Emmet County, Michigan

2024 Hazard Mitigation Plan

DRAFT 10/31/2024

FEMA Letter of Approval

Emmet County's Resolution of Adoption

ACKNOWLEDGEMENTS

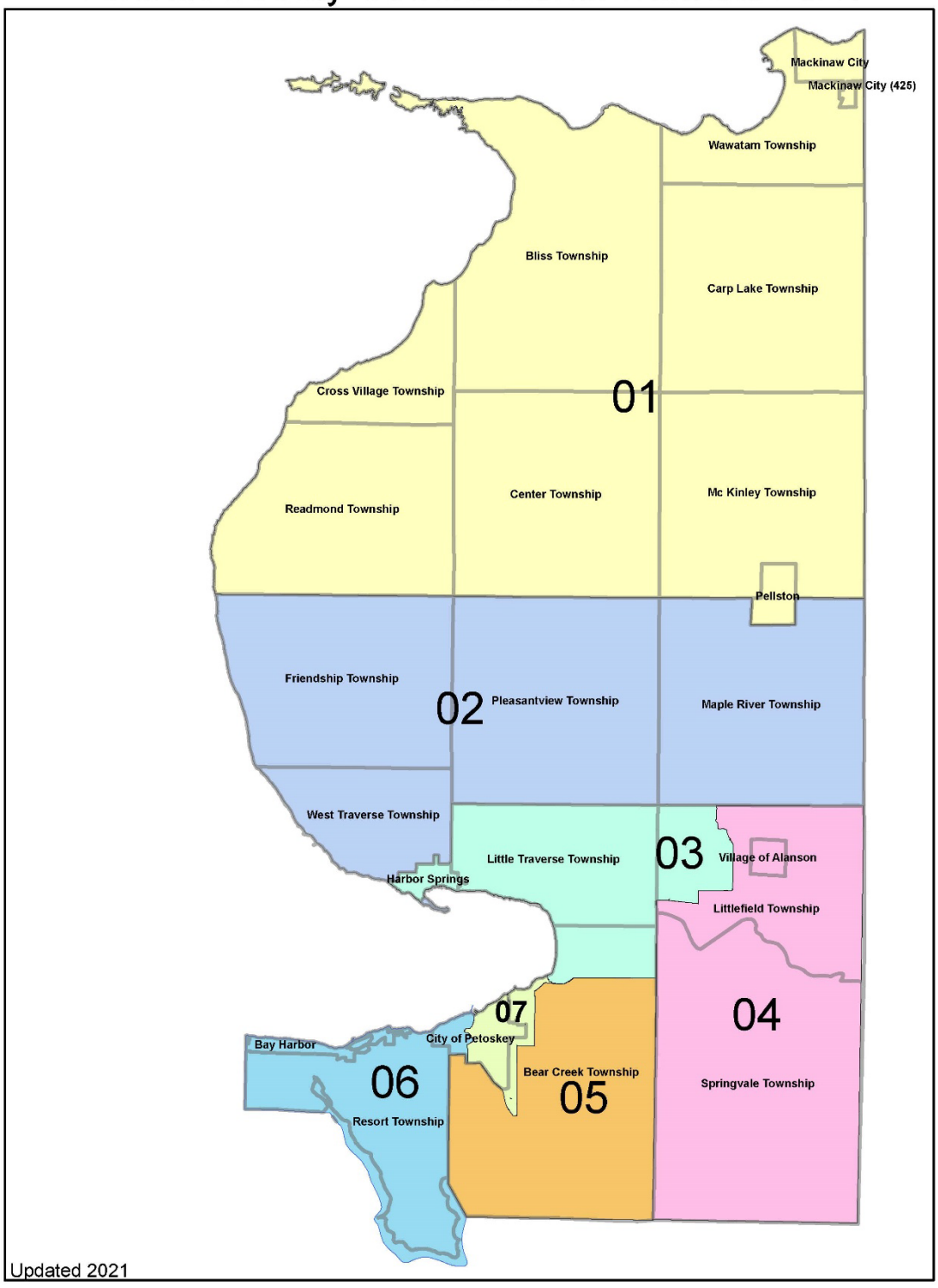
The 2024 Emmet County Hazard Mitigation Plan is prepared for Emmet County, Michigan and its local units of government. The plan is the culmination of an interdisciplinary and interagency planning effort that required the technical assistance and contributions from representatives of the organizations and jurisdictions listed below. Refer to Appendix G for a table of how and when the representatives of each participating entity contributed to the development of the plan. Each jurisdiction is invited to be a continuing participant in future regular review and updating of the plan.

PARTICIPATING AGENCY/ JURISDICTION	REPRESENTATIVE	TITLE
Emmet County Board of Commissioners	Charles Laughbaum	District 1 Commissioner
	Neil Ahrens	District 2 Commissioner
	Don Mapes	District 3 Commissioner
	Rich Ginop	District 4 Commissioner
	Brian Gutowski	District 5 Commissioner
	Dave White	District 6 Commissioner
	Matt Koontz	District 7 Commissioner
Emmet County Planning Commission	Thomas Urman	Planning Commission Chair
	John Eby	Planning Commission Vice Chair
	Brian Bates	Planning Commission Secretary
	Scott Herceg	Planning Commissioner
	Neil Ahrens	Planning Commissioner
	Julie Hinterman	Planning Commissioner
	Chuck Laughbaum	Planning Commissioner
	Kelly Alexander	Planning Commissioner
	Jennifer Neal	Planning Commissioner
Emmet County Staff	David Boyer	County Administrator
	Mike Keiser	Assistant County Administrator
	Matt Blythe	Emergency Management Coordinator
	Brian Patten	EMS Director
	Tammy Doernenburg	Planning & Zoning Director, Zoning Administrator
	Hillary Taylor	Assistant Planning & Zoning Director
	Pete Wallin	Emmet County Sheriff
	Ryan Bachelor	Pellston Airport Director
	Andi Tolzdorf	DPW Director
	Michael Larson	Equalization/GIS Deputy Director (former)
	Valerie Snyder	Probate Court Judge

PARTICIPATING AGENCY/ JURISDICTION	REPRESENTATIVE	TITLE
	Amanda Guarisco	Friend of the Court Director
	Mike Erickson	Community Corrections Director
	Mary Mitchell	County Treasurer
	Agnes Shaw	Emmet-Charlevoix County Fair Manager
Emmet County Emmet County Road Commission	Brett Shank	Engineer/Manager
City of Harbor Springs	Kyle Knight	Police Chief
	Bonnie Kulp	Harbor Springs Chamber of Commerce Director
City of Petoskey	Matthew Breed	Public Safety Director (former)
	Adrian Karr	Public Safety Director (current)
	Lindsey Walker	City Councilmember
	Michelle Blint	Resident
Village of Alanson		
Village of Pellston		
Village of Mackinaw City	Todd Woods	Police Chief
	Brian Boesel	DPW Supervisor
Bear Creek Township	Al Welsheimer	Resort-Bear Creek Township Fire Chief
Bliss Township		
Carp Lake Township		
Center Township	Charles Grimm	Assessor
Cross Village Township	Charles Grimm	Assessor
Friendship Township		
Little Traverse Township	Bill Dohm	Supervisor
Littlefield Township		
Maple River Township		
McKinley Township		
Pleasantview Township	Amie Tiffany	Deputy Clerk
	Gail Ives	Property Owner
Readmond Township	Charles Grimm	Assessor
Resort Township	Al Welsheimer	Resort-Bear Creek Township Fire Chief
Springvale Township		
Wawatam Township		

PARTICIPATING AGENCY/ JURISDICTION	REPRESENTATIVE	TITLE
West Traverse Township	Jim Bartlett	Supervisor
Little Traverse Bay Bands of Odawa Indians	David Thom	Emergency Management Coordinator
	Terry McDonnell	Tribal Police Chief
	Traven Michaels	Tribal Environmental Dept. – Environmental Response Specialist
Charlevoix County	Sienna Wenz	Emergency Management Coordinator
Cheboygan County	Jeremy Runstrom	Emergency Management Coordinator
Charlevoix-Cheboygan-Emmet (CCE) 911 Central Dispatch	Pam Woodbury	Director
	Chris Heckman	Deputy Director (current)
	Rob Jerman	Deputy Director (former)
Bay Bluffs Medical Care Facility	Lisa Ashley	Administrator
AuxComm – Charlevoix, Cheboygan, and Emmet Counties Public Service Communications organization	Chuck Brew	Director
	Michael Sears	Radio Operator
	James Cook	Member
Radio Amateur Civil Emergency Service (RACES)	Blaine Rawson	Board Director
Friendship Centers of Emmet County (Emmet County Council on Aging)		
McLaren Northern Michigan Healthcare	Robert Kronberg	Environment of Care Manager
	Kathy St. Pierre	Clinical Nurse Manager
Health Department of Northwest Michigan	Chloe Capaldi	Emergency Preparedness Coordinator
American Red Cross	Matt Glen	
Tip of the Mitt Watershed Council	Jennifer McKay	Policy Director
	Lauren Day	Watershed Management Coordinator
	Marcella Domka	Water Resources Manager
Emmet Conservation District	Chris Anderson	Michigan Agricultural Environmental Assurance Program (MAEAP) Technician
Charlevoix, Antrim, Kalkaska, and Emmet (CAKE) Cooperative Invasive Species Management Area (CISMA)		
Circuit Controls Corp./Yazaki North America	Kirk Sevenski	
	Diane Morse	Production Manager
Michigan State Police EMHSD	Lt. Mike DeCastro	Region 7 District Coordinator

Emmet County Commissioner Districts 2021



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I. INTRODUCTION

Hazard mitigation is defined as any action taken before, during, or after a disaster or emergency to permanently eliminate or reduce the long-term risk to human life and property from natural, technological and human-related hazards. Mitigation is an essential element of emergency management, along with preparedness, response and recovery.

Mitigation allows repairs and reconstruction to be completed after an incident occurs in such a way that does not just restore the damaged property as quickly as possible to pre-disaster conditions. It also ensures that such cycles are broken, that post-disaster repairs and reconstruction take place after damages are analyzed, and that sounder, less vulnerable conditions are produced. Through a combination of regulatory, administrative, and engineering approaches, losses can be limited by reducing susceptibility to damage. When successful, hazard mitigation will lessen the impact of a disaster on people, property, the environment and economy, and continuity of services through the coordination of available resources, programs, initiatives, and authorities.

A *hazard*, in the context of this plan, is an event or physical condition that has potential to cause fatalities; injuries; damage to personal property, infrastructure, or the environment; agricultural product loss; or interruption of business or civic life. A broad perspective was taken in developing this plan to examine multiple hazard mitigation activities and opportunities in Emmet County. Each hazard was analyzed from a historical perspective, evaluated for potential risk, and considered for possible mitigation. This plan focuses primarily on *natural* hazards such as severe weather, thunderstorms and high winds, lightning, hail, inland flooding, tornadoes, extreme temperatures, drought, wildfires, coastal hazards, dense fog, space weather, subsidence, invasive species, and a changing climate. However, the plan also considers risk incurred by these technological and human-related hazards:

- Technological Hazards - Industrial
    - Hazardous Materials: Fixed Site Incident
    - Hazardous Materials: Transportation Incident
    - Oil and Gas Accidents (well and pipeline)
    - Structure Fires
    - Scrap Tire Fires

- Technological Hazards - Infrastructure
    - Major Transportation Incidents (air, highway, marine)
    - Built Infrastructure Failures (water, sewer, trails, roads, bridges, communications)
    - Built Infrastructure Failure (dams)
    - Energy Failures and Shortages (electric, natural gas, petroleum)

- Human-Related Hazards
    - Public Health Emergencies (contagions, food and water contamination)
    - Cyberattacks and Major Network Disruptions
    - Terrorism and Similar Critical Incidents
    - Civil Disturbance
    - Nuclear Attack

The following natural hazards were not included in the analysis for this Hazard Mitigation Plan: earthquakes; meteorites and other impacting objects; and nuclear power plant emergencies. According to Michigan State Police's 2019 *Michigan Hazard Analysis*, most of Michigan is not located in an area subject to major earthquake activity. Damaging meteorite events were not evaluated due to the lack of historical impact in northern Michigan and their low probability of occurrence. Nuclear power plant emergencies were not evaluated because there are no active nuclear power plants in northern Michigan.

The main objective of the Emmet County Hazard Mitigation Plan is to permanently eliminate or reduce long-term risks to people and property from hazards so that assets such as transportation, infrastructure, commerce, and tourism can be sustained and strengthened. This can be accomplished through collaborative efforts/activities amongst agencies within the county to protect the health, safety, and economic interests of the residents and businesses through planning, awareness, and implementation.

Since the 2016 Emmet County Hazard Mitigation Plan's adoption period, the following notable projects have been completed that aid in the county's hazard mitigation efforts:

- The City of Harbor Springs completed a Federal Emergency Management Agency (FEMA) floodplain project in 2019 (based on preliminary FEMA floodplain maps issued in 2019) in order to protect City infrastructure and private properties from a "100-year flood" event (a catastrophic flood that has a 1% chance of occurring every year). The project allows flood waters from the Shay Drain to reach Lake Michigan without damaging City infrastructure or flooding private homes and businesses. The project involved constructing a box culvert underneath M-119, a concrete spillway and the reconstruction of Zoll Street.

- Emmet County received an updated FEMA Flood Insurance Study effective June 1, 2022, which included updated digital Flood Insurance Rate Maps (FIRMs) for West Traverse, Little Traverse, Friendship, Cross Village and Readmond Townships; the Village of Mackinaw City; the City of Petoskey; and the City of Harbor Springs; and new digital flood maps for Bear Creek, Bliss, Resort, and Wawatam Townships. The townships of Bear Creek, Bliss, Resort, and Wawatam are listed as non-participants in the National Flood Insurance Program, as they have not submitted documentation of local adoption of the FIRM(s) to FEMA. The other communities have adopted their respective updated FIRMs and have enacted local floodplain management ordinances designating the Emmet County Building Department as the NFIP-enforcing agency. Local units of governments can utilize these FIRMs as a resource to pursue, for example, acquisition of flood-prone properties, or revising their local zoning ordinances to include shoreline protection/property protection measures.

- The Crooked River Lock in Alanson and the Maple River Dam were indicated as hazard areas of concern in the 2016 plan regarding flooding risk.

    - The Maple River Dam (also known as the Lake Kathleen Dam) was a former low hazard dam in Maple River Township that had a poor condition assessment rating. The dam was built in 1884 as part of a hydroelectric plant. In 2014, it nearly failed due to high water levels and was finally dismantled in 2019 with assistance from the Conservation Resource Alliance and the Emmet County Road Commission. The Maple River now runs unobstructed and potential flood risk in the area has been significantly reduced with the removal of the dam.

    - The US Army Corps of Engineers (USACE) owns the Crooked River Lock (Crooked Lake Dam) in Alanson and leases the facility to the Department of Natural Resources (DNR). Emmet County Parks and Recreation Department operates the Lock with a sub-lease through the DNR in order to raise and maintain the water level of Pickerel Lake and Crooked Lake, which had dropped considerably after completion of dredging in the mid-1950s. In 2023, the USACE closed the lock for the remainder of the season to perform critical maintenance – namely, replacement and repair of the electrical safety relay and an inspection of the lock to determine additional future maintenance funding requirements.

Appendix D provides a list of mitigation strategies included in the Emmet County 2016 Natural Hazards Mitigation Plan, along with their current status and how they may have been integrated into other local planning mechanisms.

Section VII of this plan, "Mitigation Strategies and Priorities", provides strategies to address the hazards described in the hazard analysis. The mitigation strategies were developed based on discussions with local officials and a review of FEMA/MSP best practices for hazard mitigation. (Refer to Appendix E for a list of Alternative Strategies that were considered.) Strategies are grouped according to their purpose: Awareness and Preparation; Shelters; Buildings & Infrastructure; Utilities & Technology; and Environment & Natural Resources. The strategies table also includes: a description of each strategy; what hazards it addresses; where the strategy applies; who is responsible for implementing the strategy; how the strategy will be implemented (what resources are available to apply the strategy); the estimated timeframe for completion; the level of priority; and what type of strategy it is.

Most strategies are intended to be action items completed during the 5-year timeframe in which the plan is active. Some long-term strategies may extend beyond the 5-year timeframe due to feasibility or level of difficulty.

Recognizing the importance of reducing community vulnerability to hazard events, Emmet County is actively addressing the issue through the development and implementation of this plan. This process will help ensure that Emmet County remains a vibrant, safe, enjoyable place in which to live, raise a family, continue to conduct business, and maintain a tourist base. This plan serves as the foundation for hazard mitigation activities and actions within Emmet County, and will be a resource for building coordination and cooperation within the community for local control of future mitigation and community preparedness around the following goals:

Goal 1: Increase local awareness and participation in hazard mitigation strategy implementation
Goal 2: Integrate hazard mitigation considerations into local community planning processes
Goal 3: Utilize available resources and apply for additional funding to implement hazard mitigation projects
Goal 4: Develop and complete hazard mitigation projects in a timely manner

II. PLANNING PROCESS

The Stafford Act, as amended by the Disaster Mitigation Act of 2000, shifted the Federal Emergency Management Agency's (FEMA) scope of work to promoting and supporting prevention, or what is referred to as hazard mitigation planning. FEMA requires government entities to have a natural hazards mitigation plan in place and updated on a 5-year cycle as a condition for applying for grant funding related to natural hazard mitigation and remediation. The last Natural Hazard Mitigation Plan was completed for Emmet County in 2016 by the former Tri-County Office of Emergency Management. The 2016 Plan also included hazard mitigation plans for Cheboygan and Charlevoix counties. Following the dissolution of the three-county Office of Emergency Management (OEM) in July 2020, Emmet County started its own OEM. The adoption of the 2024 Plan will reaffirm the eligibility of the county, as well as those local municipalities who participated in the planning process and adopted the plan, to apply for FEMA pre-disaster mitigation grants.

Plan Development

The update of the County's plan was led by the Natural Hazards Task Force ("Task Force") composed of the County's Local Emergency Planning Committee (LEPC), organized by the Emmet County Emergency Management Coordinator. LEPC members consist of first responders and local, regional, and state public entities that ensure the preparedness of the County through efforts such as coordination and cooperation amongst members; recommending equipment purchases; and conducting training, exercises, and public education. Networks Northwest staff assisted with development of the updated plan by providing meeting and public input facilitation, conducting an online survey, and writing the plan. Task Force/LEPC meetings were held in person at the Emmet County Emergency Operations Center, and were open to the public. Notifications of all meetings involving work sessions/public input sessions were posted on the Emmet County's OEM webpage.

Representatives of all of the following types of stakeholders were invited to participate in the planning process by various methods: email invitation, phone calls, meeting attendance/presentation, or mailed letters. Stakeholders included local and regional agencies involved in hazard mitigation activities; agencies that have the authority to regulate development; neighboring communities; representatives of businesses and other private organizations; and representatives of nonprofit organizations, including community-based organizations that work directly with and/or provide support to underserved communities and socially vulnerable populations (such as the Health Department of Northwest Michigan, Emmet County Council on Aging, and the Little Traverse Bay Bands of Odawa Indians). Please refer to the Acknowledgements section in the beginning of this plan for a list of participants; Appendix F for a detailed table showing how and when representatives participated in the planning process; and Appendix G for meeting and public input documentation. Refer to Table _ in this plan for information on jurisdictional participation in the 2016 Hazard Mitigation Plan.[1] All Emmet County jurisdictions - except for ___- have participated in the development of this 2024 Hazard Mitigation Plan.

The following list of events contributed to the development of the 2024 Emmet County Hazard Mitigation Plan:

- An online survey was available from November 9, 2022 to January 4, 2023. The survey received 58 responses where participants answered at least 42% of questions. The 17 survey questions were crafted to obtain input from Emmet County stakeholders on their experiences with past hazard events; perceived level of concern regarding impacts from future hazard events; and past and future mitigation projects.

- On March 16, 2023 Networks Northwest staff provided a brief presentation to the Emmet County Board of Commissioners to describe the purpose and process of the County's Hazard Mitigation Plan update.

- Meetings where Networks Northwest staff presented to the Task Force:

7/6/2022	4/5/2023
10/5/2022	4/3/2024
1/4/2023	7/10/2024
3/14/2023	10/9/2024

[1] The 2016 Hazard Mitigation Plan for Emmet County did not specify which communities participated in the development of the plan; information on local government participation in the 2016 plan process was inferred from meeting documentation appended to the plan.

Appendix C provides a summary of feedback received from meetings held with stakeholders and the public during the planning process.

During development of the plan, all Emmet County municipalities were provided the opportunity to participate in the online community survey, participate in scheduled meetings, and comment on draft plan materials. Additionally, representatives from county and regional agencies that encompass or share borders with Emmet County (listed below) were invited to participate in the planning meetings, and were able to view the draft and final plan materials on the hazard mitigation project page of Network Northwest's website.

- David Thom, Jr., Safety/Emergency Management Coordinator, Little Traverse Bay Bands of Odawa Indians
- Sienna Wenz, Emergency Management Coordinator, Charlevoix County Office of Emergency Management
- Lieutenant Jeremy Runstrom, Director, Cheboygan County Office of Emergency Management
- Mike Kasper, Emergency Management Coordinator, Mackinac County Department of Emergency Management
- Robert Carson, Regional Director of Community Development, Networks Northwest
- Emmet County Planning Commission
- Charlevoix County Planning Commission
- Cheboygan County Planning Commission
- Mackinac County Planning Commission

Community Survey Results

The online survey was available in an online format from November 2022 to January 2023. A link to the survey was made available on the Emmet County OEM's webpage and Networks Northwest's project webpage. The Emmet County Emergency Management Coordinator also emailed Task Force members, local government officials and other community stakeholders with an invitation to take the survey. The 17 survey questions were crafted to obtain input from Emmet County stakeholders on their experiences with past hazard events; perceived level of concern regarding impacts from future hazard events; and past and future mitigation projects. The survey received 58 responses where participants answered at least 42% of questions. The majority of responses were from elected or appointed officials, emergency personnel, and property owners/residents. The complete survey results are included as Appendix B. Table 1 lists the local representatives that responded to the survey.

Table 1: Survey Responses by Local Municipality

Local Unit	# of Reps*	Title/Role (if provided)
Emmet County	25	County Commissioners, Airport Director, Planning & Zoning staff, DPW Director, Sheriff's Dept., Probate Court Judge, County Treasurer, Friend of the Court Director, Equalization/GIS Deputy Director, Community Corrections Director, County Fair Manager, Road Commission Engineer/Manager, Medical Care Facility Manager; County Employees
City of Harbor Springs	4	Police Chief; Chamber of Commerce Director, resident, property/business owner
City of Petoskey	13	City Councilmember, Public Safety Director, residents, property/business owners
Village of Alanson	4	Resident
Village of Pellston	2	
Village of Mackinaw City	5	DPW Superintendent, Mackinaw City Police Dept., Charlevoix Cheboygan Emmet Counties Public Service Communication Organization Inc.,
Bear Creek Township	11	Fire Chief, residents
Bliss Township	2	
Carp Lake Township	4	Resident
Center Township	3	Assessor, Property Owner

Local Unit	# of Reps*	Title/Role (if provided)
Cross Village Township	3	Assessor
Friendship Township	3	Resident
Little Traverse Township	8	Twp. Supervisor, residents, business owner
Littlefield Township	4	Residents
Maple River Township	2	
McKinley Township	2	
Pleasantview Township	6	Deputy Clerk, residents
Readmond Township	1	Assessor and resident
Resort Township	8	Fire Chief, local government employee, residents, business owner
Springvale Township	8	Local Government Employee, residents
Wawatam Township	4	Mackinaw City Police Dept.
West Traverse Township	5	Twp. Supervisor, residents, property owners
Other	5	Health Dept. of NW MI; Tip of the Mitt Watershed Council; AuxComm for Charlevoix, Cheboygan, Emmet Counties; Emergency Management Coordinators for Charlevoix and Cheboygan Counties

Note: *When asked to identify which jurisdiction a survey participant represented, they could select multiple communities where they reside, work and/or own property.

Responses to Question 3-5 asked about participants' knowledge of local planning efforts including the current hazard mitigation plan (78% indicated they were unfamiliar with the plan), local master plans (49% said that the community they represent has an adopted Master Plan), and a local Capital Improvements Plan (CIP) (42% indicated that the community they represent has a CIP).

Questions 6 through 11 asked participants to rank their level of concern with each type of hazard, and to describe their concerns regarding impacts from those hazards. The results are described in Tables 2 through 8 below.

Table 2. Community Survey Results: "Please rate your level of concern regarding each type of potential Natural Hazard affecting your community" (Not Concerned = 1, Somewhat Concerned =2, Very Concerned =3)

Rank	Hazard	Mean Score
1	Severe Winter Weather (blizzard, snowstorm, ice, sleet, etc.)	2.38
2	High Winds/Straight-line Winds	2.36
3	Lake MI Shoreline Hazards (fluctuating water levels, rip current, erosion, seiche, landslide, flooding)	2.17
4	Severe T-storm (lightning, hail, wind, intense rainfall)	2.12
5	Invasive Species (aquatic or terrestrial)	1.97
6	Plant and Animal Diseases	1.91
7	Extreme Cold	1.88
8	Excessive Rainfall/Flooding	1.83
9	Tornado or Waterspout	1.81
10	Wildfire	1.72
11	Dense Fog	1.53
12	Extreme Heat	1.52
13	Drought	1.52
14	Subsidence (i.e., sinkholes)	1.36
15	Space Weather (i.e., solar-geomagnetic storm, solar flare)	1.17
16	Meteorites & Other Impacting Objects from Space	1.09
17	Earthquakes	1.07

Table 3. Community Survey Results: “Please describe your concerns regarding impacts from the above Natural Hazards.”

Response by Category
AVAILABLE RESOURCES TO ENSURE HEALTH AND SAFETY
I believe Emmet County fairgrounds is designated as a major disaster shelter particularly for housing animals in our barns.
Resources available in the community to respond to such events; lack of goods
Whether we can sustain one of these events.
Ensuring the safety & health of our constituents (food, heat, shelter, medical) and ensuring our ability to collect & distribute tax money to continue operations in the case of a long term service outage.
Concerns about how to handle widespread severe weather, and other Natural Hazards in order to keep people safe.
What is the plan for each one. As there is really unknown information
Human injury or loss of life.
Severe weather concerns as related to health and safety
ELECTRICITY
Ensuring that local power grid resources are available to operate our facility or support prompt response to our facility in the event of a natural disaster impacting our operation.
Trimming of trees around power lines. Higher winds this year showed how vulnerable our grid system is to Northern Michigan tree density.
Inconvenience of no electricity for a period of time. Lack of resource such as food and clean water.
safety of residents and visitors, utility services availability
Business interruption
Rural areas are quickly isolated and inaccessible after storms and power outages
PROPERTY DAMAGE
Home damage, severe property damage
Damage to county structures
Wildfire and Drought - Effect on farming and potential loss of property/life.
Wildfires with the number of trees that have come down from the winds we have had.
Living in a forested area and near the Great Lakes, fire and storm impacts from the lake are always in my thinking when I think of natural disasters.
TRANSPORTATION
The impacts on air travel & the Airport
In my role as a judge, I am concerned to the extent these hazards impact the ability of the court to provide services to county residents (i.e., unexpected closures) and the safety of residents in relation to their attendance at or access to the courts.
Keeping the road network and bridges open for travel
STORM CLEAN UP
Who cleans up after natural disasters and where does the material go?
July of 2020's big storm that blew thru Petoskey and HS in a matter of hours, downed thousands of trees on private and public lands. Emmet County DPW managed the majority of the wood waste and was inundated with over 10,000 cubic yards of wood waste that we stockpiled then had ground and hauled to CMS energy's co-gen facility @ the cost of $6 per yard. Wood debris needs to be sustainably managed and burying it in a pit (like city of Gaylord) is not the BMP. Emmet County DPW is willing and able to provide consultation and BMP's for managing all storm debris including waste to landfill, recycling, reuse and recovery of materials to their highest and best use.
NATURAL RESOURCES
Impacts from climate change are detrimental to our infrastructure, water quality, and public health - flooding, extreme storm events, unprecedented lake level fluctuations (record lows to record highs in record time), erosion, sewage and septic contamination, spread of invasive species, etc.
Invasive Species impact on our water,
Continued erosion along Lake Michigan shoreline.
Shoreline erosion, rip current, plant and animal diseases

Response by Category
GENERAL CONCERNS
Severe weather especially winter
Winter months are unavoidable and create hazardous conditions for all.
Damage to public infrastructure, damage to the economy
The above natural hazards may cause disruption of the economy and threaten life in Emmet County.

Table 4. Community Survey Results: "Rate your level of concern regarding each type of potential technological hazard affecting their community" (Not Concerned = 1, Somewhat Concerned =2, Very Concerned =3)

Rank	Technological Hazard	Mean Score
1	Energy Failure (electric, natural gas, or petroleum)	2.23
2	Communications Failure	2.14
3	Oil and Gas Accident (well and pipeline)	2.09
4	Structural Fire	2.04
5	Transportation Hazardous Materials Accident (i.e., railcar, aircraft, road vehicle or watercraft)	1.98
6	Transportation Accident (air, land, or marine vehicle crashes)	1.89
7	Road or Bridge Failure	1.88
8	Sanitary Sewer Failure	1.86
9	Hazardous Materials Release From a Fixed Site	1.79
10	Storm Sewer Failure	1.72
11	Dam Failure	1.35
12	Scrap Tire Fire	1.33

Table 5. Community Survey Results: "Describe your concerns regarding impacts from the above Technological Hazards"

Response by Category	Representative
Electricity and Communications	
The airport is at the end of two provider's "runs" and experiences power fluctuations.	Emmet County Airport in Pellston
Long duration electrical outages pose a threat.	Center Twp., Cross Village Twp., Readmond Twp.
Renting an old home and concerned for electrical safety	Bear Creek Township
Need to be able to access all systems hardware & software with up to date backups in order to collect & distribute monies.	Emmet County Government
Electric & communications are vital to operation of the fairgrounds particularly during disasters because of being an emergency shelter.	Emmet County Fairgrounds
Electrical outages are frequent	Pleasantview Township
Communication is so important and so dependent on outside influences. Many buildings lack backup electricity.	
City of Petoskey has over 70% of their utilities underground so electrical outages are rare.	
Pipeline Incident	
A rupture in Line 5, an oil spill @ the straights of mackinaw is an imminent disaster waiting to happen, only one way to resolve, shut it down. Infrastructure failures are a concern,	
Oil and gas pipelines in lakes and watersheds are very dangerous	
Pipeline leaks and or explosions are a concern for the aging Line 5 both under water and in ground.	

Response by Category	Representative
Definitely concerned that a line 5 spill would impact our community.	
Line 5	
Structural Fires	
how do you help people with fires	Carp Lake Township
fires are a very likely concern as well.	Little Traverse Township
Wastewater Infrastructure	
Waste water infrastructure is sound as city has invested millions in the past decade. City of Petoskey has a livable petoskey master plan and CIP's for every department.	City of Petoskey
Discharge of contaminates in waterways.	
Hazardous Materials Release - Fixed Site Incident	
The Old Big Rock Nuclear power plant in Bay Shore (formerly Consumers Power) has spent, radioactive fuel rods stored in cement casks 100 feet from an ever eroding shoreline.	
General Concerns	
Do we have the infrastructure to deal with any of these if they happen???	
The lack of any plan to restore power, sewer, or roads after a significant event effecting these resources.	
safety of residents and visitors, utility services availability	
Again, my responses relate only to concerns as they impact county residents' access to the courts.	
damage or results that effect our home and lively hood	
Adverse economic impact	
Ensuring that any event of this nature near our campus is contained so as not to impact resident safety.	Emmet County Medical Care Facility
Failure to respond to incident or emergency.	
Human injury or loss of life.	
We are a rural community in the center of the county. Most items on this page would be outside of the township	Pleasantview Township
Some of these events would be concerning if they occurred.	

Table 6. Community Survey Results: "Rate your level of concern regarding each type of potential Human-Related Hazard affecting your community" (Not a Concern = 1, Somewhat of a Concern = 2, A Serious Concern = 3)

Rank	Human-Related Hazard	Mean Score
1	Public Health Emergency (i.e., epidemic, drinking water contamination)	2.18
2	Cyber Attack	2.11
3	Terrorism & Similar Criminal Incidents (i.e., biological/nuclear/chemical weapons, active shooter)	1.93
4	Civil Disturbance (i.e., protests, riots, insurrection)	1.77

Table 7. Community Survey Results: "Describe your concerns regarding impacts from the above Human-Related Hazards"

Response by Category
Cyber-Attack
Cyber-attacks are insured against.
Cyber-Attack without real-time backups would be devastating.
Cyber attacks seem potentially more likely.
Cyber-attacks are increasing on pipeline infrastructure across the country and we have Line 5 in our service area that is a potential target.
Have concern about other countries interfering with our communication system.
The effect on our communication.

Public Health Emergency	
	The response to our recent pandemic was not efficient and lacked clear guidelines for the community to access.
	Our response to pandemics needs better communication and community cooperation
	The effect on our health and welfare
	Most people are on wells so ground water contamination is a concern.
	We have already experienced epidemics and drinking water contamination.
Civil Disturbance	
	Civil disturbances related to politics, which have divided our community beyond what I thought possible. What happened to agreeing to disagreeing and being neighbors?
	With the polarization around a lot of things recently, civil disturbances seem potentially more likely.
	Protest for the most part have remained peaceful, but it seems there has been an increase in frustrations by friends and neighbors.
Terrorism/Criminal Incidents	
	Terrorism is something to be planned for but not worried about.
	Highly politicized environment with a lot of antigovernment sentiment. Never really secure. Feel our [County Building] is not prepared for a criminal incident.
	Concerned about safety in the courtroom/county building and the security of court communications.
General Concerns	
	These types of hazards seem to come up so suddenly and without provocation. Difficult to predict.
	What are you plans and how do you train for this kind of thing
	All of the above can affect all county operations.
	We should be prepared for any of the above events.
	All are somewhat of a concern
	If any of these events occurred they would be of concern. I'm just not sure if some would directly impact
	Loss of life and panic in the Citizenry.
	safety of residents and visitors, utility services availability

Table 8. Community Survey Results: "Describe any disrupting or damaging hazard events that have occurred within your community in the last ten years."

Event Type	# of Times Mentioned	Description
Winter Weather	12	Winter storms, blizzard, ice, snow, severe cold, heavy snowfalls with reduced visibility, impact on roads, closure of the county court due to severe weather conditions
Shoreline Erosion/Flooding	10	Lake MI shoreline; high lake water events causing damage to public investment/infrastructure; collapse of LTW due to erosion in 2020; road and trail closures due to erosion; snowmelt and rainfall resulting in landslides causing significant property damage; hardening of the shoreline which causes further erosion and other ecological problems for the waters
High Winds	10	Straight line winds damage; July 2020 storm and clean up of it; the storms that have occurred with high winds and power outages have caused the most problems but thankfully it's only been a temporary inconvenience…It would be much more concerning if these events happened in the winter.
Power Outages	10	Caused by storms. There are still pockets of Emmet County that occasionally go 3-4 days without power following even a mild inclement weather event; Not able to perform county government work functions due to communication and power disruptions.
Thunderstorms	8	July 2020 severe thunderstorm caused significant damage in and around Petoskey
COVID Pandemic	7	

Event Type	# of Times Mentioned	Description
Inland Flooding	4	Roads flooded after a storm; excessive flooding and stormwater overflow. Septic failures due to high water tables or failure to maintain systems. Tannery Creek flooding on US-31.
Tornado	3	Gaylord tornado in May 2022 showed there is a possibility of damaging tornadoes in our area as well. Tornado touchdown in downtown Petoskey a couple of years ago.
Other	2	Road crumbling; Dead and falling trees on our roads appear to be a serious potential problem.
Invasive Species	1	Invading many inland lakes and streams and the Great Lakes shoreline.

Table 9. Community Survey Results: "Has your community considered mitigation strategies for potential or current hazards? If so, please identify potential strategies you would like to explore in the future."

Comment	Representative
Feasibility studies for shoreline restoration and native plantings, rerouting bike path to Highway, a suspension bridge as a replacement for bike path etc...	County employee/City of Petoskey Council member
It continues to dumbfound me that Emmet County WILL NOT embrace a comprehensive, sustainably-financed, countywide public transit system. For hazards where masses of people need to be efficiently moved and/or traffic congestion is not ideal, public transit is a critical piece of infrastructure.	City of Petoskey resident/business owner
I would like to work with you on creating a plan for disaster debris clean up. I know this is a part of planning that is generally overlooked or assumed that someone else will take care of it but we (the transfer station) likely doesn't have capacity for large scale clean up efforts.	Emmet County DPW Director
Our emergency operations plan includes risk mitigation strategies for many types of events.	County Medical Care Facility Administrator
Green Infrastructure, Flooding Management, Shoreline Bioengineering	Tip of the Mitt Watershed Council
Tannery Creek flooding study started (Bear Creek Township). Need property owner cooperation and grant funding to correct the issues.	Emmet County Planning & Zoning
Flood mitigation.	City of Harbor Springs
Update emergency preparedness plan and hold emergency response exercises.	Little Traverse Twp. Supervisor
PFAS contamination (around Pellston Airport)	Emmet County BOC
Removal of hazardous and dead trees along road rights of way.	Center, Cross Village and Readmond Townships

Questions 16 and 17 asked participants if their community has requested assistance for mitigation projects in the past, such as from FEMA or other partner agencies, and if their request was granted, the type of project:

- The City of Harbor Springs completed a FEMA floodplain project in 2019 (based on preliminary FEMA floodplain maps issued in 2019) in order to protect City infrastructure and private properties from a "100-year flood" event (a catastrophic flood that has a 1% chance of occurring every year). The project allows flood waters from the Shay Drain to reach Lake Michigan without damaging city infrastructure or flooding private homes and businesses. The project involved constructing a box culvert underneath M-119, a concrete spillway and the reconstruction of Zoll Street.
- Emmet County's Bay Bluffs Medical Care Facility received funding from the Michigan Department of Health and Human Services for staffing during the COVID pandemic

- Emmet County received MDEQ PFAS mitigation grants to conduct water quality monitoring around the Pellston Airport
- Emmet County received ARPA and COVID funds pertaining to pandemic response and recovery efforts

The final survey question asked survey-takers to respond with their contact information if they wish to be involved in the plan development process. Several responded with their name and/or email address.

Draft Plan Review and Comment

Upon approval by the Natural Hazards Task Force, the draft plan was released for public review and comment on __. Figures 1 and 2 illustrate the posting of draft plan materials and public hearing notification on Networks Northwest's project webpage and the County OEM's webpage. The public was also notified through a published notice in the ___ on __ of the County's draft Hazard Mitigation Plan and the opportunity to provide feedback at the public hearing held on ____ (Figure 3). The following comments were received during the public review period or at the public hearing:

Figure 1: Networks Northwest Project Webpage

Source: Accessed ___

Figure 2.

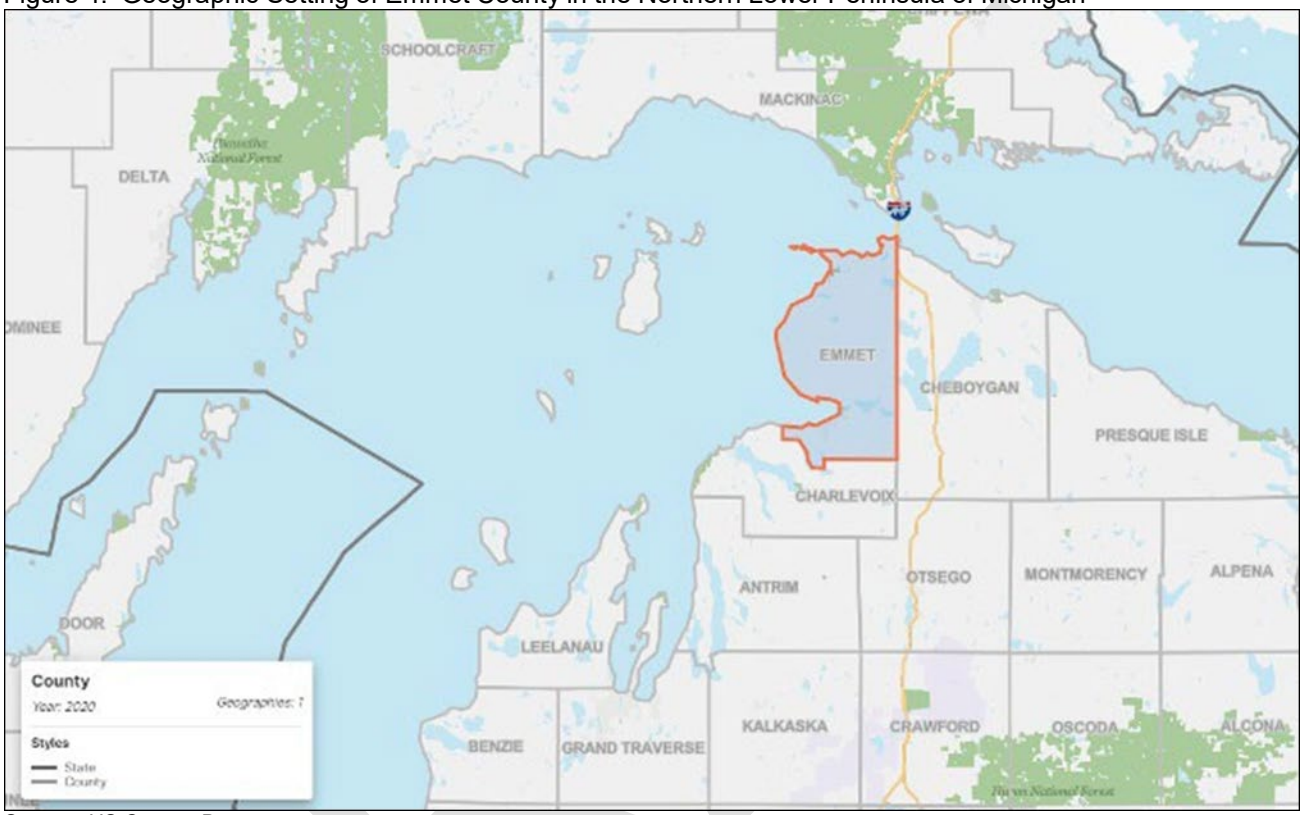
Figure 3. Public Notice in the ___ Newspaper, DATE

III. COMMUNITY PROFILE

Location

Emmet County is located at the Northwest tip of Michigan's Lower Peninsula (Figure 4). The county is bordered by Lake Michigan to the north and west; Mackinac County to the north, Cheboygan County to the east, and Charlevoix County to the west (via the Beaver Island archipelago) and south.

Figure 4. Geographic Setting of Emmet County in the Northern Lower Peninsula of Michigan

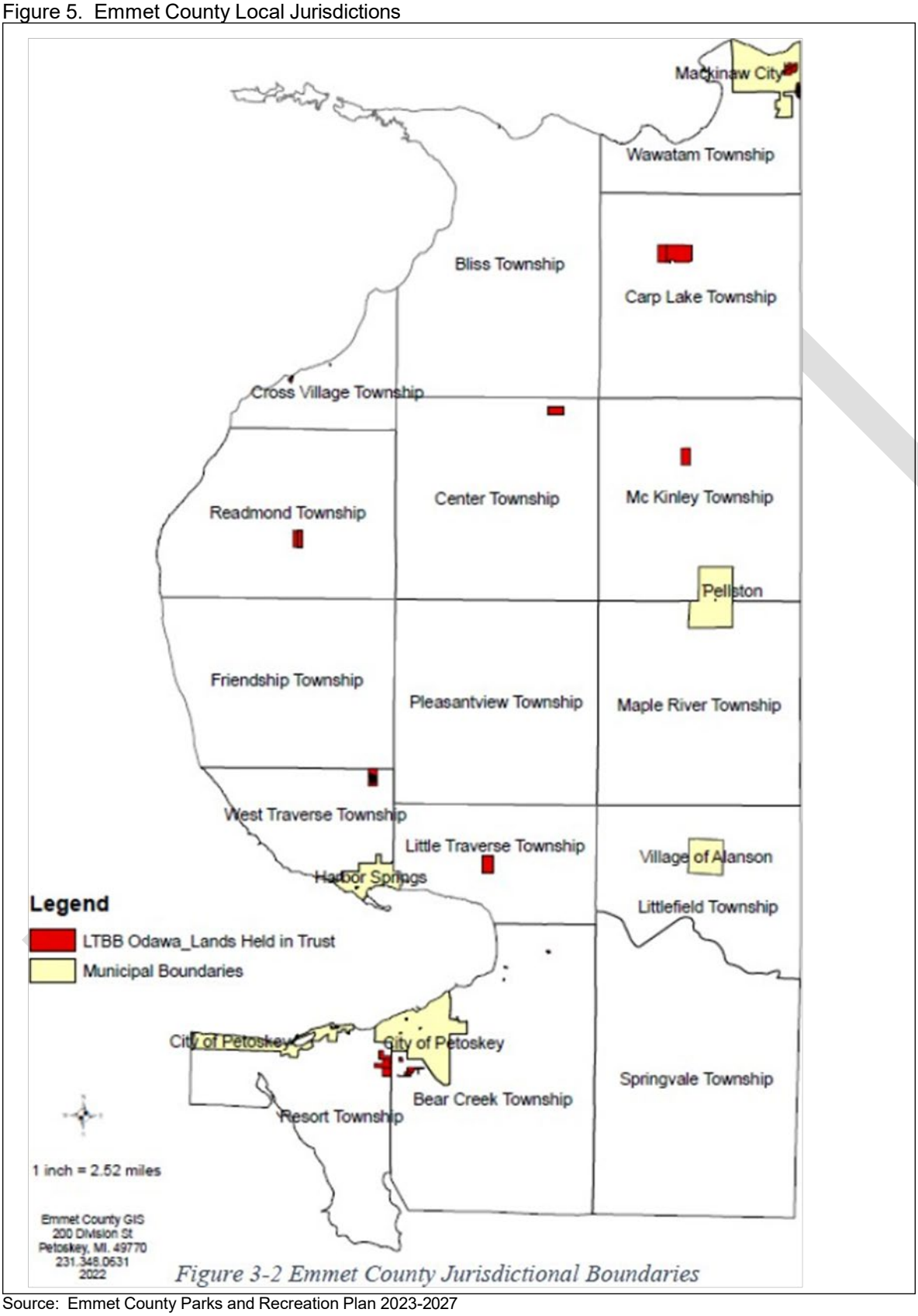


Source: US Census Bureau

Land Use/Land Cover

Emmet County contains 467.55 square miles of land, with a near equal amount of 414.45 square miles consisting of surface water. The county contains 16 townships, 2 cities, 3 villages, tribal trust land, and 68 miles of Lake Michigan shoreline (Figure 5). The Village of Mackinaw City is located in both Emmet County (west of Nicolet St.) and Cheboygan County (east of Nicolet St.). The Little Traverse Bay Bands of Odawa Indians (LTBB) have governmental properties and tribal trust lands in various locations of all jurisdictions in Emmet County, except for the Village of Alanson and Springvale, Littlefield, Maple River and Pleasantview townships.

Figure 5. Emmet County Local Jurisdictions



Source: Emmet County Parks and Recreation Plan 2023-2027

The communities of Wawatam, Bliss, Cross Village, Little Traverse and Bear Creek townships contain nearly 3,800 acres of State-designated "Critical Dune Areas" (CDAs) The State legislature identifies these coastal dunes as unique, irreplaceable, and fragile resources that provide significant recreational, economic, scientific, geological, scenic, botanical, educational, agricultural, and ecological benefits.

High-Risk Erosion Areas (HREAs) are shorelines of the Great Lakes where the land is receding at a rate of one foot or more per year for a minimum of 15 years. Recession rates change as water levels fluctuate and coastal conditions change. HREAs are located in the City of Petoskey and the townships of Bliss, Cross Village, Readmond, West Traverse, and Bear Creek

Emmet County's water features include Lake Michigan, 28 inland lakes, rivers and numerous stream systems. Major inland lakes include Round Lake, Crooked Lake, Pickerel Lake and Walloon Lake in the southern portion of the county, Lark's Lake, Wycamp Lake, Paradise Lake, French Farm Lake and O'Neal Lake in the central and northern portions of the county. Burt Lake and Douglas Lake are located in easterly adjoining Cheboygan County, but because their watersheds are located within Emmet County, both lakes have significant influences on both counties.

Many of the county's streams are quality fishing resources, while the Bear River, Crooked River and Maple River are the most significant canoe streams. The Michigan Resource Inventory System has identified 632 acres of streams, 9,605 acres of inland lakes and 75 acres of reservoir in Emmet County. This totals 10,312 acres, representing approximately 3.5 percent of the county's total area. Emmet County boasts 68 miles of Lake Michigan shoreline and countless miles of lake and stream shores. The Inland Water Route connects Lake Huron by a chain of lakes and rivers to its headwaters in Spring Lake in Bear Creek Township.

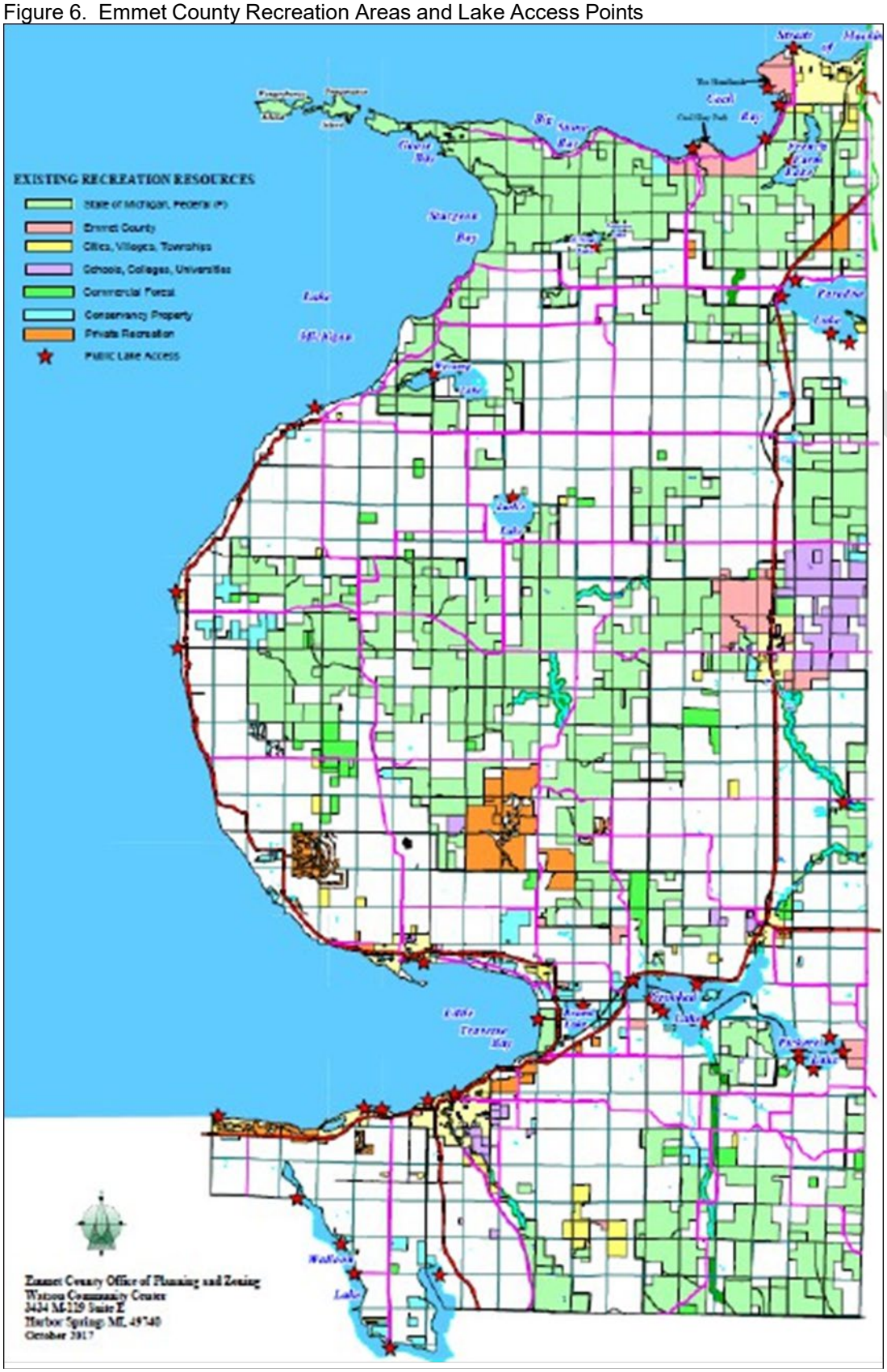
The county's plentiful natural resources provide aesthetic and recreational value; a clean water supply; an economic base for tourism, fishing, forestry and agriculture; and habitat biodiversity. Public recreation areas are present in every jurisdiction in the county (Figure 6). There are also several Federally-listed species that have a "threatened" or "endangered" status in Emmet County (Table 10). Many of these species are present near Lake Michigan.

Table 10: Federally-Listed Endangered and Threatened Species in Emmet County

Scientific Name	Common Name	Federal Status
Allium schoenoprasum var. sibiricum	Chives, Wild chives	Threatened
Amerorchis rotundifolia	Round-leaved orchis	Endangered
Beckmannia syzigachne	Slough grass	Threatened
Bombus affinis	Rusty-patched bumble bee	Endangered
Botrychium michiganense	Michigan moonwort	Threatened
Bromus pumpellianus	Pumpell's brome	Threatened
Brychius hungerfordi	Hungerford's crawling water beetle	Endangered
Calamagrostis stricta	Narrow-leaved reedgrass	Threatened
Callitriche heterophylla	Large water-starwort	Threatened
Calypso bulbosa	Calypso, fairy-slipper	Threatened
Castanea dentata	American chestnut	Endangered
Charadrius melodus	Piping plover	Endangered
Cirsium pitcheri	Dune thistle, Pitcher's thistle	Threatened
Filipendula rubra	Queen-of-the-prairie	Threatened
Helianthus mollis	Ashy sunflower, downy sunflower	Threatened
Iris lacustris	Dwarf lake iris	Threatened
Mimulus michiganensis	Michigan monkey-flower	Endangered
Platanthera macrophylla	Large round-leaved orchid	Threatened
Potamogeton hillii	Hill's pondweed	Threatened
Pterospora andromedea	Pine-drops, giant's bird's-nest	Threatened
Sistrurus catenatus	Eastern massasauga	Threatened
Solidago houghtonii	Houghton's goldenrod	Threatened
Tradescantia virginiana	Virginia spiderwort	Threatened
Woodsia obtusa	Cliff fern	Threatened

Sources: Michigan Natural Features Inventory (MNFI); Emmet Conservation District.

Figure 6. Emmet County Recreation Areas and Lake Access Points



Source: *Emmet County Parks and Recreation Plan 2023-2027*

The predominant land cover type in Emmet County is “forested” at 45.8%, or 141,365 acres. The second most prevalent land cover type is “wetlands” at 19.5% (60,302 acres), followed by “agriculture” at 12.1% (37,230 acres) (Table 11). Wetlands contribute significantly to water quality by acting as filters of storm water in addition to sustaining forest growth and providing habitat for wildlife. These areas generally are not suitable for development, but provide ecological and recreational value.

Emmet County’s 2021-2025 Master Plan indicates there are pockets of prime agricultural land and some small prime farm communities throughout the county. Seven farm communities have continued to be significant farming centers: Resort Township, Bear Creek Township, Good Hart (Readmond Township), Woodland Road in Maple River Township, Van Road in McKinley Township, Levering (Carp Lake Township/McKinley Township) and Bliss Township. These prime agricultural lands and farm communities are illustrated in Figure 7 as Emmet County Agricultural Preservation Districts and are areas intended to be preserved. The areas mentioned have been selected because they have productive soil types, they have been designated prime/unique farmland by the United States Department of Agriculture (USDA), they are large unbroken tracts of agricultural lands, or they already exist as farming communities, including Centennial Farms.

According to the 2022 USDA Census of Agriculture’s County Profile for Emmet County, there were 34,319 acres of farmland (376 total farms) in the county, with the average farm size being 93 acres. Compared to the 2017 Agricultural Census, this represents an 11% decrease in the acres of land in farm use; a 16% increase in the number of farms, and a 23% decline in the average size of a farm (in acres) in the county.

The market value of agricultural products sold in 2022 was $11,382,000. Crops (particularly nursery, greenhouse, floriculture, sod, hay, fruits, tree nuts and berries) represented 63% of those sales, while livestock, poultry and products (particularly cattle and calves) represented 37%. Emmet County ranks 65 out of 83 counties in the State of Michigan for the amount in sales of agricultural crops, and 59 out of 83 counties in the State for the amount in sales of livestock, poultry, and agricultural products sold.

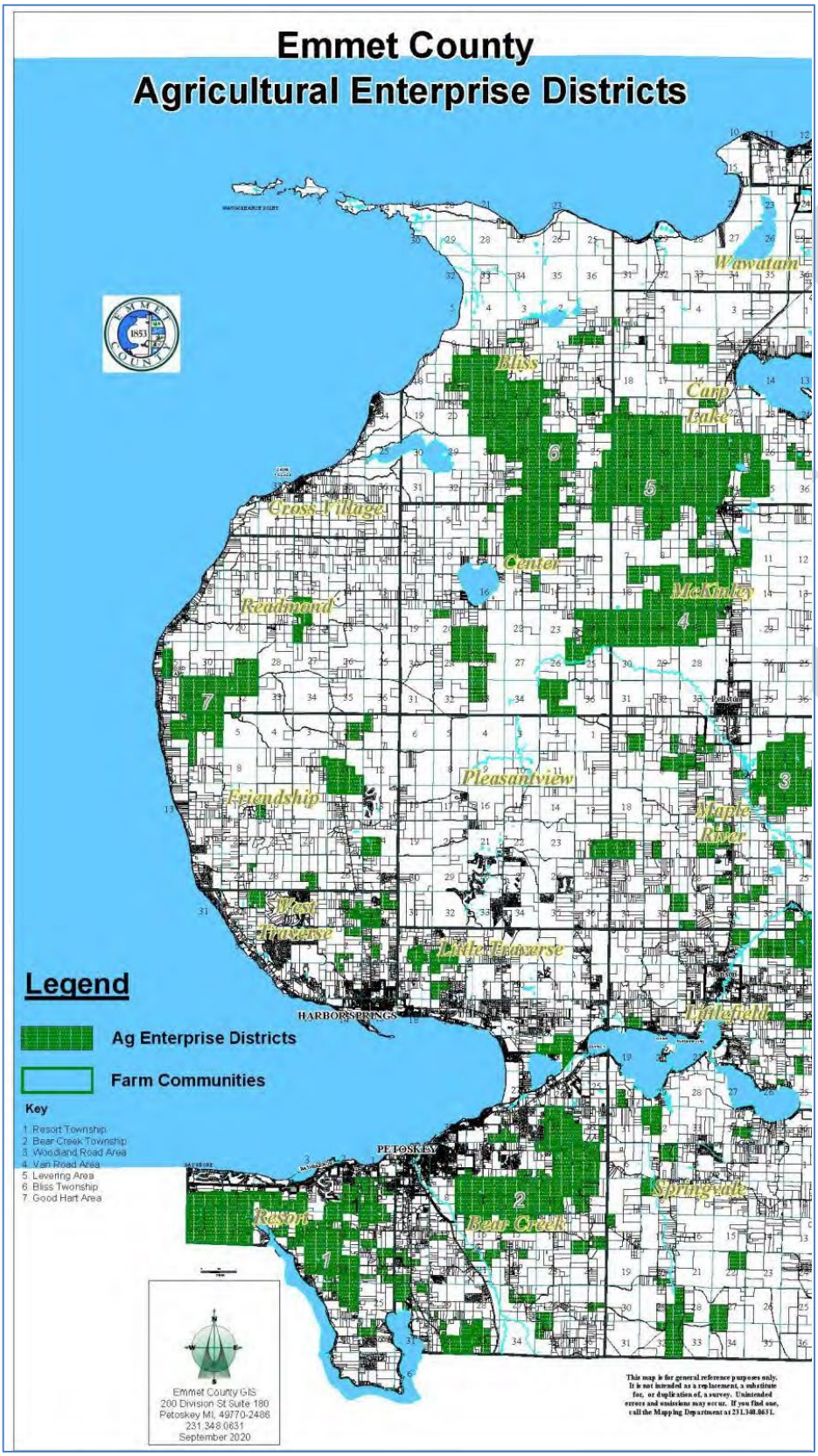
The top crops in acres:

- Forage (hay/haylage, all..... 7,277
- Corn for grain 722
- Cultivated Christmas trees 383
- Oats for grain 282
- Corn for silage/greenchop 275

The livestock inventory as of December 31, 2022:

- Layers 6,479
- Broilers and other meat-type chickens 2,563
- Cattle and calves..... 2,258
- Sheep and lambs 1,191
- Pullets 724
- Horses and ponies 195
- Goats 162
- Hogs and pigs 148
- Turkeys 47

Figure 7. Emmet County Agricultural Enterprise Districts



Source: *Emmet County 2021-2025 Master Plan*

Developed land cover is found predominantly in and around the cities of Petoskey and Harbor Springs; the Villages of Mackinaw City, Pellston and Alanson; and major roads such as M-119, M-68, US-31 and US-131.

Table 11: Land Cover by Type, Emmet County

Classification	Acres	Percent
Developed, High Intensity	521.6	0.2%
Developed, Low Intensity	7,420.9	2.4%
Developed, Medium Intensity	2,024.1	0.7%
Developed, Open Space	15,368.6	5.0%
Forested (Deciduous, Evergreen, Mixed)	141,365.1	45.8%
Wetlands	60,302.0	19.5%
Agriculture (cultivated crops; hay/pasture)	37,229.5	12.1%
Herbaceous	26,164.0	8.5%
Open Water	9,141.4	3.0%
Shrub/Scrub	6,082.1	2.0%
Barren Land	3,019.7	1.0%
Total	**547,535.6**	**100.0%**

Source: Networks Northwest

The 2016 Emmet County Hazard Mitigation Plan indicated that 208,100 acres, or 69.5% of the county's total land area contained forested lands; and 58,589 acres, or 19.6% contained wetlands. In comparison to current land use data, the amount of forested areas have decreased, while the acreage of wetlands have increased.

Housing of all types and prices is in demand, but many communities desire smaller housing units and multiple family units to meet the demand of a growing senior population and the needs of the local workforce. In the past decade, there has been a growing gap between housing demand and availability of units. In many instances, an older home is purchased, demolished, and the land is re-built upon with a new home, adding to the issue of maintaining an adequate housing supply.

The Environmental Features Map in Appendix A shows the intensity of development in the county as well as natural features.

Transportation
The information in this section was primarily sourced from the 2021-2025 Emmet County Master Plan.

Roads
There are 217 miles of highway, 244 miles of primary roads and 590 miles of local roads serving Emmet County. The Emmet County Road Commission is responsible for a total of 1,050 miles of roads, consisting of 217 miles of state trunk line, 244 miles of primary roads and 589 miles of local roads. The Emmet County Road Commission operates from two facilities. The administrative offices and main vehicle service garages are located in Little Traverse Township, while additional garages and storage facilities are located in Levering (Carp Lake Township). The maps in Appendix A illustrate the road network throughout the county.

Highways

- M-68 (Minor State Highway) enters the county at its easterly boundary in Littlefield Township, terminating 2.5 miles west in the Village of Alanson. This corridor links US-31 in Alanson with I-75 near Indian River.

- M-119 (Minor State Highway & Heritage Route) winds along the shoreline of Little Traverse Bay and is the primary link between the cities of Petoskey and Harbor Springs. It is a popular scenic drive between Harbor Springs and Cross Village. A conflict between the highway's natural wonders and the increased housing pressures in the area generated attention from concerned residents. In 1997, with much support, M-119 was granted Heritage Route status from MDOT. The Heritage Route Program (Scenic By-ways) is designed to identify, inventory, protect, enhance and in some cases, promote state trunk lines.

- US-31 (Major Highway) passes north-south through the entire length of the county. This highway links the Mackinac Bridge (and I-75) with the Pellston Regional Airport, Petoskey and Bay Harbor. Recent upgrades creating passing lanes between the Charlevoix/Emmet County line and the City of Petoskey have allowed for smoother flowing traffic before converging with US-131.

- US-131 (Major Highway) reaches a length of 268 miles in Michigan, from the Indiana state line northerly to Petoskey. The direct connection between Grand Rapids and Emmet County is significant. US-131 provides a major connection between Emmet County and neighboring towns to the south such as Boyne Falls, Mancelona, Kalkaska and Cadillac.

- US-31 and US-131 come together on the south side of Petoskey. This point of convergence acts as a focal point for individuals driving from the North, South and West. The intersection funnels a high volume of daily traffic entering and leaving the county and serves as the gateway to local businesses, tourist destinations and residential areas.

- I-75 (Major Interstate Highway) is the only interstate in Northern Michigan. It runs parallel to the east county line through Cheboygan County. Although only a short segment of I-75 physically enters Emmet County (at the "tip of the mitt" in the Village of Mackinaw City), its influence is substantial. I-75 is the major traffic link between the Upper Peninsula and the rest of Michigan.

County Major Connector Roads

- State Road (Primary County Road) begins on the north side of Harbor Springs and serves as a direct route to Cross Village. It also serves as an important alternate travel corridor to M-119 (Tunnel of Trees). Due to lack of sharp curves on State Road, traffic is able to move more efficiently with better visibility there than on M-119.

- Pleasantview Road (Primary County Road) runs north-south in the central region of Emmet County. It is particularly significant in serving skiers going to Boyne Highlands and Nubs Nob resorts. The traffic is fed primarily from US-31 and M-119.

- Mitchell Street (County Primary Road) is an east-west route across Emmet County, acting as a collector route for commuters between the City of Petoskey, Bear Creek Township and Springvale Township.

When it enters Cheboygan County, it is renamed Wolverine Road. The road then terminates in Wolverine (Cheboygan County), where drivers can then access I-75.

- River Road (County Primary Road) River Road runs north/south parallel to US-131 and stretches from the City of Petoskey south into Charlevoix County. Slicing through the heart of Bear Creek Township, it gathers considerable traffic from residents of Bear Creek Township, Clarion and Springbrook Hills. The latter communities are both located in Charlevoix County. River Road is a popular alternative route to US- 131 for many residents because it allows individuals to drive to and from Petoskey with relative ease and less traffic.

- Resort Pike (County Primary Road) Although short in comparison to the rest of the major connectors, Resort Pike plays a vital role in moving traffic through Resort Township. It links to US-31 outside the city limits of Petoskey. This road connects residents from the west and southwest of Petoskey with the Walloon Lake area.

- Levering Road (Secondary County Road) gathers many residents from Bliss and Cross Village Townships. It acts as the primary east/west road in northern Emmet County, running from US-31 (and the community of Levering) to Cross Village. Traveling east from US-31, Levering Road traverses the Cheboygan County line and provides access to I-75. Levering Road is a direct route into downtown Cheboygan.

- Robinson Road (Secondary County Road) is an east-west rural collector road and begins at an intersection with US-31 in the Village of Pellston. The east part of Robinson Road is also a major connector route to I-75 and the City of Cheboygan. When Robinson Road enters Cheboygan County, it is renamed Riggsville Road. The west half of Robinson Road goes from US-31 to M-119 near the lakeshore at Good Hart, collecting traffic as it crosses both Pleasantview and State Roads.

Bridges

- The Mackinac Bridge opened in 1957 across the Straits of Mackinac. The overall length of the bridge is approximately five miles from shore to shore and it is the third largest suspension bridge in the United States. The “Mighty Mac,” as it is referred to, acts as a gateway to and from Michigan’s Upper Peninsula and is part of the I-75 corridor. This modern marvel provides historic perspective and scenic allure to northern Emmet County while it serves as an important link in the transportation network.

- The West Mitchell Street Bridge located in the City of Petoskey was built in 1930 and was added to the National Register of Historic Places on October, 10, 1986. The 330 ft. long bridge is the fourth largest concrete girder bridge in the State of Michigan. The West Mitchell Street Bridge is a part of US-31 and allows for passage over the Bear River. The bridge also serves as a funnel, channeling traffic to and from downtown Petoskey.

- The M-68 Bridge crosses the Crooked River at the north edge of the Village of Alanson. Built in 1937, the bridge enables traffic and commerce to flow east and west along M-68 connecting the Village of Alanson to Indian River and I-75. The M-68 Bridge received an upgrade in 2013. The bridge allows convenient access to Emmet County for commuters from neighboring counties.

Rail

Currently there are seven miles of active rail remaining in Emmet County, on what is known as the Tuscola and Saginaw Bay Railway. This section is classified as a type-two railway, with speed limits not to exceed 25 mph. Emmet County's section of rail begins at the south county line near Bear River Road and follows River Road, running north through Bear Creek Township into the City of Petoskey. Although there is only a short distance of track remaining in Emmet County, it plays a vital role for at least one area business. Petoskey Plastics Inc. utilizes the rail service as a cost-effective way to move mass quantities of materials and products.

Air

Located in northern Emmet County within McKinley Township, Pellston Regional Airport connects northern Michigan to the rest of the world. In operation since 1936, Pellston Regional Airport, owned by Emmet County, offers quick and efficient commercial passenger, private plane and cargo services. It provides commercial flights daily to and from Detroit, Michigan. Both Federal Express and UPS serve the county via the airport. Flight services include the sale of jet fuel and AV Gas, minor repairs by appointment, WSI pilot weather briefing system, Instrument Landing System (ILS) and GPS approaches and a VOR navigation system.

The Harbor Springs Municipal Airport is owned by the City of Harbor Springs and is located along M-119 in Little Traverse Township. It is operated by the Harbor-Petoskey Area Airport Authority, with Board of Directors appointees from the cities of Harbor Springs and Petoskey, and Bear Creek, Little Traverse, Pleasantview and West Traverse townships. The airport allows private pilots an easy commute to Emmet County, and serves as a location for emergency patient transport and organ delivery. McLaren Northern Michigan Hospital in Petoskey relies on the airport because strong winds off Little Traverse Bay don't allow the hospital to safely operate a helipad. Harbor Springs Municipal Airport is open year-round and has staff on call 24 hours a day. Services provided include flight planning, tie-downs, hangers, supplies, JET A and 100LL fuel and a courtesy car.

Marine

There are nine marinas in the county. The 3 municipal marinas are located in Petoskey (Little Traverse Bay), Harbor Springs (Little Traverse Bay) and Littlefield Township (Admirals Point/Hay Lake Marina – Inland Waterway access). The others are privately owned and are located in Bay Harbor (Little Traverse Bay), Ponshewaing and Oden (Crooked Lake), Carp Lake Township (Paradise Lake), Alanson (Crooked River) and Harbor Springs (two private marinas on Little Traverse Bay).

The Little Traverse Bay Ferry Company began operation in Little Traverse Bay in 2020. It offers ferry service and cruises between Petoskey (from Bayfront Park/Petoskey Municipal Marina), Harbor Springs (Josephine Ford Park) and Bay Harbor (Bay Harbor Lake).

Public Transportation

Emmet County's rural character and scattered development patterns leave most residents dependent on the use of private vehicles. Emmet County citizens have access to Straits Regional Ride, an on-demand-response (dial- a-ride) bus service available weekdays.

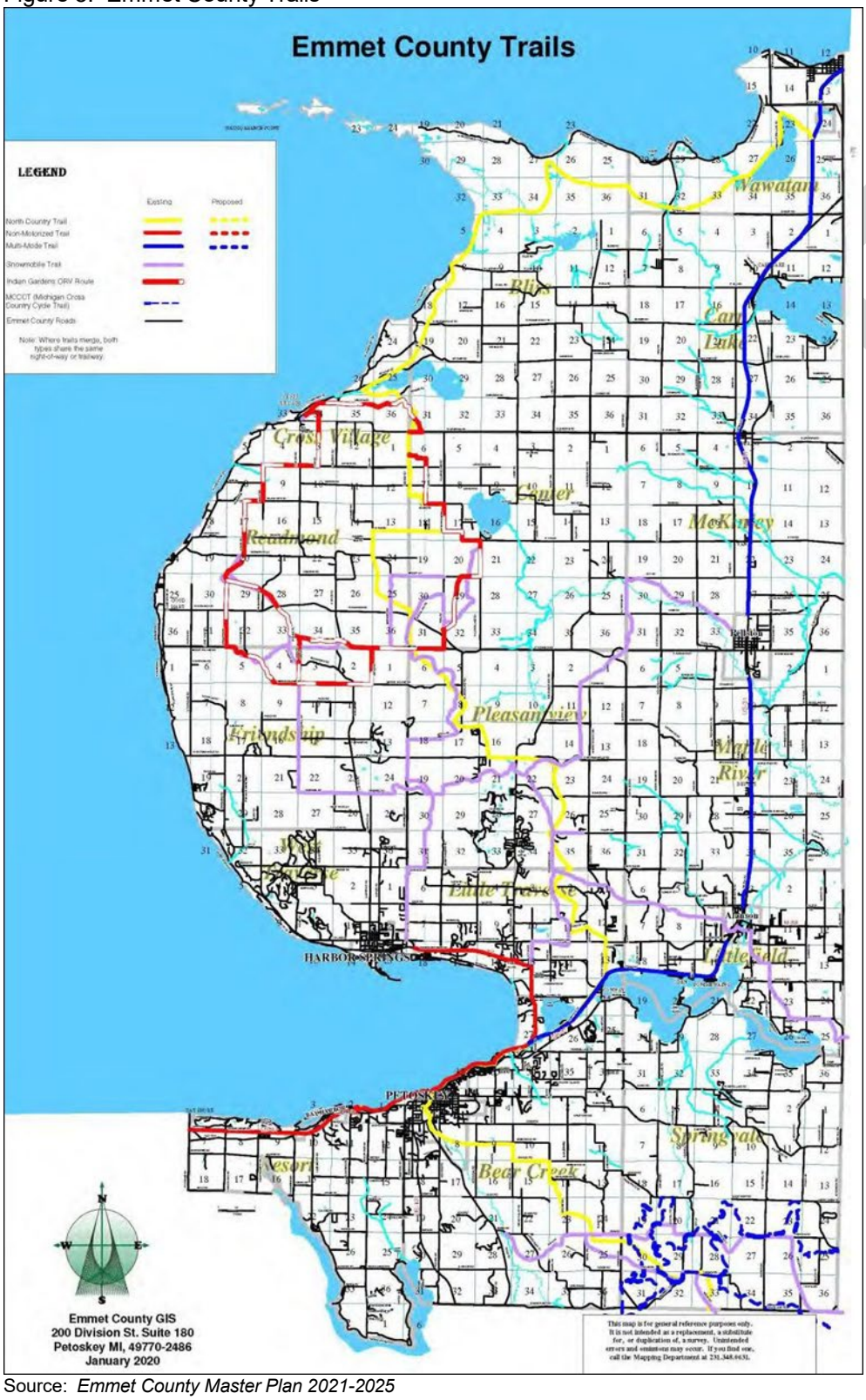
Friendship Centers of Emmet County provides weekday, on-demand bus service to help meet the mobility needs of Emmet County senior citizens (age 60+) and those with disabilities for a variety of purposes including doctor appointments, employment, grocery shopping, volunteering, socialization, and personal care requirements.

The Little Traverse Bay Bands of Odawa Indians provides transportation service via their Odawa Casino Resort Shuttle for Petoskey area hotel guests to their hotel/resort, and residential pickups for Tribal Elders and VIPs.

Trails

There are also many miles of recreational trails for motorized and non-motorized use throughout the county (Figure 8). While these trails are a main asset and draw to the county for outdoor recreation enthusiasts, many of these trails are located in remote areas and are located on public land and quasi-public land with limited cell phone reception. Also, some of the more remote trails may not be maintained well, or are not well-signed. Rescue/response efforts can be delayed or difficult for trail users who get lost or need medical assistance.

Figure 8. Emmet County Trails



Source: *Emmet County Master Plan 2021-2025*

Climate
Northwest Lower Michigan has a four season climate with mild summers and cold, snowy winters. The presence of Lake Michigan generally keeps coastal areas warmer in the winter and cooler in the summer compared to inland areas. Table 12 provides historical climate information for the NOAA weather stations in Emmet County.

Table 12. NOAA Online Weather Data for Emmet County, 2000-2023

NOAA Weather Station	Petoskey – North Central Michigan College	Pellston Airport
Monthly Average Precipitation – Annual Mean	38.01”	29.19”
Monthly Total Precipitation – Greatest Mean	5.05” in October	4.51” in October
Monthly Average Temperature – Annual Mean	43.4 degrees	43 degrees
Monthly Lowest Min. Temperature Range (Deg. F.)	-3 degrees in Feb. 2023 to -27 degrees in Feb. 2014	-8 degrees in Feb. 2023 to -35 degrees in Feb. 2015 & Jan. 2018
Monthly Highest Max. Temperature Range (Deg. F.)	87 degrees in September 2007 to 96 degrees in July 2018	88 degrees in June 2004 to 97 degrees in July 2018
Coldest Month	February	
Warmest Month	July	
Total Annual Snowfall - Mean	117.4"	No data available
Total Annual Snowfall - Maximum	184.8” in 2013-14 season	No data available
Total Annual Snowfall - Minimum	73" in 2020-21 season	No data available

Source: National Weather Service’s Climate Information, NOAA Online Weather (NOW) data https://www.weather.gov/wrh/Climate?wfo=apx
Note: Some NOAA Weather Stations are missing monthly data records

Depending on the time of the year, Lake Michigan has a significant impact on temperatures, precipitation, and the strength of storms. Quick, sudden changes in the weather are possible in coastal communities. In the spring when the water is colder than the air, the lake extracts heat from the atmosphere. During the fall, the lake gives off heat and moisture. In both cases, storms arrive on land stronger and more persistent than they might otherwise be.

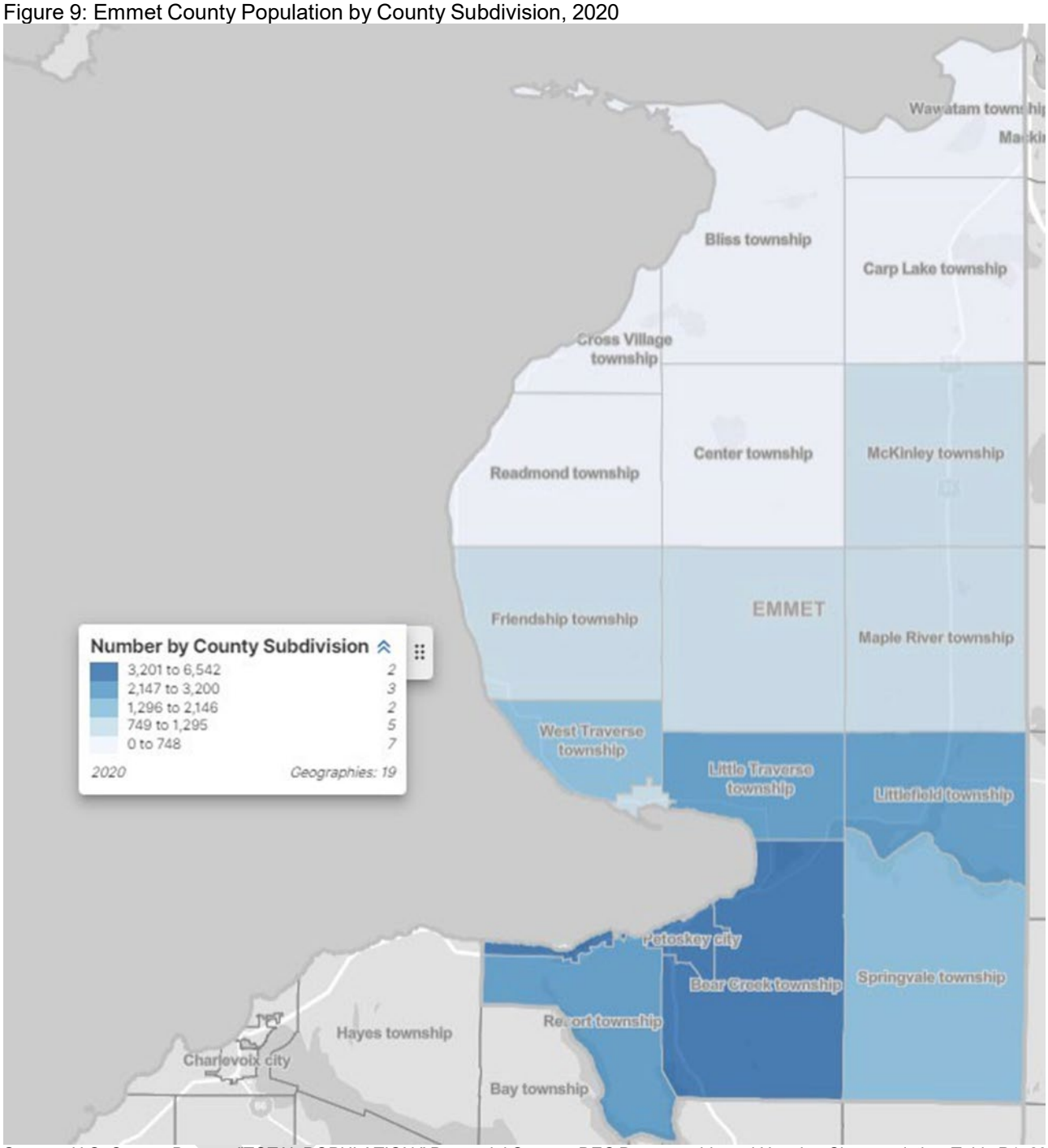
Population
Emmet County is the third most populated county in the ten county region of Northwest Lower Michigan (Table 13), with a 2020 census population count of 33,673 persons.

Table 13: Population by County, State, 2020

Jurisdiction	Population
Missaukee County	15,052
Kalkaska County	17,939
Benzie County	17,970
Leelanau County	22,301
Antrim County	23,431
Manistee County	25,032
Charlevoix County	26,054
Emmet County	**33,673**
Wexford County	34,112
Grand Traverse County	95,238
State of Michigan	10,077,331

Source: US Census Bureau, 2020 Decennial Census, File DP1

Figure 9: Emmet County Population by County Subdivision, 2020



Source: U.S. Census Bureau. "TOTAL POPULATION." Decennial Census, DEC Demographic and Housing Characteristics, Table P1, 2020

Emmet County contains 16 townships, two cities and three villages. In addition, there are indigenous tribal lands within the county under the ownership of the Little Traverse Bay Bands of Odawa Indians (LTBB). The most populated areas include Bear Creek Township at 6,500 residents, the City of Petoskey at 5,877 residents, and Littlefield Township at 3,200 residents.

A comparison of the 2010 and 2020 decennial census data indicates there was a 4.3% increase in Emmet County's total population, with an addition of 1,418 persons (Table 14). The communities with the greatest

number of new residents include Bear Creek Township (341 persons), Little Traverse Township (277 persons), Littlefield Township (222 persons), City of Petoskey (207 persons), West Traverse Township (162 persons), and Resort Township (138 persons).

Maple River Township lost the most residents (53), followed by Bliss Township (52), the Village of Pellston (48), Center Township (43) and Cross Village Township (41), Readmond Township (21) and Carp Lake Township (11). Cross Village Township had the greatest percentage of population loss, while the Little Traverse Township had the greatest percentage of population gain.

