred to as Bt.

Plum Pox Virus (PPV) Hosts: Peach, plum, nectarine, apricot, almond, cherry.

Symptoms: Discolored viral rings on leaves and fruit. Damage: Smaller deformed fruit and reduced fruit production.

Control/Treatment: Control and prevention measures include field surveys, use of certified nursery materials, use of virus-resistant plants (when available), control of aphids, and the elimination of infected trees in nurseries and orchards. A team of scientists from the United States and France has genetically engineered a PPV-resistant plum (known as C5), and this resistance can be transferred through hybridization to other plum trees. This provides a source of germplasm for future breeding programs worldwide. Similar success has not yet occurred in attempts to genetically modify other Prunus species. First found in North America in 1999 (in Pennsylvania), this was confirmed in Michigan for the first time in July 2006, in a Berrien County location, resulting in a large-scale survey and eradication effort. A PPV quarantine was issued by the Michigan Department of Agriculture on March 12, 2007. As of a decade later, the problem seems to have been resolved with that eradication effort and quarantine.



From left to right: Dutch Elm disease, emerald ash borer, gypsy moth, the plum pox virus

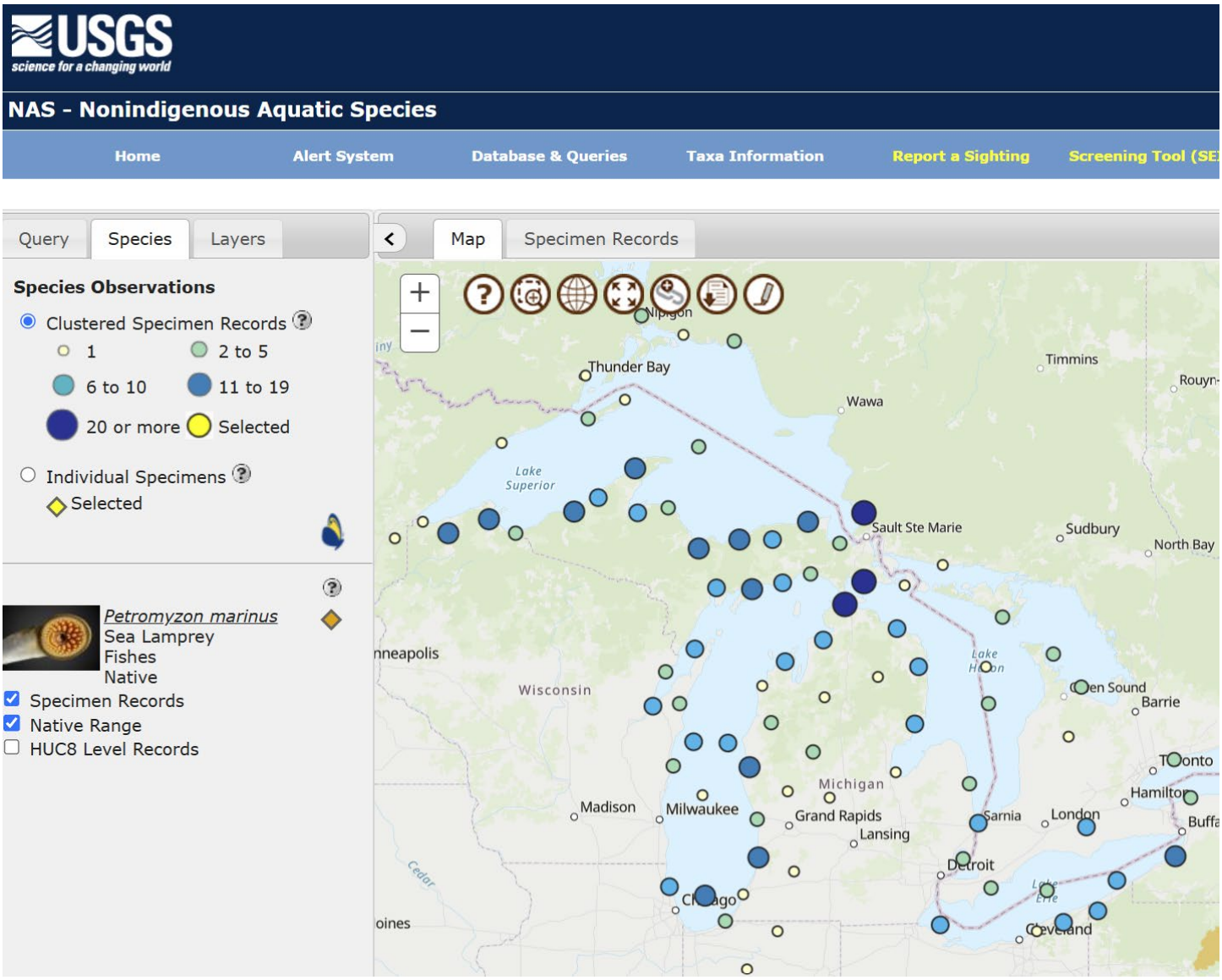
Sea Lamprey (Petromyzon marinus)

Hosts: Found in both fresh water and salt water habitats, they breed in freshwater streams and lakes and were first discovered in the Great Lakes in the 1800s.

Symptoms: Sea lampreys prey on a wide variety of fish. The lamprey uses its suction-cup like mouth to attach itself to the skin of a fish (possibly for days) and rasps away tissue with its sharp probing tongue and many hooked teeth, arranged in numerous rows. Secretions in the lamprey's mouth prevent the victim's blood from clotting, and the lamprey sucks the victim’s blood. Victims (usually smaller ones) typically die from excessive blood loss or infection. Mature sea lampreys average 2 to 2½ feet long, up to a maximum of about 3 feet. Sea lampreys are considered a pest in the Great Lakes region and were introduced as an invasive species in the 1800s, originating from the inland Finger Lakes and Lake Champlain in New York and Vermont. Sea lampreys created a problem for key predator fish species including lake trout, lake white fish, and lake herring. The elimination of these key predator fish allowed the alewife, another invasive species, to explode in population, having adverse effects on many native fish species.

Damage: The introduction of the sea lamprey to Lake Superior caused serious declines in fish populations, and an alteration of the ecosystem. The lake trout played a vital role in the Lake Superior ecosystem because it is considered an apex predator, which means that the entire system relies on its

presence to be diverse and healthy. As an apex predator was removed from the system, the entire system felt the effects all the way down the food chain. The sea lamprey is an aggressive predator by its nature, which gives it a competitive advantage in a lake system where it has no predators and its prey lack defenses against it. The sea lamprey played a large role in the drastic decline of the Lake Superior lake trout population. One sea lamprey can upset an ecosystem and food chain by eating an estimated 40 pounds of fish or more in its lifetime. This resulted in an unbalanced relationship between predators and prey in the Great Lakes' Ecosystem.



https://nas.er.usgs.gov/viewer/omap.aspx?SpeciesID=836

Control/Treatment: Control efforts to mitigate the destructive effects of the sea lamprey have included the use of electric currents, chemicals, and barriers. In 1958, scientists found a chemical (still used today) that selectively killed sea lamprey larvae in their spawning streams, and brought the lamprey under control. In 1986, DNR fish managers, technicians and engineers designed a new lamprey barrier

which let fish migrate through to spawn, but captured the lamprey. The new barrier was expected to reduce the number of lamprey beyond it to nearly zero. Lamprey numbers in Lake Michigan are currently only about 10 percent of their peak numbers in the 1950s. Today, biologists and researchers are still looking for new ways to stop the spread of lampreys in lakes, streams, and rivers. It is the hope of the Great Lakes Fishery Commission that at least some of this scientific work on the sea lamprey, including genetic and pheromone studies, will result in a more effective management technique that could one day drastically reduce the need for chemical treatments of spawning grounds. Several million dollars are spent each year on environmentally friendly control methods. Native predatory fish, like the whitefish and lake trout, have been restocked by fisheries professionals to help maintain a healthy level of these species.





A couple of invasive aquatic species: Asian carp and zebra mussel.

Wild Hogs or Boar (Sus scrofa)

Feral swine are defined as free-ranging pigs and are considered to be an aggressive public nuisance. They have been known to attack and chase humans. They can become infected with, and may transmit, diseases that affect human health, domestic livestock, and wildlife, such as brucellosis, tuberculosis, bubonic plague, tularemia, anthrax, and trichinosis. In Michigan, pseudorabies-positive feral swine were removed from private land in 2008. Feral swine have the potential to cause great economic harm to the domestic swine industry, if they were to transmit such disease to commercial swine. The appearance of feral swine may vary greatly, as they can originate from several subspecies, including the Russian Boar, the wild Eurasian boar, escaped domestic swine, and quite often a mix of domestic and wild-type breeds. These animals can weigh up to 400 pounds, may be covered in coarse hair, may have tusks, and are known to travel in groups. Females in warm states produce two large litters of 8 to 10 piglets per year. In Michigan, feral swine are known to survive the harsh winters. Feral swine tend to follow creeks and drains between food sources. They favor agricultural crops, but when the crops are harvested in the fall, they turn to wildlife food plots, acorns, and other mast foods. Feral swine are known to eat ground nesting birds, small mammals, and grubs. **Damage:** Feral swine can tear up the landscape, killing wildlife and pets, damaging farm crops and wildlife habitats, and scavenging uncovered garbage. Their devastating effect on crops accounts for up to $1.5 billion in annual damages nationally. Unlike most animals, feral swine don't stop at just eating crops. They also root holes in the ground as deep as a foot, destroying the crops. Wild hogs can damage as much as 10 percent of a farmer's crop. To date, the Department of Natural Resources has logged 288 unofficial feral swine sightings by residents in almost every county in Michigan. Since 1999, national experts have estimated that, if unchecked, the feral swine population could become established statewide and cause economic hardship for farmers, and for businesses that cater to wildlife enthusiasts.

Control: On May 13, 2010, the Michigan Legislature amended Public Act 328 of 1976 (Domestic Animals Running at Large) by allowing people to pursue and harvest feral swine at any time. The law does the following: (1) declares swine running at large on public or private property to be a public nuisance, (2) permits a local animal control officer or a law enforcement officer to kill swine running at large on public or private property, (3) permits a person with a concealed weapon permit or a valid hunting license to kill swine running at large on public property, and (4) permits a property owner or other authorized person to kill swine running at large on private property. In the last case, the landowner does not need a hunting license. Michigan residents who see or shoot a feral pig are asked to report it to the Michigan Department of Natural Resources at (517) 336-5030. USDA Wildlife Services (517-336-1928) and the Wildlife Conservancy (517-641-7677) have feral swine traps available for the use of landowners who are experiencing feral swine damage. The animals will be trapped, removed, and tested for disease, then euthanized and disposed of.

In December 2010, the Michigan Department of Natural Resources classified feral swine as an invasive, exotic or prohibited species under Public Act 451, the state's Natural Resources and Environmental Protection Act of 1994, but the Director's order does not go into effect until April of 2011.

Partners: The Feral Swine Working Group is an interagency team of veterinarians, biologists, and policy personnel within the state and federal governments, Michigan State University, and from numerous stakeholder groups, including the Michigan Animal Control Association, Michigan Farm Bureau, Michigan Pork Producers Association, Michigan United Conservation Clubs, Michigan Corn Growers Association, the Nature Conservancy, United Deer Farmers of Michigan, the Michigan Hunting Dog Federation, and the Michigan Wildlife Conservancy.

Invasive Plant Species in Michigan

Numerous online resources provide more information about plants, such as the NRCS database at http://plants.usda.gov/java/. Please refer to the information in the MDNR publication "Meeting the Challenge of Invasive Plants: A Framework for Action," which can be found at the following website: http://www.michigan.gov/documents/dnr/Invasives_strategy_final_289799_7.pdf.

Animal Diseases

There are many animal diseases that have the potential to impact Michigan. Diseases from outside Michigan or the United States have the potential to cause widespread mortality in livestock, wildlife, and companion animals. They could result in huge economic losses (primarily through trade restrictions), require significant resources to be allocated for response, and in some cases could also threaten public health. For more information, please refer to the Reportable Animal Diseases documents of the Department of Agriculture and Rural Development. (One introductory link is: https://www.michigan.gov/mdard/0,4610,7-125-48096_48097---,00.html.) Chronic Wasting Disease is an example of a wildlife disease that requires a heightened response, when detected. Foot and Mouth Disease is an example of a livestock disease that would also require a heightened response from Michigan agencies.

Chronic Wasting Disease (CWD)

This is a prion disease of the brain. The infectious agent contaminates the environment and is transmitted from one animal to another. Hosts: Deer and elk are affected by this brain disease that is present in several western states and in Minnesota and Wisconsin. It was also detected in one Michigan location in 2008 (at an enclosed deer breeding facility in Kent County). Mule deer, white-tailed deer, and Rocky Mountain Elk are the only three species of the family Cervidae that are known to be naturally susceptible to CWD. However, it is very likely that other subspecies of C. elaphus are susceptible to the disease. Although no other deer in Michigan have tested positive for CWD (outside of the isolated Kent County case), it remains a major concern due to the large wild population of deer in the state.

Symptoms: Emaciation, wide stance, lowered head, droopy ears and excessive salivation.

Damage: Animal fatalities

Control/Treatment: Chronic wasting disease is both transmissible and infectious, but most details of its transmission remain to be determined. No treatment is available for animals affected with CWD. Once clinical signs develop, CWD is invariably fatal. Affected animals that develop pneumonia may respond temporarily to treatment with antibiotics, but ultimately the outcome is still fatal. Similarly, no vaccine is available to prevent CWD infection in deer or elk.

Foot and Mouth Disease

Hosts: This infectious virus spreads on surfaces and in the air, and impacts cattle, swine, sheep, goats, deer, and other cloven-hoof ruminant animals. It does not currently exist in Michigan or the United States and has not existed in the U.S. since 1929. However, the disease is of great concern because it is highly contagious and would have grave economic consequences for Michigan's livestock industry.

Symptoms: In cattle, blisters inside the mouth that lead to excessive secretion of stringy or foamy saliva and to drooling; and blisters on the feet that may rupture and cause lameness. Adult animals may suffer weight loss from which they do not recover for several months, as well as swelling in the testicles of mature males. In cows, milk production can decline significantly. Damage: Though most animals eventually recover from FMD, the disease can lead to myocarditis (inflammation of the heart muscle) and death, especially in newborn animals. Some infected animals do not suffer from or show signs of the disease, but they are carriers of FMD and can transmit it to others.

Control/Treatment: The Michigan Department of Agriculture and Rural Development (MDARD) licenses and regulates Michigan's 500 livestock dealers, truckers, livestock sales, and auction markets to help monitor animal health and ensure the safe and humane handling of animals. The MDARD also monitors and controls the interstate and intrastate shipment of animals and animal products, to eradicate and control the spread of disease. If this disease were discovered in the United States, it would trigger national and state response plans and require rapid and coordinated response in order to control the disease and protect the nation's livestock industry.





Two threatening animal diseases: Chronic wasting disease and foot and mouth disease.

Programs and Initiatives

Note: These listings highlight the breadth of existing programs and initiatives currently under way, but are not intended to be comprehensive.

Michigan Aquatic Nuisance Species (ANS) Program

In 1996, Michigan developed its first comprehensive ANS state management plan to provide guidance on actions for the prevention, control, and impact-management for ANS that have invaded, or may invade, Michigan waters. This state management plan was updated in 2002, and includes a summary of accomplishments, goals, and activities. The MDNR was awarded funding through the Great Lakes Restoration Initiative in 2010, to update and continue the implementation of the plan. A core team of staff members and managers from the Fisheries, Wildlife, Water Resources, Recreation, and Law Enforcement Divisions (of the DNR and DEQ), as well as representatives from the Pesticide and Plant Pest Management Divisions (of the Department of Agriculture and Rural Development) and the Project Planning Division (of MDOT) are currently in the initial stages of updating the state management plan. The 2013 plan is accessible at https://www.michigan.gov/deq/0,4561,7-135-3313-276823--,00.html.