Table 14: Population by Municipality and County, 2010 and 2020

Label	2010 Total Population	2020 Total Population	Numeric Change	Percent Change
Emmet County	32,694	34,112	1,418	4.3%
Bear Creek Township	6,201	6,542	341	5.5%
Petoskey City	5,670	5,877	207	3.7%
Littlefield Township	2,978	3,200	222	7.5%
Resort Township	2,697	2,835	138	5.1%
Little Traverse Township	2,380	2,657	277	11.6%
Springvale Township	2,141	2,146	5	0.2%
West Traverse Township	1,606	1,768	162	10.1%
Maple River Township	1,348	1,295	-53	-3.9%
McKinley Township	1,297	1,294	-3	-0.2%
Harbor Springs City	1,194	1,274	80	6.7%
Friendship Township	889	954	65	7.3%
Pleasantview Township	823	918	95	11.5%
Pellston Village*	822	774	-48	-5.8%
Mackinaw City Village**	806	846	40	5.0%
Carp Lake Township	759	748	-11	-1.4%
Alanson Village***	738	778	40	5.4%
Wawatam Township	661	711	50	7.6%
Bliss Township	620	568	-52	-8.4%
Readmond Township	581	560	-21	-3.6%
Center Township	568	525	-43	-7.6%
Cross Village Township	281	240	-41	-14.6%

Sources:
U.S. Census Bureau. "TOTAL POPULATION." Decennial Census, DEC Summary File 1, Table P1, 2010; U.S. Census Bureau. "PROFILE OF GENERAL POPULATION AND HOUSING CHARACTERISTICS." Decennial Census, DEC Demographic Profile, Table DP1, 2020.
Notes:
*The population counts for the Village of Pellston are included in the population counts for McKinley and Maple River Townships
** The population counts for the area Village of Mackinaw City within Emmet County are included in the population counts for Wawatam Township
*** The population counts for the Village of Alanson are included in the population counts for Littlefield Township

Like many northwest Michigan communities, Emmet County experiences an influx of seasonal residents and tourists during the summer months. However, the decennial Census and the American Community Survey only consistently and comprehensively track the permanent population. The 2022 *Seasonal Population Study for Northwest Lower Michigan* analyzed the 2020 seasonal population for these ten counties: Antrim, Benzie, Charlevoix, Emmet, Grand Traverse, Kalkaska, Leelanau, Manistee, Missaukee, and Wexford. The study collected data for permanent and part-time residents and overnight visitors in accommodations and short-term rentals by County. Northwest Lower Michigan's permanent base population is 310,802 and expands to its largest seasonal population of 676,052 in July, a 118% increase.

In July, Emmet County's combined population (full-time residents, part-time residents and overnight visitors) increases by as much as 162.7% (89,627 persons) from the base full-time population of 34,112 persons (Table 15). February is the month with the lowest number of seasonal residents and visitors. On average, the county's population grows by 84.2%, or 62,830 people, throughout the year.

Table 15: Emmet County Seasonal Population by Month

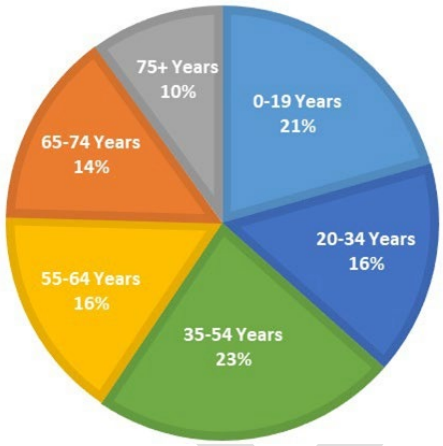
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Avg.
Permanent (Full-Time) Population	34,112	34,112	34,112	34,112	34,112	34,112	34,112	34,112	34,112	34,112	34,112	34,112	34,112
Seasonal (Part-Time and Overnight) Population	10,074	9,554	10,318	10,004	40,899	53,640	55,515	55,402	38,577	38,592	10,523	11,513	28,718
Total Population	44,186	43,666	44,430	44,116	75,011	87,752	89,627	89,514	72,689	72,704	44,635	45,625	62,830
% Increase from Permanent Population	29.5%	28.0%	30.2%	29.3%	119.9%	157.2%	162.7%	162.4%	113.1%	113.1%	30.8%	33.8%	84.2%

Source: 2022 Seasonal Population Study for Northwest Lower Michigan, Networks Northwest

Age, Race, and Disability

Understanding the age distribution and median age of Emmet County residents can help identify social, economic, and public service needs in the community. The county's total estimated 2020 population is broken into age cohorts (analyzing which proportions of a municipality's population are in which stages of life). This gives a nuanced view of the makeup of a community. The adult workforce population in the county (those aged between 20 and 64 years) represents 55% of the population. Family-forming households (those aged between 20 and 54 years) represent 39% of the population. Older adults (aged 65+) represent nearly a quarter of the population, and youth (ages 0-19 years) represent 21% of the population.

Figure 10: Population by Age Cohort, Emmet County, 2020



Source: U.S. Census Bureau. "PROFILE OF GENERAL POPULATION AND HOUSING CHARACTERISTICS." Decennial Census, DEC Demographic Profile, Table DP1, 2020

As shown in Figure 11, the County, like the State, is aging, but at a faster rate. In 2020 the median age (the midpoint where half the population is younger and half the population is older) of Emmet County was 45.7 years, compared to 39.8 years for the State. The youngest community in Emmet County is Littlefield Township with a median age of 36.3 years; the oldest community is the City of Harbor Springs with a median age of 62.4 years (Figure 12).

Figure 11: Median Age Trends, 2000, 2010, and 2020

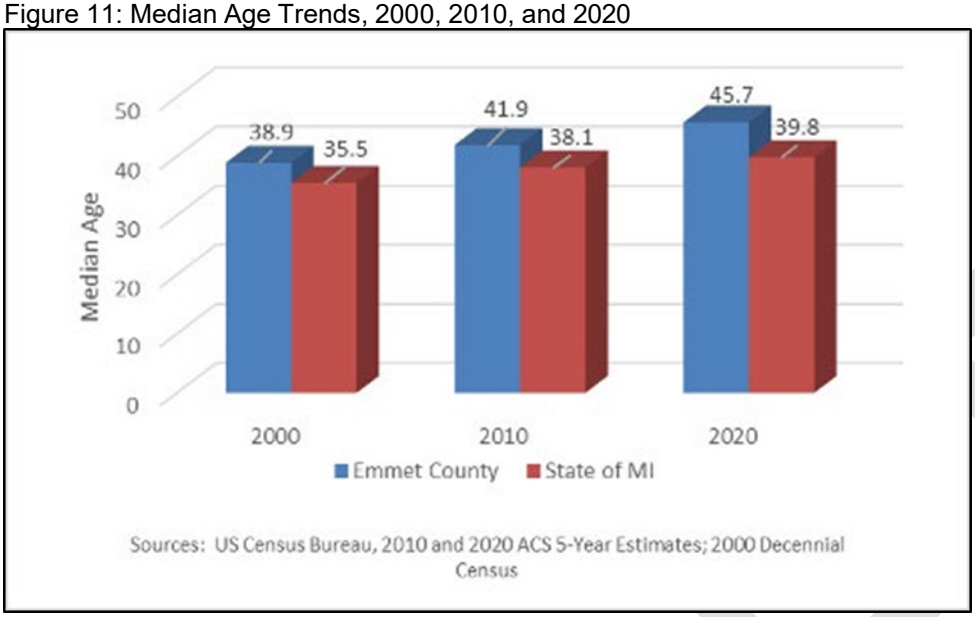
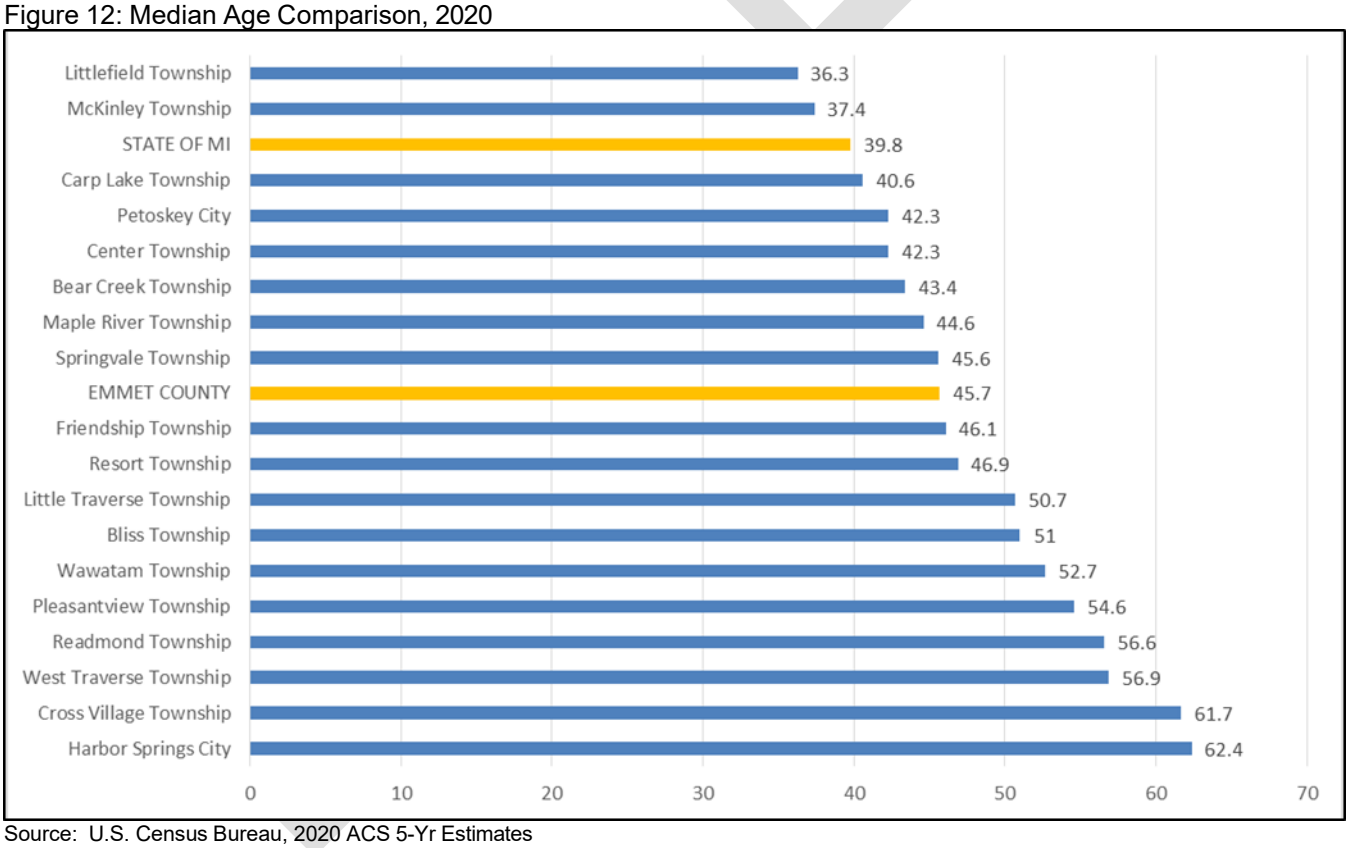


Figure 12: Median Age Comparison, 2020



Source: U.S. Census Bureau, 2020 ACS 5-Yr Estimates

Persons over the age of 65 can be more vulnerable to the effects of natural hazard events, such as power outages, extreme temperatures, and illness outbreaks. An estimated 25.5% of county residents aged 65 years or older have one or more type of disability (Table 17). Table 16 indicates that the greatest numbers of this age cohort are located in Bear Creek Township, City of Petoskey, West Traverse Township, Resort Township, Little Traverse Township, Littlefield Township and the City of Harbor Springs. The communities that have the greatest percentage of their population who are aged 65 and older are the City of Harbor Springs (44%), West Traverse Township (43.9%), Cross Village Township (40.8%) and Wawatam Township (33.9%) (Figure 13).

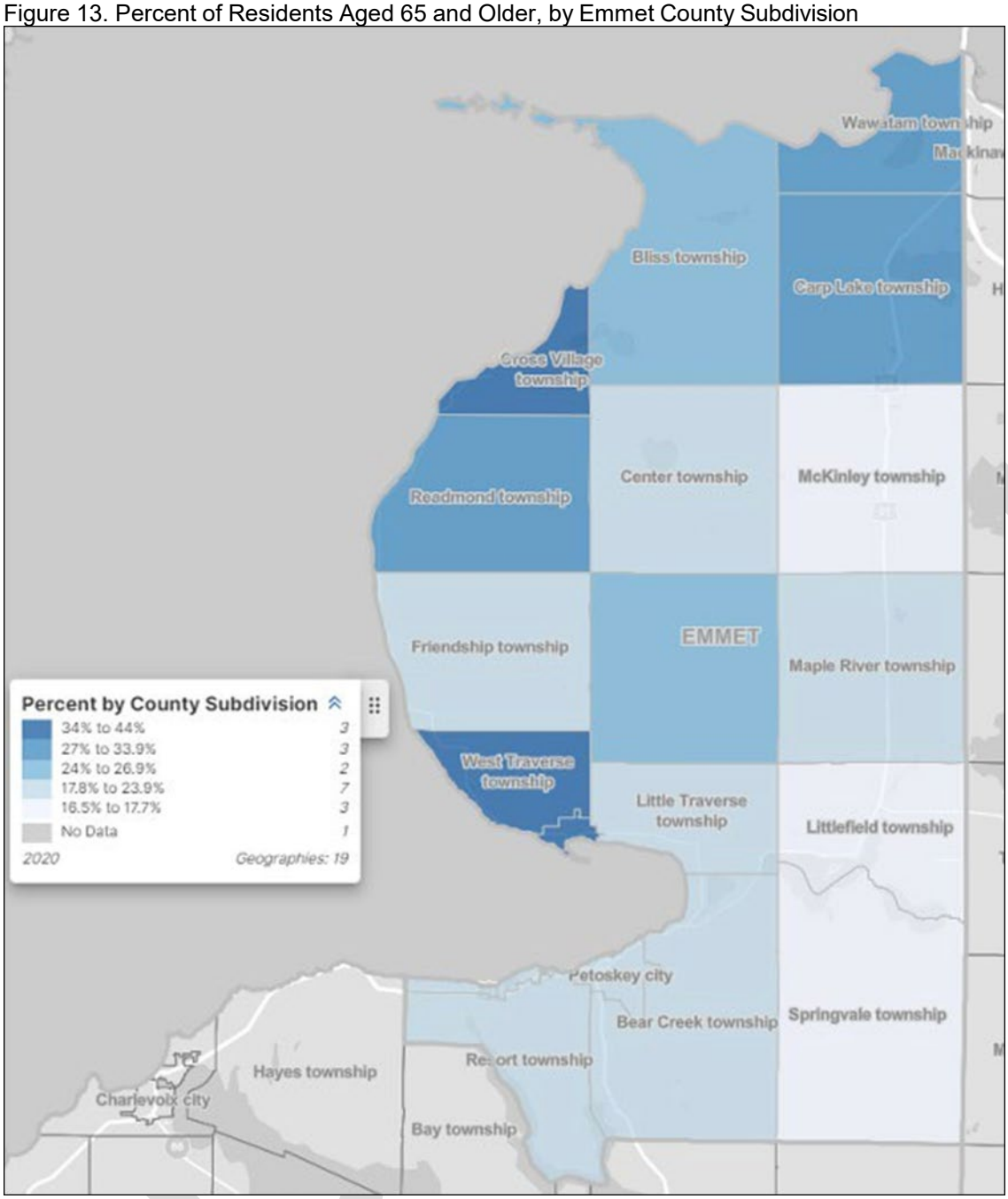
Table 16. Population Over Age 65 by Community

Community	Age 65 years and over	% of Community Population
Emmet County	8,377	24.6%
Bear Creek Township	1,458	22.3%
Petoskey City	1,381	23.5%
West Traverse Township	776	43.9%
Resort Township	678	23.9%
Little Traverse Township	597	22.5%
Littlefield Township	567	17.7%
Harbor Springs City	560	44.0%
Springvale Township	377	17.6%
Mackinaw City Village*	298	35.2%
Maple River Township	266	20.5%
Pleasantview Township	247	26.9%
Carp Lake Township	245	32.8%
Wawatam Township	241	33.9%
Friendship Township	220	23.1%
McKinley Township	213	16.5%
Readmond Township	183	32.7%
Bliss Township	147	25.9%
Center Township	123	23.4%
Cross Village Township	98	40.8%
Pellston Village*	95	12.3%
Alanson Village*	90	11.6%

Source: U.S. Census Bureau. "PROFILE OF GENERAL POPULATION AND HOUSING CHARACTERISTICS." Decennial Census, DEC Demographic Profile, Table DP1, 2020

*Note: Village counts are incorporated into counts of their surrounding townships.

Figure 13. Percent of Residents Aged 65 and Older, by Emmet County Subdivision



Source: Source: U.S. Census Bureau. "PROFILE OF GENERAL POPULATION AND HOUSING CHARACTERISTICS." Decennial Census, DEC Demographic Profile, Table DP1, 2020

As indicated in Table 17, an estimated 12.8% of Emmet County residents have one or more type of disability. An estimated 25.5% of persons aged 65 years or older have one or more type of disability. Bear Creek Township is the community with the greatest number of persons with a disability (839), and Center Township has the least (30) (Table 18).

Table 17: Estimated Persons with a Disability in Emmet County

Total Civilian Noninstitutionalized Population	Estimated Persons
With one or more disability	4,307 (12.8% of 2022 estimated county population – 33,705 persons)
Age 0-17 with a disability	312 (5.0% of that age group)
18 to 64 years with a disability	2,026 (10.3% of that age group)
65 years and over with a disability	1,969 (25.5% of that age group)

Source: U.S. Census Bureau. "Disability Characteristics." American Community Survey, 5-Year Estimates Subject Tables, Table S1810, 2022

Table 18. Estimated Persons with a Disability in Emmet County Jurisdictions

Jurisdiction	Est. total civilian noninstitutionalized population	Est. # with a disability	Est. % with a disability
Emmet County	33,705	4,307	12.8%
Bear Creek Township	6,522	839	12.9%
Petoskey City	5,698	742	13.0%
Littlefield Township	3,153	444	14.1%
Little Traverse Township	2,647	342	12.9%
Resort Township	2,829	312	11.0%
West Traverse Township	1,796	222	12.4%
Springvale Township	2,336	214	9.2%
McKinley Township	1,278	206	16.1%
Carp Lake Township	739	187	25.3%
Harbor Springs City	984	154	15.7%
Maple River Township	1,396	141	10.1%
Bliss Township	644	109	16.9%
Wawatam Township	513	92	17.9%
Friendship Township	881	87	9.9%
Pleasantview Township	1,017	85	8.4%
Readmond Township	570	63	11.1%
Cross Village Township	217	38	17.5%
Center Township	485	30	6.2%

Source: U.S. Census Bureau. "Disability Characteristics." American Community Survey, ACS 5-Year Estimates Subject Tables, Table S1810, 2022

The racial composition estimates of each jurisdiction in the County, as well as those identifying as being of Hispanic and Latino Origin, are shown in Table 19. The racial makeup of Emmet County is predominantly white (90.7%). 2% of the population identifies as Hispanic or Latino (and may identify as any race or a combination of races). 4.9% of the population is of two or more races; 2.5% of the population is American Indian and Alaska Native; 0.8% is of some other race; 0.8% is Black or African American; 0.3% is Asian; and 0% is Native Hawaiian or Other Pacific Islander.

Persons of a minority race/ethnic origin are considered socially vulnerable populations in a hazard event scenario. Yellow highlighted entries in Table 19 indicate the largest estimates of persons of non-white race or those of Hispanic or Latino origin by geography. There may be an increased need for public assistance in these communities as these population groups may have limited social and financial resources to withstand or recover from a hazard event.

- Black or African American race alone: Little Traverse Township (102 persons); City of Petoskey (59 persons)
- American Indian/Alaskan Native alone: Littlefield Township (329 persons); City of Petoskey (62 persons); Bear Creek Township (57 persons); McKinley Township (52 persons)
- Of Some Other Race Alone: Pleasantview Township (84 persons); Maple River Township (65 persons)
- Of Two or More Races: City of Petoskey (367 persons); McKinley Township (273 persons); Bear Creek Township (168 persons); Little Traverse Township (148 persons); Littlefield Township (116 persons); City of Harbor Springs (109 persons); Bliss Township (67 persons); Springvale Township (60 persons); West Traverse Township (55 persons)
- Of Hispanic or Latino Origin (these survey respondents can identify as any type of race): City of Petoskey (194 persons); Littlefield Township (113 persons); Bear Creek Township (93 persons); Little Traverse Township (86 persons).

Table 19: Race and Hispanic/Latino Origin Population Estimates, Emmet County Communities

	Total Estimated Population	White alone	Black or African American alone	American Indian and Alaska Native alone	Asian alone	Native Hawaiian and Other Pacific Islander alone	Some Other Race alone	Two or More Races	Hispanic or Latino (of any race)
Emmet County	34,072	30,889	285	850	100	17	259	1,672	688
	100.0%	90.7%	0.8%	2.5%	0.3%	0.0%	0.8%	4.9%	2.0%
Bear Creek Township	6,543	6,241	44	57	7	0	26	168	93
	100.0%	95.4%	0.7%	0.9%	0.1%	0.0%	0.4%	2.6%	1.4%
Bliss Township	644	540	0	26	10	0	1	67	2
	100.0%	83.9%	0.0%	4.0%	1.6%	0.0%	0.2%	10.4%	0.3%
Carp Lake Township	739	657	7	25	0	0	1	49	5
	100.0%	88.9%	0.9%	3.4%	0.0%	0.0%	0.1%	6.6%	0.7%
Center Township	485	407	0	31	0	0	0	47	2
	100.0%	83.9%	0.0%	6.4%	0.0%	0.0%	0.0%	9.7%	0.4%
Cross Village Township	217	181	0	18	0	0	0	18	0
	100.0%	83.4%	0.0%	8.3%	0.0%	0.0%	0.0%	8.3%	0.0%
Friendship Township	881	819	0	25	12	7	1	17	16
	100.0%	93.0%	0.0%	2.8%	1.4%	0.8%	0.1%	1.9%	1.8%
Harbor Springs City	1,091	939	0	17	5	0	21	109	35
	100.0%	86.1%	0.0%	1.6%	0.5%	0.0%	1.9%	10.0%	3.2%
Littlefield Township	3,192	2,712	11	329	9	10	5	116	113
	100.0%	85.0%	0.3%	10.3%	0.3%	0.3%	0.2%	3.6%	3.5%
Little Traverse Township	2,647	2,330	102	48	0	0	19	148	86
	100.0%	88.0%	3.9%	1.8%	0.0%	0.0%	0.7%	5.6%	3.2%
McKinley Township	1,317	977	7	52	5	0	3	273	7
	100.0%	74.2%	0.5%	3.9%	0.4%	0.0%	0.2%	20.7%	0.5%
Maple River Township	1,396	1,244	1	43	0	0	65	43	4
	100.0%	89.1%	0.1%	3.1%	0.0%	0.0%	4.7%	3.1%	0.3%
Petoskey City	5,859	5,335	59	62	36	0	0	367	194
	100.0%	91.1%	1.0%	1.1%	0.6%	0.0%	0.0%	6.3%	3.3%
Pleasantview Township	1,017	912	1	2	7	0	84	11	17
	100.0%	89.7%	0.1%	0.2%	0.7%	0.0%	8.3%	1.1%	1.7%

Readmond Township	570	517	0	14	0	0	2	37	32
	100.0%	90.7%	0.0%	2.5%	0.0%	0.0%	0.4%	6.5%	5.6%
Resort Township	2,829	2,722	8	38	9	0	4	48	6
	100.0%	96.2%	0.3%	1.3%	0.3%	0.0%	0.1%	1.7%	0.2%
Springvale Township	2,336	2,240	0	18	0	0	18	60	44
	100.0%	95.9%	0.0%	0.8%	0.0%	0.0%	0.8%	2.6%	1.9%
Wawatam Township	513	407	45	22	0	0	0	39	13
	100.0%	79.3%	8.8%	4.3%	0.0%	0.0%	0.0%	7.6%	2.5%
West Traverse Township	1,796	1,709	0	23	0	0	9	55	19
	100.0%	95.2%	0.0%	1.3%	0.0%	0.0%	0.5%	3.1%	1.1%

Sources: U.S. Census Bureau. "Race." American Community Survey, ACS 5-Year Estimates Detailed Tables, Table B02001, 2022. U.S. Census Bureau. "Hispanic or Latino Origin." American Community Survey, ACS 5-Year Estimates Detailed Tables, Table B03003, 2022

Housing

The average household size for Emmet County residents is 2.32 persons, which is slightly lower than the State's average of 2.45 persons.[2] Locally and at a state-wide level, the average household size has continued to get smaller over the decades of census reporting.

The county had 21,771 housing units in 2020 (Table 20). Of those, there were an estimated 14,862 households, or "occupied housing units". The Census defines a household as all the people who occupy a single housing unit, regardless of their relationship to one another.

Between 2010 and 2020, the county experienced a slight increase in the number of housing units (2.2%, or 467 units). Bear Creek Township has the largest percentage of housing units of all municipalities in the county (17.8%), followed by the City of Petoskey, Little Traverse Township, Littlefield Township, Resort Township and West Traverse Township. The community that experienced the greatest percentage of growth in housing units between 2010 and 2020 was the City of Petoskey at a 5.2% gain (174 units), followed by Bear Creek Township at a 4.8% gain (177 units). Some communities that experienced a loss in housing units also experienced population loss between 2010 and 2020, as described in Table 14. These include Carp Lake Township, Maple River Township, Readmond Township, Cross Village Township and the Village of Pellston.

Table 20: Housing Units by Municipality

Jurisdiction	2010 Total Housing Units	2020 Total Housing Units	% Change	% of 2020 Total Housing Units
Emmet County	21,304	21,771	2.2%	
Bear Creek Township	3,695	3,872	4.8%	17.8%
Petoskey City	3,359	3,533	5.2%	16.2%
Littlefield Township	1,774	1,747	-1.5%	8.0%
Little Traverse Township	1,754	1,818	3.6%	8.4%
Resort Township	1,460	1,517	3.9%	7.0%
West Traverse Township	1,410	1,431	1.5%	6.6%
Harbor Springs City	1,122	1,133	1.0%	5.2%
Pleasantview Township	1,020	973	-4.6%	4.5%
Springvale Township	993	1,014	2.1%	4.7%
Mackinaw City Village*	814	756	-7.1%	3.5%

[2] U.S. Census Bureau. "Households and Families." American Community Survey, ACS 5-Year Estimates Subject Tables, Table S1101, 2022.

Carp Lake Township	753	736	-2.3%	3.4%
Wawatam Township	655	685	4.6%	3.1%
McKinley Township	640	639	-0.2%	2.9%
Maple River Township	635	626	-1.4%	2.9%
Friendship Township	532	549	3.2%	2.5%
Readmond Township	477	470	-1.5%	2.2%
Alanson Village*	429	418	-2.6%	1.9%
Pellston Village*	364	361	-0.8%	1.7%
Bliss Township	362	366	1.1%	1.7%
Center Township	338	343	1.5%	1.6%
Cross Village Township	325	319	-1.8%	1.5%

Sources: U.S. Census Bureau. "HOUSING UNITS." Decennial Census, DEC Summary File 1, Table H1, 2010. U.S. Census Bureau. "TOTAL POPULATION." Decennial Census, DEC Demographic and Housing Characteristics, Table P1, 2020.
*Note: Village counts are incorporated into counts of their surrounding townships.

An estimated 44.8% of the County's housing stock was built before 1980. The rate of new home construction has declined since 2010, and therefore the existing housing stock continues to age. An estimated 72.9% of the county's household units are 1-unit, detached structures, which are commonly referred to as single-family homes, and 6.3% are mobile homes. Table 22 indicates the estimated number of mobile home units by community. Littlefield Township has the most units (448), followed by Bear Creek Township (198), Carp Lake Township (132), McKinley Township (94), and Resort Township (87). Concentrated areas of mobile homes are indicated on the Hazard Area Maps in Appendix A.

Table 21: Year Built, Emmet County Housing Units

Year Built	Estimated Units	% of Total	
Built 2020 or later	29	0.1%	
Built 2010 to 2019	1,109	5.1%	
Built 2000 to 2009	3,234	14.8%	
Built 1990 to 1999	4,492	20.6%	
Built 1980 to 1989	3,175	14.6%	55.2%
Built 1970 to 1979	3,250	14.9%	44.8%
Built 1960 to 1969	1,406	6.5%	
Built 1950 to 1959	1,125	5.2%	
Built 1940 to 1949	840	3.9%	
Built 1939 or earlier	3,131	14.4%	
Total:	21,791		

Source: U.S. Census Bureau. "Selected Housing Characteristics." American Community Survey, 5-Year Estimates Data Profiles, Table DP04, 2022.

Table 22: Estimated Mobile Homes in Emmet County

Community	Mobile Homes	% of Housing Units
Emmet County	1,376	6.30%
Littlefield Township	448	23.80%
Bear Creek Township	198	4.70%
Carp Lake Township	132	19.50%
McKinley Township	94	14.60%
Resort Township	87	5.90%
Alanson Village*	72	14.90%
Pellston Village*	51	14.10%
Maple River Township	49	7.20%
Little Traverse Township	48	2.60%
Bliss Township	45	10.50%
Harbor Springs City	45	4.20%
Center Township	40	12.30%
Pleasantview Township	36	3.40%
Wawatam Township	33	6.10%
Readmond Township	32	6.50%
Springvale Township	30	2.90%
West Traverse Township	24	1.70%
Cross Village Township	19	6.30%
Friendship Township	16	3.40%
Mackinaw City Village*	5	0.80%
Petoskey City	0	0.00%

Source: U.S. Census Bureau. "Selected Housing Characteristics." American Community Survey, ACS 5-Year Estimates Data Profiles, Table DP04, 2022. *Note: Village counts are incorporated into counts for the townships surrounding the villages.

Areas of New or Planned Future Development

Since the completion of the 2016 Emmet County Hazard Mitigation Plan, there have been some areas in the county that are targeted for new development in the near future, listed below. In particular, construction of storage facilities has increased dramatically in the County in the past decade, creating a potential hazard depending on what is being stored within the buildings.

- Countywide: Infill of existing housing developments
- Bear Creek Township
  - Expansion of Jellystone RV Park development on US-31
  - Commercial development/redevelopments (particularly around US-131, Anderson and Lears Roads; and US-31/M-119)
  - Multiple new storage facility businesses along US-31 Hwy; Howard Road; and between Intertown, US 131 Hwy, Anderson Road and Lears Road.
  - New housing & motorcoach home development (Hearthside Grove on US-31 Hwy)
  - New housing developments at Howard/Lears Roads, Anderson Road and Atkins Road.
- City of Petoskey
  - US-31/ US-131 intersection commercial development/redevelopment; McLaren Hospital Expansion
  - Rehabilitation home expansion (redevelopment of the former site of Gruler's Pet & Farm Supply)
  - Former Michigan Maple Block property to become an affordable housing development
  - Former Hankey Lumber site to become an affordable housing development

- Littlefield Township
  - Development of the Meadowlands Subdivision on Hem Road – homes built by Habitat for Humanity

- Little Traverse Township
  - Creation of Little Traverse Conservancy's "Offield Family Viewlands" at the former Little Traverse Golf Club property for recreation and conservation use
  - Expansion of commercial/industrial development along W. Conway Road
  - Expansion of "Conway Commons" manufactured home community
  - New storage unit facilities and an assisted living facility along M-119

- Resort Township
  - New storage unit facility and hotel along US-31

- Springvale Township
  - Creation of Little Traverse Conservancy's "Tanton Family Working Forest Reserve" with mountain bike trail system

- Maple River Township
  - Planned Unit Development of former Maple Ridge Golf Club, east of US-31, between Brutus and Maple River Roads. Campground, housing and amenities. 197 to 213 total units proposed.
  - Redevelopment of sawmill site along US-31

- West Traverse Township
  - Storage unit businesses along State Street, south of Hughston Road

Housing Tenure, Table 23, summarizes the status of housing units, whether occupied or vacant, as well as the median housing value of owner-occupied units ($246,300) and the median gross rent ($985). About two-thirds of all occupied housing units are owned vs. rented. Of the 21,791 total estimated housing units, 66.7% are occupied (indicating physically occupied, principal residence housing units), and 33.3% are categorized as vacant (this includes seasonally-occupied homes).

Table 23: Emmet County Housing Tenure Estimates, 2022

Total Housing Units	21,791	%
Occupied housing units	14,530	66.7%
Owner-occupied	11,039	76%
Median Housing Value	$246,300	
Renter-occupied	3,491	24%
Median Gross Monthly Rent	$985	
Vacant* housing units	7,261	33.3%

Source: U.S. Census Bureau. "Selected Housing Characteristics." American Community Survey, ACS 5-Year Estimates Data Profiles, Table DP04, 2022. Note: * "Vacant" indicates a non-occupied residence at the time of the survey

Economic Profile

The *2021 Comprehensive Economic Development Strategy (CEDS)* prepared by Networks Northwest is the product of a locally-based, regionally-driven economic development planning process to identify strategies for economic prosperity. The plan was prepared for the ten county region of northwest Lower Michigan. Table 24 provides a comparison of annual average wage for each county in the CEDS planning area for 2018. Emmet County has the fifth highest average annual wage at $40,258.

Table 24: Average Annual Wage by County, 2018

County	Average Annual Wage
Antrim	$33,081
Manistee	$33,821
Benzie	$33,908
Missaukee	$35,917
Leelanau	$36,833
Emmet	**$40,258**
Wexford	$40,586
Charlevoix	$44,558
Grand Traverse	$44,562
Kalkaska	$50,971

Source: 2021 Comprehensive Economic Development Strategy (CEDS) prepared by Networks Northwest

The economic profile of Emmet County is further described in Table 25. The county's industry makeup is divided into 20 different North American Industry Classification Sectors (NAICS) with associated industry job numbers and annual average wages. The industry with the largest number of jobs in 2018 was "Health care, social assistance" at 17.7% of jobs, followed by "Accommodation and food services" at 16.7%, and "Retail trade" at 14.8%. The latter two categories have lower annual average wages compared to most other industries, at $21,684 and $32,091. The industry with the highest annual average wage was "utilities" at $104,862 followed by "Finance and insurance" at $66,065 and "Manufacturing" at $61,695.

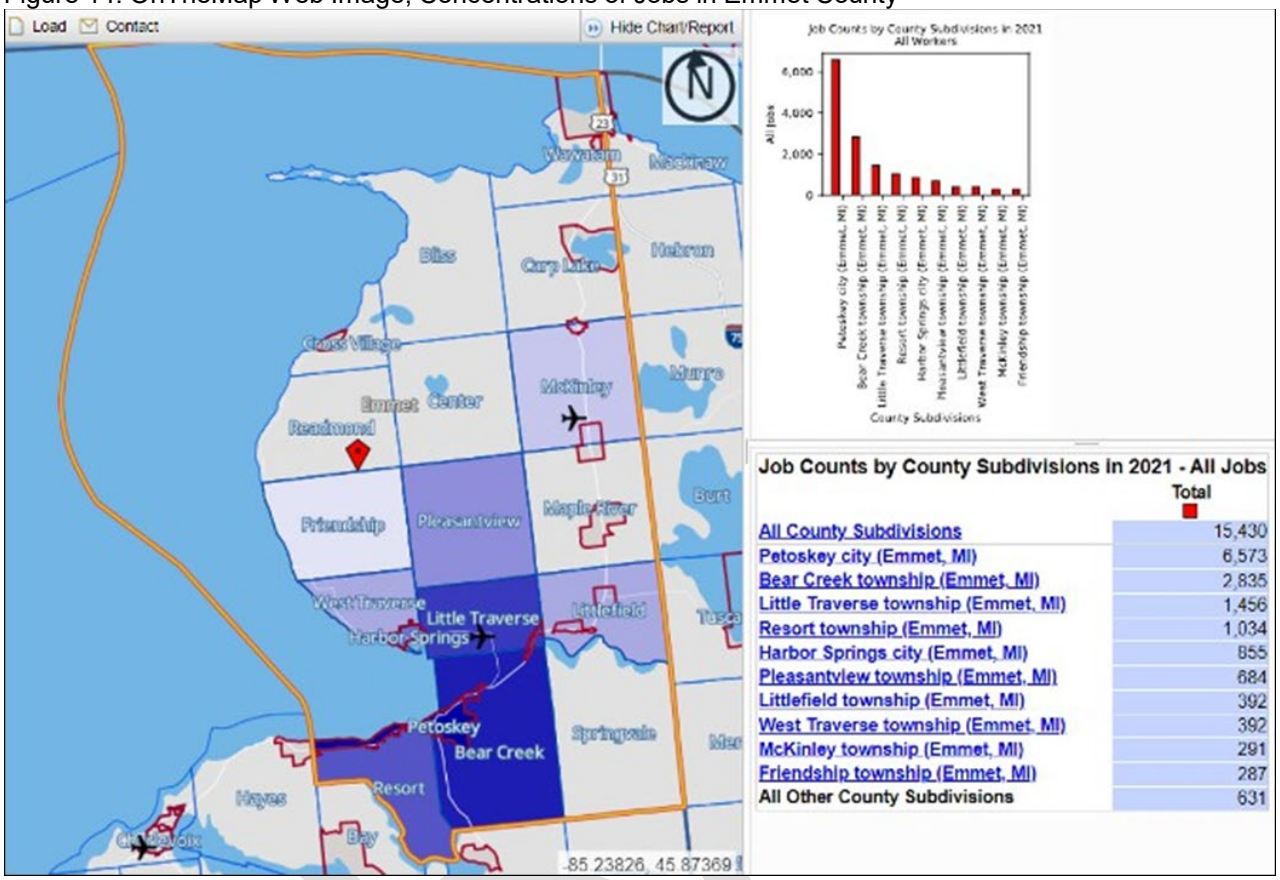
Table 25: Emmet County Economic Distribution by Industry, 2018

Industry (NAICS)	Establishments	Jobs	% Distribution of Jobs	Annual Average Wage
Total Covered Employment	1,385	18,111	100.00%	$40,258
Agri., forestry, hunting	12	D	D	D
Mining	1	D	D	D
Construction	229	1,280	7.10%	$43,198
Manufacturing	59	1,416	7.80%	$61,695
Wholesale trade	40	287	1.60%	$45,639
Retail trade	211	2,683	14.80%	$32,091
Transportation, warehousing	29	297	1.60%	$43,070
Utilities	4	43	0.20%	$104,862
Information	20	180	1.00%	$50,786
Finance and Insurance	52	286	1.60%	$66,065
Real Estate, rental, leasing	40	215	1.20%	$36,966
Professional, technical services	101	D	D	D
Administrative, waste services	100	1,485	8.20%	$30,833
Educational services	20	594	3.30%	$57,913
Health care, social assistance	139	3,206	17.70%	$51,458
Arts, entertainment, recreation	42	549	3.00%	$30,010
Accommodation and food services	116	3,031	16.70%	$21,684
Other services, excluding public admin.	136	656	3.60%	$31,598
Public administration	27	777	4.30%	$43,503
Other (includes private, management of business, and unallocated)	3	1,126	6.30%	N/A

Source: 2021 CEDS, Networks Northwest **D means limited industries of a sector that would disclose confidential information*

Additionally, OnTheMap, an online interactive tool available from the US Census Bureau, allows for viewing the estimated job density within the county. This website may be useful for emergency preparedness planning as related to response and potential impact to local economic activity areas. The City of Petoskey contains the most jobs, followed by Bear Creek Township, Little Traverse Township, and Resort Township.

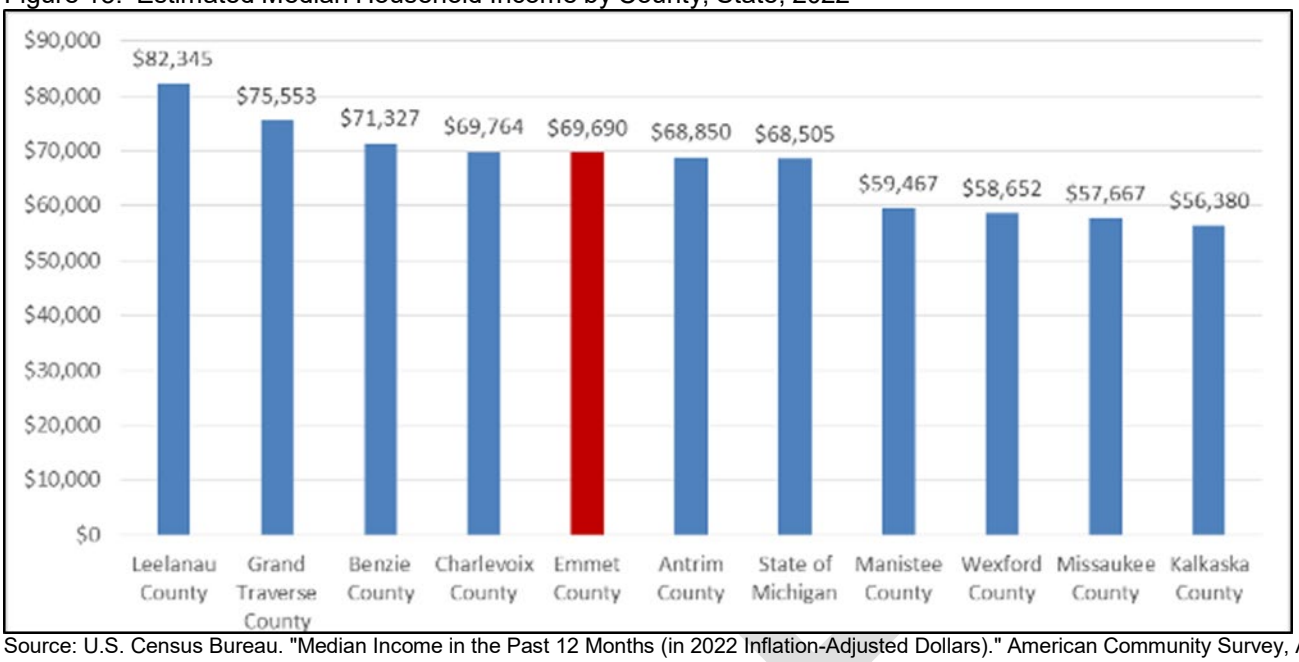
Figure 14. OnTheMap Web Image, Concentrations of Jobs in Emmet County



Source: https://onthemap.ces.census.gov/

Figure 15 and Table 26 present a comparison of the median household income (MHI) across the ten county region, the State of Michigan, and local jurisdictions. Emmet County has a median household income of $69,690, ranking the fifth highest in the region, and slightly higher that the State of Michigan's HMI of $68,505. Leelanau County has the highest median household income at $82,345. Within Emmet County's jurisdictions, MHI levels range greatly; Resort Township has the highest MHI at $109,609, and Carp Lake Township has the lowest MHI at $40,391.

Figure 15. Estimated Median Household Income by County, State, 2022



Source: U.S. Census Bureau. "Median Income in the Past 12 Months (in 2022 Inflation-Adjusted Dollars)." American Community Survey, ACS 5-Year Estimates Subject Tables, Table S1903, 2022

Table 26: Estimated Median Household Income (MHI), 2022

Jurisdiction	Median Household Income (dollars)
Resort Township	109,609
Springvale Township	93,125
West Traverse Township	90,132
Friendship Township	78,125
Little Traverse Township	70,139
EMMET COUNTY	**69,690**
Petoskey City	69,784
Bear Creek Township	68,155
Harbor Springs City	66,146
Readmond Township	62,963
Littlefield Township	61,767
Center Township	61,500
Pleasantview Township	60,625
Maple River Township	59,333
Cross Village Township	53,636
McKinley Township	52,045
Bliss Township	51,118
Pellston Village*	50,227
Wawatam Township	47,917
Alanson Village*	46,800
Mackinaw City Village*	40,804
Carp Lake Township	40,391

Source: U.S. Census Bureau. "Median Income in the Past 12 Months (in 2022 Inflation-Adjusted Dollars)." American Community Survey, ACS 5-Year Estimates Subject Tables, Table S1903, 2022. *Note: Village counts are included in their surrounding townships.

The following tables describe the population with the lowest incomes. It is estimated that in 2022, 8.4% of people in the county lived at or below the poverty level (Table 27). Bear Creek Township has the highest estimated number of persons in poverty, followed by the City of Petoskey, Littlefield Township and Carp Lake Township. Carp Lake Township also has the highest estimated percentage of its community population living in poverty, at 30.7% (Table 28). The Census describes poverty thresholds differently based on the size of the family and the number of related children living together, as illustrated in Table 29.

Table 27. Poverty Estimates, Emmet County and State of Michigan

Poverty	Emmet County	State of Michigan
Families living below the poverty level	504 (5.2%)	231,919 (9.1%)
Families with related children under age 18, in poverty	320 (9.0%)	162,017 (15.1%)
Persons living below the poverty level	2,816 (8.4%)	1,315,899 (13.4%)

Sources: U.S. Census Bureau. "Poverty Status in the Past 12 Months of Families." American Community Survey, ACS 5-Year Estimates Subject Tables, Table S1702, 2022. U.S. Census Bureau. "Poverty Status in the Past 12 Months." American Community Survey, ACS 5-Year Estimates Subject Tables, Table S1701, 2022.

Table 28. Poverty Estimates, Emmet County Communities, 2022

	Est. Total Population for Whom Poverty Status is Determined	Est. # Below Poverty Level	Est. % Below Poverty Level
Emmet County	33,648	2,816	8.40%
Bear Creek Township	6,525	511	7.80%
Petoskey City	5,621	445	7.90%
Littlefield Township	3,192	354	11.10%
Carp Lake Township	739	227	30.70%
Little Traverse Township	2,647	188	7.10%
Maple River Township	1,382	179	13.00%
Springvale Township	2,328	132	5.70%
McKinley Township	1,296	123	9.50%
Pleasantview Township	1,017	111	10.90%
Harbor Springs City	984	108	11.00%
Mackinaw City Village*	647	108	16.70%
Resort Township	2,819	106	3.80%
Alanson Village*	862	102	11.80%
Pellston Village*	755	101	13.40%
Bliss Township	640	70	10.90%
Wawatam Township	512	59	11.50%
Friendship Township	881	58	6.60%
West Traverse Township	1,793	57	3.20%
Readmond Township	570	40	7.00%
Center Township	485	29	6.00%
Cross Village Township	217	19	8.80%

Source: U.S. Census Bureau. "Poverty Status in the Past 12 Months." American Community Survey, ACS 5-Year Estimates Subject Tables, Table S1701, 2022

Table 29. US Census Poverty Thresholds for 2022

Poverty Thresholds for 2022 by Size of Family and Number of Related Children Under 18 Years (in dollars)										
Size of family unit	Weighted average thresholds	Related children under 18 years								
		None	One	Two	Three	Four	Five	Six	Seven	Eight +
One person (unrelated individual):	14,880									
Under 65 years.....	15,230	15,225								
65 years and over.....	14,040	14,036								
Two people:	18,900									
Householder under 65 years…….	19,690	19,597	20,172							
Householder 65 years and over	17,710	17,689	20,095							
Three people.....	23,280	22,892	23,556	23,578						
Four people.....	29,950	30,186	30,679	29,678	29,782					
Five people.....	35,510	36,402	36,932	35,801	34,926	34,391				
Six people.....	40,160	41,869	42,035	41,169	40,339	39,104	38,373			
Seven people.....	45,690	48,176	48,477	47,440	46,717	45,371	43,800	42,076		
Eight people.....	51,010	53,881	54,357	53,378	52,521	51,304	49,760	48,153	47,745	
Nine people or more.....	60,300	64,815	65,129	64,263	63,536	62,342	60,699	59,213	58,845	56,578

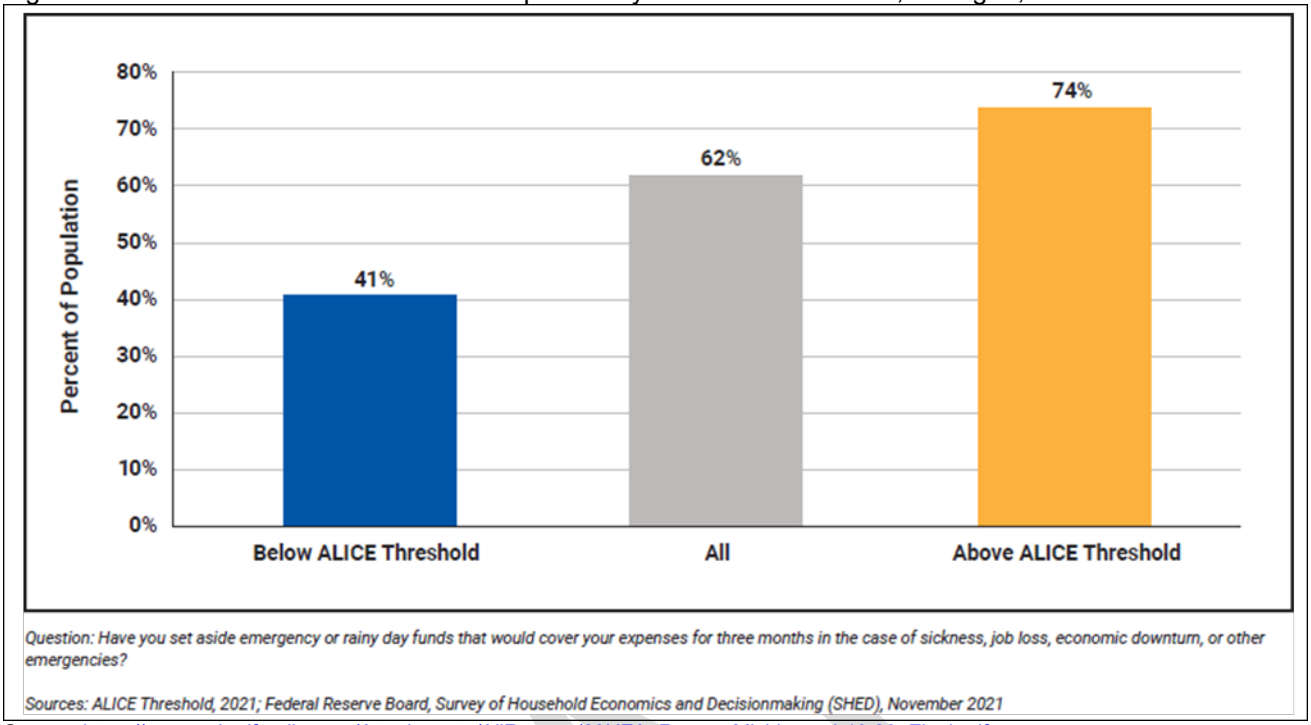
Source: https://www.census.gov/programs-surveys/cps/data/data-tools/cps-table-creator-help/poverty-thresholds.html
Note: The source of the weighted average thresholds is the 2023 Current Population Survey Annual Social and Economic Supplement (CPS ASEC).

Financial hardship is further described in the United Ways of Michigan 2023 report entitled *ALICE in the Crosscurrents: COVID and Financial Hardship in Michigan.* [3] ALICE, an acronym for "Asset Limited, Income Constrained, Employed", are those households with income above the Federal Poverty Level, but below the basic cost of modern living, such as housing, child care, food, health care, technology and transportation. The ALICE threshold is described as, "*the average income that a household needs to afford the basic necessities… for each county in Michigan. Households earning below the ALICE Threshold include both ALICE and poverty-level households*". Of the estimated 14,530 households in Emmet County in 2022, 25% were considered ALICE (below the State average of 28%). Refer to Table 30 for estimates of the percentage and number of ALICE households in Emmet County communities.

ALICE households likely would not have reserve savings to cover an emergency, such as impacts to their personal property from a natural hazard event. While it has been widely reported that U.S. household savings increased during the pandemic, analysis of the data from the Federal Reserve's annual Survey of Household Economics and Decision making (SHED) reveals that the national average conceals different experiences by state and even more so by income level in terms of rainy day funds and retirement assets. According to the 2023 ALICE report for Michigan, one of the questions in the SHED survey asks whether respondents had set aside emergency savings or "rainy day funds" that would cover their expenses for three months in case of sickness, job loss, economic downturn, or other emergencies. Only 35% of respondents classified as "Below ALICE Threshold" in Michigan reported having rainy day funds in October 2019, with a slight drop to 34% by November 2020, and then an increase to 41% by November 2021. In contrast, 65% of those classified as "Above ALICE Threshold" in Michigan had rainy day funds in October 2019, increasing to 71% in November 2020 and rising even higher, to 74%, in November 2021.

[3] https://www.unitedforalice.org/Attachments/AllReports/23UFA_Report_Michigan_4.19.23_Final.pdf

Figure 16. Funds to Cover Three Months' Expenses by the ALICE Threshold, Michigan, 2021



Source: https://www.unitedforalice.org/Attachments/AllReports/23UFA_Report_Michigan_4.19.23_Final.pdf

Table 30. ALICE Households in Emmet County, 2022

Location	Total Households	% Below ALICE Threshold	# Below ALICE Threshold
Bear Creek Township	2,864	33	945
Petoskey City	2,583	35	904
Littlefield Township	1,292	33	426
Little Traverse Township	1,144	35	400
McKinley Township	570	51	291
Maple River Township	550	45	248
West Traverse Township	806	29	234
Harbor Springs City	513	40	205
Resort Township	1,069	19	203
Carp Lake Township	295	65	192
Pleasantview Township	487	38	185
Springvale Township	856	18	154
Bliss Township	307	48	147
Wawatam Township	256	52	133
Readmond Township	274	41	112
Friendship Township	350	28	98
Cross Village Township	108	46	50
Center Township	206	24	49

Data Sources: https://www.unitedforalice.org/county-reports/michigan; US Census Bureau 2022 ACS 5-Year Estimates

The county's economic profile can be further described by considering the cost of housing, transportation, and other goods and services. The budgeting rule of thumb has been that a household should spend no more than 30 percent of its income on housing costs. According to the 2023 Housing Needs Assessment for Emmet County (produced by Housing North), the greatest rental housing gaps in the county are for the two lowest housing affordability segments (rents below $1,665 that are affordable to households earning up to 80% of the Average Median Household Income [4]). The study also found that the greatest for-sale housing gap in the county is for products priced between $222,868 and $332,800, which is affordable to households earning between $66,561 and $99,840. Additionally, many households are already cost burdened – paying more than 30% of their income toward housing costs (Table 31).

Table 31. Cost Burdened Households in Emmet County

Cost Burdened Households – Paying more than 30% of income toward housing costs		Severe Cost Burdened Households – Paying more than 50% of income toward housing costs	
Renter	**Owner**	**Renter**	**Owner**
34%	23%	14%	10%

Source: Housing North *2023 Housing Needs Assessment: Emmet County Data Summary*

[4] 2022 Median Household Income: $67,354

IV. HAZARD IDENTIFICATION AND ASSESSMENTS

Hazard Analysis Overview

Emmet County is vulnerable to a wide range of natural hazards. Hazard events have the potential to impact community residents and visitors, economic drivers in the community, critical infrastructure, the built environment, and the natural environment. Emmet County Emergency Management is challenged with managing these threats to protect life and property.

Hazard impacts on the community can be understood by evaluating vulnerabilities for commonly agreed upon assets. A community's assets are defined broadly to include anything that is important to the character and function of a community and can be described very generally in the following categories:

- People
- Economy
- Built environment
- Natural environment

Vulnerable populations include persons of racial/ethnic minority groups, the economically disadvantaged, elderly (particularly those living alone), homeless, and persons with a disability. Those that live unsheltered or in homeless encampments, assisted living facilities, mobile homes, or isolated residences are more susceptible to impacts from hazardous events. Campgrounds are also areas where persons in RVs or tents are more vulnerable to the effects of thunderstorms, high winds, lightning, hail, tornadoes, wildfire and extreme heat. Locations of mobile/manufactured homes and campgrounds/RV parks are represented on the *Vulnerable Populations and Hazard Areas Map* in Appendix A. Table 33 provides the State Equalized Value (SEV) of the approximate area of these properties, and is based on available equalization record data from Emmet County.

The natural environment is the primary influencing factor for residents choosing to live and vacation in northwest Michigan. Emmet County is home to abundant forest lands, wetlands, inland lakes and streams, unique sand dune areas, Lake Michigan shoreline and all of the wildlife within that are integral to the identity of the community. While natural resources are abundant, they are vulnerable to all types of hazards. Northwest Lower Michigan is also home to many sensitive wildlife populations that require specific climates and habitats to survive. Damaged, destroyed, or changing natural environments may decrease the chances for certain species' survival.

Northwest Michigan receives an influx of seasonal residents in the summer months. According to the 2022 report by Networks Northwest, *Seasonal Population Study for Northwest Lower Michigan*, Emmet County's combined population (full-time residents, part-time residents and overnight visitors) increases by as much as 105% (an addition of 45,962 persons) from the minimum monthly population of 43,666 in February to the greatest monthly population of 89,628 in July. While the seasonal population changes are integral to the local tourism-based economy, they also create an increased demand for limited public services and can put pressure on existing infrastructure capabilities.

Emmet County is the second-most seasonal county in the region, largely driven by an influx of overnight visitors in the months of May – October. In the summer, the permanent population of 34,112 individuals accounts for less than 40% of the total population compared to over 70% in the off-season. In other words, an estimated 38,577 to 55,515 part-time residents/visitors per month between May and October are added to the base permanent population.

Over 17% of the regional accommodation visitors in the month of July stay in Emmet County. The seasonal workforce heavily mirrors the substantial monthly fluctuations in population. In the off-season, the seasonal workforce represents less than 4% of the total labor force, and in the on-season, seasonal workers are upwards of 15% of the total labor force. In the month of July, there are an estimated 2,789 seasonal workers in Emmet County, 18% of the region's seasonal workforce.

The available condition ratings for bridges, stream crossings, and dams are shown on the Infrastructure Map in Appendix A. Additionally, Table 32 below provides a summary of critical facilities and infrastructure sites in Emmet County.

Table 32. Critical Facilities and Infrastructure in Emmet County

Governmental Facilities (other) (25)		
Jurisdiction	**Facility Name**	**Address**
City of Harbor Springs	City Hall	1607 Zoll St.
	Department of Public Works	204 Fairview St.
City of Petoskey	City Hall	101 E. Lake St.
	Department of Public Works	110 Sheridan St.
	Emmet County Administration	200 Division St.
	Emmet-Charlevoix County Fairgrounds	1129 Charlevoix Ave.
Village of Alanson	Littlefield-Alanson Community Building	7631 US-31
Village of Pellston	Township Hall	125 N. Milton St.
Bear Creek Township	Township Hall	373 Division Rd.
Bliss Township	Township Hall	265 W. Sturgeon Bay Trail
Carp Lake Township	Township Hall	6339 E. Gill Rd.
Center Township	Township Hall	981 Van Rd.
Cross Village Township	Township Hall	5954 Wadsworth Rd.
Friendship Township	Township Hall	3018 S. Beacon Ln.
Little Traverse Township	Township Hall	8288 Pleasantview Rd.
	Emmet County Transfer Station	7363 Pleasantview Rd.
	Little Traverse Bay Bands of Odawa Indians Governmental Center	7500 Odawa Circle
Maple River Township	Township Hall	3989 US-31, Brutus
McKinley Township	Township Hall	1820 US-31, Levering
Pleasantview Township	Township Hall	2982 Pleasantview Rd.
Readmond Township	Township Hall	6034 Wormwood Ln.
Resort Township	Township Hall	2232 Resort Pike Rd.
Springvale Township	Township Hall	8198 E. Mitchell Rd.
Wawatam Township	Township Hall	123 Etherington St., Mackinaw City
West Traverse Township	Township Hall	8001 S. Lakeshore Dr.
Emergency Response: Law Enforcement, Fire and EMS (23)		
Jurisdiction	**Facility Name**	**Address**
City of Harbor Springs	Police Station	170 Zoll St.
	Fire Department (with generator)	824 S. State St.
City of Petoskey	Fire Dept. and Public Safety	100 W. Lake St.
	Emmet County Sheriff's Office & Jail	450 Bay St.
Village of Alanson	Fire Department	6200 West St.
Village of Mackinaw City	Emmet County EMS Station 3	201 W. Central Avenue
	Fire Department (in Cheboygan County)	102 S. Huron Ave.
Village of Pellston	Fire Department	150 Milton St.
Bear Creek Township	Resort-Bear Creek Fire Station	373 Division Rd.
	CCE-911 Center	1694 US-131
Bliss Township	Fire Department	9198 N. Pleasantview Rd.
Carp Lake Township	Fire Department	6339 E. Gill Road
Little Traverse Township	County Sheriff's Office	3460 Harbor-Petoskey Road
	Fire Department	8288 Pleasantview Rd.
	Emmet County EMS Station 2	8269 Harbor-Petoskey Road

McKinley Township	County Sheriff's Station at Pellston Airport; Aircraft Rescue and Firefighting	1395 US-31, Pellston
Readmond Township	Fire Department	6034 Wormwood Road
	Readmond, Friendship, and Cross Village Fire and Rescue	8338 W. Robinson Road
Resort Township	Emmet County EMS Station 1	1201 Eppler Road
	Petoskey Public Safety Station West	3625 Charlevoix Road
	Resort Township Fire Station	2232 Resort Pike Road
Springvale Township	Fire Department	8198 E. Mitchell Road
West Traverse Township	Birchwood Fire and Medical First Response (serves the community of Birchwood Farms and also West Traverse Township)	600 Birchwood Ave.
Transportation (19)		
Jurisdiction	**Facility Name**	**Facility Type**
Carp Lake Township	Emmet County Road Commission - Levering Rd.	Road Maintenance
Little Traverse Township	Emmet County Road Commission - Hathaway Rd.	Road Maintenance
City of Petoskey	US-31 / Bear River	MDOT Bridge
	W. Lake St. / Bear River	City Bridge
	Bridge St. / Bear River	City Bridge
	Sheridan St. / Bear River	City Bridge
	Standish Ave. / Bear River	City Bridge
Village of Alanson	M-68 / Crooked River	MDOT Bridge
	River Street Swing Bridge / Crooked River	Village Bridge
Village of Mackinaw City	Mackinaw Bridge / Straits of Mackinac	I-75 Bridge
City of Harbor Springs	Harbor Springs Marina	Municipal Marina
	Josephine Ford Park	City Boat Launch
West Traverse Township	Harbor Point (Little Traverse) Lighthouse	Marine Navigation
City of Petoskey	Petoskey Marina	Municipal Marina / Boat Launch
	Bay Harbor Lake Marina	Private Marina / Boat Launch
	Bayfront Lighthouse	Marine Navigation
Village of Mackinaw City	McGulpin Point Lighthouse	Marine Navigation
McKinley Township	Pellston Airport	Regional Airport
Little Traverse Township	Harbor Springs Airport	Local Airport
Healthcare (7)		
Jurisdiction	**Facility Name**	**Facility Type**
City of Harbor Springs	The Village of Hillside	Assisted Living
	Bay Bluffs County Medical Care Facility	Assisted Living
City of Petoskey	McLaren Northern Michigan	Hospital
	Villa at the Bay	Assisted Living
Bear Creek Township	Independence Village	Assisted Living
	American House	Assisted Living
Resort Township	Mallard Cove	Assisted Living
Little Traverse Township	Pineview Cottage	Assisted Living
West Traverse Township	Perry Farms Village & The Birches	Assisted Living
Energy (petroleum products) (4)		
Jurisdiction	**Facility Name**	**Address**

City of Petoskey	Derrer Oil and Propane	1414 Standish Ave.
Bear Creek Township	Suburban Propane	2090 Fochtman Industrial Dr.
	Amerigas Propane	1901 River Rd.
Littlefield Township	Alpine Propane	7470 Keystone Park Dr.
	Ellsworth Farmers Exchange (bulk propane facility)	7488 M-68 Hwy.
Wawatam Township	Enbridge Energy Line 5 Pipeline - Mackinaw Hub	16309 Headlands Rd.

Source: Emmet County Office of Emergency Management

This plan includes a profile for each hazard event the County is likely to face, which includes descriptions of the following:

- **Location** is the geographic areas within the planning area that are affected by the hazard, such as a floodplain. The entire planning area may be uniformly affected by some hazards, such as drought or winter storm. Location may be described in narrative and or through map illustrations.
- **Extent** is the strength or magnitude of the hazard. Extent can be described in a combination of ways depending on the hazard.
- **Previous occurrences** describe the history of previous hazard events within the county. This information helps to estimate the likelihood of future events and predict potential impacts. The extent of historic events may be included when the data is available.
- **Probability of future events** is the likelihood of the hazard occurring in the future based on previous event occurrences and any trends that may appear. Probability may be defined using historical frequencies or statistical probabilities.
- **Vulnerability assessment** accounts for the type, amount, and value of assets such as: existing and future buildings, infrastructure, critical facilities, populations, recreation areas and environmental features that may be impacted by a hazard, along with existing community assets to mitigate or respond to the hazard.

Information utilized in the analysis of **Natural Hazards** in Emmet County was compiled from the following sources:

- **FEMA's webpage on Disaster Declarations for States and Counties** was referenced for the most up-to-date data on Presidential- and Governor-Declared emergencies and disasters (Table 35)

- **Michigan State Police's** 2019 Michigan Hazard Analysis and 2020 Michigan Hazard Analysis Supplement

- **NOAA Online Weather Data** https://www.weather.gov/wrh/Climate?wfo=apx – Historical local observed weather data; Climate prediction and variability; local high impact event summaries.

- **Past Severe Weather Events - NOAA Storm Event Database** https://www.ncdc.noaa.gov/stormevents/ Data available to search beginning in 1950 to within 3 months from present day; however, information for various events is limited and non-contiguous. The database provides local storm reports, damage reports, and recorded event descriptions. The event types researched for Emmet County include the following (the event types in italics are as these types of events are listed in the Storm Events Database):
    - Dangerous Currents (i.e., *Rip Current*)
    - Dense Fog (*Dense Fog*)
    - Drought (*Drought*)
    - Extreme Temperatures (*Cold/Wind Chill, Extreme Cold/Wind Chill, Heat, Excessive Heat)*
    - Extreme Winter Weather (*Blizzard, Freezing Fog, Frost/Freeze, Heavy Snow, Ice Storm, Lake-Effect Snow, Sleet, Winter Storm, Winter Weather*)
    - Flooding *(Flash Flood, Flood*)
    - Hail (*Hail*)
    - Seiche (*Seiche*)
    - Shoreline Flood (*Lakeshore Flood*)
    - Thunderstorm and High Wind (*Heavy Rain, Lightning, High Wind, Strong Wind, Thunderstorm Wind*)
    - Tornado (*Tornado, Funnel Cloud, Waterspout*)
    - Wildfire (*Wildfire*)

- **Wildfires -** The *Michigan Hazard Analysis*, completed by the Michigan State Police in 2019, was referenced to collect data on wildfires that occurred on State-owned land between 1981 and 2018 (as reported by the MDNR). MDNR's Wildland Fire interactive mapping application was also referenced for reports of wildland fires.

- **Dangerous Currents** - The National Weather Service's/MI Sea Grant's Great Lakes Beach Hazards Incident Database indicates current-related incidents on the Great Lakes from 2002 to 2020. The NOAA NCEI Storm Events Database also provides information on reported rip current incidents.

- **Drought** - Historical local observed drought data was obtained from the US Drought Monitor.

- **Invasive Species** - Michigan Invasive Species Program; Midwest Invasive Species Information; Network; CAKE-CISMA

- **Shoreline Erosion and Flooding**: LIAA's Northwest Lower Michigan Coastal Resilience Atlas; MI EGLE's Wetlands Map Viewer

- **Climate Change** – EPA Climate Change Indicators; Great Lakes Environmental Research Laboratory; GLISA, the Great Lakes Climate Adaptation Partnerships/RISA team

Information utilized in the analysis of **Technological and Human-Induced Hazards** in Emmet County came from the following sources**:**

- Emmet County Road Commission
- MDOT Annual Average Daily Traffic Maps, Bridge Condition Ratings
- Great Lakes Stream Crossing Inventory
- The National Inventory of Dams and MI-EGLE's Michigan Dam Inventory
- Health Department of Northwest Michigan
- Michigan Department of Health and Human Services Coronavirus Case Data
- USDOT – Pipeline & Hazardous Materials Safety Administration's Hazmat Incident Report Search Tool
- National Pipeline Mapping System Public Viewer
- US Energy Administration Information's U.S. Energy Atlas
- US Department of Homeland Security
- Enbridge Energy
- Transportation Accidents: National Transportation Safety Board's Case Analysis and Reporting Online
- National Fire Incident Reporting System
- U.S. Fire Administration
- MDNR, MI EGLE, US EPA
- MSP's 2019 Michigan Hazard Analysis and 2020 Michigan Hazard Analysis Supplement

Additional data sources utilized for all types of hazards included: the Emmet County Office of Emergency Management; local government planning and zoning documents; local non-profit publications and websites; local newspaper articles; and public/stakeholder input.

The Historical Analysis of hazards in Emmet County uses information on impacts and losses from previous hazard events to predict potential impacts and losses during a similar event. There have been seven incidents involving a federal or state declaration of an emergency or disaster affecting Emmet County (Table 35 in red, bold text). These events (with the exception of the 2005 hurricane evacuation incident) are also included in the hazard analysis for individual event types.

Table 35. Presidential and Governor Declared Disasters or Emergencies for Emmet County

Date of Incident	Type of Incident	Affected Area	(P)residential Declaration* / Federal ID Number** or State of Emergency (G)overnor's Declaration***
3/13/2020, 3/27/2020 Ended 5/11/2023	Pandemic	**Statewide**; Nationwide	(P) Emergency (3455) (P) Major Disaster (4494) (G) Emergency
1/29/2019	Extreme Cold	**Statewide**	(G) Emergency
2/13/2014	Deep Frost	Charlevoix, Cheboygan, Chippewa, Delta, **Emmet**, Gogebic, Luce, Mackinac, and Marquette Co.	(G) Emergency
9/7/2005	Hurricane evacuation	**Statewide** (resulting from the influx of evacuees to Michigan from states impacted by Hurricane Katrina beginning on August 29, 2005)	(P) Emergency (3225)
9/4/2005			(G) Disaster
12/24/2001	Heavy Snow	**Emmet** and Charlevoix Counties	(G) Emergency
1/26-27/1978	Blizzard, snowstorm	**Statewide**	(P) Emergency (3057); (G) Disaster
3/2/1977	Drought	44 counties: Alcona, Alger, Alpena, Antrim, Arenac, Baraga, Benzie, Charlevoix, Cheboygan, Chippewa, Clare, Crawford, Delta, Dickinson, **Emmet**, Gladwin, Gogebic, Grand Traverse, Houghton, Iosco, Iron, Isabella, Kalkaska, Lake, Leelanau, Luce, Mackinac, Manistee, Marquette, Mason, Mecosta, Menominee, Missaukee, Montmorency, Oceana, Ogemaw, Ontonagon, Osceola, Oscoda, Otsego, Presque Isle, Roscommon, Schoolcraft, and Wexford Co.	(P) Emergency (3035)

***Does not include separate Secretary of Agriculture or Small Business Administration (SBA) disaster declarations, which are issued under other authorities. Declarations after 1974 were issued under PL 93-288 (Disaster Relief Act), as amended by the Robert T. Stafford Disaster Relief and Emergency Assistance Act (1988) and the Disaster Mitigation Act (2000).**

****Indicates federal declaration number assigned by FEMA or its predecessor agencies**

*****Declarations since 1977 were issued under 1976 PA 390, as amended (Michigan Emergency Management Act).**

Sources: Sources: FEMA https://www.fema.gov/data-visualization/disaster-declarations-states-and-counties and Michigan State Police 2019 Michigan Hazard Analysis (MHA) pub. 103

The NOAA NCEI Storm Event Database is updated on a rolling basis, and thus is always being added to. The most up to date information was added to Table 36, but as events occur the database will change, and additional events will be added in subsequent years. The database indicates that 238 events were reported between 01/01/1950 and 12/30/2023 (27,027 days) for Emmet County. There were a total of 214 days with an event; 39 days with an event and property damage; 2 days with an event and death or injury; 1 day with an event and death; and 1 day with an event and crop damage. It is important to note when viewing the data that many of the events were recorded starting in the mid-1990's, even though the available search range dates back to 1950. Those events, as well as emergency declaration events, are included in the hazard analysis.

Table 36. Emmet County Hazard Events by Type, Frequency, Location, and Year

Type of Event	# of Events	Event Location	Years Event Recorded
Wildfire	377	MDNR Lands	1981-2018
Severe Winter Weather (i.e. Ice storm, Heavy Snow, Blizzard)	127	County/Region/State	1978*, 1996-2001, 2001*, 2002-2010, 2012-2019, 2021-2023
Thunderstorm/Wind; High Wind	57 / 16	County/Region	1967, 1971, 1972, 1974, 1976, 1982-84, 1988, 1991, 1994, 1995, 1997-2007, 2010, 2012, 2014-2021
Rip Current	19	Good Hart Beach; Petoskey State Park Beach	2005, 2010, 2012
Hail	18	Countywide	1983, 1996, 1998, 2000, 2002, 2005, 2006, 2008, 2010-2012, 2019
Extreme Temperatures (Heat / Cold)	2 / 6	County/Region/Statewide	2001, 2018 / 2007, 2012, *2014, 2015, *2019
Tornado	5	Petoskey, City of Harbor Springs, West Traverse Township, Little Traverse Township, Pleasantview Township, Littlefield Township	1953, 1955, 1957, 1987, 1996
Drought	3	County/ Region	*1977, 2007
Riverine and Urban Flooding (Flash Flood)	3	Cross Village Township, Littlefield Township, City of Harbor Springs	2011, 2020, 2022
Lakeshore Flood	2	Resort Township, Wawatam Township	4/13/2020, 10/23/2020
Lightning	1	City of Petoskey	2011
Public Health Emergency	1	Statewide/Nationwide	*2020
Waterspout	1	Little Traverse Bay – Petoskey	1999
Dense Fog	1	Michigan's Lower Peninsula	1995
Seiche	0		
Space Weather (solar flares, geomagnetic storms)	12	Canada, Eastern U.S., Illinois, or International (none specifically in Michigan)	1859, 1921, 1989, 1922, 1994, 1997, 1998, 2003, 2005, 2006, 2012
Invasive Species	-	Countywide/Regionwide	Ongoing

Sources: NOAA National Centers for Environmental Information Storm Events Database; MDNR; USFS/USDA; Michigan State Police-Dept. of Homeland Security; FEMA; NWS Great Lakes Beach Hazards Incident Database. Note: * indicates a state or federal declaration of an emergency or disaster

Table 37 presents the *reported* deaths, injuries/rescues/illnesses, property damages, and crop damages from hazard events in Emmet County from 1950-2023. It should be noted that many events likely cause numerous small amounts of property damage, but these often go unreported.

Table 37: Extent of Damage by Event Type, Emmet County

Event	Deaths	Rescue, Injury/ or Illness	Property Damages	Crop Damages
Severe Winter Weather	0	0	$204,000	$0
Thunderstorm/Wind; High Wind	0	1	$379,000 / $244,500	$0
Lakeshore Flooding and Erosion	0	0	$155,000	$0
Hail	0	0	$100,000	$0
Tornado	0	0	$52,500	$0
Riverine and Urban Flooding	0	0	$103,000	$0
Extreme Temperatures (Heat or Cold)	0	0	$0	$5,000,000
Lightning	0	0	$4,000	$0
Drought	0	0	$0	$0
Wildfire	0	0	$0	$0
Dangerous Currents	1	18	$0	$0
Dense Fog, Seiche, or Waterspout	0	0	$0	$0
Public Health Emergency (COVID-19 Pandemic)	*116	*7,867	N/A	N/A
Space Weather	0	0	$0	$0
Invasive Species	N/A	N/A	N/A	N/A
TOTAL	**117**	**7,886**	**$1,242,000**	**$5,000,000**

Sources: NOAA's National Centers for Environmental Information; NWS Great Lakes Beach Hazards Incident Database; Michigan State Police-Dept. of Homeland Security; *State of Michigan https://www.michigan.gov/coronavirus/stats reported confirmed and probable cases and deaths and cases attributed to COVID-19 as of 12/26/2023.

The estimated impact of certain hazard events on locations within Emmet County. The State Equalized Values (SEV) for real and personal property (residential and commercial) for these locations is also provided. SEV is equal to half the true value of the property.

Table 33. Natural Hazard Impacts by Location (associated with Hazard Areas and Vulnerable Population Map in Appendix A)

Hazard Event	Potential Affected Areas	State Equalized Value of Areas on Hazard Maps
Extreme Winter Weather, Thunderstorm, Hail, Lightning, Tornado, Extreme Temperatures, Dense Fog, Drought	Countywide	$4,571,074,131
Inland Flooding	Tannery Creek in Bear Creek Township; Inland Waterway (Crooked River)	$36,026,508
Shoreline Erosion and flooding	Communities adjoining Lake Michigan and inland lakes: Wawatam, Bliss, Cross Village, Readmond, Friendship, West Traverse, Little Traverse, Bear Creek, and Resort Townships; City of Petoskey; City of Harbor Springs; Village of Mackinaw City	$1,380,354,173 Also refer to Table 34 for estimated SEV values of properties affected in coastal flooding scenarios
Wildfire	Wildfire concern areas mentioned from public input	$163,973,779
	Pine forest areas (White, Red and Jack Pine) are scattered through every community except the Village of Mackinaw City.	

Invasive Species	Inland water bodies	$1,798,278,516
Tornado, High Wind, Thunderstorm/Wind, Hail, Lightning, Extreme Temps, Wildfire, Flooding	Campgrounds: City of Petoskey, Village of Alanson, Bear Creek Twp., Bliss Twp., Little Traverse Twp., Littlefield Twp., Readmond Twp., Resort Twp., Springvale Twp., Wawatam Twp.	$78,613,960.04
Tornado, High Wind, Thunderstorm/Wind, Hail, Heavy Snow	Mobile/Manufactured Home Communities: City of Harbor Springs, Village of Alanson, Littlefield Twp., Resort Twp.	$3,617,898.66

Sources: US Census Bureau 2020 Decennial Census; Emmet County Equalization
*Note: According to the 2022 report, Seasonal Population Study for Northwest Lower Michigan, apply an 84% increase to account for the estimated average seasonal population change throughout the year for Emmet County.

Table 34. Coastal Flooding Scenario Impacts on SEV of Lakeshore Properties in Emmet County

Real Property Impact - 2019

	Lucky	Expected	Perfect	% SEV
Mackinaw City	1,147,108	14,115,200	17,639,100	32%
Wawatam Township	1,013,800	11,021,100	18,063,900	22%
Bliss Township	-	2,373,300	2,706,900	7%
Cross Village Township	-	2,676,600	19,694,200	24%
Readmond Township	-	390,900	1,418,500	1%
Friendship Township	-	-	2,965,500	2%
West Traverse Township	979,700	34,154,000	115,892,300	19%
City of Harbor Springs	7,727,100	58,032,600	114,688,800	23%
Little Traverse Township	-	35,789,200	104,095,100	16%
Bear Creek Township	-	26,645,500	60,944,700	9%
City of Petoskey	20,177,200	74,400,000	119,350,700	14%
Resort Township	-	-	-	
	31,044,908	259,598,400	577,459,700	13%

Source: Emmet County Coastal Resiliency Workshop - Online Presentation April 11, 2024.
https://us02web.zoom.us/rec/share/FY_FgG_JX3Fje5BZtnUCTzHYjiunK0C11HOuxeHYYROWZ2ngp7IphLR0KjXCNqtM.FDauDc--d_7KTJHL

NATURAL HAZARDS

- Severe Winter Weather
- Thunderstorms and High Winds
- Lightning
- Hail
- Riverine and Urban Flooding
- Tornado
- Extreme Temperatures
- Drought
- Wildfire
- Dense Fog
- Coastal Hazards - Dangerous Currents
- Coastal Hazards – Seiche
- Coastal Hazards – Waterspout
- Coastal Hazards – Shoreline Recession and Flooding
- Space Weather
- Subsidence
- Invasive Species
- Impacts from Climate Change

Severe Winter Weather

The National Weather Service defines a winter weather event as: *a winter weather phenomenon (such as snow, sleet, ice, wind chill) that impacts public safety, transportation, and/or commerce. It typically occurs during the climatological winter season between October 15 and April 15.* The Extreme Winter Weather category in this Plan's hazard analysis includes the following subcategories: winter weather, winter storm, ice storm, heavy snow, blizzard, frost/freeze, and lake effect snow. Blizzards are the most perilous snowstorms and are characterized by low temperatures, strong winds, and enormous amounts of fine, powdery snow. Snowstorms have the potential to reduce visibility, cause property damage, and loss of life.

According to the 2019 Michigan Hazard Analysis, the 29 counties of the Northern Lower Peninsula of Michigan have an annual average of 79 snowstorm events, with 0 average annual deaths or injuries, $6.53 million in average annual property damage and $20 million in crop damage. Michigan experiences large differences in snowfall over short distances due to the Great Lakes. The average annual snowfall accumulation ranges from 30 to 200 inches with the highest accumulations in the northern and western parts of the Upper Peninsula. In Lower Michigan, the highest snowfall accumulations occur near Lake Michigan and in the higher elevations of northern Lower Michigan. For example, the average snowfall ranges from 141 inches in the Gaylord area to 101 inches in Traverse City.

Ice and sleet storms generate sufficient quantities of ice or sleet that result in hazardous conditions and/or property damage. Ice storms occur when cold rain freezes on contact with the surface and coats the ground, trees, buildings, and overhead wires with ice. Ice storms are often accompanied by snowfall, which can cause property damage, treacherous conditions, and power loss. When electric lines are down, households are inconvenienced, and communities experience economic loss and the disruption of essential services. Conversely, sleet storms are small ice pellets that bounce when hitting the ground or other objects. The ice pellets do not stick to objects, but can cause hazardous driving conditions.

According to the 2019 Michigan Hazard Mitigation Plan, Michigan has 16 average annual ice and sleet storm events with 0.2 average annual deaths, 0.5 average annual injuries, and $11.4 million in average annual property and crop damage.

Location

Severe winter weather events are regional events that are not confined to geographic boundaries and can affect several areas at one time with varying severity depending on factors such as elevation and wind patterns. All areas of Emmet County are at risk from severe winter weather, including lake-effect snow due to proximity to Lake Michigan.

Extent

Snowstorms can be measured based on snowfall accumulations or damages. The monthly mean snowfall for the City of Petoskey, according to NOAA's Online Weather data dating back to the winter season of 1999-2000, is 117.4". The maximum monthly mean snowfall in Petoskey was 184.8" in 2014; the minimum was 73" in 2021. Severe winter weather events in total caused $204,000 in property damages between 1996 and 2023 (Table 38), and have the third highest amount of property damages on record compared to any other hazard event in Emmet County.