These efforts include the Asian Carp Control Strategy, which includes studies performed by the U.S. Army Corps of Engineers. The USACE Asian Carp Study stems from a nearly $80-million initiative from the White House Council on Environmental Quality in 2007, involving a multi-pronged federal attack against Asian Carp. The Asian Carp study examines the possibility of permanently shutting down the Chicago waterway system that links Lake Michigan to the Mississippi River Basin, and coordinating state efforts in response to the Asian carp threat. Although some actions may be taken before the study is completed, a final recommendation on how to stop the movement of the Asian Carp and other related species is expected to be made by 2013. However, the USACE has been accused of moving too slowly to prevent Asian carp and other exotic species from invading the Great Lakes. The USACE will release a short list of possible solutions in 2013 to quicken the process. The USACE will pick up the pace under a revised strategy in which it no longer will devise a single preferred method. Instead, the agency will put forward several options and leave it to congress and the public to decide.

Proposed Legislation to Prevention Asian Carp Invasion

Due to Asian Carp being detected beyond established barriers and less than six miles from direct access to the Great Lakes, a bill (The Permanent Prevention of Asian Carp Act) was created to direct

the U.S. Army Corps of Engineers to study the watersheds of the Illinois, Chicago, and Calumet Rivers, and their tributaries, that drain directly into Lake Michigan, to determine the feasibility and best means of implementing the hydrologic separation of the Great Lakes and Mississippi River basins to prevent the introduction or establishment of populations of aquatic nuisance species along that pathway. In 2010, this bill was introduced in the U.S. House of Representatives (H.R. 5625) and the U.S. Senate, but it was merely referred to committee (and thus "died"). Numerous similar legislative efforts have suffered similar fates or otherwise not been acted upon, such as the Asian Carp Prevention Act of 2013. The latest congressional bill is H.R. 4001, the Defending Against Aquatic Invasive Species Act of 2014, which was rated as having a slightly higher chance of making progress than the earlier efforts.

The Sea Lamprey Control Program

Administered by the Great Lakes Fishery Commission, this program may be the best example of integrated pest management in North America. The program costs over $20 million per year, but has been tremendously successful in protecting the multi-billion-dollar Great Lakes fishery for millions of persons who fish or are involved in a related sector of the economy. Sea lamprey control efforts have resulted in a 90% reduction in sea lamprey populations in most areas of the Great Lakes. http://www.glfc.org/control.php

National Strategy and Implementation Plan for Invasive Species Management

The National Strategy and Implementation Plan for Invasive Species Management was developed by a team of researchers and specialists. This plan is responsible for preparing the Forest Service to deal with the ecological and economic problems associated with the types of invasive species that affect the nation. The plan maps out a strategic direction for Forest Service programs, which include Research and Development, International Programs, State and Private Forestry, and the National Forest System.

Animal and Plant Health Inspection Service

The Animal and Plant Health Inspection Service (APHIS) is responsible for protecting and promoting U.S. agricultural health, administering the Animal Welfare Act, and carrying out wildlife damage management activities. The APHIS mission is an integral part of U.S. Department of Agriculture's (USDA) efforts to provide the nation with safe and affordable food. In recent years, the scope of APHIS' protection function has expanded beyond pest and disease management. Because of its technical expertise and leadership in assessing and regulating the risks associated with agricultural imports, APHIS has assumed a greater role in the global agricultural arena. Now, the agency must respond to other countries' animal and plant health import requirements and negotiate science-based standards to ensure that America's agricultural exports, worth over $50 billion annually, are protected from unjustified trade restrictions. In response to needs expressed by the American people and Congress, APHIS' protection role also includes wildlife damage management, the welfare of animals, human health and safety, and ecosystems vulnerable to invasive pests and pathogens. In carrying out its diverse protection responsibilities, APHIS makes every effort to address the needs of all those involved in the U.S. agricultural sector.

The United States Geological Survey (USGS)

The U.S. Geological Survey plays an important role in federal efforts to combat invasive species in natural and seminatural areas. USGS services include the early detection and assessment of newly established invaders, the monitoring of invading populations, contributions to the understanding of the ecology of invaders and the understanding of factors involved in the resistance of habitats to invasion. The USGS is also involved in the development and testing of prevention, management, and control methods. USGS science centers conduct research relevant to invasive species in Michigan, and these are located at La Crosse, Wisconsin (the Upper Midwest Environmental Science Center), and Ann Arbor, Michigan (the Great Lakes Science Center). Each state in the U.S. is also home to a USGS Water Science Center, some of which conduct or support research relevant to invasive species in the Great Lakes.

The USGS maintains databases that may assist with the monitoring and reporting of invasive species occurrences, as well as provide information on their control. An example of these resources is the Nonindigenous Aquatic Species Database, at http://nas.er.usgs.gov. Sophisticated modeling capabilities, to predict the potential distribution of invasive species, are also available through the National Institute of Invasive Species Science in Fort Collins, Colorado.

NOAA Great Lakes Environmental Research Laboratory (GLERL)

This agency includes research on aquatic invasive species, and focuses on the biological and ecological effects of these species in the Great Lakes, and on the prevention of new species introductions. GLERL houses the NOAA National Center for Research on Aquatic Invasive Species (NCRAIS), which helps to coordinate the agency's aquatic invasive species outreach efforts across the U.S.

Eastern Michigan University Detroit River International Wildlife Refuge Study

Researchers from Eastern Michigan University made an effort to study and help contain the spread of invasive species at the Detroit River International Wildlife Refuge, along 5,700 acres of the Detroit River and Lake Erie. In November 2010, EMU was awarded $487,000 by a program that is part of the National Oceanic and Atmospheric Administration. The purpose is to expand upon work that had examined the spread of Phragmites australis (which impairs the refuge's economic and environmental viability), that had set up monitoring points, looked at efforts to control the reed, and also measured effects on water quality. The purple loosestrife and reed canary grass are among the invasive plant species that also might be studied. For the next phase of the project, researchers plan to use a combination of on-the-ground surveys, water quality analysis, and remote satellite detection of invasive species to study their spread. Locations will be mapped, and data will be presented in a new way that is designed to help refuge officials in making management decisions.

Michigan Invasive Plant Council

The Michigan Invasive Plant Council (MIPC) is a non-profit organization that spans a wide array of groups, including government agencies, commercial enterprises, conservation organizations,

educational institutions, and the gardening public. MIPC is an affiliate organization of the Southeast Exotic Pest Plant Council and its mission is to protect Michigan from the threat of invasive species. The council develops and publishes an invasive species list; facilitates the exchange of information concerning the management, control, and monitoring of invasive plants; provides a forum for all interested parties to discuss issues relating to invasive plants; serves as an educational, advisory, and technical support council for all aspects of invasive plants and related issues; and helps to prevent future introductions of new invasive plants.

Emerald Ash Borer (EAB) Awareness Week

EAB Awareness Week provides information on the steps that everyone can take to prevent the spread of EAB infestation, as well as fostering a cooperative spirit between citizens, communities, government and industry to reduce the risk that the insect poses to the 700 million ash trees blanketing the state. During the week and throughout the year, the Michigan Department of Agriculture and Rural Development (MDARD) urges Michigan residents and visitors to learn about EAB, be on the look-out for and immediately report possible signs of infestation, and adhere to policies regarding the transport of ash trees, materials, and all firewood. Each spring, many outreach, education and compliance activities are planned (or will be highlighted) to help increase awareness and understanding of the EAB. The EAB Awareness week is typically held during the last week in May.

Michigan Chronic Wasting Disease Task Force-Final Report

In 2003, Governor Granholm signed an executive order creating a task force to address the threat of Chronic Wasting Disease in Michigan's deer and elk populations. The task force includes five members appointed by the Governor, who serve as the voting members of the task force. The directors of the Department of Agriculture (now MDARD), Community Health, Natural Resources, Environmental Quality, State Police, and Transportation serve as non-voting members of the task force. In October of 2003, the task force presented its findings and recommendations in a report delivered to the Governor. Please see https://www.michigan.gov/dnr/0,4570,7-350-79136_79608_90516---,00.html.

Michigan Cooperative Suppression Program – Gypsy Moth Infestations

The main goal of the Cooperative Suppression Program is to provide technical and funding assistance to county governments. This allows them the opportunity to provide protection from severe gypsy moth populations. The objectives are 1) to reduce the risk of severe defoliation and 2) to reduce the nuisance created by large caterpillar numbers. A county, interested in participating in the Cooperative Suppression Program, enters into an agreement with MDARD to conduct the program. MDARD provides training, technical support and operational guidelines to the county. The training and guidelines are used to identify areas for treatment. The State of Michigan enters into a contract with an applicant for treatment of the qualified areas and the county is granted up to 50% cost-share for the cost of conducting the program.

Aquatic Invasive Species Awareness Week

In a continued effort to raise public awareness about the negative impacts caused by aquatic invasive species, the State of Michigan has established the Aquatic Invasive Species (AIS) Awareness Week, usually the second week in June. An aquatic invasive species is defined as a waterborne, non-native organism that threatens the diversity or abundance of native species, the ecological stability of impacted waters, or threatens a commercial, agricultural, aquacultural, or recreational activity. The AIS Awareness Week recognizes that Michigan's expansive shorelines and inland waters draw millions of tourists and recreational users each year, and that appropriate preventive steps must be taken to protect the state's water resources from invasive aquatic species. The AIS Awareness Week is sponsored by the MDEQ, working in collaboration with other state and federal agencies as well as private and nonprofit organizations.

Some Hazard Mitigation Alternatives for Invasive Species

- Restrictions on the import and transport of species carriers.
- Adjustments to hunting, fishing, and other policies and regulations related to wildlife populations.
- Use of barriers to prevent invasive species travel.
- Use of competing species or other population control techniques.

Newaygo County Invasive Species Hazards

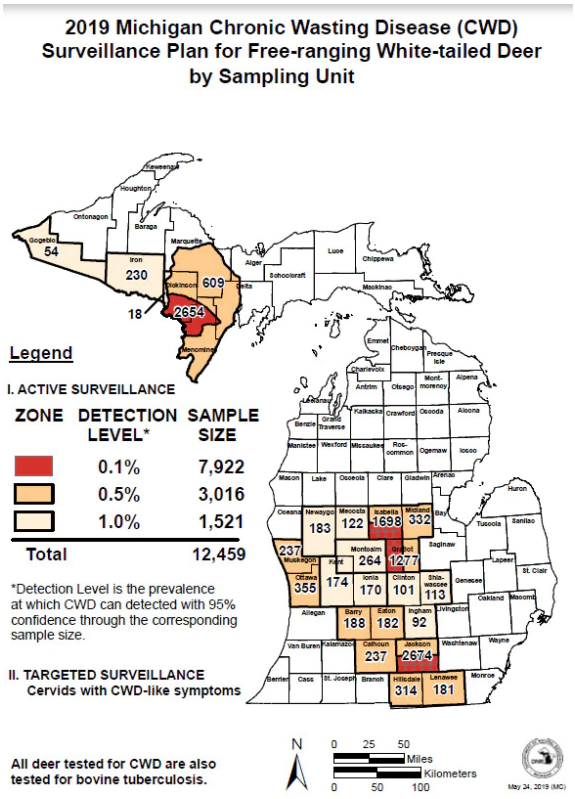
CWD is a fatal neurological disease that affects white-tailed deer, mule deer, elk, and moose. CWD can be transmitted directly from one animal to another, as well as indirectly through the environment. Infected animals may display abnormal behavior, progressive weight loss and physical debilitation. To date, there have been no reported cases of CWD infection in humans. However, as a precaution, the U.S. Centers for Disease Control and the World Health Organization recommend that infected animals not be consumed as food by either humans or domestic animals.

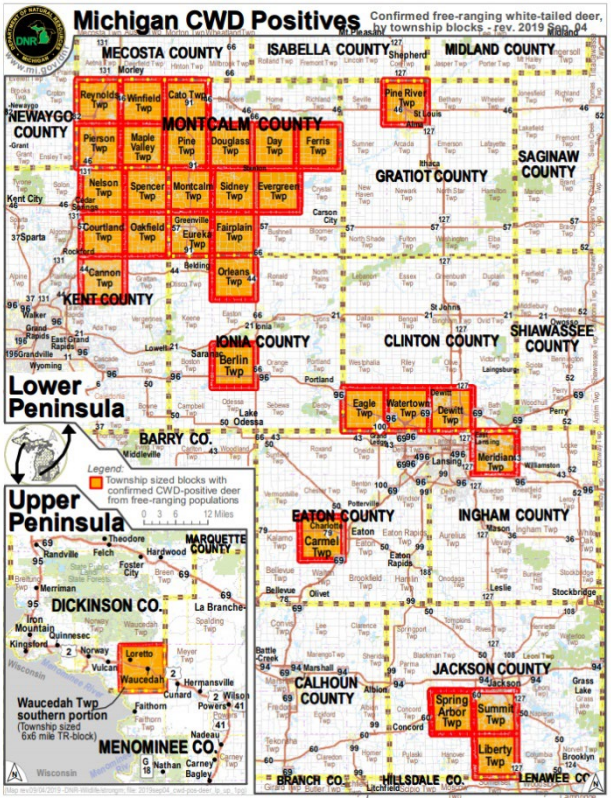
2018 the Michigan Department of Natural Resources tested 3,527 free ranged deer in Newaygo County and in 2019 the Michigan Department of Natural Resources tested 1,961 free ranged deer in Newaygo County. Both years NO dear tested positive for Chronic Wasting Disease.

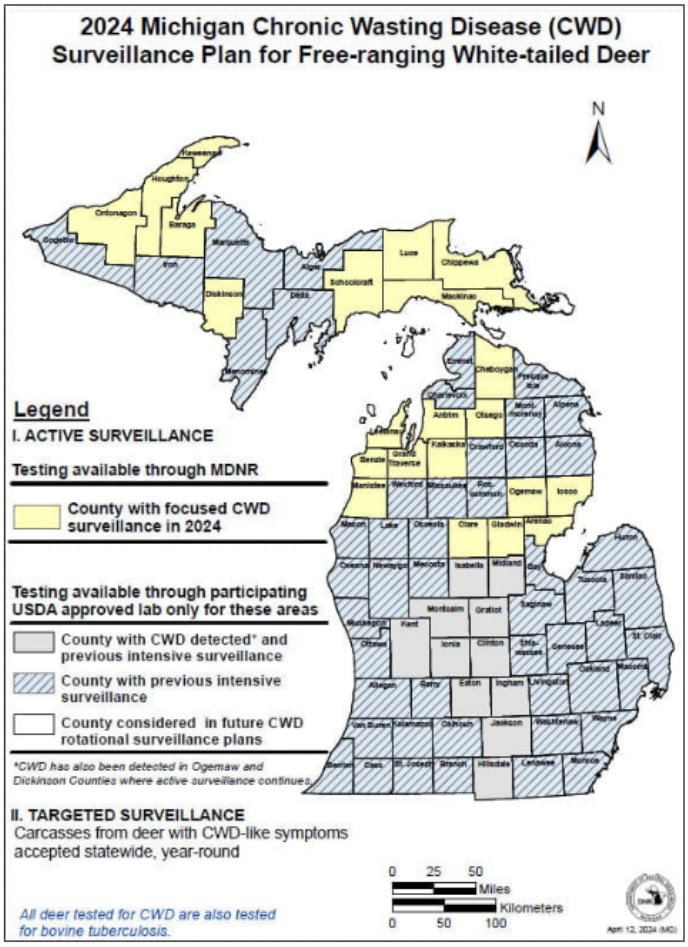
On January 14, 2020, the Michigan Department of Agriculture and Rural and Development (MDARD) confirmed chronic wasting disease (CWD) in three white-tailed deer from a Newaygo County deer far. All three deer were four-and-a-half years old. The samples were submitted for routine testing as part of the state's CWD surveillance program for farmed deer.