Table 38. Extreme Winter Weather Events and Impacts, Emmet County

Event Type	Number of Events	Property Damage	Crop Damage	Event Year(s)
Winter Weather	1	$ -	$ -	2006
Ice Storm	4	$ -	$ -	1997, 2001, 2008
Blizzard	7	$ -	$ -	1978, 1997-1999, 2002, 2019, 2022
Lake-Effect Snow	12	$ -	$ -	2007-2010, 2013, 2014, 2016
Heavy Snow	50	$ 200,000 (3/2/2012)	$ -	1996-2000, 2001*, 2001-2009, 2012 - 2014, 2016, 2018, 2019
Winter Storm	53	$ 4,000 (3/1/2007)	$ -	1996-1998, 2002-2010, 2012-2019, 2021-2023
TOTAL	**127**	**$ 204,000**	**$ 0**	

Source: NOAA: National Centers for Environmental Information; Michigan State Police 2019 *Michigan Hazard Analysis*
Note: * indicates a state declaration of an emergency

Previous Occurrences

Since 1996, there have been 126 severe winter weather events reported for Emmet County, which include heavy snow, ice storms, frost/freeze, blizzard, lake effect snow, winter storm and winter weather events (Table 37). Additionally, in 1978, Emmet County, along with the rest of the state of Michigan, received a Presidential Emergency Declaration for a snowstorm and blizzard. In recent years, the more common events are winter storms with moderate snowfall of 5-10 inches. Heavy snow, blizzards, and lake-effect snows have been less common. Nonetheless, severe winter weather events are the most frequently recorded type of weather event affecting all of Emmet County, with the potential to cause widespread damage. The NOAA storm event narratives for some of the most impactful events are provided below:

The heavy snow event from December 24-31, 2001: A stalled out area of low pressure near the Ontario and Quebec border caused a prolonged period of lake effect snow across northern Michigan from December 24th to the 31st. While the heavy areas of snow shifted around from day to day, snow was falling across some portion of the region through the period. The most impressive snowfall totals were reported across Emmet and Charlevoix counties and to a lesser extent across Grand Traverse and Cheboygan counties. In fact, a State of Emergency was declared in Emmet and Charlevoix counties by Michigan Governor Engler so that equipment, personnel, and money would become available to assist with snow removal. The cities of Petoskey and Charlevoix broke their 2 and 3 day snowfall total records with amounts of 44 and 60 inches (on the 25th through the 27th) and 27 and 39 inches (on the 26th through the 28th) respectively. Emmet County requested $59,538.34 in disaster assistance from the state for snow removal operations December 24th through the 29th and Charlevoix County requested $15,906.85 for the same period. Traverse City tied their 2 day snowfall record with 20.5 inches from the 28th through the 29th. Many other areas saw snowfall totals of a foot or more during the last week of December.

The winter storm event on March 1, 2007 was the result of a strong low pressure system that approached the region from the southwest. Associated precipitation spread northward into the region on the 1st. Eastern Upper Michigan stayed all snow, mixed with sleet and freezing rain at times in far Northern Lower Michigan, and turned over to all freezing rain further south. Precipitation was turning showery during this transition time, so significant accumulations of ice were localized. Still, Cadillac picked up around a quarter-inch of ice accumulation, and East Tawas and Oscoda had almost an inch of glaze - on top of a few inches of snow. Some power lines were downed near both Cadillac and Tawas. A number of large tree limbs were downed in Iosco County, one of which destroyed a shed. To the north, the snowfall was heavy, with 16 inches in Rogers City, 14 inches in Paradise, and 11 inches in Comins. Strong easterly winds were enhanced by showery precipitation, with some gusts in excess of 50 mph. Trees were downed in the Gaylord area, damaging a home. Downed power lines were also common, thanks to the winds and the heavy, wet snow which clung to lines. Substantial blowing and drifting snow occurred where precipitation stayed all snow. A number of school districts closed early on the 1st, and stayed closed through the 2nd. [This event accounts for $4,000 in reported damages in Emmet County.]

The heavy snow event from March 2-3, 2012: Low pressure tracked from Missouri, to southern Lower Michigan, and on to eastern Canada, while rapidly strengthening. Precipitation surged northward into the region on the evening of the 2nd. This was primarily snow, except in parts of east central Lower Michigan (especially near Lake Huron), where temperatures were mild enough for rain. Snow wound down on the morning of the 3rd, and though somewhat blustery winds occurred behind the system on the 3rd, blowing snow was limited because the snowfall was so wet. Snow totals ranged from 6 to 14 inches across most of Northern Michigan. Higher amounts fell near and west of Grand Traverse Bay,

with a maximum amount of 20 inches near Lake Ann. With relatively warm temperatures, the snow was very wet; Traverse City saw around a foot of snow during the night, with a low temperature of 33 degrees. The snow stuck to everything, with the weight of the snow downing many, many trees and power lines. Power outages were widespread, with an outright majority of Northern Michigan residents losing power at some time during or after the storm. In Benzie County, 95 percent of residents lost power. Outages lasted up to a week in some spots. Great Lakes Energy described it as the worst snowstorm (in regards to power outages) in 30 years. A number of counties and communities opened shelters to aid those without power or heat. Also included in the tree damage was substantial damage to fruit trees in the Grand Traverse Bay region, particularly cherry trees. [$200,000 in reported damages associated with this event in Emmet County.]

Probability of Future Events and Vulnerability Assessment

Between 1996 and 2023, Emmet County has had 126 severe winter weather events. This averages to about 4.5 events every year. Therefore the probability of an event occurring in future years is 100 percent. Severe winter weather events have the potential of shutting down towns and businesses for a significant period of time. Travel is also limited or impossible during extreme winter weather events. Blowing/drifting snow causes driving hazards and can make air travel impossible. Ice damage may occur when high winds push lake or river water and ice past the shoreline, causing damage to infrastructure and private property. The agriculture industry in the county is also vulnerable to ice storms.

During the winter months, the population is largely made up of the base permanent residents. However, there is increasing demand from seasonal residents to purchase property and retire or work remotely from highly desirable northern and coastal communities like those in Emmet County. Winter storm events cause difficult driving conditions and can make travel increasingly difficult for emergency personnel who may be more frequently dispatched to rural areas. The most vulnerable include elderly persons; persons living at or below the poverty level; members who live in remote rural areas; those with limited access to technology including cellular phone service and broadband internet; and those without an emergency power source.

Thunderstorms and High Winds

The National Weather Service defines a severe thunderstorm as: *a thunderstorm that produces a tornado, winds of at least 58 mph (50 knots or ~93 km/h), and/or hail at least 1" in diameter.* These storms can also produce lightning or heavy rain (that could cause flash flooding). Severe thunderstorms can occur at any time in Michigan, although they are most frequent during the warm spring and summer months from May through September.

High wind events are also included in this hazard category. Long-lived wind events associated with fast-moving severe thunderstorms are known as a *derecho* (pronounced similar to "deh-REY-cho"). According to the National Weather Service, a derecho is a widespread, long-lived wind storm that is associated with a band of rapidly moving showers or thunderstorms. Although a derecho can produce destruction similar to the strength of tornadoes, the damage typically is directed in one direction along a relatively straight swath. As a result, the term "*straight-line wind damage*" sometimes is used to describe derecho damage. By definition, if the wind damage swath extends more than 240 miles (about 400 kilometers) and includes wind gusts of at least 58 mph (93 km/h) or greater along most of its length, then the event may be classified as a derecho. A derecho often occurs during the spring or summer; however, it can occur any time of the year.

Location
Thunderstorms and severe wind are regional events that are not confined to geographic boundaries and can affect several areas at one time with varying severity depending on factors such as elevation and wind patterns. All of Emmet County is at risk from thunderstorms and severe winds.

Extent
Thunderstorms can be measured based on wind speed or damages. The recorded wind gusts for thunderstorm/wind and high wind events in Emmet County range from 43 to 65 knots. These events have caused a total of $623,000 in property damages and caused one injury.

Table 39. Thunderstorm and Wind Events Previous Occurrences, Emmet County

Event Type	Number of Events	Deaths	Injuries	Property Damage	Crop Damage	Event Year(s)
Thunderstorm/ Wind	57	0	1	$244,000	$ -	1967, 1971, 1972, 1974, 1976, 1982-84, 1988, 1991, 1994, 1995, 1997-99, 2001-07, 2010, 2012, 2015-2021
High Wind or Strong Wind	16	0	0	$379,000	$ -	1998-2001, 2003-2005, 2007, 2010, 2014, 2015, 2017, 2021
TOTAL	**73**	**0**	**1**	**$623,000**	**$ 0**	

Source: NOAA: National Centers for Environmental Information

Previous Occurrences
Between the years 1967 and 2023, there have been 73 thunderstorm/wind or high wind events reported in Emmet County (Table 39). This is the second-most frequently occurring type of severe weather event in the county.

The event narratives on record with NOAA indicate that most of the damages associated with the events were from high winds blowing objects or falling trees on homes, businesses, power lines, and cars (one injury was reported from an August 2001 storm in Alanson when a tree fell on a car injuring the occupant). The NOAA storm event/episode narratives particularly impactful events are provided below:

- 12/16/2021 High Wind Event: An impressive sub-980mb cyclone tracked across western Lake Superior into Ontario during the morning of 12/16, bringing widespread wind gusts of 60-70mph across all of northern Michigan. The highest gust recorded was 70 mph at Traverse City Cherry Capitol airport. Widespread downed trees, limbs and powerlines were seen across the County Warning Area, leaving many with power outages that extended for several days. Some schools and businesses across the area were forced to close for the day due to power outages. The Mackinac Bridge was forced to partially close to high profile vehicles for around 12 hours due to winds reported of 82 mph from the mid-span of the bridge. [$25,000 in property damages.]

- 7/18/2020 Thunderstorm/Wind Event: Thunderstorm activity earlier in the day laid down an outflow boundary across far northern Lower Michigan. Severe thunderstorms reignited along that boundary by mid-afternoon. Damaging winds and excessive rainfall were the primary hazards. Severe winds caused extensive tree damage and some property damage in Petoskey and Bay View. Many trees and large limbs were downed, damaging a few structures. A large sign outside of a hotel was blown down, and trees on the property were uprooted. The Pennsylvania Plaza Building in Petoskey suffered damage to roofing and exterior brickwork. [Wind gusts of 60 knots; $135,000 in property damage.]

- 9/4/2014 High Wind Event: The second significant wake low event of the day impacted primarily far northern Lower Michigan, in particular the Little Traverse Bay area. Wind speeds were measured in the 50 to 55 mph range in and around Petoskey. They were likely higher in Harbor Springs, where considerable damage was done at the marina. The winds were accompanied by a significant rise in water level. Numerous docks were damaged, and multiple boats were capsized and/or pushed ashore. [$65,000 in property damage.]

- 10/27/2010 High Wind Event: An historically deep low pressure system lifted across Minnesota on the 26th, and passed just north of Lake Superior on the 27th. This storm produced widespread strong to damaging winds across Northern Michigan. Damaging winds kicked in at a few spots by mid-afternoon on the 26th, but the 27th saw the highest winds, with widespread tree and roofing damage, along with power outages. Some vehicles and structures were damaged by falling trees. Power was out for several days at some locations. Peak wind speeds included: 72 mph in Naubinway; 63 mph at Whitefish Point, Manistee Harbor, and Gaylord; 59 mph in Pellston; and 58 mph in Alpena. At one point, the Alpena Airport suspended operations due to flying debris [$47,000 in property damage].

- 7/10/2007 (Two Thunderstorm/Wind Events): A line of thunderstorms, well ahead of a cold front, advanced out of Wisconsin and across Lake Michigan. The line produced a few spots of wind damage in Northern Lower Michigan. Showers along the front itself managed to produce a waterspout on Torch Lake. Many trees and power lines were downed, from the east end of Little Traverse Bay, extending inland a few miles. One car was crushed by a falling tree. A woman at Petoskey State Park was briefly trapped inside a motorhome. A car at the Petoskey post office was damaged by a falling tree. [Wind gusts of 52 and 58 knots. $37,000 in property damage.]

- 11/13/2005 High Wind Event: Another big wind storm, as another strong low pressure system moved northeast across Lake Superior. Winds gusted to 66 mph at Sleeping Bear Dunes, 63 mph at Northport, 62 mph at Point Iroquois, 59 mph at Pellston, and 58 mph in Gaylord. Hundreds of trees were downed, and power outages were widespread. A number of homes lost shingles, and several homes and vehicles saw substantial damage when struck by falling trees. A dock on Houghton Lake was flipped over. Business signs and billboards were blown over in Chippewa County. The Mackinac Bridge was closed to all trucks and trailers, causing tremendous backups during this very busy travel period (the lead-up to deer firearms season). Numerous trees downed. Shingles torn off of roofs. 59 mph gust measured at Pellston Regional Airport. [$20,000 in property damage.]

- 4/18/2004 High Wind Event: Strong southerly winds ushered warm air into Northern Michigan after sunset. Numerous wind gusts of 50 to 55 mph occurred during the night of the 18th. These winds downed a stray tree here or there, along with the occasional power line. More significant damage occurred at the Pellston Regional Airport, where a parked turboprop commercial aircraft was spun into nearby boarding docks, damaging the wings and tail section of the aircraft. At the same airport, a Cessna 150 was flipped by the strong winds, causing substantial damage [$20,000 in property damage.]

- 8/26/2003 Thunderstorm/Wind Event: Thunderstorms, originating in northern Minnesota, developed into a squall line that moved across Lake Michigan into far northern Lower Michigan near dawn. The storms resulted in widespread wind damage. Numerous trees and power lines were downed. Several homes and cottages were damaged by falling trees near Crooked and Pickerel Lakes, and a small aluminum boat was tossed into a tree. At a dealership in Petoskey, trailers were rolled off of a parking lot and into a ditch. [Wind gusts of 55 knots; $51,000 in property damage.]

Probability of Future Events and Vulnerability Assessment

Between the years 1967 and 2023, there have been 73 thunderstorm/wind or high wind events reported in Emmet County. This averages to 1.3 events per year; therefore the probability of an event occurring in a future year is 100 percent. Damage from straight line winds usually affects multiple counties with the loss of electricity from trees/tree limbs downing power lines; widespread property damage; and potentially exposing people to severe injury or fatality due to flying debris. The magnitude of the impact of thunderstorm/wind and high wind events depends on the seasonal population, seasonal activities, and the spread of development.

During the warm or summer months, the area's population expands to include both the permanent population and visitors. Residents and visitors are attracted to both rural, sparsely populated rural areas and urbanized areas (particularly for annual special events; see Table 41). Mobile home communities, and campgrounds, and numerous annual special events that draw a large number of tourists to outdoor recreation areas were identified as specific areas of vulnerability (see Tables 40 and 41).

Thunderstorms can appear quickly and cause significant damage. Aside from the cities of Petoskey and Harbor Springs and the villages of Alanson, Pellston, and Mackinaw City, the county's population is geographically spread out and notifying them of tornado warnings or watches can be difficult. Severe thunderstorm/high wind alerts are provided to the public via the BeAlert notification system, television and radio announcements. The efficacy of the BeAlert system is limited due to the sign up process, as citizens must request to be added to the alert system.

Table 40. Campgrounds and Mobile Home Communities in Emmet County

Community	Campground	Mobile Home Community
City of Harbor Springs		Harbor Springs Estates
City of Petoskey	Magnus Park CG	
Village of Alanson	El Rancho RV Campers Country Club	Banwell and Armock Roads
	Artesian Springs RV Resort	El Rancho Mobile Home Community
Bear Creek Township	Jellystone Park	Chalet Estates Mobile Home Park (Pickerel Lake Rd., east of Bellmer Rd.)
	Hearthside Grove Motorcoach Resort	
	Petoskey State Park Dunes Campground	
	Petoskey State Park Tannery Creek CG	
	Petoskey State Park Youth CG Sites	
Bliss Township	Wilderness State Park CG	
	Nebo Rustic Cabin - Wilderness State Park	
	O'Neal Lake Rustic CG Site Wilderness SP	
Little Traverse Township	LTBBOI Rustic Campground	Conway Commons
Littlefield Township	El Rancho RV Campers Country Club	6700 US-31 (unknown community name)
	Camp Petosega	El Rancho Mobile Home Community
Readmond Township	Blissfest Campground	
Resort Township	Sun Outdoors RV Park	Bay Shore Estates
Springvale Township	Camp Petosega	
Wawatam Township	KOA Campground Mackinaw City	

Table 41. Annual Major Special Events and Activities in Emmet County

Location	Event	Typical Dates of Event
City of Harbor Springs	4th of July running races, parade and fireworks	4th of July
	Boyne Thunder powerboat poker run (HS stop)	2nd Saturday of July
City of Petoskey	Bay Harbor Classic Car and Boat Festival	3rd weekend of June
	Boyne Thunder powerboat poker run (Bay Harbor Stop)	2nd Saturday of July
	Bay Harbor fireworks	3rd of July
	Downtown parade and fireworks	4th of July
	Art in the Park	3rd Saturday of July
	Emmet-Charlevoix County Fair	3rd week in August
Village of Alanson	4th of July Parade	July 4
	Top O' Michigan Outboard Races	Mid-August
	Labor Day Festival	Labor Day
Village of Mackinaw City	Memorial Day Parade and Pageant at the Fort	Memorial Day
	Bridge Walk	Labor Day
LTBBOI Tribal Headquarters, 7500 Odawa Circle (Little Traverse Twp.)	Annual Homecoming Pow Wow	2nd weekend in August
Pleasantview Township	The Highlands Resort	Winter skiing; special events throughout the year
Pleasantview and Little Traverse Townships	Nub's Nob Ski Resort	Winter skiing
Pleasantview, Little Traverse, West Traverse, Friendship, Readmond, Cross Village, Bliss, Carp Lake, and Wawatam Townships; Village of Mackinaw City	Zoo-De-Mack Bike Ride	3rd Saturday of May
Readmond Township	Blissfest Music Festival	2nd weekend of July

Lightning

Lightning is a random and unpredictable discharge of electricity in the atmosphere between the clouds, air, or ground to equalize the charged regions in the atmosphere. It is still being debated how the electrical charges build up in the clouds. Lightning generally occurs during thunderstorms; however, it can occur without a thunderstorm, such as during intense forest fires and heavy snowstorms. Lightning that occurs without nearby rain is most likely to cause forest fires.

Location
Lightning is not confined to geographic boundaries and is a regional event. Since lightning occurs randomly, it is impossible to predict where lightning will occur and how severe it will be. All of Emmet County is at risk from lightning strikes.

Extent and Previous Occurrences
Lightning can be measured by damages-caused including deaths, injuries, property damages, and/or crop damages. There has been one lightning incident reported to NOAA for Emmet County (Table 42), which resulted in no injuries or deaths, but $4,000 in property damages when lightning struck a home in Petoskey, igniting a small roof fire that was brought under control within an hour.

Table 42. Lightning Events in Emmet County

LOCATION	DATE	DEATHS	INJURIES	PROPERTY DAMAGE
City of Petoskey	5/11/2011	0	0	$4,000

Source: NOAA: National Centers for Environmental Information

Probability of Future Events and Vulnerability Assessment
There has been one damaging lightning event on record in the last 13 years for Emmet County. This indicates there is a 7.7% chance of an impactful lightning strike occurring in a future year. However, it is assumed that not all lightning events have been reported since events with injuries, deaths, and extensive damages tend to be the only ones reported. Therefore, the amount of damages from lightning strikes is likely higher.

Vegetation (especially in dry soils), buildings and infrastructure are at risk from lightning events that may cause structural and wildland fires, loss of electrical and telecommunications equipment, and damage to buildings or vehicles from falling trees struck by lightning.

People that work outside or participate in outdoor recreation activities are at a higher risk to be struck by lightning. Emmet County is rich in land and water-based outdoor recreation areas.

One of the concerns indicated in the community survey for this plan was the possibility of a lightning strike at the location of the former Big Rock Nuclear Plant in Hayes Township (adjoins Emmet County's Resort Township to the west, in Charlevoix County) where casks of spent nuclear fuel are stored. However, according to personnel responsible for management of the site, risk of public exposure to any radiation would likely be very minimal in the event of a direct lightning strike to the casks. Lightning rods surround the casks as a preventative measure against lightning strikes, and any damage to the cask would only result in localized radiation at that site. Unlike an active nuclear power plant, the Big Rock site is not required to have protective action guidelines for a mass evacuation scenario (a plume of radioactive material would not be disbursed into the air if the casks were damaged). Areas of developed land are at least 1/3 mile away from the location of the stored nuclear waste.

Hail

Hailstorms occur when a severe thunderstorm produces hail that falls to the ground. Hail is formed when the updrafts of the storm carries water droplets above the freezing level, where they form into rounded or irregular lumps of ice that range from the size of a pea to the size of a grapefruit. When the weight of the hail is no longer supported by the air, it falls to the ground and has the potential to batter crops, dent automobiles, and injure people and wildlife. Sometimes, large hail appears before a tornado since it is formed in the area of a thunderstorm that tornadoes are most likely to form.

According to the 2019 Michigan Hazard Mitigation Plan, Michigan has on average 191 hail storms, an expected annual statewide loss of about $16.6 million, no deaths, and approximately 1 injury per year. Despite damaging hail occurring in every part of Michigan, the areas of the state most prone to severe thunderstorms (e.g. the Southern half of the Lower Peninsula) are also most prone to large and damaging hail. The majority of the hailstorms occur during the growing season from May through August when crops have the greatest potential to be damaged by hail.

According to the 2012 Michigan Hazard Analysis, the National Weather Service began recording hail activity in Michigan in 1967. The National Weather Service issues forecasts for severe thunderstorms with sufficient warning time to allow residents to take appropriate action to reduce the effects of hail damage to vehicles and some property. However, little can be done to prevent damage to crops. For example, during September 26-27, 1998, a line of severe thunderstorms moved across northern Lower Michigan producing hail up to 2" in diameter, destroying an estimated 30,000-35,000 bushels of apples at area farms, and damaging several homes and vehicles.

Location
Hailstorms are regional events that frequently accompany thunderstorms, and are not confined to geographic boundaries. The severity of hailstorms may range across the affected areas. All of Emmet County is at risk from hailstorms. According to the National Weather Service, Emmet County is in an area of the United States that has on average two days of hailstorm events per year.

Extent
The description of hail is based on its approximate size, as described as follows in Table 43. If a thunderstorm produces hail that is 1 inch in diameter (quarter size) or larger, it is considered to be a severe thunderstorm.

Table 43. NOAA Hail Size Description

Appearance	Approximate Size in Inches
Pea	0.25-0.5 inch
Penny	0.75 inch
Nickel	0.88 inch
Quarter	1.00 inch
Walnut/Ping Pong	1.50 inch
Golf Ball	1.75 inch
Hen Egg	2.00 inch
Tennis Ball	2.50 inch
Baseball	2.75 inch
Tea Cup	3.00 inch
Grapefruit	4.00 inch
Softball	4.50 inch

Hail can damage aircraft, homes and cars, and can be deadly to livestock and people. Hailstorms have caused no deaths or injuries, no recorded crop damages, but $100,000 worth of property damage in Emmet County. The greatest extent hail reported in Emmet County was 2.5 inches in diameter on June 24, 1998, causing $100,000 in property damage to cars on two lots west of Petoskey.

Previous Occurrences
Between 1983 and 2023, Emmet County had 18 hail events reported to NOAA (Table 44).

Table 44. Hail Events, Emmet County

Place	Date	Magnitude (inches)
	7/31/1983	1
	7/31/1983	1
PELLSTON	8/14/1996	0.75
BAYSHORE	6/24/1998	1.5
PETOSKEY	6/24/1998	2.5
PETOSKEY	6/24/1998	1.25
PETOSKEY	8/23/1998	1
PELLSTON	7/13/2000	0.75
PETOSKEY	4/18/2002	0.75
PETOSKEY	6/27/2005	0.75
CONWAY	6/27/2005	0.88
CROSS VLG	10/14/2005	1
ALANSON	7/30/2006	0.75
BRUTUS	6/22/2008	0.75
BAY VIEW	6/9/2010	0.75
BAY VIEW	6/8/2011	0.75
(PLN)EMMET CO APT PE	9/21/2012	0.88
LEVERING	9/30/2019	1

Source: NOAA: National Centers for Environmental Information

Probability of Future Events and Vulnerability Assessment
There have been 18 hail events reported between 1983 and 2023 in Emmet County, which equates to a 44% chance that an impactful hail event would occur in a future year. All buildings, exposed infrastructure, and populations are at risk from hailstorms since hail causes damage to roofs, brick walls, glass, landscaping, crops, and cars. Mobile homes and campground populations located throughout the county and are more susceptible to impacts from hail. Hail can also damage roads, sidewalks, bridges, and above ground utilities. Hail has the potential to cause injury and death, and populations are advised to take shelter when an event occurs.

Riverine and Urban Flooding

Fluvial, or Riverine flooding occurs when rivers, streams, and lakes overflow into adjacent floodplains due to prolonged, intense rainfall, rapid snowmelt or ice jams. Flooding can damage or destroy property, disable utilities, destroy crops and agricultural lands, make roads and bridges impassable, and cause public health and safety concerns. Floods occur in the early spring, but also occur in the winter due to ice jams, and during the summer or fall from severe thunderstorms. Flooding caused by severe thunderstorms has a greater impact on watercourses with smaller drainage areas.

Pluvial, or *Urban, flooding* occurs when water flows into low-lying areas because it does not have a place to go, due to impervious surface coverage. This flooding occurs from a combination of excessive rainfall, snowmelt, saturated ground, and inadequate drainage, and is becoming more common in Michigan. Since development is occurring in floodplains, the natural landscape is unable to properly disperse the water. Urban flooding also has the potential to overflow onto docks or other structures with electricity running to them, which increases the risk for an electric shock drowning. Additionally, storm and sanitary sewers are unable to handle the water flows associated with storm events, which can result in sewer overflows and affect the water quality of nearby lakes and rivers, as well as structures with basements or shallow groundwater tables.

Dam failure is also a potential source of flooding, and is discussed as a Technological Hazard in Section IV of this plan.

According to the 2019 Michigan Hazard Analysis, the most damaging hazard in Michigan, based upon estimated physical damages and known response/recovery costs, appears to be floods. The MSP reports that flooding events have a statewide expected annual loss estimated at more than $100 million ($25.69 million had previously been estimated in the 2014 Michigan Hazard Mitigation Plan, but Federal Disaster 4195 confirmed a higher magnitude more in line with earlier EGLE estimates, as that Metro Detroit flood event was quite similar to Federal Disaster 1346 during the previous decade).

The MSP's 2019 Michigan Hazard Analysis indicates that the Northern Lower Peninsula averages 0.3 annual flooding events, with average annual property and crop damages of $2,591,244 due to flooding.

Location

Areas of urban development (Cites of Petoskey and Harbor Springs; Villages of Alanson, Pellston and Mackinaw City) are more vulnerable to flash flooding than other rural areas of the county due to their concentration of impervious surfaces.

Also, seasonally high water tables, often occurring in late winter and the spring, can compromise aging or inadequate septic systems, leading to contamination of local lakes and streams. Seasonal flooding in the spring also affects many road/stream crossings, particularly near wetlands, throughout the county.

Participants in the public input session held in March 2023 identified the following specific sites as areas of concern regarding flooding (Table 45). These sites are also indicated on the hazard maps in Appendix A.

Table 45. Flooding Sites of Concern in Emmet County, per Stakeholder Input

Alanson Village
Entire village area
Particular concern along the Crooked River south of M-68 and east of US-31
Bear Creek Township
Tannery Creek corridor, especially around its crossing under US-31
US-31 corridor between Division and M-119
All of the Bear River corridor along River Road
Bear River Road, east of River Road

Bliss Township
Southwest side of O'Neal Lake
Carp Lake Township
Carp River, near US-31 and Lake Paradise
Lake Paradise
Cross Village Township
Wycamp Creek near west side of Wycamp Lake around Lakeshore Drive, Chippewa Drive, and Arbutus Road.
Littlefield Township
Oden Island
Mission Road, north of Hilltop Road
Crooked River corridor
Maple River Township
Snider Road, south of the Crooked River
Cedar Road around White's Creek crossing
Crooked River corridor to Burt Lake
McKinley Township
Ely Road, between Reed Road and US-31
City of Petoskey
The Bear River corridor
Springvale Township
King Road, west of Maxwell Road
Wawatam Township
French Farm Creek
Carp River near Cecil Bay Road, Wilderness Park Drive, and Pointe Drive
West Traverse Township
Five Mile Creek near M-119 and Lower Shore Drive[5]

Extent and Previous Occurrences

The extent of an inland flooding event can be measured by the amount of property damage and accumulation of rainfall. There are two flash flood events and one flood event on record with NOAA for Emmet County, which caused a total of $103,000 in property damages (Table 46). No reported crop damages, deaths or injuries are associated with those events.

Table 46. Emmet County Fluvial and Pluvial Flood Events

LOCATION	DATE	EVENT TYPE	DEATHS / INJURIES	PROERTY DAMAGE	CROP DAMAGE	FLOOD CAUSE
Cross Village Township	6/22/2011	Flash Flood	0	$18,000	-	Heavy rain
Littlefield Township	7/18/2020	Flash Flood	0	$80,000	-	Heavy rain
City of Harbor Springs	9/3/2022	Flood	0	$5,000	-	Heavy rain
TOTAL			**0**	**$ 103,000**	**$ -**	

Source: NOAA National Centers for Environmental Information Storm Events Database

[5] The Michigan Department of Transportation (MDOT) replaced the culvert that carries the Five Mile Creek tributary beneath M-119 in June 2024. This work will help maintain the integrity of the roadway in this location and guard against future washouts.

The NOAA episode and event narratives for those events are provided below:

- 6/2/2011 Flash Flood in Cross Village Township: *Bands of training thunderstorms affected parts of Northwest and North Central Lower Michigan. Locally very heavy rain occurred in a few spots, including between Manistee and Cadillac. The only flooding occurred in the Cross Village area of Emmet County.*

  A culvert was washed out along Levering Road (C-66) a few miles east of Cross Village. Substantial soil erosion occurred in the yards of some homes. The co-operative observer, one mile east of Cross Village, measured 4.79 inches of rain in 12 hours, most of which fell in a four hour period either side of midnight.

- 7/18/2020 Flash Flood in Littlefield Township: *Thunderstorm activity earlier in the day laid down an outflow boundary across far northern lower Michigan. Severe thunderstorms reignited along that boundary by mid afternoon. Damaging winds and excessive rainfall were the primary hazards. Thunderstorms moved repeatedly over the same area on the afternoon of the 18th. Rainfall amounts of 2 to 4 inches were estimated to fall from just northeast of Petoskey, on toward Indian River. Measured rainfall amounts by the next morning were as high as 5.25 inches near Afton, though this occurred over multiple rounds of thunderstorms, not just this late afternoon batch.*

  Flash flooding was reported in the community of Oden in Emmet County, where knee-high water flooded homes along Pingree Avenue, on the east side of town.

- 9/3/2022 Flood in the City of Harbor Springs: *A line of strong thunderstorms formed along an advancing cold front early in the morning on 9/3, eventually tracking into northern lower Michigan and producing heavy rainfall. Additional storms initiated just behind the line and continued to produce heavy rainfall in the vicinity of Little Traverse Bay, leading to significant erosion of the shoulder of M-119. A 24 hour rainfall total of 2.80 inches was measured 1 mile NNE of Harbor Springs at 9:30 AM EST with the majority of that falling in a 3 hour period that morning. M-119 (Bluff Dr) closed at Harrison St due to significant erosion of shoulder of highway.*

Figure 17. Washout Area on M-119, near Harrison Street, Harbor Springs, September 2022

Photo Credit: Harbor Light Newspaper

In addition, stakeholders providing input for this plan identified concerns regarding erosion along the bluff on the Lake Michigan side of M-119 in portions of: West Traverse Township; the City of Harbor Springs; and Readmond Township. In Readmond Township, stormwater runoff from M-119 along the bluff has caused road washouts/landslides affecting some properties in the Sequoia Yacht Club homeowner's association, near the community of Good Hart.

Probability of Future Events and Vulnerability Assessment
Since 2011, Emmet County has had 3 inland flooding events on record with NOAA, indicating there is a 23% annual chance of another damaging riverine or urban flood event. The magnitude and severity depend on the area of impact's population, seasonal activity, and the spread of development. During the warm or summer months, the population expands to include both the permanent population and visitors to the area. Areas of urban development (cities of Petoskey and Harbor Springs; Villages of Mackinaw City, Pellston and Alanson) are more vulnerable to flash flooding than other rural areas of the county due the greater amount of impervious surfaces in those jurisdictions.

FEMA's proposal of FIRM updates in 2018 prompted the City of Harbor Springs to complete a floodplain project in order to protect City infrastructure and private properties from a "100-year flood" event (a catastrophic flood that has a 1% chance of occurring every year). The project was completed in 2019 and allows flood waters from the Shay Drain to reach Lake Michigan without damaging City infrastructure or flooding private homes and businesses. This project included construction of a concrete culvert and pathway underneath M-119 that connects to Zoll Street.

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. 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.

Inland flooding will continue to occur at times in Emmet County. Years with exceptional snowfall levels will likely result in flooding events from snowmelt. Increasing Lake Michigan water temperatures will create more active storm systems and heavier rainfalls. Fluctuating Lake Michigan water levels will also increase inland flooding events as groundwater tables rise. Furthermore, increased development, reduction in green space, and subsequent soil erosion can cause sedimentation to accumulate in river and lake beds reduce the amount of water flow. Rivers and lakes with sedimentation buildup will experience water backups and flooding events unless mitigated.

Also, seasonally high water tables, often occurring in late winter and the spring, can compromise aging or inadequate septic systems, leading to contamination of local lakes and streams.

The specific flooding areas of concern in Emmet County communities are provided in Table 47 and indicated on Hazard Areas maps in Appendix A.

The Infrastructure Map included in Appendix A illustrates the locations of road/stream crossings, bridges and Michigan-inventoried dams with their currently available condition rating. It should be noted that data is not available for every infrastructure location.

NFIP Participation Status
FEMA identifies floodplains to determine eligibility for the National Flood Insurance Program. Floodplain lands abut surface waters and generally follow creeks and streams. Table 47 provides recent National Flood Insurance Program statistics for Emmet County:

Table 47. National Flood Insurance Program Statistics, Emmet County

Total Policies	Total Coverage	Total Premium	Claims since 1978	Total Paid Since 1978
30	$11,900,000	$20,255	4	$13,550

Source: FEMA NFIP Policy and Claims Report, 5/24/2023 https://www.michigan.gov/msp/divisions/emhsd/programs-and-publications/mhmp-appendix-5

Emmet County received an updated Flood Insurance Study effective June 1, 2022, which included updated digital flood maps for West Traverse, Little Traverse, Friendship, Cross Village and Readmond Townships, the Village of Mackinaw City, the City of Petoskey and the City of Harbor Springs; and new digital flood maps for Bear Creek,

Bliss, Resort, and Wawatam Townships. Community input and coordination with FEMA will determine the extent, if any, of future mapped flood areas.

An NFIP-insured structure that has had at least two paid flood losses greater than $1,000 each in any 10-year period since 1978 is considered a "repetitive loss" property by FEMA.[1] A formal request was made to FEMA Region 5 on September 3, 2024 (via email at FEMA-R5-NFIP@fema.dhs.gov) for current information on repetitive loss properties within Emmet County. At the time this hazard mitigation plan was finalized and sent to the Michigan State Police and FEMA for review, a response to the request had not been received.

Table 48 outlines the NFIP information for participating communities. The communities of Bear Creek, Bliss, Resort, and Wawatam townships are listed as non-participants in the NFIP as they have not submitted documentation of local adoption of the FIRM(s) to FEMA (Table 49). During the development of this hazard mitigation plan, inquiries were made with local government officials as to the reason why they are a non- participant in the program. No responses were received.

Table 48. Emmet County Communities Participating in the NFIP

Municipality	Community ID	Floodplain Management /FIRM Map Adoption*	Current Effective Map Date	Reg- Emerg Date**	Implementation Method***	Implementation of Damage Provisions****
Cross Village Township	260745A	Y	6/1/2022	9/4/1986	The Emmet County Building Department is the designated agency to administer, apply and enforce the floodplain management regulations as contained in the state construction code. The FIRMS are declared to be a part of Section 1612.3 of the Michigan Building Code and provide the content of the "Flood Hazards" section of Table R301.2 (1) of the Michigan Residential Code. Local zoning ordinances regulate development pertaining to flood hazard areas.	Per the State of Michigan Building Code, if more than 50% of a building is damaged by a flood, the entire structure must comply with current construction code standards.
Friendship Township	261573A	Y	6/1/2022	6/1/2022		
City of Harbor Springs	260272A	Y	6/1/2022	5/16/1977		
Little Traverse Township	260748A	Y	6/1/2022	12/18/1986		
Village of Mackinaw City	260675A	Y	7/19/2022	9/18/1987		
City of Petoskey	260072A	Y	6/1/2022	10/19/1982		
Readmond Township	260755A	Y	6/1/2022	12/18/1986		
Springvale Township	261017A	Y	NSFHA as of 6/1/2022; panels not printed	3/3/2000		
West Traverse Township	260721A	Y	6/1/2022	3/1/1987		

Data Source: FEMA Community Status Book Report, Accessed 1/5/2024
* Adoption of NFIP minimum Floodplain management criteria via local regulation.
** The date the community first joined the NFIP.
*** How local floodplain management regulations are implemented and enforced in Special Flood Hazard Areas.
****How participants implement the substantial improvements/substantial damage provisions of their floodplain management regulations after an event.
"NSFHA" = non-special flood hazard areas; all Zone C – an area that is in a moderate-to-low risk flood zone.

[1] https://www.fema.gov/glossary/repetitive-loss-structure

Table 49. Emmet County Communities Not Participating in the NFIP

Municipality	Community ID	Floodplain Management /FIRM Map Adoption*	Initial FIRM Identified / Current Effective Map Date	Sanction Date [6]
Bear Creek Township	261574A	N	6/1/2022	6/1/2023
Bliss Township	261566A	N	6/1/2022	6/1/2023
Resort Township	261575A	N	6/1/2022	6/1/2023
Wawatam Township	261572A	N	6/1/2022	6/1/2023

[6] A community that does not join the NFIP after being identified for one year as floodprone, has withdrawn from the program, or is suspended from it, faces the following sanctions:

1. No resident will be able to purchase a flood insurance policy.
2. Existing flood insurance policies will not be renewed.
3. No Federal grants or loans for development may be made in identified flood hazard areas under programs administered by Federal agencies such as HUD, EPA, and SBA;
4. No Federal disaster assistance may be provided to repair insurable buildings located in identified flood hazard areas for damage caused by a flood.
5. No Federal mortgage insurance or loan guarantees may be provided in identified flood hazard areas. This includes policies written by FHA, VA, and others.
6. Federally insured or regulated lending institutions, such as banks and credit unions, must notify applicants seeking loans for insurable buildings in flood hazard areas that there is a flood hazard and that the property is not eligible for Federal disaster relief.

Tornado

Tornadoes are rapidly rotating columns of air that impact the ground after forming from some of the severe thunderstorms that occur during Michigan's warm months. Tornadoes can cause catastrophic damage to either a limited or an extensive area. A tornado can have winds exceeding 200 miles per hour and can have widths over one mile. These storms are the most violent of the atmospheric storms since they have the potential to destroy buildings, uproot trees, hurl objects, and cause loss of life.

According to the National Oceanic and Atmospheric Administration/National Weather Service's Storm Prediction Center, tornadoes cause approximately 60 deaths and hundreds of millions of dollars in property damage each year. The Michigan State Police's *2019 Michigan Hazards Analysis*, Michigan is located on the northern fringe of the nation's tornado belt, and since 1996 has averaged about 18 tornadoes per year. The longer term annual average (since 1950) is 8 injuries and one death per year, and over $17 million in property damages statewide.

Between 1999 and 2019, Michigan has had 314 reported tornado events with 52.9% as EF0 (weak) or EF1 (moderate), 38.9% reported as F0 or F1 (weak), 6.7% as EF2 (significant) or EF3 (severe), and 1.6% as F2 (strong). In Northern Michigan, tornados are most likely in the summer months, although some have occurred in the spring and fall.

Location
Tornadoes are a regional event that are not confined to geographic boundaries and can affect several areas at one time. Also, the magnitude of tornadoes may range across the affected areas. All of Emmet County is at risk from tornadoes. It is impossible to predict where and with what magnitude a tornado will touch down. Approximate trajectories of recorded tornadoes with NOAA are illustrated on the Hazard Areas Map in Appendix A.

Extent
The Fujita Scale (Table) categorizes tornado severity based on observed damage. The six-step scale ranges from F0 (light damage) to F5 (incredible damage). As of February 2007, the National Weather Service uses the Enhanced Fujita Scale (EF Scale), which ranges from EF0 to EF5. Based on the Fujita Scale, Emmet County's strongest tornado occurred on July 4, 1957 with winds ranging from 86-109 mph. It caused no injuries or deaths, but $25,000 in property damage.

Table 50: Fujita and Enhanced Fujita Scale Comparison

Fujita Scale		EF Scale	
Fujita Scale	**3-Second Gust Speed (mph)**	**EF Scale**	**3-Second Gust Speed (mph)**
F0	45-78	**EF0**	65-85
F1	79-117	**EF1**	86-109
F2	118-161	**EF2**	110-137
F3	162-209	**EF3**	138-167
F4	210-261	**EF4**	168-199
F5	262-317	**EF5**	200-234

Source: FEMA

Previous Occurrences
Since 1953, Emmet County has had five reported tornados, which caused a total $52,000 in reported property damage (Table 51). As a result of these tornadoes, there were no deaths, no injuries, and no reported crop damage.

An F1 tornado occurred in Petoskey in 1953. Its path was 33 yards wide. The exact location of the tornado is unknown.

An F1 tornado occurred in Petoskey on June 6, 1955. Its path was 1 mile long and 33 yards wide. The exact location/trajectory of the tornado is unknown. This tornado caused $2,500 in property damage.

An F1 tornado touched down in the City of Harbor Springs on July 4, 1957, traveling in a northeast direction and ending in Pleasantview Township. Its path was 6.1 miles long and 33 yards wide, causing $25,000 in property damage.

An F0 tornado occurred in Littlefield Township on August 18, 1987. Its path was 0.3 miles long and 30 yards wide. The exact location/trajectory is unknown. $25,000 in property damages are reported for this event.

On August 14, 1996, an F0 tornado was spotted in a field northeast of Pellston Airport (McKinley Township). Its path was 0.1 mile long and 5 yards wide. The NOAA episode narratives for this event is as follows: *"Observers at the Pellston airport reported a small tornado northeast of the airport. It remained nearly stationary for much of its existence then moved northeast. The tornado touched down in a field and did no damage."*

Table 51. Tornado Events in Emmet County

LOCATION	DATE	MAGNITUDE	DEATHS	INJURIES	PROPERTY DAMAGE
Petoskey	9/20/1953	F1	0	0	
Petoskey	6/6/1955	F1	0	0	$2,500
City of Harbor Springs; West Traverse, Little Traverse, & Pleasantview Townships	7/4/1957	F1	0	0	$25,000
Littlefield Township	8/18/1987	F0			$25,000
McKinley Township	8/14/1996	F0	0	0	0
TOTAL	**5**		**0**	**0**	**$52,500**

Source: NOAA - National Centers for Environmental Information

Probability of Future Events and Vulnerability Assessment

Since there have been four tornadoes events reported in the last 71 years, the data shows that there is a 7% annual chance a tornado would occur in a future year. While the chance for a tornado is low, if an event occurs, there is potential for a higher magnitude tornado to touch down. The cities of Petoskey, Harbor Springs, and adjoining communities, where the densities of population and developed lands are highest, would bear the greatest amount of impact from a tornado. Mobile homes are also more at risk from tornado-induced damage than homes built on permanent foundations (Table 52).

Table 52. Estimated Mobile Homes in Emmet County Communities

Community	Mobile Homes	% of Housing Units
Emmet County	1,376	6.30%
Littlefield Township	448	23.80%
Bear Creek Township	198	4.70%
Carp Lake Township	132	19.50%
McKinley Township	94	14.60%
Resort Township	87	5.90%
Alanson Village*	72	14.90%
Pellston Village*	51	14.10%
Maple River Township	49	7.20%
Little Traverse Township	48	2.60%
Bliss Township	45	10.50%
Harbor Springs City	45	4.20%

Community	Mobile Homes	% of Housing Units
Center Township	40	12.30%
Pleasantview Township	36	3.40%
Wawatam Township	33	6.10%
Readmond Township	32	6.50%
Springvale Township	30	2.90%
West Traverse Township	24	1.70%
Cross Village Township	19	6.30%
Friendship Township	16	3.40%
Mackinaw City Village*	5	0.80%
Petoskey City	0	0.00%

Source: U.S. Census Bureau. "Selected Housing Characteristics." American Community Survey, ACS 5-Year Estimates Data Profiles, Table DP04, 2022. *Note: Village counts are incorporated into counts for the townships surrounding the villages.

Tornados can appear quickly and cause significant damage. Aside from the two cities and three villages, the county population is geographically spread out and notifying them of tornado warnings or watches with an audible warning signal can be difficult.

Select Existing Programs and Resources

Emmet County currently uses the BeAlert public notification system, which is limited in efficacy as citizens must sign up for the service's phone alerts. As mentioned previously, outdoor recreation areas are abundant in every community in the county.

Other emergency public notification methods available include:

- Integrated Public Alert & Warning System (IPAWS): FEMA's national system for local alerting that provides authenticated emergency and life-saving information to the public through mobile phones using Wireless Emergency Alerts, to radio and television via the Emergency Alert System, and on the National Oceanic and Atmospheric Administration's Weather Radio.
- The FEMA Mobile App: provides real-time weather alerts, locations of emergency shelters, and allows for notifications to be sent to loved ones.
- NOAA Weather Radio All Hazards: a nationwide network of radio stations broadcasting continuous weather information directly from the nearest National Weather Service office. NWR broadcasts official Weather Service warnings, watches, forecasts and other hazard information 24 hours a day, 7 days a week.
- The following communities have manually operated tornado sirens: City of Harbor Springs; Wilderness State Park in Bliss Township; North Central Michigan College in Petoskey.

Extreme Temperatures

Prolonged periods of very high or very low temperatures are often accompanied by other extreme meteorological conditions, such as high humidity, drought, heavy snowfall, or high winds. Extreme heat or extreme cold primarily affect the most vulnerable segments of the population, such as the elderly, children, impoverished individuals, and people in poor health.

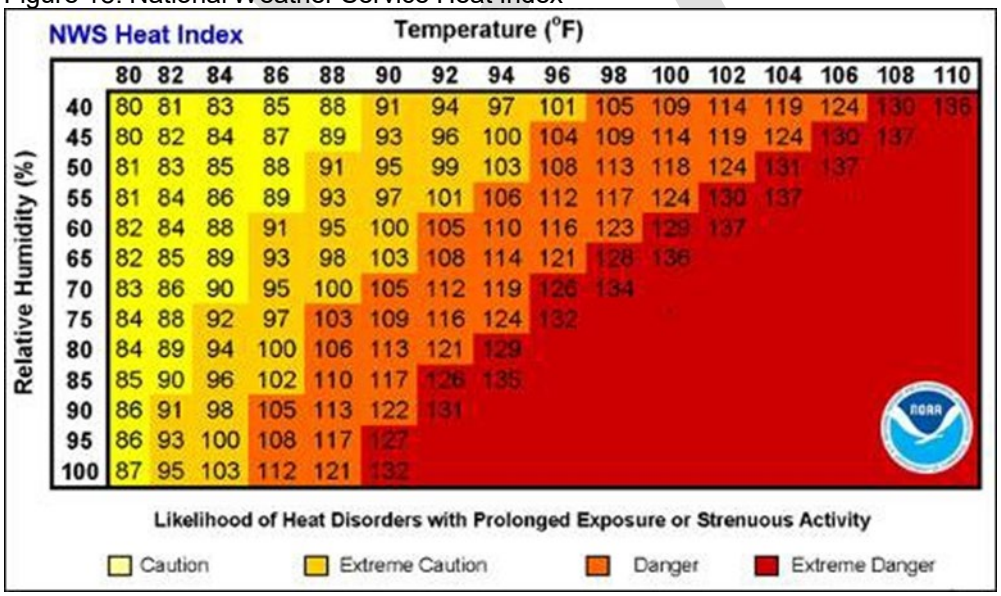
Nationwide, there have been approximately 175 deaths per year that are attributable to extreme heat according to the 2019 Michigan Hazard Analysis. The threats from extreme heat are heatstroke, sunstroke, muscle cramps, heat exhaustion, and fatigue. It is hazardous to livestock and agricultural crops, causes water shortages, exacerbates fire hazards, exacerbates respiratory problems, prompts excessive electrical energy demands, and causes infrastructure failures. Urban areas experience the most serious extreme heat with the combined high temperatures and high humidity that produce a heat-island effect.

According to the 2019 Michigan Hazard Mitigation Plan, Michigan has 11 average annual extreme heat events with 0.4 average annual deaths and 41 average annual injuries.

In the United States, approximately 700 people die each year as a result of severe cold temperature-related causes according to the 2019 Michigan Hazard Analysis, with a significant number of deaths occurring due to illnesses or disease that are negatively impacted by severe cold weather, such as stroke, heart disease, and pneumonia. Exposure to extreme cold temperatures can be life threatening and can cause hypothermia and frostbite. According to the 2019 Michigan Hazard Mitigation Plan, Michigan has 35 average annual extreme cold events with 1 death, 9.4 average annual injuries, and $6.4 million in average annual property and crop damage. Extreme cold affects transportation modes and power utilities, resulting in dead vehicle batteries and loss of power/heat.

Measuring Extreme Temperatures (Extreme Heat and Extreme Cold)
Extreme heat is measured with the National Weather Service's Heat Index Chart (Figure 18). The chart uses relative humidity and air temperature to determine the likelihood of heat disorders with prolonged exposure or strenuous activity. Individuals are unable to shed excess heat from their bodies when they experience prolonged exposure to hot temperatures, which results in heat disorders.

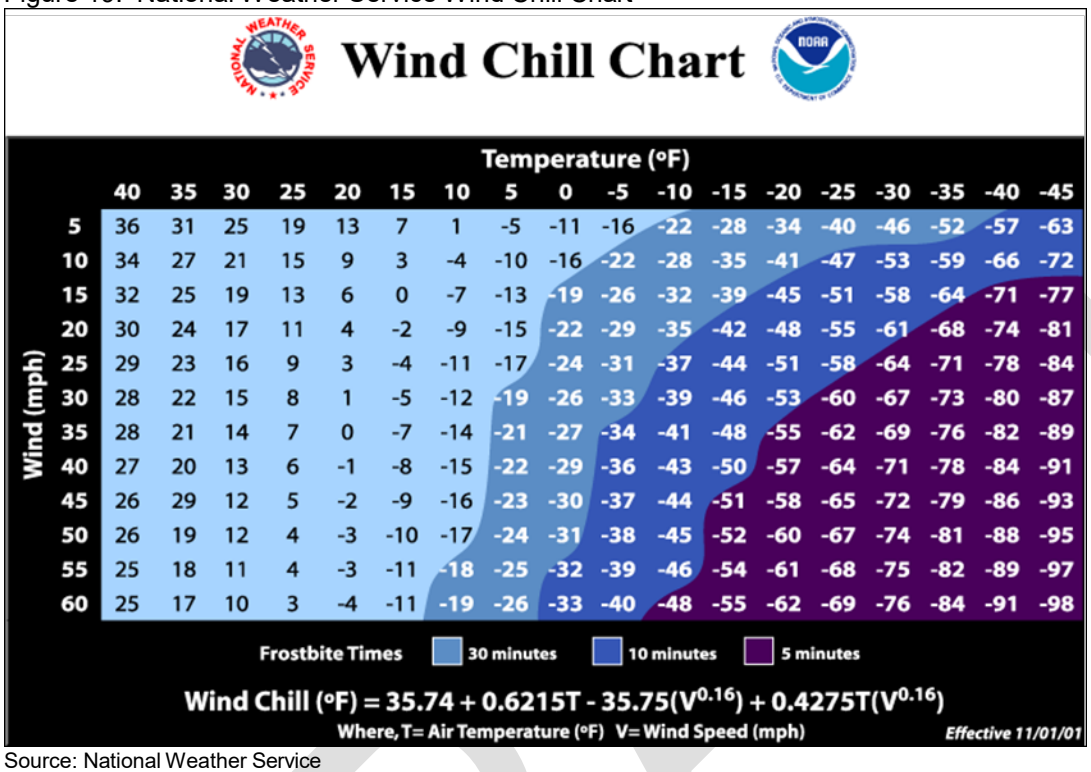
Figure 18. National Weather Service Heat Index



Source: National Weather Service

Extreme cold is measured with the wind chill index, which is a measure of the rate of heat loss from exposed skin caused by the combined effects of wind and cold. As the wind increases, heat is carried away from the body and reduces the external and internal body temperatures. Figure 19 is the NOAA Wind Chill Chart as it corresponds to various temperatures and wind speeds.

Figure 19. National Weather Service Wind Chill Chart

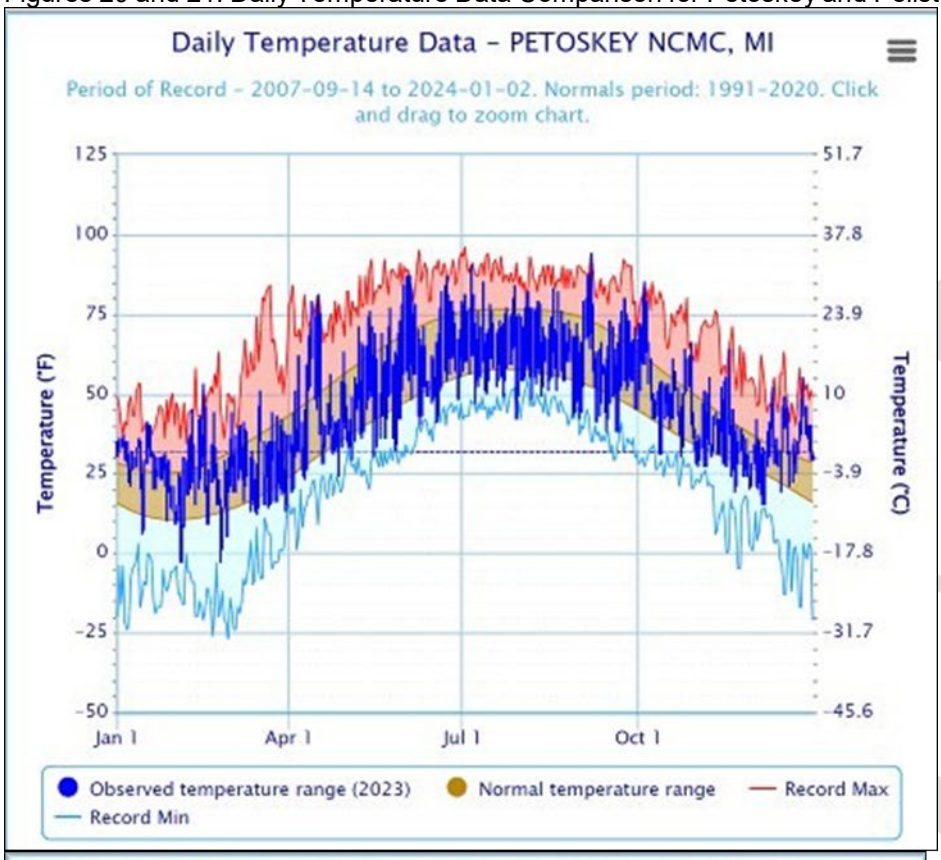


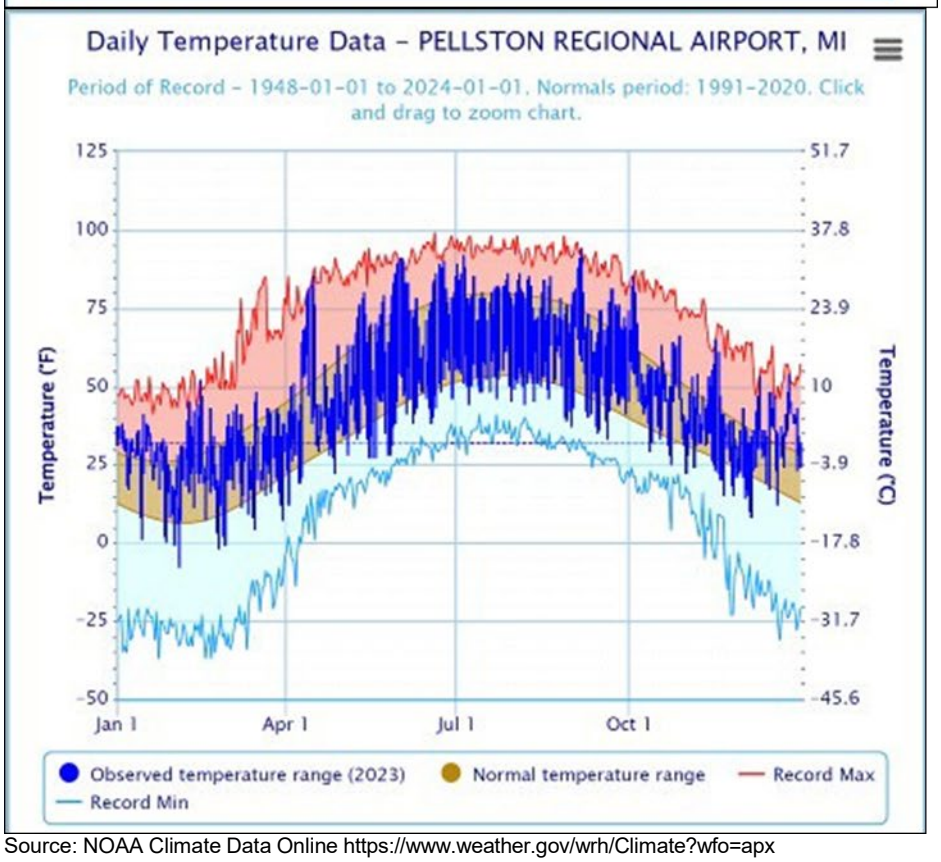
Wind (mph)	40	35	30	25	20	15	10	5	0	-5	-10	-15	-20	-25	-30	-35	-40	-45
5	36	31	25	19	13	7	1	-5	-11	-16	-22	-28	-34	-40	-46	-52	-57	-63
10	34	27	21	15	9	3	-4	-10	-16	-22	-28	-35	-41	-47	-53	-59	-66	-72
15	32	25	19	13	6	0	-7	-13	-19	-26	-32	-39	-45	-51	-58	-64	-71	-77
20	30	24	17	11	4	-2	-9	-15	-22	-29	-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	29	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

Source: National Weather Service

Figures 20 and 21 illustrate the daily observed temperatures at the NOAA weather stations in Petoskey (at North Central Community College, or NCMC) and Pellston (at the county airport) in 2023 (dark blue line). This data is shown in comparison to the daily maximum temperatures (red line), daily normals temperature range, and daily minimum temperatures (light blue line) for the time period on record. Pellston Airport is located at least 15 miles east of Lake Michigan and is surrounded by flat, plain-like topography. Petoskey's NCMC is located within 1.25 miles of Lake Michigan. These factors influence the daily temperature range for each location. Because of its proximity to Lake Michigan, Petoskey experiences a smaller range in daily high and low temperatures in comparison to Pellston. In other words, Petoskey and other lakeshore communities in Emmet County experience slightly warmer minimum temperatures and cooler maximum temperatures than Pellston and other communities located further inland from Lake Michigan.

Figures 20 and 21: Daily Temperature Data Comparison for Petoskey and Pellston, 2023





Source: NOAA Climate Data Online https://www.weather.gov/wrh/Climate?wfo=apx

Location and Extent
Extreme temperatures are a regional event that are not confined to geographic boundaries and range in severity across the affected areas. All of Emmet County is at risk from extreme temperature events.

Previous Occurrences
Emmet County has had two extreme heat events that occurred in the summers of 2001 and 2018 (Table 53). The events were not associated with any reported deaths or property/crop damages. The heat events consisted of hot and humid conditions that caused outdoor events to be modified and attendance at outdoor events to be lower than normal. The NOAA episode narratives are provided below.

Table 53. Extreme Heat Events, Emmet County

LOCATION	DATE	EVENT TYPE	DEATHS	NOAA EPISODE NARRATIVE
EMMET (ZONE)	8/1/2001	Heat	0	Excessive Heat was also a problem the first two weeks in August across all of northern Michigan. Temperatures reach the mid to upper 90s, on average, a few days each year; however, for a 5 day (8/5 - 8/9) stretch overnight low temperatures failed to fall below the lower 70s in most areas. This very humid air mass was unusual for northern Michigan, an area which typically sees cool nighttime temperatures and for this reason has very few homes with air conditioners. Most outdoor events were modified due to the forecasts of hot and humid conditions. County fairs sent animals home, yet still there were livestock losses at fairs in Otsego and Alcona counties. Attendance at county fairs was well below normal and this was attributed to the heat.
EMMET (ZONE)	6/30/2018	Excessive Heat	0	The month of June closed with one of the hottest days in recent memory. Highs were well into the 90s, including 99 at Alpena, and 98 at Traverse City and Gaylord. The National Weather Service office near Gaylord also hit 98; that was (by several degrees) the warmest reading recorded at that location since observations began there in the late 1990s. Heat indices exceeded 105 degrees across most of northern lower Michigan, and some locations exceed 110. The warmest reported heat index on the day was 114 near Indian River. There were estimated to be between 25 and 30 individuals who visited local hospitals due to heat-related illnesses.

Source: NOAA: National Centers for Environmental Information

There have been six extreme cold events reported for Emmet County (Table 54). The events were not associated with any deaths or injuries. One killing freeze in April 2012 caused $5 million in crop damages in Emmet County.

Table 54. Extreme Cold Events, Emmet County

LOCATION	DATE	EVENT TYPE	INJURIES, DEATHS, DAMAGES	EVENT NARRATIVE
EMMET (ZONE)	2/4/2007	Extreme Cold / Wind Chill	0	High temperatures on the 4th (Super Bowl Sunday) were around zero, with low temperatures that night from five to ten below zero. Gusty northwest winds produced hazardous wind chills of 20 to 30 below zero, along with blowing and drifting snow. Many area schools closed on the 5th, due to the extreme cold and poor road conditions.
EMMET (ZONE)	4/27/2012	Frost/Freeze	$5,000,000 in crop damages in Emmet County	A killing freeze caused extreme damage to agriculture, particularly in the fruit belt of Northwest Lower Michigan. Traverse City saw low temperatures of 25 degrees on the 27th, 31 degrees on the 28th, and 26 degrees on the 29th. These values were not exceptionally colder than normal lows, which are in the middle 30s. Ultimately, the main culprit was a stretch of unprecedented warmth in mid-March, which included five consecutive 80-degree days (17th-21st). This caused fruit trees to bud out far, far ahead of schedule, and left them vulnerable to even relatively normal weather as the spring progressed. The tart cherry crop was a total loss, while other orchard fruits such as sweet cherries, apples, pears, and peaches saw losses exceeding 90% of the expected crop.
Emmet, Charlevoix, Cheboygan, Chippewa, Delta, Gogebic, Luce, Mackinac, and Marquette Counties	12/13/2014	Deep Frost*	-	Governor Declared Emergency
EMMET (ZONE)	2/14/2015	Extreme Cold / Wind Chill	0	A clipper system passing just north and east of Michigan would bring a multitude of weather hazards. Widespread light snow occurred ahead of the system's cold front, but that snow was enhanced by Lake Michigan into northwest lower Michigan. Snowfall totals of 6 to 8 inches were seen, especially west and southwest of Traverse City, with the highest amounts near Wellston. The coldest air of the winter so far surged in behind the cold front, along with gusty northwest winds and lake effect snow. Considerable snowfall, blowing and drifting snow, and low wind chills were realized in northwest lower Michigan. Across the rest of northern Michigan, away from the temperature-mitigating effects of Lake Michigan, wind chills reached warning criteria. Wind chills reached 30 to 40 below zero in northern lower Michigan, and 40 to 50 below zero in eastern upper.
EMMET (ZONE)	2/19/2015	Extreme Cold / Wind Chill	0	The second blast of extremely cold air into northern Michigan in about a week. This event featured colder air (including the coldest high temperature ever recorded in Gaylord), but not quite as much wind, as the event a week previous. As a result, wind chills were not quite as drastically cold. Still, wind chills reached 30 to 40 below zero across part of northern Michigan, bottoming out at -43 near Cadillac early in the morning on the 19th.
STATEWIDE	1/29/2019	Extreme Cold / Wind Chill*	-	Governor Declared Statewide Emergency. Wind chills of 15 to 30 below zero were common in northern lower Michigan. Wind chills were much colder in eastern upper Michigan, including -51 at Kinross, and -42 at Sault Ste. Marie and Mackinac Island.

Source: NOAA: National Centers for Environmental Information Note: * not an event recorded in the NOAA NCEI database; sourced from MSP 2019 *Michigan Hazard Analysis*

Probability of Future Events and Vulnerability Assessment
Since 2001, there have been two extreme heat events in Emmet County. This indicates there is an 8.7% annual chance than an extreme heat event would occur in a future year.

Since 2007, there have been six extreme cold events in Emmet County. This indicates there is a 35% chance an extreme cold event would occur in a future year. Since extreme cold events tend to occur during the winter months and are coupled with blustery winds and snowstorms, these events may have been reported as other hazards or not at all, which means there may have been more extreme cold events in the county.

Extreme heat and cold events are more likely to impact unsheltered populations, such as the urban homeless population and people working or recreating outside. The following locations can serve as emergency shelters in the event of an extreme heat/cold emergency in the county: the Emmet County Fairgrounds, Odawa Casino and Hotel, and the Village of Mackinaw City's recreation building.

The agriculture industry in the county is also vulnerable to unseasonable temperature fluctuations, such as the killing frost/freeze that occurred in 2012.

Anecdotally, emergency personnel see more fatalities during extreme temperature events. Vulnerable populations may not be able to find or access heating or cooling stations, or communicate their needs. In addition to human vulnerability to extreme temperatures, because heat is an additive, there are also environmental concerns when heat increases the risk of wildfire and drought.

The *Northwest Lower Michigan Coastal Resilience Atlas* written by the Land Information Access Association completed a Heat Vulnerability Assessment [7] of coastal communities. A community's vulnerability is their exposure to the hazard (determined by tree canopy and impervious surface coverage) + their sensitivity. Sensitivity is determined by the following factors:

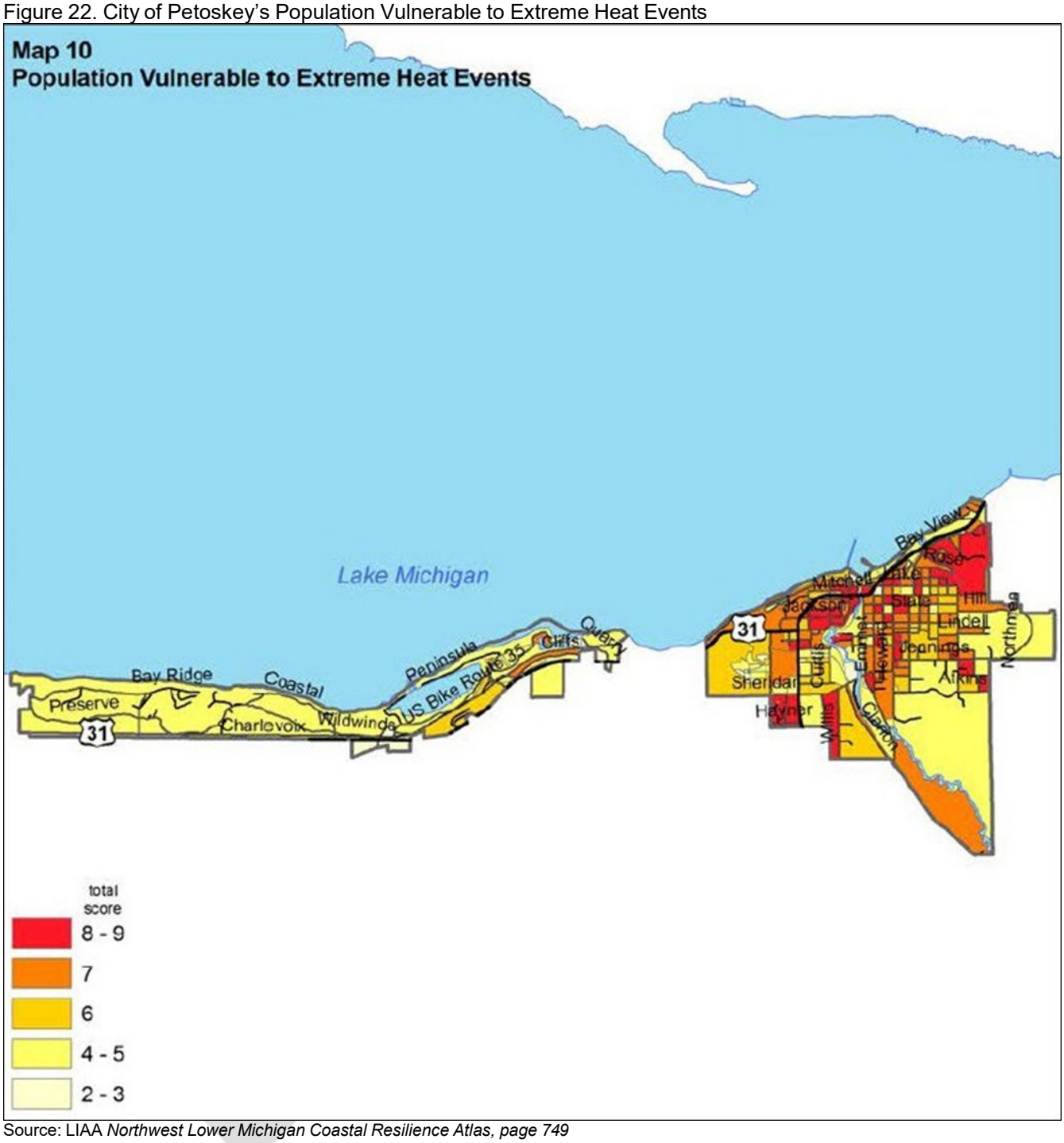
- Persons > 65 years
- Persons living alone
- Minority (non-white) persons
- Persons living below the poverty threshold
- People > age 25 with less than a high school education
- Disability status (i.e., ambulatory difficulty, mental disability)

Considering all of these factors, Figure 22 indicates the levels of vulnerability to extreme heat events for the City of Petoskey's population (by census block). Similar maps were created in the *Atlas* for the City of Harbor Springs, the Village of Mackinaw City, and the townships of Wawatam, Bliss, Cross Village, Readmond, Friendship, West Traverse, Little Traverse, Bear Creek and Resort.

Additionally, as previously described in Section III of this plan, approximately 24.6% of Emmet County residents are over age 65; an estimated 9% of households are in poverty; an estimated 25% of households are considered "Asset Limited, Income Constrained, and Employed"; and an estimated 12.8% of the population has one or more type of disability. Additionally, an estimated 44.8% of the housing stock in the county is over 40 years old. Many homes do not have air conditioning, which may be needed more often with expected increasingly warmer summers in Michigan.

[7] Land Information Access Association. (2019). *Northwest Lower Michigan Coastal Resilience Atlas.* http://www.resilientmichigan.org/nw_atlas.asp

Figure 22. City of Petoskey's Population Vulnerable to Extreme Heat Events



Source: LIAA *Northwest Lower Michigan Coastal Resilience Atlas, page 749*

Drought

Drought is a normal part of the climate cycle. It is a slow-moving hazard, which causes people to underestimate the damage it can do, but losses from drought are as substantial as those from hurricanes, tornadoes and other faster-moving disasters. Drought can cause crop loss; affects domestic water supply, energy production, public health, and wildlife; and contributes to wildfire risk.

Location
Drought is a regional event that is not confined to geographic boundaries and range in severity across the affected areas. All of Emmet County is at risk from a drought event.

Extent
The Palmer Drought Severity Index (PDSI) uses readily available temperature and precipitation data to estimate relative dryness. It is a standardized index that generally spans -10 (dry) to +10 (wet). Maps of operational agencies like NOAA typically show a range of -4 to +4, but more extreme values are possible. The PDSI has been reasonably successful at quantifying long-term drought.

The U.S. Drought Monitor combines several input sources including the PDSI and the Standardized Precipitation Index to prepare a weekly map showing parts of the U.S. that are in drought. The map uses five classifications: abnormally dry (D0), showing areas that may be going into or are coming out of drought, and four levels of drought: moderate (D1), severe (D2), extreme (D3) and exceptional (D4) (Figure 23).

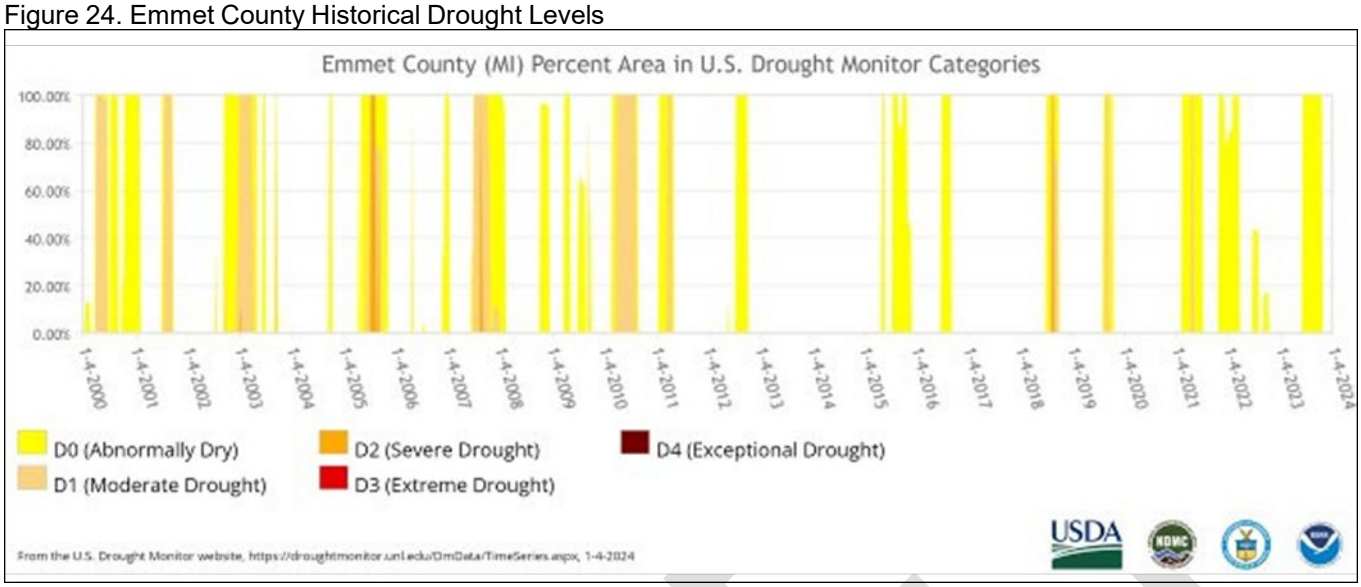
Figure 23. U.S. Drought Categories and Possible Impacts

Category	Description	Possible Impacts
D0	Abnormally Dry	Going into drought: • short-term dryness slowing planting, growth of crops or pastures Coming out of drought: • some lingering water deficits • pastures or crops not fully recovered
D1	Moderate Drought	• Some damage to crops, pastures • Streams, reservoirs, or wells low, some water shortages developing or imminent • Voluntary water-use restrictions requested
D2	Severe Drought	• Crop or pasture losses likely • Water shortages common • Water restrictions imposed
D3	Extreme Drought	• Major crop/pasture losses • Widespread water shortages or restrictions
D4	Exceptional Drought	• Exceptional and widespread crop/pasture losses • Shortages of water in reservoirs, streams, and wells creating water emergencies

Source: US Drought Monitor

Based on the historical data presented, between 2000 and 2023, Emmet County encountered its worst levels of drought (D2) in January 2003; August 2005; August and September 2007; and August 2018 (Figure 24).

Figure 24. Emmet County Historical Drought Levels



Previous Occurrences

There have been three major drought events on record for Emmet County (Table 55). There were no reported deaths, injuries, or damages are associated with these events.

Table 55. Major Drought Events in Emmet County

LOCATION	DATE	EVENT TYPE	INJURIES, DEATHS, DAMAGES	EVENT DESCRIPTION
Emmet County and 43 other counties	3/2/1977	Drought	0	Federally Declared Emergency (3035)
Emmet County (Zone)	8/28/2007 to 8/31/2007	Drought	0	Drought conditions (severe, D2) expanded into the tip of Northern Michigan by the end of August. The dry conditions in the region dated as far back as May 2007, when only 1.09 inches of rain fell in Pellston. June rainfall was 1.92 inches. July rainfall was near normal and brought some respite, but August saw just 1.21 inches of rain at Pellston. A ban on burning was issued for most of the state in mid-August, the first such ban since 1998. Golf courses and farmers complained of very high utility bills, due to the need for near-constant irrigation. Corn and bean crops were severely impacted. Rains in September would partially alleviate drought conditions for a spell.
Emmet County (Zone)	9/1/2007 to 9/10/2007	Drought	0	Drought conditions (severe, or D2) carried over from August in Eastern Upper Michigan and far Northern Lower Michigan. Several rain events eased the drought by mid-month. The area received half an inch to an inch of rain on September 3-4, again on the 7th, and again on the 11th.

Sources: NOAA National Centers for Environmental Information; MSP 2019 Michigan Hazard Analysis

Probability of Future Events and Vulnerability Assessment

There have been three occurrences of a drought incident affecting Emmet County since 1977. This indicates a 6.4% annual chance of a future drought event in Emmet County. In Northern Michigan's forested regions, drought can adversely impact timber and agricultural production and some tourism and recreational enterprises. This can also cause a drop in income, which impacts other economic sectors.

Based on the most recent climate change models, the climate of Emmet County will continue to warm, with greater increases in average temperatures during the winter months and at night. One of the anticipated impacts of this is an increased risk of drought, particularly in summer months.

The biggest problem drought presents, however, is the increased threat of wildfire. Every community in the county (except for the Village of Mackinaw City) has scattered areas of pine trees which are highly vulnerable to wildfire in dry soil conditions (see the Environmental Features map in Appendix A). Public input sessions for the development of this plan indicated particular concern for agricultural areas of the county. Additionally, many remote areas in the county have limited access via seasonal roads in the event of a wildfire.

Additionally, the threat to water sources should also be considered. Even drought events in category D1 experience water well level decline. Drought events combined with excessive heat can also have severe impacts on the health of the elderly, disabled and lower income people.

Wildfire

A wildfire is an unplanned, uncontrolled fire in grassland, brushland, or forested areas. Wildfires can occur in any forest or grassland type under dry conditions; however, some forest types are more susceptible to wildland fires. For example, jack and red pine forest stands have a high risk for wildfires, as they are dependent on fire to provide all the right conditions for regeneration, while aspen and white pine forest stands have a moderate risk.

The primary cause of wildfire is from human activities, specifically burning outdoor debris. Recently, only about 4% of all wildfires in Michigan were caused by lightning strikes, and most other causes have been attributed to human activity. Most Michigan wildfires occur close to where people live and/or recreate, which puts both people and property at risk. The immediate danger from wildfires is the destruction of property, timber, wildlife, and injury or loss of life of persons who live in the affected area or who are using recreational facilities in the area. Long- term effects include scorched and barren land, soil erosion, landslides/mudflows, water sedimentation, and loss of recreational opportunities.

Approximately 55% (20.4 million acres) of Michigan's total land area is forest cover. The vast forests provide Michigan with the largest state-owned forest system in the United States. In addition, Michigan has the fifth largest quantity of timberland acreage, with 19.3 million acres (including hardwoods and softwoods). That vast forest cover is a boon for both industry and recreation, and these areas have been gradually increasing in recent years. However, it also means that many areas of Michigan are vulnerable to wildfires.

Michigan's fire season starts in early spring, when leaves and grasses remain dry from fall and winter and trees are not yet green. Wildfires are often accompanied by drought where dry conditions increase the potential to burn. Occasionally a thunderstorm will roll through and lightning will strike, causing sparking of dry leaves and dead wood. High winds can then spread wildfire. Wildfires can become unpredictable in windy conditions or when the wind changes direction suddenly. Cooler nighttime temperatures often help suppress wildfires and the potential for wildfire; however Michigan has had several major fire events.

According to MDNR and U.S. Forest Service records, between 1910 and 1949, over 5.8 million acres of forest were burned in the state of Michigan; 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. 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.

Location
All Emmet County communities and developed areas are vulnerable to wildfires since the community centers and rural residential developments interface with the high risk forest types (e.g. Red Pine, Eastern White Pine, and Jack Pine). In terms of tree type and coverage, there 9,759 acres of Red Pine (4.8% of forested land cover); 1,068.49 acres of Jack Pine (0.5%) and 388.74 acres of White Pine (0.2%) in Emmet County. As shown in the Environmental Features map in Appendix A, Red Pine and Eastern White Pine forest types are scattered throughout the county. Many of the pine forest areas overlap with publicly owned lands. Concentrations of pine forest are located along the Lake Michigan shoreline in Wawatam, Bliss, Cross Village, and Bear Creek Townships (including Petoskey State Park); around Paradise Lake in Carp Lake Township; and in McKinley and Maple River Townships around the Village of Pellston and the County Airport.

Extent and Previous Occurrences
Extent can be measured by the number of acres burned and the cost of property damage. According to the Michigan State Police's *2019 Michigan Hazard Analysis*, between 1981 and 2018 there were 377 reported fires on land in Emmet County under MDNR jurisdiction. This equated to 649.6 total acres burned, averaging 9.9 acres burned and 17.1 wildfires per year. No wildfires were reported as a hazard event in Emmet County in the NOAA NCEI database.

The MDNR's Wildland Fire interactive mapping application depicts the locations of past and present wildland fire incidents throughout Michigan and the resources that are available to manage them. A search in the application indicates that between 2014 and 2023, there were 54 wildland fire incidents in Emmet County (Tables 56-58). Most of the fires were small (an acre or less burned) and were often caused by human activities such as open debris burning, campfires or firework usage. Two large fires were caused by prescribed burns on MDNR land.

Table 56. Wildland Fire Incidents in Emmet County, 2014-2023

Date	Jurisdiction	Location	Acres Burned	Fire Source
4/13/2014	Cross Village Township	State Road, South of Forest Ave.	0.1	Structure
4/28/2014	McKinley Township	Douglas Lake Road	0.3	Power Line
4/28/2014	Springvale Township	Pickerel Lake Rd	0.8	Debris Burn
5/10/2014	Pleasantview Township	Brutus and Conway Roads	0.1	Debris Burn
5/29/2014	Little Traverse Township	SE of Hathaway and Pleasantview Roads	0.1	Misc.
6/4/2014	West Traverse Township	Marion Drive	0.9	Debris Burn
7/5/2014	Maple River Township	McPhee Creek, NE of Brutus and North Ayr Roads	0.8	Campfire
4/14/2015	Resort Township	SW Resort Pike and Williams Road	0.1	Misc.
4/18/2015	Little Traverse Township	SW of Hedrick and Catob Roads	3.5	Debris Burn
4/25/2015	Maple River Township	Brutus and Snider Roads	1	Campfire
5/1/2015	Maple River Township	NE of Valley and Sunny Ridge Road	0.5	Debris Burn
5/2/2015	Little Traverse Township	NE of Powers and Conway Roads	1.6	Misc.
5/3/2015	Bear Creek Township	NE Greenwood and Cedar Valley Roads	0.2	Misc.
5/14/2015	Springvale Township	*Fireline Road; State Land Prescribed Burn	53	Primary fuel source: unknown
5/7/2015	Resort Township	Manthei and Townsend Roads	0.1	Misc.
5/8/2015	Pellston	NW of State and Townline Roads	0.1	Misc.
5/18/2015	Center Township	SW ov Van and Pleasantview Roads	0.1	Misc.
5/23/2015	McKinley Township	US-31, north of Van Creek	0.1	Misc.
5/23/2015	Maple River Township	Pine Trail and Woodland Road	0.6	Power Line
6/29/2015	Littlefield Township	Powers and Luce Street	2.5	Debris Burn
4/23/2016	Maple River Township	Brutus Road	0.1	Misc.