Since 2008, CWD has been detected in four additional privately-owned cervid facilities from Kent, Mecosta, and Montcalm Counties. The deer farm in Newaygo County is the fifth Michigan farm in which CWD has been detected.

The following Maps are from the Michigan Department of Natural Resources:
https://www.michigan.gov/dnr/managing-resources/wildlife/wildlife-disease/disease-monitoring/cwd/cwd-testing-data/2024-cwd-testing-goals-and-results


2019 Michigan Chronic Wasting Disease (CWD) Surveillance Plan for Free-ranging White-tailed Deer by Sampling Unit
Legend
I. ACTIVE SURVEILLANCE
ZONE DETECTION LEVEL* SAMPLE SIZE
0.1% 7,922
0.5% 3,016
1.0% 1,521
Total 12,459
*Detection Level is the prevalence at which CWD can detected with 95% confidence through the corresponding sample size.
II. TARGETED SURVEILLANCE
Cervids with CWD-like symptoms
All deer tested for CWD are also tested for bovine tuberculosis.
Miles
Kilometers
May 24, 2019 (MC)


Michigan CWD Positives
Confirmed free-ranging white-tailed deer, by township blocks - rev. 2019 Sep. 04
Lower Peninsula
Upper Peninsula
Legend:
Township sized blocks with confirmed CWD-positive deer from free-ranging populations
MECOSTA COUNTY
ISABELLA COUNTY
MIDLAND COUNTY
NEWAYGO COUNTY
MONTCALM COUNTY
GRATIOT COUNTY
SAGINAW COUNTY
KENT COUNTY
IONIA COUNTY
CLINTON COUNTY
SHIAWASSEE COUNTY
BARRY CO.
EATON COUNTY
INGHAM COUNTY
DICKINSON CO.
MARQUETTE COUNTY
CALHOUN COUNTY
JACKSON COUNTY
Waucedah Twp southern portion (Township sized 6x6 mile TR-block)
MENOMINEE CO.
BRANCH CO.
HILLSDALE CO.
LENAWEE CO.


2024 Michigan Chronic Wasting Disease (CWD) Surveillance Plan for Free-ranging White-tailed Deer
N
Legend
I. ACTIVE SURVEILLANCE
Testing available through MDNR
County with focused CWD surveillance in 2024
Testing available through participating USDA approved lab only for these areas
County with CWD detected* and previous intensive surveillance
County with previous intensive surveillance
County considered in future CWD rotational surveillance plans
*CWD has also been detected in Ogemaw and Dickinson Counties where active surveillance continues.
II. TARGETED SURVEILLANCE
Carcasses from deer with CWD-like symptoms accepted statewide, year-round
All deer tested for CWD are also tested for bovine tuberculosis.
Miles
Kilometers
April 12, 2024 (MC)

Hazards Evaluation Methodology

Although the MSP-EMD Pub201A Hazard Analysis Guidance Tool was utilized and followed as closely as possible, the following adjustments were necessary in order to make this document easy to utilize in the local emergency planning process utilized by Newaygo County Emergency Services.

Hazard Classification

Local planning considerations have resulted in Newaygo County's existing hazards being organized into major hazard classes. This method allows for focused evaluation and management of 13 hazard considerations while actually addressing 35 hazards identified in the MSP-EMD Pub 103 Michigan Hazard Analysis. This method has allowed for an effective planning approach for a variety of reasons.

First, the Newaygo County Emergency Operations Plan is an all-hazard document dependent on implementation of emergency functions, not related to specific hazard response. In example, many flood hazards require similar planning, response, and mitigation measures despite their specific type. Second, Newaygo County is a moderately sized jurisdiction with its population and resources concentrated in villages and cities, creating a need to generalize hazards. Concentrating on the primary local considerations for the entire hazard class allows for a more efficient planning process than otherwise analyzing each of the individual hazards.

The following relates Newaygo County's Hazard Classes to the Michigan Hazard Analysis 2019 Document.

Newaygo County Hazard Analysis	Michigan Hazard Analysis	
Natural Hazards: Weather Hazards		
Thunderstorm	• Thunderstorm • Lightning	• Hail
Tornados	• Tornadoes	• Severe Winds
Severe Winter Weather	• Snowstorms • Extreme Cold	• Ice and Sleet Storms •
Natural Hazards: Hydrologic Hazards		
Flooding	• Riverine Flooding • Great Lakes Shoreline	• Urban Flooding • Dam and Levee Failures
Drought	• Drought	• Extreme Heat

Newaygo County Hazard Analysis	Michigan Hazard Analysis	
Natural Hazards: Ecological Hazards		
Wildfires	• Wildfires	
Invasive Species	• Invasive Species (aquatic and terrestrial)	
Natural Hazards: Geologic Hazards		
Geologic Hazards	• Impacting Object	• Space Weather
Technological Hazards: Industrial Hazards		
Fires	• Structural Fires	• Industrial Fires
Hazardous Materials	• Fixed Site (Industrial Accidents) • Transportation • Oil and Natural Gas Well Accidents	• Nuclear Power Plant Emergencies • Petroleum and Natural Gas Pipeline Accidents
Technological Hazards: Infrastructure Problems		
Infrastructure Failure	• Infrastructure Failures	• Energy Emergencies
Transportation	• Major Transportation Accidents (air, rail, highway, marine)	
Human Related Hazards		
Public Health	• Public Health Emergencies	
Criminal Incidents	• Civil Disturbances • Cyber-attack	• Terrorism & similar activities • Nuclear Attack

Hazard / Emergency Level Evaluations

All hazards were evaluated according to their emergency effect on the local jurisdiction. This has been defined as an emergency or disaster condition requiring significant level of coordination among local government, public, and private entities. This would be further defined locally as a Newaygo County Emergency Services “Alert” condition.

An example that demonstrates the difference between the local effect and standard state definition is best represented in the area of transportation accidents and mass casualty incidents. Although Newaygo County rarely gets large airplane or bus accidents, frequently all EMS units and hospital capacity are dedicated to a single incident due to only having a maximum of 5 available ambulances housed between 4 different EMS services and 8 emergency care beds. As such, although the jurisdiction doesn’t frequently experience any large bus, airplane, or railway accidents, it frequently experiences small incidents that involve a 75%-100% capability response.

Multi-jurisdictional and Single Jurisdictional Hazard Evaluations

Based on the affected area, all hazards were broken down into two categories, Multi-jurisdictional or single jurisdictional. Multi-jurisdictional hazards impact a large area and are wide spread. These hazards were only ranked on Newaygo County's Hazard Analysis. These hazards include:

- Thunderstorm
- Tornado
- Severe Winter Weather
- Public Health
- Drought
- Geologic

Single jurisdictional hazards impact a small area and are isolated or are increased on geography of jurisdiction. These hazards are ranked on the Newaygo County's Hazard Analysis and the individual local jurisdiction's hazard analysis. These hazards include:

- Infrastructure Failure
- Flooding
- Hazardous Materials
- Fires
- Wildfires
- Transportation
- Criminal

Evaluation Benchmarks

Once again, although MSP-EMHSD Pub201A was followed as closely as possible, several benchmarks had to be modified to accurately reflect their contribution to hazard ranking. Most noticeably, Population Impact, Economic Effects, and Collateral Damage were evaluated on their relation value (High, Medium, Low, None).

Evaluation Benchmark Weighting For Hazard Ranking

The benchmarks are also weighted according to their effect to local response efforts. A percentage is given to each benchmark to calculate the value of response organizations capability to handle the response locally or if the hazard will tax local response systems and require the need for mutual aide.

Hazard Ranking

As each hazard is unique in its dynamics, any of the listed hazards can be equally devastating in its occurrence. As such, the hazard rankings are listed for planning purposes only. They are in no way a scientific result demonstrating that one hazard should be focused on more than any other. Instead, it is important for the jurisdiction to focus on the most potentially hazardous aspects of the hazard itself. In example, tornadoes occur with minimal warning time but strike a small area. Flooding occurs with a slower time of onset yet affects a

larger area. As such, local efforts should be focused on improving tornado warning systems and flooding mitigation measures and implemented appropriately.

Advanced Hazards Profile and Evaluation

Evaluation Measures and Benchmark Factors for each Measure

This model uses a common set of 10 evaluation measures and 44 corresponding benchmark factors to evaluate each hazard facing the community. Those measures are:

1) Historical occurrence
2) Affected area
3) Speed of onset
4) Population impact (casualties)
5) Economic effects
6) Duration
7) Seasonal pattern
8) Predictability
9) Collateral damage potential
10) Availability of warnings.

Each corresponding benchmark factor has been assigned a specific point value (10, 7, 4 or 1 point), based on each individual factor's relative severity and negative impacts. Following is a synopsis of each hazard evaluation measure and benchmark factor used in this analysis:

(Note: The Michigan Hazard Analysis, EMD Pub. 103, serves as the baseline for information, supplemented by locally-obtained information.)

Historical Occurrence

Historical occurrence measures the frequency with which a particular hazard occurs in Michigan communities. The more frequently a hazard event occurs, the more potential there is for damage and negative impact on a community. The specific benchmark factors used in the historical occurrence analysis are:

Excessive Occurrence, indicating the hazard event is likely to occur 4 or more times in one year;
High Occurrence, indicating the hazard event is likely to occur 2-3 times per year;
Medium Occurrence, indicating the hazard event is likely to occur 1 time per year;
Low Occurrence, indicating the hazard event occurs less than 1 time per year (i.e., once every 4 years).

Weighted Value is 20% Benchmark factor point values are:

1 pt	4 pts	7 pts	10 pts
Low	**Medium**	**High**	**Excessive**
<1 event / yr	**1 event / yr**	**2-3 events / yr**	**4+ events / yr**

Affected Area

Each hazard affects a geographic area. For example, a blizzard might affect an entire state or even several states, while a flood might only affect a portion of a county or municipality. Although size of the affected area is not always indicative of the destructive potential of the hazard (a tornado is a good example), generally the larger the affected area, the more problematic the hazard event is on a community. The specific benchmark factors used in the affected area analysis are:

Large Area, if a hazard event has the potential to impact 3 more townships in a county, or 1/2 of a municipality;
Small Area, if the hazard event could impact 1 or 2 townships in a county, or 1/4 of a municipality;
Multiple Sites, if the hazard event could impact more than 1 village, city, or other sites within 1 township, or more than 1 neighborhood or other site within a municipality;
Single Site, if the hazard event is likely to only impact only 1 village, city or other site within a county, or 1 neighborhood or other site within a municipality.

Weighted Value is 20% Benchmark factor values are:

1 pt	4 pts	7 pts	10 pts
Single Site	**Multiple Sites**	**Small Area**	**Large Area**

Speed of Onset

Speed of onset refers to the amount of time it typically takes for a hazard event to occur. Speed of onset is an important evaluation measure because the faster an event occurs, the less time local governmental agencies typically have to warn the potentially impacted population of appropriate protective actions. The specific benchmark factors used in the speed of onset analysis are:

Minimal or No Warning, indicating that the hazard event could occur without any advance notice or warning;
Less than 12 Hours, indicating the hazard event generally allows less than 12 hours advance notice before occurring;
12-24 Hours, indicating the hazard event generally allows 12-24 hours advance notice before occurring;
Greater than 24 Hours, indicating the hazard event generally allows more than 24 hours advance notice before occurrence.

Weighted value is 10% Specific benchmark factor values are:

1 pt	4 pts	7 pts	10 pts
> 24 Hours	**12 – 24 Hours**	**< 12 Hours**	**Minimal / None**

Casualty Effects

Casualty Effects refers to the number of casualties (deaths and injuries) that can be expected if a particular hazard event occurs. Specific benchmark factors used in the population impact analysis are:

High Impact, indicating 10 or more casualties can be expected;
Medium Impact, indicating 6-10 casualties can be expected;
Low Impact, indicating 1-5 casualties can be expected;
No Impact (none), indicating that no casualties can be expected.

Weighted Value is 10% Specific benchmark factor values are:

1 pt	4 pts	7 pts	10 pts
None	**Low**	**Medium**	**High**
No Casualties	**1 – 5 Casualties**	**6 – 10 Casualties**	**10+ Casualties**

Economic Effects

Economic effects are the monetary damages incurred from a hazard event, and include both public and private damage. Direct physical damage costs, as well as indirect impact costs such as lost business and tax revenue, are included as part of the total monetary damages. Specific benchmark factors used in the economic effects impact analysis are:

Significant Effects, indicating over $100,000 in monetary damages incurred;
Medium Effects, indicating $50,001-$100,000 in monetary damages incurred;
Low Effects, indicating $10,000-$50,000 in monetary damages incurred;
Minimal Effects, indicating less than $10,000 in monetary damages incurred.

Weighted value is 10% Specific benchmark factor values are:

1 pt	4 pts	7 pts	10 pts
Minimal	**Low**	**Medium**	**High**
<$10,000	**$10,000 - $50,000**	**$50,000 - $100,000**	**>$100,000**

Note: An alternative to this economic effects measure would be in a relational potential.

Duration

Duration refers to the time period the hazard event is actively present and causing damage (often referred to as the "time on the ground".) Duration is not always indicative of the damaging potential of a hazard event (a tornado is a good example). However, in most cases, the longer an event is "active" and thus causing damage, the greater the total damages will be. Specific benchmark factors used in the duration analysis are:

Long Duration, indicating the hazard event is likely to last longer than 1 week;
Medium Duration, indicating the hazard event is likely to last from 1 day to 1 week;
Short Duration, indicating the hazard event is likely to last from 12-24 hours;
Minimal Duration, indicating the hazard event is likely to last less than 12 hours.

Weighted value is 5% Specific benchmark factor values are:

1 pt	4 pts	7 pts	10 pts
Minimal	**Short**	**Medium**	**Long**
<12 Hours	**12 – 24 Hours**	**1 Day – 1 Week**	**> 1 Week**

Seasonal Pattern

Seasonal pattern refers to the time of year in which a particular hazard event can reasonably be expected to occur. Some hazard events can occur at any time of the year, while others occur primarily during one particular season (i.e., blizzards in winter). Oftentimes, hazard patterns coincide with peak tourism seasons and other times of temporary population increases, greatly increasing the vulnerability of the population to the negative impacts of certain hazard events. The specific benchmark factors used in the seasonal pattern analysis are:

Year-round Occurrences, indicating the hazard event can occur at any time of the year;
Three Season Occurrences, indicating the hazard event can realistically occur during 3 seasons of the year;
Two Season Occurrences, indicating the hazard event can realistically occur during 2 seasons of the year;
One Season Occurrences, indicating the hazard event realistically occurs during only 1 season of the year.