Date	Jurisdiction	Location	Acres Burned	Fire Source
4/28/2016	Springvale Township	*Hopper Road/County Line Road; State Land; Prescribed Burn	53	Primary Fuel Source: Open Lands - Light Load
5/9/2016	Springvale Township	Pickerel Lake Rd	2	Misc.
5/10/2016	Wawatam Township	NW of US31 and Mackinaw Hwy.	4.5	Structure Fire
5/11/2016	Center Township	Canby Road	0.1	Structure Fire
5/17/2016	Wawatam Township	NW of US31 and Mackianw Hwy.	0.1	Debris Burn
5/21/2016	Little Traverse Township	Quick Rd., between Hedrick and Pleasantview	1.5	Misc.
7/4/2016	Petoskey	Bear River near Mitchell Street	0.1	Misc.
7/5/2016	Maple River Township	S. of Ringler Road	0.5	Fireworks
11/13/2016	Cross Village Township	Arbutus Road	7	Misc.
4/26/2017	Little Traverse Township	Conway Commons Mfg. Home Community	0.1	Arson
3/24/2018	Petoskey	Atkins Road	1.1	Debris Burn
4/30/2018	Springvale Township	Ellsworth Road	0.1	Debris Burn
5/9/2018	Maple River Township	Milton Road	1.5	Debris Burn
5/13/2018	Maple River Township	Cedar Road	0.1	Equipment
5/18/2018	Maple River Township	Woodland Road	1	Debris Burn
7/7/2018	Littlefield Township	Barney Road	1.2	Debris Burn
7/20/2018	McKinley Township	Beckon Road	0.1	Misc.
4/15/2019	Littlefield Township	Barney Road	3.2	Debris Burn
4/20/2019	Carp Lake Township	Elder Road	1.3	Debris Burn
4/21/2019	Village of Alanson	Chicago Street	0.5	Misc.

Date	Jurisdiction	Location	Acres Burned	Fire Source
6/8/2019	Little Traverse Township	Leigl Drive	0.1	Campfire
7/22/2019	Bliss Township	Gravel pit, NW of Pleasantview and Munger Roads	2.5	Misc.
8/25/2019	McKinley Township	Maple River	0.1	Campfire
4/1/2021	Carp Lake Township	DeKruif Road	13	Misc.
4/23/2021	Springvale Township	Heaton Road	1	Misc.
4/12/2022	Littlefield Township	Smith Road	2.2	Debris Burn
4/29/2022	Little Traverse Township	Dayton Road	1.2	Misc.
4/30/2022	Friendship Township	Lamkin Road	1	Debris Burn
7/27/2022	Little Traverse Township	Conway Commons Mfg. Home Community	0.1	Equipment
4/15/2023	Center Township	Valley Road	1.7	Misc.
6/24/2023	Springvale Township	Blanchard Road	0.1	Debris Burn
7/4/2023	Maple River Township	Robinson Road, W. of Village of Pellston	0.1	Fireworks
7/4/2023	Maple River Township	Robinson Road, W. of Village of Pellston	0.5	Fireworks
54 Total Wildland Fires			**169.2 Total Acres Burned**	

Source: Michigan DNR Wildland Fire Application https://www.mcgi.state.mi.us/wildfire/index.html

Table 57. Wildland Fires by Year in Emmet County, 2014-2023

Year	Total Wildland Fires
2014	7
2015	13
2016	10
2017	1
2018	7
2019	6
2020	0
2021	2
2022	4
2023	4
Total	**54**
Avg. Fires/Yr.	**5.4**

Source: Michigan DNR Wildland Fire Application https://www.mcgi.state.mi.us/wildfire/index.html

Table 58. Number of Wildland Fires by Jurisdiction, Emmet County, 2014-2023

Jurisdiction	# Wildland Fires
Maple River Township	11
Little Traverse Township	8
Springvale Township	7
Littlefield Township	4
McKinley Township	4
Center Township	3
Cross Village Township	2
Carp Lake Township	2
Petoskey	2
Resort Township	2
Wawatam Township	2
Bear Creek Township	1
Bliss Township	1
Friendship Township	1
Pellston	1
Pleasantview Township	1
Village of Alanson	1
West Traverse Township	1
Total	**54**

Source: Michigan DNR Wildland Fire Application https://www.mcgi.state.mi.us/wildfire/index.html

Probability of Future Events and Vulnerability Assessment

There is a 100% annual chance of a wildfire event in Emmet County. Nearly 46% of the total lands in Emmet County are forested and a major source of economic and ecological benefit. Red Pine, Eastern White Pine, and Jack Pine forest are scattered throughout the county and are susceptible to wildfires in drought conditions. Jack pine is the most flammable pine species.

Wildfire data for Emmet County (Tables 56-58) indicate that the County can expect an annual average of 5.4 wildfire events, with most of the events occurring in the spring and summer seasons. Between 2014 and 2023, Maple River Township experienced the greatest number of wildland fires (11), followed by Little Traverse Township (8) and Springvale Township (7).

Information obtained from participants in the March 2023 public input session helped to identify local areas of concern in the county pertaining to wildfire. These areas include the following:

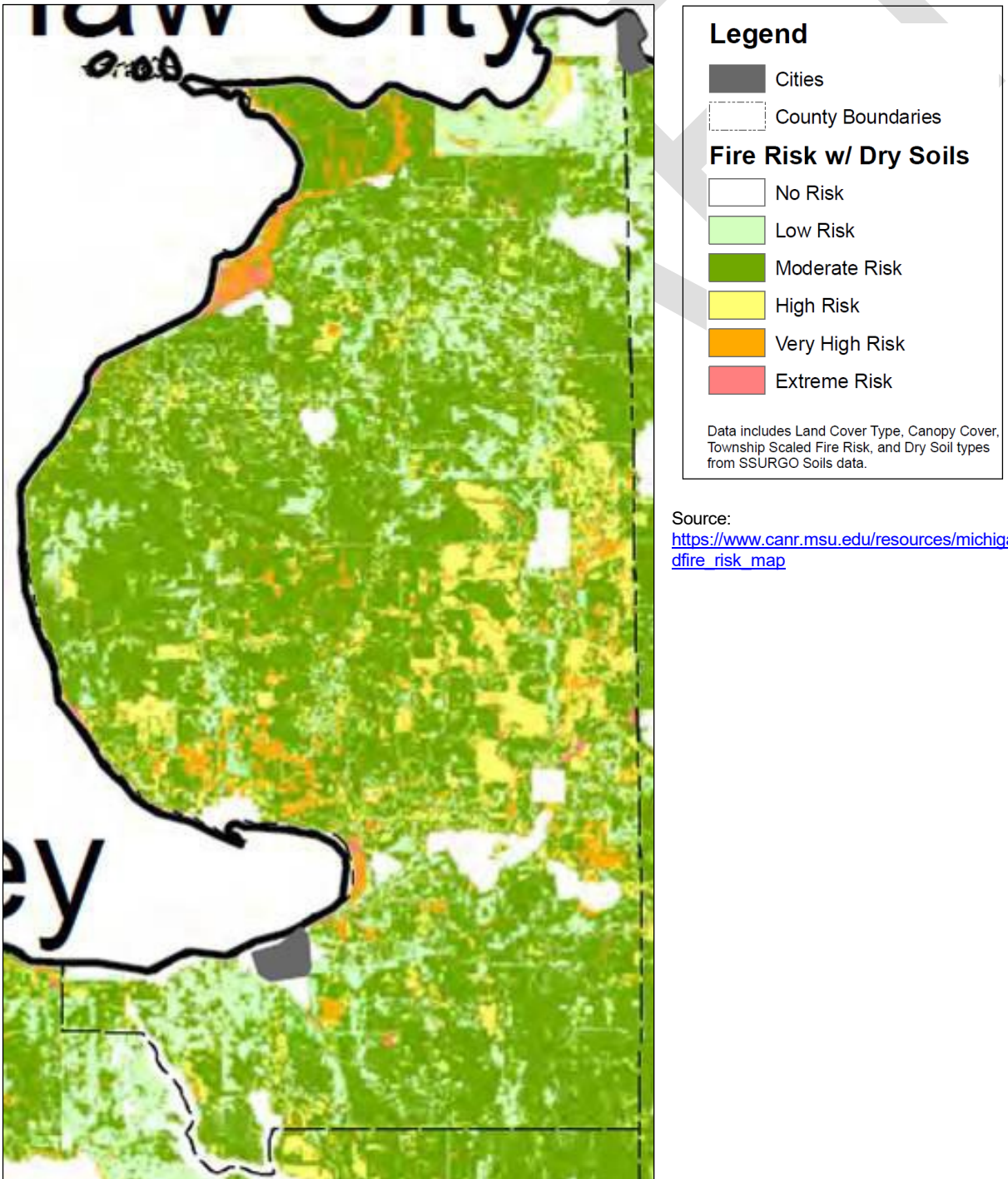
- Cross Village Township: Chippewa Drive/Lake Shore Drive/Sturgeon Bay Drive
- Little Traverse Township: Quick Road corridor between Hoyt and Pleasantview Roads
- Concentrations of farmland in the townships of Bliss, Carp Lake, Center, McKinley, Pleasantview and West Traverse

Additionally, the Michigan Department of Natural Resources (MDNR) created a map in 2017 that identifies wildfire

risk in Michigan, utilizing factors such as land cover, canopy, and soil dryness (Figure 25). In Emmet County, areas with very high risk to extreme risk include the areas of critical dunes (in Wawatam, Cross Village, Bliss, Little Traverse, and Bear Creek Townships) and concentrations of pine forest.

Factors that increase fire risk include dead or dying trees as a result of disease/invasive species, invasive species itself, lightning strikes, and human factors such as the number of persons residing, camping, or traveling through the County. Historically, Michigan's landscape has been shaped by wildfire; however, over the last several decades, the current landscape has transformed from wildland to residential development. With the increase in residential development in and around rural areas prone to wildfires, there is an increase in the potential for loss of life and property damage. Local fire departments have mutual aid agreements in order to provide additional coverage for rural, sparsely populated, or difficult to reach areas. Residential and camping areas in rural parts of the county are often isolated from town centers and emergency services. Many of these areas interface with public lands and local emergency services coordinate fire services with State (MDNR) fire protection agencies.

Figure 25. Excerpt of MDNR's Michigan Wildfire Risk Map Showing Emmet County



Source: https://www.canr.msu.edu/resources/michigan_statewide_wildfire_risk_map

Dense Fog

Fog forms when water vapor condenses into tiny liquid water droplets that remain suspended in the air just above the Earth's surface, reducing visibility to values equal to or below locally/regionally established values for dense fog (usually 1/4 mile or less) and impacting transportation or commerce.

Two ways that air can become saturated with water are by cooling it to its dew point temperature, or by evaporating moisture into it to increase its water vapor content. Although most fog, by itself, is not generally a hazard because it does not actually apply damaging forces, the interaction between humans and fog can be a dangerous situation, sometimes resulting in disastrous consequences. It must be noted, however, that freezing fog (a hazard for which the National Weather Service issues special statements) can cause direct harm by causing slickness on roadways, walkways, bridges, and highway ramps, and therefore leading to serious transportation accidents.

Fog is not so easy to classify as a severe and high-impact hazard, although it has caused costs and casualties in the transportation sector, sometimes with deadly consequences. Fog has played a contributing role in several multi-vehicle interstate highway pileups during recent years. While statistics suggest that highway accidents and fatalities, in general, have fallen, that trend is not evident with respect to accidents and fatalities caused by fog. The vast majority of automotive accidents are caused by unsafe driving habits and risk-taking behaviors, such as following too closely behind another vehicle, driving too fast for weather and visibility conditions, and distracted driving. Airplanes have their own inherent vulnerabilities when foggy conditions develop and make a safe landing more difficult.

Fog can be very dangerous when it reduces visibility. Although some forms of transport can penetrate fog using radar, road vehicles have to travel slowly and use their lights to become visible to each other. Localized fog is dangerous if drivers are surprised by it. At airports, some efforts have been made to develop methods (such as using heating or spraying salt particles) to aid fog dispersal, especially at temperatures near or below freezing.

One severe fog event is estimated to occur in Michigan approximately every two years. Property damage can be significant for vehicles, although real property and structures are usually unaffected. Fog has not yet been identified as one of the most significant hazards in any of Michigan's local hazard mitigation plans.

Location

Dense fog can be a local, regional, or state-wide event that is not confined to geographic boundaries and ranges in severity across the affected areas. All of Emmet County is at risk from the occurrence and impacts of dense fog.

Extent / Previous Occurrences

There is one record of an impactful dense fog event affecting Emmet County, according to MSP's *2019 Michigan Hazard Analysis*. Dense fog blanketed much of Lower Michigan's Lower Peninsula from the evening of the January 11th through the morning on the 13th of January, 1995. Numerous traffic accidents occurred during this fog, resulting in four fatalities [throughout the State]. School openings were delayed in parts of southwest Michigan as visibilities dropped to near-zero. Low visibilities caused most of the flights at Detroit's metro airport to be cancelled, delayed, or diverted on the 12th. About seventy-five flights were also delayed or cancelled at Kent County International Airport in Grand Rapids.

Probability of Future Events and Vulnerability Assessment

One dense fog event occurred affecting Emmet County, in 1995, nearly 30 years ago. While the likelihood of another dense fog event occurring is low (a 3.3% annual chance), all of Emmet County is at risk from a dense fog event. The continued and increased use of NOAA Weather Radio and mobile alert systems can inform people of hazardous conditions and the appropriate precautions to take (such as limiting travel) during a dense fog event.

Coastal Hazards - Dangerous Currents

Dangerous currents and breaking waves are common in the Great Lakes region. Rip currents and other currents found near piers are extremely dangerous for swimmers and can lead to drownings. Currents in the Great Lakes can form from any combination of wind, waves, bottom formation, beach slope, water temperature, man-made structures, and natural outlets. In the Great Lakes, swimmers are most likely to encounter one of five common currents: rip, longshore, structural, outlet, and channel.

During rip currents, the water "piles up" between a sandbar and the beach. It has to find a way back out to sea. After the pressure builds up, the water creates a pathway and gushes from the shore back out to open water. That's a rip current: a narrow but powerful stream of water and sand moving (ripping) swiftly away from shore. Rip currents vary in size and speed and can be found on many beaches every day. They typically extend from the shoreline through the surf zone, and past the line of breaking waves. Typically, they form at breaks in sandbars, and also near structures, such as jetties and piers, as well as cliffs that jut into the water.

Rip currents carry swimmers into deeper water, where they may not be able to get their footing. These currents rarely extend far out, and will not pull a swimmer underwater. Rip currents vary in size from very narrow to more than 50 yards wide. Speeds can also vary. The average speed is 1-2 feet per second, but they have been measured as fast as 8 feet per second.

Longshore currents move parallel to or the "long" way along the shoreline. These currents will exert a force to move along shore, making it difficult to remain in front of a spot on the beach. They often happen between the first and second sandbars near the shore. Longshore currents become more dangerous when they combine with rip currents or structural currents since they can move a swimmer swiftly down a beach and into the path of another current or into a structure (pier or breakwall), making it more difficult to swim to shore.

Structural currents - the currents found alongside or as a result of structures like piers and breakwalls - are usually present. Structural currents are dangerous on their own, but when paired with others like longshore or rip currents, the combination can create a washing machine effect, moving the swimmer from one dangerous current area to another with no clear path to safety.

Outlet currents can be found where rivers and streams empty into the Great Lakes. The flow of water from the river or stream can move quickly. As it enters the open water of a lake, it may take a while for that current to dissipate. Pair that with currents that are present in the lake and the situation can become dangerous.

Channel currents are like a river running parallel to shore. With a channel current, typically there is an island or structure such as a large group of rocks not far from shore. A channel current forms when the flow of water speeds up as it goes between the island and shore, like a bottleneck. This is made worse by the presence of a submerged or partially submerged sandbar connecting the beach to the island, which allows pressure to build behind the water and waves until it breaks through. When the wind speed increases, the waves also increase in intensity, and this causes the current to become stronger and faster.

According to the Great Lakes Current Incident Database, between 2002 and 2020, there have been 75 deaths and 274 persons rescued from dangerous current incidents along the Lake Michigan coastline of Michigan's Lower Peninsula.

It is important to note that there are no "rip tides" or "undertows" in the Great Lakes. Since there are no tides in the Great Lakes, and rip currents don't pull a person down under the water (it will carry them out to the open water, away from shore), "rip tides" or "undertows" are inaccurate coastal hazard terms.

Dangerous current-related incidents in the Great Lakes most often occur when:

- Winds are blowing towards the shore
- Wave heights reach 3 to 6 feet
- A cold weather front is passing through

Location
Dangerous currents are coastal events that are not confined to geographic boundaries and may occur anywhere in Lake Michigan waters. Persons swimming in Lake Michigan coastal areas in Emmet County are at risk from dangerous currents.

Extent/Previous Occurrences
The National Weather Service provides a Surf Zone Forecast to measure the risk level associated with rip current hazards. Surf Zone Forecasts contain three levels of Rip Current Outlooks:

- Low Risk: The risk for rip currents is low, however, life threatening rip currents often occur in the vicinity of groins, jetties, reefs, and piers.
- Moderate Risk: Life threatening rip currents are possible in the surf zone.
- High Risk: Life threatening rip currents are likely in the surf zone.

Dangerous currents can be measured by damages-caused including deaths and injuries.

There is one record of a death associated with a rip current in Emmet County, according to the NOAA NCEI Storm Events Database. On July 7, 2012, a teenaged male drowned near Cross Village Beach. Dive teams were called in and found the body about 40 feet from the shore. West winds gusting to 20 mph that day produced considerable wave action on Lake Michigan and provided a favorable environment for rip currents.

There are 18 dangerous current-related rescues reported for Lake Michigan in Emmet County, according to the NWS/MI Sea Grant's Great Lakes Current Incident Database [8]. The database provides recorded incidents on Great Lakes between 2002 and 2010. On July 18, 2005, 16 rescues occurred at the Petoskey State Park beach due to a classic rip current. The reported wave direction was from the southwest, with a wave height of 3-4 feet. On August 17, 2010, two rescues occurred at the Petoskey State Park beach due to a classic rip current. Wave direction was from the west, with a wave height of 5-6 feet.

Probability of Future Events and Vulnerability Assessment
There have been a total of 19 reported current-related incidents on Lake Michigan in Emmet County, which occurred in 2002, 2010, and 2012 at Petoskey State Park beach. The chance of a future event is relatively low.

Strong currents are dangerous to all swimmers, especially those who are unprepared to be swept up in them. Many Lake Michigan beaches do not have a lifeguard on duty who may identify potential hazardous swimming conditions. Swimmers who are caught unaware may panic when caught up in the fast-moving water, tire as they try to swim against the current, and drown. Every jurisdiction in Emmet County that adjoins Lake Michigan has public and/or private beach access. Structural currents are more likely to be found near the City of Petoskey's breakwall, accessible from Bayfront Park.

Example Prevention Resources [9]
On May 20, 2024, Grand Haven State Park (in Ottawa County, Michigan) celebrated the deployment of a new electronic beach safety notification system. The new system features 12 electronic and web-enabled towers, demonstrating the DNR's ongoing commitment to enhancing public safety and emergency response times at this popular state park. "To boost safety at popular Great Lakes state park beaches, SwimSmart towers will help provide real-time warnings to beachgoers," said Ron Olson, chief of the DNR Parks and Recreation Division. "This innovative, technology-based system features two types of towers visible along the Grand Haven swim beach, marking the first state park location for this initiative."

Eight orange towers, located on the beach, feature an easy-to-understand electronic light display that mimics the familiar double-red, red, yellow and green flag system visitors are used to seeing on the beach. Additionally, life

[8] https://apps.michiganseagrant.org/dcd/dcdsearch.php
[9] https://www.michigan.gov/dnr/about/newsroom/releases/2024/05/20/grand-haven-unveils-new-high-tech-beach-warning-system

rings are stationed at each tower. If one of the rings is accessed to aid in helping someone in the water, 911 and park rangers will simultaneously be contacted. The towers can play prerecorded messages to alert users to changing conditions, emergencies and other important information.

The four blue light towers, located along the sidewalk, feature a readily accessible emergency phone that park staff and visitors can press to trigger an immediate emergency response. The blue light towers are equipped with a higher-power loudspeaker, video monitoring system and a direct line to the Ottawa County 911 center. The loudspeaker system will work in conjunction with the prerecorded messages of the orange beach towers and allow park staff to broadcast live messages.

The $570,000 project was made possible with a $200,000 grant from the Michigan Economic Development Corporation, and the balance covered through DNR Parks and Recreation capital outlay funds.

The products were invented, developed and installed by Michigan-based SwimSmart, an innovative technology company whose products are created to empower beachgoing families and patrons to make informed decisions when it comes to water recreation.

The DNR will leave the current flagpoles in place but will only fly the flags if the new system goes down due to loss of electricity or other reasons.

The images below of the SwimSmart towers at Grand Haven State Park (in Ottawa County) are courtesy of the Michigan Department of Natural Resources.

Coastal Hazards - Seiche

According to the National Weather Service, a seiche is a standing-wave oscillation in any enclosed lake that continues after a forcing mechanism has ceased and results in shoreline flooding and/or damage. In the Great Lakes and large inland lakes, large pressure differences, high winds, or fast-moving squall lines may act as the forcing mechanism. In addition, earthquakes or debris flows can initiate a seiche. When the forcing mechanism ends, the water sloshes back and forth from one end of the lake to the other, causing water level fluctuations of up to several feet before damping out.

A seiche is usually limited to partially or fully enclosed basins, such as Lake Erie. Lake Erie is known for seiches, especially when strong winds blow from southwest to northeast. In 1844, a 22-foot seiche breached a 14-foot- high sea wall killing 78 people and damming the ice to the extent that Niagara Falls temporarily stopped flowing. As recently as 2008, strong winds created waves 12 to 16 feet high in Lake Erie, leading to flooding near Buffalo, New York.

In some of the Great Lakes and other large bodies of water, the time period between the "high" and "low" of a seiche can be as much as four to seven hours. This is very similar to the time period between a high and low tide in the oceans, and is often mistaken as a tide.

According to the NOAA-NCEI Storm Events Database, there have been 15 seiche events in Michigan since 1998. There are no deaths, no injuries, and $31,000 in property damages in Michigan due to seiche events.

Location
A seiche is a coastal event that is not confined to geographic boundaries and may occur anywhere in Lake Michigan waters or on large inland lakes. All coastal areas are at risk from a seiche.

Extent and Previous Occurrences
Seiche events are primarily measured by the amount of damage caused to property. There are no official seiche events on record for Emmet County in the NOAA Storm Events Database. However, on July 20, 2019, high water levels, combined with waves and a likely seiche-like event, caused significant damage to dozens of docks along the Little Traverse Bay shoreline east of Harbor Springs. The weather event happened sometime around 2:30 a.m. and impacted areas along Beach Drive in the Wequetonsing Association and farther east into the Roaring Brook community.[10]

Probability of Future Events and Vulnerability Assessment
Seiche events have likely occurred along the Lake Michigan coastline in Emmet County, but may have been unreported if injuries, deaths, or significant property damages did not occur. However, persons and property along the lake shore, particularly marinas (such as those in the City of Petoskey and the City of Harbor Springs), are vulnerable to high waves caused by a seiche. Seiche events are also dangerous to all swimmers, especially those who are unprepared to be swept up in the current. Many Lake Michigan beaches do not have a lifeguard on duty who may identify potential hazardous swimming conditions.

[10] https://www.petoskeynews.com/story/news/local/2019/07/22/rapid-water-rise-causes-shoreline-damage-early-saturday/44221983/

Coastal Hazards - Waterspout

NOAA defines a waterspout as a "funnel which contains an intense vortex, sometimes destructive, of small horizontal extent and which occurs over a body of water." Tornadic waterspouts generally begin as true tornadoes over land in association with a thunderstorm, and then move out over the water. They can be large and are capable of considerable destruction, and are often accompanied by high winds and seas, large hail, and frequent dangerous lightning.

Fair weather waterspouts, on the other hand, form only over open water. They develop at the surface of the water and climb skyward in association with warm water temperatures and high humidity in the lowest several thousand feet of the atmosphere. They are usually small, relatively brief, and less dangerous. The fair weather variety of waterspout is much more common than the tornadic.

Waterspouts occur most frequently in northern Michigan during the months of August, September, and October, when the waters of the Great Lakes are near their warmest levels of the year. Waterspout formation typically occurs when cold air moves across the Great Lakes and results in large temperature differences between the warm water and the overriding cold air. They tend to last from about two to twenty minutes, and move along at speeds of 10 to 15 knots.

There are five stages of waterspout formation:

1. Dark spot. A prominent circular, light-colored disk appears on the surface of the water, surrounded by a larger dark area of indeterminate shape and with diffused edges.
2. Spiral pattern. A pattern of light and dark-colored surface bands spiraling out from the dark spot which develops on the water surface.
3. Spray ring. A dense swirling annulus (ring) of sea spray, called a cascade, appears around the dark spot with what appears to be an eye similar to that seen in hurricanes.
4. Mature vortex. The waterspout, now visible from water surface to the overhead cloud mass, achieves maximum organization and intensity. Its funnel often appears hollow, with a surrounding shell of turbulent condensate. The spray vortex can rise to a height of several hundred feet or more and often creates a visible wake and an associated wave train as it moves.
5. Decay. The funnel and spray vortex begin to dissipate as the inflow of warm air into the vortex weakens.

According to NOAA's National Weather Service, the best way to avoid a waterspout is to move at a 90-degree angle to its apparent movement.

Location

Waterspouts are a common occurrence posing a great threat to marine traffic. According to the MSP's 2019 *Michigan Hazard Analysis*, Michigan waterspouts have been noted by National Climatic Data Center between 1993 and 2001. Many additional events have occurred since, which NCDC has classified according to the corresponding lake location rather than as part of Michigan itself. Waterspouts are less frequent on Lake Superior (8 events since 2001) than on Lakes Huron (23 events) or Michigan (51 events).

Extent and Previous Occurrences

Waterspouts typically last from about two to twenty minutes, and move along at speeds of 10 to 15 knots. They can overturn watercraft and cause damage to bridge structures. According to the MSP's 2019 *Michigan Hazard Analysis*, a waterspout caused $200,000 in damage to a boat house and storage building at Drummond Island (Lake Huron) on July 3, 1999.

There is one waterspout event on record with NOAA's NCEI Storm Event Database for Emmet County. On August 4 1999, "unseasonably cold air over the warmer waters of Lake Michigan triggered numerous cold air funnel clouds over Little Traverse Bay; three of which developed into waterspouts." There are no reported deaths, injuries or property damages associated with this event.

Probability of Future Events and Vulnerability Assessment

It is likely that other waterspouts have occurred in the past in Emmet County, but have not been officially documented. The National Weather Service (NWS) meteorologists consider forecasting waterspouts during the late summer and fall whenever large, cool air masses overspread the waters of the Great Lakes. Once the NWS has determined that waterspouts are possible, the threat is outlined in the Nearshore Marine Forecast and Hazardous Weather Outlook. The NWS strives to provide this information to the public 12 to 24 hours prior to waterspout occurrence.

When waterspouts have been detected by Doppler radar or reported by local law enforcement or spotters, the NWS issues a Special Marine Warning. Since it is not uncommon for numerous waterspouts to occur simultaneously over a large area, these warnings tend to cover larger geographic areas than land-based tornado warnings which generally cover a single county.

In most cases, waterspouts which make landfall are much weaker than tornadoes, produce little or no damage, and dissipate quickly. Once on land, they tend not to be a great threat to life and property. In these instances, the NWS issues a Tornado Warning.

A mitigation strategy for marine vessel operators on the Great Lakes includes education and awareness about the prevailing weather conditions, appearance and destructive potential related to waterspouts. When warnings are issued for waterspouts, boaters should be prepared to quickly seek safe harbor, or to find shelter out of the path of the waterspout. The best source for waterspout forecast information is NOAA Weather Radio (NWR). These continuous broadcasts from transmitters scattered around the Great Lakes provide forecasts and warnings 24 hours a day. Mobile emergency alert systems can also be utilized as an informational source for waterspout forecasts and warnings.

Coastal Hazards - Recession and Shoreline Flooding

Coastal recession (erosion) is the wearing away of land, such as loss of riverbank, beach, shoreline, or dune material. It is measured as the rate of change in the position or displacement of a riverbank or shoreline over a period of time. Short-term erosion typically results from periodic natural events, such as flooding, hurricanes, storm surge, and windstorms, but may be intensified by human activities. Long-term erosion is a result of multi- year impacts such as repetitive flooding, wave action, sea level rise, sediment loss, subsidence, and climate change. Death and injury are not typically associated with erosion; however, it can destroy buildings and infrastructure. Waters of the Great Lakes may cause shoreline hazards to occur, making the entire northwest Michigan coastline susceptible to shoreline hazards. As indicated in Figure 26, much of the Lake Michigan shoreline throughout west Michigan is identified as having “High Risk Erosion Areas”.

Coastal (shoreline) flooding results when Great Lakes water levels rise and push inland, or when rainfall or snowmelt accumulates along the shoreline and is not able to drain properly. Shoreline flooding may also be caused during storms and wind events with high-energy waves.

Most of the northwest Michigan coastline is susceptible to coastal recession and shoreline flooding.

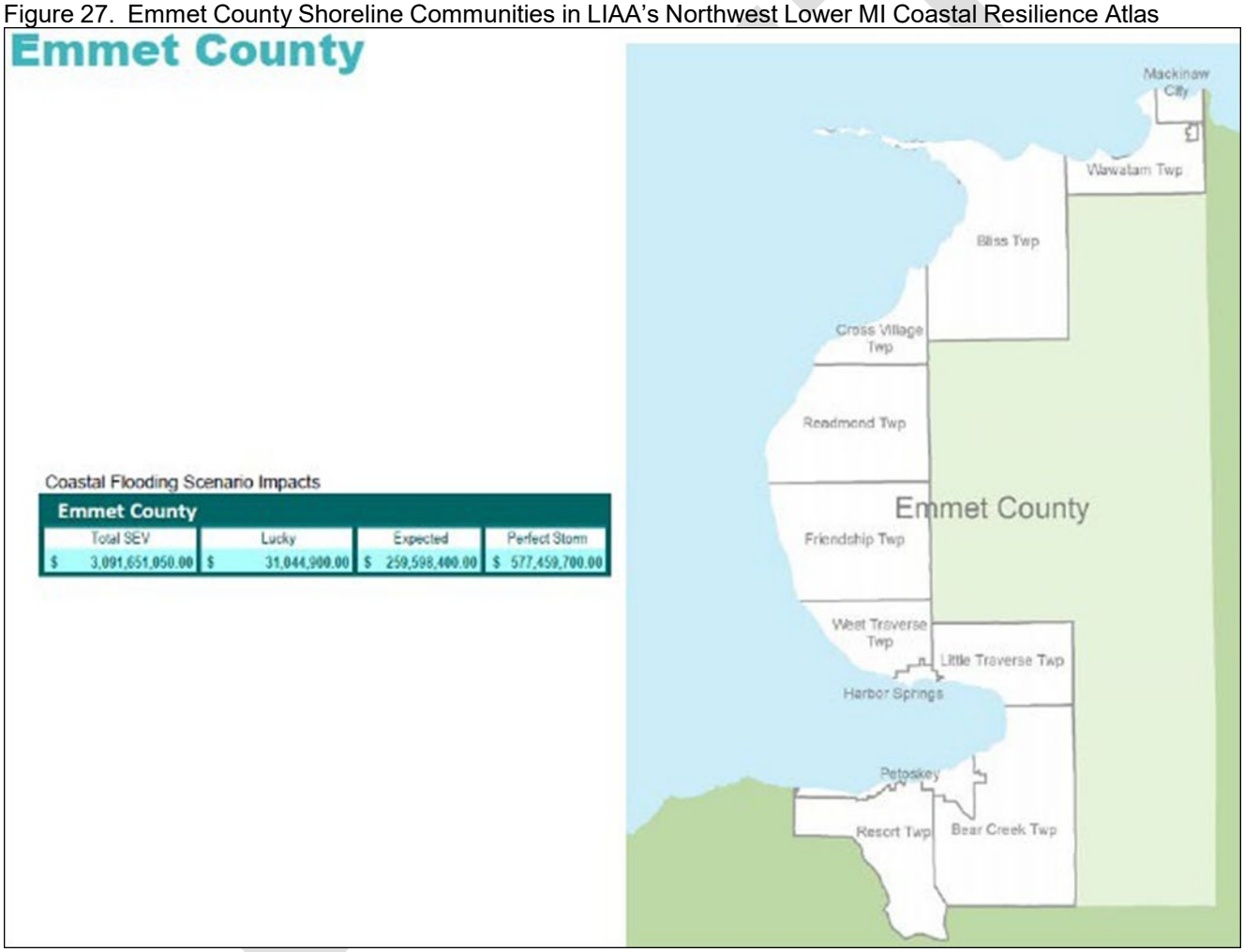
Figure 26. Great Lakes Shorelines with High Risk Erosion Areas, 2019

Location – Coastal Flooding

To reference the 2019 *Northwest Lower Michigan Coastal Resilience Atlas*, completed by the Land Information Access Association (LIAA), "Climate scientists predict that northwest Lower Michigan can expect more frequent storms of increasing severity in the decades ahead. The total amount of rainfall per year is also likely to increase. The potential for substantially larger rain events and severe storms raises concerns of harm to human health and damage to buildings and infrastructure, especially for areas along the Lake Michigan coastline."

The potential shoreline hazards for Emmet County communities in LIAA's *Northwest Lower Michigan Coastal Resilience Atlas include*: Village of Mackinaw City, Wawatam Twp., Bliss Twp., Cross Village Twp., Readmond Twp., Friendship Twp., West Traverse Twp., Little Traverse Twp., Bear Creek Twp., Resort Twp., and the cities of Harbor Springs and Petoskey (Figure 27). Additionally, specific areas of shoreline hazards that were identified by stakeholders during the public input process for the development of this plan are marked as a "shoreline erosion" type of hazard area on the Hazard Area Maps in Appendix A.

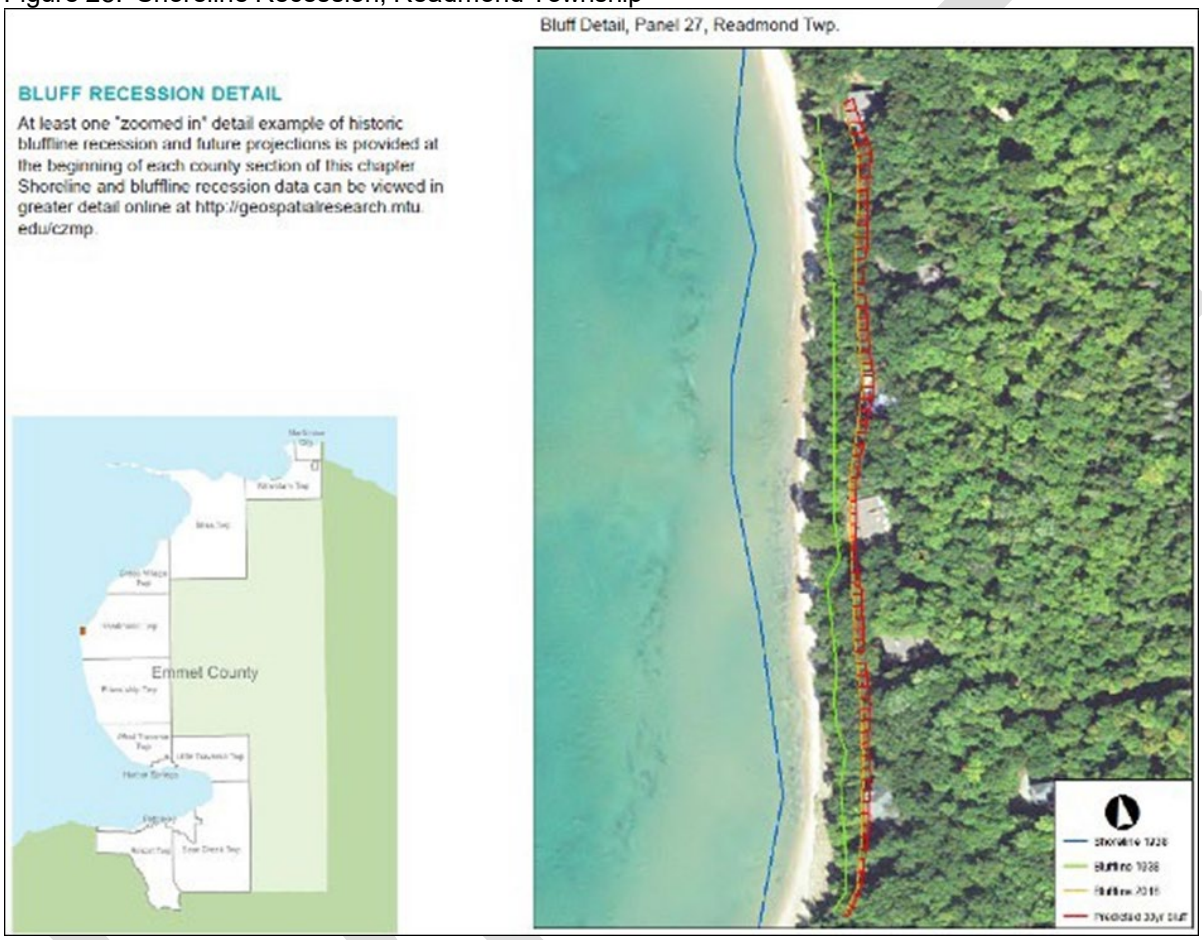
Figure 27. Emmet County Shoreline Communities in LIAA's Northwest Lower MI Coastal Resilience Atlas



Location – Coastal Recession

Coastal recession, or erosion, to Lake Michigan communities is a constant, but small wearing away of the shoreline. The Great Lakes are estimated to lose one foot of shoreline per year to normal wave and wind activity. However, storms and increased wave activity have caused increased coastal recession to varying degrees in Lake Michigan coastal communities. Chapter 4 of the *Northwest Lower Michigan Coastal Resilience Atlas* describes bluffline recession since the 1938 recorded shoreline location. The blue line indicates the shoreline in 1938, the green line indicates the bluffline in 1938, the yellow line is the bluffline in 2016, and the red line is the predicted 30 year bluffline (Figure 28).

Figure 28. Shoreline Recession, Readmond Township



Source: LIAA, Northwest Lower Michigan Coastal Resilience Atlas

Location – Critical Dune Areas

The townships of Wawatam, Bliss, Cross Village, Little Traverse and Bear Creek townships contain nearly 3,800 acres of State-designated “Critical Dune Areas” (CDAs) (Table 55). CDAs are a combination of coastal barrier dunes, land that has dune-like features, and unique plant communities along a Great Lake shoreline. Regulatory authority goes to the water’s edge. The CDAs include public lands and private properties where developmental, silvicultural, and recreational activities are regulated and a permit is required under Part 353, Sand Dunes Protection and Management, of the Natural Resources and Environmental Protection Act (NREPA, Act 451 of 1994). The law balances the benefits of protecting, preserving, restoring and enhancing the diversity, quality, functions, and value of the critical dunes with the benefits of economic development, multiple uses, and public access. A permit is required for activities that significantly alter the CDA, such as the construction of a house or garage, building a road or driveway, installing a septic system, installing retaining walls, and sand removal. Currently EGLE administers Part 353 for all CDAs within the mainland of Emmet County.

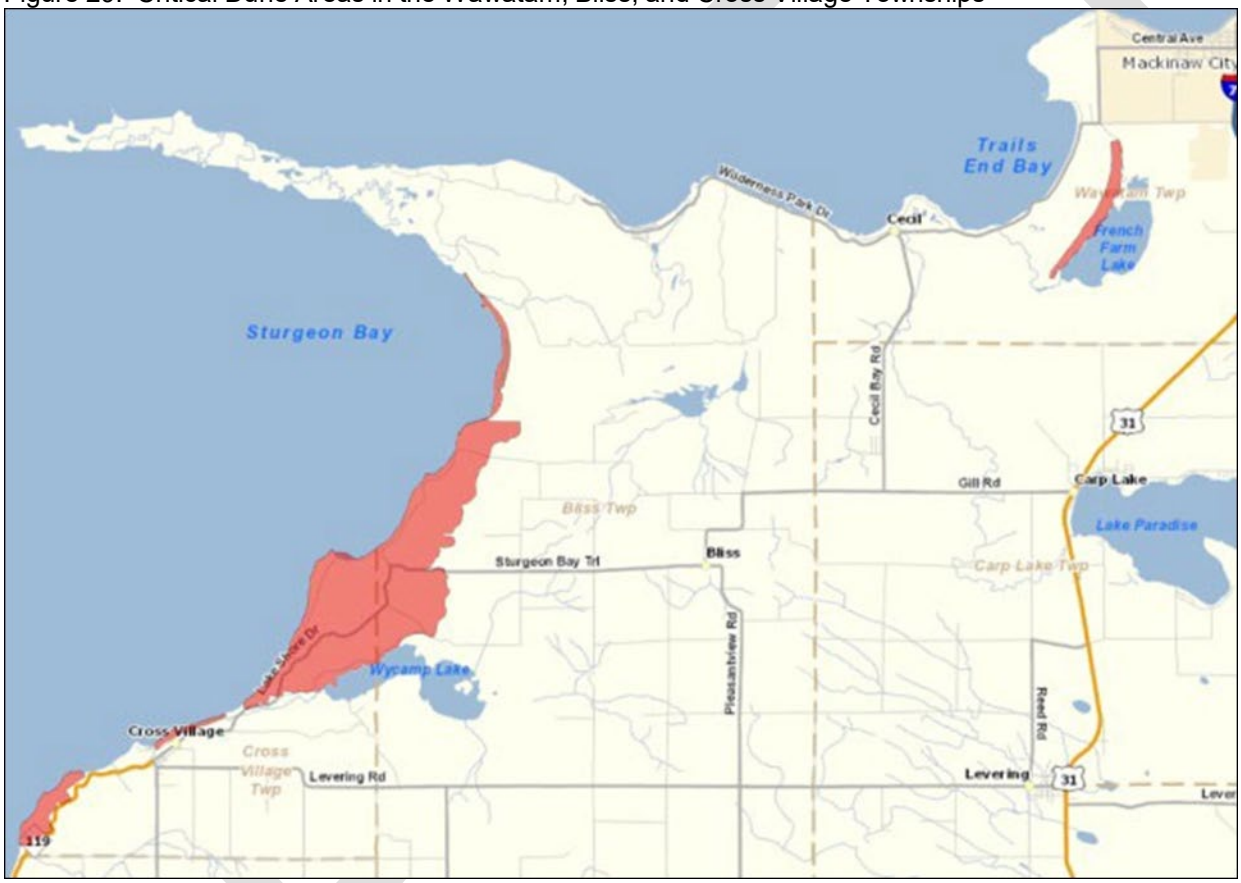
Figures 29 and 30 illustrate the Critical Dune Areas in Emmet County for the coastal communities that have dunes. These areas are also labeled on the Environmental Features Map in Appendix A. Detailed maps of CDAs provided by EGLE can be viewed at: https://www.michigan.gov/egle/about/organization/water-resources/sand-dunes/critical-dunes/maps. The types of dunes in each community in is described in Table 59.

Table 59. Critical Dune Types and Acreage Jurisdiction

Community	Dune Type	Acres
Wawatam Township	Barrier Dunes	189
Bliss Township	Barrier Dunes	1,524
Bliss Township	Exemplary dune associated plant community	116
Cross Village Township	Barrier Dunes	1,449
Little Traverse Township	Areas that exhibit dune-like characteristics	103
Bear Creek Township	Barrier Dunes	410

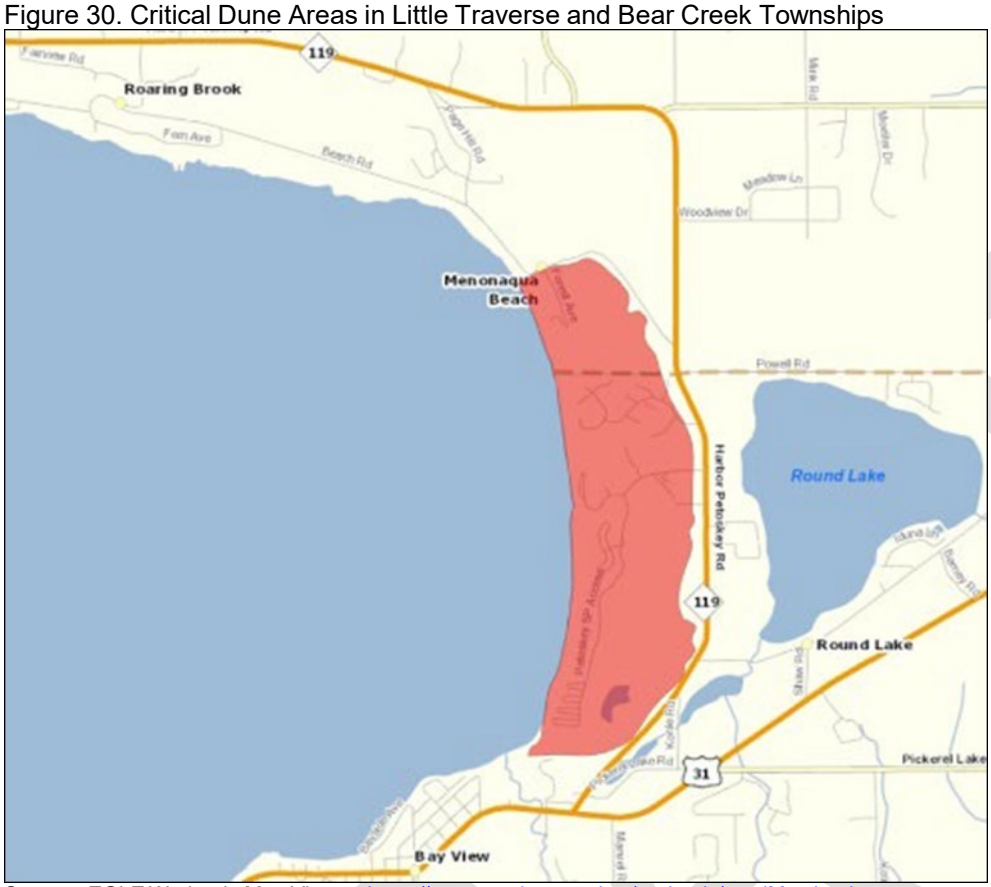
Source: "Planning for Coastal and Climate Trends", 2019, Emmet County Planning and Zoning Department

Figure 29. Critical Dune Areas in the Wawatam, Bliss, and Cross Village Townships



Source: EGLE Wetlands Map Viewer, https://www.mcgi.state.mi.us/wetlands/mcgiMap.html

Figure 30. Critical Dune Areas in Little Traverse and Bear Creek Townships

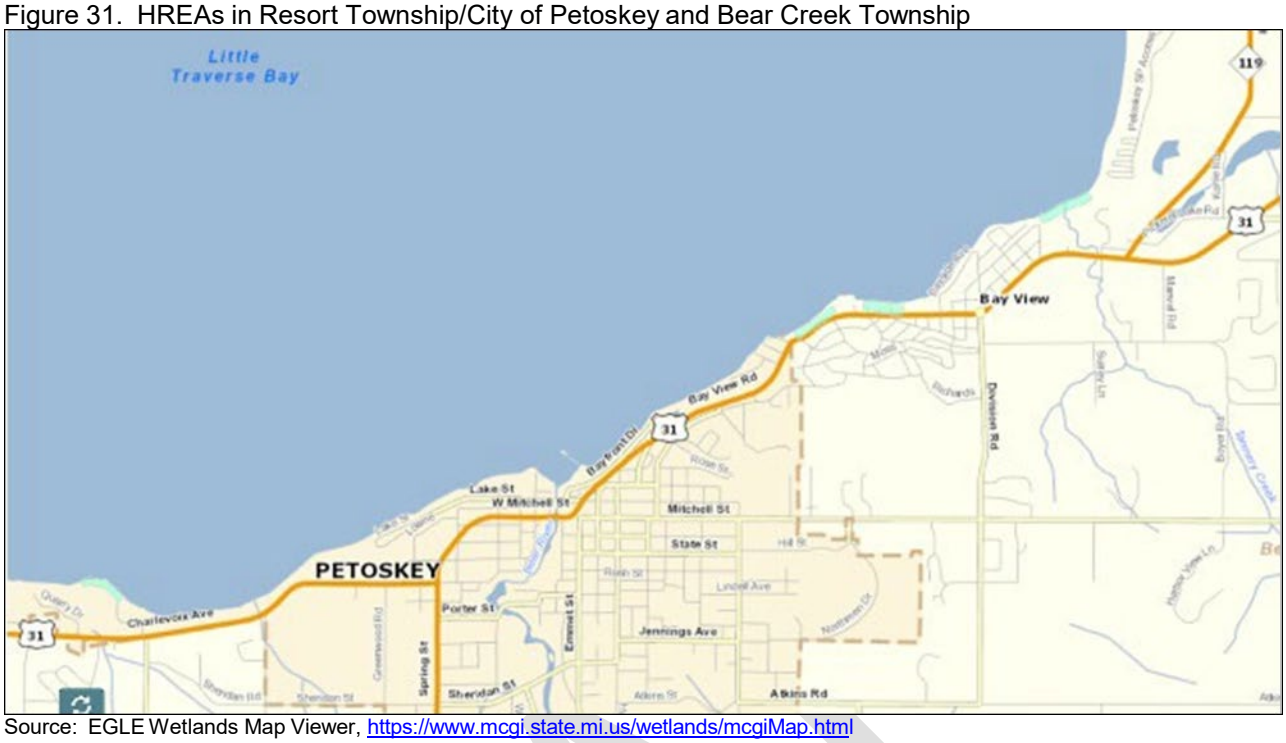


Source: EGLE Wetlands Map Viewer, https://www.mcgi.state.mi.us/wetlands/mcgiMap.html

Location – High Risk Erosion Areas

There are also High-Risk Erosion Areas (HREAs) within Emmet County, in the City of Petoskey/Resort Township and the townships of Bliss, Bear Creek, Cross Village, Readmond, and West Traverse. HREAs are shorelines of the Great Lakes where the land is receding at a rate of one foot or more per year for a minimum of 15 years. Recession rates change over time as water levels fluctuate and coastal conditions change. Along these shorelines, new structures are required to meet setbacks for their protection from a changing shoreline. When structures are not in danger, the shoreline does not need to be altered to protect the structure. A permit is required for construction of a structure on any portion of a designated High-Risk Erosion Area parcel regardless of how far the project is from the lakeshore. Common activities requiring a permit include construction of a house, garage, or addition, substantial reconstruction of an existing home, the installation of a septic system, covered porches, or a commercial building. HREAs are regulated by the Administrative Rules of Part 323, Shorelands Protection and Management, of the Natural Resources and Environmental Protection Act, 1994 PA 451, as amended.

Figure 31. HREAs in Resort Township/City of Petoskey and Bear Creek Township

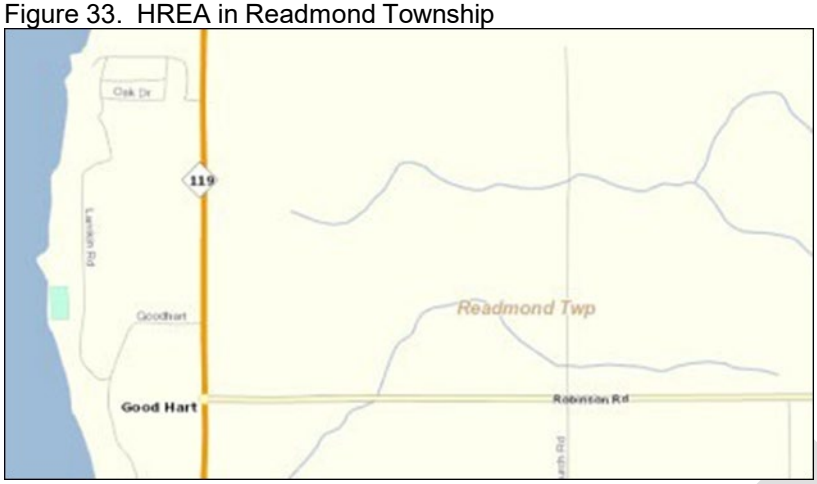


Source: EGLE Wetlands Map Viewer, https://www.mcgi.state.mi.us/wetlands/mcgiMap.html

Figure 32. HREA in West Traverse Township

Source: EGLE Wetlands Map Viewer, https://www.mcgi.state.mi.us/wetlands/mcgiMap.html

Figure 33. HREA in Readmond Township



Source: EGLE Wetlands Map Viewer, https://www.mcgi.state.mi.us/wetlands/mcgiMap.html

Figure 34. HREAs in Cross Village and Bliss Townships

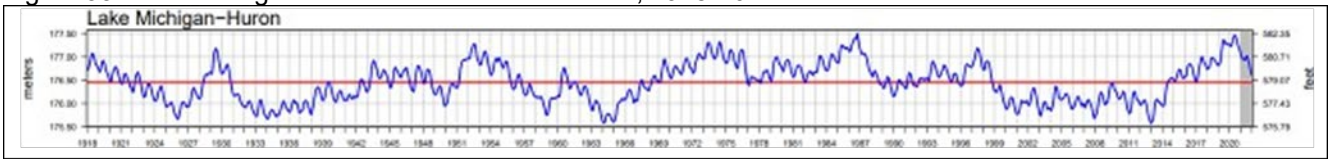
Source: EGLE Wetlands Map Viewer, https://www.mcgi.state.mi.us/wetlands/mcgiMap.html

Extent

Shoreline erosion can be measured by feet of bluffline retreat and property damages. Bluffline retreat distances vary across the county, and there are no reported damages from bluffline recession. Shoreline flooding can be measured by flood water levels, inches of rainfall, lake water levels (shown in Figure 35), and damages. The two lakeshore flooding events in 2020 caused $155,000 in reported property damages in Emmet County (Table 60).

In recent years, the swings in water levels have been unprecedented. In January 2013, Lake Michigan-Huron set an all-time record low of 576.02 feet, and seven years later in July of 2020 Lake Michigan-Huron reached a monthly record high of 582.22 feet, only second to the October 1986 monthly record high of 582.35 feet.

Figure 35. Lake Michigan-Huron Historic Water Levels, 1918-2021



LAKES MICHIGAN-HURON

2021	*580.94*	*580.68*	*580.54*	*580.54*	*580.54*	*580.48*	*580.71*	*580.77*	*580.48*	*580.41*	*579.95*	*579.69*	*580.48*
Mean	**578.48**	**578.44**	**578.48**	**578.77**	**579.07**	**579.30**	**579.40**	**579.33**	**579.17**	**578.94**	**578.77**	**578.61**	**578.90**
Max	581.56	581.53	581.43	581.69	581.96	582.19	582.22	582.09	581.96	582.35	581.96	581.56	
	2020	2020	2020	2020	2020	2020	2020	2020	1986	1986	1986	1986	
Min	576.02	576.08	576.05	576.15	576.57	576.64	576.71	576.67	576.64	576.44	576.28	576.15	
	2013	1964	1964	1964	1964	1964	1964	1964	1964	1964	1964	2012	

Source: US Army Corps of Engineers

In developing the *Northwest Lower Michigan Coastal Resilience Atlas,* scenario planning was used to determine the potential impact of three differing levels of storms combined with high waters:

"Lucky" Future: Great Lakes water levels will continue to stay relatively low. Although there will be wave and wind action, major storm events and wave impacts will not encroach on properties landward of current beaches. A Lucky Future projection, indicating the land areas that would be affected by high-energy waves along the shorefront and/or adjacent riverine flooding under these conditions, is shown in green on the maps.

"Expected" Future: Great Lakes water levels will continue to fluctuate according to long-term decadal patterns, including recent extreme storm events incorporated into the ongoing Great Lakes Coast Flood Study being conducted by the Federal Emergency Management Agency (FEMA). Given those ongoing fluctuations, this Climate Future accounts for periods when Great Lakes still-water elevations are closer to the long-term average. In addition, this Climate Future anticipates the so-called "100-year storm event" (or 1% storm) becoming more like a 20- or 50-year storm event (i.e., an expected storm within the normal community planning time horizon) because of increased storminess. The Expected Future projection is shown in yellow on the maps.

"Perfect Storm" Future: Great Lakes water levels will continue to fluctuate according to decadal patterns, consistent with assumptions made for the Expected Future. However, for this Perfect Storm Climate Future, the estimated still-water elevation is set higher than the long-term average and closer to the long-term high (583 feet). In addition, this Climate Future anticipates the occurrence of a so-called "500-year storm event" (or 0.2% storm) occurring within the planning time horizon while lake levels are high. The Perfect Storm Future projection is shown in red on the maps.

As an example of maps featured in the NW MI Coastal Resilience Atlas for Emmet County, Figures 36 and 37 illustrate the potential flooding scenarios in parts of West Traverse Township and the City of Harbor Springs as examples. "Lucky" scenario flooding is shown in green, "Expected" flooding scenario is shown in yellow, and "Perfect Storm" future scenario is shown in red.

Figure 36. Panel #35 Coastal Flooding Scenario, Harbor Springs/West Traverse Township

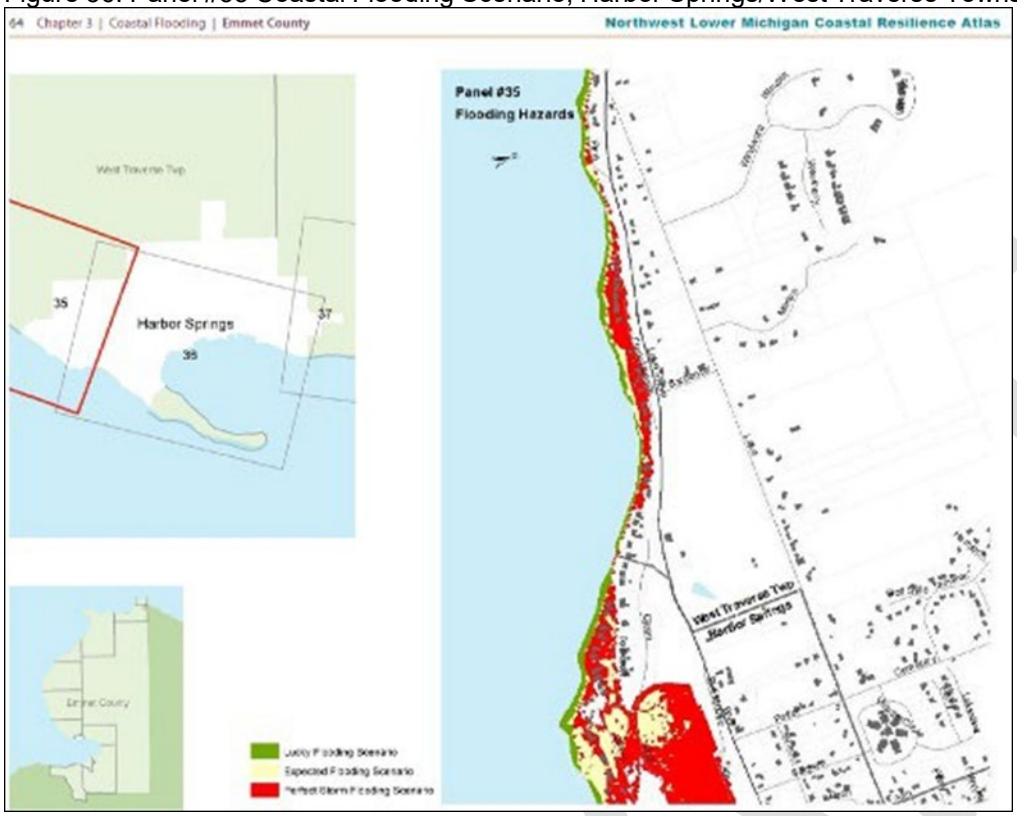
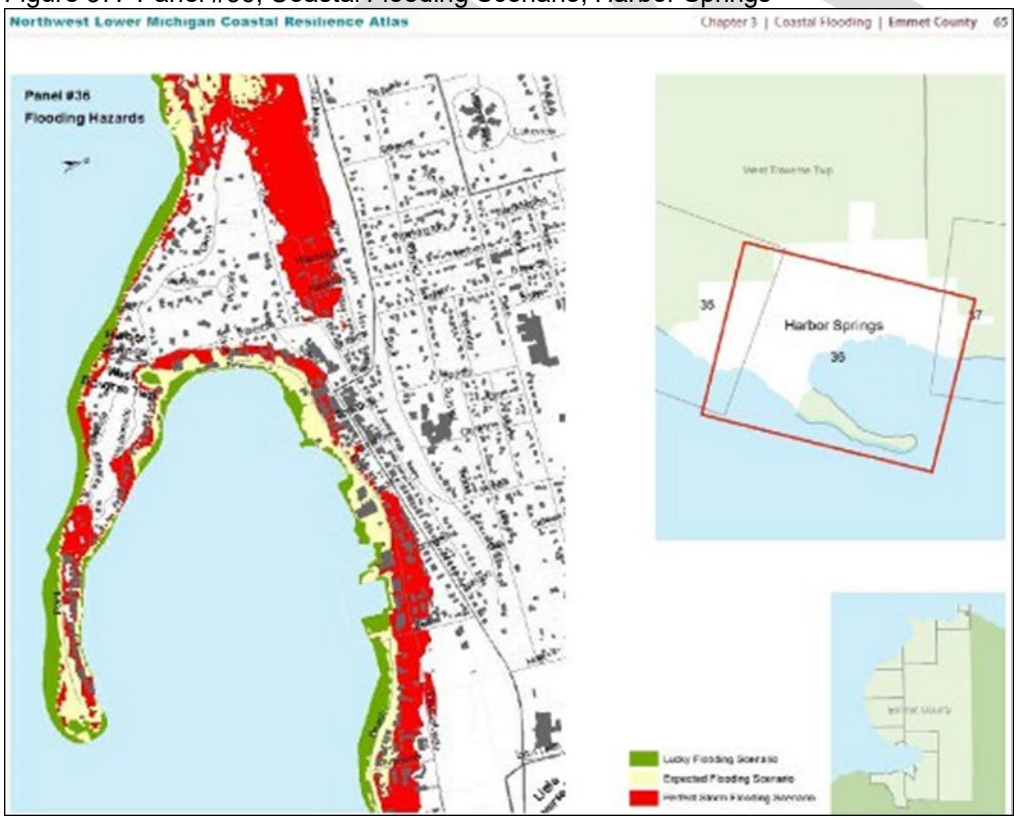


Figure 37. Panel #36, Coastal Flooding Scenario, Harbor Springs



LIAA also completed a detailed community vulnerability assessment in 2019 specifically for Emmet County's coastal communities, to provide information aimed at improving climate resilience by reducing human and community vulnerabilities. This assessment utilized the three Climate Futures to create distinct scenarios, focused on potential impacts to land use and environmental conditions in the county, such as acreage, parcels, and structures that would be at risk under different climate futures. Acres of land impacted by flooding progressively increase from the Lucky Climate Future to the Perfect Storm Climate Future. Table 60 shows the total acres of land impacted under each future flood forecast for coastal communities.[11] Mackinaw City data reflects only the portion of the village inside Emmet County. In each scenario, Bliss Township would have the most land acreage impacted by shoreline flooding.

Table 60. Total Land Acres Impacted by Flooding Jurisdiction

	Lucky	Expected	Perfect Storm
Mackinaw City (Emmet Co.)	13	37	71
Wawatam Township	177	441	873
Bliss Township	1,486	1,927	3,058
Cross Village Township	51	112	245
Friendship Township	41	55	72
Readmond Township	49	66	101
West Traverse Township	66	105	164
Harbor Springs	25	63	157
Little Traverse Township	39	68	189
Bear Creek Township	15	32	97
Petoskey	87	123	231
Resort Township	3	4	5

Table 61 shows the total number of parcels (by zoning district) impacted by flooding for each coastal community in which Emmet County is in charge of zoning. [12]

Table 61. Total Number of Parcels Impacted by Flooding, by Zoning District

Wawatam Parcels Impacted	Lucky	Expected	Perfect Storm
EC B-1 **Local Tourist Business District**	0	1	1
EC B-2 **General Business District**	0	0	0
EC FF-1 **Farm and Forest District**	0	0	0
EC FF-2 **Farm and Forest District**	1	1	1
EC FR **Forest Recreation District**	6	7	8
EC I **Industrial District**	0	0	0
EC R-2 **General Residential District**	0	0	0
EC RR **Recreational Residential District**	202	239	261
EC SR **Scenic Resource District**	0	0	0
Bliss Parcels Impacted	**Lucky**	**Expected**	**Perfect Storm**
EC B-1 **Local Tourist Business District**	0	0	0
EC B-2 **General Business District**	0	0	0
EC FF-2 **Farm and Forest District**	0	0	0
EC FR **Forest Recreation District**	19	19	21
EC RR **Recreational Residential District**	2	3	4
EC SR **Scenic Resource District**	23	23	37

[11] Source: "Planning for Coastal and Climate Trends", 2019, Emmet County Planning and Zoning Department

[12] Ibid.

Cross Village Parcels Impacted	Lucky	Expected	Perfect Storm
EC B-1 **Local Tourist Business District**	0	0	0
EC B-2 **General Business District**	0	0	0
EC FF-1 **Farm and Forest District**	1	1	1
EC FF-2 **Farm and Forest District**	0	0	0
EC FR **Forest Recreation District**	1	1	1
EC R-2 **General Residential District**	0	0	0
EC RR **Recreational Residential District**	106	136	175
EC SR **Scenic Resource District**	58	66	71
Readmond Parcels Impacted	**Lucky**	**Expected**	**Perfect Storm**
EC B-1 **Local Tourist Business District**	0	0	0
EC FF-2 **Farm and Forest District**	2	2	2
EC FR **Forest Recreation District**	0	0	0
EC I **Industrial District**	0	0	0
EC RR **Recreational Residential District**	108	138	152
EC SR **Scenic Resource District**	23	24	24
Bear Creek Parcels Impacted	**Lucky**	**Expected**	**Perfect Storm**
EC B-1 **Local Tourist Business District**	0	0	0
EC B-2 **General Business District**	0	0	2
EC FF-1 **Farm and Forest District**	0	0	0
EC FF-2 **Farm and Forest District**	0	0	0
EC FR **Forest Recreation District**	0	0	0
EC I **Industrial District**	0	0	0
EC PUD **Planned Unit Development District**	0	0	0
EC R-1 **One- and Two-Family Residential District**	14	20	31
EC R-2 **General Residential District**	0	0	0
EC RR **Recreational Residential District**	6	8	25
EC SR **Scenic Resource District**	0	0	0

Table 62 summarizes the total number of structures impacted in each coastal community, based on scenario. Mackinaw City data reflects only the portion of the village inside Emmet County. In a "Lucky" scenario, Wawatam Township would have the most structures impacted by shoreline flooding; in an "Expected" scenario, the Village of Mackinaw City; and in a "Perfect Storm" scenario, the City of Harbor Springs.

Table 62. Number of Structures Impacted by Flooding Jurisdiction

Community	Lucky	Expected	Perfect Storm
Mackinaw City (Emmet Co.)	6	92	143
Wawatam Township	15	70	128
Bliss Township	0	21	43
Cross Village Township	0	12	89
Friendship Township	0	0	2
Readmond Township	0	1	6
West Traverse Township	2	23	86
Harbor Springs	8	51	176
Little Traverse Township	0	32	103
Bear Creek Township	0	13	66
Petoskey	14	63	131
Resort Township	0	0	1

Source: "Planning for Coastal and Climate Trends", 2019, Emmet County Planning and Zoning Department

Previous Occurrences
In the approximately the past four decades, the Great Lakes experienced record high lake levels in 1985-86, 1997-98, and most recently in 2019-20. Two lakeshore floods in Emmet County are on record with NOAA.

Table 63. Shoreline Flooding Events

LOCATION	DATE	EVENT TYPE	DEATHS / INJURIES	PROERTY DAMAGE	CROP DAMAGE
Emmet County – Resort Twp.	4/13/2020	Lakeshore Flood	0 / 0	$150,000	$ -
Emmet County – Wawatam Twp.	10/23/2020	Lakeshore Flood	0 / 0	$5,000	
TOTAL				**$155,000**	$ -

Source: NOAA NCEI Storm Events Database

The episode narrative for the April 13, 2020 lakeshore flood event:

> *Strong low pressure passed just north of eastern upper Michigan on the morning of the 13th. Gusty west to northwest winds developed during the day, in the wake of the low. Gusts of 40 to 50 mph were common across northern Michigan, especially during the afternoon. The highest measured wind gust was 58 mph at the airport in Gaylord. Some localized power outages resulted. Lakeshore flooding also occurred along portions of the Lake Michigan coastline of northwest lower Michigan. The city boat launch in Frankfort experienced flooding of docks and the parking lot. And severe coastal erosion destroyed a portion of the Little Traverse Wheelway between Petoskey and Charlevoix.*

Figure 38. Collapsed Portion of the Little Traverse Wheelway in Petoskey, April 13 2020

Source: W.F. Baird & Associates Ltd. Petoskey Slope Failure Study, September 16, 2020

The episode and event narratives for the October 23, 2020 lakeshore flood event:

> *Low pressure lifted across northern lower Michigan early in the morning of the 23rd. Very heavy rain fell just in advance of this low, late on the 22nd and early on the 23rd. 24 hour rainfall totals were 5.00 in Suttons Bay, 4.98 in Lake Ann, and 4.73 in Gaylord. Following a period of relatively dry weather, most flooding issues were minor. However, more significant road flooding occurred in and near Traverse City. In addition, gusty northwest winds in the wake of the low contributed to lakeshore flooding along the Lake Michigan coast on the 23rd. Wilderness Park Drive was closed between Headlands Rd and Straits View Dr. for five hours due to lakeshore flooding.*

Probability of Future Events and Vulnerability Assessment
There have been two lakeshore flooding events on record with NOAA in Emmet County. These events occurred at the same time as near-record high Great Lakes water levels, in 2020.

As lake water levels fluctuate and increased storminess occurs, shoreline recession and flooding will continue. In 2021 the level of Lake Michigan began to decline, however, as historic data indicates, the water will begin to rise again. Historic lake level fluctuations have ranged between 3 to 16 year intervals. Those communities that have already faced shoreline hazards are likely to experience issues in the future. Changes in land use practices and improvements to the shoreline such as natural vegetation plantings or shoreline armoring may reinforce the shoreline for a period of time, but is not a permanent solution.

Shoreline flooding can also result in soil erosion, which carries a risk of loss to shoreline properties. It may necessitate the relocation of homes or other structures as sand or soil is removed by flowing water (lake, river, etc.) and carried away over time. 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. Shoreline banks that support roadways may erode and cause the road surface to crack, become unstable, or more prone to deposits of sand, snow, water, and ice. Shoreline flooding and erosion is especially relevant to those municipalities that contain residential and commercial development along Lake Michigan that experience seasonal shifts in water levels and possible ice erosion hazards.

Local Plans, Programs and Resources
Emmet County administers Zoning for the Townships of Bear Creek, Bliss, Carp Lake, Center, Cross Village, Friendship, Littlefield, Maple River, McKinley, Readmond, Springvale and Wawatam. Section 22.10 of the Emmet County Zoning Ordinance pertains to Shoreline Bluff Protection, which has established setbacks from the shoreline bluff and waterfront. Development and construction are prohibited within the shoreline bluff zone and 15 feet on either side, however stairways, utilities, and repairs/remodeling to existing structures and driveways are exempt. The waterfront setback ranges from 25 feet to 60 feet, depending on the underlying zoning district. The setback is measured from the 1986 ordinary high-water mark, the historic high of Lake Michigan at 582.35 feet. Existing and proposed waterfront setback requirements for Emmet County communities are listed in Figure .

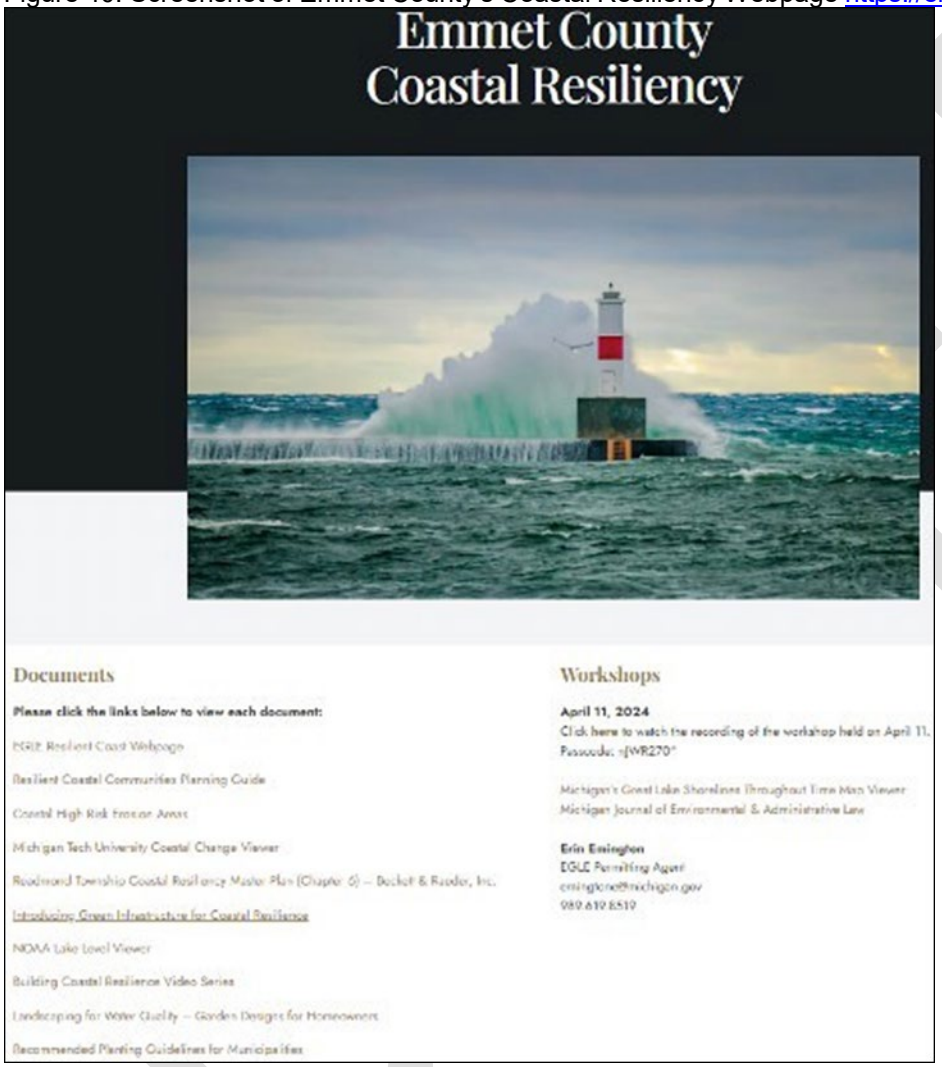
Figure 39. Lake Michigan Shoreline Setback Regulations in Emmet County Communities

Municipality	Required	Suggested
Emmet County (*includes Bear Creek, Bliss, Cross Village, Friendship, Readmond, and Wawatam)*	60-foot setback from 1986 OHWM	35-foot shoreline setback (vegetation)
West Traverse	60-foot setback from 1986 OHWM (581.99')	
Harbor Springs	25 feet from water edge *(current)* 35 feet from 1985 OHWM *(proposed)* (580.5')	
Little Traverse	None	
Petoskey	None	
Resort	40 feet from OHWM	

Source: Screenshot from the April 11, 2024 Emmet County Coastal Resilience Workshop Recorded Presentation

The Emmet County Planning and Zoning Department was awarded a NOAA/EGLE Coastal Resiliency Grant in 2023. In 2024, the Department compiled coastal education materials to send to Lake Michigan property owners in all coastal townships within the county, and conducted meetings to promote education and build awareness of coastal resilience among shoreline property owners. A webpage, https://emmetcountyczm.org/, was created to provide links to these education resources (Figure 40). The Department is also reviewing current county ordinance standards and provide suggestions for revisions to the Emmet County Planning Commission that might bolster resilient coastal planning efforts.

Figure 40. Screenshot of Emmet County's Coastal Resiliency Webpage https://emmetcountyczm.org/



The City of Petoskey's 2024-2029 Capital Improvement Plan includes the following projects related to address shoreline erosion and/or flooding:

- Design and engineering for the slope failure area of the Little Traverse Wheelway in 2024. Funded with $200,000 from City's General Fund and an $800,000 grant from EGLE.

- Potential relocation of the Little Traverse Wheelway from Magnus Park to East Park in 2029 to address the trail washout that occurred in 2020 due to high lake levels and erosion of the shoreline. Funded from the City's operating revenue; cost estimate undetermined.

- Bayfront Park Shoreline Stabilization Improvements to address past high water levels and resulting damage. Date undetermined. Partially funded with $7 million from the City; other funding sources undetermined.

- Bayfront West Livable Shoreline Installation - Convert revetment and shoreline to a natural livable design to help with high water erosion issues. Date undetermined. TIFA as possible funding source; cost estimate and other funding sources undetermined.

Readmond Township's 2024 Master Plan includes a chapter specifically addressing coastal resilience. The chapter provides an overview of the fluctuations of historic Great Lakes water levels and shifting dynamics of the lakes as the effects of climate change occur. Warmer air, fewer days of ice cover, more severe and frequent storms, and faster evaporation will cause an acceleration of water level fluctuations and the fluctuations will become less predictable. These shifting dynamics will speed the erosion of the shoreline at a pace where it cannot be replenished by natural systems, posing a threat to structures, infrastructure, and critical facilities located near the shoreline.

The plan identified which areas of the shore are likely to flood during a storm, providing insight into where the greatest risk for people, structures, and the natural environment is located. While this analysis of coastal flooding from storms does not provide a direct correlation to shoreland erosion, it does highlight what areas of the shore are likely to experience the most severe interactions with the water.

The analysis developed for coastal flooding scenarios in the township utilized a combination of elevation, water levels, storm surges, FEMA data, and Geographic Information Systems (GIS) to determine what areas are likely to flood in a given storm scenario. The analysis uses three different storm scenarios, a "lucky," "expected," and "perfect," storm to accurately project the full range of risk.

Under the "lucky" storm scenario, an estimated 170 parcels would be impacted by coastal storm flooding (18.4% of all parcels in the Township). These parcels total roughly $43.4 million in state equalized property value (SEV), almost half of the total value in the Township. Therefore, a substantial portion of the Township's tax base is at risk from coastal flooding, even under a "best case scenario." The majority of the shoreline properties are residential and almost identical numbers of residential properties are impacted by coastal storm flooding, compared to the total parcels.

The "expected" storm scenario results in identical results to the lucky storm scenario. The "perfect" storm scenario models a slight increase in risk (2.4% increase in affected properties) but aligns very closely with the previous storm scenarios. The lack of variability between the storm scenarios is driven by the topography of Readmond Township's coastline. The presence of bluffs and steep slopes in the shoreland means that there are very few areas of flat coastland, which tend to be heavily impacted by coastal flooding. Essentially, storm flood waters run into a topographic wall which keeps them from moving further inland.

While there is little change in the geography impacted under each scenario, the impact on property varies. The more intense the storm scenario, the more water moves over the land, and if the geography doesn't expand it means the flood waters in the affected areas will be deeper and more impactful in the more intense storm scenarios. Additionally, the water is likely to stay inland for longer, prolonging the damage to structures.

The plan included the following adaptation strategies for Readmond Township:

- Zoning setbacks are the minimum distance a structure can be from a lot line, other structure, or natural feature. Zoning in Readmond Township is administered at the county level, so zoning changes would need to be made by the Emmet County Planning Commission; however, Readmond Township can advocate for zoning changes.
- Promote cluster developments in shoreline areas. It is less impactful on the shoreline and preserves greater amounts of natural space, reducing the amount of built land that is at coastal risk. Cluster developments allow for some flexibility in design to ensure efficient use of the land and the promotion of environmentally sensitive areas. Clustering development can be promoted through a planned unit development, the zoning map, or the future land use map.

- Preserve and enhance coastal wetlands, as they act as natural water retention areas and offer a barrier of protection during coastal floods. Section 20.11 of Emmet County's zoning ordinance does include wetland regulation, but it does not add any additional protection beyond what is already regulated by the State. Additional enhancement measures should be taken for wetlands near the shore.
- Vegetative buffers along the shore (including dune grass, lichens, and woody plants would reduce the distance flood water travels inland and would lessen the force flood water would have on the built environment. Emmet County's zoning ordinance mandates that a shoreline greenbelt of 35ft must be maintained for waterfront properties; however the language specifically for greenbelts could be strengthened in regard to native planting requirements. Additionally, expanding greenbelt requirements around coastal flood zones would provide enhanced protection during flood events.
- Discourage shoreline armoring through public education efforts. A revised zoning ordinance could require or incentivize the use of native landscaping and nature-based shorelines in lieu of hard armoring structures.

Space Weather and Electromagnetic Pulses

Space weather is a naturally occurring phenomenon in which the sun releases solar flares, energetic particles and/or coronal mass ejections (CME). These events are known as solar storms. In particular, if a CME is directed towards Earth, it can interact with the Earth's magnetic field and cause geomagnetic storms. Under these circumstances extra currents, known as geo-magnetically induced currents (GIC), are created in the ground which can impact the electric grid. These GICS can cause widespread outages in two ways: First, they can cause permanent damage of critical grid components, such as high-voltage power transformers. This is of particular concern as high voltage transformers are not easily replaceable. Second, the GICs can cause voltage instability in the grid and cause the system voltage to collapse, resulting in a widespread but temporary outage.

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.

An electromagnetic pulse (EMP) is a burst of electromagnetic energy produced by a nuclear explosion in the atmosphere, considered capable of widespread damage to power lines, telecommunications, and electronic equipment. EMPs are associated with intentional attacks using high-altitude nuclear detonations, specialized conventional munitions, or non-nuclear directed energy devices. Effects vary in scale from highly local to regional to continental, depending upon the specific characteristics of the weapon and the attack profile. High-altitude electromagnetic pulse attacks (HEMP) using nuclear weapons are of most concern because they may permanently damage or disable large sections of the national electric grid and other critical infrastructure control systems.

According to the U.S. Department of Homeland Security, Science and Technology Directorate's 2022 report *Electromagnetic Pulse Shielding Mitigations: Best Practices for Protection of Mission Critical Equipment*, the civilian Critical Infrastructure (CI) within the United States faces threats from natural EMPs caused by major solar storms, as well as from manmade EMP attacks. As described in Executive Order (EO) 13865, Coordinating National Resilience to Electromagnetic Pulses (March 26, 2019). "An EMP event has the potential to disrupt, degrade, and damage technology and critical infrastructure systems."

Public awareness of manmade EMPs began on July 9, 1962 following the Starfish Prime test, during which the U.S. detonated a 1.4-megaton thermonuclear weapon 250 miles above Johnston Island in the mid-Pacific. On the Hawaiian Islands, 900 miles away, burglar alarms were triggered, circuit breakers opened, and over 300 streetlights in Honolulu failed nearly simultaneously. A few months later, to better understand EMP effects, the Soviet Union conducted a series of high-altitude nuclear tests over Southwestern Siberia, inadvertently demonstrating the weaponization potential of high-altitude EMP (HEMP), as revealed to U.S. scientists in 1995.

Location

Space weather and EMPs are not confined to geographic boundaries and can be a regional, national or international event. Since space weather occurs more often during solar maximums, however, it is impossible to predict where space weather will occur and how severe it will be. All electric and communications infrastructure in Emmet County is at risk to a space weather or EMP event.

Extent

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), and (3) radio blackouts (R-scale). 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, refer to https://www.swpc.noaa.gov/noaa-scales-explanation

Previous Occurrences

Space weather is a term that denotes the impacts of the Sun's activity upon the bodies within this heliosphere (the volume of space inside the heliopause areas), including our own Earth. As is observable with ordinary weather on Earth, there are some clear patterns that are exhibited by space weather. More turbulent space weather is produced during times when more sunspots are present (called a solar maximum), and space weather is calm during times when sunspots are rare and small (or not even detectable at all, called a solar minimum). 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.

In addition, it has been observed that long periods can occur with little or no apparent sunspot activity. The "Maunder minimum," which occurred between the years 1645 and 1715, is the primary example of such long-term variation from the normal cycle, but it is not yet known what caused it, or when it might recur.

The following is a list of significant solar weather events. While no specific impacts occurring in Michigan were mentioned, the events were either international or regional in their effects.

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.

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.

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.

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."

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.

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.

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.

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.

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.

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.

July 23, 2012 – International
The STEREO solar observatory 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.

Probability of Future Events and Vulnerability Assessment
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 generated by large solar flares, causing problems with radio communications, damage to satellites, and even disruptions in power delivery networks on the Earth.

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.

Space weather prediction services in the United States are provided primarily by NOAA's Space Weather Prediction Center (SWPC) and the U.S. Air Force's (USAF) 557th Weather Wing, which work closely together to address the needs of their civilian and military user communities. The SWPC draws on a variety of data sources, both space and ground-based, to provide forecasts, watches, warnings, alerts and summaries as well as operational space weather products to civilian and commercial users. The following are NOAA's definitions of a Space Weather Watch, Warning, and Alert:

> Watch: A Watch is issued when the risk of a potentially hazardous space weather event has increased significantly, but its occurrence or timing is still uncertain. It is intended to provide enough advanced notice so those who need to set their plans in motion can do so. The purpose of a Watch is to give preliminary notification of possible space weather activity with a lead-time of hours to days. A Watch can be upgraded to a higher-level Watch.
>
> Warning: A Warning is issued when a significant space weather event is occurring, imminent or likely. A Warning is a short-term, high confidence prediction of imminent activity. The purpose of a Warning is notification of impending space weather activity with a lead-time of minutes to a few hours. A Warning can be upgraded to a higher Warning if space weather conditions are expected to change sufficiently enough to warrant the upgrade.
>
> Alert: Alerts indicate that the observed conditions, highlighted by the warnings, have crossed a preset threshold or that a space weather event has already started.

In September 2022, the Department of Homeland Security (DHS) released a report titled Electromagnetic Pulse Shielding Mitigations. The report describes operational approaches to protect the National Public Warning System from an EMP, as well as best practices and design principles that can be implemented by critical infrastructure owners and operators who seek to secure their assets against EMP in a similar manner to the NPWS equipment. The report is a collaborative effort between the DHS Science and Technology Directorate (S&T), the Federal Emergency Management Agency (FEMA) Integrated Public Alert and Warning System (IPAWS) Program, and the Cybersecurity & Infrastructure Security Agency (CISA). Content of the S&T press [13] release pertaining to this report is as follows:

> "Electromagnetic pulses, whether caused by an intentional EMP attack or a naturally occurring geomagnetic disturbance from severe space weather, could disrupt critical infrastructure such as the electrical grid,

communications equipment, water and wastewater systems, and transportation modes," said Kathryn Coulter Mitchell, DHS Senior Official Performing the Duties of the Under Secretary for Science and Technology. "This could impact millions of people over large parts of the country. It is critical to protect against the potential damage an EMP event could cause."

The National Public Warning System ensures the President of the United States can communicate with Americans in the event of a national emergency. The FEMA IPAWS Program equips 77 private sector radio broadcast stations with EMP-protected backup transmitters, communications equipment, and power generators that would enable the station to broadcast national emergency information to the public in the event of an EMP event. "These stations represent a key public-private sector partnership and serve as the primary sources for a national emergency broadcast during a catastrophic disaster," said Antwane Johnson, FEMA IPAWS Program Director. The stations are located across the country providing radio broadcast coverage to more than 90 percent of U.S. population.

As part of a broader DHS effort to ensure critical infrastructure and emergency response systems are protected against EMPs, FEMA conducted high-altitude electromagnetic pulse (HEMP) testing on the NPWS equipment to evaluate its operational resiliency. The testing confirmed the effectiveness of protection for NPWS stations, showing they could withstand the effects of an EMP in accordance with military specifications. "Protecting critical assets from EMP is part of a larger DHS effort to assess and mitigate EMP risk in both the public and private sector," said Acting CISA Assistant Director Mona Harrington. "CISA remains committed to working with our partners to implement requirements outlined in the Executive Order on Coordinating National Resilience to Electromagnetic Pulses, which strengthens our nation's preparedness from EMP."

Subsidence

Note: much of the information presented in this section was obtained from MSP's 2019 Michigan Hazard Analysis.

Subsidence is defined as the lowering or collapse of a land surface, caused by natural or human-induced activities that erode or remove subsurface support. Natural subsidence occurs when the ground collapses into underground cavities produced by the dissolution of limestone or other soluble materials by groundwater. Human-induced subsidence is caused principally by groundwater withdrawal, drainage of organic soils, and mining.

More than 80% of the identified subsidence in the United States is a consequence of human impact on subsurface water. Three distinct processes account for most of the water-related subsidence: compaction of aquifer systems, drainage and subsequent oxidation of organic soils, and dissolution and collapse of susceptible rocks.

Approximately 18% of the United States land surface is underlain by cavernous limestone, gypsum, salt, or marble, making the surface of these areas susceptible to collapse into sinkholes. The term *karst*, first applied to a plateau region of the Dinaric Alps in Yugoslavia, is now used to describe regions throughout the world that have features formed largely by underground drainage. Karst terrains are characterized by caves, steep valleys, sinkholes, and a general lack of surface streams. Within Michigan, sinkholes are found predominantly in the northeastern Lower Peninsula and eastern Upper Peninsula.

Additionally, an increasing number of urban subsidence events have resulted from infrastructure failures, such as water main breaks, which cause road surfaces to collapse. Construction-related incidents have also occurred in Michigan.[14]

Location

There are no mine-related subsidence threats, such as abandoned coal mines or other underground mining activity in Emmet County (Figure 41). The sinkhole risk categories for Emmet County range from "infrequent or likely infrequent" to "absent or likely absent" (Figure 42).

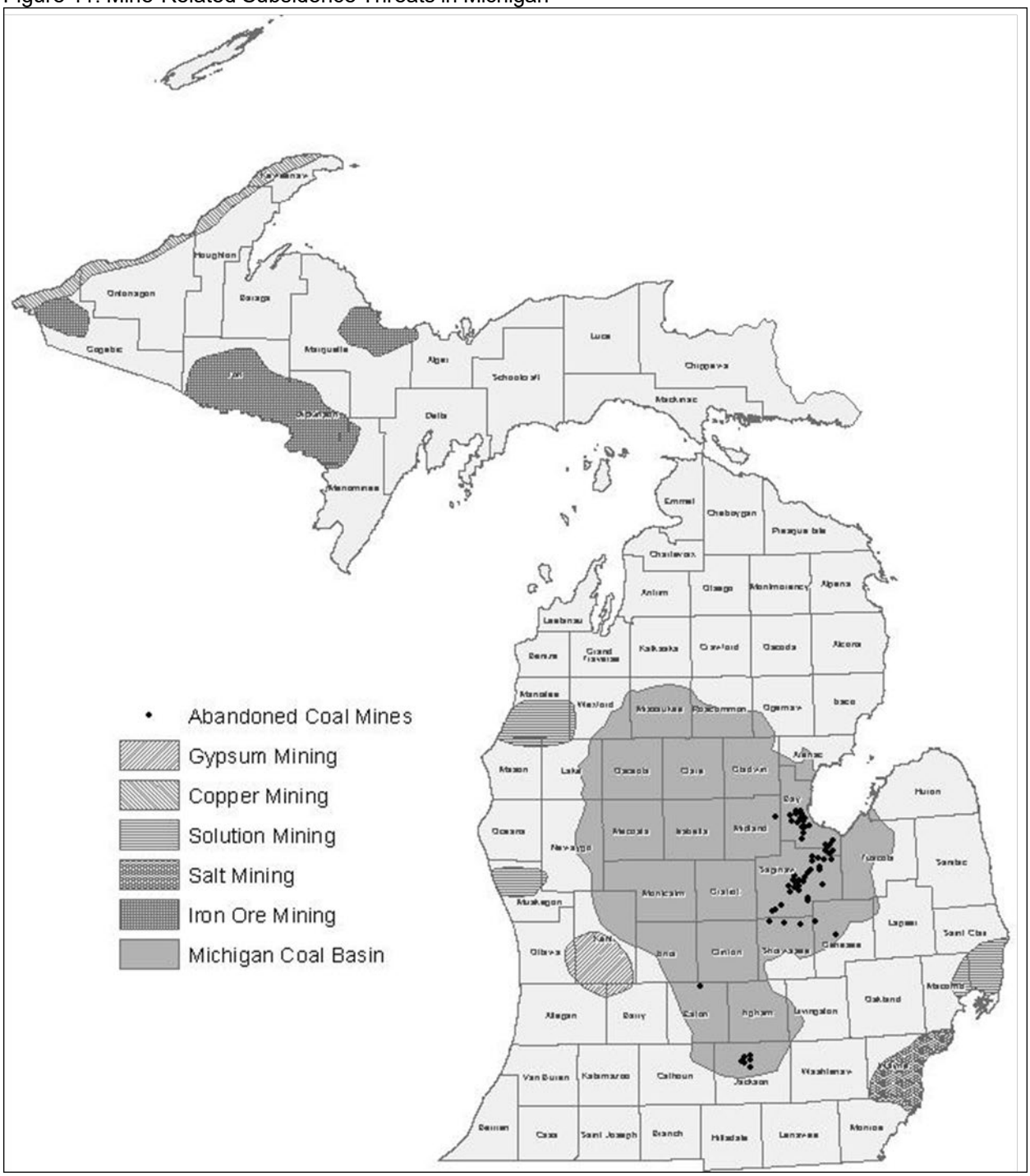
Extent

Although some subsidence incidents may cause private property damage and casualties within Michigan, others may affect roadways or other public infrastructure, and thus cause a more general impact on the population of an area. Most past incidents have had limited effect upon the general public, but in time, some exception may arise. Roadways have now been identified that are in proximity to, if not completely overlaying, abandoned mine lands that therefore may be vulnerable to collapse, potentially injuring or killing persons traveling in vehicles or trapped within a collapse area. A recent rain event revealed that mudslides and structural collapse can occur as a result of rapid hydrological runoff within hilly areas of the state, and can cause fatal impacts. The number of houses and other buildings that may be at substantial risk has not yet been pinned down, but probably numbers over 100 on the basis of the identified mine locations mapped by MDNR. Infrastructure is likely to be affected just as surface roads are. It is not yet clear what facilities may be at risk, but they probably include some that will impact the quality of life in some of Michigan's oldest communities (both small and large). Likely forms of infrastructure vulnerability include transportation, water supply, urban sewage, and underground pipelines for oil and gas. One of the most serious such events could have resulted from the 2016 incident in Fraser, which involved a major component of the water infrastructure within one of the most heavily and densely populated counties in Michigan, but fortunately was handled promptly and carefully in a way that limited its impacts to the broader metropolitan area.

[14] A crack in a concrete retention system caused a 40-foot sinkhole to occur on March 23, 2011, outside an underground parking structure's construction site in Ann Arbor. The combination of the state of the retention wall, the thawing of the ground, and sandy soils could have caused an underground cavity behind the concrete retention system to bubble up vertically to open the hole. Two businesses were closed for the day after the ground opened in their shared parking lot.

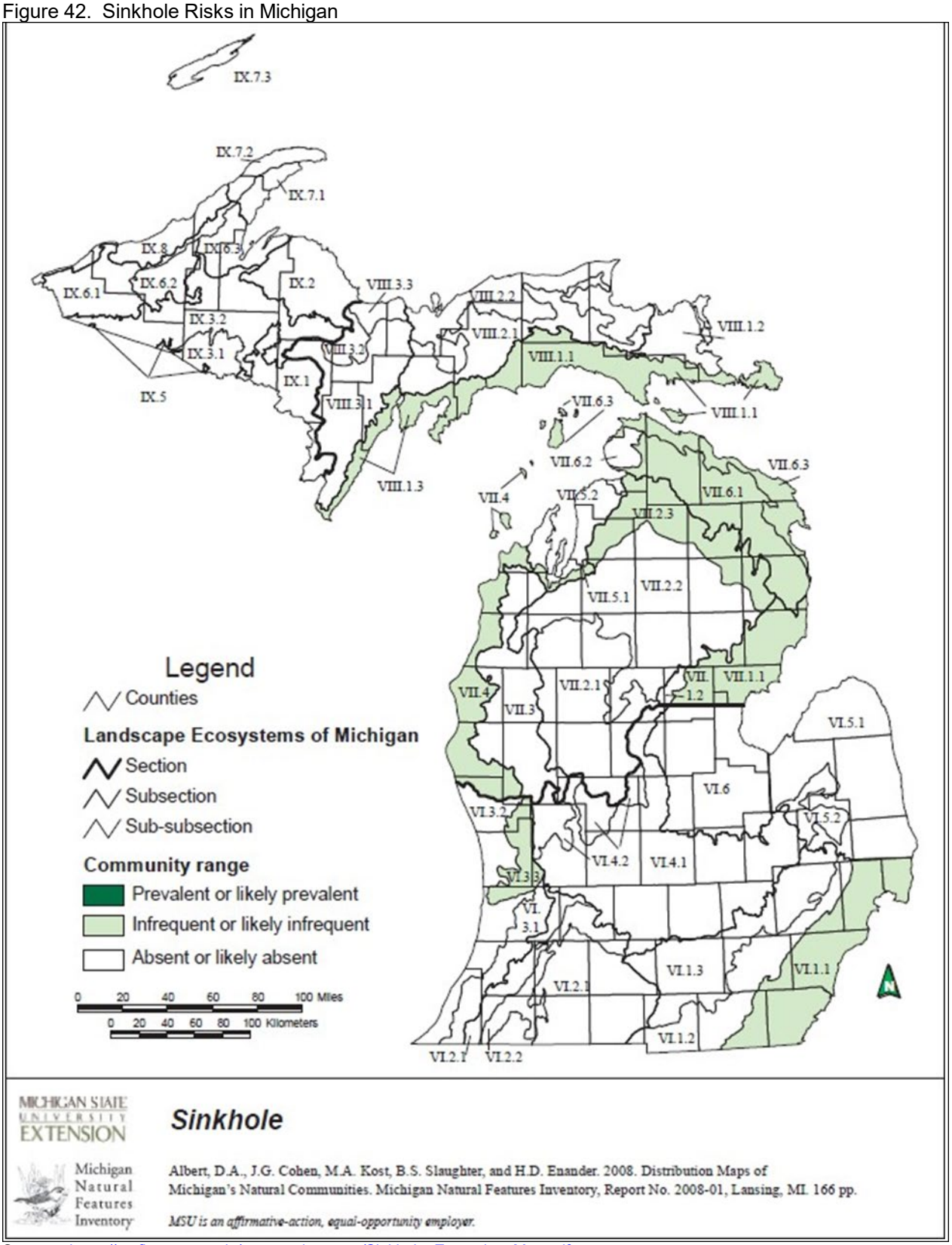
Previous Occurrences
The *2019 Michigan Hazard Analysis*, completed by the Michigan State Police, does not indicate that any significant subsidence incidents, such as mine cave-ins or sinkholes, have occurred in Emmet County or adjoining counties.

Figure 41. Mine-Related Subsidence Threats in Michigan



Sources: Michigan State Police – *Michigan Hazard Analysis*, 2019; Michigan Department of Environmental Quality, Office of Geological Survey

Figure 42. Sinkhole Risks in Michigan



Source: https://mnfi.anr.msu.edu/community-maps/Sinkhole_Ecoregion_Map.pdf

Probability of Future Events and Vulnerability Assessment

The probability of a subsidence event occurring within Emmet County is low, but not impossible. Areas of underground water and sewer infrastructure in urbanized areas of the county, such as Petoskey, Harbor Springs, and Mackinaw City, are more likely to experience a subsidence event caused by an underground utility failure. Regular maintenance of water and sewer infrastructure operations is essential to ensure the continuous availability of clean potable water and proper collection and treatment of sanitary sewage.

Invasive Species

The National Invasive Species Council defines an invasive species as, "A species that is not native and whose introduction causes, or is likely to cause, economic or environmental harm or harm to human health." The Council was formed under Presidential Executive Orders 13112 and 13751 to prevent the introduction and spread of invasive species, and to support efforts to eradicate and control invasive species that are established throughout the United States. NOAA's National Ocean Service identifies invasive species as "capable of causing extinctions of native plants and animals, reducing biodiversity, competing with native organisms for limited resources, and altering habitats." There are a wide variety of species considered invasive. Known and monitored species include:

- Mammals
- Birds
- Insects
- Fish
- Crustaceans
- Mollusks
- Worms
- Plants
- Diseases

Invasive species harmful to Michigan and Emmet County may be either terrestrial invasive species (TIS) or aquatic invasive species (AIS). Terrestrial invasive include non-native, land-based plants, insects, animals and diseases that harm Michigan's environment, economy, and human health. Aquatic invasive include non-native, water-dwelling plants, animals, and other organisms that have evolved to live primarily in water (aquatic habitats) rather than on land. Aquatic habitats are habitats that are covered with water all or part of every year. Michigan State Departments cooperated to prepare the Terrestrial Invasive Species State Management Plan and the 2013 Aquatic Invasive Species State Management Plan Update: Prevention, Detection, and Management in Michigan Waters. Each plan outlines a statewide strategy to reduce the environmental and economic damages caused by either TIS or AIS.

Non-native terrestrial and aquatic species are introduced to Michigan and the Great Lakes both intentionally and unintentionally. Aquatic invasive species are the result of unwanted fish and aquatic plants released from home aquariums, travelled across the ocean in ballast water carried by freighters, or entered from the ocean through human-built channels such as the Welland Canal [15].

The Midwest Invasive Species Information Network (MISIN) is a regional effort to develop and provide early detection and response resources for invasive species. Among many tools and resources, the website https://www.misin.msu.edu/ provides a catalog of species information and a report of occurrences submitted within each state. Animals, plants, and diseases are included in the catalog. The top reported invasive species in Michigan are:

- Phragmites (Invasive): 65,135
- Garlic mustard: 18,462
- Autumn olive: 17,120
- Spotted knapweed: 15,734
- Brown marmorated stink bug: 13,300
- Japanese knotweed: 12,922
- Purple loosestrife: 11,058
- Common buckthorn: 8,735
- Japanese barberry: 8,161
- Bush honeysuckle: 7,451

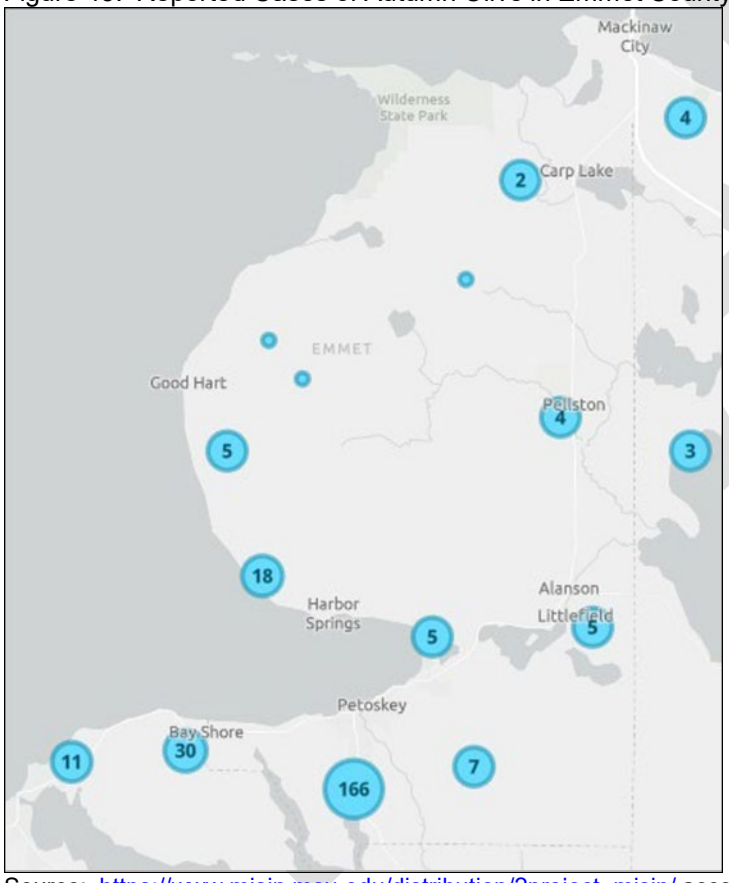
[15] The Welland Canal is a ship canal in Ontario, Canada, connecting Lake Ontario and Lake Erie.

Location

Invasive species pose a significant threat to the County's lakes, wetlands, and forests. These non-native, introduced species outcompete native species; impact food chains and fish and wildlife habitat; reduce property values; impact water-based recreation and navigation; and among the many other environmental and economic problems, invasive species are costly to control and manage. Certain high profile species, such as phragmites and Eurasian watermilfoil, have been especially prolific, disruptive, and costly.

Terrestrial and aquatic invasive species threaten sensitive ecosystems and may be present in Emmet County forest, wetland, farmland, grassland, aquatic, shoreline, and urban environments. "A Field Guide to Invasive Plants of Aquatic and Wetland Habitats for Michigan" (Campbell, Higman, Slaughter, Schools) identifies the Lake Michigan coastline as particularly vulnerable. "Lake-moderated climates along the Lake Michigan shoreline, Saginaw Bay, the Thumb, Lake St. Clair, and western Lake Erie are much milder than those in the state's interior… These areas have the potential to harbor species typically found far south of Michigan." TIS and AIS designation generally applies, however, several upland species appear to be spreading to wetland and aquatic areas. Regular monitoring and reporting introductions detected is the only way to know where an invasive species has infested. The MISIN website provides species observation maps of invasive animals, plants and diseases that can be created by selecting a species' common name, scientific name or family type. Figure 43 is an example of a map generated when querying invasive species observations in Emmet County; in this case, for Autumn olive.

Figure 43: Reported Cases of Autumn Olive in Emmet County



Source: https://www.misin.msu.edu/distribution/?project=misin/ accessed 1/12/2024

Figure 44 is from the MDNR interactive mapping resource "Look for Oak Wilt," which allows users to view an interactive map to see the known extent of oak wilt throughout Michigan and report a possible infection location. While there are no reported cases of Oak Wilt in Emmet County, there are a few in the adjoining counties of Charlevoix and Cheboygan.

Figure 44. Reported Oak Wilt Cases in Northern Lower Michigan

Source: https://www.michigan.gov/invasives/id-report/disease/oak-wilt Accessed 11/18/2023

Participants in the public input session held in March 2023 identified the following specific sites as areas of concern regarding invasive species (Table 64). These sites are also indicated on the hazard maps in Appendix A.

Table 64. Invasive Species Sites of Concern in Emmet County, per Stakeholder Input

Bear Creek Township
Entire Bear River corridor
Tannery Creek area near US-31
Round Lake – Powell Rd. boat launch
Carp Lake Township
Lake Paradise – Paradise Trail boat launch
Center Township
Larks Lake – Kaz Rd. boat launch
Littlefield Township
Crooked Lake
Little Traverse Township
Crooked Lake; boat launch near Conway Rd / US-31
Maple River Township
Crooked River near Snider Road
City of Petoskey
The Bear River corridor
Springvale Township
Pickerel Lake – Botsford Road end boat launch
Crooked Lake
Wawatam Township
French Farm Lake

Extent
Invasive species impact can be measured by its damaging effects. TIS cause billions of dollars in damage annually, are extremely costly to control, and often have irreversible ecological effects. Native habitats, agriculture lands and livestock, and the outdoor recreation economy are threatened or damaged by invasive species. *Michigan's Terrestrial Invasive Species State Management Plan* lists these state impacts:

- The State of Michigan estimates 42% of threatened or endangered species are considered at risk due to non-native species.
- Visitors spent over $22 billion dollars in Michigan in 2014, supporting nearly 327,000 jobs (Tourism Economics 2014). Invasive species impact the use and beauty of Michigan's shorelines, trails and parks, which may result in a reduction in visitor spending and citizen enjoyment
- Michigan's Forest Products Industry supports 96,000 jobs and contributes more than $20 billion to the state's economy each year (Michigan DNR 2015). Invasive forest pests including emerald ash borer, oak wilt and beech bark disease kill trees and significantly impact the value of urban properties, forests and timber resources. The estimated cost of treating or removing dead ash within developed land in Michigan's communities due to emerald ash borer was $230 million in 2009 [16].

Estimated annual costs for some local invasive species management efforts:

- Paradise Lake Improvement Board
  - Invasive species management services: budgeted $90,000 in 2022; budgeted $56,000 in 2023
  - Boat wash operations: budgeted $1,000 in 2022; budgeted $1,500 in 2023
- Pickerel-Crooked Lakes Association
  - Aquatic plant management expenditures: $3,243 in 2021; $756 in 2022

Previous Occurrences
The Department of Environment, Great Lakes, and Energy oversees invasive species programs for the State. The State has produced prohibited and restricted species lists, watch lists, and state management plans for terrestrial and aquatic species. Many of the species listed in this plan are also listed as a prohibited or restricted species: it is unlawful to possess, introduce, import, sell, or offer that species for sale as a live organism, except under certain circumstances. A full list of prohibited and restricted species can be found at Michigan.gov/invasives.

On a regional level, the following terrestrial invasive species are causing significant harm in the northwestern Lower Peninsula:

- Japanese knotweed, Giant knotweed and Bohemian knotweed, *Polygonaceae,* can be a concern to homeowners, and municipalities because of these plants' ability to grow into a structure's foundation, through sidewalks and road surfaces. These plants can also be spread by root fragments and stem sections. It can create monocultures that shade out desirable vegetation, creating poor habitats for native species. This is of particular concern along water bodies and has been shown to be extremely detrimental to waterways in the Eastern US.
- (Invasive) Phragmites is a large-scale clonal grass that rapidly colonizes wetlands. Phragmites crowds out native plants and alters habitat for native fauna. In doing so, Phragmites also alters human access to water resources and has adverse economic effects, including decreasing property value, inhibiting recreational use, and limiting populations of game species. It can become a fire hazard when it dries down
- Cypress spurge is an erect, herbaceous to semi-woody perennial with bright yellow-green flowers that turn to purple-red as they mature. Cypress Spurge is toxic to horses and cows.
- Black Swallow Wort is a rapidly growing, herbaceous perennial in the Milkweed family. However, Black Swallow Wort is toxic to animals and the monarch butterfly.
- Oriental bittersweet is a vine plant that can strangle a tree and causes tree mortality. This impacts ecosystem health and economic health that is associated with trees' health.

[16] Kovacs, K.F., R.G. Haight, D.G. McCullough, R.J. Mercader, N.W. Siegert and A.M. Liebhold. 2010. Cost of potential emerald ash borer damage in U.S. communities, 2009−2019. Ecological Economics 69: 569-578.

- Autumn olive is very widespread in Michigan. It is spread by birds and is recolonizing old farm fields. Its value to wildlife is relatively low (low in protein and other nutrients compared to our natives). It also is known for its nitrogen-fixing abilities.
- Oak wilt is an infectious vascular disease that can affect all species of oak. Red oaks get the disease more often and succumb more readily than white oak. The disease spreads via root grafts and sap- feeding beetles.
- Beech bark disease is caused by the combination of the *Neonectria* fungus and beech scale. Beech scales are yellow, soft-bodied insects that are 0.5 to 1.0 mm long as adults. The insects, found on the tree trunk and branches, feed on sap in the inner bark. The minute wounds caused by the scale insects eventually enable the Nectria fungus to enter the tree. The Nectria kills areas of woody tissue.
- Garlic mustard is an herbaceous biennial, up to 4 feet in height. Forms round basal rosette the first year, flowers the second year and dies. Grows in forests, particularly floodplain forest, open wetlands, parking lots, campgrounds, paths, and roadsides.

On a regional level, the following aquatic invasive species are causing significant harm in the northwestern Lower Peninsula:

- Didymo or "rock snot" is an aquatic diatom that is brown, tan, or yellow in color. Unlike most algae, it feels like wet cotton and is not slimy. Grows in rivers, streams, and lakes. It occurs particularly in cool, oligotrophic, clear water.
- Purple loosestrife is an herbaceous wetland perennial reaching 5 feet with reddish-purple flowers with five to seven petals are held in dense terminal cluster. Grows in moist soils, in wet meadows and prairies, shallow marsh, ditches, waste areas, and along lakes, ponds, streams, and rivers.
- Eurasian water-milfoil is a submergent, aquatic perennial that reached 3-10 feet or more in length. Grows in ponds, lakes, and low-energy zones in rivers and streams.
- New Zealand mudsnail is an aquatic mollusk with an elongated shell 1/8 inch long with 7-8 whorls. Shell color varies from gray and dark brown to light brown. Grows in flowing freshwater with silt/sand to very brackish rivers; lives in water as deep as 60 feet in lakes or reservoirs.
- Red swamp crayfish is an aquatic crustacean with a dark red body and claws with spiky, bright red bumps, and black wedge-shaped stripe on underside. Grows in flowing to non-flowing freshwater or salt water; permanent ponds; areas of streams and ditches with organic debris; agricultural areas; wetlands.
- Zebra mussel is an aquatic mollusk with striped shells or dark or light shells with no stripes. They attach to objects (pipe, boats, etc.) causing major damage as colonies can block pipes, affecting power and water-treatment plants.

Many of the species listed above are monitored and managed in Emmet County. However, the list of all invasive species impacting the county and region is extensive and many established species are treated on a case-by- case basis. Other species of concern include: Honeysuckle (non-native), Glossy buckthorn, Common buckthorn, Wild parsnip, Multiflora rose, and Periwinkle.

The Charlevoix, Antrim, Kalkaska, and Emmet counties Cooperative Invasive Species Management Area (CAKE CISMA) current Strategic Plan (updated April 2023) contains a priority list for aquatic, terrestrial, and invertebrate invasive species in the service area. The list is sorted into aggregate tiers (indicated below) intended to be used as a framework to guide management decisions. Rankings are subject to change at a county level, depending on the spatial distribution of certain species within each county. The list also indicates which species are present in the CAKE area. The list is a living document and is reviewed and updated annually by CAKE CISMA staff to be approved by a majority vote from the CAKE CISMA steering committee.

- Tier 1- Prevention/Early Detection: These species are not yet present in the service area. They pose a great ecological threat to the region if introduced. Tier 1 species are a high priority to the State of Michigan and are either very limited in their presence or not yet detected in Michigan. Management actions for these species include detection surveys, rapid response, and eradication if effective tools exist. Prevention, education, and outreach are important for Tier 1 species.

- Tier 2- Eradication - Rapid Response: Species that are not yet present in the service area or confined to a limited area. Small, localized populations make eradication possible for these species. Management actions for Tier 2 species are delimitation, containment, and eradication where feasible.

- Tier 3: Containment Species that are rapidly increasing in distribution throughout the CISMA region. Managed on a site-by-site basis based on ecological importance. Management actions for Tier 3 species are determined through project-based planning with the objective to slow spread and improving existing habitat function.

- Tier 4: Local Control/ Asset Protection Species that are widespread throughout the State of Michigan and can no longer be eradicated. As such, these species are managed by CISMA only on sites of high ecological value and where partnerships exist. CISMA will assist the public with Tier 4 species through education and outreach.

CAKE CISMA prioritizes invasive species management based on the ecosystem and management feasibility. Some species, like spotted knapweed (Centaurea stoebe) or Autumn olive (Elaeagnus umbellata), are so widespread that it is no longer feasible to eradicate them. That means that when CAKE CISMA does manage those species, efforts are focused on areas of high ecological importance - like a fen or a dune community.

Invasive species that are not yet widespread or recently detected in the service area are the highest management priority for CAKE CISMA. Special consideration is also given to "satellite" populations of more established species, as they are easier to control than large source populations (and treatment prevents them from turning into source populations themselves!). In these cases, no-cost treatment for landowners is offered.

Throughout 2024, CAKE CISMA will be targeting 1,000 acres of Fresh Water Dune Swales, Fens, and Rich Conifer Swamps for restoration. These natural communities identified by MNFI are significant in maintaining resiliency to the changing climate.

Probability of Future Events and Vulnerability Assessment
The services and collaborative efforts of CAKE-CISMA, Emmet Conservation District, Tip of the Mitt Watershed Council, Little Traverse Land Conservancy, LTBBOI, MDNR and other land and water management agencies are crucial to make progress on invasive species management and prevention in Emmet County for established invasive species, as well as for the monitoring of "watchlist" species.

Invasive species on Michigan's "Invasive Species Watchlist" are priority species that have been identified as posing an immediate and significant threat to Michigan's natural resources. These species have either never been confirmed in Michigan, have very limited distribution, or are localized. Early detection and timely reporting of occurrences of these species is crucial for increasing the likelihood of stopping an invasion and limiting negative ecological and economic impacts. Species are listed below by category. This list is reviewed and updated periodically, and the most current list is available at www.michigan.gov/invasives. Potential impact from the species listed on watch list could be catastrophic for Emmet County's natural resources, agriculture, recreation, tourism, and economy.

Insects and Tree Diseases (Tree diseases list the scientific name for the pathogen or fungus associated with the disease)
• Asian longhorned beetle (*Anoplophora glabripennis*)
• Balsam woolly adelgid (*Adelges piceae*)
• Hemlock woolly adelgid (*Adelges tsugae*) (*description of local monitoring efforts on the following page)
• Thousand cankers disease (*Geosmithia morbida*)
• Beech leaf disease *(Litylenchus crenatae and potential associates)*
• Spotted lanternfly (*Lycorma delicatula*)

Mammals
• Nutria (*Myocastor coypus*)

Terrestrial Plants

• Asiatic sand sedge (*Carex kobomugi* Ohwi)
• Chinese yam (*Dioscorea oppositifolia* L.)
• Himalayan balsam (*Impatiens glandulifera*)
• Japanese stiltgrass (*Microstegium vimineum* (Trin.) A. Camus)
• Kudzu (*Pueraria montana* var. *lobata*)
• Mile-a-minute weed (*Persicaria perfoliata*)
• Japanese chaff flower (*Achyranthes japonica*)

Aquatic Plants
• Parrot feather (*Myriophyllum aquaticum*)
• Yellow floating heart (*Nymphoides peltata*)
• European frog-bit (*Hydrocharis morsus-ranae*)
• European water-clover (*Marsilea quadrifolia*) – This species is currently allowable for sale and possession. Please contact EGLE if these plants are observed outside of cultivation.
• Brazilian elodea (*Egeria densa*)
• Hydrilla (*Hydrilla verticillata*)
• Water chestnut (*Trapa natans*)
• Water hyacinth (*Eichhornia crassipes*) – This species is currently allowable for sale and possession. Please contact EGLE if these plants are observed outside of cultivation.
• Water lettuce (*Pistia stratiotes*) – This species is currently allowable for sale and possession. Please contact EGLE if these plants are observed outside of cultivation.
• Water soldier (*Stratiotes aloides*)

Fish and other Aquatic Animals
• Invasive carps
    • Silver carp *(Hypophthalmicthys molitrix)*
    • Bighead carp *(Hypophthalmichthys noblis)*
    • Grass carp *(Ctenopharyngodon idella)*
    • Black carp *(Mylopharyngodon piceus)*
• Northern snakehead *(Channa argus)*
• Marbled crayfish *(Procambarus virginalis)*
• Red swamp crayfish *(Procambarus clarkii)*
• New Zealand mud snail *(Potamopyrgus antipodarum)*

One of the “watchlist” species that CAKE CISMA is currently monitoring for is the hemlock woolly adelgid (HWA) (Adelges tsugae), which affects eastern hemlock trees (*Tsuga canadensis*). HWA have specialized mouthparts that enable it to pierce the base of a needle, then suck out nutrients from cells in the shoots of their host tree. A host tree can die in as little as four years. HWA decimated stands of native hemlock in the eastern United States, particularly in the Smokey Mountains National Park.

Often found along ravines, hillsides, and stream banks, eastern hemlock offer habitat for wildlife and provide shade for streams, effectively lowering stream temperatures and increasing oxygen for fish and other aquatic species. Hemlocks provide aesthetic value and are loved by homeowners. It is estimated that Michigan is home to 170 million eastern hemlock trees. Areas near the Lake Michigan shoreline are the most probable for new infestations, as the adelgids favor the temperatures and conditions found near the lake more than those inland.

In the winter of 2024, the Michigan Department of Agriculture and Rural Development (MDARD) verified anew detection of invasive hemlock woolly adelgid (HWA) near Torch Lake in western Antrim County. An extensive survey of the surrounding area is underway. With this new detection, Antrim becomes the eighth county in the state with an active hemlock woolly adelgid infestation, joining Allegan, Benzie, Mason, Muskegon, Oceana, Ottawa, and Washtenaw counties.

Select Existing Prevention Programs and Resources
CAKE CISMA offers free surveys of hemlock trees for HWA. Property owners within the orange area on the map below (Figure 45) can request a free HWA survey from CAKE CISMA. Surveys will be conducted in the winter and property owners will be notified prior to the survey.

Figure 45. CAKE CISMA's Survey Range for Hemlock Wooly Adelgid

Source: https://www.cakecisma.org/hemlock

In 2010, the Emmet County Board of Commissioners adopted the Phragmites Control Ordinance, allowing for a more coordinated effort in the control and eradication of phragmites along the Lake Michigan shoreline. The county partnered with Tip of the Mitt Watershed Council to carry out the mapping of locations of phragmites within the county and the follow up application of herbicide as part of an overall management plan. The program continues and is permitted annually.

In 2019, it became Michigan law that boaters must ensure that plants and aquatic organisms are free of their boats and trailers when transporting them between water bodies. The use of public boat wash stations aids in the reducing the chance of spreading or transporting invasive species in and out of lakes. Permanent boat wash stations in Emmet County are listed in Table 65. Additionally, the Tip of the Mitt Watershed Council's (TOMWC) Mobile Boat Washing Station (MOBO) Program was started in Northern Michigan in 2020. TOMWC volunteers visit various Northern Michigan lake landings and wash boats for free throughout the summer, using heated, pressurized water.

Table 65. Boat Wash Stations in Emmet County

Jurisdiction	Waterbody	Installation Site	Year Installed	Partnerships Involved
Carp Lake Township	Paradise Lake	MDNR public access boat launch	2013	Paradise Lake Improvement Board, Paradise Lake Assn., Little Traverse Bay Bands of Odawa Indians, and MDNR; U. S. Environmental Protection Agency's Great Lakes Restoration Initiative grant awarded to LTBBOI
Bear Creek Township	Walloon Lake	Jones Landing boat launch	2022	Walloon Lake Association and Conservancy; watershed protection grant from Petoskey Harbor Springs Area Community Foundation
Resort Township	Walloon Lake	Townsend Road Boat Launch	2023	

TOMWC staff conducts surveys on inland lakes to document current aquatic plant species and communities, with a particular emphasis on documenting the presence of Eurasian watermilfoil, phragmites, or other invasive aquatic plant species. The following inland lake organizations in Emmet County work with TOMWC and other partners to monitor, treat and eradicate aquatic invasive species) and improve water quality:

- Pickerel-Crooked Lakes Association (Springvale, Littlefield, Bear Creek and Little Traverse Townships)
  - Annual treatment/monitoring of Eurasian water-milfoil
- Paradise Lake Improvement Board and Paradise Lake Association (Carp Lake Township)
  - Purple loosestrife is being mechanically removed and treated on an annual basis with a biological control (Galerucella beetles)
- Larks Lake Association (Center Township)
  - Phragmites control and purple loosestrife control
- Walloon Lake Association and Conservancy (Resort and Bear Creek Townships)
  - Annual treatment/monitoring of Eurasian water milfoil

Additionally, several local master plans and park & recreation plans have included goals and objectives related to invasive species management and protection.

Impacts from Climate Change

Climate describes the average weather conditions for a particular location and over a long period of time. The changing climate impacts society and ecosystems in a broad variety of ways. For example, climate change can alter rainfall, influence crop yields, affect human health, cause changes to forests and other ecosystems, and even impact our energy supply. Climate-related impacts are occurring across the country by increasing the severity of storms and weather-related events. Natural disasters then have a direct impact on our economy.

According to a new comprehensive report from the World Meteorological Organization (WMO), "A disaster related to a weather, climate or water hazard occurred every day on average over the past 50 years – killing 115 people and causing $202 million (US $) in losses daily The number of disasters has increased by a factor of five over the 50-year period, driven by climate change, more extreme weather and improved reporting. But, thanks to improved early warnings and disaster management, the number of deaths decreased almost three-fold [17]" (World Meteorological Organization, 2021).

The impacts of climate change already are, and continue to be, deep and widespread in the Great Lakes Region and Michigan as a whole. The National Climate Assessment (NCA) assesses the science of climate change and variability and its impacts across the United States, now and throughout this century. Chapter 21 of the NCA *Fourth National Climate Assessment Volume II: Impacts Risks, and Adaptation in the United States reports,* the Great Lakes influence regional weather and climate conditions and impact climate variability and change across the region. The lakes influence daily weather by:

1) Moderating maximum and minimum temperatures of the region in all seasons,
2) Increasing cloud cover and precipitation over and just downwind of the lakes during winter, and
3) Decreasing summertime convective clouds and rainfall over the lakes.

The Great Lakes Integrated Sciences and Assessments (GLISA) is one of 11 NOAA Regional Integrated Sciences and Assessments teams that focus on helping the nation prepare for and adapt to climate variability and change. A summary of findings from the NCA and the GLISA report, *Climate Change in the Great Lakes Region* [18], is provided below to show the impacts of climate change throughout the state of Michigan.

Temperature
Warm-season temperatures are projected to increase more in the Midwest than any other region of the United States. [19] Since 1951, annual average air temperatures have increased by 2.3°F (1.3°C) in the U.S., Great Lakes region. By mid-century (2050), average air temperatures are projected to increase by 3°F to 6°F (1.7°C to 3.3°C). By end of century (2100), average air temperatures are projected to increase by 6°F to 11°F (3.3°C to 6.1°C).

The frost-free season is projected to increase 10 days by early this century (2016–2045), 20 days by mid-century (2036–2065), and possibly a month by late century (2070–2099) compared to the period 1976–2005 according to the higher scenario (RCP8.5). [20]

Precipitation
Since 1951, total annual precipitation has increased by 14% in the U.S., Great Lakes Region. Future projections suggest more precipitation on average, but not necessarily during all seasons (summer to be drier) and not for all

[17] *World Meteorological Organization*. (2021, August 31). Retrieved from Weather-related disasters increase over past 50 years, causing more damage but fewer deaths: https://public.wmo.int/en/media/press-release/weather-related-disasters-increase-over-past-50-years-causing-more-damage-fewer

[18] (2019, February 14). Retrieved from Climate Change in the Great Lakes Region: https://glisa.umich.edu/wp-content/uploads/2021/04/GLISA-2-Pager.pdf

[19] Vose, R. S., D. R. Easterling, K. E. Kunkel, A. N. LeGrande, and M. F. Wehner, 2017: Temperature Changes in the United States. *Climate Science Special Report: Fourth National Climate Assessment, Volume I*. Wuebbles, D. J., D. W. Fahey, K. A. Hibbard, D. J. Dokken, B. C. Stewart, and T. K. Maycock, Eds., U.S. Global Change Research Program, Washington, DC, USA, 185–206. doi:10.7930/J0N29V45.

[20] Hibbard, K. A., F. M. Hoffman, D. Huntzinger, and T. O. West, 2017: Changes in Land Cover and Terrestrial Biogeochemistry. *Climate Science Special Report: Fourth National Climate Assessment, Volume I*. Wuebbles, D. J., D. W. Fahey, K. A. Hibbard, D. J. Dokken, B. C. Stewart, and T. K. Maycock, Eds., U.S. Global Change Research Program, Washington, DC, USA, 277–302. doi:10.7930/J0416V6X.

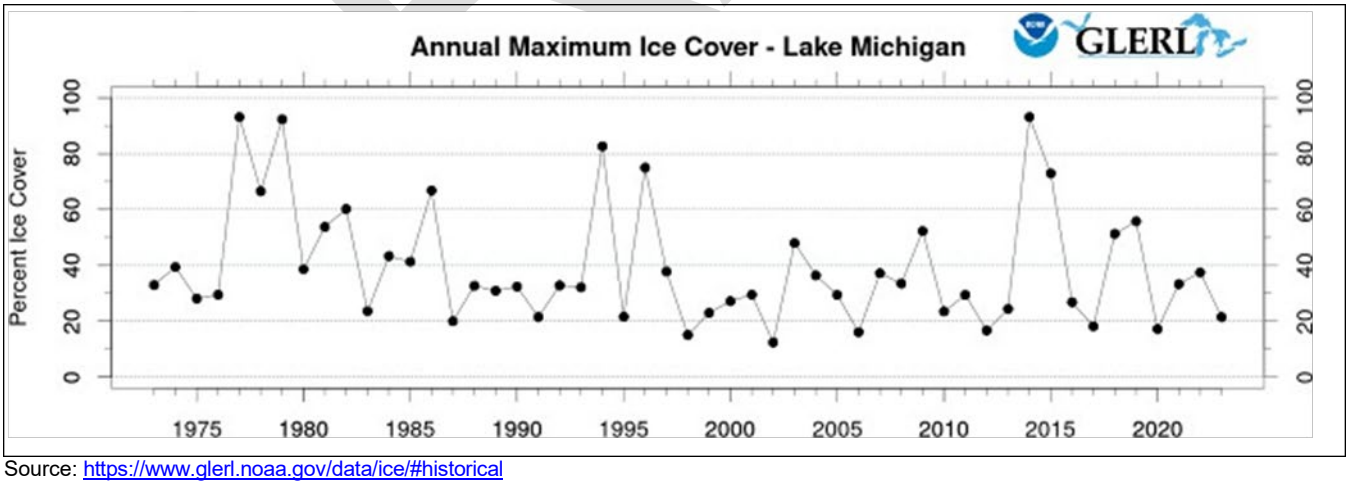
locations depending on which model is used. Reduced lake ice cover and enhanced evaporation may lead to increased lake-effect snowfall in the near-term, but rising temperatures will cause more winter precipitation to fall as rain as opposed to snow across the region by late century.

From 1951-2017, the United States, Great Lakes Region, overall, has seen increases in average temperature, frost-free season, total precipitation, and heavy precipitation events.

Snow, Ice Cover and Lake Temperature

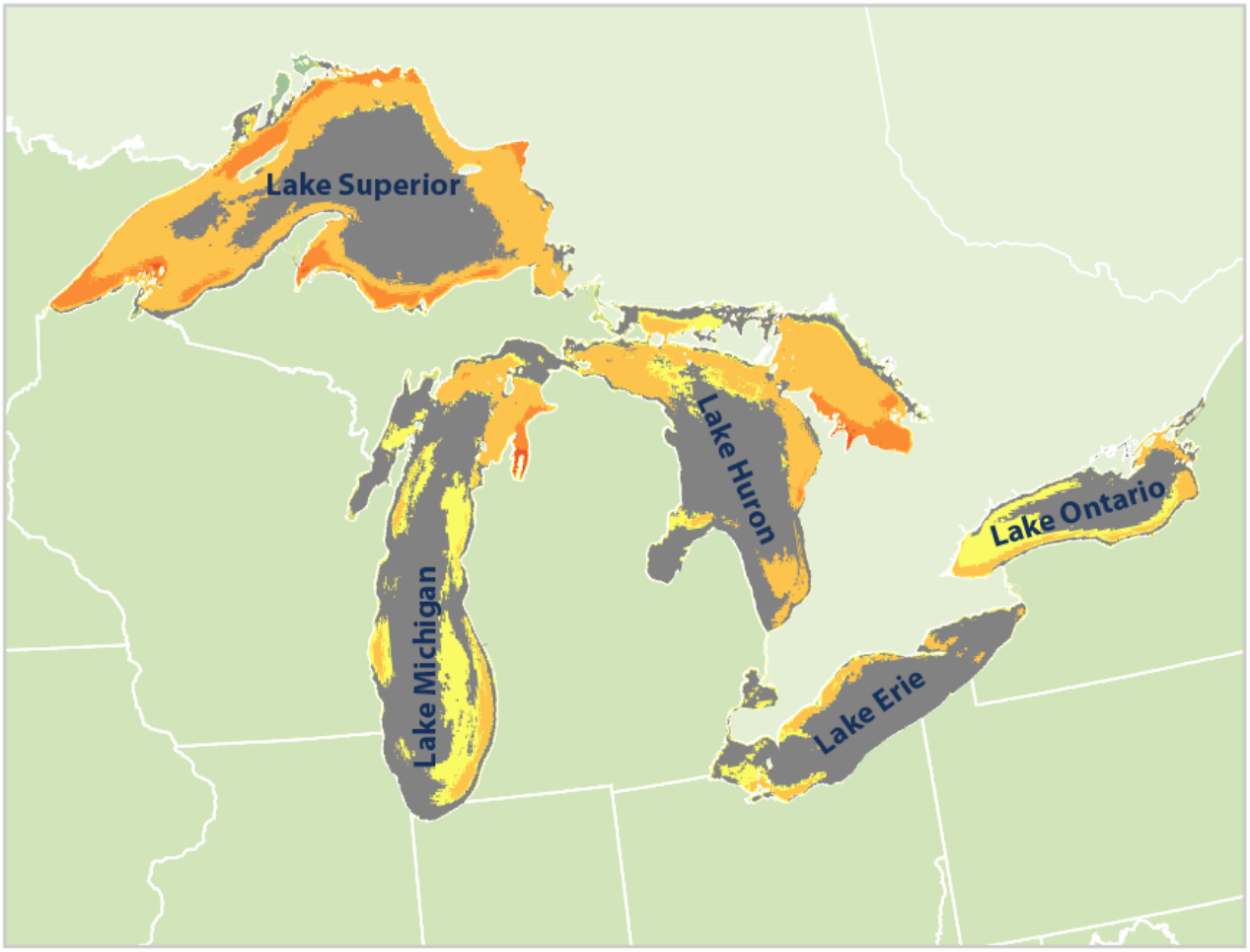
Summer lake surface temperatures have been increasing faster than the surrounding air temperatures, with Lake Superior increasing by 4.5°F between 1979 and 2006. Annual average ice cover on the Great Lakes shifted from higher amounts prior to the 1990s to lower amounts in recent decades. There remains strong year-to-year variability, and high ice years are still possible. Lake-effect snowfall has increased in northern areas and may continue to increase through mid-century.

Lake Michigan has experienced seven winter seasons where the maximum ice coverage was sixty percent or greater since 1973 (Figure). The last major freeze of the lake occurred in the 2013-14 winter season. A detailed map (see Figure) shows that many areas of the Great Lakes have experienced significant decreases in ice cover duration, but other parts of the lakes have not changed significantly. Duration of ice cover has decreased the most in areas near the shorelines.



Source: https://www.glerl.noaa.gov/data/ice/#historical

Change in Ice Cover Duration in the Great Lakes, 1973–2019



Trend in days per year:

Data source: NOAA (National Oceanic and Atmospheric Administration). 2019. Great Lakes Environmental Research Laboratory: Historical ice cover. Accessed December 2019. www.glerl.noaa.gov/data/ice/#historical.

For more information, visit U.S. EPA's "Climate Change Indicators in the United States" at www.epa.gov/climate-indicators.

Source: https://www.epa.gov/climate-indicators/climate-change-indicators-great-lakes-ice-cover#ref5

Per *GLISA's Sustained Assessment of the Great Lakes* [21], changes in regional climate have affected the patterns of Great Lakes precipitation, runoff, evaporation, and lake ice, and will continue to drive changes in the future. The following observational trends affect the water supply of the Great Lakes and water levels:

- Since 1951, there has been a 14% increase in region-total precipitation as well as a 35% increase in the amount of precipitation falling in the heaviest 1% of storms.
- Annual average air temperatures have increased by 2.3°F in the U.S. Great Lakes region since 1951, with lake temperatures increasing even faster.
- Annual average ice cover on the Great Lakes underwent a shift from higher amounts prior to the 1990s to lower amounts in recent decades. There remains strong year-to-year variability, and high ice years are still possible.
- The timing of spring snowmelt is changing. During the period of 1960-2000, observed snow depths in the late winter and early spring decreased, implying an earlier onset of spring thaw.

Changes in lake levels are the result of these different competing physical processes. For example, warming temperatures enhance evaporation over the lakes and in the drainage basin, and can lead to more years with low lake ice cover. Increases in evapotranspiration coupled with reduced ice cover duration can subsequently lead to lower water levels. Warmer temperatures can also reduce snowpack and soil moisture contributing to weaker runoff and lower water levels. Conversely, increases in precipitation frequency and intensity could lead to rising water levels. Any water level changes will depend on how one or more of these processes will dominate another in the future.

The future may hold another shift in ice cover but not necessarily in the downward direction. There is still the possibility of years with very high ice cover, as experienced in the 2013-2014 season. Practitioners should prepare for increased variability – high ice cover years followed by low ice cover years, and vice versa. Most certainly, ice will continue to form first where it always has, in protected areas near the shore, but it may not persist for as long.

Extreme Weather

The frequency and intensity of severe storms has increased. This trend will likely continue as the effects of climate change become more pronounced. The amount of precipitation falling in the heaviest 1% of storms increased by 35% in the U.S. Great Lakes region from 1951 through 2017. More severe storms may have a negative economic impact due to resulting damages and increased costs of preparation, clean up, and business disruption.

According to the NCA *Fourth National Climate Assessment Volume II: Impacts Risks, and Adaptation in the United States, "*Climate change is transforming where and how we live and presents growing challenges to human health and quality of life, the economy, and the natural systems that support us. Risks posed by climate variability and change vary by region and sector and by the vulnerability of people experiencing impacts. Social, economic, and geographic factors shape the exposure of people and communities to climate-related impacts and their capacity to respond. Risks are often highest for those that are already vulnerable, including low-income communities, some communities of color, children, and the elderly" (*Ch. 14: Human Health, KM 2*; *Ch. 15: Tribes, KM 1–3*; *Ch. 28: Adaptation, Introduction*).

[21] https://glisa.umich.edu/sustained-assessment/lake-ice/

Climate Change Vulnerability Assessment
A vulnerability assessment in the report *Climate Change in the Great Lakes Region* by GLISA at https://glisa.umich.edu/wp-content/uploads/2021/04/GLISA-2-Pager.pdf lists key challenges in the Great Lakes Region from climate change:

- Public Health
  - Increased risk of extreme heat and humidity may *amplify the number of heat-related deaths and illnesses*.
  - More storm activity and flooding, resulting in increased point- and non-point source pollution, will likely *increase watershed contamination and water-borne illnesses*, while warmer surface waters amplify the *risk of toxic algal blooms and fish contamination*.

- Tourism and Recreation
  - *Winter recreation/tourism are likely to suffer* due to reduced snow cover and shorter winters. Reduced lake ice cover and enhanced evaporation may lead to increased lake-effect snowfall in the near-term, but rising temperatures will cause more winter precipitation to fall as rain as opposed to snow across the region by late century.
  - Increasing temperatures and a longer summer season may *increase the demand for lake and beach use*.
  - Overall, *summer tourism may grow before temperature rise becomes unfavorable* for outdoor recreation.
  - *The fishing industry* (commercial and recreation) is likely to be impacted by the *decline of coldwater species of fish, such as lake trout and whitefish*.

- Natural Environment
  - Despite increasing precipitation, *land surfaces in the region are expected to become drier overall* due to increasing temperatures and evaporation rates.
  - More frequent summer droughts could affect soil moisture, surface water, and groundwater supply.
  - Increased evaporation rates and sustained levels of high or low water levels may change wetland areas in the region.
  - The rate of warming may *outpace the rate at which ecosystems are able to migrate and adapt*.
  - *Wildlife populations better adapted to cold temperatures will continue to decline* as competing species migrate into the region with rising air and surface water temperatures.
  - *Forest and agricultural productivity will likely increase in the short term* with an extended growing season, until other impacts of climate change such as increased drought, fire and invasive species present additional stressors to forests.

GLISA has partnered with Great Lakes city adaptation practitioners to produce a set of plausible climate scenarios to aid in city and local planning. These scenarios can also be used at larger spatial scales (e.g., county) and are intended to be transferable across cities or communities, meaning the basic scenario details are relevant for any city in the Great Lakes region with the option to customize them further. While the scenarios are informed by climate model projections, they provide much greater detail than what models alone tell us; although still backed by models and projections, GLISA's scenarios make it easier to understand what projected climate changes could look like in reality. This combination of model data and real-world experience represents a holistic and practitioner-driven approach to scenario development.

Each scenario consists of a narrative description of weather conditions or events with details about sector-specific community impacts (e.g., city transportation, emergency response, etc.). Communities can customize the impacts described in the scenarios based on their own vulnerabilities and planning priorities to make the scenarios more relevant for their planning needs. Example customizations are provided with each scenario and this scenario planning workbook also helps guide these customizations. The scenarios can be used as a starting point for thinking about a future that may look different than the past and to develop ideas, recommendations, and plans to better prepare for that future.

For additional background information about GLISA's scenarios and access to the scenarios: https://glisa.umich.edu/climate-data/climate-scenarios/ For a list of GLISA's past scenario planning projects and examples: https://glisa.umich.edu/engagement/scenario-planning/#examples

TECHNOLOGICAL HAZARDS

Industrial Hazards

- Hazardous Materials: Fixed Site Incident
- Hazardous Materials: Transportation Incident
- Pipeline and Wellhead Incident: Petroleum and Natural Gas
- Structure Fires
- Scrap Tire Fires

Infrastructure Hazards

- Major Transportation Incidents (air, highway, rail, marine)
- Built Infrastructure Failures (water, sewers, bridges, communications)
- Built Infrastructure Failures (dams)
- Energy Failures and Shortages (electric, natural gas, petroleum)

*Note: Information used in the descriptions of the hazards in this section of the plan were largely sourced from the Michigan State Police's *2020 Michigan Hazard Analysis – a Supplement to the 2019 Michigan Hazard Analysis*.

Hazardous Materials: Fixed Site Incident

A Hazardous Material Fixed Site Incident is an uncontrolled release of hazardous materials from a specific location capable of posing a risk to life, health, safety, property, or the environment.

According to FEMA, a hazardous material is any solid, liquid, or gas that can harm people, other living organisms, property, or the environment. They may be naturally occurring but are also increasingly man-made or brought more into human contact by our activities. Chemical manufacturers and industrial sites are sources for many such materials. When spilled or otherwise accidentally released at these facilities, known as a fixed site location, they pose a risk to quickly spread and create harm to the public. Other locations of concern include certain end user facilities (e.g., gas stations, hospitals, farms, universities) and storage areas where their quantities exist in sufficient amounts. The unique risks associated with the transportation of these materials is covered separately.

Because of their chemical, physical, or biological nature, a hazardous material may be a biohazard, poisonous, corrosive, explosive, flammable, or radioactive. They may also be an oxidizer, an asphyxiant, or a substance capable of causing severe allergic reactions. Such substances can vary greatly in their ability to cause harm and can be classified in a variety of ways.

Some hazardous material releases may impact food or water supply chains for large regions or even the entire state. An example would include the persistent chemical commonly known as PFAS (Per- and polyfluoroalkyl substances). Such releases may be treated as a transmittable public health emergency because of their ability to spread to significant portions of the entire state. While these may have been local releases at one time, their aggregate or long-term effect has moved beyond that of a typical acute hazardous materials release.

The Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), or “Superfund,” was enacted by Congress in 1980. It was designed to clean up the nation's hazardous waste sites and to also provide for emergency response to potential future releases of hazardous materials.

The Superfund Amendments and Reauthorization Act (SARA) amended the CERCLA on October 17, 1986 to include Title III, the Emergency Planning and Community Right-To-Know Act (EPCRA). The purpose of EPCRA is to encourage and support emergency planning efforts at the state and local levels and to provide the public with information regarding where potential chemical hazards are present in their communities. Chemical companies and other facilities must monitor their materials and the quantities of those materials they have on site. The U.S. EPA maintains a Consolidated List of Chemicals Subject to the EPCRA, CERCLA, and Section 112(r) of the Clean Air Act (CAA). This is otherwise known as the “List of Lists”.

The emergency planning provisions of SARA Title III require each state to establish a State Emergency Response Commission (SERC), emergency planning districts, and a Local Emergency Planning Committee (LEPC) for each County. These committees and commissions ensures the public can access information on the hazardous materials stored in their communities. Facilities that store a quantity that meets the EPA reporting threshold are required to submit annual Tier II[2] hazardous substance reports to the SERC, LEPCs, EGLE and local fire departments.

Not all facilities with hazardous materials fall under the requirements of SARA Title III. The Michigan Department of Environment, Great Lakes, and Energy (EGLE) also regulates certain hazardous wastes under the federal Resource Conservation Recovery Act (RCRA), which grants them oversight of certain waste generators from the time of generation through transportation, treatment, storage, and disposal. The Resource Conservation and Recovery Act (RCRA) regulations establish basic hazardous waste management standards for persons who produce hazardous waste, called hazardous waste generators. These standards are found in title 40 of the Code of Federal Regulations (CFR) in part 262. The generator regulations ensure that hazardous waste is appropriately identified and handled safely to protect human health and the environment, while minimizing interference with daily business operations.

[2] Tier II (SARA 312) is under section 312 of EPCRA and it is a mandatory report of hazardous and toxic substances that are housed at a facility at any given point during the reporting year. Facilities are required to report Tier II substances and Extremely Hazardous Substances (EHS) that are equal to or greater than the defined Tier II reporting thresholds.

Rural portions of Emmet County, where farming uses are located, may include fertilizers, pesticides, and other chemicals, although typically in much lower amounts than would be found at production facilities. The Michigan Department of Agriculture and Rural Development (MDARD) oversees the Agrichemical Bulk Storage Program, which provides a uniform standard to guide the industry. Each new, existing, and proposed commercial pesticide and/or fertilizer bulk storage facility is required to register annually with MDARD. Currently, over 220 bulk storage facilities are registered and inspected in Michigan on an annual basis by staff in the MDARD Pesticide and Plant Pest Management Division (PPPMD). PPPMD staff also conducts consultations with firms in the initial stages of bulk storage construction to discuss and provide site planning, containment, and recordkeeping assistance.

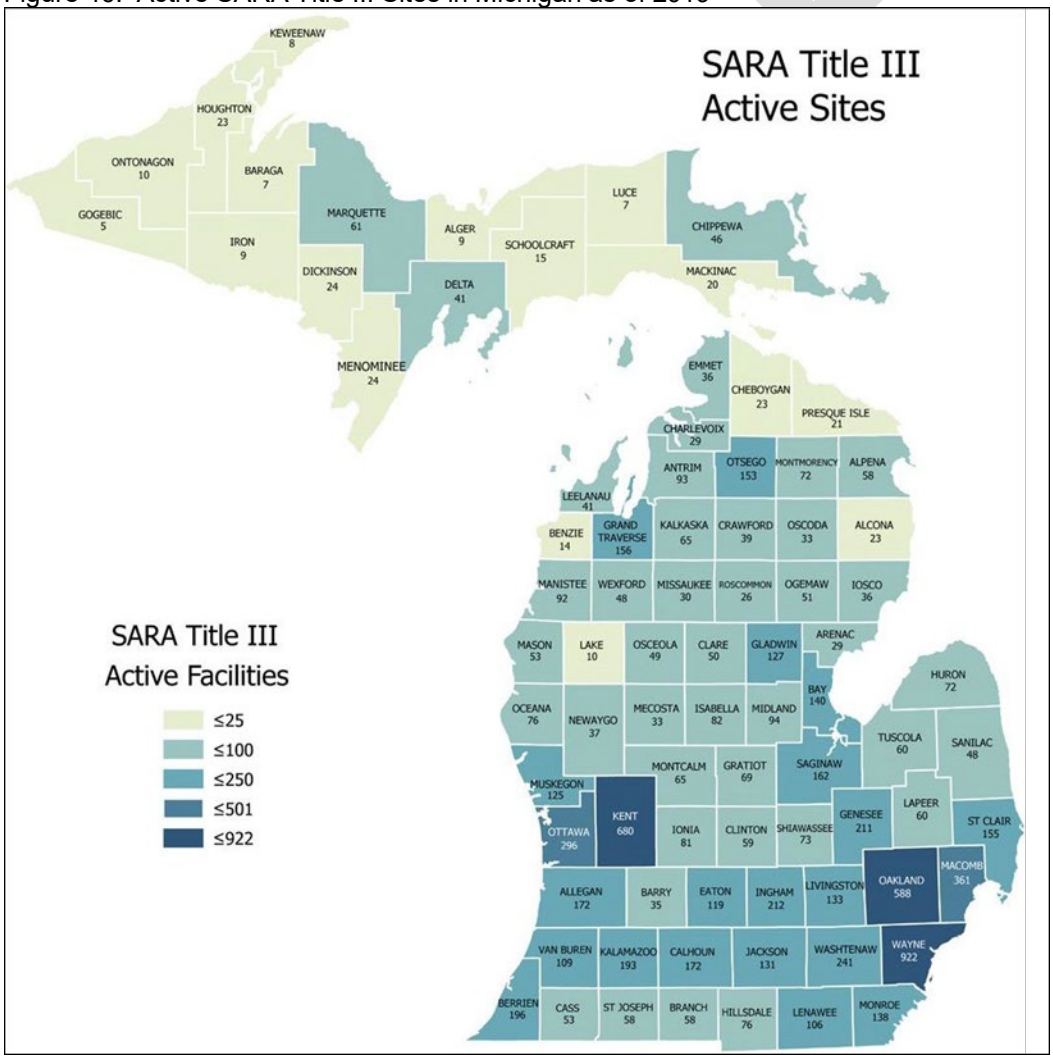
MDARD utilizes the following definitions:

- Bulk Pesticide: > 55 gallons individual quantity; > 100 lbs. individual quantity; minibulks, solutions and rinsates
- Minibulk Pesticide: Undivided quantity ranging from 55 to 400 gallons
- Bulk Fertilizer: > 2,500 gallons individual quantity; > 7,500 gallons combined total; > 2,000 lbs. individual quantity; includes solutions and rinsates

Location

Figure 46 indicates the number of SARA Title III, Tier II facilities within each county in Michigan, as of 2019. The greatest concentration of sites are located in the southeastern part of the state and other more urbanized counties. Emmet County is shown to have 36 active facilities in 2019; however, as of March 31, 2023, the Emmet County Department of Emergency Management reports that there were 39 actives facilities in the county in 2019.

Figure 46. Active SARA Title III Sites in Michigan as of 2019



Sources: EGLE; Michigan State Police's *Hazard Analysis Supplement to the 2019 Michigan Hazard Analysis*, 2020.

A query of EGLE's Waste Data System [22] of general sites indicates there are 336 current or former hazardous waste generators in Emmet County.

According to EGLE, there are no facilities in Emmet County associated with the treatment, storage, and disposal (TSD) of hazardous wastes, in compliance with Part 111 of Hazardous Waste Management, of the Natural Resources Environmental Protection Act of 1994.

According to EGLE, there are no active Type I or II Solid Waste Landfills operating within or adjoining Emmet County.

A tool that can be used to further investigate potential or existing sources of hazardous materials fixed site incidents is EGLE's "RIDE Mapper", an online map application (https://www.michigan.gov/egle/maps-data/ride- mapper) showing sites related to the work of the Remediation and Redevelopment Division (RRD), including:

- Sites of environmental contamination regulated under Part 201
- Leaking underground storage tank sites (open and closed) regulated under Part 213
- Underground storage tank facilities (active and closed) regulated under Part 211
- Land or resource use restrictions that have been provided to EGLE

Extent

Hazardous material incidents involve the potential for evacuation (or sheltering in place), creating significant concerns for special populations in hospitals, schools, nursing homes, and other such facilities. Certain types of extremely hazardous substances may result in a public health emergency and a resulting need for triage, mass treatment, and congregate care. Release location and accompanying weather may be important factors. Both short- and long-term health impacts may occur, including cancer or birth defects.

Significant economic consequences may occur depending on the type of hazardous material, quantities, and geographic location of a fixed site release. The worst could be for nuclear accidents or events that would contaminate the food supply chain or drinking water. Other releases could still have a significant effect but would be more localized and more likely to have major impacts within only a limited area. This could still impact transportation, industry, and other economically sensitive areas for the region. Releases into water could have negative impacts on the boating and tourism industries.

Additional risks to emergency responders may be present from exposure to extremely hazardous substances at or near these incident locations. Exposure can involve direct contact, the presence of toxic fumes, or the risk of fires and explosions from chemical reactions. Closed space incidents with certain chemicals and fertilizers can be quickly lethal, as is seen with methane.

A hazardous spill involving an industrial or chemical plant can affect air quality, the soil, and water bodies. A toxic release can also destroy wildlife habitat in or around the areas where the release occurs, resulting in death, birth defects, cancer, or other problems for animals. While vegetative mitigation measures may be employed to help clean an area, contaminated flora, or even crops, may experience a long-lasting, negative environmental impact. Many chemicals are considered "persistent" and are not biodegradable (i.e., able to be broken down into their component parts by microorganisms). Such materials can be very difficult to clean without removing large portions of the land.

Previous Occurrences

No community in Michigan has had a large hazardous materials release with mass fatalities. However, numerous fixed-site hazardous material incidents have happened throughout the state that required a response by local fire departments and hazardous materials teams. These may result in evacuation, in-place sheltering, and other protective measures.

[22] https://www.egle.state.mi.us/wdspi/AdvancedSearch.aspx

There are two (2) hazardous materials fixed site incidents undergoing environmental investigations in Emmet County that are included in the hazard analysis portion of this Hazard Mitigation Plan:

1. PFAS Contamination Associated with the Pellston Regional Airport

The airport historically used PFAS-containing firefighting foam as part of routine fire protection and safety practices. PFAS (Per- and polyfluoroalkyl substances) is a long-standing chemical contaminant that began to gain statewide attention when it was detected at significant levels in drinking water in 2010. It is a broad term for a variety of related chemicals with unique properties useful in non-stick applications, as stain removers, water repellants, and in firefighting foams (e.g., aqueous film forming foams or AFFF). Generally available beginning in the 1940s, ongoing studies of this environmentally persistent chemical have shown harmful health effects in chronically exposed individuals. This is especially true with drinking water contamination or in persons showing high levels that have increased over time (many people in Michigan exhibit at least some level of accumulation).

The following information about PFAS contamination associated with these historic activities at Pellston Regional Airport was obtained from EGLE's webpage on 5/24/24 https://www.michigan.gov/pfasresponse/investigations/sites-aoi/emmet-county/pellston-regional-airport:

PFAS has been detected above Drinking Water Criteria in residential samples south of the Pellston Regional Airport. EGLE has been working to determine source and extent of PFAS contamination. Priority residential sampling areas were determined based on regional groundwater flow, possible source areas of PFAS, and areas of sensitive populations.

The Michigan Department of Health and Human Services (MDHHS) has been contacting residents via phone as results are received. Result letters will also be sent to residents. The Health Department of Northwest Michigan (HDNW) representatives have secured a supply of bottled water and a delivery point. The water is available to residents with elevated levels of PFAS in their drinking water and water vouchers have been provided to residents within the village of Pellston. An agreement was reached with a local plumbing contractor to install point of use filter systems and provide replacement cartridges to individuals with detectable levels of PFAS chemicals as a precautionary action.

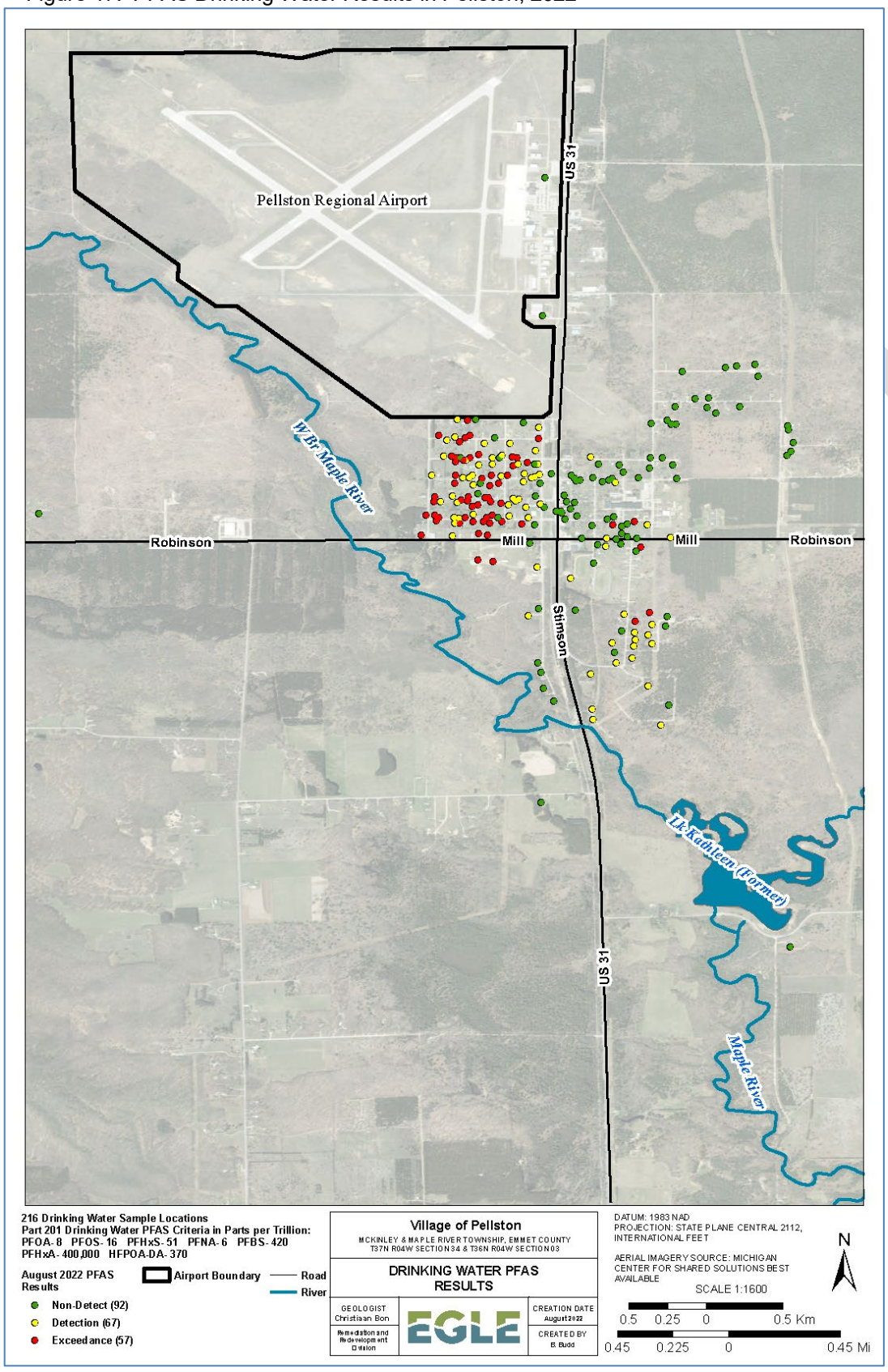
A Public Health Information Line (PHIL) has been established to address any community health concerns throughout the response: 1-800- 386-5959.

MDHHS drinking water well resampling is underway. MDHHS will send results by mail after all data is compiled. Due to initial sampling results, the residential testing area has been expanded to the south to include former Lake Kathleen and portions west and south of the West Branch Maple River. The sampling area now includes portions of Woodland Road, Ringler Road, Hartman Road, and Pine Trail.

Emmet County is preparing a Phase 4 Groundwater Investigation Report. EGLE will conduct a final round of vertical aquifer sampling to delineate the southern extent of the plume in fall of 2023.

Figure 47 is a map showing the results of 216 drinking water sample locations completed in 2022 by EGLE.

Figure 47. PFAS Drinking Water Results in Pellston, 2022



2. The PMC Groundwater Superfund Site at 200 W. Lake Street in the City of Petoskey

The following information was obtained from information available on the site's project webpage, accessed 5/24/24: www.epa.gov/superfund/pmc-groundwater

The Petoskey Manufacturing Co., or PMC, was located at 200 W. Lake St. in Petoskey and contained a die casting plant from the 1940s and a painting operation from the mid- to late-1960s. Disposal of spent solvents and paint sludge onto the ground outside the PMC building contaminated soil and groundwater in the vicinity of the site.

The site consists of groundwater, soil and soil vapors contaminated with volatile organic compounds, or VOCs, primarily trichloroethene, or TCE. Groundwater is underground supplies of water. VOCs, including TCE, are a group of chemicals often used as solvents that turn to vapor when exposed to air. These vapors can get into buildings through cracks in foundations or pipe openings, or through a sump or drain, and can contaminate indoor air. This process is called vapor intrusion.
Several site cleanup milestones have already been achieved through federal and state actions since the 1980's. The former PMC facility was sold in April 2003 to a developer, and the PMC building was demolished in July 2004. The construction of the residential condominium complex started in September 2004, and by 2008, 10 of the planned 16 residences were completed. In fall 2009, the property was in foreclosure because the developer went bankrupt. Construction for the remaining six units was completed by 2014 by a subsequent developer. It is reported that a barrier was placed beneath a portion of the complex in five of the units, which left 12 units either partially or completely without a barrier. However, final completion of this activity was not formally documented in a report. Presence of the membrane was confirmed when it was encountered at 4 feet below ground during drilling activities. The incomplete installation likely limits the barrier's effectiveness.

EPA reviews the health and environmental protectiveness at all its National Priority List (NPL) sites every five years. EPA completed the third five-year review in 2014, which identified vapor intrusion as a potential issue at the former PMC source area. It is important to note that the science of the health effects of TCE has evolved in the 15 or more years since the original source area cleanup was completed. EPA's screening criteria for determining whether vapor intrusion might be a health concern are now much lower and conservative. That means the levels of TCE considered safe are much lower than they use to be.

Beginning in January 2017, EPA conducted sampling under the slab of some condominiums built directly over the former PMC facility. The sampling looked for VOC vapors trapped between soil particles. After preliminary results showed high levels of TCE under some units, EPA conducted air sampling to determine if TCE was also detected in the air inside those residences. Results showed that some units did have levels of TCE that could pose a health risk. EPA and the local health department notified affected residents of the results and installed vapor mitigation systems. Currently, all condo units on the former PMC property have vapor mitigation systems and EPA is pursuing access agreements to sample additional private properties offsite.

During the fourth five-year review for the site in 2020, EPA determined that the groundwater remedy of monitored natural attenuation, or MNA, is not functioning as intended because natural attenuation of the groundwater TCE plume is not occurring at a rapid enough rate, and vapor intrusion has been found to be an exposure pathway of concern. The US EPA, working with MI EGLE, signed an Interim Record of Decision (ROD) on September 27, 2022, outlining the following interim remedial actions to address the vapor intrusion pathway:

- Conducting additional sampling of soil, soil vapor and groundwater to gather the information for the design phase of the cleanup.
- Using technologies called air sparging and soil vapor extraction, or SVE. Air sparging involves pumping air into the contaminated groundwater and exposing it to air turning the contaminants into vapor and capturing them with the SVE system. SVE is a system of wells that pump the vapors out of the ground for treatment.
- Monitoring groundwater and soil vapor to ensure the cleanup is working.
- Installing signs and fencing to protect people during construction and, if needed, during cleanup.

EPA will further assess the MNA once the above interim remedial actions are implemented.

Figure 48. Site Location Map of the PMC Groundwater Superfund Site in Petoskey, Michigan

Vulnerability Assessment

Vulnerable locations for hazardous materials fixed site incidents are SARA Title III sites (sites that store hazardous substances) in the county and those areas within the affected zone of these sites. There were 36 active facilities in Emmet County, according to EGLE (2019).

Federal guidance is provided regarding proper evacuation zone sizes of SARA Title III facilities based on the characteristics of the hazardous substances. A risk assessment of each facility can be further based upon the population size of the surrounding community, paying special attention to vulnerable facilities (e.g., schools, hospitals, senior facilities, day care centers). Facilities that are typically upwind from a site that stores hazardous materials, or that have rivers or groundwater that flow into their area, are susceptible to contamination if a fixed site release occurs. When hazardous material releases do occur, they may be obvious, rupturing above ground tanks, setting off alarms, creating odors, causing fires, or immediately impacting people's health. Other releases are more insidious, leaking from underground storage tanks, seeping long distances through groundwater, or causing cancer that does not become apparent for several decades.

Historical records of past incidents should also be considered. Wide variation in estimates is likely, depending on whether the history of an entire industry or only of a particular location is used. Local sites may have an incident-free history, but past compliance with reporting cannot be assured. The safety record for new management may also change over time.

Most hazardous material releases are unintentional, although a lack of proper training or neglecting regulations can play an important role. Terrorists may attempt to weaponize chemicals, or criminals may steal fertilizer to make methamphetamine or explosives. Container design or other equipment flaws may occur. Less common are natural disasters that might impact an otherwise properly stored substance, such as a flood washing barrels downstream. Regardless of cause, the impact of hazardous releases on the public can be significant in both the short and long run.

<u>PMC Groundwater Superfund Site:</u>

As part of their investigation, the EPA evaluated the current and future risks to human health and the environment from contaminants at the PMC Groundwater Superfund Site in what is called a human health assessment (for people) and an ecological risk assessment (for the environment). The risk assessment determined that the contaminated vapors from vapor intrusion into indoor air pose a risk to residents via inhalation. The EPA's proposed cleanup plan (2022) addresses the potential human health risks from vapor intrusion from the former PMC facility, as well as at the surrounding residential and commercial properties. The vapor intrusion is believed to be coming from both groundwater and soil contamination.

At this site, activity and use limitations that EPA calls institutional controls (ICs) are in place. Institutional controls play an important role in site remedies because they reduce exposure to contamination by limiting land or resource use. They also guide human behavior. For instance, zoning restrictions prevent land uses – such as residential uses – that are not consistent with the level of cleanup. Based on inspections and interviews, EPA is not aware of site or media uses which are inconsistent with the stated objectives of the ICs.

Per the EPA's 2022 Interim Record of Decision, the EPA expects the recommended alternative to be protective of

human health and the environment; comply with comply with federal, state, and tribal requirements – Applicable or Relevant and Appropriate Requirements, or ARARs.; be cost-effective; utilize permanent solutions and alternative treatment technologies or resource recovery technologies to the maximum extent practicable; and satisfy the preference for treatment. It also provides long-term and permanent protection against exposure to site- related contaminants by the combination of groundwater and soil vapor treatment, installing vapor mitigation systems as needed and land-use restrictions.

PFAS Contamination of Groundwater in the Village of Pellston:

The most recent events associated with the investigation, according to EGLE[23]:

- On September 27, 2022, the Village of Pellston received an EGLE grant agreement for $819,000 in EPA funds to determine the feasibility and potential service area for alternate water options due to PFAS contamination.
- On November 17, 2022, Emmet County submitted the final Response Activity Plan for Groundwater Remediation Pilot Testing of PlumeStop Permeable Reactive Barrier at Pellston Regional Airport to EGLE.
- On July 17, 2023, Village of Pellston's grant contractor completed a Single Home Filtration Alternative Analysis technical memorandum.
- On July 24, 2023, Village of Pellston's grant contractor completed a Phase I Village of Pellston Preliminary Groundwater Resource Evaluation.
- It is anticipated that Emmet County will prepare a Phase 4 Groundwater Investigation Report in the future, and EGLE will conduct a final round of vertical aquifer sampling to delineate the southern extent of the plume.