Weighted value is 5% Benchmark factor values are:

1 pt	4 pts	7 pts	10 pts
1 Season	**2 Seasons**	**3 Seasons**	**Year Round**

Predictability

Predictability refers to the ease with which a particular hazard event can be predicted - in terms of time of occurrence, location, and magnitude. Predictability is important because the more predictable a hazard event is, the more likely it is a community will be able to warn the potentially impacted population and take other preventive measures to minimize loss of life and property. The specific benchmark factors used in the predictability analysis are:

Unpredictable, indicating the hazard is extremely difficult, if not impossible, to predict in terms of time of occurrence, location and magnitude;
Somewhat Predictable, indicating the time of occurrence, location and magnitude of the hazard can be predicted at less than 50% accuracy;
Fairly Predictable, indicating the time of occurrence, location and magnitude of the hazard can be predicted at 50% or greater accuracy;
Highly Predictable, indicating the time of occurrence, location and magnitude of the hazard is predictable virtually 100% of the time.

Weighted value is 5% Benchmark factor values are:

1 pt	4 pts	7 pts	10 pts
Highly Predictable	**Fairly Predictable**	**Somewhat Predictable**	**Unpredictable**
100% Accuracy	**50% Accuracy**	**<50% Accuracy**	**Difficult / Impossible**

Collateral Damage

Collateral damage refers to the possibility of a particular hazard event causing secondary damage and impacts. For example, blizzards and ice storms can cause power outages, which can cause loss of heat, which can lead to hypothermia and possible death or serious injury. Generally, the more collateral damage a hazard event causes, the more serious a threat the hazard is to a community. The specific benchmark factors used in the collateral damage analysis are:

High Possibility, indicating there is a great likelihood (76% or greater chance) that a particular hazard event will cause secondary hazard events and damage;
Good Possibility, indicating there is a higher than average likelihood (50-75% chance) that a particular hazard event will cause secondary hazard events and damage;
Some Possibility, indicating there is a less than average likelihood (less than 50% chance) that a particular hazard event will cause secondary hazard events and damage;
No Possibility, indicating there is virtually no likelihood (0% chance) that a particular hazard event will cause secondary hazard events and damage.

Weighted value is 10% Benchmark factor point values are:

1 pt	4 pts	7 pts	10 pts
No Possibility 0% Chance	**Some Possibility <50% Chance**	**Good Possibility 50% - 75% Chance**	**High Possibility >76% Chance**

Availability of Warnings

Availability of warnings indicates the ease with which the public can be warned of a hazard. This measure does not address the availability of warning systems in a community, per sae. Rather, it looks at the overall availability of warning in general for a particular hazard event. For example, a community might receive warning that a flood will occur within 24 hours, but receive no warning when a large structural fire occurs. Generally, hazards that have little or no availability of warning tend to be more problematic for a community from a population protection and response standpoint. The specific benchmark factors used in the availability of warnings analysis are:

Warnings Available, indicating that the nature of the hazard is such that warning of the hazard event is always available (100% of the time) and received in a timely manner;
Warnings Sometimes Available, indicating that the nature of the hazard is such that warning of the hazard event is available most of the time (50-99% of the time) and received in a timely manner;
Warnings Generally Not Available, indicating that the nature of the hazard is such that warning of the hazard event is generally not available much of the time (>50% of the time) and generally not received in a timely manner;
Warnings Unavailable, indicating that the nature of the hazard is such that warning of the hazard event is not available (0% of the time).

Weighted value is 5% Benchmark factor values are:

1 pt	4 pts	7 pts	10 pts
Available	**Sometimes**	**Generally Not**	**Unavailable**
100% of time	**50% – 99% of time**	**<50% of time**	**0% of time**

EVALUATION MEASURES AND BENCHMARK FACTORS SUMMARY

Historical Occurrence	
Excessive Occurrence	10 pts
High Occurrence	7 pts
Medium Occurrence	4 pts
Low Occurrence	1 pt

Affected Area	
Large Area	10 pts
Small Area	7 pts
Multiple Sites	4 pts
Single Site	1 pt

Speed of Onset	
Minimal/No Warning	10 pts
Less than 12 Hours	7 pts
12 – 24 Hours	4 pts
Greater than 24 Hours	1 pt

Casualty Impact	
High Impact	10 pts
Medium Impact	7 pts
Low Impact	4 pts
No Impact	1 pt

Economic Effects	
Significant Effects	10 pts
Medium Effects	7 pts
Low Effects	4 pts
Minimal Effects	1 pt

Duration	
Long Duration	10 pts
Medium Duration	7 pts
Short Duration	4 pts
Minimal Duration	1 pt

Seasonal Pattern	
Year Round Occurrences	10 pts
Three Season Occurrences	7 pts
Two Season Occurrences	4 pts
One Season Occurrence	1 pt

Predictability	
Unpredictable	10 pts
Somewhat Predictable	7 pts
Predictable	4 pts
Highly Predictable	1 pt

Collateral Damage	
High Possibility	10 pts
Good Possibility	7 pts
Some Possibility	4 pts
No Possibility	1 pt

Availability Of Warnings	
Warnings Unavailable	10 pts
Generally Not Available	7 pts
Somewhat Available	4 pts
Warnings Available	1 pt

The following table reveals the results of the quantitative evaluation of the Newaygo County hazards evaluation conducted for the 2026 edition of this plan. Similar evaluations were also conducted for municipal jurisdictions in the county, and can be found in the Hazards Profile and Evaluations Appendix.

Hazards Profile and Evaluation – County of Newaygo, Michigan

Evaluation Criteria	**Infrastructure Failure**	**Wildfires**	**Criminal**	**Public Health**	**Hazardous Materials**	**Flooding / Dam Failure**
Historical Occurrence	Excessive 4+ events/yr 10 pts x 20% = **2.0**	Excessive 4+ events/yr 10 pts x 20% = **2.0**	Excessive 4+ events/yr 10 pts x 20% = **2.0**	High 2 - 3 events/yr 7 pts x 20%= **1.4**	Excessive 4+ events/yr 10 pts x 20% = **2.0**	Medium 1 event/yr 4 pt x 20%= **0.8**
Affected Area	Large Area >3 Juris. 10 pts x 20% = **2.0**	Small Area 2-3 Juris. 7 pts x 20%= **1.4**	Multiple Sites > 1 Neighbor.. 4 pts x 20%= **0.80**	Large Area >3 Juris. 10 pts x20% = **2.0**	Multiple Sites > 1 Neighbor.. 4 pts x 20%= **0.80**	Large Area >3 Juris. 10 pts x 20% = **2.0**
Speed of Onset	Minimal No Warning 10 pts x 10% = **1.0**	Minimal No Warning 10 pts x10% = **1.0**	Some <12 Hours 7 pts x 10% = **0.7**	High >24 Hours 1 pt x 10% = **0.1**	Minimal No Warning 10 pts x10% = **1.0**	Medium 12-24 Hours 4 pts x 10% = **0.4**
Casualty Effects	Low Impact <5 injured 4 pts x 10% = **0.4**	Low Impact <5 injured 4 pts x 10% = **0.4**	High Impact >10 injured 10 pts x10% = **1.0**	High Impact >10 injured 10 pts x10% = **1.0**	Medium <10 injured 7 pts x10%= **0.7**	High Impact >10 injured 10 pts x10% = **1.0**
Economic Effects	High >$100k 10 pts x10% = **1.0**	High >$100k 10 pts x10% = **1.0**	High >$100k 10 pts x10% = **1.0**	High >$100k 10 pts x10% = **1.0**	High >$100k 10 pts x10% = **1.0**	High >$100k 10 pts x10% = **1.0**
Duration	Medium <1 Week 7 pts x5%= **0.35**	Long > 1 Week 10 pts x5%= **0.5**	Medium <1 Week 7 pts x5%= **0.35**	Long > 1 Week 10 pts x5%= **0.5**	Medium <1 Week 7 pts x5%= **0.35**	Long > 1 Week 10 pts x5%= **0.5**
Seasonal Pattern	Year Round 4 Seasons 10 pts x5%= **0.5**	¾ Year 3 Seasons 7 pts x5%= **0.35**	Year Round 4 Seasons 10 pts x5%= **0.5**	Year Round 4 Seasons 10 pts x5%= **0.5**	Year Round 4 Seasons 10 pts x5%= **0.5**	Year Round 4 Seasons 10 pts x5%= **0.5**
Predictability	Unpredictable Difficult 10 pts x5%= **0.5**	Unpredictable Difficult 10 pts x5%= **0.5**	Unpredictable Difficult 10 pts x5%= **0.5**	Fairly Predict. >50% Accuracy 4 pts x 5%= **0.20**	Unpredictable Difficult 10 pts x5%= **0.5**	Fairly Predict. >50% Accuracy 4 pts x 5%= **0.2**
Collateral Damage	Some Poss. <50% 4 pts x 10%= **0.4**	Good <75% 7 pts x10%= **0.70**	Good <75% 7 pts x10%= **0.70**	High Poss. >75% 10 pts x10%= **1.0**	Some Poss. <50% 4 pts x 10%= **0.4**	High Poss. >75% 10 pts x10%= **1.0**
Availability of Warnings	Unavailable No Warnings 10 pts x5%= **0.5**	Generally Not <50% 7 pts x5%= **0.35**	Unavailable No Warnings 10 pts x5%= **0.5**	Available 100% 1 pt x 5%= **0.05**	Unavailable No Warnings 10 pts x5%= **0.5**	Most of the time >75% 4 pts x 5%= **0.2**
Hazard Score	**8.65**	**8.20**	**8.05**	**7.75**	**7.60**	**7.60**
Rank	**1**	**2**	**3**	**4**	**5**	**6**