Additionally, in September 2024 the U.S. Department of Transportation's Federal Aviation Administration (FAA) announced that Pellston Regional Airport will be awarded a $700,000 grant which will be used to test soil and eliminate further leaching of PFAS to groundwater.

Existing Pollution Prevention Efforts in Emmet County

- Facilities that store a quantity of a hazardous material that meets the EPA reporting threshold are required to submit annual Tier II hazardous substance reports to the SERC, LEPCs, EGLE and local fire departments. The Emmet County LEPC develops off-site response plans for all sites with one or more Extremely Hazardous Substances (EHS) and quantities over the threshold planning quantity (TPQ). An EHS is any of the 406 chemicals identified by the EPA as toxic and listed under SARA Title III. Resources are available on the EPA website to determine if a facility exceeds the TPQ for an EHS.

- The Emmet County Department of Public Works (ECDPW) provides a Household Chemical Drop-Off Program to residents two days a year. There is no charge for residents to participate, but they must make an appointment for the event. There are only a few kinds of chemicals that are not accepted through the Household Chemical Drop-off program: explosives and ammunition, and radioactive materials.

  ECDPW's Household Chemical Drop-off Program can also take hazardous materials from businesses and organizations which meet both of the following limits:
  - Never accumulate more than 2,200 pounds of material at a time.
  - Produce less than 220 pounds of hazardous waste a month

  Emmet County DPW also accepts pesticides FREE while funds last annually from any user* in Michigan, thanks to a Clean-Sweep grant from the Michigan Department of Agriculture. This encompasses households, but also all kinds of businesses, except retailers selling pesticides. Farmers, landscapers, and businesses using pesticides on their buildings and grounds are all welcome to use this free service.

  Mercury – The DPW accepts mercury FREE while funds last annually from anyone in Michigan, thanks to a grant from the Michigan Department of Environmental Quality, while funding lasts annually.

  An appointment on a Household Chemical Drop-off Day is required to drop off your mercury or pesticides.

  Latex paint is accepted for recycling at the Pleasantview Road Drop-off Center, April 1st-November 1st. Motor oil, antifreeze, electronics, and batteries are collected for recycling year-round at the Emmet County Drop-Off Center. Fees may apply.

[23] https://www.michigan.gov/pfasresponse/investigations/sites-aoi/emmet-county/pellston-regional-airport

Hazardous Materials: Transportation Incident

A hazardous material transportation incident is an uncontrolled release of hazardous materials during transport that poses a risk to health, safety, property, or the environment. All modes of traditional transportation (e.g. highway, rail, air and marine) carry thousands of hazardous material shipments on a daily basis through communities. For transportation purposes, a hazardous material is defined by the United States Department of Transportation (USDOT) as a "substance or material capable of posing an unreasonable risk to health, safety, or property when transported in commerce." Examples include solids, liquids, or gasses that can cause unreasonable harm to humans and other living organisms due to being radioactive, flammable, explosive, toxic, corrosive, a biohazard, an oxidizer, an asphyxiant, or hyperallergenic. Not all hazardous materials carry the same level of risk or have the potential to create a local emergency.

Although typically not cargo itself, vehicle fuel is extremely flammable and may complicate routine incidents. Trained teams may be deployed to address this fuel, even when incidents do not otherwise involve hazardous cargo. In addition to highway-related concerns, damaged or submerged ships may leak fuel into water, and planes may drop jet fuel mid-air prior to emergency landings.

A local emergency may occur depending on the material released and its amount, the weather, location, and other factors. Minor incidents involving hazardous materials can still prove dangerous but are routinely handled by response teams in an effective manner. Major incidents may involve a widespread hazardous release, adversely impacting the life safety of those near the incident site or affected by subsequent spread. Explosions, air plumes, and fires can occur. The environment can be severely impacted depending on the effectiveness of containment measures.

Statistics show that almost all hazardous material transportation incidents are the result of unintentional motor vehicle crashes or train derailments. Lack of sleep, drug use, poor training, or simple human error are contributing factors. Rarely are they caused solely by mechanical failures on the vessels carrying hazardous cargo.

The location of a spill is an important factor and the major distinction between preparing for fixed site incidents. While communities with known fixed location hazards can more easily prepare for specific dangers in a given area, travelling hazards can generate "surprise incidents" associated with non-familiar materials in a variety of potential locations. Response teams will need to be mobilized and cannot be as readily embedded near potential sites, especially in rural areas far away from onloading and offloading locations. Weather is another important factor, as it pertains to how likely an incident may spread, with winds, rain, and temperature impacting containment efforts. Events involving bridges and tunnels may create significant transportation bottlenecks.

For events related specifically to what most people would think of as accidents (e.g., crashes, derailments), highway incidents represented by far the greatest number of occurrences. Based on data from the U.S. Department of Transportation's Pipeline and Hazardous Materials Safety Administration (PHMSA) Office of Pipeline Safety, trucks represent 95 percent of such highway shipments and typically haul only one bed, trailer, or tanker, limiting the individual effects of each incident. Train related events carry the potential for involving multiple railcars, creating larger and more damaging single events when they do occur.

All areas in Michigan are vulnerable to a hazardous material transportation incident, with Southern Michigan being more vulnerable due to its highly concentrated populations. The State has experienced numerous small scale incidents that are responded to by local fire departments and hazardous material teams. Fortunately, Michigan has not experienced large scale incidents.

Location, Previous Occurrences and Probability of Future Occurrences

The PHMSA's Hazmat Incident Report Search Tool [24] can be used to query data from the USDOT Hazardous Materials Incident Report Form. The data include the size, frequency, and impacts of hazardous materials releases during transportation, and can be used to improve the safe transportation of hazardous materials. While a search of the database did not provide any incidents for Emmet County, there may have been minor accidents that were not reported.

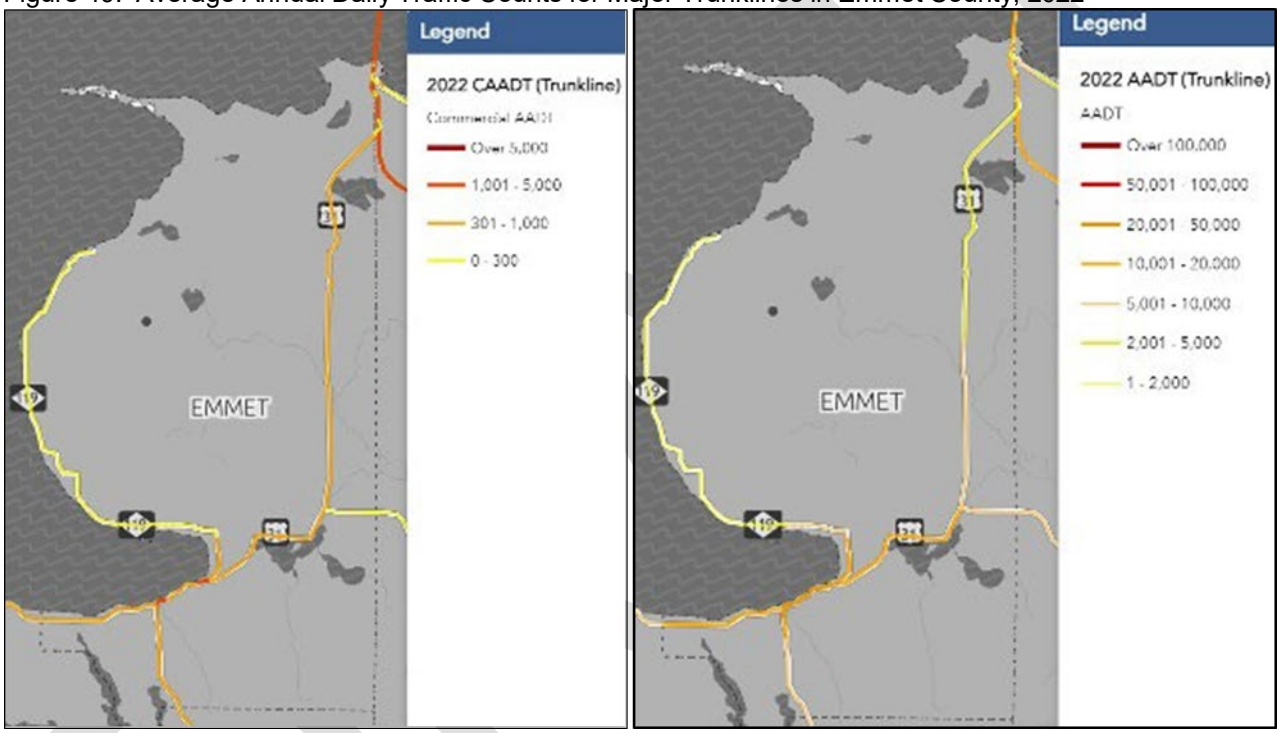
[24] https://www.phmsa.dot.gov/hazmat-program-management-data-and-statistics/data-operations/incident-statistics

There is the potential for an accident on these major federal/state transportation corridors in the County:

- I-75 (Wawatam Township; Village of Mackinaw City)
- US-31 (Wawatam Township, Carp Lake Township, McKinley Township, Village of Pellston, Maple River Township, Littlefield Township, Village of Alanson, Little Traverse Township, Bear Creek Township, City of Petoskey, Resort Township)
- US-131 (Bear Creek Township, City of Petoskey)
- M-119 (Bear Creek Township, Little Traverse Township, City of Harbor Springs, West Traverse Township, Friendship Township, Readmond Township, Cross Village Township).
- M-68 (Littlefield Township, Village of Alanson)

Sections of US-31 within Petoskey and Bear Creek Township have the highest average annual daily traffic (AADT) count estimates, followed by I-75 in Wawatam Township and the Village of Mackinaw City. This includes commercial traffic counts as well, which can carry hazardous material products.

Figure 49. Average Annual Daily Traffic Counts for Major Trunklines in Emmet County, 2022



Source: MDOT AADT Maps, https://www.michigan.gov/mdot/programs/planning/asset-mgt/traffic-monitoring-program

Rail

Currently there are seven miles of active rail remaining in Emmet County, on what is known as the Tuscola and Saginaw Bay Railway. This section is classified as a type-two railway, with speed limits not to exceed 25 mph. Emmet County's section of rail begins at the south county line near Bear River Road and follows River Road, running north through Bear Creek Township into the City of Petoskey. Although there is only a short distance of track remaining in Emmet County, it plays a vital role for at least one area business. Petoskey Plastics Inc. utilizes the rail service as a cost-effective way to move mass quantities of materials and products. (Does it transport hazardous materials?)

Air

Located in northern Emmet County within McKinley Township, Pellston Regional Airport connects northern Michigan to the rest of the world. In operation since 1936, Pellston Regional Airport, owned by Emmet County, offers quick and efficient commercial passenger, private plane and cargo services. It provides commercial flights daily to and from Detroit, Michigan. Both Federal Express and UPS serve the county via the airport. Flight

services include the sale of jet fuel and AV Gas, minor repairs by appointment, WSI pilot weather briefing system, Instrument Landing System (ILS) and GPS approaches and a VOR navigation system.

The Harbor Springs Municipal Airport is owned by the City of Harbor Springs and is located along M-119 in Little Traverse Township. It is operated by the Harbor-Petoskey Area Airport Authority, with Board of Directors appointees from the cities of Harbor Springs and Petoskey, and Bear Creek, Little Traverse, Pleasantview and West Traverse townships. The airport allows private pilots an easy commute to Emmet County, and serves as a location for emergency patient transport and organ delivery. McLaren Northern Michigan Hospital in Petoskey relies on the airport because strong winds off Little Traverse Bay don't allow the hospital to safely operate a helipad. Harbor Springs Municipal Airport is open year-round and has staff on call 24 hours a day. Services provided include flight planning, tie-downs, hangers, supplies, JET A and 100LL fuel and a courtesy car.

Marine

There are nine marinas in the county. The 3 municipal marinas are located in Petoskey (Little Traverse Bay), Harbor Springs (Little Traverse Bay) and Littlefield Township (Admirals Point/Hay Lake Marina – Inland Waterway access). The others are privately owned and are located in Bay Harbor (Little Traverse Bay), Ponshewaing and Oden (Crooked Lake), Carp Lake Township (Paradise Lake), Alanson (Crooked River) and Harbor Springs (two private marinas on Little Traverse Bay).

The Little Traverse Bay Ferry Company began operation in Little Traverse Bay in 2020. It offers ferry service and cruises between Petoskey (from Bayfront Park/Petoskey Municipal Marina), Harbor Springs (Josephine Ford Park) and Bay Harbor (Bay Harbor Lake).

Extent

Most hazardous material transportation incidents in Michigan are relatively small and localized to a specific community. In general, their impact is greatest when it occurs in urban areas, shutting down traffic and potentially presenting health hazards to large populations. Evacuations of the surrounding population may be necessary. Typically impacted infrastructure includes highways, overpasses, and rail crossings. Large airports are more of a concern than smaller ones, but often include highly trained, embedded response teams.

Only the severest of such incidents would have a significant impact on the economic condition of the entire state. An incident with perhaps the greatest potential impact on the economy would be one involving a massive petroleum spill in the Great Lakes, which would significantly impact fishing, tourism, and other industries depending on its location.

The impacts on the ability of first responders, operations and services would be very similar to those seen for fixed-site hazardous materials event when combined with a major transportation incident. The nature of the material, location and severity of the incident, weather, and a host of other factors, may require trained hazardous materials response teams. Continuity of operations would be largely unaffected in most circumstances.

The nature of materials, volume of spill, and effectiveness of containment efforts would again determine the extent of environmental damage. A significant incident damaging the Great Lakes or other bodies of water would be of great concern due to potential spread and difficulty in clean up. Toxic plumes and air pollution can also cause harm to wildlife and the environment. Soil, crops, and vegetation may also be affected.

Vulnerability Assessment

Buildings, infrastructure, and populations located along the major roadways, airports, and marinas (and rail?) in Emmet County are at-risk for a transportation hazardous material accident. An accident has the potential to leak material into the county's surface water and groundwater systems. Additionally, an accident could cause damage to buildings near the road, other vehicles, and damage communication and utility infrastructure that could cause power outages and a loss of communication.

Depending on the severity of an incident, individuals may experience chemical burns, nausea, vomiting, poisoning, and disorders of the body's organ systems. Businesses may close and a spill could cause the soil around businesses and residences to become contaminated.

Oil and Gas Accidents (well and pipeline)

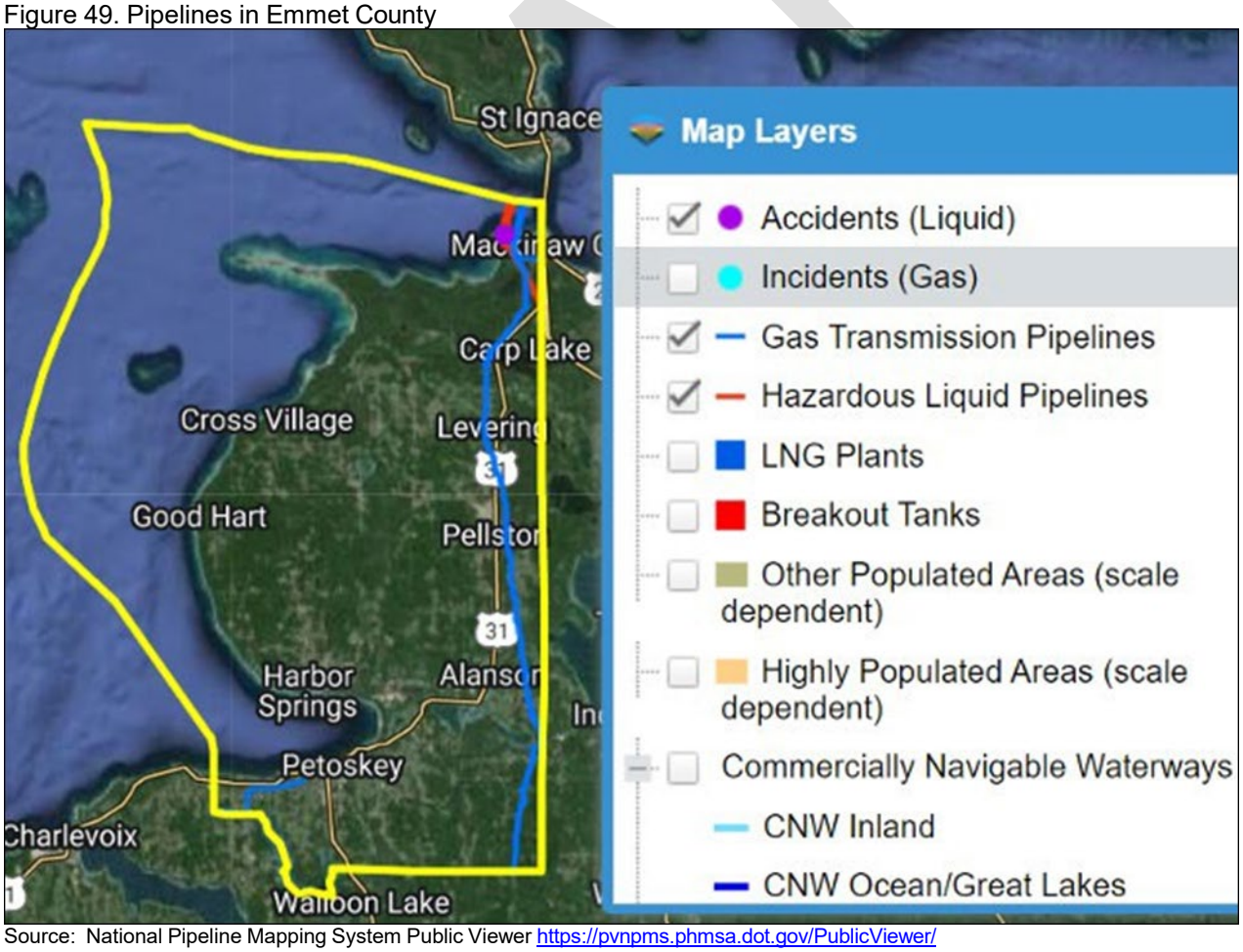
Petroleum and natural gas pipelines and wellheads represent a significant hazard in many Michigan communities. When accidents occur, they can cause environmental contamination, explosions, and fires. Because pipelines are typically buried, many residents are unaware of their proximity to such infrastructure and their associated risks. Many pipeline incidents are caused by third party damage to pipelines, usually accidental, and often due to construction or other activity involving digging operations. Other significant causes include corrosion, incorrect operation, and equipment failures. The threat of explosions represents the greatest potential danger to property, although uncontrolled fires can produce additional damage. Hydrogen sulfide (H2S) may also be poisonous in natural gas products that have a sufficiently high sulfur content (also known as sour gas). It can cause deadly incidents when inhaled around wellheads, pipeline terminals, storage areas, or transportation facilities. Despite these risks, major wellhead incidents in Michigan are rare, and pipelines are often considered the safest form of transportation for these products. Significant accidents do occur however. One of the largest inland oil releases in the country occurred when a pipeline in Calhoun County released heavy crude into the Kalamazoo River in 2010.

Location

According to EGLE's Michigan Oil, Gas and Minerals Division Data Explorer, there are no active oil and gas wells within Emmet County.

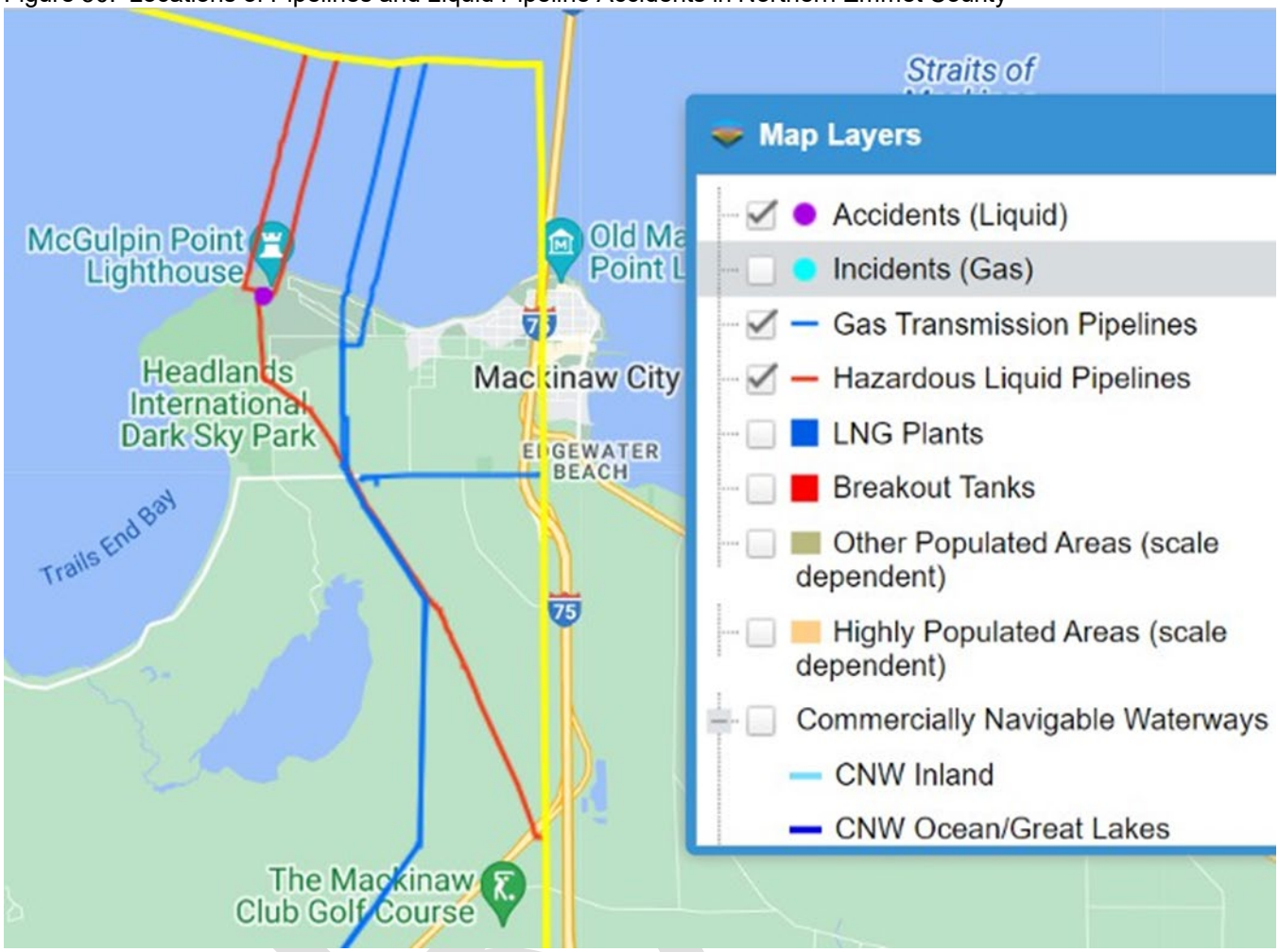
According to the National Pipeline Mapping System, three companies operate gas transmission and hazardous liquid pipelines in the county. Details of the pipelines in operation are indicated in the Figures 49-51 and Table 66.

Figure 49. Pipelines in Emmet County



Source: National Pipeline Mapping System Public Viewer https://pvnpms.phmsa.dot.gov/PublicViewer/

Figure 50. Locations of Pipelines and Liquid Pipeline Accidents in Northern Emmet County



Source: National Pipeline Mapping System Public Viewer https://pvnpms.phmsa.dot.gov/PublicViewer/

Figure 51. Gas Transmission Pipeline Location in Resort Township, Emmet County

Source: National Pipeline Mapping System Public Viewer https://pvnpms.phmsa.dot.gov/PublicViewer/

Table 66. Details on Active Pipelines in Emmet County

Operator	Contents	System Name/ Pipeline ID	Mileage of Pipeline	Jurisdictions
Great Lakes Transmission Limited Partnership	Natural Gas	GLGT Line 100 / 110400-2	79.42 miles	The Village of Mackinaw City; the Townships of Wawatam, Carp Lake, McKinley, Maple River, Littlefield, and Springvale
		GLGT Line 200 / 210450-1		
Enbridge Energy, Limited Partnership	Natural Gas Liquids*	Lakehead System / Line 5	8.71 miles	The Village of Mackinaw City; Wawatam Township
DTE Gas Company	Natural Gas	Great Lakes Mackinaw / Line 8968	7.22 miles	Wawatam Township, Village of Mackinaw City
		Charlevoix System / Line 8430		Resort Township
		Petoskey System / Line 8411		

Source: https://www.npms.phmsa.dot.gov/Documents/NPMS_Active_Pipe_County_Mileage.xlsx
*Note: According to Enbridge Energy, Line 5 is a 30-inch-diameter pipeline that carries light crude oil, light synthetic crude oil, and natural gas liquids (NGL). It originates at Enbridge's Superior Terminal in Superior, WI, and terminates at Sarnia, ON. Its average annual transport capacity is 540,000 barrels per day.

Previous Occurrences and Probability of Future Occurrences
Data available on pipeline accidents from the National Pipeline Mapping System's Public Viewer indicates that two accidents occurred at the Enbridge Energy Distribution Facility in Wawatam Township. On October 23, 2007, an onshore equipment failure resulted in the release of 0.71 barrels of crude oil; 0.48 barrels of the oil were recovered. On June 5, 2013, an onshore equipment failure resulted in the release of 0.48 barrels of highly volatile liquids (HVL; such as propane, butane, ethylene, or condensates) or other flammable or toxic fluid which is a gas at ambient conditions. None of the released HVL was recovered. No injuries or fatalities occurred as a result of those two accidents.

On April 1, 2018, a release of dielectric fluid into the Great Lakes/Straits of Mackinac occurred when the barge Erie Trader unintentionally dragged its 6-ton anchor for days as it sailed through the region. The anchor struck and damaged three underwater electrical transmission cables and two oil pipelines. About 800 gallons of the fluid leaked from the electric cables, where it was used as an interior coolant and insulator. The Enbridge "Line 5" oil pipelines running through the Straits of Mackinac sustained only superficial damage but created great concern due to their location. An incident brief by the National Transportation Safety Board can be found at https://www.ntsb.gov/investigations/AccidentReports/Reports/MAB1912.pdf.

Line 5 had been the subject of prior controversy when its capacity had been expanded in 2013, as well as in 2014 when it was found to not be meeting all of its pipeline anchoring requirements. This resulted, in part, to the creation of the Michigan Petroleum Task Force, whose report was published in 2015, and had kept the topic of the pipeline fresh in the public's mind leading up to the anchor strike. Michigan and Enbridge subsequently agreed to build a tunnel beneath the Straits of Mackinac to house Line 5. The agreement has been the source of various lawsuits. Parts of the line were shut down in 2020 when an issue was discovered with a screw anchor assembly. No product release was observed.

It should be noted that no transportation incidents related to the modes of "hazardous materials" or "pipelines" were found for Emmet County from a search of the National Transportation Safety Board's (NTSB) Case Analysis and Reporting Online (CAROL) tool.

Extent
Two of the three accidents involving the Enbridge Pipeline facility resulted in small amounts of pipeline product released on land at the facility.

Vulnerability Assessment
People, structures and natural resources that are near the oil and gas pipelines are at-risk if there is a future incident, such as an accidental release, fire, or explosion. Oil and gas well and pipeline accidents have the potential to contaminate water wells and spread into the surface water and groundwater systems. These accidents can also negatively impact air quality through the release of hydrogen sulfide that can accumulate in oil and gas wells, pipeline terminals, storage facilities, transportation facilities, and nearby buildings. Hydrogen sulfide can cause paralysis of the olfactory nerves, burns, death, and the failure of high strength metals.

The risk remains for another accidental anchor strike or a structural failure of the underwater pipelines in the Straits of Mackinac.

In June 2019, after Enbridge refused to enter an agreement with Governor Whitmer to decommission Line 5, Attorney General Nessel filed suit against Enbridge in Ingham County Circuit Court, asking the court to declare that Enbridge's continued operation of the Straits pipelines violates the public trust, is a common law public nuisance, and violates the Michigan Environmental Protection Act. The suit seeks an injunction requiring Enbridge to permanently shutdown Line 5 after a reasonable notice period. Underscoring the importance of the legal issues presented in this case, the states of California, Minnesota and Wisconsin took the unusual step of filing an amicus curiae [friend of the court] brief supporting the ability of a state to protect its waters and submerged lands under the public trust doctrine. The parties to the case have filed and argued cross-motions for summary disposition that are awaiting decision by the court. https://www.michigan.gov/ag/environment/pipelines

In November 2020, after completing a detailed review by the Department Natural Resources of Enbridge's compliance with the 1953 Easement that allowed Enbridge to construct the pipelines, Governor Whitmer and DNR Director Eichinger issued a Notice revoking the Easement based on the public trust doctrine and terminating the Easement based on Enbridge's repeated violations of its requirements. The Notice requires Enbridge to cease operation of the pipelines within 180 days (May, 2021). At the same time, AG filed a second lawsuit on behalf of the Governor and the DNR asking the Ingham County Circuit Court to uphold and enforce the Notice. https://www.michigan.gov/ag/environment/pipelines

Enbridge Energy has plans to relocate the pipelines underneath the lakebed, with the intent to greatly reduce the chance of a potential pipeline incident causing a damaging release of petroleum products into the Great Lakes. On December 19, 2018, Enbridge announced that it had reached an agreement with the Mackinac Straits Corridor Authority (MSCA) on the future of Enbridge's Line 5 light oil and natural gas liquids (NGL) pipeline at the Straits of Mackinac. The Great Lakes Tunnel will be bored through rock, as much as 100 feet below the lakebed, and house a newly constructed pipeline for "Line 5". Upon completion of the tunnel, Enbridge will permanently deactivate the existing dual "Line 5" pipelines at the Straits, which have been in operation since 1953. Enbridge continues efforts to obtain the required federal permit approvals from the US Army Corp of Engineers in order to begin the project. https://www.enbridge.com/projects-and-infrastructure/public-awareness/line-5-michigan/great-lakes-tunnel-project

Structure Fires

A structure fire is defined as a fire or explosion that ignites one or several buildings, spreading to cause injury or loss of life, property damage, or the loss of important services.

Structure fires are a common risk, having great overlap with many other hazards. A fire may be the primary cause of an incident or secondary to other events. Setting scale aside, simple structure fires (as compared to those involving forests, hazardous substances, etc.) are often the most straightforward for emergency personnel to respond to. This is especially true for small residential fires.

Structure fires can be defined in different ways. The National Fire Protection Association (NFPA)'s definition states "any fire in or on a building or other structure is considered a structure fire, even if the structure itself was not damaged. Mobile property used as a fixed structure, such as manufactured homes and portable buildings, are considered structures. A vehicle that burns inside a structure with the fire limited [to] the vehicle is considered a vehicle fire."

Structural fires in facilities, such as hotels, entertainment venues, schools, and hospitals, pose a great risk due to the large number of persons involved. The largest of all potential structure fires, an urban conflagration, spreads beyond a block and can destroy whole sections of a city if left unchecked.

According to the NFPA, the U.S. averages about 3,500 fire deaths each year for the past ten years (2013-2022). In the 1980s, the U.S. averaged about 6,000 fire deaths per year. Fire deaths have decreased about 42 percent from the 1980s until 2022. Since 2013, however, fire deaths in the U.S. have been increasing. The majority of fire deaths occur in structure fires (average of 2,870 deaths in structure fires each year for the past ten years – or 82 percent). This is a fairly significant 44 percent drop from the annual average of about 5,130 fire deaths in the 1980s. While structure fires represent 35 percent of the fires, they result in 77 percent of the fire deaths.

Research projects and studies have shown that fires in modern structures are developing faster and that occupants may not have sufficient time to escape. These studies have identified newer construction materials and the increased use of synthetic materials in furnishings and furniture as major factors that have made fires spread faster and produce more toxic combustion products. These factors may explain the recent increase in structure fire deaths and injuries. This rapid fire growth points to the need for early warning smoke alarms or detection to alert occupants and fire sprinkler systems to slow the fire's growth.[25]

Location
All of the existing and future structures in Emmet County are at-risk for a structural fire.

Previous Occurrences and Probability of Future Occurrences
Data obtained from a search of the National Fire Incident Reporting System (NFIRS) indicates that for the year 2022, Emmet County's fire departments responded to 95 fires, of which 30 were structure fires (1.9% of all emergency calls made; Table 67). No incidents were reported regarding pressure ruptures, explosions or overheating conditions.

Table 67. Fire Department Call Data for Fire Incidents, Emmet County, 2022

Fire Type	Frequency of Emergency Call	Percent of Total Emergency Calls	Total Fire Incidents
Structural Fires	30	1.90%	49
Vehicle Fires	20	1.27%	21
Other Fires	22	1.40%	25

Source: Emmet County Office of Emergency Management; NFIRS 5.0 National Reporting System

[25] https://nfsa.org/2024/04/30/structure-fire-trends-in-the-us/#:~:text=While%20structure%20fires%20represent%2035,the%20three%20types%20of%20fires.

It is expected that structural fires will continue to occur every year in the county. All of the existing and future buildings are at-risk to a structural fire dependent on the age of the structures, quality of existing infrastructure, and the distance between structures.

Extent

No casualties (injuries or deaths) were reported for any of the fire incidents reported for Emmet County in 2022. The total estimated dollar loss of the all fires (structure, vehicle and other) was reported as $1,530,350.

Data from the NFIRS for 2022 indicates that Michigan has a higher number of reported deaths and injuries per 1,000 fires compared to the national average (Table 68).

Table 68. NFIRS 2022 Reported Data on Fire Casualties, per 1,000 Fires

	Michigan	National Average
All Fire Casualties	4.0 Deaths	2.1 Deaths
	11.1 Injuries	6.47 Injuries
Residential Structure Fire Casualties	7.2 Deaths	6.1 Deaths
	23.3 Injuries	19.8 Injuries

Source: https://www.usfa.fema.gov/statistics/states/michigan.html

Structural fires can cause displacement and homelessness, in addition to serious injuries, death, and economic hardship. Beyond the small-scale structural fires that only affect a single home or two at a time, fire events involving multiple or major structures such as nursing homes, dormitories, hospitals, hotels, and other locations involve greater risk and complexity due to the potential numbers of vulnerable people involved. Facilities and infrastructure may be taken out of service even from smoke damage, resulting in relocation or disruption. An unchecked urban conflagration can destroy entire portions of a city.

While special training and equipment is still necessary to deal with structure fires, more “routine” fires are more likely to be effectively controlled and dealt with, resulting in only minor impact on public services and local government operations. Government buildings can also be potentially targeted for arson-related structure fires. Furthermore, any large fire has the potential to overwhelm local resources. The capability of area fire services, particularly in rural areas, may require outside assistance.

Air pollution issues are inherent to structural fire events, including vast amounts of carbon released from the flames, various chemicals burning within the building’s materials, other forms of air pollution, and ash spread. Large, dark, and thick smoke plumes from large burning structures can alter atmospheric conditions and lead to shifting wind patterns that affect other areas. Fires may spread to other structures and to natural vegetation, negatively affecting the environment. The burning of nearby native forests, trees, and grasslands can have environmental consequences. Chemicals from combustion may contaminate nearby water in lakes, reservoirs, rivers, and swamps. Agricultural structural fires can also affect farm animals and destroy agricultural products. The waters used to quell fires can spread the combustion products (chemicals, soot, ash) into nearby areas and into municipal sewer systems where they may affect the environment at system outlet locations.

Vulnerability Assessment

All of the existing and future buildings, populations, and infrastructure in Emmet County are at-risk to a structural fire. The county has aging housing stock and infrastructure that was built under building codes and rules for fire prevention that are no longer in effect today. Aged electrical lines increase a buildings risk for structural fires. Also, buildings without smoke and carbon monoxide detectors increase the risk for deaths. If not contained, the structural fires can also turn into large neighborhood fires or wildfires.

The hospital in Petoskey, theatres, schools, nursing homes, hotels, apartments, and other facilities carry high risk, not only due to their number of occupants, but also due to potential special needs such as age and mobility.

Communities of dense, seasonally-occupied and older housing stock, such as the resort associations of Harbor Point (West Traverse Township), Wequetonsing (Little Traverse Township), and Bay View (Bear Creek Township) are of concern regarding a potential structure fire spreading rapidly from one dwelling to another. Additionally, the

geographic location of Harbor Point Association (it is located on a peninsula surrounded by Little Traverse Bay, with one narrow ingress/egress location from the mainland) poses a potential difficulty for fire truck access via roadway, and may require firefighting response via marine vessel access.

Emmet County relies on a network of township volunteer fire departments, which means there is a lack of full-time professional firefighters who are available to conduct fire inspections and take other preventive measures to lessen the threat of structural fires. Therefore, efforts in Emmet County are directed at fire suppression education, via social media, community newsletters or community gatherings. Additionally, some communities may not have fire prevention codes and rely on the State Rules for Fire Prevention, while other communities have developed local ordinances. However, the costs of compliance for existing buildings may be prohibitive for business owners, yet it would be beneficial for new construction to comply with both State building code and State Rules for Fire Prevention.

Scrap Tire Fire

Scrap tires end up in dumps and landfills, forestlands, along roads, or in recycling facilities, some of which have more than several hundred thousand tires. The tires provide fuel for fires since the shape of a tire allows air to flow into the interior of a pile of tires, which renders standard firefighting practices nearly useless. Scrap tire fires impact the air, soil and water quality since the burning tires release hazardous compounds into the air, and the tires' oily residue can seep into the ground and water system. Sometimes, the burning oil can spread the fire to adjacent areas and burn for months. These fires can cause an area to become a Superfund site. Although infrequent, scrap tire fires can become a major hazard affecting entire communities due to the difficulty in extinguishing them and the expensive cleanup. Scrap tire fires differ from conventional fires since small scrap tire fires can require significant resources to control and extinguish, the costs of fire management are beyond what local governments can absorb, the environmental consequences are significant, and the Rubber Manufacturers Association reports that a fire can convert a standard passenger vehicle tire into about two gallons of oily residue.

According to the EPA and the Rubber Manufacturers Association, approximately 290 million tires are discarded in the United States each year, with approximately 80% of the tires being reused or recycled. As of 2017, Michigan generates approximately 10 million scrap tires annually according to the Michigan Department of Environment, Great Lakes, and Energy (EGLE). At the time of the 2014 update, Michigan had more than 24 million scrap tires at disposal sites throughout the state.

It is illegal to dispose of whole motor vehicle tires in Michigan landfills.

The Department of Environment, Great Lakes, and Energy's (EGLE) Scrap Tire Program is responsible for overseeing the handling of scrap tires generated in Michigan, cleaning up existing scrap tire piles of 500 or more tires, and expanding the reuse and recycling of scrap tires. The Program regulates transportation, storage, and disposal of scrap tires under Part 169, Scrap Tires, of the Natural Resources and Environmental Protection Act, 1994 PA 451, as amended.

An annual registration is required for scrap tire transporters and collection sites. Program staff regularly inspects scrap tire collection sites, processors, end-users, and generators, which include tire dealers and auto scrap yards.

Location
The Emmet County Department of Public Works' Pleasantview Drop-off Center accepts certain types of tires for recycling, for a fee. https://www.emmetrecycling.org/what-do-i-do-with/tires

Previous Occurrences and Probability of Future Occurrences
There have been no recorded occurrences of scrap tire fires in Emmet County. However, with the collection of scrap tires at the County DPW's Pleasantview Dropoff Center, and at illegal scrap tire dump sites in unknown areas throughout the county, there is the potential for a fire in the future.

Extent
Extent can be measured by the number of acres burned and property damage costs. Since Oscoda County has not had a reported scrap tire fire, data is not available to determine the number of acres burned, property damage, and cost to fight the fire. However, there is a potential for an event to occur in an area of the county that few people know has a stockpile of tires.

Vulnerability Assessment
If a scrap tire fire were to occur in the county, all of the county's existing and future buildings and populations would be at-risk. Additionally, neighboring counties would also be at-risk since the fires are difficult to control and can spread across political and geographical boundaries. Depending on the location of a scrap tire fire, it has the potential to cause a wildfire since pre-settlement data shows Oscoda County has a history of wildfires and federal agencies have found the county's communities have a high wildfire risk. Similar to wildfires, scrap tire fires burn

property and structures, and have the potential to cause death and injuries for people who become trapped in the fire or are fighting the fire.

Scrap tire fires also have high costs due to property damage and firefighting needs. Scrap tire fires can cause a loss in timber production and agricultural revenue from the fire damaging timber supplies and agricultural products, and killing livestock. Communication and power infrastructure can be damaged by the fires resulting in power outages, reduced/loss of warning notifications to the public, and the inability to call for emergency services. Also, residents and businesses may have to evacuate and find shelter.

Depending on where illegal dumping is occurring, there may be support for illegal dumping cleanup efforts from a variety of programs. This can minimize the risk of scrap tire fires and potential resulting contamination.

- Adopt-a-Forest - addresses state forest and parks (Michigan Department of Natural Resources)
- Adopt-a-Highway - covers state highway right-of-ways (Michigan Department of Transportation)
- Adopt-a-Road is a program to help keep county road right-of-ways picked up (Emmet County Road Commission)
- Emmet County DPW may be able to assist with cleanup projects on other public land in Emmet County.
- Some communities provide vouchers covering the cost of disposal of illegally-dumped materials found on private property.

Transportation Accidents (air, land, and water)

For the purposes of this hazard mitigation plan, a "transportation accident" is defined as a major crash or incident of air, land, or water-based vehicles, predominantly involving commercial passenger carriers.

Major air transportation incidents primarily occur when an airplane crashes while taking off or landing. An inflight crash may also be the result of mechanical problems, sabotage, or being hit by mid-air objects. Planes may experience more simple collisions on the runway while taxiing, but a mix of variable speeds occurring on the tarmac may still result in fatalities. Helicopters tend to carry far fewer commercial passengers.

Major land transportation incidents can involve passenger buses, motor coaches, and similar vehicles. "Ordinary" automobile crashes may be of significance if they result in a massive "chain reaction" type event, causing multiple injuries and result in lengthy closures of major highways. Passenger rail also carries risk due in part to the greater number of people transported.

A water transportation incident involving commercial passenger ferries can have significant life safety consequences. Most of these marine services operate on a seasonal basis (typically May through November). Vessel sizes vary, but 100–200 passengers may be on board at the peak of tourist season. Specialized ferries can carry cars or trucks.

These accidents can result in mass casualties and tremendous injuries due to large numbers of passengers, unpredictable weather, mechanical failures, and human error. These accidents have the potential to strain local response and medical services. Airplane accidents tend to occur either during take-off or landing according to the National Transportation Safety Board (NTSB) and airline industry. When responding to these accidents, it may be difficult to suppress the fires, rescue and provide first aid to survivors, establish a mortuary facility, detect the presence of explosive, radioactive, or other hazardous materials, and provide crash site security and crowd control. Water transportation accidents may require underwater rescue and recovery efforts.

Vulnerable populations to these hazards include communities near airports, communities with railroad tracks through them, communities with commercial intercity passenger bus or local transit bus service, communities with school bus service, and communities with commercial marine passenger service or along water bodies. Michigan has approximately 19 commercial passenger airports, more than 130 certified intercity carriers that provide passenger, charter, commuter, and special bus service to 220 Michigan communities with six offering regular route service, an intercity rail passenger system that consists of 568 route miles, along three corridors, serving 22 Michigan communities, 72 local bus transit systems serving 85 million passengers and 20 commercial marine passenger ferries.

Location
The entire county is susceptible to air, land, and water transportation accidents.

The potential for water accidents can occur on the Little Traverse Bay (public and private marinas in Petoskey and Harbor Springs; ferry service between Harbor Springs and Petoskey) and the Inland Waterway Route (marinas on Crooked Lake in Littlefield Township, Crooked River in the Village of Alanson, and Hay Lake in Littlefield Township). Additionally, freight and private passenger marine traffic routes are present within Lake Michigan and the Mackinaw Straits along the west and north sides of Emmet County. Occasionally, freighter vessels may take temporary refuge from rough waters by anchoring within Little Traverse Bay.

The air transportation accidents have a greater chance of occurring at or near the Emmet County airport in Pellston and the Harbor Springs Municipal Airport in Little Traverse Township.

Major land-based transportation accidents are more likely to occur on the highways within the County that permit higher travel speeds (55 mph), such as US-131, US-31, and M-68. Additionally, a portion of I-75 is located within the Wawatam Township and the Village of Mackinaw City within Emmet County.

Previous Occurrences and Probability of Future Occurrences
The National Transportation Safety Board's (NTSB) Case Analysis and Reporting Online (CAROL), allows for searching accident investigation data across all modes. For aviation investigations, incidents dating from 1982 to present were research for Emmet County. Data pertaining to investigation of other modes (rail, pipeline, hazardous materials, highway and marine) were available dating from 2010 to present.

Data researched indicates there are no incidents for rail, pipeline, hazardous materials or highway modes of transportation in Emmet County.

There are records of three (3) marine transportation accidents in or adjoining Emmet County over the past 14 years, indicating there is a 21.4% annual chance of a marine accident occurring in a future year.

- 1/5/2014, near the Straits of Mackinaw. The USCG Cutter *Hollyhock* collided with M/V *Mesabi River*. The collision occurred due to difficulty in marine vessel operation through dense ice cover. No injuries or pollution resulted from the collision. Both vessels sustained significant damage but remained operational.
- 4/1/2018, Mackinaw City. The towing vessel *Clyde S. Van Enkevort/Erie Trader*'s anchor struck underground transmission lines, releasing 800 gallons of dielectric mineral oil into the waterway. The investigation found that the anchor windlass on the vessel had malfunctioned.
- 5/7/2023, Mackinaw City. As of 7/8/2024, the NTSB had not completed an investigation report for this incident (NTSB# DCA23FM032). However, it is reported to have involved two towing/barge vessels, the *Nickelena and BMI 209*.

Additionally, there have been 21 aircraft crashes in Emmet County in the past 42 years, between 1982 and 2023 (Table 69). This indicates there is a 50% chance of an aircraft crash happening in the County in a future year. Most of the incidents were caused by pilot error, and/or aircraft equipment deficiencies.

Table 69. Air Transportation Accidents in Emmet County

Date of Incident	City	Airport Name	Fatalities	Serious Injuries	Minor Injuries	Probable cause	Findings	Aircraft Damage	Docket URL	NTSB Report URL
12/18/1982	PELLSTON	EMMET COUNTY AIRPORT	0	0	0			None		https://data.ntsb.gov/carol-repgen/api/Aviation/ReportMain/GenerateNewestReport/72182/pdf
12/17/1983	HARBOR SPRINGS	HARBOR SPRINGS	0	0	0			Substantial		https://data.ntsb.gov/carol-repgen/api/Aviation/ReportMain/GenerateNewestReport/12507/pdf
12/14/1985	CARP LAKE	EMMET COUNTY	5	0	0			Destroyed		https://data.ntsb.gov/carol-repgen/api/Aviation/ReportMain/GenerateNewestReport/13534/pdf
2/13/1990	HARBOR SPRINGS	HARBOR SPRINGS	0	0	0	The student pilot's failure to maintain adequate directional control of the aircraft. The unfavorable wind was a related factor.		Substantial		https://data.ntsb.gov/carol-repgen/api/Aviation/ReportMain/GenerateNewestReport/14632/pdf
8/22/1991	HARBOR SPRINGS	HARBOR SPRINGS	0	0	0	The pilot's failure to adequately compensate for wind conditions. A factor associated with the accident was his delay in initiating the go-around.		Substantial		https://data.ntsb.gov/carol-repgen/api/Aviation/ReportMain/GenerateNewestReport/15162/pdf

Date of Incident	City	Airport Name	Fatalities	Serious Injuries	Minor Injuries	Probable cause	Findings	Aircraft Damage	Docket URL	NTSB Report URL
3/13/1994	HARBOR SPRINGS	HARBOR SPRINGS	0	0	2	The pilot's improper decision to continue flight into icing conditions after the conditions were first encountered. A factor related to the accident was the trees contacted during the landing roll.		Destroyed		https://data.ntsb.gov/carol-repgen/api/Aviation/ReportMain/GenerateNewestReport/9482/pdf
6/8/1995	ALANSON		1	0	0	Improper planning/decision by the pilot, which resulted in fuel exhaustion due to an inadequate supply of fuel, and failure of the pilot to maintain control of the airplane, which resulted in a stall/spin and collision with the ground.		Destroyed		https://data.ntsb.gov/carol-repgen/api/Aviation/ReportMain/GenerateNewestReport/9906/pdf
2/10/1996	PELLSTON		1	0	0	Flight into known adverse weather conditions (fog) at too low an altitude by the pilot. Factors associated with this accident were inadequate preflight planning and an improper inflight decision by the pilot when he chose to continue flight into the fog conditions.		Destroyed		https://data.ntsb.gov/carol-repgen/api/Aviation/ReportMain/GenerateNewestReport/10069/pdf
5/31/1997	ALANSON	PRIVATE AIRSTRIP	0	2	0	Inadequate preflight by the pilot, which resulted in fuel starvation, due to an improper fuel tank selector position. A factor relating to the accident was: the pilot's improper inflight planning/ decision, which resulted in his delay or inability to flare the airplane during the emergency landing.		Destroyed		https://data.ntsb.gov/carol-repgen/api/Aviation/ReportMain/GenerateNewestReport/10583/pdf
1/21/1999	PELLSTON	PELLSTON REGIONAL AIRPORT	3	0	0	The pilot's failure to maintain proper altitude/clearance on the approach and his flight into known icing conditions. Factors relating to this accident were the pilot flying with known equipment deficiencies, the pilot's physical impairment (alcohol), the icing conditions, and the trees.		Destroyed		https://data.ntsb.gov/carol-repgen/api/Aviation/ReportMain/GenerateNewestReport/45659/pdf

Date of Incident	City	Airport Name	Fatalities	Serious Injuries	Minor Injuries	Probable cause	Findings	Aircraft Damage	Docket URL	NTSB Report URL
7/4/1999	HARBOR SPRINGS	HARBOR SPRINGS	0	0	0	The pilot's inadequate compensation for the wind conditions and his failure to maintain clearance with the trees. Factors associated with the accident were the gusty winds, wind shear, and the trees.		Substantial		https://data.ntsb.gov/carol-repgen/api/Aviation/ReportMain/GenerateNewestReport/46761/pdf
7/27/2000	HARBOR SPRINGS	HARBOR SPRINGS	0	0	0	The pilot selected the wrong runway direction in which to land and he did not perform a go-around when he realized the landing approach was too high. Factors associated with the accident were the tailwind condition, the improper glidepath, and the intentional ground loop/swerve, and the fence at the end of the runway.		Substantial		https://data.ntsb.gov/carol-repgen/api/Aviation/ReportMain/GenerateNewestReport/49875/pdf
8/17/2000	HARBOR SPRINGS	HARBOR SPRINGS MUNICIPAL	0	0	0	The pilot's long touchdown, and inadequate braking to stop on the runway. Factors relating to this accident were the pilot's improper in-flight planning and decision resulting in the long touchdown, and the fence.		Substantial		https://data.ntsb.gov/carol-repgen/api/Aviation/ReportMain/GenerateNewestReport/50065/pdf
9/23/2001	Petoskey		0	0	2	The pilot's inadequate preflight planning, the pilot's improper in-flight decisions, and the unsuitable terrain for landing. A factor relating to this accident was fuel exhaustion.		Substantial		https://data.ntsb.gov/carol-repgen/api/Aviation/ReportMain/GenerateNewestReport/53522/pdf
1/9/2005	Harbor Springs	Harbor Springs Airport	0	0	0	The pilot's inadequate preflight planning/preparation by his failure to remove the accumulated airframe ice which resulted in deteriorated aircraft takeoff performance. Airframe ice, the snow bank and the fence were contributing factors.		Substantial		https://data.ntsb.gov/carol-repgen/api/Aviation/ReportMain/GenerateNewestReport/60904/pdf

Date of Incident	City	Airport Name	Fatalities	Serious Injuries	Minor Injuries	Probable cause	Findings	Aircraft Damage	Docket URL	NTSB Report URL
1/12/2007	Harbor Springs	Harbor Springs Airport	0	0	2	The pilot's failure to maintain aircraft control and adequate airspeed during landing flare. Contributing to the accident was the aerodynamic stall/mush encountered at a low altitude.		Destroyed		https://data.ntsb.gov/carol-repgen/api/Aviation/ReportMain/GenerateNewestReport/65227/pdf
2/10/2007	Pellston		0	2	2	The fatigue failure of the engine cylinder which resulted in a complete loss of engine power, and the unsuitable terrain encountered by the pilot during the subsequent forced landing. Contributing to the accident were the night lighting condition, and trees.		Substantial		https://data.ntsb.gov/carol-repgen/api/Aviation/ReportMain/GenerateNewestReport/65308/pdf
1/11/2012	Alanson		0	1	1	The powered parachute's encounter with a downdraft/windshear during takeoff, which resulted in a loss of lift.	Aircraft - Aircraft oper/perf/capability - Performance/control parameters - Altitude - Not attained/maintained, Environmental issues - Conditions/weather/phenomena - Wind - Downdraft - Effect on operation	Substantial	https://data.ntsb.gov/Docket?ProjectID=82671	https://data.ntsb.gov/carol-repgen/api/Aviation/ReportMain/GenerateNewestReport/82671/pdf
1/15/2013	Pellston	PELLSTON RGNL AIRPORT OF EMMET	1	0	0	The pilot's inadvertent controlled descent into terrain due to spatial disorientation. Contributing to the accident was lack of visual reference due to night conditions.	Aircraft - Aircraft oper/perf/capability - Performance/control parameters - Directional control - Not attained/maintained, Personnel issues - Psychological - Perception/orientation/illusion - Spatial disorientation - Pilot, Environmental issues - Conditions/weather/phenomena - Light condition - Dark - Effect on personnel	Destroyed	https://data.ntsb.gov/Docket?ProjectID=86027	https://data.ntsb.gov/carol-repgen/api/Aviation/ReportMain/GenerateNewestReport/86027/pdf
8/9/2015	Harbor Springs	HARBOR SPRINGS	1	0	0	The pilot's failure to maintain clearance from the trees during the approach in dark, night conditions, which resulted in controlled flight into trees and terrain.	Personnel issues - Psychological - Attention/monitoring - Monitoring environment - Pilot, Aircraft - Aircraft oper/perf/capability - Performance/control parameters - Altitude - Not attained/maintained, Environmental issues - Conditions/weather/phenomena - Light condition - Dark - Effect on personnel, Environmental issues - Physical environment - Object/animal/substance - Tree(s) - Effect on operation	Substantial	https://data.ntsb.gov/Docket?ProjectID=91738	https://data.ntsb.gov/carol-repgen/api/Aviation/ReportMain/GenerateNewestReport/91738/pdf

Date of Incident	City	Airport Name	Fatalities	Serious Injuries	Minor Injuries	Probable cause	Findings	Aircraft Damage	Docket URL	NTSB Report URL
6/1/2023	Pellston	PELLSTON RGNL/EMMET COUNTY	0	0	0	The failure of the left main landing gear strut and clevises due to fatigue cracks that initiated at multiple casting solidification voids.	Aircraft - Aircraft systems - Landing gear system - Main gear strut/axle/truck - Fatigue/wear/corrosion	Substantial	https://data.ntsb.gov/Docket?ProjectID=192285	https://data.ntsb.gov/carol-repgen/api/Aviation/ReportMain/GenerateNewestReport/192285/pdf

Source: https://www.ntsb.gov/safety/data/Pages/Data_Stats.aspx

Extent

All of Emmet County is at-risk for an air, land, or water transportation accident. Air accidents would primarily occur around the Harbor Springs Airport and Pellston Airport (although, the 2001 incident on record occurred near along the shore of Little Traverse Bay in Petoskey). Water transportation accidents would primarily occur on the along the Inland Waterway, Little Traverse Bay, and Lake Michigan. Land transportation accidents would primarily occur along roadways and motorized trails, with a higher risk in areas with large volumes and speeds of traffic (US 31, US-131, M-68, and I-75). The extent of such accidents is typically measured by property damages, deaths, and injuries.

Nine (9) of the aviation accidents on record resulted in no injuries; six (6) events resulted in fatalities; five (5) events resulted in minor injuries; and three (3) events resulted in serious injuries. Most of the events occurred near either the Harbor Springs airport of the Pellston (County) airport. Most of the crashes resulted in substantial aircraft damages, or the complete destruction of the aircraft.

The two marine transportation incidents on record with Emmet County in 2014 and 2018 did not result in any deaths or injuries, but did result in a release of 800 gallons of dielectric mineral oil into the Mackinaw Straits waterway, and marine vessel damage.

While there are no NTSB highway traffic crash investigations on record for Emmet County, the potential for a major incident remains a possibility. According to the University of Michigan Transportation Research Institute's Societal Costs of Traffic Crashes and Crime in Michigan: 2023 Update, in 2023 Emmet County had 4 fatal traffic crashes, 31 traffic crashes with serious injuries, 69 crashes with moderate injuries, 117 crashes with minor injuries, and 1,540 crashes with property damage only. The average estimated cost of these traffic crash casualties was $62,217, with the total estimated traffic crash cost for all 1,761 accidents equaling $109,564,463. Total estimated costs were in 2021 dollars and represent the monetary values for medical care; work loss; public services; adjudication and sanctioning; insurance administration; congestion & environmental impacts (the costs of travel delay, excess fuel consumption, and pollution resulting from crashes); property damage and loss; as well as a value given to the loss of the affected person's quality of life.

Vulnerability Assessment

Emmet County does not have passenger rail service or intercity bus service. However, there are two public airports, and school bus and specialized public transit services that could result in deaths and/or injuries from an accident.

An air transportation accident has the potential to cause deaths, injuries, and large amount of property damage if a plane hits the county's buildings, infrastructure, or year-round and/or seasonal populations.

Land transportation accidents have the potential to cause damage to other vehicles, injuries, and possibly death. MDOT provides Annual Average Daily Traffic Counts for the major roads in the county (M-119, M-68, US-31, US-131, and I-75), which ranges from 1,660 vehicles on M-119 north of Harbor Springs, to 29,285 vehicles on US-31 between Rice Street and M-119. Dependent on the severity of the accident, it can cause a road closure that would impact the county's traffic flow patterns. Additionally, it could reduce emergency service response times.

The I-75 Mackinaw Bridge is designated by the State as a Restricted Hazardous Materials Route. All placarded loads (a vehicle carrying any type of hazardous material) require an escort by the Mackinaw Bridge Authority.[3]

Water transportation accidents can cause death and injuries to individuals as well as high property damage costs. Dependent on the severity of the incident, the accidents have the potential to contaminate the water resources.

[3] Source: MSP 2020 *Michigan Hazard Analysis Supplement*, referencing the Federal Motor Carrier Safety Administration, last updated 2018.

Built Infrastructure Failures (water, sewer, roads, bridges, trails, communications)

Citizens are dependent on built infrastructure to provide essential life-supporting services. A built infrastructure failure can be defined as a temporary loss of essential services provided by critical public infrastructure. For purposes of this section of the plan, this primarily includes water supply infrastructure, sewer systems, major non-motorized trail networks, roads, bridges and communication systems. Dam failures, energy related infrastructure failures, subsidence and space weather have their own individual hazard analyses in this plan.

When one or more of these independent yet frequently co-located systems fail, they can frequently impact each other or generate cascading effects with other hazards. For example, when wastewater treatment systems in a community are inoperable, serious public health problems can arise that must be addressed immediately to prevent outbreaks of disease. The collapse of a bridge on a major highway may not only result in significant loss of life but also create gridlock that impedes the transportation of essential goods such as food, the hauling of gasoline, and the efficiency of emergency services responding to other emergencies. Infrastructure failures also cause widespread economic losses to businesses and industries, limit security, and alter lifestyles.

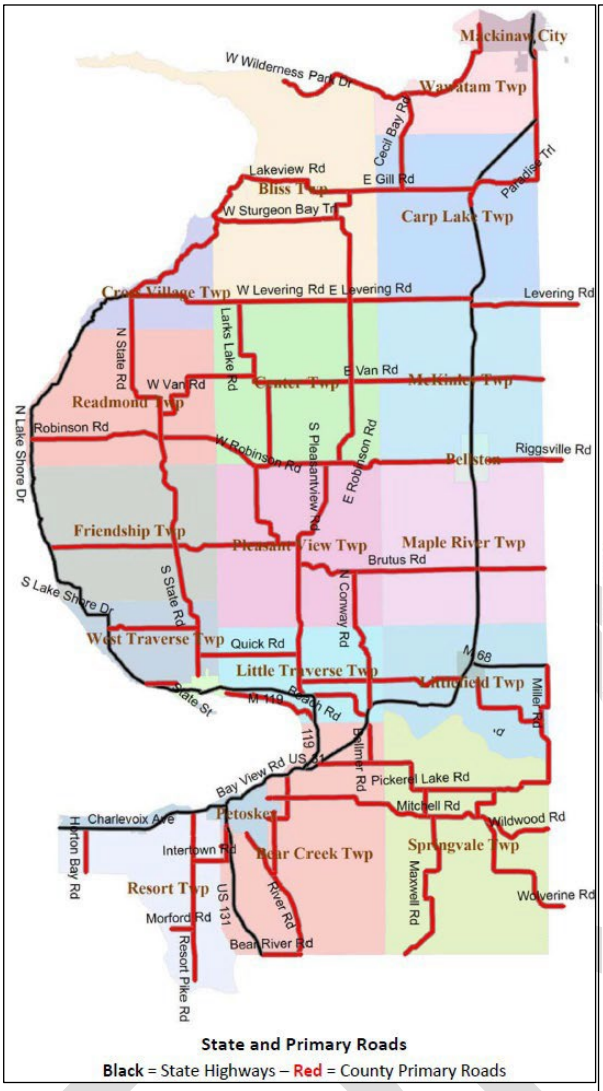
Local and state budgetary constraints, combined with physical structures near the end of their useful service life, means that many types of infrastructure are suffering from a lack of support. Routine maintenance and repairs may be delayed, increasing risk and creating more expensive situations in the future. Worst-case scenarios would result in structure collapse. Some deterioration includes simple things, such as missing manhole covers, sewer grates, chain link fences, and road signs. While small in comparison, they can still present life-safety hazards under certain circumstances.

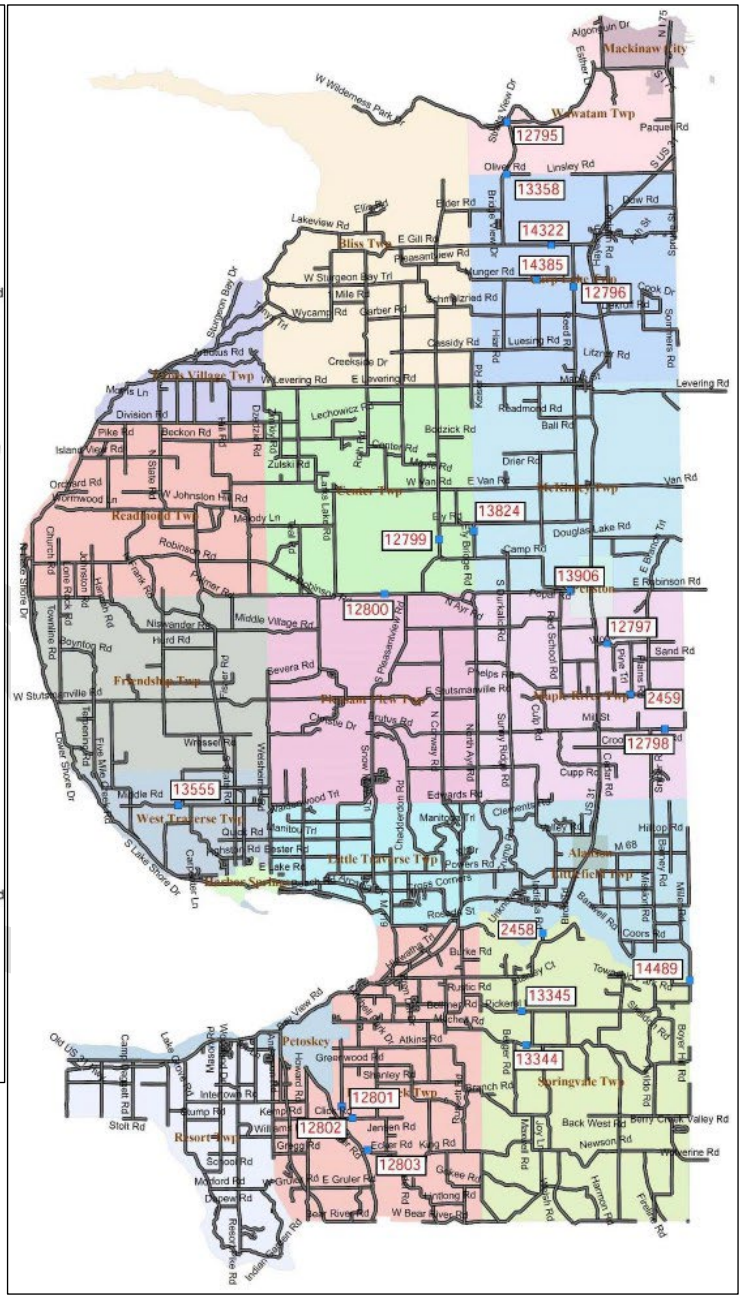
Much of Michigan's pipe infrastructure is especially vulnerable, made of materials that have weakened, been severely corroded, or that contain contaminating elements such as lead. Because most pipes are underground and out of visual site, their age is easier to dismiss compared to that of a crumbling bridge. Some pipe networks are so old that it may be difficult to find accurate location maps. Inspecting pipes with cameras or using underground detection methods is often necessary. Water testing quality is essential and can provide an early indicator of problems in the system. Compromised water quality, such as high lead levels, can also lead to a full- blown public health crisis.

While not unique, Michigan's roads and bridges experience annual winter freeze and thaw cycles that causes a continual breakdown of their surfaces. The state has also frequently experienced significant related funding challenges. This will be exacerbated over time as more vehicles use less gasoline (or none at all) because a major portion of the state's transportation funding comes from taxes placed upon gasoline. Although underinvestment can create risk anywhere in the system, bridge related incidents can be particularly dangerous. Michigan ranks above both national and regional averages as they relate to bridges rated in severe condition.

Location

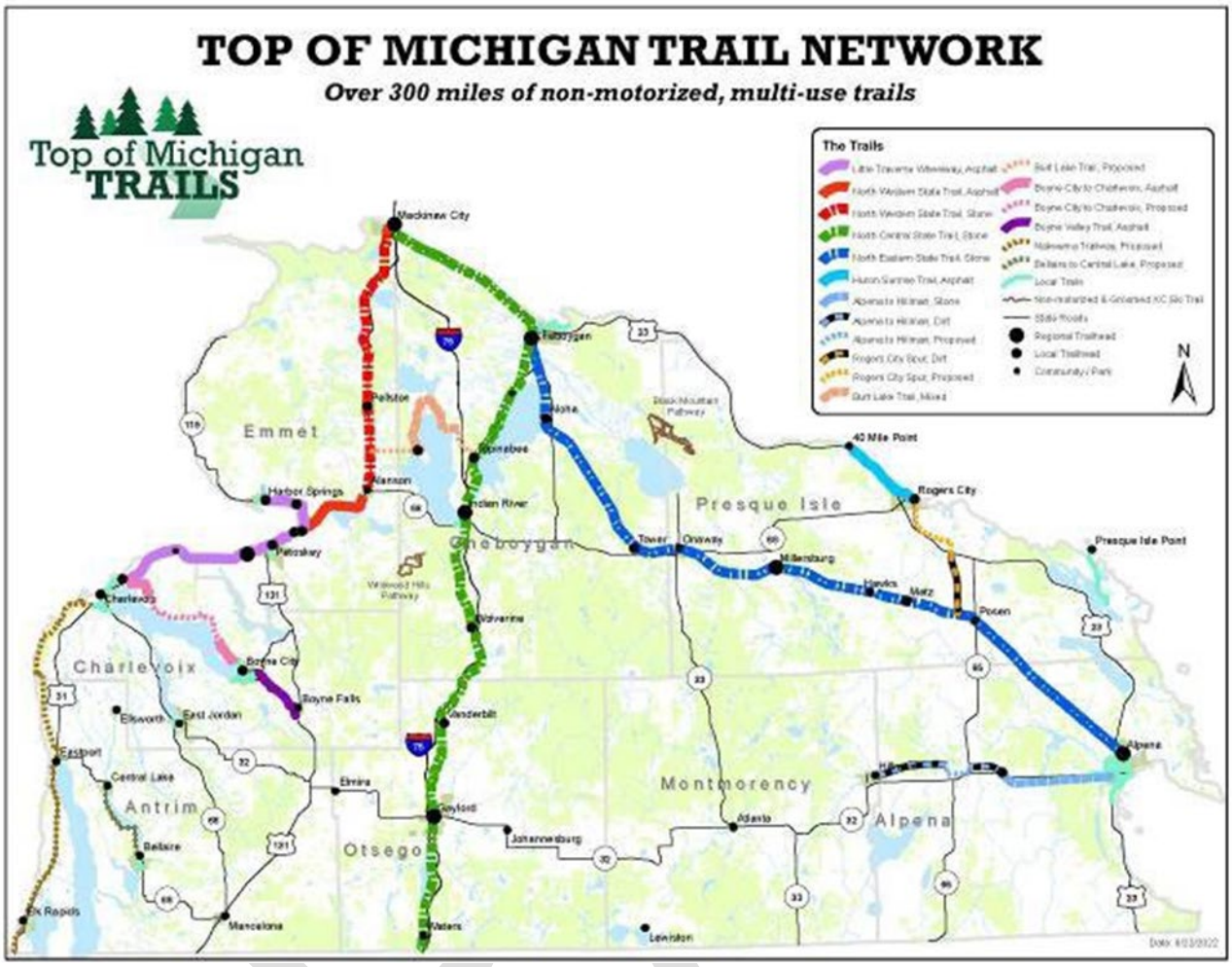
Figure 52. State and Primary Roads in Emmet County; ECRC Bridge Locations





Source: [ECRC 2023 Primary Road and Bridge Report]

Figure 53. Regional Non-Motorized Trail Network



Source: https://www.trailscouncil.org/wp-content/uploads/2022/10/TOMTC-2022-network.jpg

The cities of Petoskey and Harbor Springs and the Village of Mackinaw City are the only jurisdictions in Emmet County with public water systems. Limited areas within Little Traverse, West Traverse and Bear Creek townships are served by their neighboring municipalities. With much of Emmet County's population spread throughout rural areas, many individuals and businesses rely on private drinking water wells and septic systems.

Municipal sewage systems are provided in the more populated areas in the County.

The Harbor Springs Area Sewage Disposal Authority (HSASDA) encompasses a large service area. The Authority serves and is supported by the City of Harbor Springs, Little Traverse Township, Littlefield Township (the areas served are primarily located close to Crooked and Pickerel Lakes), and the Village of Alanson. The City of Harbor Springs has a 425 Agreement with West Traverse Township to serve the Glenn Beach portion of the township with utilities, public safety and other services.

The City of Harbor Springs has separate sanitary sewer and storm sewer systems. The storm sewer system collects runoff from rainstorms, while the sanitary sewer system collects and treats sewage from homes, businesses and other locations. Approximately 80% of the developed portion of the City is served by the HSASDA.

The City of Petoskey's DPW treats wastewater for customers within and near the city at its sewage treatment plant. The City is also the treatment contractor for the neighboring Springvale/Bear Creek Sewage Disposal Authority. With oversight and approval from EGLE, treated wastewater from the City's reclamation plant is

discharged into Lake Michigan and treated solids are taken to area farms and used as fertilizer. Growth pressures include demands from the Bay Harbor community and ongoing development activity in Bear Creek Township. The City of Petoskey and Resort Township have a 425 Agreement (a mutually beneficial agreement between two jurisdictions in lieu of annexation) that provides Bay Harbor with utilities and public safety services from the city. In 2018 the City's certified secondary-stage reclamation plant went through a $4 million upgrade for operational and energy efficiency improvements.

Petoskey's storm water system is crucial to ensuring water quality in the Bear River and Little Traverse Bay, and has an increased challenge given the City's topography and resulting high velocity of run-off as it reaches the bay. The City maintains approximately 150,000 lineal feet of storm sewer pipes. The system includes approximately 1,800 catch basins with sumps that trap debris and sediment entering the system before discharging into Lake Michigan and the Bear River via 25 outfalls. The basins are cleaned out on a two-year rotating basis. The three City retention/detention structures are maintained and the street sweeper cleans sediment from roadway gutter pans on a regular basis. Since 2008, the amount of road salt has been reduced by 50% to protect water quality without negatively impacting winter driving safety.

The Village of Mackinaw City has a sewage treatment facility operated by the Mackinaw City Water Department. The Village operates a design flow of 820,000 gallons per day from a modified lagoon treatment facility with aerators and a clarifier unit. Staff conducts daily sampling and testing to meet the Village's National Pollutant Discharge Elimination System permit requirements and also maintains the Village's eight sewer pumping stations. The Village of Mackinaw City has two 425 Agreements, one with Mackinaw Township in Cheboygan County and the other with Wawatam Township. Both agreements have been put in place to supply water and sewer services.

The Village of Mackinaw City also has a stormwater collection and drainage system for many of the Village streets. There are 16 outfall points, with four to Lake Michigan and 12 to Lake Huron. The Village has also utilized leaching basins in lieu of storm sewer for portions of the northeast residential streets.

Telecommunications services – including internet, cellular and landline phone services - are all provided by private companies throughout the County. The Emmet County 911 Call Center is located on 1694 US-131 in Bear Creek Township.

Previous Occurrences and Probability of Future Occurrences

As described previously in this plan in the section on coastal hazards – recession and shoreline flooding, a portion of the Little Traverse Wheelway collapsed in March 2020, due to a combination of high lake levels, wave action, and precipitation events. This section of the trail provided an important connection for local and regional trail users between the City of Petoskey and the City of Charlevoix. A temporary re-route of trail traffic has been created along a portion of US-31 until funds can be raised to reconstruct the missing portion of the trail.

The following events, as described previously in this plan in the section on riverine and urban flooding, resulted in flooding of culverts/roads from heavy rain events causing property damage in the County:

- On June 2, 2011, a flash flood occurred in Cross Village Township as the result of heavy rain. A culvert was washed out along Levering Road (C-66) a few miles east of Cross Village. Substantial soil erosion occurred in the yards of some homes.
- In September 3, 2022, heavy rainfall lead to significant erosion of the shoulder of M-119 in the City of Harbor Springs. A 24 hour rainfall total of 2.80 inches was measured 1 mile NNE of Harbor Springs at 9:30 AM EST with the majority of that falling in a 3 hour period that morning. M-119 (Bluff Dr) was closed at Harrison St due to significant erosion of shoulder of highway.

Additionally, during the planning process for this plan, stakeholders identified concerns regarding erosion along the bluff on the Lake Michigan side of M-119 in portions of Readmond Township (affecting the Sequoia Yacht Club homeowner's association properties near the community of Good Hart). Stormwater runoff along M-119 has caused washouts of the roadbed in areas and impacted some private property downslope of the bluff.

Due to the varying causes of multiple types of built infrastructure failure incidents, it is not possible to provide a probability estimate of how frequently an event may occur.

Extent
Infrastructure failures can occur anywhere, but urbanized areas may be more susceptible because they experience higher use volumes and additional wear and tear. Rural parts of the County may have fewer infrastructure networks, but greater geographic areas may be impacted during their failures. For example, a blocked rural road may affect significantly more square miles than a similar occurrence in a city, but ultimately fewer individuals and businesses are affected.

A bridge, trail, or culvert collapse can cause vehicle accidents, excessive streambank erosion, property damage, and a loss of economic productivity. If a main transportation route is disabled for an extended length of time until it is fixed, trail users and motorists cannot effectively use the route and may result in a reduction of economic benefits from their patronage of businesses along the route. Road closures would also increase drive times and emergency response times.

A failure of a municipal water or sewer system would affect persons in the more densely developed areas of the County, such as the cities of Harbor Springs and Petoskey, the Village of Mackinaw City, and parts of Bear Creek Township, Little Traverse Township and Littlefield Township. Sewer backups could damage buildings and water system operational failures could result in the distribution of portable potable water to residents. Overwhelmed or malfunctioning storm sewer systems could result in localized flooding and contamination of surface water.

Vulnerability Assessment
The entire county is susceptible to failures of various types of built infrastructure. Even though the county has a large amount of uninhabited areas, infrastructure does traverse these areas.

The potential for an incident is also associated with the age and condition of the infrastructure and the availability of funding for maintenance efforts.

There remain some parts of the county, particularly in the most rural areas, that are not covered by cell phone service due to topographic features and/or a lack of infrastructure. Businesses, residents, and visitors would not be able to reach out to family and friends, or call for emergency services if the existing communication infrastructure fails.

The Top of Michigan Trails Council is pursuing fundraising efforts for engineering plans to rebuild the collapsed portion of the Little Traverse Wheelway. The intent is to stabilize the slope along the original trail route and rebuild the trail in a simpler fashion that will be more resilient to lakeshore erosion and climate change. Instead of restoring the old railroad grade, the trail will be built at a lower grade that follows the topography while also addressing drainage from groundwater at the top of the slope. These simplifying concepts will eliminate points of potential failure and be cheaper to build.

Emmet County Road Commission's (ECRC) 2023 Primary Road and Bridge Report indicates that all of the bridges under Road Commission jurisdiction are currently in good or fair condition, and the goal is to maintain the system in the same condition. As such, other resources may be spent on improving other road structures in the County, such as upgrading some existing culverts to a bridge that would be part of the Pavement Surface Evaluation and Rating (PASER) inventoried system. Funding for these structure improvements would come from mostly outside funds, such as the Little Traverse Bay Bands of Odawa Indians, Conservation Resource Alliance, or the Michigan Transportation Fund, with some Road Commission participation.

All County paved primary roads are rated each year using the PASER system (seasonal roads are not included). The roads are rated on a scale of 1 to 10 according to surface conditions of the pavement.

Gravel roads are rated using the Inventory-Based Rating System for Gravel Roads (IBR). The IBR system considers three characteristics of a road segment to determine a rating for the segment: surface width, drainage adequacy and structural adequacy.

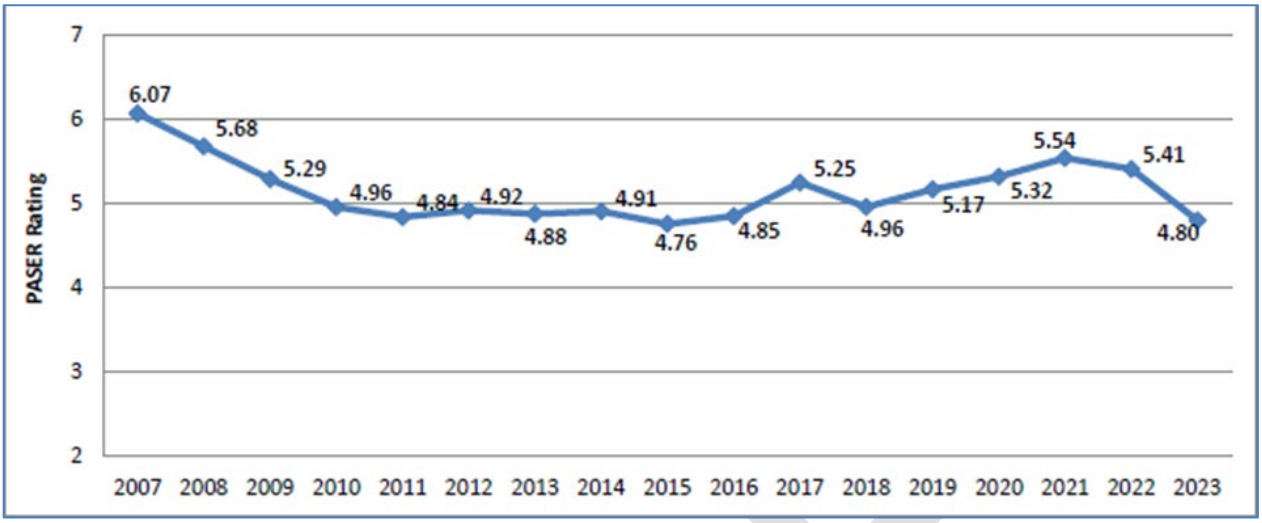
All of the County's primary roads are paved, with the exception of 2.47 miles of Larks Lake Road in Pleasantview Township (gravel, and rated as in good condition). One-third of the County's primary roads are rated as being in good condition, with 28% in fair condition and 39% in poor condition.

Figure 54. 2023 PASER Ratings for Emmet County's Primary Paved Roads

Source: ECRC 2023 Primary Road and Bridge Report

The average PASER ratings of primary roads in the County have generally declined over the years.

Figure 55. Average PASER Rating for Primary Roads in Emmet County, 2007-2023



Source: ECRC 2023 Primary Road and Bridge Report

The ECRC's 2023 report states that the Asset Management process concentrates resources on roads that are relatively easy to improve, then allows resources to be expended on more expensive improvement or repairs. Major road improvement projects are scheduled out in the report through the year 2026.

Built Infrastructure Failure: Dams

A dam is either man-made or constructed by wildlife, and controls the flow of water for agriculture, flood-control, artificial lakes, municipal water supplies, and energy generation. A dam failure occurs when an impoundment either collapses or fails which results in flash flooding downstream or water pouring over the top of the dam during a flood event. This failure may be due to poor operation, lack of maintenance, or vandalism of the dam. Dam failures can result in loss of life and extensive damage to property and natural resources since they occur unexpectedly.

FEMA has created guidelines that describe the approach and terminology used to classify dams, as explained in their *Federal Guidelines for Dam Safety: Hazard Potential Classification System for Dams (April 2004)*. The dam hazard potential classification system, as shown in Figure 56, was developed by the Interagency Committee on Dam Safety (ICODS) as part of the National Dam Safety Program. The system provides groups who manage dams a common way to understand and talk about the possible negative impacts to people and property downstream in the case a dam fails or is mis-operated. Although the system does not speak to the condition of the dam, it does reflect probable loss of human life and impacts on economic, environmental, and lifeline interests.

Figure 56. Dam Hazard Potential Classification System

DAM HAZARD POTENTIAL CLASSIFICATION	LOW HAZARD POTENTIAL	SIGNIFICANT HAZARD POTENTIAL	HIGH HAZARD POTENTIAL
LOSS OF HUMAN LIFE	None Expected	None Expected	Probable
ECONOMIC LOSSES	Low and generally limited to owner	Yes	Yes *(but not necessary for this classification)*
ENVIRONMENTAL DAMAGES	Low and generally limited to owner	Yes	Yes *(but not necessary for this classification)*
LIFELINE INTERESTS IMPACTED	No	Yes	Yes *(but not necessary for this classification)*

Source: National Inventory of Dams

EGLE's Dam Safety Program is responsible for ensuring the safety of Michigan's state regulated dams, which are owned by both public and private entities. The program focuses on ensuring that dams are properly constructed, inspected and maintained, and that the owners have adequately prepared for potential emergencies.

There are 2,500 dams in Michigan with 813 regulated by Part 307, Inland Lake Levels, and 235 regulated by Part 315, Dam Safety of The Natural Resources and Environmental Protection Act, 1994 PA 451, as amended.

The dams regulated by Part 307 have a court issued order that establishes the level at which the lake is to be maintained; while the dams regulated by Part 315 are over 6 feet in height and over 5 acres are impounded during the design flood.

Part 315 requires EGLE staff to determine the hazard potential classification for each dam according to the potential downstream impact the dam would have if it failed and to establish an inspection schedule. Dam inspections are required every three to five years for state regulated dams based on their hazard potential rating. For dams classified with a high or significant hazard potential, dam owners are required to prepare and maintain emergency action plans. Additionally, owners are required to have the local emergency management coordinators

review the plans for consistency with local emergency operations plans before the owners submit the emergency action plan to EGLE.

Location
EGLE's Michigan Dam inventory indicates there are 15 dams in Emmet County (Table 70). Fourteen of the fifteen dams have a "low" downstream hazard potential rating; the Windward Dam in West Traverse Township has a "significant" hazard potential rating. None of the dams in the county are required to have an Emergency Action Plan on file. Additionally, there are no federally-regulated hydroelectric dams in Emmet County.

The Maple River Dam (also known as the Lake Kathleen Dam) was a former low hazard dam in Maple River Township that had a poor condition assessment rating. The dam was built in 1884 as part of a hydroelectric plant. In 2014, it nearly failed due to high water levels and was dismantled in 2019. The Maple River now runs unobstructed and potential flood risk has been significantly reduced with the removal of the dam.

The US Army Corps of Engineers (USACE) owns the Crooked River Lock (Crooked Lake Dam) in Alanson and leases the facility to the Department of Natural Resources (DNR). Emmet County Parks and Recreation Department operates the Lock with a sub-lease through the DNR in order to raise and maintain the water level of Pickerel Lake and Crooked Lake, which had dropped considerably after completion of dredging in the mid-1950s. In 2023, the USACE closed the lock for the remainder of the season to perform critical maintenance – namely, replacement and repair of the electrical safety relay and an inspection of the lock to determine additional future maintenance funding requirements.

Extent
Depending on the land uses downstream, a flood event due to a dam failure could prevent access to buildings, carry people and vehicles away, cause businesses to lose their businesses and inventories, and residents to lose their houses and belongings. Buildings in the flood zone would be damaged, destroyed, and compromised, and would develop mold, rot, and foundation damage from floodwaters. The presence of mold would increase the health risk for populations with breathing conditions. Floodwaters may damage roads, bridges, electrical systems, communication systems, overflow sewers, and impact natural gas tanks where they are at-risk for fire or explosions. Roads may be closed for long periods of time, which would impact traffic flow, economic productivity, and emergency response times.

Floodwaters also can conceal damaged electrical wires and debris. Contaminants and pollutants in the floodwaters can degrade watersheds, and increase the population's risk for diseases, infections, and injuries.

Additionally, surface water quality and aquatic habitat downstream of the dam break would be negatively impacted when inundated by large volumes of water, debris, and sediment.

Previous Occurrences and Probability of Future Occurrences
Emmet County has not had any previous reported dam failures. According to the National Inventory of Dams and the Michigan Dam Inventory, Emmet County has thirteen dams with an average age of 75 years (Table 70; two of the dams did not have construction dates listed). The oldest dams are the Lake Street Dam and Flume in Petoskey (129 years); the Five Mile Creek Dam in West Traverse Township (114 years); the Ottawa Trout Ponds #1 and #3 in Maple River Township (104 years); and the French Farm Lake Dam in Wawatam Township (75 years).

Based on the aging infrastructure of many of the dams, there is a potential for a dam failure. Proper dam maintenance procedures may be able to predict and prevent the possibility of a future event. However, these older dams have a low hazard potential and are not required to have an emergency action plan. If they were to fail, there would be no expected loss of human life or impact to lifeline interests (critical infrastructure/services), and economic losses and environmental damages would be low.

Vulnerability Assessment

In 2020, the Tip of the Mitt Watershed Council (TOTMWC), in partnership with the City of Petoskey and with funding from the Great Lakes Fishery Trust, contracted OHM Advisors to conduct a study of engineering alternatives for long-term management of the Lake Street Dam. An inspection of the dam in June 2018 identified some needed repair and maintenance work, but no structural deficiencies that would lead to the immediate failure of the dam. Since the dam is aging and will require maintenance and repair in the future, the TOTMWC and the City are interested in removal of the dam based on community and stakeholder preferences. Dam removal may improve fisheries, reduce ownership costs, increase public safety, and reduce liabilities.

The 2020 study provides alternatives to keeping and maintaining the existing dam: partial removal/modification, or complete removal of the dam. Modification or partial removal design alternatives include partially removing the dam to create a low-head, fixed-crest weir, or modifying the dam to create a low-head, adjustable-crest weir. Either alternative may be combined with a trap-and-sort fishway, but the adjustable-crest weir may allow some additional fish passage during periods outside the lamprey spring migration period of April to June without an additional fishway structure. [26]

The City of Petoskey's 2024-2029 Capital Improvements Plan includes implementation of the chosen alternative from the 2020 engineering study for the Lake Street Dam, intended for the year 2029. The project will be funded from the City's operating revenue budget; the estimated amount for the project is yet to be determined.

Table 70. Dams in Emmet County

	West Traverse Twp.				City of Petoskey	Alanson Village	Maple River Twp.	
Dam Name	Windward Dam	Birchwood Farms Dam	Birchwood Farms #2 Dam	Five Mile Creek Dam	Lake Street Dam And Flume	Crooked Lake Dam	Ottawa Trout Pond #1 Dam	Ottawa Trout Pond # 3 Dam
Other Dam Names				Mill Pond Dam			Pond #1 Dam	Pond #3 Dam
Pond Name						Crooked Lake		
Downstream Hazard Potential	Significant	Low	Low	Low	Low	Low	Low	Low
Emergency Action Plan	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required
Owner Type	Private	Private	Private	Private	Local Government	Private	Private	Private
Owner Name	Windward Development Company	Birchwood Poa	Bill Cottrill	James Smith*	City of Petoskey	U S Government (USACE)	Gordon Bennet	Gordon Bennet
Inspector	MDNR	Bryan Nolan, Bidstrup & Young	MDNR	None	None	None	MDNR	MDNR
Regulatory Authority	Inventory	Part 315	Inventory	Failed	Inventory	Inventory	Inventory	Inventory
Inspection Date	6/14/1990	5/1/2000	8/4/1977	1/1/1901	1/1/1901	1/1/1901	4/20/1989	4/20/1989
Condition Assessment	Not Rated	Satisfactory	Not Rated	Not Rated	Not Rated	Not Rated	Not Rated	Not Rated
Condition Assessment Detail	Not under state jurisdiction	Meets applicable tolerable risk criteria	Not under state jurisdiction	Not under state jurisdiction	Not under state jurisdiction	Not under state jurisdiction	Not under state jurisdiction	Not under state jurisdiction
Inspection Frequency								
Next Inspection		12/31/2020						

[26] https://portal.glft.org/projects/1867 Healing the Bear: Engineering Alternatives for the Lake Street Dam

	West Traverse Twp.				City of Petoskey	Alanson Village	Maple River Twp.	
Report Date	6/19/1990	7/6/2000					4/28/1989	4/26/1989
Year Completed	1989	1977	1977	1910	1895	1967	1920	1920
Dam Type	Earth	Earth	Earth	Earth	Gravity	Gravity	Earth	Earth
Purposes	Recreation	Other		Other	Retired Hydro	Other	Recreation	Recreation
River	Tributary to Lake Michigan			Five Mile Creek	Bear River	Crooked River	Tributary to Crooked River	Tributary to Crooked River
Spillway Type	Uncontrolled	Uncontrolled	Uncontrolled	Controlled	Uncontrolled		Uncontrolled	Uncontrolled
Public Access	No	No	No	No	No	No	No	No
Trout Stream	No						Yes	Yes
Fish Passage	No	No	No	No	No	No	No	No
Lamprey Barrier	No						No	No

	Springvale Twp.	Bliss Twp.		Cross Village Twp.	Carp Lake Twp.	Wawatam Twp.	
Dam Name	Starks Mill Dam	O'Neal Lake Dam	Goose Pond Dam	Wycamp Lake Dam	Paradise Lake Dam	French Farm Lake Dam	Carp Lake River Lamprey Barrier
Other Dam Names		O'Neal Dam			Carp Lake	French Lake Dam	
Pond Name	Silver Creek Pond	O'Neal Lake	Canada Goose Pond	Wycamp Lake	Lake Paradise	French Farm Lake Flooding	
Downstream Hazard Potential	Low	Low	Low	Low	Low	Low	Low
Emergency Action Plan	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required
Owner Type	Private	State	State	Private	Private	State	Private
Owner Name	George Stark	MDNR Parks & Recreation	MDNR Parks & Recreation	Emmet County Dran Commissioner	Unknown	MDNR Wildlife	Great Lakes Fishery Commission
Inspector	None	MDEQ Pawloski	MDEQ Pawloski	Richard Bidstrup	MDNR	Michael Size	
Regulatory Authority	Inventory	Part 315/ MOU	MOU	Part 307	Inventory	Part 315/ MOU	Inventory
Inspection Date	1/1/1901	10/12/2011	6/26/2001	5/21/1997	4/20/1989	6/24/2021	
Condition Assessment	Not Rated	Unsatisfactory	Satisfactory	Not Rated	Not Rated	Satisfactory	Not Rated
Condition Assessment Detail	Not under state jurisdiction		Meets applicable tolerable risk criteria	Other	Not under state jurisdiction	Meets applicable tolerable risk criteria	Not under state jurisdiction
Inspection Frequency						5 Years	
Next Inspection		12/31/2022	12/31/2006	12/31/2000		12/31/2026	
Report Date		11/3/2011	9/6/2001	6/3/1997	4/26/1989	12/20/2021	
Year Completed	1951	1954	1966	1961		1949	
Dam Type	Earth Gravity	Earth Gravity	Earth	Earth	Gravity	Earth	

	Springvale Twp.	Bliss Twp.		Cross Village Twp.	Carp Lake Twp.	Wawatam Twp.	
Purposes	Other	Recreation	Recreation	Other	Other	Recreation	
River	Silver Creek	Big Sucker Creek	Big Stone Creek	Camp Creek	Carp River	French Farm Creek	Carp Lake River
Spillway Type	Controlled	Uncontrolled	Uncontrolled	Uncontrolled		Controlled	
Public Access	No	No	No	Yes	No	No	Yes
Trout Stream		Yes	Yes			Yes	No
Fish Passage	No	No	No	No	No	No	Yes
Lamprey Barrier			Yes			Yes	Yes

National Inventory of Dams; EGLE Michigan Dam Inventory
* Current owner is Little Traverse Conservancy, Inc.

Energy Failures and Shortages (electric, natural gas, petroleum)

A lack or shortage of electric power, natural gas, fuel oil, propane, or gasoline of a sufficient magnitude and duration can threaten public safety, technological capabilities, or economic stability. A reliable and adequate energy supply is critical to economic and social well-being, and the United States has become accustomed to uninterrupted and relatively inexpensive power. Transient energy disruptions caused by weather damage (downed power lines) or temporary shortages (brownouts) have a relatively small impact, but even minor inconveniences have become more problematic as society's dependence on technology grows. Beyond energy related infrastructure failures, the inadequate supply of fuel itself can also create a hazard.

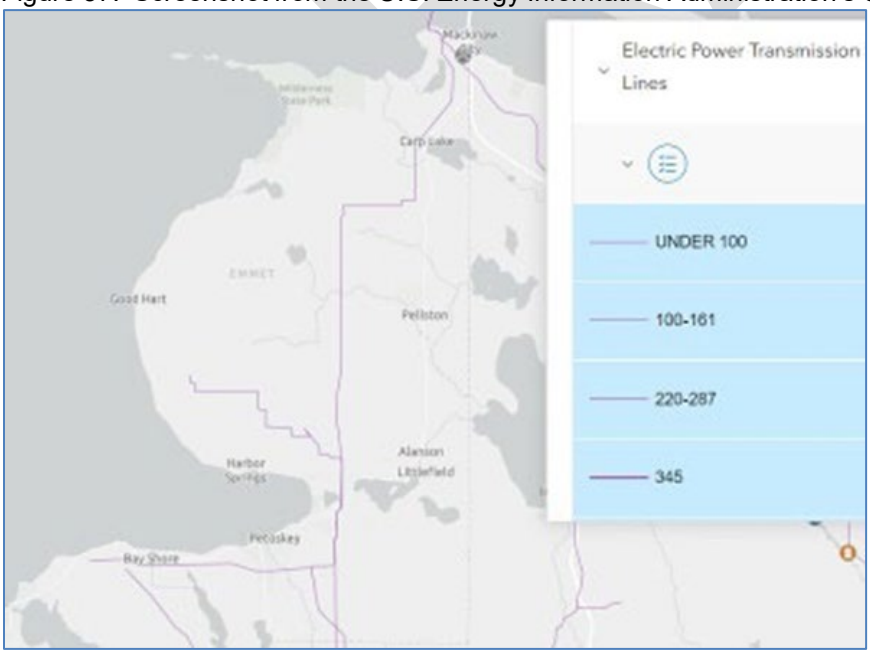
There are, in general, four types of energy emergencies. The first involves the physical failures of energy production or distribution facilities due to aged or faulty equipment, poor maintenance, or employee accidents. The second involves exogenous factors, such as severe storms, cyberattacks, or other sabotage. Michigan has experienced several storm related disruptions in particular, mostly due to high winds or damage caused by ice. The third type of emergency involves a sharp and sudden escalation in energy prices, often by market manipulation or a reduction in oil supplies. The fourth to consider is a surge in demand caused by war and involving the mass mobilization of prioritized U.S. defense forces.

Michigan utilizes a diverse mix of energy, including from nuclear power, coal, wind, solar, hydroelectric, wood, natural gas, propane, and petroleum. State generation and storage capacity exhibit various strengths and weaknesses with, for example, Michigan having the largest natural gas storage capacity in the country. At the same time, crude oil reserves and production are extremely modest.

Electric generation varies greatly by region, although the nature of modern electric grids means that energy created in one corner of the state (or outside of it) can be widely used elsewhere, most generally within a specific Independent System Operator (ISO) region. Michigan resides almost entirely within the Midcontinent Independent System Operator (MISO) region (some southwest areas of the state are part of the PJM Interconnection LLC). These organizations work together during emergencies to adjust generation and balance loads.

Location
The main electric power grid distribution lines in the county, along with the electric-generating wind turbines in the Village of Mackinaw City, are illustrated in the Figure 57. Aside from the electric generating wind turbines, there are no other electric generation facilities located in Emmet County.

Figure 57. Screenshot from the U.S. Energy Information Administration's U.S. Energy Atlas



Source: https://atlas.eia.gov/

The Michigan Public Power Agency is a non-profit, customer-owned joint power supply agency. The cities of Petoskey and Harbor Springs participate in this joint ownership of electrical generating plants and transmission facilities as well as the pooling of utility resources. They are the only municipalities in Emmet County that distribute electricity as a utility. The City of Harbor Springs' electric system also serves, West Traverse and Little Traverse Townships, along with the community associations of Harbor Point, Roaring Brook and Wequestonsing.

The remaining portion of the population in the County relies on Great Lakes Energy and Consumers Energy to meet their electrical needs. In order to better facilitate future growth and reliable service in Emmet County, new lines and substations may need to be installed.

Although the Village of Mackinaw City does not operate an electrical distribution system, it does help in the generation of power. Taking advantage of the traditionally strong winds coming off the lake, in 2001 two wind turbine generators were installed in the Village at the Wastewater Treatment Plant. The turbines are privately owned and utilize a land lease from the Village. Together they generate enough electricity to power about 600 homes for a year. The power generated by the turbines is sold to Consumers Power Company and distributed to customers throughout Michigan.

Natural gas service is provided by DTE Gas Company to certain communities (mostly the urbanized areas) in the County. Propane gas or home heating oil delivery service is available to areas without access to natural gas.[27]

The locations of natural gas and petroleum pipelines were described in the section in this plan pertaining to oil and gas accidents.

Previous Occurrences and Probability of Future Occurrences

Electric power service outages, lasting from a few hours to several days, occasionally occur in the County, and are usually caused by severe weather events with conditions such as high winds, lightning strikes, heavy snow, ice, or extreme temperatures. In 2022 CCE911 reported 149 instances of downed electrical lines; however, there is no documentation of the cause and location of those incidents.

The following are historic statewide or national energy shortage or failure events that have affected Emmet County.

- October 1973 – March 1974 – Entire United States – Middle East (OPEC) Oil Embargo. In October 1973, the Organization of Petroleum Exporting Countries (OPEC)—a Middle East oil cartel composed of most of the world's major oil producing countries—halted the flow of oil to the United States in retaliation for U.S. support of Israel in the 1973 Arab-Israeli War. From October 1973 – March 1974, OPEC maintained an embargo on oil imports to the United States and other Western nations that supported Israel, causing gasoline shortages and inflated oil prices. The embargo had a particularly negative effect on the U.S. economy and was one of the primary causative factors of the economic recession that plagued the country from 1973–1975.
- Winter of 1976-77 – Entire United States – National Energy Emergency (declared). A natural gas shortage during the bitter winter of 1976-77 forced President Carter to proclaim a national energy emergency on February 2, 1977.
- 1979 – 1980 – Entire United States – Oil Price Increases. In 1979, the "Iranian Revolution" reduced world oil production. OPEC announced a 14.5 percent increase in oil prices, and by June 1979, OPEC again raised the average price of a barrel of oil by more than 50 percent. This forced the price of gasoline and fuel oil for American consumers to skyrocket, creating panic conditions in many parts of the country and causing a nationwide strike by independent truckers. The energy price increases resulted in long lines at gasoline stations, higher inflation, and signaled a reaffirmation of America's energy vulnerability. During this time, federal price and allocation controls moderated the price increases and caused oil companies to allocate supply. For a period of several months, customers were only able to purchase 70–80 percent of their historical amounts. Under the federal allocation program, states had the authority to direct up to three percent of the monthly gasoline supply to meet the needs of priority users, such as police, fire, and emergency medical services, in addition to other emergency hardship needs. The State of Michigan redirected over 100 million gallons of gasoline, heating oil, and diesel fuel. The peak of the supply shortfall occurred in May 1979. The combination of higher price levels set by OPEC and the American oil companies caused gasoline and fuel oil prices to nearly double. The start of war between Iran and Iraq in 1980 further boosted oil prices. By the end of 1980, the price of crude oil stood at 19 times what it had been just ten years earlier.

[27] https://utilitysearch.apps.lara.state.mi.us/search

- 1999 – 2000 – Northeastern United States – Home Heating Oil Shortage. In mid-January 2000, a combination of adverse weather conditions, low heating oil inventories, natural gas capacity and delivery constraints, and production problems created rapid price increases in fuel oil and natural gas markets in the Northeast United States. When colder weather hit, consumers increased their demand for home heating oil and natural gas, and prices rose significantly. The temperature changes increased weekly heating requirements by about 40 percent. Because fuel oil stocks were below normal levels, available supplies were limited, and prices responded sharply to the increase in demand. The surge in home heating oil prices lasted for approximately four weeks and then subsided. However, the level and duration of the price increase prompted the President to ask the Secretary of Energy to examine opportunities for converting factories and major users from oil to other fuels, helping to free up oil supplies for use in heating homes. Michigan also saw increased prices, as supply was pulled from the Midwest in response to the higher prices in the Northeast.
- December 2000 – State of Michigan – Propane Supply Problems. Propane supplies were tight and inventories low going into the winter, with Midwest inventories in mid-October 44 percent below their levels a year earlier. The state then experienced record cold weather. Heating degree days showed that temperatures were 27 degrees colder than normal—the second coldest December on record and the snowiest on record. The propane industry found it increasingly difficult to keep up with deliveries. In response to the situation and industry requests, the chair of the Michigan Public Service Commission, in consultation with the Michigan State Police, Emergency Management and Homeland Security Division, requested a 10-day waiver of limits on driver hour restrictions from the regional administrator of the Federal Motor Carrier Safety Administration. The waiver was granted. The extremely tight supply, coupled with additional demand to use propane as a substitute for natural gas (which also had a sharp run-up in prices), caused residential propane prices to reach a record high in Michigan of $1.76 per gallon in January 2001 before declining to $1.00 per gallon by the end of the heating season. A significant warming trend in January allowed the industry time to replace seriously depleted supplies, helping to partially alleviate the situation.
- August 2005 – State of Michigan – Petroleum Product Supply Problems. On August 31, 2005, Governor Granholm issued three executive orders to address the energy-related issues in Michigan caused by Hurricane Katrina. The massive hurricane had blocked off oil refineries stationed in Louisiana and affected the supply in Michigan. Executive Order 2005-16 declared a State of Energy Emergency in accordance with 1982 PA 191. Executive Order 2005-17 temporarily waived regulations relating to motor carriers and drivers transporting gasoline, diesel fuel, and jet fuel. Executive Order 2005-18 provided for a temporary suspension of rules for gasoline vapor pressure. The State of Energy Emergency was in effect until November 29, 2005.
- Winter of 2005–2006 – United States – Natural Gas Price Increases. During the winter of 2005–2006, Michigan saw record-high natural gas prices. Eighty percent of Michigan homes rely on natural gas as their primary heating source, and Michigan's average monthly residential heating bill from November to March increased from $128 a month the previous winter to $180 during 2005 and 2006. The reason for the high prices was largely due to both the lingering effects of Hurricane Ivan in 2004 and Hurricanes Katrina and Rita in 2005. Substantial disruption of natural gas production in the Gulf of Mexico had reduced supply, driving up prices. There was further uncertainty about the prospect of even higher prices, depending on how long it might take to return natural gas production from the Gulf of Mexico to normal levels. Fortunately, prices did go down, averaging $152 a month for the 2006–2007 winter and the 2007–2008 winter.
- 2008 – United States – Oil Price Increases. Crude oil prices began to steadily increase over a series of years. Prices rose above $30 a barrel in the peak summer months of 2003, reaching $60 a barrel in 2005 due in part to refineries damaged by hurricane. Deferred maintenance on the refineries to make up for production down time then resulted in accidents and fires that disrupted supplies years later. By March of 2008, prices were at $80 a barrel, then $100 in May, and finally peaking at $147 a barrel in July. The increase led to gasoline prices of over $4 a gallon during the summer. Commentators attributed the problem to many factors, including high demand, the decline in petroleum reserves, Middle East tension, and oil market speculation. The situation was exacerbated by Hurricane Ike in September, but prices eventually declined to under $40 a barrel by November 2008.
- Winter of 2008–2009 – United States – Natural Gas Price Increases. During the winter of 2008 and 2009, Michigan saw nearly record high natural gas prices, like those of the 2005–2006 winter. State regulators attributed higher heating costs to the increased price of crude oil. Regulators said Michigan fared better than other states because Michigan stores some natural gas in underground tanks. The economic recession's higher unemployment rate, combined with higher heating costs, caused utility companies to shut off more power or natural gas because of unpaid bills. The number of gas shutoffs were up 39 percent in Michigan.
- December 2013 – Statewide – Electrical Power Infrastructure Failure. A massive ice storm hit Michigan shortly before Christmas, knocking out power to approximately 380,700 homes and businesses, some of whom were then without power for up to a week and a half. The outages came in waves, with the first hitting on the night of the storm and others following later on, as ice weighed down tree branches and power lines which then broke. Consumers Energy, DTE Energy, and the Lansing Board of Water and Light were the hardest hit companies. Additional snow and frigid temperatures continued throughout repairs.
- Winter 2013–2014 – Statewide – Propane Shortages. Michigan residents struggled with propane shortages during a period of extreme cold, with average prices more than doubling. The problem was exacerbated by: (1) farmers' use of more propane to dry grain crops following a wet, late harvest season during the fall, (2) pipeline disruptions and

shutdowns, and (3) a rail closure in Canada. Heavy snowfall also made it difficult for propane delivery drivers who were forced to spend more time on the roads. Governor Snyder declared an energy emergency, which in part suspended state and federal regulations on the number of hours and consecutive days the drivers could operate. The U.S. Department of Transportation similarly declared an emergency and relaxed transportation rules until the emergency was over. The Michigan Department of Natural Resources offered a program for firewood permits, not typically sold during the winter. Other state-level efforts included $7 million in Michigan Energy Assistance Program (MEAP) funds devoted to deliverable fuel heating assistance, as well as $7 million in Low Income Heating and Energy Assistance Program (LIHEAP) assistance.

Due to the varying causes of multiple types of energy failure or shortage incidents, it is not possible to provide a probability estimate of how frequently an event may occur. However, the potential for a major energy shortage or failure in Emmet County always remains a future possibility. Economic and political conditions and severe weather incidents are considered factors that would increase the likelihood of such an event.

Extent

The public relies heavily on energy to power their homes and vehicles, and even short outages can cause mass disruption. Health impacts can be extensive, depending on length of the energy emergency, associated temperature extremes, and other conditions. The loss of Internet during blackouts in today's modern world can be profound. Chilled food storage can be compromised, and water wells without backup power will be inoperable. A failure of electric power systems may cause severe problems for persons who rely on medical equipment for their very survival, or for the maintenance of good health.

A properly functioning power supply is also essential to maintain the safety of citizens who are working, traveling, attending to domestic matters, or involved in certain types of recreational activities. A sudden power failure may cause: (1) traffic lights to stop functioning, (2) traffic patterns to slow dramatically (resulting in traffic jams and delays in emergency response capabilities), (3) interference with important communication networks and needed machinery (including other important infrastructure, such as sewer lift stations and hospital equipment), or (4) sudden darkness when vital operations are taking place or dangerous activities are being performed as a part of people's ordinary occupations and activities. Food storage and safety relies heavily on an ongoing supply of electrical power. Community events, business operations, and tourist attractions are similarly reliant upon electrical infrastructure. More people would be impacted by an energy failure in the summer months in Emmet County, with the influx of seasonal visitors and residents.

Without adequate heating fuel/electricity in temperatures below freezing, water in a structure's plumbing system can burst and cause property damages. An increased structure fire risk from overload or faulty energy infrastructure is also possible. Facilities that cannot be adequately heated or cooled may be closed to the public. In some cases, energy emergencies may delay necessary infrastructure maintenance. The costs of asphalt in particular correlates heavily with the price of oil and may result in delayed road building or the need for other construction methods.

Energy emergencies cause significant financial impacts to the general public, either directly (high prices for energy sometimes associated with an emergency), or indirectly (cost of burst pipes, spoiled food, hotel rooms, etc.). The cost of manufacturing and other business-oriented downtime can be substantial. Energy cost and reliability is one factor that companies consider when looking to locate in an area.

Vulnerability Analysis

In Emmet County, much of the electrical system consists of above ground power transmission lines, which are more susceptible to damage from storms or accidental impacts. Damage to these lines would cause a power outage over a large area since the county is mostly rural in nature. Maintaining regular tree/brush trimming in the powerline corridors is a key preventative measure towards reducing the risk of power outages.

The time of year is also a factor in the magnitude of impact from a power outage; winter would require heating stations to be set up and summer would require cooling stations to be set up; and the "year-round" population of the County more than doubles in the summer months.

Generally, the elderly, children, impoverished individuals, and people in poor health are most impacted by energy infrastructure failures. For example, people without air conditioning, reliable transportation, or a home power generator, or those living in substandard housing conditions will have more difficulty getting through a power failure in extreme heat or cold conditions. Residents with medical issues may require backup emergency power generators to run health equipment machines or refrigerate medicine. A power outage during extreme heat and cold events has the potential to cause a person to suffer from heat stroke, hypothermia, frostbite, or death.

The County, similar to the others in the region, has been experiencing an aging population trend for the last few decades. US Census from the 2020 decennial census indicates that 20.5% of the county's population is aged 19 and under, and 24.6% of the population is 65 years and older, with a median age 45.7 of years. American Community Survey 5-Year Estimates from 2022 indicate that 12.8% of the county's population has one or more type of disability (such as hearing, vision, cognitive, ambulatory, self-care, or independent living); and 25.5% of those aged 65 or older have one or more type of disability. Additionally, an estimated 9% of the County's households live below the federal poverty level, and 25% are considered ALICE.

Select Existing Programs and Resources

The federal government has put into place significant legislative and programmatic infrastructure to address energy emergencies, frequently operated in conjunction with the states and other entities. The Michigan Public Service Commission (MPSC) is the state's lead agency.

Emmet County uses the BeAlert public notification system, which can inform the public about emergency situations. The County has four emergency shelter sites with generators that can be opened to the public in the event of an energy failure or shortage: The County Fairgrounds in Petoskey; the Odawa Casino and Odawa Hotel in Bear Creek Township, and the Village of Mackinaw City's Recreation Center.

The Environmental Stewardship chapter of the City of Petoskey's Master Plan provides information on how the City is reducing energy demand, while increasing its use and promotion of alternative energy sources. Also, for many years the City has been working to place the electric distribution system underground, with 70 percent completed in 2019. In addition to the aesthetic benefits of removing poles and wires, this is an important investment in system reliability to decrease outages during wind and ice storms. The July 18, 2020 storm event that downed hundreds of trees did not result in power outages where the distribution system was underground. In addition, the absence of overhead wires improve the resiliency of the city's street tree canopy.

Per the City of Harbor Springs' 2022 Master Plan, the City has recognized the demands, acceptance, and the plausibility of adopting the benefits of renewable energy. In June 2019, community leaders adopted the option of Net Metering for their electricity consumers in the amount of 20kw per residential unit. The City and the Harbor Springs Area Sewage Disposal Authority (HSASDA) have discussed increasing their reliance on renewable energy, recommending that the MPPA investigate sources of renewable energy and thus increase the percent of renewable energy distributed to the City's energy users. Likewise, the HSASDA is currently evaluating the feasibility of a solar array project on a vacant HSASDA property parcel.

The City now allows electric customers who have (or want) solar panels, geothermal or other renewable energy generator systems on their properties to connect to the City's grid. Net metering gives customers the opportunity to offset a substantial portion of the cost of power drawn from the City's utility. The City is currently only allowing customers to install generating equipment that is not expected to exceed the annual peak demand of the load that the customer is off-setting (averaged over the previous five years), or a total output of 20 kW, whichever is smaller. The customer is compensated at retail rate on their next bill for any excess energy generated.

Over 20% of the energy provided to City of Harbor Springs Electric customers is generated from renewable sources. Customers may elect to pay an added charge and receive a higher percentage of power from renewable sources. Those customers who elect to have 50% or more of their energy come from renewable sources do not have to pay the monthly energy optimization plan surcharge.

Great Lakes Energy also provides opportunities for electric customers to participate in renewable energy programs. Consumers Energy is planning on offering a "renewable solutions" program to its customers in 2025.

HUMAN-RELATED HAZARDS

- Public Health Emergencies (contagions, food and water contamination)
- Cyberattack and Major Network Disruptions
- Terrorism and Similar Critical Activities
- Civil Disturbances
- Nuclear Attack (military, terrorist)

Human-related hazards can also be frequently viewed as human-caused hazards. They may overlap with components of technological hazards and even natural hazards.

*Note: Information used in the descriptions of the hazards in this section of the plan were largely sourced from the Michigan State Police's *2020 Michigan Hazard Analysis – a Supplement to the 2019 Michigan Hazard Analysis*.

Public Health Emergencies

Public health emergencies occur when there is a widespread and/or severe epidemic, contamination incident, bioterrorist attacks, or other situation that negatively impacts the health and welfare of the public. These emergencies include disease epidemics, food or water contamination incidents, extended periods without adequate water and sewer services, harmful exposure to chemical, radiological or biological agents, and large- scale infestations of disease-carrying insects or rodents. A common characteristic of public health emergencies is that they impact or have the potential to impact a large number of people either statewide, regionally, or locally in scope and magnitude. These health emergencies can occur as primary events or as secondary events from another hazard or emergency (e.g. flood, tornado, or hazardous material incident).

Location

A public health emergency can be a worldwide, national, state or regional event that is not confined to geographic boundaries and range in severity across the affected areas. All persons in Emmet County are at risk from the occurrence and impacts from an infectious disease. Depending on the type of disease, different populations are more susceptible.

There are a variety of sources that contribute bacteria (such as Escherichia coli, or E. coli) and other pathogens to the surface water. These sources include illicit waste connections to storm sewers or roadside ditches, failing septic systems, combined and sanitary sewer overflows, storm (rain) runoff, wild or domestic animal waste, and agriculture runoff. Most strains of the E. coli bacteria are not dangerous, but they can indicate the presence of other disease-causing bacteria. E. coli bacteria do not survive long in water. Factors such as wind and wave action, as well as ultraviolet light from the sun help to reduce the level of bacteria. The amount of time needed to reduce bacteria levels can be unpredictable, however it usually takes less than 48 hours. Additionally, bacteria contamination originates from conditions or factors present on or near the shore. Two beaches on opposite ends of a lake that have different on-shore conditions will not have the same bacteria levels.

The beaches along Lake Michigan and many inland lakes are essential to Emmet County's summer tourism economy. The Health Department of Northwest Michigan (HDNW) conducts a beach monitoring program that has been successful in protecting public health and supporting the economic benefits of having clean, safe swimming areas. County health departments are required by law to take a minimum of three samples each time a beach area is monitored. The daily geometric mean of these three samples must be below 300 E. coli per 100 milliliters (ml) of water for the water to be considered safe for swimming. During the summer months, HDNW sends out public beach advisories if a sample comes back with bacteria higher than is safe for partial or full body contact. Updates are also provided when a sample shows the bacteria level has returned to a safe level. In Emmet County, HDNW provides beach monitoring for eleven public beaches (Table 71).

Table 71. HDNW Public Beach Monitoring Sites in Emmet County

Beach Name	Waterbody	Location
Mackinaw Beaches 1 and 2	Cecil Bay (Lake MI)	Wawatam Township; Owned and operated by Village of Mackinaw City
Wilderness State Park	Big Stone Bay (Lake MI)	Bliss Township
Sturgeon Bay	Sturgeon Bay (Lake MI)	Bliss Township
Cross Village Beach	Lake MI	Cross Village Township
Middle Village Park	Lake MI	Readmond Township
Zorn Park	Little Traverse Bay (Lake MI)	City of Harbor Springs
Petoskey State Park	Little Traverse Bay (Lake MI)	Bear Creek Township
Oden (Littlefield Township Park)	Crooked Lake	Littlefield Township
Little Traverse Township Park	Crooked Lake	Little Traverse Township
Camp Petosega	Pickerel Lake	Springvale Township

Extent

The extent of a public health emergency can be determined by the number of cases and deaths, and the amount of money spent to prepare for and respond to public health threats. In Emmet County, the Health Department of Northwest Michigan works with local, state, and federal agencies to prepare for and respond to public health threats. The Michigan Department of Health and Human Services (MDHHS) reports [28] that between March 1, 2020 and December 26, 2023, there were 7,867 cases and 116 deaths attributed to COVID-19. This includes confirmed and probable cases and deaths. [29] The Michigan statewide case fatality rate is 1.4%.

Of the reported deaths attributed to COVID-19 in Emmet County, the majority were of persons aged 70 years and older, followed by lower numbers in the 60-69 year old group and less than ten persons in the 50-59 year old group.

The HDNW conducts weekly beach monitoring studies at public beaches in Emmet County, usually from the last week in June through the end of August each year. Table 72 indicates the recommended limits of body contact with the water in relation to the detected levels of E. coli bacteria.

Table 72. Water Quality Index for Beach Monitoring

Water Quality Index	Body Contact Limits	E. coli/100ml (Single Event)	E. coli/100ml (30 day geo-mean)
Level 1	E. coli levels meet EGLE swimming standard for full body contact.	0-300	0-130
Level 2	E. coli levels meet EGLE standard for wading, fishing, and paddling. Contact above the waist not advised.	301-1000	131-1000
Level 3	E. coli levels exceed EGLE standards, no body contact advised.	>1000	>1000
Level 4	**Health alert.** E. coli levels and/or known gross contamination of beach waters. Avoid contact with beach waters.	>1000 E. coli/ gross contamination	>1000 E. coli/ gross contamination

Source: Health Department of Northwest Michigan, Environmental Health Division

The extent of a public health emergency can also be measured in economic terms, such as expenditures related to disease preparation, response and prevention, as well as potential loss of income and jobs within industries that cannot solely operate on remote workers, such as hospitality, personal services, construction, manufacturing, and brick and mortar retailers.

Previous Occurrences

Throughout the years, there have been many pandemics. For example, there was an outbreak of severe acute respiratory syndrome (SARS) in 2003. This virus was a new coronavirus that resulted in over 8,000 illnesses worldwide. Of these, 774 died. Since 2012, Middle East respiratory syndrome (MERS), a coronavirus, has been reported in 27 countries where there have been approximately 2,494 people infected and 858 deaths. In 2017, the World Health Organization (WHO) put SARS and MERS on its priority pathogen list to spur further research into coronaviruses.

[28] https://www.michigan.gov/coronavirus/stats

[29] MDHHS classification: Confirmed cases are those individuals who have had a positive diagnostic laboratory test for COVID-19. Probable cases include individuals who have a positive presumptive laboratory test for COVID-19. Confirmed deaths include individuals who had a confirmed COVID-19 infection AND are either classified as deceased during the case investigation OR have COVID-19 indicated as a cause of death on their death certificate. Similarly, probable deaths include individuals who had a presumptive COVID-19 infection AND are either classified as deceased during the case investigation OR have COVID-19 indicated as a cause of death on their death certificate.

More recently in March 2020, federal/state disaster/emergency declarations were enacted in response to the international COVID-19 Pandemic. The U.S. Department of Health and Human Services ended the COVID-19 public health emergency (PHE) May 11, 2023. Variants of the coronavirus are still being found years after the initial spread; vaccinations are available to limit the reaction from exposure and limit the spread of the disease.

The HDNW's 2023 Beach Monitoring Report indicates that Camp Petosega, Little Traverse Township Park, and Zorn Park had water quality index levels of two (2) or greater (Table 73). All sites with exceedances of contact criteria were re-sampled until water quality index levels returned to one (1).

Table 73. Water Quality Index Readings Exceeding 1, Emmet County Beaches, 2023

Sample Date	Beach Site	Sample results E. coli count per 100ml	Water Quality Index
6/28/23	Camp Petosega	613.1	2
6/28/23	Little Traverse Township Park	1986.3	3
6/29/23	Camp Petosega	16.8	1
6/29/23	Little Traverse Township Park	89.8	1
8/2/23	Little Traverse Township Park	387.3	2
8/3/23	Little Traverse Township Park	42.0	1
8/9/23	Camp Petosega	727	2
8/10/23	Camp Petosega	1564.6	3
8/14/23	Camp Petosega	64.6	1
8/22/23	Zorn Park	387.3	2
8/23/23	Zorn Park	1268.3	3
8/24/23	Zorn Park	443.9	2
8/28/23	Zorn Park	7.0	1

Source: HDNW 2023 Beach Monitoring Report http://www.nwhealth.org/

Probability of Future Events and Vulnerability Assessment

Pandemics will continue to result in widespread precautions around the world. The Michigan Department of Health and Human Services created a Pandemic Response Plan (Annex 12 of the MDHHS Emergency Operations Plan, June 2023) to respond to a large-scale outbreak of influenza and other highly infectious respiratory diseases. The elderly, immune-compromised, and low income populations are most vulnerable to public health emergencies.

The HDNW and the Little Traverse Bay Bands of Odawa Indians successfully administered COVID-19 vaccination services to the public and tribal citizens beginning in 2021, and can utilize their knowledge of this experience in a future scenario where vaccinations are needed to mitigate the effects of a pandemic. Additionally, strides continue to be made in the advancement of broadband internet installation throughout the rural areas of northern lower Michigan. Access to broadband internet, which has expanded in availability throughout the county in recent years, is an essential tool that allows for remote work, schooling, commerce and communications to continue during a public health emergency.

Select Existing Prevention Programs and Resources

Most homes and businesses outside of urbanized areas in Emmet County depend on septic systems to treat wastewater. If not maintained, failing septic systems can contaminate groundwater, surface water, and harm the environment by releasing bacteria, viruses, and household toxics to local waterways. Proper septic system maintenance protects public health, the environment, and saves the homeowner money through avoided costly repairs. One of the barriers preventing the replacement of septic systems and installation of systems designed to protect our waters is a lack of funding options available to homeowners. In May 2024, the Michigan Department of Environment, Great Lakes, and Energy (EGLE) received funding and contracted with a non-profit third-party lender, Michigan Saves Inc., to develop and implement a statewide loan program to replace failing and near- failing septic systems. The Septic Replacement Loan Program (SRLP) provides financing for the installation of residential Onsite Wastewater Treatment Systems (OWTS) that are protective of public health and the environment. To assure these protections, EGLE has developed a set of program minimum standards for OWTS constructed through the SRLP. The primary purpose of the SRLP is to provide loans to eligible homeowners to repair and replace existing septic systems that are at or near failure to protect public health and water quality.

The HDNW performs a site evaluation and issues a permit before a resident or business installs a drinking water well, as well as do a final review once the well is installed. The HDNW also offers test kits for many types of water sampling, including the two most common: bacteriological and partial chemical.

The HDNW beach monitoring program will continue to protect public health and support the economic benefits of having clean, safe swimming areas through their beach monitoring program.

Additionally, while plastic waste is not considered a hazardous substance, microplastics can bind to compounds containing toxic metals, such as mercury and dioxins. The Tip of the Mitt Watershed Council (TOMWC) secured a grant to fund the use of a beach cleaning robot that that mechanically sifts sand, rakes seaweed, and levels sandy areas to remove plastic waste and other debris without harming the local environment. They also are deploying a floating, remote-controlled, mobile waste collector that collects waste in all forms: organic, plastic, glass, metal, paper, rubber, etc.

These devices, provided by TOMWC, will be deployed at various locations throughout the Watershed Council's service area until October 2024.

Cyberattack and Major Network Disruptions

Cyberattacks and major network disruptions are human-caused actions designed to disable or gain unauthorized access to computers and their networks for the purposes of electronic data manipulation (exposure, erasure, theft, recoding) or changed functionality (including repurposing or inoperability). Major network disruptions are sometimes accidental or secondary to other hazards.

Cyberattacks typically involve the use of computers and electronic devices over the Internet to attack other computers and network systems. Examples of cyberattacks include computer viruses that damage infected computers, denial-of-service attacks that shut down targeted websites, and hacking attacks that damage sensitive information or attempt to hold it for ransom. Incidents can range in severity from relatively mundane electronic vandalism to more serious extortion schemes, espionage, or sabotage designed to harm or destroy communications and other infrastructure.

Major Internet network disruptions often come about from intentional actions (hacking, criminal activity, terrorism). In some cases, networks are left compromised due to poor training or lax security. Major network disruptions can also be the result of accidents (equipment malfunction, human error) or secondary to other hazards (power outages, tornados, solar flares).

Ultimately, cyberattacks cause harm to critical cyber functions and Internet services by impairing the confidentiality, integrity, and availability of electronic information, services, and networks. This hazard will continue to grow as the Internet of Things (IoT) expands, with hacking concerns moving beyond “desktop computers,” as cars and devices not previously connected to the Internet become widely adopted.

Michigan has not been immune to cyberattacks but depending on how their prevalence is measured (complaints, known attacks, successful attacks, etc.), the impact appears above average. An October 2019 article in Crain’s Magazine indicated that Michigan was ranked first in cybercrime complaints, with 201.89 per 100,000 population based on FBI and Insurance Information Institute data. For perspective, Florida was the next ranked state at 176.37 per 100,000 population.

Other sources, whose ranking criteria could not be independently verified, has Michigan as the seventh highest state target in the country. Examples are given, such as the Detroit News reporting in 2017 that private information, such as social security numbers for roughly 1.9 million citizens stored on governmental servers, was potentially exposed to unauthorized viewers. The security vulnerability was caused by a software update. A 2019 breach of the Inmediata Health Group was investigated by the Michigan Attorney General after some of their deep web patient data was indexed by search engines. That same year, the Attorney General also investigated a ransomware attack on the Wolverine Solutions Group that impacted 600,000 patients associated with Blue Cross Blue Shield of Michigan, Health Alliance Plan, Three Rivers Health, North Ottawa Community Health System, Mary Free Bed Rehabilitation Hospital, Covenant Hospital, Sparrow Hospital, and McLaren Health Care.

Location

With the increased use of technology, the impact of cyberattacks on the public is continually growing. This is true even though not all cyberattacks are known, and when detected, not always reported. Indeed, a challenge in fully assessing their impact is that unlike many other hazards, they are not always easy to identify. It can, for example, be difficult to tell if exposed data was the result of a hack or simply due to lax security, and compromised data may not be criminally used until years after the fact. For affected members of the public, they may know that their identity has been stolen, but they frequently don’t know how or if it was the result of a specific attack. To be shielded from bad publicity, the reporting of some breaches may be muted or go unreported.

Property and facilities are typically not physically affected, except in the case of cyberattacks that are designed to take control of environmental systems (HVAC) or other machinery. The nation’s electric grid is now wirelessly connected, even at the residential level, as are many traffic systems and larger transportation networks. Airline systems have also been the focus on some cyberattacks.

The cost of mounting an effective cyber-defense is now considered part of the cost of doing business within industries. For some smaller businesses who don't have the money or expertise to fight cyberattacks, successful attacks can quickly destroy a business. One high-profile case included a small physician practice in Battle Creek, Michigan, that was victim to a ransomware attack. The practice's computers were locked down, with patient data and appointments frozen. The doctors refused to pay and announced the closure of their office. Successful attacks causing disruptions at larger industries could have significant impacts on an area's local economy.

Communication services are a potential target for hackers, and responders who can't communicate with others may have operations impaired. In some instances, a lack of communication could put the lives of first responders in jeopardy.

If the computer system of law enforcement (or other responders) is the focus of the attack, response and continuity of operations could be severely compromised. Some reported examples include from 2016 when a Dallas area law enforcement agency was the victim of a ransomware attack whereby an employee was fooled by a phishing email pretending to be from another law enforcement agency. A significant number of digital files were lost, including video evidence. In March 2018, a ransomware attack encrypted data on the city of Atlanta's computer servers, affecting various Atlanta Police Department files. The same year, hackers took the city of Baltimore's dispatch system offline for more than 17 hours. At least 12 U.S. states during October 2016 experienced denial of service attacks affecting their 9-1-1 centers. Hacking was believed to be responsible for false alarms seen in the emergency warning sirens in Genesee County, Michigan, in 2018.

In 2020, a Richland, Michigan school district fell prey to a ransomware attack, with hackers seizing control of its computer system and demanding $10,000 in bitcoin. The virus affected connected telephones, copiers, and classroom technology. The district was forced to close three schools for a week to fix the problem. On a larger scale, the city of Plainfield, New Jersey, was likewise struck by hackers demanding money in exchange for the release of encrypted files. The virus entered through their computers in the sensitive area of their finance department. Other reported cases include the Lansing Board of Water and Light and Genesee County government, both of which were targets of ransomware and experienced weeks of internal disruption of computer systems, costing hundreds of thousands of dollars.

An attack with an unusual consequence occurred in Baltimore amid a ransomware attack on city government computers, including those essential for completing real estate transactions. Because real estate transactions had to be completed manually during that time but were still necessary in order to close on home sales, many transactions were held up for long periods of time leaving buyers and sellers in a state of limbo. Recorded home sales fell more than 18 percent and created havoc for two weeks as manual workarounds were instated.

Most recently, on June 12, 2024, Grand Traverse County's government was the victim of a cyberattack. It disabled the computer-aided dispatch system for the County's 911 service for two weeks. First responders had been relying on radios and cellphones to communicate with the central dispatch center — and each other. Emergency services were still available to the public during that time, though without the detailed information that the problem was largely solved by migrating to a cloud-based solution. Instead of running their software on local servers, the software will reside on secure internet servers maintained and protected by a Texas-based company. The migration to a cloud-based solution was estimated to cost $231,000 in upfront, one-time fees, plus about
$301,000 in annual fees going forward. That's an increase of approximately $167,000 from the County's current annual service contract. Grand Traverse County has insurance coverage for cyberattacks, but it typically doesn't pay for upgrades of this sort. Overall, about 80 percent of the county's computer infrastructure was back online as of June 27, 2024. The County's OnBase document management system that is heavily used by the city staff wasn't fully restored, nor was the BS&A software used for human resources. Other problem areas include the software application for permitting, and the county's GIS systems that power mapping services for both county staff and local residents. Migrating the OnBase system to the cloud may take an estimated three years, because the state's Office of Administration is currently in the process of moving court documents to the cloud-based services.[30]

[30] https://www.govtech.com/security/michigan-county-restores-80-percent-of-systems-after-cyber-attack

Cyberattacks typically have a negligible direct impact on the environment. However, indirect attacks still have the potential to cause significant problems. Attacks on a fire department's system could cripple response efforts should a large-scale fire occur. Attacks on an underground hazardous materials pipeline operating facility could also cause a facility malfunction that could potentially result in large-scale, long-term damage to the surrounding natural environment.

Previous Occurrences and the Probability of Future Occurrences
Emmet County government operations have experienced cybercrime in the form of e-mail hacking in 2023.

It is expected that the threat of a cyberattack/major network disruption will continue to be an ongoing threat to local and tribal governments, businesses, institutions and individuals.

Extent
The impact of a cyberattack event can disrupt critical communications networks amongst first responders, government entities, and medical and financial computer operating systems. Ransom payments may be demanded by the criminals for the return of the victim's operating system and/or stolen data.

Vulnerability Assessment
Emmet County's IT department plays a crucial role in modern governance by managing and maintaining technology infrastructure, safeguarding critical data from cyber threats, providing technical support to county employees, and leveraging innovative solutions to streamline operations and deliver enhanced services to the community. Their efforts contribute to increased efficiency, improved communication, and effective decision- making within the county, ultimately benefiting both staff and residents alike.

In light of the June 12, 2024 cyberattack on Grand Traverse County, which is located within the northwest Michigan region, migrating an organization's software systems from in-house servers to the cloud (internet) is a fast-growing strategy for both governments and private industry. Grand Traverse County already uses Microsoft Azure for some cloud-based hosting services, while the City of Traverse City uses Amazon Web Services for similar purposes. Diversifying the network host sites for services utilized reduces the risk of all systems being compromised at once if they are hosted on a single local network.

Terrorism and Similar Criminal Activities

Terrorism is the unlawful use of violence and intimidation, especially against civilians, in the pursuit of political, social, or religious objectives. The most recognized forms of terrorism include assassination, bombings, extortion, use of weapons of mass destruction (a nuclear, radiological, chemical and/or biological device that is intended to harm a large number of people), information warfare, ethnic/religious/gender intimidation (hate crimes), state and local militia groups that advocate to overthrow the U.S. Government, sabotage, eco-fanaticism (destruction or disruption of research or resource-related activities), and narcotics smuggling and distribution organizations.

Since terrorism objectives are widely varied, the potential targets are also varied. Any public facility, infrastructure, controversial business, assembly place, large computer systems operated by government agencies, financial institutions, healthcare facilities and colleges/universities can be considered a potential target. Regardless, terrorists seek the greatest possible media exposure to frighten as many people as possible.

These acts are often identified with groups or organizations. The Middle East and portions of Europe, South America and Asia have been greatly impacted for many years by acts of terrorism and sabotage. In more recent years, the United States has been victim to acts of terrorism.

International terrorism includes violent, criminal acts committed by individuals and/or groups who are inspired by, or associated with, designated foreign terrorist organizations or nations (state-sponsored).

Domestic terrorism includes violent, criminal acts committed by individuals and/or groups to further ideological goals stemming from domestic influences, such as those of a political, religious, social, racial, or environmental nature.

An active assailant is an individual actively engaged in killing or attempting to kill people in a confined and populated area. An active assailant may or may not be affiliated with a terrorist organization and may not otherwise be considered a terrorist. In the US many active assailant events have been lone shooter driven. In this plan, they are described together despite ideological objectives.

The Homeland Security Act of 2002, Public Law 107-296, established the Department of Homeland Security (DHS) with the mandate and legal authority to protect the American people from the continuing threat of terrorism. In the act, Congress assigned the DHS the primary mission to (1) prevent terrorist attacks within the United States, (2) reduce the vulnerability of the United States to terrorism at home, (3) minimize the damage and assist in the recovery from terrorist attacks that occur, and (4) act as the focal point regarding natural and manmade crises and emergency planning.

Previous Events and Probability of Future Occurrences
An individual in the United Kingdom was identified as the person who initiated a bomb threat in downtown Harbor Springs on January 25, 2021. The police department received a call from a man who claimed he had placed a pipe bomb downtown, was heavily armed, and planned to hurt people. The threat kept students in the Harbor Springs School District in a “shelter in place” for more than an hour after standard dismissal time. At the height of the law enforcement presence, there were between 40-60 officers in Harbor Springs. All roads leading into the downtown area were blocked off by law enforcement. When it became clear the suspect was likely not in the area, and was instead a potential “swatter” - a person who criminally harasses through false reports that triggered an emergency response - the area was cleared and students were released.[31]

In 2022, CCE-911 reported 8 incidents of an “active shooter” or “bomb assailant” in local schools; however, no actual threat was realized.

The likelihood of a major terrorism or similar criminal incident in Emmet County is low, but remains a potential threat. Potential targets include eco-terrorism related attacks associated with land and water development, particularly the Enbridge Line 5 tunnel project under the Mackinac Straits. Also, schools, public spaces and election polling stations are potential targets.

[31] https://www.harborlightnews.com/articles/2021-harbor-springs-bomb-threat-suspect-identified-in-united-kingdom/

For context, the following terrorist events have occurred in Michigan[32]:

- Case: Bath School Disaster (1927)
  On May 18, 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 a criminal 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: Pontiac School Bus Bombings (1971)
  Ten empty school buses were bombed and destroyed on August 30 in response to a controversial, court-ordered busing plan to integrate Pontiac schools. Authorities believe that several individuals gained access through a hole cut in the fence that surrounded the bus depot and placed dynamite under the vehicles. The destroyed buses focused national attention on Pontiac and school integration. Subsequent attempts to overturn the busing plan failed, and eventually 70 other school districts across the country were ordered to implement similar measures to achieve racial integration. The Pontiac bombers, later apprehended and convicted of the attack, were identified as members of the Ku Klux Klan.

- Case: Michigan State University Agriculture Building Arson (1999)
  On December 31, environmental terrorists affiliated with the Earth Liberation Front set fire to the Agriculture Biotechnology Support Project, located in a classroom and office building at MSU. 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. This attack, a similar attack against MSU in 1992, and an attempted attack against the Michigan Technological University Forestry Center in 2001 are typical of attacks by environmental terrorist groups. These attacks generally are designed to cause property damage but few deaths and injuries, and demonstrate the vulnerability of universities and research centers to terrorist attack.

- Case: Byron Center Meat Tampering (2003)
  A disgruntled employee intentionally contaminated 250 pounds of ground beef sold at a local supermarket. The meat was poisoned with insecticide containing harmful amounts of nicotine. The attacker was seeking revenge on his supervisor, whom he hoped would be blamed for the illnesses. Although the ground beef contained potentially lethal doses of toxin, there were no fatalities resulting from the attack. Investigation did identify 92 individuals sickened by the poison. The attacker was convicted and sentenced to seven years in prison. This incident demonstrates the willingness of some saboteurs to endanger the lives of numerous bystanders in pursuit of their goals. In this case, the attacker wanted to use the victims to embarrass a personal enemy.

- Case: Northwest Airlines Flight 253 Bombing Attempt (2009)
  Umar Farouk Abdulmutallab attempted to destroy Northwest Airlines Flight 253 as it approached 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 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.

[32] *2020 Supplement to the 2019 Michigan Hazard Analysis*, EMHSD Publication 103, Emergency Management and Homeland Security Division, Michigan Department of State Police, published November 2020.

- 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. 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 16–40 years. This was in addition to a sentence of at least six years received in Oakland County. 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.

Other recent terrorist activities in Michigan include the following:

- On October 7, 2020 the FBI and Michigan State Police arrested 13 suspects who were accused of plotting to kidnap Governor Whitmer in response to actions they felt exceeded her authority during the COVID-19 response and in violation of the United States Constitution. The suspects were tied to a paramilitary group called the Wolverine Watchmen. The group met repeatedly over the summer of 2020 for firearms training, combat drills, and to practice building improvised explosive devices to further their skills to execute the kidnapping. The subjects also carried out surveillance on Governor Whitmer's vacation residence and explored avenues of exploiting the surrounding area to aid in the plot. Although no attack was ever made, the case demonstrates how terrorism may be directed at high level targets within the state.

- In October 2021, approximately 10 masked individuals claiming association with environmental groups broke into the Enbridge pipeline facility in Tuscola County, Michigan and used tools and equipment to close an emergency shut-off valve on the pipeline. [33] The event was livestreamed and posted to multiple social media accounts. This incident remains under investigation as potential environmental violent extremism. [34]

According to the FBI, the frequency and lethality of active shooter incidents in America is increasing. In 2022, the FBI designated 50 shootings in the United States as active shooter incidents. These active shooter incidents occurred in 25 states and the District of Columbia and represent seven location categories, including open spaces, commerce, residences, education, government, houses of worship, and a health care facility. Although incidents decreased by 18% from 2021 (61 incidents), the number of active shooter incidents increased by 66.7% compared to 2018 (30 incidents). Texas had the most incidents (six) followed by Arizona, Florida, **Michigan (in Detroit)**, and New York, each with the second highest number of incidents (three). The national casualty count for 2022 (313) was the highest in the last five years. There was a casualty count increase of 28.8% compared to 2021 (243), which was above the average for the years 2018–2021 (222.5). [35]

Other major recent active shooter incidents in Michigan include the November 30, 2021 mass shooting at Oxford High School in the Detroit exurb of Oxford Township, and the February 13, 2023 mass shooting in two buildings on the campus of Michigan State University (MSU) in East Lansing.

Extent

The specific impact of terrorism, or similar criminal activities, would depend on the nature of the terrorist targets and the type of weapons used against those targets. Given the wide range of possibilities, it is difficult to generalize about damage or casualties. In a worst-case scenario, a terrorist or criminal attack could cause significant damage to people, property, and to the economy, instilling fear and mistrust that can discourage many persons from normal activities and relationships. A public health emergency might arise from the use of biological

[33] "FBI joins investigation into alleged trespassing and vandalism on Line 5" WCMU, By Brett Dahlberg. Published October 22, 2021. https://radio.wcmu.org/local-regional-news/2021-10-22/fbi-joins-investigation-into-alleged-trespassing-and-vandalism-on-line-5

[34] *Strategic Intelligence Assessment and Data on Domestic Terrorism*, Federal Bureau of Investigation, U.S. Department of Security, Washington, D.C., published June 2023. https://www.fbi.gov/file-repository/fbi-dhs-domestic-terrorism-strategic-report-2023.pdf

[35] *Active Shooter Incidents in the United States in 2022*, Federal Bureau of Investigation, U.S. Department of Justice, Washington, D.C., and the Advanced Law Enforcement Rapid Response Training (ALERRT) Center at Texas State University, published 2023. https://www.fbi.gov/file-repository/active-shooter-incidents-in-the-us-2022-042623.pdf

or chemical agents. Infrastructure, such as transportation, computer networks, or communications might be directly damaged or subsequently overwhelmed by a fearful population. Critical facilities and infrastructure might be deliberately targeted, but the impacts are likely to be limited. Most bridges, dams, power plants, etc. seem to be of little interest to terrorists. Facilities with symbolic value, like government offices and monuments, are more likely targets. Only rarely is the facility itself targeted. More often, it is the occupants who are the focus of a terrorist.

Worst-case scenarios, however, are unusual. Most attacks will cause limited damage in a single area, and only a very few will cause mass casualties or widespread impacts. However, since the specific purpose of terrorism is, after all, to cause terror, a public increase in fear, uncertainty, and resulting inconveniences will be very likely and could affect the function of important facilities, such as through greater absenteeism, activities that are cancelled or postponed, or difficulties in accessing or using physical resources in or near an affected area. In some cases, innocent citizens may suffer misguided retaliation if they are identified with an ethnic group or political movement held responsible for terrorism. Public impact may also be increased by the effects of government anti-terrorism programs, as demonstrated by the inconvenience created by increased airport security measures. Services, such as mail delivery, could be slowed, as new precautionary or detection measures are adopted. Some operations may have to shift to an increased use of virtual work.

Emergency responders may face difficult and unexpected challenges following a terrorist or criminal attack, especially if the attack involves mass casualties or uses chemical, biological, radiological, nuclear, or cyberattack. Terrorists, and criminals who conduct terrorist-like violent attacks, may behave very differently from other types of criminals with which responders are familiar. Terrorist weapons may pose a direct hazard to the life and safety of responders, especially in the case of secondary devices specifically targeted on those responders. When it comes to continuity of operations and delivery of services, most terrorist activities are not likely to have a great deal of impact. Most terrorist attacks occur within a limited area at a level that does not cause sustained, widespread disruption to services and operations. Attacks on key facilities could cause local disruptions until recovery activities have advanced sufficiently.

Terrorist and violent criminal attacks are very rarely targeted specifically on the environment, but environmental damage is possible as an indirect consequence of an attack. This would be especially true in the case of chemical, radiological, biological, or nuclear weapons which could contaminate a significant area for an extended period. Damage to infrastructure may also cause environmental problems, as in the case of an oil pipeline sabotaged with explosives.

Finally, governments may also be pressured to create new legal restrictions and law enforcement measures in response to a terrorist attack. Such measures could create public opposition from citizens who feel their rights are violated by counter-terrorism efforts. Finding the correct balance between individual civil liberties and national/public security is likely to remain a difficult challenge.

Vulnerability Assessment

High-risk targets for acts of terrorism include military and civilian government facilities, schools, international airports, large cities, and high-profile landmarks. Terrorists might also target large public gatherings, water and food supplies, utilities, and corporate centers. Terrorist groups more often choose to strike a “soft target" - a person, thing, or location that is easily accessible to the general public and relatively unprotected, making it vulnerable to military or terrorist attack. By contrast, a "hard target" is heavily defended or not accessible to the general public.

In most cases, active shooters use firearms and there is no pattern or method to their selection of victims.

While unlikely, the following places in Emmet County are considered at risk for a terrorist attack: the Mackinaw Bridge, the Enbridge pipeline operation facility, government facilities, election polling stations, schools, and large event venues.

Select Existing Prevention Programs and Resources

- "If You See Something, Say Something™" is a national campaign that raises public awareness of the indicators of terrorism and terrorism-related crime, as well as the importance of reporting suspicious activity to state and local law enforcement. Informed, alert communities play a critical role in keeping our state safe.

- The Michigan Intelligence Operations Center (MIOC) is Michigan's fusion center, operated by the Michigan State Police and providing 24-hours a day statewide information sharing among local, state, and federal public safety agencies and private sector organizations in order to facilitate the collection, analysis, and dissemination of intelligence relevant to terrorism and public safety, including the state's OK2SAY school safety program and suspicious activity reporting system, MichTip.

  OK2SAY is a student safety program that allows anyone to confidentially report tips on potential harm or criminal activities directed at school students, school employees, and schools. Threats of retaliation and stigmatization often discourage students from reporting the dangerous behaviors of their peers. OK2SAY aims to eliminate this culture of silence by providing a confidential, collaborative communication system where students and authorities can work together to respond to safety threats.

- In addition to its involvement with OK2SAY, the Michigan State Police's Office of School Safety provides educational resources and expertise for the hardening of schools buildings against attackers. Information on the School Safety Commission and Competitive School Safety Grant program is also available. The School Safety Grant program provides funding to help purchase equipment and/or technology which will improve the safety and security of school buildings, students, and school staff. The goal of this program is to create a safer school environment through equipment and technology enhancements.

- The Michigan Regional Response Team Network (RRTN) includes geographically positioned teams spread throughout the state that can respond to a weapons of mass destruction incident anywhere in Michigan within two hours of activation. These regional teams include local police, fire, and medical agencies, with support from the Michigan Urban Search and Rescue Team (MUSAR) and local and state bomb squads.

- Michigan Emergency Drug Delivery and Resource Utilization Network (MEDDRUN) and CHEMPACK: During the early stages of a mass casualty incident, the health care system may be overwhelmed—especially with cases involving chemical weapons where the early use of antidotes may be lifesaving. The MEDDRUN establishes standardized caches of medications and supplies strategically located throughout Michigan. It is intended to rapidly deliver these resources to hospitals and other sites via Michigan's rotary air and other emergency medical service (EMS) agencies. CHEMPACK provides a sustainable, supplemental source of pre-positioned nerve-agent/organophosphate antidotes and associated pharmaceuticals that will be readily available for use when local supplies become depleted.

- Michigan Department of Health and Human Services' (MDHHS) Bioterrorism Laboratory Preparedness webpage offers resources to help the state's laboratories prepare for and respond to bioterrorist attacks. Past related departmental initiatives have included a statewide bioterrorism response plan (2001) under an agreement with the U.S. Centers for Disease Control.

Civil Disturbance

Civil disturbances occur from collective behavior that results in lawbreaking, a perceived threat to public order, or the disruption of essential functions. Large portions of a community may be encompassed by civil disturbances and require the involvement of multiple community agencies to respond to the disturbance. Some facilities that may be adversely impacted by civil disturbances include government buildings, military bases, colleges/universities, businesses, hospitals, and police and fire facilities. There are four types of civil disturbances:

- Protests: Formal organization of demonstrations to achieve collective goals that are threatening, disruptive, and malicious (e.g. political protests, labor disputes, etc.). Sometimes these events result in property destruction, service interruptions, and interference with law abiding citizens and emergency responders.
- Hooliganism: Unorganized, unlawful acts by either an individual or a collective that are inspired by crowds (e.g. disorder following sporting events and college parties, "block parties," etc.). These acts cause property destruction, assaults, disorderly conduct, and criminal victimization. Sometimes hooliganism can include elements of protest.
- Riots: A disorganized, violent gathering of people that involves assaults, intimidation, and property destruction. Sometimes, individuals attempt to exploit the disorder (e.g. looting, arson, etc.).
- Insurrection: A deliberate effort to disrupt or replace the established government or its representatives (e.g. prison uprisings, political conflicts, ethnic conflicts, etc.). Large-scale civil disturbances rarely occur; however, they are usually an offshoot of labor disputes with a high degree of animosity between two dissenting parties, high profile/controversial judicial proceedings, the implementation of controversial laws or other governmental actions, resource shortages caused by a catastrophic event, disagreements between special interest groups over a particular issue or cause, or a perceived unjust death or injury to a person held in high esteem by a particular segment of society.

Location

The population centers in Emmet County are at risk for civil disturbances, particularly the City of Petoskey County Buildings. A potential location for a civil disturbance in the county is the Enbridge Pipeline facility in Wawatam Township, near the Straits of Mackinac. The Mackinaw Bridge is also a potential target, particularly associated with special events such as the annual Labor Day Bridge Walk, which is usually attended by the Governor of Michigan.

Previous Occurrences and Probability of Future Occurrences

Emmet County has not had any recorded incidents of non-peaceful protests or other impactful civil disturbances. However, an event does have the potential to occur dependent on political, social, and religious interests. Unfortunately, it is impossible to predict when an event will occur and how severe it will be.

Extent

The extent of civil disturbances can be measured by the amount of damage that occurs. Since an event has not occurred in the county, no injuries, deaths, or damages have been incurred.

Vulnerability Assessment

Civil disturbance events will have minimal impacts and financial burdens on residents and businesses since the County has few areas that would provide high profile media coverage (with the exception of the Mackinac Bridge or the Enbridge Pipeline facility) or areas that regularly attract crowds.

Nuclear Attack

A nuclear attack is any hostile action taken against the United States that involves nuclear weapons and results in property destruction and/or loss of life. Nuclear weapons are powerful explosive devices that can devastate an area. The entire United States is subject to the threat of a nuclear attack; however, the strategic importance of military bases, population centers and certain types of industries place these areas at a greater risk. With the end of the Cold War, the threat of a nuclear attack against the U.S. diminished slightly with the dismantling of nuclear warheads aimed at U.S. targets. However, the number of countries capable of developing nuclear weapons continues to grow despite the ratification of an international nuclear non-proliferation treaty. Additionally, nuclear weapons have the potential to be acquired and/or developed by terrorist organizations.

Even though a nuclear attack is unlikely in Michigan, the extent of destruction and casualties from a nuclear weapon still make this hazard a possibility. Unfortunately, there is no way to assess the probability of a nuclear attack and most mitigation strategies would originate from and be prompted by federal initiatives and defense priorities. However, some things should be considered, such as the ability to shelter or evacuate people, maintain government functions and social services, protect critical computer and communications systems, and create redundancies in infrastructure and critical services.

Location
While unlikely, the small population centers in Emmet County are at risk for terrorism, sabotage, and nuclear attack. Additionally, the Mackinaw Bridge and the Enbridge pipeline operation facility in northern Emmet County would be the most likely locations for an attack.

Previous Occurrences and the Probability of Future Occurrences
Emmet County has not had any recorded incidents of a nuclear attack. Based on this information, the likelihood of an incident is low. However, an event does have the potential to occur dependent on furthering political, social, and religious interests. Unfortunately, it is impossible to predict when an event will occur and how severe it will be.

Extent
The extent of a terrorism/sabotage/nuclear attack can be measured by the amount of damage that occurs. Since an event has not occurred in the county, no injuries, deaths, or damages have been incurred. Analyzing incidents that have occurred elsewhere, it is anticipated that such an incident would be damaging to life, property, infrastructure, and the economy. The globalization of today's economy means that even international events can affect our energy needs, supply of goods, and the well-being of the state's residents. An attack against public infrastructure can directly impact the county's ability to operate essential facilities and provide services. Successful attacks would require a large-scale response from all levels of government.

Vulnerability Assessment
Terrorism/Sabotage/Nuclear Attack will have minimal impacts and financial burdens on residents and businesses since Emmet County does not have high profile targets, such as military installations, Federal and State government offices, large population centers, etc. The most likely targets for an incident would be the Mackinac Bridge and the Enbridge pipeline facility in northern Emmet County, as well as Pellston Regional Airport.

Various criteria may be used in determining the vulnerability of facilities to attack. These include factors such as population, accessibility, criticality to everyday life, economic impact, and symbolic value. A nuclear power would have the ability to attack several locations at the same time. These attacks would probably be targeted on large cities and military bases and would use strategic nuclear weapons. Other potential targets may include critical infrastructure and facilities (e.g., commercial power plants, chemical facilities, refineries), military support facilities (e.g., counterforce military installations, military support bases and industries), and political targets (e.g., state

capitals). In evaluating the vulnerability of facilities, State and local planners need to consider the existing security measures in place and the need, if any, to upgrade security.

In addition, the FBI has a standard vulnerability assessment paradigm that can be used for evaluating the vulnerabilities of potential targets. Planners should also be aware that once target lists and vulnerability information are developed, careful decisions must be made regarding security considerations for handling this information based upon applicable State and Federal law regarding confidentiality and public information.

Existing Prevention Programs

The U.S. Department of Homeland Security's Countering Weapons of Mass Destruction Office (CWMD) works to prevent attacks against the United States using a weapon of mass destruction through timely, responsive support to operational partners. Strategic goals include:

- Anticipate, identify, and assess current and emerging WMD threats.
- Strengthen detection and disruption of Chemical, Biological, Radiological, and Nuclear (CBRN) threats to the homeland.
- Synchronize homeland counter-WMD and health security planning and execution.

The "10 Plus 10 Over 10 Program" is a global partnership against the spread of weapons and materials of mass destruction. The Partnership is a formal multilateral nonproliferation initiative created by the G-8 countries in 2002. G-8 countries fund and implement projects to prevent terrorists and other proliferators from acquiring WMDs.

V. COMMUNITY VULNERABILITIES AND CAPABILITIES

The tables on the following pages summarize much of the information presented in Sections III (Community Profile) and IV (Hazard Identification and Assessments) as it pertains to hazard vulnerabilities and mitigation capabilities for each community in Emmet County. While most types of hazards considered in this plan could affect every jurisdiction in the County, certain characteristics of people, property, the economy and the environment were considered to evaluate each community's unique vulnerabilities (as well as assets) for each type of hazard. For reference, the locations of some of these characteristics (i.e., public lands, pine forest area, infrastructure, campgrounds, mobile home areas, hazard areas) are illustrated in the maps provided in Appendix A.

Emergency Warning System Coverage

Integrated Public Alert & Warning System (IPAWS)

- FEMA's national system for local alerting that provides authenticated emergency and life-saving information to the public through mobile phones using Wireless Emergency Alerts, to radio and television via the Emergency Alert System, and on the National Oceanic and Atmospheric Administration's Weather Radio.

Mobile Warning Systems

- If there is a major emergency, or if a Local State of Emergency is declared, community notifications will be conducted utilizing the "Be Alert" emergency notification system, which is an electronic, high-speed, outbound notification service available at no charge to the general public. The system notifies a participant via their mobile phone, land-line phone and/or email address.
- The FEMA Mobile App is also a publicly available mobile warning system providing real-time weather alerts, locations of emergency shelters, and allows for notifications to be sent to loved ones.
- The National Weather Service may concurrently utilize their mobile warning notification system when deemed necessary in severe weather event situations to send phone notifications to users within signal of a cellular tower.

Radio Warning Systems

- Emmet County uses radio channels 580 AM and 103.5 WTCM for emergency alerts.
- NOAA Weather Radio All Hazards is a nationwide network of radio stations broadcasting continuous weather information directly from the nearest National Weather Service office. NWR broadcasts official Weather Service warnings, watches, forecasts and other hazard information 24 hours a day, 7 days a week. Local radio stations include: 96.3 FM, 105.1 FM, 103.3 FM, 1270 AM and 1340 AM.

Tornado/Severe Weather Warning Systems

- The BeAlert system is primarily used in the event of a potential or current severe weather or tornado event.

- Emergency alert sirens are located at/maintained by:
  - City of Harbor Springs (at E. Bluff Drive and N. Spring Street)
  - City of Petoskey (in operation? Location?)
  - North Central Michigan College
  - Wilderness State Park

Flood Warning Systems

- For dam failures that would result in downstream flooding, the dam owners would immediately notify the County Emergency Manager, who would then post a notification on the BeAlert Emergency Communications Network.

Website and Social Media Platforms

- Emmet County 911/Dispatch Department posts emergency preparedness information or emergency alerts on their website or via social media.
- Local police and the county Sheriff's Department, in coordination with the County Emergency Manager, post information on emergency events and preparedness on the county Sheriff's Department Facebook page.

Emergency Shelter Sites
The Emmet County Fairgrounds (1129 Charlevoix Avenue, Petoskey) is the only county-owned shelter with a Memorandum of Understanding/Agreements in place. It can be utilized for both short and longer term occupancy and has a generator.

The Village of Mackinaw City's Recreation Center (507 West Central Avenue, Mackinaw City) has a generator, and is capable of short and longer term occupancy.

The Odawa Casino (1760 Lears Rd., Petoskey) and Odawa Hotel (1444 US-131, Petoskey) both have generators and are capable of short or long term occupancy.

Emmet County Emergency Management is working towards establishing agreements (MOU/MOA) with some of the local faith based organizations for use of their buildings as emergency shelter sites.