Evaluation Criteria	**Thunderstorm**	**Severe Winter Weather**	**Drought / Extreme Heat**	**Fires**	**Transport**	**Tornado**	**Geologic Hazards**
Historical Occurrence	High 2 - 3 events/yr 7 pts x 20%= **1.4**	High 2 - 3 events/yr 7 pts x 20%= **1.4**	High 2 - 3 events/yr 7 pts x 20%= **1.4**	Excessive 4+ events/yr 10 pts x20% = **2.0**	Excessive 4+ events/yr 10 pts x20% = **2.0**	Low >1 event/yr 1 pt x 20%= **0.2**	Low >1 event/yr 1 pt x20%= **0.2**
Affected Area	Large Area >3 Juris. 10 pts x 20% = **2.0**	Large Area >3 Juris. 10 pts x20% = **2.0**	Large Area >3 Juris. 10 pts x20% = **2.0**	Single Site <1 City 1 pt x 20%= **0.2**	Single Site <1 City 1 pt x 20%= **0.2**	Multiple Sites > 1 Neighbor.. 4 pts x 20%= **0.80**	Large Area >3 Juris. 10 pts x20% = **2.0**
Speed of Onset	Some <12 Hours 7 pts x 10% = **0.7**	High >24 Hours 1 pt x 10% = **0.1**	High >24 Hours 1 pt x10% = **0.1**	Minimal No Warning 10 pts x10% = **1.0**	Minimal No Warning 10 pts x10% = **1.0**	Minimal No Warning 10 pts x10% = **1.0**	Some <12 Hours 7 pts x 10% = **0.7**
Casualty Effects	Low Impact <5 injured 4 pts x 10% = **0.4**	Low Impact <5 injured 4 pts x 10% = **0.4**	Low Impact <5 injured 4 pts x 10% = **0.4**	Low Impact <5 injured 4 pts x 10% = **0.4**	Medium <10 injured 7 pts x10%= **0.7**	Medium <10 injured 7 pts x10%= **0.7**	None No casualties 1 pt x 10% **0.10**
Economic Effects	High >$100k 10 pts x10% = **1.0**	High >$100k 10 pts x10% = **1.0**	High >$100k 10 pts x10% = **1.0**	High >$100k 10 pts x10% = **1.0**	Low $10k - $50k 4 pts x 10% = **0.4**	Medium <$100k 7 pts x10%= **0.7**	High >$100k 10 pts x10% = **1.0**
Duration	Minimal <12 Hours 1 pt x 5%= **0.05**	Medium <1 Week 7 pts x5%= **0.35**	Long > 1 Week 10 pts x5%= **0.5**	Short <24 Hours 4 pts x 5%= **0.2**	Minimal <12 Hours 1 pt x 5%= **0.05**	Minimal <12 Hours 1 pt x 5%= **0.05**	Minimal <12 Hours 1 pt x 5%= **0.05**
Seasonal Pattern	Year Round 4 Seasons 10 pts x5%= **0.5**	¾ Year 3 Seasons 7 pts x5%= **0.35**	Year Round 4 Seasons 10 pts x5%= **0.5**	Year Round 4 Seasons 10 pts x5%= **0.5**	Year Round 4 Seasons 10 pts x5%= **0.5**	¾ Year 3 Seasons 7 pts x5%= **0.35**	Year Round 4 Seasons 10 pts x5%= **0.5**
Predictability	Fairly Predict. >50% Accuracy 4 pts x 5%= **0.2**	Fairly Predict. >50% Accuracy 4 pts x 5%= **0.2**	Fairly Predict. >50% Accuracy 4 pts x 5%= **0.20**	Unpredictable Difficult 10 pts x5%= **0.5**	Unpredictable Difficult 10 pts x5%= **0.5**	Unpredictable Difficult 10 pts x5%= **0.5**	Somewhat Predictable 7 pts x 5% **0.35**
Collateral Damage	High Poss. >75% 10 pts x10%= **1.0**	High Poss. >75% 10 pts x10%= **1.0**	Good <75% 7 pts x10%= **0.70**	Some Poss. <50% 4 pts x 10%= **0.4**	Some Poss. <50% 4 pts x 10%= **0.40**	High Poss. >75% 10 pts x10%= **1.0**	High Poss. >75% 10 pts x10%= **1.0**
Availability of Warnings	Most of the time >75% 4 pts x 5%= **0.2**	Available 100% 1 pt x 5%= **0.05**	Available 100% 1 pt x 5%= **0.05**	Unavailable No Warnings 10 pts x5%= **0.5**	Unavailable No Warnings 10 pts x5%= **0.5**	Generally Not <50% 7 pts x5%= **0.35**	Generally Not <50% 7 pts x5%= **0.35**
Hazard Score	**7.45**	**6.85**	**6.85**	**6.70**	**6.25**	**6.25**	**6.25**
Rank	**6**	**7**	**9**	**10**	**11**	**12**	**13**

It should be noted that the hazard rankings resulting from this evaluation are different from the rankings within the previous editions of this plan. A majority of the ranking changes are due to change in historical occurrences. For example, since 2020 weather patterns have gone from very wet to very dry. Therefore, there has been a decrease in Flooding and Dam Failure Risk along with Thunderstorms and Tornados with an increase risk in Wildfires and Drought / Extreme Temperature. In addition, there has been an influx over the last five years of public health related emergencies, hazardous materials incidents, and larger criminal incidents.

In 2014, Flooding and Dam Failure replaced Infrastructure Failure as the #1 hazard in Newaygo County due to increased flooding occurrences. During this hazard evaluation, Infrastructure Failures returned to the #1 hazard due to the increased failures across multiple sectors as a result of aging infrastructure. Other significant changes also include the promotion of Criminal #5 (previously #8) and Public Health #6 (previously #11) and the demotion of Tornados #12 (previously #5).

The following chart highlights the changes from the previous Hazard Rankings to the updated rankings for 2026:

2026 Rank	Hazard	2020 Rank	2014 Rank	2008 Rank	Change
1	Infrastructure Failure	1	2	1	-
2	Wildfires	3	3	6	↑1
3	Criminal	5	8	11	↑2
4	Public Health	6	11	10	↑3
5	Hazardous Materials	9	9	4	↑5
6	Flooding / Dam Failure	2	1	2	↓3
7	Thunderstorms	4	4	3	↓2
8	Severe Winter Weather	7	6	7	-
9	Drought	13	12	12	↑1
10	Fires	8	7	8	↓2
11	Transport	10	9	9	↓1
12	Tornado	12	5	4	-
13	Geologic Hazards	11	-	-	↓1