Emmet County Community Vulnerabilities																					
	Bear Creek Township	Bliss Township	Carp Lake Township	Center Township	Cross Village Township	Friendship Township	Harbor Springs City	Little Traverse Township	Littlefield Township	Maple River Township	McKinley Township	Petoskey City	Pleasantview Township	Readmond Township	Resort Township	Springvale Township	Wawatam Township	West Traverse Township	Village of Alanson	Village of Mackinaw City	Village of Pellston
Population (2020 Decennial Census)	6,542	568	748	525	240	954	1,274	2,657	3,200	1,295	1,294	5,877	918	560	2,835	2,146	711	1,768	778	846	774
Severe Winter Weather and Extreme Temperature Vulnerabilities																					
Estimated number of residents with a disability	839	109	187	30	38	87	154	342	444	141	206	742	85	63	312	214	92	222			
% of residents > age 65	22.3%	25.9%	32.8%	23.4%	40.8%	23.1%	44.0%	22.5%	17.7%	20.5%	16.5%	23.5%	26.9%	32.7%	23.9%	17.6%	33.9%	43.9%	11.6%	35.2%	12.3%
Est. % of residents that are in poverty (in 2022)	7.8%	10.9%	30.7%	6.0%	8.8%	6.6%	11.0%	7.1%	11.1%	13.0%	9.5%	7.9%	10.9%	7.0%	3.8%	5.7%	11.5%	3.2%	11.8%	16.7%	13.4%
Est. % of households that are ALICE (in 2022)	33%	48%	65%	24%	46%	28%	40%	35%	33%	45%	51%	35%	38%	41%	19%	18%	52%	29%	N/A	N/A	N/A
Est. # of residents that are of a minority race	645	77	73	86	43	83	121	240	405	119	189	659	80	42	239	199	102	132	99	113	120
Est. # of residents that are of Hispanic or Latino origin (of any race)	112	4	5	10	2	10	20	57	49	10	11	140	27	7	64	25	12	27	7	24	4
Public Outdoor Recreation Acreage (excluding LTC properties)	2,269	13,412	6,945	6,309	1,556	5,092	79	1,068	1,582	2,862	9,965	1,522	10,096	5,636	690	10,702	6,507	132	Included in Littlefield Twp.	Included in Wawatam Twp.	Included in McKinley Twp. & Maple River Twp.
Private/Semi-private Outdoor Recreation Acreage	178	81	180	0	0	212	9	163	4	240	2,700	0	2,700	0	450	0	46	1,032	43	0	0
Emmet County-designated Agricultural Enterprise District Areas	X	X	X	X		X		X	X	X	X		X	X	X	X		X			

Emmet County Community Vulnerabilities																					
	Bear Creek Township	**Bliss Township**	**Carp Lake Township**	**Center Township**	**Cross Village Township**	**Friendship Township**	**Harbor Springs City**	**Little Traverse Township**	**Littlefield Township**	**Maple River Township**	**McKinley Township**	**Petoskey City**	**Pleasantview Township**	**Readmond Township**	**Resort Township**	**Springvale Township**	**Wawatam Township**	**West Traverse Township**	**Village of Alanson**	**Village of Mackinaw City**	**Village of Pellston**
Population (2020 Decennial Census)	6,542	568	748	525	240	954	1,274	2,657	3,200	1,295	1,294	5,877	918	560	2,835	2,146	711	1,768	778	846	774
Thunderstorm, High Winds, Hail, Tornado Vulnerabilities																					
Previous Tornadoes							1 (in 1957)	1 (in 1957)	1 (in 1987)		1 (in 1996)	2 (in 1953 and 1955)	1 (in 1957)					1 (in 1957)			
Est. # of Mobile Homes (2022)	198	45	132	40	19	16	45	48	448	49	94	0	36	32	87	30	33	24	72	5	51
Mobile Home Communities	Chalet Estates						Harbor Springs Estates	Conway Commons	6700 US-31; El Rancho						Bay Shore Estates				El Rancho; Banwell and Armock Roads		
Campgrounds	Jellystone Park; Hearthside Grove Motorcoach Resort; Petoskey State Park	Wilderness State Park - campground and two rustic cabin sites						LTBBOI Rustic Campground	El Rancho RV Campers Country Club; Camp Petosega			Magnus Park		Blissfest CG	Sun Outdoors RV Park	Camp Petosega	KOA Campground Mackinaw City		El Rancho RV Campers Country Club; Artesian Springs RV Resort		
Public Outdoor Recreation Acreage (excluding LTC properties)	2,269	13,412	6,945	6,309	1,556	5,092	79	1,068	1,582	2,862	9,965	1,522	10,096	5,636	690	10,702	6,507	132	Included in Littlefield Twp.	Included in Wawatam Twp.	Included in McKinley Twp. & Maple River Twp.
Private/Semi-private Outdoor Recreation Acreage	178	81	180	0	0	212	9	163	4	240	2,700	0	2,700	0	450	0	46	1,032	43	0	0
Emmet County-designated Agricultural Enterprise District Areas	**X**	**X**	**X**	**X**		**X**		**X**	**X**	**X**	**X**		**X**	**X**	**X**	**X**		**X**			
Communications Critical Infrastructure (CI): Towers/Structures	CCE 911 Call Center, 1694 US-131																				
Energy CI: petroleum fuel storage and pipelines (https://pvnpms.phmsa.dot.gov/PublicViewer/)	Suburban Propane; Amerigas Propane		Natural Gas Pipeline						Alpine Propane; Ellsworth Farmers Exchange; Natural Gas Pipeline	Natural Gas Pipeline	Natural Gas Pipeline	Derrer Oil and Propane			Natural Gas Pipeline	Natural Gas Pipeline	Natural Gas Pipeline; Enbridge Energy Line 5 Pipeline			Natural Gas Pipeline; Enbridge Energy Line 5 Pipeline	
Energy CI: major overhead electrical transmission lines, 69 or 138 volts (https://atlas.eia.gov)	Yes	Yes	Yes	Yes		Yes		Yes				Yes	Yes		Yes		Yes			Yes; also 2 wind turbines	
Estimated number of residents with a disability	839	109	187	30	38	87	154	342	444	141	206	742	85	63	312	214	92	222			
% of residents > age 65	22.3%	25.9%	32.8%	23.4%	40.8%	23.1%	44.0%	22.5%	17.7%	20.5%	16.5%	23.5%	26.9%	32.7%	23.9%	17.6%	33.9%	43.9%	11.6%	35.2%	12.3%
Est. % of residents that are in poverty (in 2022)	7.8%	10.9%	30.7%	6.0%	8.8%	6.6%	11.0%	7.1%	11.1%	13.0%	9.5%	7.9%	10.9%	7.0%	3.8%	5.7%	11.5%	3.2%	11.8%	16.7%	13.4%
Est. % of households that are ALICE (in 2022)	33%	48%	65%	24%	46%	28%	40%	35%	33%	45%	51%	35%	38%	41%	19%	18%	52%	29%	N/A	N/A	N/A
Est. # of residents that are of a minority race	645	77	73	86	43	83	121	240	405	119	189	659	80	42	239	199	102	132	99	113	120
Est. # of residents that are of Hispanic or Latino origin (of any race)	112	4	5	10	2	10	20	57	49	10	11	140	27	7	64	25	12	27	7	24	4

Emmet County Community Vulnerabilities																					
	Bear Creek Township	**Bliss Township**	**Carp Lake Township**	**Center Township**	**Cross Village Township**	**Friendship Township**	**Harbor Springs City**	**Little Traverse Township**	**Littlefield Township**	**Maple River Township**	**McKinley Township**	**Petoskey City**	**Pleasantview Township**	**Readmond Township**	**Resort Township**	**Springvale Township**	**Wawatam Township**	**West Traverse Township**	**Village of Alanson**	**Village of Mackinaw City**	**Village of Pellston**
Population (2020 Decennial Census)	6,542	568	748	525	240	954	1,274	2,657	3,200	1,295	1,294	5,877	918	560	2,835	2,146	711	1,768	778	846	774
Lightning and/or Space Weather Vulnerabilities																					
Communications Critical Infrastructure (CI): Towers/Structures	CCE 911 Call Center, 1694 US-131																				
Energy CI: petroleum fuel storage and pipelines (https://pvnpms.phmsa.dot.gov/PublicViewer/)	Suburban Propane; Amerigas Propane		Natural Gas Pipeline						Alpine Propane; Ellsworth Farmers Exchange; Natural Gas Pipeline	Natural Gas Pipeline	Natural Gas Pipeline	Derrer Oil and Propane			Natural Gas Pipeline	Natural Gas Pipeline	Natural Gas Pipeline; Enbridge Energy Line 5 Pipeline			Natural Gas Pipeline; Enbridge Energy Line 5 Pipeline	
Energy CI: major overhead electrical transmission lines, 69 or 138 volts (https://atlas.eia.gov)	Yes	Yes	Yes	Yes		Yes		Yes				Yes	Yes		Yes		Yes			Yes; also 2 wind turbines	
Airports (CI)									Harbor Springs Airport		Pellston Regional Airport										Pellston Regional Airport
Municipal Wastewater Infr. Sites								Harbor Area Sewage Disposal Authority, 699 E Hathaway Rd				City WWTP at 1000 W. Lake St.								Village WWTP, 8636 Trailsend Rd	
Campgrounds	Jellystone Park; Hearthside Grove Motorcoach Resort; Petoskey State Park	Wilderness State Park - campground and two rustic cabin sites						LTBBOI Rustic Campground	El Rancho RV Campers Country Club; Camp Petosega			Magnus Park		Blissfest CG	Sun Outdoors RV Park	Camp Petosega	KOA Campground Mackinaw City		El Rancho RV Campers Country Club; Artesian Springs RV Resort		
Public Outdoor Recreation Acreage (excluding LTC properties)	2,269	13,412	6,945	6,309	1,556	5,092	79	1,068	1,582	2,862	9,965	1,522	10,096	5,636	690	10,702	6,507	132	Included in Littlefield Twp.	Included in Wawatam Twp.	Included in McKinley Twp. & Maple River Twp.
Private/Semi-private Outdoor Recreation Acreage	178	81	180			212	9	163	4	240	2,700		2,700		450		46	1,032	43		

Emmet County Community Vulnerabilities																					
	Bear Creek Township	**Bliss Township**	**Carp Lake Township**	**Center Township**	**Cross Village Township**	**Friendship Township**	**Harbor Springs City**	**Little Traverse Township**	**Littlefield Township**	**Maple River Township**	**McKinley Township**	**Petoskey City**	**Pleasantview Township**	**Readmond Township**	**Resort Township**	**Springvale Township**	**Wawatam Township**	**West Traverse Township**	**Village of Alanson**	**Village of Mackinaw City**	**Village of Pellston**
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Lake Michigan Shoreline Hazards																					
Lake MI Shoreline Flooding Issues							Beach Drive, S. of Pennsylvania Ave.					Yes - along Little Traverse Wheelway					Wilderness Park Drive flooding in Oct. 2020 lakeshore flood				
Lake MI Shoreline Erosion Issues																					
Critical Dunes	Yes	Yes			Yes			Yes									Yes				
High Risk Erosion Areas	Yes	Yes			Yes									Yes	Yes			Yes			
Lake MI Public Beach Access	Petoskey State Park	Sturgeon Bay; Wilderness State Park	N/A	N/A	The Port of Cross		Zoll Street Park; City Beach		N/A	N/A	N/A	Magnus Park	N/A	Park Preserve; Middle Village Park	None	N/A	Cecil Bay; The Headlands; Village Beaches #1 and #2	Thorne Swift Nature Preserve	N/A	None	N/A
Marinas connected to Lake MI							City Marina; Walstrom Marina; Irish Boat Shop Marina					Petoskey City Marina			Bay Harbor Lake Marina						
FEMA FIRMS issued - adjoining Lake MI	6/1/2022	6/1/2022			6/1/2022	6/1/2022	6/1/2022	6/1/2022				6/1/2022		6/1/2022	6/1/2022		6/1/2022	6/1/2022		7/19/2022	
FEMA FIRMs not locally adopted	**X**	**X**													**X**		**X**				

Emmet County Community Vulnerabilities																					
	Bear Creek Township	**Bliss Township**	**Carp Lake Township**	**Center Township**	**Cross Village Township**	**Friendship Township**	**Harbor Springs City**	**Little Traverse Township**	**Littlefield Township**	**Maple River Township**	**McKinley Township**	**Petoskey City**	**Pleasantview Township**	**Readmond Township**	**Resort Township**	**Springvale Township**	**Wawatam Township**	**West Traverse Township**	**Village of Alanson**	**Village of Mackinaw City**	**Village of Pellston**
Population (2020 Decennial Census)	6,542	568	748	525	240	954	1,274	2,657	3,200	1,295	1,294	5,877	918	560	2,835	2,146	711	1,768	778	846	774
Inland Flooding Vulnerabilities																					
FEMA FIRM issued, NFIP participant					**X**	**X**	**X**	**X**				**X**		**X**		**X**		**X**		**X**	
Historic Flood Events					6/2/2011 heavy rain caused Levering Rd. washout a few miles E. of Cross Village		9/3/2022 heavy rain caused washout of bluff at M-119 and Harrison St.; road closure		7/18/2020 heavy rain caused flooding of homes on Pingree Ave. in Oden												
Inland Flooding Areas of Concern (public input)	Tannery Creek corridor, especially around US-31; US-31 between Division Rd. and M-119; Bear River corridor along River Road; Bear River Rd., east of River Rd.	SW side of O'Neal Lake	Carp River, near US-31 and Lake Paradise; Lake Paradise		Wycamp Creek near W. side of Wycamp Lake, around Lakeshore Dr., Chippewa Dr. and Arbutus Rd.				Oden Island; Mission Rd. N. of Hilltop Rd.; Crooked River corridor	Snider Rd., S. of Crooked River; Cedar Rd. around White's Creek crossing; Crooked River to Burt Lake	Ely Rd, between Reed Rd. and US-31	Bear River corridor		Stormwater runoff from M-119 has caused erosion of the bluff, affecting and residential properties in Sequoia Yacht Club neighborhood near Good Hart		King Rd., west of Maxwell Rd.		French Farm Creek; Carp River near Cecil Bay Rd., Wilderness Park Dr., and Pointe Dr.	Five Mile Creek near M-119 and Lower Shore Dr.	Entire Village Area; Crooked River S. of M-68 and E. of US-31		
Dams (and hazard potential rating)		2 Low; O'Neal Lake Dam rated "unsatisfactory" condition	1 Low		1 Low					2 Low		1 Low				1 Low	2 Low	1 Significant; 4 Low	1 Low		
# of Road/Stream Crossings with a Moderate to Severe Rating	32		1		1	1	1	5	2	15	7	12			12	10	2	6	2		1
# of Bridges with Poor, Serious, Critical or Closed Ratings																				1	
Estimated number of residents with a disability	839	109	187	30	38	87	154	342	444	141	206	742	85	63	312	214	92	222			
% of residents > age 65	22.3%	25.9%	32.8%	23.4%	40.8%	23.1%	44.0%	22.5%	17.7%	20.5%	16.5%	23.5%	26.9%	32.7%	23.9%	17.6%	33.9%	43.9%	11.6%	35.2%	12.3%
Est. % of residents that are in poverty (in 2022)	7.8%	10.9%	30.7%	6.0%	8.8%	6.6%	11.0%	7.1%	11.1%	13.0%	9.5%	7.9%	10.9%	7.0%	3.8%	5.7%	11.5%	3.2%	11.8%	16.7%	13.4%
Est. % of households that are ALICE (in 2022)	33%	48%	65%	24%	46%	28%	40%	35%	33%	45%	51%	35%	38%	41%	19%	18%	52%	29%	N/A	N/A	N/A
Est. # of residents that are of a minority race	645	77	73	86	43	83	121	240	405	119	189	659	80	42	239	199	102	132	99	113	120
Est. # of residents that are of Hispanic or Latino origin (of any race)	112	4	5	10	2	10	20	57	49	10	11	140	27	7	64	25	12	27	7	24	4

Emmet County Community Vulnerabilities																					
	Bear Creek Township	**Bliss Township**	**Carp Lake Township**	**Center Township**	**Cross Village Township**	**Friendship Township**	**Harbor Springs City**	**Little Traverse Township**	**Littlefield Township**	**Maple River Township**	**McKinley Township**	**Petoskey City**	**Pleasantview Township**	**Readmond Township**	**Resort Township**	**Springvale Township**	**Wawatam Township**	**West Traverse Township**	**Village of Alanson**	**Village of Mackinaw City**	**Village of Pellston**
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Wildfire Vulnerabilities																					
Eastern Pine and Red Pine Forest	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X
Jack Pine Forest	X	X	X		X				X		X			X	X	X	X				X
Campgrounds	Jellystone Park; Hearthside Grove Motorcoach Resort; Petoskey State Park	Wilderness State Park - campground and two rustic cabin sites						LTBBOI Rustic Campground	El Rancho RV Campers Country Club; Camp Petosega			Magnus Park		Blissfest CG	Sun Outdoors RV Park	Camp Petosega	KOA Campground Mackinaw City		El Rancho RV Campers Country Club; Artesian Springs RV Resort		
Wildland Fire Incidents, 2014-2023 https://www.mcgi.state.mi.us/wildfire/index.html	1	1	2	3	2	1	0	8	4	11	4	2	1	0	2	7	2	1	1	0	1
Wildfire Hazard Concern Areas (from public input)		Farmland			Area along Chippewa Dr., Lake Shore Dr., Sturgeon Bay Dr.			Quick Road corridor between Hoyt and Pleasantview Roads			Farmland		Farmland					Farmland			
Emmet County-designated Agricultural Enterprise District Areas	X	X	X	X		X		X	X	X	X		X	X	X	X		X			
Estimated number of residents with a disability	839	109	187	30	38	87	154	342	444	141	206	742	85	63	312	214	92	222			
% of residents > age 65	22.3%	25.9%	32.8%	23.4%	40.8%	23.1%	44.0%	22.5%	17.7%	20.5%	16.5%	23.5%	26.9%	32.7%	23.9%	17.6%	33.9%	43.9%	11.6%	35.2%	12.3%
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Est. % of households that are ALICE (in 2022)	33%	48%	65%	24%	46%	28%	40%	35%	33%	45%	51%	35%	38%	41%	19%	18%	52%	29%	N/A	N/A	N/A
Est. # of residents that are of a minority race	645	77	73	86	43	83	121	240	405	119	189	659	80	42	239	199	102	132	99	113	120
Est. # of residents that are of Hispanic or Latino origin (of any race)	112	4	5	10	2	10	20	57	49	10	11	140	27	7	64	25	12	27	7	24	4
Drought Vulnerabilities																					
Public Outdoor Recreation Acreage (excluding LTC properties)	2,269	13,412	6,945	6,309	1,556	5,092	79	1,068	1,582	2,862	9,965	1,522	10,096	5,636	690	10,702	6,507	132	Included in Littlefield Twp.	Included in Wawatam Twp.	Included in McKinley Twp. & Maple River Twp.
Private/Semi-private Outdoor Recreation Acreage	178	81	180			212	9	163	4	240	2,700		2,700		450		46	1,032	43		
Municipal Water Systems							Yes					Yes								Yes	
Emmet County-designated Agricultural Enterprise District Areas	X	X	X	X		X		X	X	X	X		X	X	X	X		X			

Emmet County Community Vulnerabilities																					
	Bear Creek Township	**Bliss Township**	**Carp Lake Township**	**Center Township**	**Cross Village Township**	**Friendship Township**	**Harbor Springs City**	**Little Traverse Township**	**Littlefield Township**	**Maple River Township**	**McKinley Township**	**Petoskey City**	**Pleasantview Township**	**Readmond Township**	**Resort Township**	**Springvale Township**	**Wawatam Township**	**West Traverse Township**	**Village of Alanson**	**Village of Mackinaw City**	**Village of Pellston**
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Invasive Species Concerns																					
Areas identified as a locations of particular concern (from public input)	Bear River corridor; Tannery Creek area near US-31; Round Lake - Powell Rd. boat launch		Lake Paradise - Paradise Trail boat launch	Larks Lake - Kaz Rd. boat launch					Crooked Lake			Bear River corridor				Pickerel Lake - Botsford Rd. boat launch; Crooked Lake	French Farm Lake				
Public Health Emergency Vulnerabilities																					
Hospital or Assisted Living Facility (CI)	Independence Village; American House						Bay Bluffs; The Village of Hillside	Pineview Cottage				McLaren Northern MI Hospital; Villa at the Bay			Mallard Cove			Perry Farms Village & The Birches			
Estimated number of residents with a disability	839	109	187	30	38	87	154	342	444	141	206	742	85	63	312	214	92	222			
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Est. # of residents that are of a minority race	645	77	73	86	43	83	121	240	405	119	189	659	80	42	239	199	102	132	99	113	120
Est. # of residents that are of Hispanic or Latino origin (of any race)	112	4	5	10	2	10	20	57	49	10	11	140	27	7	64	25	12	27	7	24	4

Emmet County Community Capabilities

	Bear Creek Township	Bliss Township	Carp Lake Township	Center Township	Cross Village Township	Friendship Township	Harbor Springs City	Little Traverse Township	Littlefield Township	Maple River Township	McKinley Township	Petoskey City	Pleasantview Township	Readmond Township	Resort Township	Springvale Township	Wawatam Township	West Traverse Township	Village of Alanson	Village of Mackinaw City	Village of Pellston
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Police, Fire, and EMS Service Locations	1 Fire Station on Division Road; 1 future fire station planned for Click Road.	1 Fire Station	1 Fire Station				Police Station and Fire Dept.	County Sheriff's Office; 1 Fire Station; 1 County EMS Station			At Pellston Aiport: County Sheriff's station; Aircraft Rescue/Fire fighting	Fire Station /Public Safety; County Sheriff's Office & Jail		1 Township Fire Station on Wormwood Road; RFC Fire and Rescue on W. Robinson Rd.	County EMS Station; Petoskey Public Safety Station West; Resort Twp. Fire Station	Fire Station		Birchwood Fire and Medical First Response	Fire Station	County EMS Station; Fire Station in Cheboygan County side of the city	Fire Station
Emergency Shelter Sites												Emmet County Fairgrounds								Village Recreation Center	
Tornado Siren		Wilderness State Park					E. Bluff Drive and N. Spring St.					At North Central Michigan College									
Hospitals	Odawa Casino; Odawa Hotel											McLaren Northern MI Hospital									
County Planning and Zoning	Yes - includes county zoning for 12 townships; remaining jurisdictions have their own zoning.																				
County Master Plan	Yes - 2021-2025																				
County Parks and Rec. Plan	Yes - 2023-2027																				
Local Zoning Ordinance	County Zoning - Updated May 2, 2024						City Zoning - Updated May 20, 2024	Township Zoning - Amended 2017	County Zoning - Updated May 2, 2024			City Zoning - March 2022	Township Zoning, 2012	County Zoning - Updated May 2, 2024	Township Zoning, Amended 2021	County Zoning - Updated May 2, 2024		Township Zoning - Amended June 2023	Village Zoning, Amended 1993	Village Zoning, 2018	Village Zoning, 2021
Local Master Plan	2020					2024	2022	2023				2021	2009	2023	2024-2029			2020		2018	2024
Local Parks & Recreation Plan	2021-2025					2009	2023-2027	2018-2022	2023-2027			2023-2027			2021-2025			2006-2011	2023-2027	2019-2024	2013-2018
Local Capital Improvements Plan and related funding							2024-2029					2022-2027								2023-2028	
Local Farmland and Open Space Preservation Program (PDR)															X						
Dam Emergency Action Plans	None of the dams in the County have a "high hazard potential" rating, and are therefore not required to have an Emergency Action Plan on file.																				
Public beaches with HDNW water quality monitoring	Petoskey State Park	Wilderness State Park; Sturgeon Bay			Cross Village Beach		Zorn Park	Little Traverse Township Park	Littlefield Township Park					Middle Village Park		Camp Petosega	Mackinaw City's Beaches #1 and #2				
Soil Erosion, Sedimentation, and Stormwater Control enforcement/permitting	Emmet County Planning, Zoning and Construction Resources Office											(City issues their own soil erosion control permits)	Emmet County Planning, Zoning and Construction Resources Office								
State Construction Codes (enforced/permitted by the County's Planning, Zoning and Construction Resources Office.)	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		
Watershed Management Plans (WMP) from Tip of the Mitt Watershed Council	Tannery Creek WMP (2013); Little Traverse Bay WMP (2007)		Paradise Lake Management Plan (2017)	Larks Lake WMP (2022)		Little Traverse Bay WMP (2007)	Little Traverse Bay WMP (2007)	Little Traverse Bay WMP (2007)				Little Traverse Bay WMP (2007)	Little Traverse Bay WMP (2007)		Little Traverse Bay WMP (2007)	Little Traverse Bay WMP (2007)		Little Traverse Bay WMP (2007)			
Lake Management Organizations	Pickerel-Crooked Lakes Association; Walloon Lake Association and Conservancy		Paradise Lake Improvement Board and Paradise Lake Assn.	Larks Lake Association				Pickerel-Crooked Lakes Association	Pickerel-Crooked Lakes Association						Walloon Lake Association and Conservancy	Pickerel-Crooked Lakes Association					
Local Floodplain Management Ordinance (NFIP participant; Flood Maps issued in 2022)					X	X	X	X				X		X		X		X		X	
State Designated Critical Dune Areas - permits issued by EGLE	X	X			X			X									X				
State Designated High Risk Erosion Areas - permits issued by EGLE	X	X			X							X		X				X			
Emmet County Phragmites Control Ordinance (enacted in 2010 to control and eradicate phragmites along the Lake MI Shoreline)	X	X			X	X	X	X				X		X	X		X	X		X	
Open Burning Regulations	MDNR's website https://www2.dnr.state.mi.us/burnpermits/ indicates if open burning is permitted in a county without a permit, or if there are burn permit restrictions in effect.						Not permitted	MDNR burn permits website				Not permitted	MDNR burn permits website						Permit required by the Village	MDNR burn permits website	

Emmet County Community Capabilities

	Bear Creek Township	Bliss Township	Carp Lake Township	Center Township	Cross Village Township	Friendship Township	Harbor Springs City	Little Traverse Township	Littlefield Township	Maple River Township	McKinley Township	Petoskey City	Pleasantview Township	Readmond Township	Resort Township	Springvale Township	Wawatam Township	West Traverse Township	Village of Alanson	Village of Mackinaw City	Village of Pellston
Population (2020 Decennial Census)	6,542	568	748	525	240	954	1,274	2,657	3,200	1,295	1,294	5,877	918	560	2,835	2,146	711	1,768	778	846	774
Local Zoning Ordinances - Waterfront Protections																					
Minimum Waterfront Setback	County Zoning Ordinance Section 22.11: Minimum Waterfront Setback						City Zoning: "Residential Waterfront" and "Waterfront" Zoning District setbacks; Floodplain and Shoreline Protection Strip (SPZ) Overlay Districts	Twp. Zoning: No specifics; Section 1105B Site Design Req. and Section 1508 Site Plan Review	County Zoning Ordinance Section 22.11: Minimum Watefront Setback			Only site plan review requirements to indicate environmental features, including floodplains	Twp. Zoning Section 4.09: minimum 100 ft. setback from odrinary high water mark	County Zoning Ordinance Section 22.11: Minimum Watefront Setback	Twp. Zoning Ord. Sections 1808 Waterfront Regulations, Setbacks and Greenbelts; and 2005 Site Plan Review	County Zoning Ordinance Section 22.11: Minimum Watefront Setback		Twp. Zoning Section 312 W-1 Waterfront Overlay District. Applies to the lake side of M-119 and all of Harbor Point.	Only general site plan review requirements to identify natural features how impacts on natural environment are mitigated	Site plan review requires identification of natural features; an Environmental Impact Statement may be required	Village Zoning, Section 4.15 The Greenbelt Area is land and water 100' from center line of the Maple River; no buildings are permitted here
Waterfront Greenbelt Requirement	County Zoning Scenic Resource (SR) District 40' greenbelt requirement						City Zoning: Shoreline Protection Strip (SPZ) Overlay District	None	County Zoning; no SR district in Littlefield Twp.	County Zoning Scenic Resource (SR) District 40' greenbelt requirement		None	No major lakes in the Township; site plan review requirements to show how impacts on natural environment are mitigated	County Zoning Scenic Resource (SR) District 40' greenbelt requirement		County Zoning Scenic Resource (SR) District 40' greenbelt requirement		Twp. Zoning Section 312 W-1 Waterfront Overlay District. Applies to the lake side of M-119 and all of Harbor Point.			Village Zoning, Section 4.15 The Greenbelt Area
Lake MI Shoreline Bluff Protection			N/A	N/A	Emmet County Zoning Ordinance - Shoreline Bluff Protection Zone		City Zoning: Shoreline Protection Strip (SPZ) and Restricted Bluff Zone Overlay Districts	Twp. Zoning: No specifics; Section 1105B Site Design Req. and Section 1508 Site Plan Review	N/A	N/A	N/A	None	N/A	County Zoning Ordinance - Shoreline Bluff Protection Zone	Twp. Zoning Ord. Sections 1807, 1808 and 2005	N/A	N/A	Twp. Zoning: Waterfront Overlay Zoning District - along all of Township adjoining Lake MI Shoreline	N/A		N/A
Critical Dune Areas	Emmet County Zoning Ordinance	Emmet County Zoning Ordinance	N/A	N/A	Emmet County Zoning Ordinance	N/A	N/A	Twp. Zoning: Section 1105B Site Design Req. and Section 1508 Site Plan Review	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	Emmet County Zoning Ordinance	N/A	N/A	N/A	N/A
High Risk Erosion Areas			N/A	N/A		N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A		Twp. Zoning Ord. Sections 1807 High Risk Erosion & Envtl. Areas and 2005 Site Plan Review	N/A	N/A		N/A	N/A	N/A

VI. GOALS AND OBJECTIVES

The mission of the Emmet County Hazard Mitigation Plan is to permanently eliminate or reduce long-term risks to people and property from hazards so that assets such as transportation, infrastructure, commerce, and tourism can be sustained and strengthened. This can be accomplished through collaborative efforts/activities amongst agencies within the county to protect the health, safety, and economic interests of the residents and businesses through planning, awareness, and implementation.

Specific goals and objectives have been established based upon the community's natural hazards analysis, as well as input from the Task Force participants and the public through meetings, request for comments on the draft plan, and the presentation of the plan to the Local Emergency Planning Team.

Goal 1: Increase local awareness and participation in hazard mitigation strategy implementation
Objectives:

A. Encourage cooperation and communication between planning and emergency management officials
B. Encourage additional local governmental agencies to participate in hazard mitigation projects
C. Encourage public and private organizations to participate in hazard mitigation projects
D.

Goal 2: Integrate hazard mitigation considerations into local community planning processes
Objectives:

A. Enforce and/or incorporate hazard mitigation provisions in building code standards, ordinances, and procedures; and into the county's comprehensive master plan
B. Incorporate hazard mitigation into basic land use regulation mechanisms
C. Update or create zoning ordinances to reflect any new building codes, shoreline protection rules, etc.
D. Incorporate hazard area classifications into standard zoning classifications
E. Improve community education efforts about hazard preparedness and prevention
F. Increase public awareness and use of available emergency warning systems
G. Strengthen the role of the Local Emergency Planning Committee in land development processes
H. Integrate hazard mitigation into the capital improvement planning process so that public infrastructure does not lead to development in hazard-prone areas
I. Encourage county agencies to review local roads, bridges, dams, and related transportation infrastructure for hazard vulnerability

Goal 3: Utilize available resources and apply for additional funding to implement hazard mitigation projects
Objectives:

A. Provide a list of desired community mitigation measures to the State for possible future funding
B. Encourage the application for project funding from diverse entities

Goal 4: Develop and complete hazard mitigation projects in a timely manner

VII. MITIGATION STRATEGIES

Types of Mitigation Actions
The mitigation planning regulations requires that each participating jurisdiction identify and analyze a comprehensive range of specific mitigation actions and projects to reduce the impacts of the hazards identified in the risk assessment. The emphasis is on the impacts or vulnerabilities identified in the risk assessment, not on the hazards themselves. The types of mitigation actions can be classified into the following types:

- Local Plans and Regulations
- Building and Infrastructure Projects
- Natural Systems Protection
- Education and Awareness Programs

Furthermore, a set of evaluation criteria was developed to determine which mitigation strategies were best suited to address the identified problems in Emmet County.

- The measure must be technically feasible.
- The measure must be financially feasible.
- The measure must be environmentally sound and not cause any permanent, significant environmental concerns.
- The measure must be acceptable to those participating in the strategy and/or primarily affected by the strategy.

By anticipating future problems, the County can reduce potential injury, structure losses, loss of utility services such as electric and internet connectivity, and prevent wasteful public and private expenditures. Appendix A can assist with determining future problem areas.

Mitigation Strategies
Strategies were developed based on discussions amongst the Task Force, local officials and a review of FEMA best practices for hazard mitigation. A list of alternative strategies considered is included as Appendix E. The strategies table is grouped according to purpose. Purpose types include: Awareness & Preparation, Shelters, Buildings & Development, Utilities & Technology, and Environment & Natural Resources. The table also includes: a description of each strategy; what natural hazards they address; where the strategy applies; who is responsible for implementing the strategy; how the strategy will be implemented (what resources are available to help execute the strategy); when the strategy could feasibly begin; the level of priority; and what type of strategy it is. Strategies are intended to be action items completed during the 5-year timeframe in which the plan is active. Some strategies may extend beyond the 5-year timeframe due to feasibility or level of difficulty.

Appendix D provides a review of mitigation strategies included in the 2016 plan, their current status, and how they have or have not been incorporated into this plan update. Note that the 2016 mitigation strategies were not assigned priority levels of “high”, “medium”, or “low”; they were simply identified as the following top priority areas for mitigation strategies:

1. Fire Hazards: structural fires and wildfires (countywide)
2. Severe Winter Weather (countywide)
3. Severe thunderstorms, hail, high winds, and tornado (countywide
4. Inland Flooding (Harbor Springs, Boyer Creek, Tannery Creek, Bear River, Alanson Locks, Maple River)
5. Shoreline and steep slope erosion (Lake Michigan/Little Traverse Bay)
6. Groundwater purity and protection from contamination (countywide)

Rationale for Prioritization of the 2024 Mitigation Strategies

The Emmet County Emergency Manager and Local Emergency Planning Committee considered factors like level of need, economic impact, ease of execution/level of effort, cost, and range of benefit (short term, long-term, small group/area, large group/area) when determining the level of priority for each strategy. In general, strategies were given either a high, medium, or low priority level based on the following rationale:

PRIORITY LEVEL	RATIONALE
HIGH	High priority strategies are considered critical to preserve life and property, and will have the largest benefit for the community. High priority strategies often address human health, community safety, and protection of property and critical infrastructure. Many of these strategies have an enforcement standard and financing in place; a high level of need and/or anticipated economic benefit; or a high probability of immediate benefit public health or safety if the hazard event were to occur.
MEDIUM	Medium priority strategies address hazards that do not appear to have immediate benefits to public health or safety, and may have benefits to specific residents or visitors. Many of these strategies consist of ongoing practices, education or planning efforts. If the action item's responsibility pertained to a party that was not available for discussion, we defaulted to "Medium" to respect that they may have a different interpretation of the priority which could not be identified at the time this plan was written.
LOW	Low priority strategies are considered to be long-term mitigation efforts that will be worked on as resources (such as staff or financing) become available. Oftentimes the probability of an impactful hazard event occurring in the geographic area is low, but not impossible, so it should be considered. The impact of these strategies is generally not considered to be absolutely critical to preserving life or property at the current time. Regarding foreseeable short- or long-term health and safety benefits (which may change within 5 years), the word "consider" was used in the action item. The strategy's priority level may also change over time as new situations arise.

The key for the strategy types in the far right columns of the strategies table are as follows:

STRATEGY TYPES

1	**Local Planning & Regulations**
2	**Building & Infrastructure Projects**
3	**Natural Systems Protection**
4	**Education & Awareness Efforts**

VIII. IMPLEMENTATION

Hazard mitigation is any action taken before, during, or after a disaster to permanently eliminate or reduce the long-term risk to human life and property from natural and technological hazards. Mitigation is an essential element of emergency management, along with preparedness, response, and recovery. Emergency management includes four phases: actions to mitigate a disaster, a community prepares for a disaster; responds when it occurs; and then there is a transition into the recovery process. The process is cyclical and mitigation measures are evaluated and adopted constantly. The evaluation improves the preparedness posture of the County for the next incident, and so on. When successful, mitigation will lessen the impacts of natural hazards to such a degree that succeeding incidents will remain incidents and not become disasters.

Resources to Assist with Implementing the Strategies
To assist with the funding and/or enacting of the proposed natural hazards mitigation strategies, the Resources Table on the previous pages lists multiple resources that can help fund, staff or otherwise support the implementation of hazard mitigation strategies. Each potential entity or program is assigned a letter code, listed in the "Resources" column of the strategies table.

The following is a general list of some of the financial assistance entities to help fund strategic actions of the Plan.

- Federal Emergency Management Administration – Hazard Mitigation Grant and Building Resilient Infrastructure and Communities Programs
- U.S. Environmental Protection Agency
- U.S. Department of Agriculture Natural Resources Conservation Service
- U.S. Department of Agriculture Rural Development: Rural broadband opportunity – high speed telecommunication funding from the Public Telecommunications Facilities Planning and Construction grants
- U.S. Department of Housing and Urban Development
- Michigan Department of Environment, Great Lakes, and Energy
- Michigan Department of Natural Resources
- National Oceanic and Atmospheric Administration
- Community, Regional Foundations
- Businesses

Plan Review, Monitoring, and Evaluation
This Plan is intended to be a resource for building coordination and cooperation within a community for local control of future mitigation and community preparedness. The County Board will lead the implementation of the Hazard Mitigation Plan with assistance from the Emergency Management Coordinator and the Administration. The Local Emergency Planning Team (LEPC) is an inter-agency partnership led by the county's Emergency Management Coordinator and will collaborate to accomplish the goals and objectives of the Plan. The LEPC meets on a regular basis to carry out its duties and has expanded its role to function as the Hazards Task Force. The Hazards Task Force will be responsible for monitoring and implementing the mitigation plan. Staff support will be provided by the Emmet County Emergency Management Coordinator and will coordinate with the County Board of Commissioners.

The Hazards Task Force will perform an annual review of the Emmet County Hazard Mitigation Plan and consider the list of mitigation strategies identified in the plan. The Task Force will identify projects that have been completed and identify new projects to be completed. The following organizations will be encouraged to actively participate in revising, updating, and maintaining the plan:

- Emmet County Government Staff
- Emmet County Road Commission
- Cities, Townships and Villages (elected and appointed officials)
- Little Traverse Bay Bands of Odawa Indians
- Mackinac Bridge Authority

- Pellston Regional Airport Authority
- Harbor-Petoskey Airport Authority
- Emmet Conservation District
- Charlevoix, Antrim, Kalkaska and Emmet Coordinated Invasive Species Management Area
- Little Traverse Conservancy
- Tip of the Mitt Watershed Council
- Walloon Lake Association and Conservancy
- McLaren Hospital – Petoskey
- Petoskey and Harbor Springs Chambers of Commerce
- Networks Northwest
- Health Department of Northwest Michigan
- Michigan State University Extension
- Michigan Department of Environment, Great Lakes, and Energy
- Michigan Department of Natural Resources
- Michigan State Police
- U.S. Environmental Protection Agency
- U.S. Coast Guard
- U.S. Army Corps of Engineers
- U.S. Department of Agriculture Natural Resources Conservation Service
- American Red Cross
- National Weather Service (Gaylord)
- Enbridge Energy
- Insurance and real estate companies

In addition, the townships, cities and villages within the county have indicated to the county emergency manager that they will follow the county's lead in identifying hazard mitigation projects and developing grant applications to fund those projects. Land use issues associated with those projects (where applicable) will be handled by each jurisdiction that have an adopted Master Plan and regulated zoning in the project area (all communities in Emmet County). Professional planners assist the individual communities in developing plans and zoning ordinances, provides resource information and technical assistance, and convenes communities to address land use issues of common interest.

Building, zoning, and soil erosion permits are issued for applicable construction projects in all Emmet County communities. The location of the property determines which agency issues the following permits. Building permits are issued by Emmet County Planning, Zoning and Construction Resources (PZCR) or Bear Creek Township. Zoning permits are issued by either the city, village, or township with an adopted zoning ordinance or Emmet County PZCR. Soil erosion permits are issued by either Emmet County or the City of Petoskey.

Permits related to water well and septic systems are issued by the Health Department of Northwest Michigan. Permits related to State-designated Critical Dune Areas and High-Risk Erosion Areas are issued by the Michigan Department of Environment, Great Lakes, & Energy (EGLE) for all communities.

Plan Integration

All governmental entities that own and manage property in Emmet County will consider integrating information from the hazard mitigation plan into their comprehensive and operations plans. As part of the education and outreach aspect of the hazard mitigation effort, the local communities will be encouraged to adopt new or modified zoning regulations to minimize the risk and impact from hazards.

All natural hazards mitigation planning could be pursued using Michigan Public Act 226 of 2003, the Joint Municipal Planning Act. This Act provides for joint land use planning by cities, villages, and townships, and allows two or more municipalities' legislative bodies to create a single joint planning commission to address planning issues. This tool helps with planning for the "big picture" issues such as natural hazards that cross jurisdictional boundaries. The intent of this legislation is for local governments to consider the following:

- Individual units of government modifying their ordinances simultaneously to include language that would incorporate aspects of protection
- Developing an overlay zoning district that would cross jurisdictional boundaries which would be incorporated into existing independent units of government's zoning ordinances
- Forming a new joint (multi-jurisdictional) planning commission or zoning board
- Sharing zoning administration and enforcement activities

Five Year Plan Review and Update

The Stafford Act, as amended by the Disaster Mitigation Act of 2000, requires the County's Hazard Mitigation Plan to be updated, adopted, and re-submitted for Federal Emergency Management Agency (FEMA) approval every five years. The plan will be reviewed by the Natural Hazards Task Force every five years in alignment with federal regulations. The update will include determining changes in the county, such as changes in development; an increase in exposure to hazards; an increase or decrease in the communities' capability to address hazards; addition and/or removal of mitigation actions and strategies; reviewing goals; and a change in federal or state legislation. Upon completion, the updated plan will be sent to the State Hazard Mitigation Officer at the Michigan State Police for final review and approval in coordination with FEMA. When the plan has received an "approved pending adoption" status from FEMA, the Emmet County Board of Commissioners, along with individual local units of government that participated in the plan's development, can formally adopt the plan. In order to properly update the plan in the future, Emmet County will need to seek funding from appropriate state and/or federal agencies.

Continued Public Involvement

Emmet County is committed to keeping the public involved in the implementation and update of the Hazard Mitigation Plan. Copies of the plan will be available at the county libraries, county clerk's office, and all township offices, and will be posted on the community websites and/or regional planning agency website. The Emergency Management Office will be responsible for keeping a record of public comments on the plan.

APPENDIX A: MAPS

1. Environmental Features
2. Infrastructure
3. Hazard Areas
4. Vulnerable Populations and Hazard Areas

APPENDIX B: COMMUNITY SURVEY RESULTS

APPENDIX C: PUBLIC INPUT SESSIONS – FEEDBACK

3/14/2023 Notes HM Community Stakeholder Meeting – Natural Hazards Discussion

Participants were asked to provide their top three natural hazards of concern in Emmet County. Severe winter weather events and high winds ranked in the top three hazards of concern, followed by shoreline erosion, inland flooding and invasive species.

Natural Hazards of Concern, 3/14/23 Emmet County Stakeholder Meeting

Hazard	# of Times Mentioned
Heavy Snow, Winter Storm or Blizzard	16
High Winds	13
Ice Storm	10
Shoreline Erosion	8
Inland Flooding	3
Invasive Species	3
Extreme Cold	2
Inland Flooding	2
Severe Thunderstorm	1
Seiche	1
Tornado	1
Shoreline Flooding	1
Wildfire	1

Discussion amongst the participants regarding the potential for the following natural hazards to affect the local economy, environment, and population:

Invasive Species
- Emerald Ash Borer, Oak Wilt and Beech Bark Disease have killed off many trees, increasing the risk of them falling over trails or onto power lines in high winds. ("Beech Snap" is when an infected beech tree breaks off in heavy winds before dying.)
- Decrease in property value; damage to property
- Loss of ecological functions/less biodiversity/ecological imbalance can impact tourism economy, local industries that rely on natural resources (i.e., quality of freshwater for recreation/tourism; diseases and pests affecting crop and tree farming, fishing)
- Effort and cost to reduce/eliminate invasive species is costly to landowners
- Animals: Cormorants, Canadian geese
- Aquatic: Sea lamprey, Zebra mussels; lakes have an ongoing invasive weeds issue – I.e., Crooked Lake and Carp Lake all have Eurasian Water Milfoil
- Insects: Gypsy moths, Japanese beetles, EAB

Severe Winter Weather
- Transportation closures and delays (road and air); secondary roads last to be cleared
- Airport has had 6-8 foot snow drifts; has aging equipment to handle snow/ice removal
- Can clear snow off main roads, but need to educate people to not drive unless necessary; still dangerous to travel
- Some areas in the County are only accessible by a single road, preventing/limiting access for emergency assistance
- Property damage; fallen trees; debris cleanup; collapsing roofs from heavy snow
- Notifications: RAVE is used to send out emergency messages. People need to sign up. Some people don't want to give up privacy when signing up. Tourists (winter and summer) may not know of the service and also might not know they won't have cellular phone service coverage in parts of the county.
- Critical infrastructure failure (electricity, communications, roads, water, sewer…Most people are on individual water wells that require electricity to operate.)

- Managing hazardous waste/material
- Understanding where to put cleared snow – this part of Emmet County Planning Commission's site plan review criteria.
- Financial impact – loss of business due to transportation delays, event and appointment cancellations, temporary closures
- Need to provide warming shelters for those without power or in substandard housing

Thunderstorm
- Can be accompanied by high winds, lightning, straight line winds, hail
- Delays in air travel, road and marine travel
- Road washout/road blockages from trees, debris, downed power lines
- Flooding
- Critical infrastructure failure: electricity (lines down; transformers damaged), communications, roads, water, sewer…
- Property damage
- Debris cleanup
- Difficult to access people who need assistance if roads are impassible
- Access to fuel an issue if power is out
- People who rely on electricity to medical devices (home dialysis, airway support) are vulnerable

Wildfire/Drought/Heat
- Large farming community – drought affects crops (particularly corn, wheat and soybeans) and livestock. The quality/quantity of local food and ag. products may drop.
- Most farms do not have large irrigation systems, but some farms have been investing in installing them recently.
- Proximity to lakes and rivers can help with enduring extreme heat events
- Extreme heat can cause heat stroke in outdoor workers, elderly, very young, disabled, especially if they don't have air conditioning.
- Extreme heat negatively affects the health of cold-water fish populations, fish hatcheries, and livestock.
- Drought reduces lake levels, causing lakeshore property owners to extend the length of their docks from the shoreline.
- Drought increases likelihood and severity of wildfire. A lighting strike during a drought could easily spark a wildfire. Also forest clear cutting can increase wildfire risk.
- Hardwood trees in the county generally don't burn; forest tree species are suited to sandy soils that drain quickly; risk is low in the early spring fire season. Leaves/grass are more prone to burning.

4/5/2023 Notes
HM Community Stakeholder Meeting Technological and Human-Induced Hazards Discussion

Participants were given five sticky notes and asked to write down their top five technological/human-induced-hazards that would have the greatest impact in Emmet County. A hazardous materials transportation accident was the most often mentioned hazard of concern, followed by energy failure, a cyberattack or public health emergency, communications failure, and road bridge failure.

Top Technological and Human-Induced Hazards of Concern, 4/5/23 Emmet County Stakeholder Meeting

Hazard	# of Times Mentioned
Hazardous Materials Transportation Accident	15
Energy failure	14
Cyber Attack	12
Public Health Emergency	12
Communications Failure	10
Road Bridge Failure	9
Public Water Failure	8
Pipeline/Wellhead Failure	6
Civil Disturbance	5

Stephanie reviewed project purpose, definitions, and survey results. Matthew reviewed non-natural hazards slides.

Discussion amongst the participants regarding the potential for the following technological or human-induced hazards to affect the local economy, environment, and population:

INDUSTRIAL HAZARDS

Hazardous Materials Fixed Sites Incidents
PFAS Contamination of Groundwater from Pellston Airport
Discuss sensitivity of the issue; it's an ongoing investigation. The county is monitoring and remedial action is underway. Will gain more awareness of impact as mitigation progresses. Ongoing coordination with EGLE and EPA, however, state and federal agencies are slow to identify PFAS as hazardous chemical. EPA does not currently recognize PFAS/AFFF as a hazardous material, which makes it difficult to regulate and will make funding difficult for future cleanup efforts.

To prevent further contamination, the Airport is not using AFFF anymore in their firefighting truck. They use a PFAS-free synthetic firefighting foam.

The Pellston Airport could experience impacts from most technological/human-induced hazards (structural fire, haz material fixed site incident, infrastructure failure, public health emergency, terrorism/civil disturbance, major transportation accident), resulting in personal injury; loss of life; damage to natural environment; damage to economy and property (major employer in area; huge source of revenue for the county).

Hazardous Materials Transportation Incidents
Matthew discussed the difficulty in getting clear, accurate reporting of what is transported through the communities. Need to clarify where the data comes from and who and how it gets reported. In the CCE 911 database, the incident reporting agency (law enforcement, fire, EGLE, police, etc.) isn't clear on what was released in a spill of hazardous materials during a transportation accident. Do things even get reported? Sharing information between agencies is also not done well.

Pipeline and Wellhead Incidents: Petroleum and Natural Gas
A portion of Enbridge Energy's Line 5 pipeline sends crude oil and natural gas liquids through the Straits of Mackinac. After the 2018 anchor strike incident, Enbridge is now alerting the USCG and private industry if

anchors are not visible on ship decks as they pass through the straits.

Structure Fires
- Neighborhoods of Wequetonsing, Harbor Point (access by boat for fire extinguishing and rescue), and Bay Harbor due to density and age of timber structures for property damage and personal injury/death.
- All downtowns (HS, Petoskey, Bay Harbor, Pellston, Alanson, Mackinaw City)
- Neighborhoods that are located in river valleys – hard to access; fire can spread quickly up the hillsides at Bay Harbor Cliffs, Bear River Valley area neighborhoods in Petoskey;
- Hospital (large complicated complex of buildings and access points)
- Elder care/assisted living facilities
- Ski Areas – Highlands, Trout Creek, Nubs Nob area neighborhoods
- Tribal Government Center in Little Traverses Township – surrounded by pine forest

Nuclear Power Plant Emergencies
CHX former nuclear power plant site: Federal government does not have money available to transport spent fuel rods to a main disposal site. CHX County does have a response plan for Big Rock Point.

INFRASTRUCTURE HAZARDS

Built Infrastructure Failure
Infrastructure update from Commissioner Brian Gutowski (Emmet County Road Commission). Maple River Dam has been replaced with clear span bridges. Was the only bridge of seven listed on the National Inventory of Dams for Emmet County that required an Emergency Action Plan.

There is one bridge left to replace in 2023 over the East Branch Maple River: Douglas Lake Road. Once this is complete both the East and West branches of the river will flow completely unencumbered with the free span bridges that replaced old culverts. ("Free Span the Maple Initiative" through the Conservation Resource Alliance").

Corridors that are shared by multiple underground utilities. If a line is accidentally severed when digging, can take out a large service network area.
Most of the County's infrastructure is aging: electrical grid, roads, culverts, water, sewer

Major Transportation Incidents
Include the Little Traverse Ferry service and Lake Michigan Cruise Lines in discussion in the plan.
Concern about electric vehicles – if they catch fire they are just left to burn, damaging the road bed. (There is no way to access the fuel cells directly to cool them down with water).
Comment from Commissioner Neil Ahrens there are concerns about condition of rail/road crossings. No specific locations mentioned. Railroad/road crossings are a weak point in our transportation system. There is however State funding to fix these but the RC/local governments have to coordinate rail line/road crossing improvements with the railroad owner. Discuss potential for passenger rail transportation in the future.
In 2018, a tug and barge shipping vessel damaged the Line 5 pipeline (no release occurred) and severed underwater power cables in the Straits of Mackinac. The vessel unknowingly dragged a 12,000-pound anchor across the underwater utility corridor. The damaged power cables spilled 600 gallons of dielectric fluid (this can also be considered an energy failure event and fixed site hazardous materials release).

Energy Failures and Shortages
<u>Pellston Airport</u>
The airport is on two different power grid sources: FAA equipment is on one, and airport equipment is on another. Often get resurges/resets of power, more in the summer/busy travel months/severe summer weather events.

About ¼ of electricity is provided from Great Lakes Energy; the remainder is Consumers Energy. IT is also separate power source with backup at the airport. Do not have power backup for fuel farm; therefore they have to keep their fuel trucks constantly full in case of an outage.

There are underground utility electric/communication utility cables in the Straits of Mackinac as well as in Lake

Michigan between Cross Village Township and Beaver Island, which could be vulnerable to damage from marine vessel anchor strikes.

HUMAN-INDUCED HAZARDS

Public Health Emergency

Chloe Capaldi gave report of experiences during the pandemic. Major issue at the beginning and throughout was communication between the state and federal agencies. Local agencies worked together well. Volunteer participation was high and were able to keep the network going. There was a good response to community testing and vaccine distribution. One drawback was that the state released information to the public that the Health Department was not able to prepare for or review first.

Cyberattack

Cyberattacks have been completed on Emmet County government and the LTBB government. In early March of 2023, Emmet County government experienced a cyberattack. It is a growing threat to county personnel and electronically controlled critical infrastructure.
Concern for communication lines and fiber network as all data and voice communication is over the same lines. One accident can take out the whole network.
There are some groups present in the region that represent a potential threat, such as eco-terrorism groups, anti-Camp Grayling expansion…
Aim to strengthen critical infrastructure, communications systems; adequate EMS/law enf./fire personnel availability, especially during special events (i.e., Labor Day Mackinac Bridge crossing)

Terrorism/Civil Disturbance

Matthew confirmed people and organizations exist within Emmet County that are capable of terrorism and civil disturbance. The group agreed this is a threat, but gathering the data and showing the exact nature of those threats is very difficult. Line 5 has been threatened previously, and it is the most likely place for a future attempt to occur.
Potential targets:

- Mackinaw Bridge (evacuation ability is limited)
    - Annual Bridge Walk
    - Annual Mackinac Policy Conference on Mackinac Island (not in Emmet County) is in late May-early June
- Public and Private Schools
- NCMC (Petoskey)
- Churches
- Large events downtown and on the water; consider summer peak tourism population
- 4th of July, parades, Labor Day, Blessing of the Fleet, Boyne Thunder, County Fair
- Hospital (Petoskey)
- Blissfest in Readmond Township (Event coordinators have their own security plan; coordinate with EM)
- Airport (McKinley Twp.)
- Line 5 area/pumping station (Wawatam Twp.)
- WWTP's (Petoskey, Little Traverse Township, Wawatam Township)
- County Fair (Petoskey)
- Tribal Government Center (Little Traverse Township)
- Bay Harbor – conference center (Petoskey)

APPENDIX D: CURRENT STATUS OF 2016 PLAN STRATEGIES

2016 Emmet County Natural Hazard Mitigation Plan Action Strategies and 2024 Status

2016 Hazard Mitigation Plan Strategies	2016 Responsible Parties	2024 Status	Related Strategies in the 2024 Plan and Priority Level
Priority Area #1. Fire Hazards: Both Structural and Wildfire Mitigation Strategies			
a. Introduce ordinances which encourage proper road and driveway construction for vehicle and fire equipment access.	Road Commission, County Planning & Zoning, Townships, Cities and Villages	Emmet County Zoning Ordinance has established standards for private roads and requires fire department review of certain developments.	Consult with engineering firm to ensure new private roads are built to withstand emergency vehicles.
b. Educate and establish programs which encourage the safe use of fireplaces and chimneys	County Building Inspector, County Planning; First Responders; Public Citizens; Insurance Agencies; Elected Officials; MSUE personnel; EM Coordinator		
c. Have adequate water supplies for emergency firefighting. Identify water supplies available for both structure fires and wildfires. Pre-incident plan identify areas that have no supply. Improve and/or install systems where possible (i.e., install water supply lines and hydrants for drafting from lakes, streams, etc.)	County Building Inspector; EM Coordinator; Local Fire Chiefs	County Planning includes fire department review in new commercial or housing developments.	
d. Identify and pre-plan seasonal roads and transportation routes for access to rural areas.	Fire Chiefs Association, County EM, Elected Officials		
e. Continue to maintain roads and develop connector roads to reduce fire response time.	Road Commission; County Planning		
f. Develop additional fire stations where needed.	Fire Departments	Bear Creek Township is constructing a new second fire station at 1710 Click Road, to meet firefighting needs of the growing Twp.	
g. Identify and/or construct prearranged shelters	County Planning; County Building Inspector; EM Coordinator; Elected Officials	Fairgrounds identified.	
h. Seek grant funding for training and equipment for a regional task force for wildfires.	Tri-County Emergency Managers; 3 Fire Chief Associations; MDNR		
i. Encourage and implement mutual and automatic aid agreements, to ensure adequate manpower is available for firefighting.	County EM, Fire Chiefs Association, Elected Officials		
Structural Fire Mitigation Strategies			
a. Continue education and enforcement of building and zoning codes	County Building Inspector; County Planning and Zoning; Townships, Cities and Villages	Conduct annual educational program "Coffee with the Inspectors". Host zoning training programs. Provide handout materials and links on webpages.	Continue annual programs and providing educational materials.
b. Education for developers, realtors, business owners, architects and engineers	County Building Inspector; County Planning; First Responders; Public Citizens; Insurance Agencies; Elected Officials; Non-profit organizations; MSUE Personnel; EM Coordinator	P&Z met with Emmet Association of Realtors 2022. Email information quarterly.	
c. Public education and school programs, which encourage the development of a Site Emergency Plan for public buildings, a Family Disaster Plan for private households, and the preparation of a Disaster Supplies Kit.			
d. Encourage first responder education of methods and training on a regular basis	First Responders; Emergency Management Coordinator		
e. Review existing publicly owned facilities and their potential need for retrofitting with generators and other services to bring them up to standard.	County Building Inspector; Elected Officials; EM Coordinator		
Wildfire Mitigation Strategies			
a. Educate and encourage the proper maintenance of property in or near wildlands to include the introduction of defensible buffer zones, short grass, thinning trees, and sweeping and cleaning dead or dry leaves and needs from roofs, decks, eaves, porches and yards.	County Building Inspector; County Planning; First Responders; Public Citizens; Insurance Agencies; Elected Officials; Non-profit organizations; MSUE Personnel; EM Coordinator; Townships; Incorporated Cities and Villages		

b. Continue to encourage safe disposal of yard and house waste (recycle or compost) rather than open burning	County Dept. of Public Works; Townships; Incorporated Cities and Villages		
c. Construct fire towers and use fire spotters and planes.	County Planning; County Building Inspector; Emergency Management Coordinator; Public Citizens; Non-profit Organizations; Townships; Incorporated Cities and Villages	"Construct Fire Towers" probably not a strategy.	
d. Encourage programs on arson prevention activities, including the reduction of blight.	County Building Inspector; County Planning; First Responders; Public Citizens; Insurance Agencies; Elected Officials; Non-profit organizations; MSUE Personnel		
e. Public education on smoking hazards and recreational fires.	County Building Inspector; County Planning; First Responders; Public Citizens; Insurance Agencies; Elected Officials; Non-profit organizations; MSUE; EM Coordinator		
f. Continue ongoing communication with media for broadcasting weather and fire warnings.	First Responders, EM Coordinator		
g. Maintain the relationship that exists between MDNR Forest Resources Division and the Local Fire Chief's organization to partner on wildfire response.	Local Fire Chiefs; EM Coordinator, MDNR		
f. Remove trees that have died from insect infestation. The dead trees cause increased fuel load to the area as well as a hazard to motorists.	Road Commission; EM Coordinator		

2016 Hazard Mitigation Plan Strategies	2016 Responsible Parties	2024 Status	Related Strategies in the 2024 Plan and Priority Level
Priority Area #2. Severe Winter Weather: Snow and Ice Mitigation Strategies			
a. Public education and awareness; encourage the use of BeAlert and IPAWS for the protection of residents and visitors.	EM Coordinator; County Planning; County Building Inspector; Non-Profit Organizations; Public Citizens; Townships; Incorporated Cities and Villages; Elected Officials Public citizens; non-profit organizations; MSUE personnel; EM Coordinator; Elected officials		
Expand public awareness that in the event of a large storm with a possible power outage, it may be several days before emergency workers could get to them. This may include being prepared with alternative sources of heat and supplies that will last up to 72 hours following an event.			
b. Identify, improve, and/or construct shelter capacity.			
Identify shelters that could be opened during a storm event and develop a plan for opening them and alerting residents to their location in the event of a storm.			
Ensure that those shelters are equipped with back-up generators, chairs, TV, kitchens and are barrier free compliant.			
c. Promote community programs that provide snow removal for the elderly and/or disabled residents of the county.			
d. Encourage elderly residents to call if help is needed. Such as their heat is out, they need help with snow removal, out of food, etc.			
e. Continue to enforce the building code snow and wind load requirements which is 70 lbs. per sq. ft., especially when there is heavy snow, or rain events preceding freezing temperatures.	County Building Inspector; Public Citizens; Insurance Agencies		

2016 Hazard Mitigation Plan Strategies	2016 Responsible Parties	2024 Status	Related Strategies in the 2024 Plan and Priority Level
Priority Area #3. Severe Thunderstorms, Hail, High Winds, and Tornado Mitigation Strategies			
a. Continue to pass and enforce local ordinances that require new developments to install utilities underground.	County Planning; County Building Inspector; Townships; Incorporated Cities and Villages	Underground utilities required within Planned Unit Developments.	
b. Pass and enforce local ordinances that prohibit plantings under and around power lines.			
c. Education and enforcement of building codes for such activities as bracing elevated platforms, and anchoring and tie downs	County Building Inspector; Public Citizens; Insurance Agencies		
d. Continue ongoing tree management coordination	Business owners; public citizens; Insurance Agencies; Non-Profit Organizations		
e. Public education; encourage the use of IPAWS and the Everbridge BeAlert applications.	EM Coordinator; County Planning; County Building Inspector; Business owners; Non-Profit Organizations; Public Citizens; Townships; Incorporated Cities and Villages; Elected Officials		
f. Seek funding for warning sirens in the most populated areas and tourists destinations. These systems can be expanded as population and tourism demands.	County EM, County/Local Planning Departments, Elected Officials		
g. Require new mobile and pre-manufactured home parks to provide a storm shelter for residents of the park.	County Building Dept.; County/Local Planning Depts.		
h. Pass and enforce special event ordinances that require a plan for patrons to seek shelter in the event of severe weather.	Townships, Elected Officials	(Note – county cannot pass a police power ordinance – which special event ordinance is.)	

2016 Hazard Mitigation Plan Strategies	2016 Responsible Parties	2024 Status	Related Strategies in the 2024 Plan and Priority Level
Priority Area #4. Flooding (around lakes, streams and wetlands)- Flood Mitigation Strategies			
a. Continue assessment of flood threat with regular inspections of dams/locks.	Researchers, Engineers, and Architects; County Planning; Townships; Incorporated Cities and Villages; Elected Officials; Non-Profit Organizations; Insurance Agencies; EM Coordinator		
b. Drainage improvements	Researchers, Engineers, and Architects; County Planning; Townships; Incorporated Cities and Villages		
Examine and improve existing storm systems to ensure storm water drains properly. Storm sewers are inadequate and cause repetitive flooding along U.S. 31 in the Bay View area and along parts of M-119 in Bear Creek Township.	Emmet County Engineer (is this ECRC?), Bear Creek Township, MDOT		Seek grant funding to enlarge Tannery Creek culvert under US 31 and former Chase Bank drive location.
Install storm sewers in Cross Village at the commercial district and at the Catholic church due to repetitive flooding during heavy rain events.	Emmet County Engineer, Cross Village Township		
Erosion and seasonal flood mitigation in Good Hart area: seek funding to prevent damage to roadways and houses along M-119	MDOT, County EM, Road Commission, Readmond Township		
c. Continue enforcement of Storm Water Management Ordinance	Researchers, Engineers, and Architects; County Planning; Townships; Incorporated Cities and Villages; County Soil Erosion and Storm Water Management Officer	County Zoning requires stormwater management plans for commercial development.	Seek consensus for Townships to adopt stormwater management plans.
d. Continue enforcement of building and zoning codes	County Planning; County Building Inspector		
Pass and enforce local zoning ordinances regarding building and development of property that falls within a floodplain.	County/Local Planning Commissions, Zoning Boards, County Building Dept.; County Board of Commissioners		
e. Open space designations: acquisition or conservation easements by land conservancies, county, townships	County Planning; Business Owners; Non-Profit Organizations; Public Citizens; Townships; Incorporated Cities and Villages; Elected Officials	ECPC hosted Little Traverse Conservancy (LTC) at a PC meeting in 2024.	Distribute materials to Townships from LTC.
f. Education for realtors through the creation of a handbook for distribution	Researchers, Engineers, and Architects; County Planning; County Building Inspector; County Soil Erosion and Storm Water Management Officer		
g. Public education	EM Coordinator; County Planning; County Building Inspector; Business Owners; Non-profit Organizations; Public Citizens; Townships; Incorporated Cities and Villages; Elected Officials	P&Z hosted 4 in person workshops & 1 webinar related to Lake Michigan resiliency.	

2016 Hazard Mitigation Plan Strategies	2016 Responsible Parties	2024 Status	Related Strategies in the 2024 Plan and Priority Level
Priority Area #5. Lake Michigan Shoreline and Steep Slope Erosion Mitigation Strategies			
a. Continue enforcement of the Storm Water Management Ordinance and the Soil Erosion and Sedimentation Control Ordinance: slide areas, drainage control, grading, debris flow measures, vegetation (native species) placement	Researchers, Engineers, and Architects; County Planning; Townships; Incorporated Cities and Villages; County Soil Erosion and Storm Water Management Officer; Non-profit organizations; Insurance Agencies		
b. Continue to utilize the Critical Dunes Overlay	– State of Michigan	Emmet County repealed the local Critical Dune Overlay due to state legislative changes.	
c. Education and enforcement of building and zoning codes: setbacks, lot sizes, driveways, relocation of structures, Lake Michigan coastal zoning ordinances – U.S. Army Corps of Engineers and Michigan Department of Environmental Quality	Emergency Management Coordinator; County Planning; County Building Inspector; Business Owners; Non-Profit Organization; Public Citizens; Townships, Incorporated Cities and Villages; Elected Officials; County Soil Erosion and Storm Water Management Officer	P&Z hosted 4 in person workshops & 1 webinar related to Lake Michigan resiliency.	Continue working with EGLE and link citizens with state regulatory contacts.
d. Continue building code enforcement through the permit process.	County Building Inspector		
e. Open space designations: acquisition or conservation easements by land conservancies, state, county, or townships.	County Planning; Business Owners; Non-Profit Organization; Public Citizens; Townships, Incorporated Cities and Villages; Elected Officials	ECPC hosted Little Traverse Conservancy (LTC) at a PC meeting in 2024.	Distribute materials to Townships from LTC.
f. Education for developers, realtors and engineers	Researchers, Engineers, and Architects; County Planning; County Building Inspector; Business Owners; County Soil Erosion and Storm Water Management Officer	P&Z hosted 4 in person workshops & 1 webinar related to Lake Michigan resiliency.	Continue working with EGLE and link citizens with state regulatory contacts.
g. Public Education	Emergency Management Coordinator; County Planning; County Building Inspector; Business Owners; Non-Profit Organization; Public Citizens; Townships, Incorporated Cities and Villages; Elected Officials; County Soil Erosion and Storm Water Management Officer	P&Z hosted 4 in person workshops & 1 webinar related to Lake Michigan resiliency.	Continue working with EGLE and link citizens with state regulatory contacts.
h. Erosion and Flood Mitigation: Seek funding for Good Hart area seasonal flooding to prevent damage to roadways and houses along the M-119 corridor.	EM Coordinator; County Planning; Incorporated Cities and Villages; Elected Officials; Non-Profit Agencies		

2016 Hazard Mitigation Plan Strategies	2016 Responsible Parties	2024 Status	Related Strategies in the 2024 Plan and Priority Level
Priority Area #6. Groundwater purity and protection from contamination strategies.			
a. Pass and enforce local ordinances regarding chemical storage, spill protection for areas where storage and use of hazardous materials is taking place, including but not limited to the storage of old motor vehicles.	County and Local Planning/Zoning Departments		
b. Educate the public about the storage and disposal of hazardous chemicals.	Garbage collection companies; County and Local Planning/Zoning Depts., Elected Officials	Emmet County DPW provides public education on this through their Household Chemical Drop-off Program.	
c. Consider partnering with local disposal companies for hazardous waste drop off days	Garbage collection companies; County and Local Planning/Zoning Depts., Elected Officials	Emmet County DPW offers two household hazardous waste collection days per year, by appointment only.	
d. Encourage and educate residents who have buried underground storage tanks to have them removed and/or pumped out and filled.	MDEQ (now MEGLE); County and Local Planning/Zoning Depts.		

APPENDIX E: CONSIDERATION OF ALTERNATIVE MITIGATION STRATEGIES

Hazard Mitigation Alternatives Considered for Emmet County – 2024 HM Plan

A check mark indicates it was included in the list of mitigation strategies.

Sources: Michigan State Police's *2019 Michigan Hazard Analysis* & *2020 Hazard Analysis Supplement*

Hazard Mitigation Alternatives for Thunderstorm Hazards, Hail, Dense Fog, and/or Lightning	
✓	Increased coverage and use of NOAA Weather Radio, and public early warning systems and networks.
✓	Buried/protected power and utility lines. (NOTE: Where appropriate: Burial may sometimes cause additional problems and costs in cases where eventual cable breakages are harder to locate and more expensive to repair.)
✓	Tree trimming and maintenance to prevent limb breakage and safeguard nearby utility lines. (Ideal: Establishment of a community forestry program with a main goal of creating and maintaining a disaster-resistant landscape in public rights-of-way.)
	Using structural bracing, window shutters, laminated glass in window panes, and impact-resistant roof shingles to minimize damage to public and private structures.
	Moving vehicles into garages or other covered areas.
	Installing lightning protection devices on the community's communications infrastructure and critical structures. More widespread use of lightning protection devices might also occur.
	Purchase of insurance that includes coverage for hail damage.
	Using surge protectors on critical electronic equipment.

Hazard Mitigation Alternatives for Tornadoes and Severe Winds	
✓	Increased coverage and use of NOAA Weather Radio, or comparable device-based notifications.
✓	Public early warning systems and networks.
✓	Tree trimming and maintenance to prevent limb breakage and safeguard nearby utility lines. (Ideal: Establishment of a community forestry program with a main goal of creating and maintaining a disaster-resistant landscape in public rights-of-way.)
✓	Buried/protected power and utility lines. (NOTE: Where appropriate. Burial may cause additional problems and costs when breakage or malfunction occurs, due to the increased difficulty in locating and repairing the problem.)
	Using appropriate wind engineering measures and construction techniques (e.g. structural bracing, straps and clips, anchor bolts, laminated or impact-resistant glass, reinforced entry and garage doors, window shutters, waterproof adhesive sealing strips, and interlocking roof shingles) to strengthen public and private structures against severe wind damage.
✓	Proper anchoring of manufactured homes and exterior structures such as carports and porches.
	Securing loose materials, yard, and patio items indoors, or where winds cannot blow them about.
✓	Construction of concrete safe rooms in homes and shelter areas in mobile home parks, fairgrounds, shopping malls, or other vulnerable public areas or event locations.

Hazard Mitigation Alternatives for Extreme Temperatures	
✓	Organizing outreach to vulnerable populations during periods of extreme temperatures, including establishing and building awareness of accessible heating and/or cooling centers in the community, and other public information campaigns about this hazard.
✓	Increased coverage and use of NOAA Weather Radio.
✓	Provide and publicize designated heating and cooling centers within the community, where persons in need may go to obtain relief from outdoor temperatures.

Hazard Mitigation Alternatives Considered for Emmet County – 2024 HM Plan

A check mark indicates it was included in the list of mitigation strategies.

Sources: Michigan State Police's *2019 Michigan Hazard Analysis* & *2020 Hazard Analysis Supplement*

Hazard Mitigation Alternatives for Winter Weather	
✓	Increased coverage and use of NOAA Weather Radio.
✓	Tree trimming and maintenance to prevent limb breakage and safeguard nearby utility lines. (Ideal: Establishment of a community forestry program with a main goal of creating and maintaining a disaster-resistant landscape in public rights-of-way.)
✓	Buried/protected power and utility lines. (NOTE: Where appropriate. Burial may cause additional problems and costs in case of breakage, due to the increased difficulty in locating and repairing the problem.)
✓	Establishing heating centers/shelters for vulnerable populations.
	Home and public building design and maintenance to prevent roof and wall damage from "ice dams."
✓	Proper building/site design and code enforcement relating to snow loads, roof slope, snow removal and storage, etc.
	Agricultural activities to reduce impacts on crops and livestock.
	Pre-arranging for shelters for stranded motorists/travelers, and others.
	Using snow fences or "living snow fences" (rows of trees or vegetation) to limit blowing and drifting of snow over critical roadway segments.

Hazard Mitigation Alternatives for Fluvial (Riverine) Flooding	
✓	Floodplain management–planning acceptable uses for areas prone to flooding (through comprehensive planning, code enforcement, zoning, open space requirements, subdivision regulations, land use and capital improvements planning) and involving drain commissioners, hydrologic studies, etc. in these analyses and decisions.
	Acceptable land use densities, coverage and planning for particular soil types and topography (decreasing amount of impermeable ground coverage in upland and drainage areas, zoning and open space requirements suited to the capacity of soils and drainage systems to absorb rainwater runoff, appropriate land use and capital improvements planning) and involving drain commissioners, hydrologic studies, etc. in these analyses and decisions.
✓	Dry floodproofing of structures within known flood areas (strengthening walls, sealing openings, use of waterproof compounds or plastic sheeting on walls).
	Wet floodproofing of structures (controlled flooding of structures to balance water forces and discourage structural collapse during floods).
✓	Elevation of flood-prone structures above the 100-year flood level.
✓	Purchase or transfer of development rights - to discourage development in floodplain areas.
	"Floating" architectural designs for structures in flood-prone areas.
✓	Construction of elevated or alternative roads that are unaffected by flooding, or making roads more flood-resistant through better drainage and/or stabilization/armoring of vulnerable shoulders and embankments.
✓	Government acquisition, relocation, or condemnation of structures within floodplain or floodway areas.
✓	Employing techniques of erosion control within the watershed area (proper bank stabilization, techniques such as planting of vegetation on slopes, creation of terraces on hillsides, use of riprap boulders and geotextile fabric, etc.).
✓	Protection (or restoration) of wetlands and natural water retention areas.
✓	Higher engineering standards for drain and sewer capacity, or the expansion of infrastructure to higher capacity.
	Joining the National Flood Insurance Program (NFIP).
	Obtaining flood insurance. (Requires community participation in the NFIP.)
	Participation in the Community Rating System (CRS).

Hazard Mitigation Alternatives Considered for Emmet County – 2024 HM Plan

A check mark indicates it was included in the list of mitigation strategies.

Sources: Michigan State Police's *2019 Michigan Hazard Analysis* & *2020 Hazard Analysis Supplement*

Hazard Mitigation Alternatives for Urban Flooding	
✓	Stormwater management–Adequate design, installation, maintenance, and monitoring of municipal storm sewer systems. Ordinances or amendments to assist in stormwater management (e.g. forbidding illicit discharges). Planning for and regulating areas prone to flooding (acceptable uses and development restrictions through comprehensive planning, code enforcement, zoning, open space requirements, subdivision regulations, purchased or transferred development rights, land use and capital improvements planning) and involving drain commissioners, hydrologic studies, etc. in these analyses and decisions.
	Homeowner's and rental insurance that includes coverage of damages and cleanup of sewer backflow impacts.
✓	Structural projects to channel water away from people and property (dikes, levees, floodwalls) or to increase drainage or absorption capacities (spillways, water detention and retention basins, relief drains, drain widening/dredging or rerouting, debris detention basins, logjam and debris removal, extra culverts, bridge modification, flood gates and pumps, wetlands protection and restoration).
	Higher engineering standards for drain and sewer capacity, or the expansion of infrastructure to higher capacity.
	Drainage easements (allowing the planned and regulated public use of privately owned land for temporary water retention and drainage).
✓	Installing (or re-routing or increasing the capacity of) storm drainage systems, including the separation of storm and sanitary sewage systems.
✓	Farmland and open space preservation.
	Elevating mechanical and utility devices above expected flood levels.
	Flood warning systems and the monitoring of water levels with stream gauges and trained monitors.
✓	Increased coverage and use of NOAA Weather Radio.
	Anchoring of manufactured homes to a permanent foundation in flood areas, but preferably these structures would be readily movable if necessary or else permanently relocated outside of flood-prone areas and erosion areas.
	Control and securing of debris, yard items, or stored objects (including oil, gasoline, and propane tanks, and paint and chemical barrels) in floodplains that may be swept away, damaged, or pose a hazard when flooding occurs.
✓	Back-up generators for pumping and lift stations in sanitary sewer systems, and other measures (alarms, meters, remote controls, switchgear upgrades) to ensure clear drainage infrastructure.
	Detection and prevention/discouragement of illegal discharges into storm-water sewer systems, from home footing drains, downspouts and sump pumps.
	Increasing the function and capacity of sewage lift stations and treatment plants (installation, expansion, and maintenance), including possible separation of combined storm/sanitary sewer systems, if appropriate.
✓	Wetlands protection regulations and policies.
	Use of check valves, sump pumps and backflow preventers in homes and buildings.
✓	Acceptable land use densities, coverage and planning for particular soil types and topography (decreasing amount of impermeable ground coverage in upland and drainage areas, zoning and open space requirements suited to the capacity of soils and drainage systems to absorb rainwater runoff, appropriate land use and capital improvements planning) and involving drain commissioners, hydrologic studies, etc. in these analyses and decisions.
✓	Employing techniques of erosion control within the watershed area (proper bank stabilization, techniques such as planting of vegetation on slopes, creation of terraces on hillsides, use of riprap boulders and geotextile fabric, etc.).
✓	Protection (or restoration) of wetlands and natural water retention areas.
✓	Landslide mitigation ideas: Do not build houses, buildings, parks, or playgrounds close to steep slopes

Hazard Mitigation Alternatives Considered for Emmet County – 2024 HM Plan

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Sources: Michigan State Police's *2019 Michigan Hazard Analysis* & *2020 Hazard Analysis Supplement*

Hazard Mitigation Alternatives for Dam Failures	
✓	Regular inspection and maintenance of dams.
	Garnering community support for a funding mechanism to assist dam owners in the removal or repair of dams in disrepair.
	Regulate development in the dam's hydraulic shadow (where flooding would occur if a severe dam failure occurred).
	Ensuring that dams meet or exceed the design criteria required by law.
✓	Public warning systems.
	Obtaining insurance.
✓	Increased coverage and use of NOAA Weather Radio
	Increased funding for dam inspections and enforcement of the Dam Safety Program (Part 315 of the Natural Resources and Environmental Protection Act) requirements and goals.
	Constructing emergency access roads to dams, where needed.
	Pump and flood gate installation/automation.

Mitigation Alternatives for Drought	
✓	Storage of water for use in drought events (especially for human needs during periods of extreme temperatures, and for responding to structural fire and wildfire events).
	Legislative acts, local ordinances, and other measures to prioritize or control water use.
✓	Encouragement of water-saving measures by consumers (including landscaping, irrigation, farming, lower priority lawn maintenance, and non-essential auto washing).
✓	Anticipation of potential drought conditions, and the preparation of drought contingency plans.
	Designs, for recreational and other water-related structures and land uses, that take into account the full range of water levels (of lakes, streams, and groundwater).
	Designs and plans for water delivery systems that include a consideration of drought events.
	Obtaining agricultural insurance.

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.

Hazard Mitigation Alternatives for Wildfire	
✓	Proper maintenance of property in or near wildland areas (including short grass; thinned trees and removal of low-hanging branches; selection of fire-resistant vegetation; use of fire resistant roofing and building materials; use of functional shutters on windows; keeping flammables such as curtains securely away from windows or using heavy fire-resistant drapes; creating and maintaining a buffer zone (defensible space) between structures and adjacent wild lands; use of the fire department's home safety inspections; sweeping/cleaning dead or dry leaves, needles, twigs, and combustibles from roofs, decks, eaves, porches, and yards; keeping woodpiles and other combustibles away from structures; use of boxed or enclosed eaves on houses; thorough cleaning-up of spilled flammable fluids; and keeping garage areas protected from blowing embers).
✓	Safe disposal of yard and house waste rather than through open burning.
✓	Use of fire spotters, towers, planes.

Hazard Mitigation Alternatives Considered for Emmet County – 2024 HM Plan

A check mark indicates it was included in the list of mitigation strategies.

Sources: Michigan State Police's *2019 Michigan Hazard Analysis* & *2020 Hazard Analysis Supplement*

✓	Use of structural fire mitigation systems such as interior and exterior sprinklers, smoke detectors, and fire extinguishers.
✓	Arson prevention activities, including reduction of blight (cleaning up areas of abandoned or collapsed structures, accumulated junk or debris, and lands with a history of flammable substances stored, spilled, or dumped on them).
✓	Public notification of fire weather and fire warnings.
✓	Prescribed burns and fuel management (thinning of flammable vegetation, possibly including selective logging to thin out some areas. Fuels cleared can be given away as firewood or made into wood chips for distribution.)
✓	Have adequate water supplies for emergency fire-fighting (in accordance with NFPA standards).
	The creation of fuel breaks (areas where the spread of wildfires will be slowed or stopped due to removal of fuels, or the use of fire-retardant materials/vegetation) in high-risk forest or other areas.
✓	Keeping roads and driveways accessible to vehicles and fire equipment–driveways should be relatively straight and flat, with at least some open spaces to turn, bridges that can support emergency vehicles, and clearance wide and high enough for two-way traffic and emergency vehicle access (spare keys to gates for properties should be provided to the local fire department, and an address should be visible from the road so homes can be located quickly).
	Enclosing the foundations of homes and buildings rather than leaving them open with their underside exposed to blown embers or materials.
✓	Safe use and maintenance/cleaning of fireplaces and chimneys (with the use of spark arresters and emphasis on proper storage of flammable items). Residents should be encouraged to inspect chimneys at least twice a year and clean them at least once a year.
	Proper maintenance and storage of motorized equipment that could catch on fire (from blown embers, etc.)
	Proper storage and use of flammables, including the use of flammable substances (such as when fueling machinery). Store gasoline, oily rags and other flammable materials in approved safety cans. Stack firewood at least 100 feet away and uphill from homes.
	Avoid building structures on hilltop locations, where they will be at greater risk from wildfires (also, hillsides facing south or west are more vulnerable to increased dryness and heat from sun exposure).
	Use of proper setbacks from slopes (outside of the "convection cone" of intense heat which would be projected up the slope of the hill as a wildfire "climbs" it).
	Obtaining insurance.

Hazard Mitigation Opportunities for Shoreline Flooding & Erosion	
✓	Floodplain/coastal zone management – planning acceptable uses for areas prone to flooding (comprehensive planning, zoning, open space requirements, subdivision regulations, land use and capital improvements planning).
	Dry floodproofing of structures within known flood areas (strengthening walls, sealing openings, use of waterproof compounds or plastic sheeting on walls).
	Wet floodproofing of structures (controlled flooding of structures to balance water forces and discourage structural collapse during floods).
✓	Elevation of flood-prone structures above the 100-year flood level.
✓	Construction of elevated or alternative roads that are unaffected by flooding, or making roads more flood-resistant through better drainage and/or stabilization/armoring of vulnerable shoulders and embankments.
	Government acquisition, relocation, or condemnation of structures within floodplains or floodways.
✓	Employing techniques of erosion control in the area (bank stabilization, planting of vegetation on slopes, creation of terraces on hillsides).
✓	Enforcement of basic building code requirements related to flood mitigation.

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Sources: Michigan State Police's *2019 Michigan Hazard Analysis* & *2020 Hazard Analysis Supplement*

	Joining the National Flood Insurance Program, obtaining insurance, and participating in the Community Rating System (CRS).
✓	Structural projects to channel water away from people and property (dikes, levees, floodwalls) or to increase drainage or absorption capacities (spillways, water detention and retention basins, relief drains, drain widening/dredging or rerouting, debris detention basins, logjam and debris removal, extra culverts, bridge modification, dike setbacks, flood gates and pumps, wetlands protection and restoration).
	Elevating mechanical and utility devices above expected flood levels.
✓	Flood warning systems.
	Monitoring of water levels with stream gauges and trained monitors.
✓	Anchoring of manufactured homes to a permanent foundation in flood areas, but preferably these structures would be permanently relocated outside of flood-prone areas and erosion areas.
	Control and securing of debris, yard items, or stored objects in floodplains that may be swept away, damaged, or pose a hazard when flooding occurs.
	Locating structures and infrastructure landward of the established setbacks.
✓	Increased coverage and use of NOAA Weather Radio.

Hazard Mitigation Alternatives for Subsidence	
	Identifying and mapping old mining areas and geologically unstable terrain, and limiting or preventing development in high-risk areas.
	Filling or buttressing subterranean open spaces (such as abandoned mines) to discourage their collapse.
	Hydrological monitoring of groundwater levels in subsidence-prone areas.
	Insurance coverage for subsidence hazards.
	Real estate disclosure laws.

Hazard Mitigation Alternatives for Space Weather and EMPs	
✓	Awareness campaigns for industries and systems involving satellite communications, GPS, or radio communications that could be disrupted by space weather events and EMPs. In addition to the use of GPS for navigation, aviation, and military applications, that technology is also important for offshore drilling operations, precision farming, transportation, and mapping and surveying.
✓	Operating procedures that include back-up systems allowing complex systems (e.g. air traffic control) to continue to function when key technological systems (e.g. GPS, radio communications, satellites) malfunction. For example, some "legacy" systems might be retained as a back-up, new GPS signals and codes could be used to remove ranging errors, and protective and back-up components could be installed in vulnerable systems.
✓	The use of special procedures, equipment, and redundancies by utility systems (e.g. electrical power and pipeline systems) to minimize the potential for geomagnetic effects to cause inappropriate shutdowns, impaired or lost functionality, and system damage. For example: the provision of reserve system capacity may offset the effects of geomagnetic storms; or the temporary disconnection of vulnerable components for their own protection.
	Additional back-up satellites, for communications and navigation, may be needed to limit the damaging effects of a major solar storm, which may put current satellite equipment out of action and require their rapid replacements. The importance and cost of satellite systems may not be well-known to the general public. As of 2009, the existing fleet of 250 commercial satellites constituted a total investment of about $75 billion, and an annual revenue stream estimated at over $250 billion.
✓	Consistent use of computer data back-up systems with secure offsite storage as appropriate.
✓	Use of uninterruptible battery supplies (UBS) and/or generators.

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Hazard Mitigation Opportunities for Fixed Site Hazardous Material Incidents	
	Compliance with and enforcement of the Resource Conservation and Recovery Act (RCRA), SARA Title III, and other regulations.
	Compliance with all industrial, fire, and safety regulations.
	Proper separation and buffering between industrial areas and other land uses.
	Location of industrial areas away from schools, nursing homes, etc.
	Public warning systems and networks for hazardous material releases.
	Increased coverage and use of NOAA Weather Radio (which can provide notification to the community during any period of emergency, including large-scale hazardous material incidents).
	Enhanced facility security.
	Elimination of clandestine methamphetamine laboratories through law enforcement and public education.
	Insurance coverage.

Hazard Mitigation Opportunities for Hazardous Material Transportation Incidents	
	Additional traffic control or new designs/routing for roadway areas that demonstrate a need for improvement.
	Long-term planning that provides more connector roads for reduced congestion of arterial roads.
	Public warning systems and networks for notification of hazardous materials incidents.
	Increased coverage and use of NOAA Weather Radio, which can provide notification to the community during any period of emergency, including large-scale hazardous material incidents.
	Locating schools, nursing homes, and similar facilities away from major hazardous materials routes.
	Proper planning, design, maintenance, and enhancements to designated truck routes.
	Railroad inspections and maintenance at railway/roadway grade crossings, along with the use of effective signs/signals in deficient areas (such as at rural railroad crossings).

Hazard Mitigation Opportunities for Petroleum and Natural Gas Pipelines	
	Locating pipelines away from dense development, critical facilities, special needs populations, and environmentally vulnerable areas whenever possible. Mitigation possibilities include the use of community zoning regulations to provide suitable open, unoccupied "buffer" areas around pipelines, storage fields, refineries, and compressor stations.
	Increasing public awareness and widespread use of the "MISS DIG" utility damage prevention service (800-482-7171).
	Proper pipeline design, construction, maintenance, and inspection.
	Using buffer strips to segregate wells, storage tanks, and other production facilities from transportation routes and adjacent land uses, in accordance with state regulations and consistent with the level of risk.

Hazard Mitigation Opportunities for Structure Fires	
	Building designs that include the use of firewalls and automatic sprinkler systems (especially in tall buildings, dormitories, attached structures, and special facilities).
	Fire codes and enforcement.
	The installation and routine maintenance of smoke alarms. Smoke alarms are recommended on each level of a home, in addition to each bedroom (tested monthly, with batteries changed twice a year).
	Proper installation and maintenance of heating systems (especially those requiring regular cleaning, those using hand-loaded fuels, such as wood, or using concentrated fuels, such as liquid propane).

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	Safe use and maintenance/cleaning of fireplaces and chimneys (with the use of spark arresters and proper storage of flammable items). Inspect chimneys at least twice a year and clean them at least once a year.
	Safe installation, maintenance, and use of electrical outlets and wiring.
	Measures to reduce urban blight and effective anti-arson programs.
	Defensible space around structures in fire-prone wildland areas that lead up to structures.
	Proper maintenance of power lines and efficient response to fallen power lines.
	Transportation planning that provides roadways and other infrastructure to maximize emergency access and response times to all developed areas of a community.
	Enforced fireworks regulations.
	Elimination of methamphetamine laboratories through law enforcement and public education.
	Obtaining fire insurance.

Hazard Mitigation Opportunities for Major Transportation Incidents	
	Improved design, routing, and traffic control at problem roadway areas.
	Railroad inspections and improved designs at problem railway/roadway intersections (at grade crossings, as well as signs/signals at rural railroad crossings.
	Long-term planning that provides more connector roads for reduced congestion of arterial roads.
	Use of designated truck routes.
	Use of ITS (intelligent transportation systems) technology.
	Airport maintenance, security, and safety programs.

Hazard Mitigation Opportunities for Energy Failures and Shortages	
	Burying electrical lines, where appropriate, to resist damage from severe winds, lightning, ice, etc.
	Energy portfolios based on a mix of generation sources (e.g., natural gas, solar, wind, nuclear).
	Generation or purchase of energy when prices are low and storage is available/feasible.
	Expanded consideration of distributed generation programs, such as net metering.
	Energy efficiency and architectural designs that reduce energy needs, such as Leadership in Energy and Environmental Design (LEED) certified buildings.
	Facility capacity to use more than one type of fuel to sustain necessary operations and functions.
	Provision of backup supply systems and redundancies.

Hazard Mitigation Opportunities for Public Health Emergencies	
✓	Maintaining proper levels of PPE for healthcare workers and first responders, with additional supplies for long-term care facilities.
✓	Immunization programs to vaccinate against communicable diseases.
	Improving ventilation techniques in areas, facilities, or vehicles that are prone to crowding or that may involve exposure to contagion or noxious atmospheres.
✓	Maintaining community water and sewer infrastructure at acceptable operating standards.
✓	Providing back-up generators for water and wastewater treatment facilities to maintain acceptable operating levels during power failures.
	Demolition and clearance of vacant condemned structures.
✓	Adequate community clinics and school health services.
✓	Brownfield and urban blight clean-up activities.
✓	Proper location, installation, cleaning, monitoring, and maintenance of septic tanks.
✓	Separation of storm and sanitary sewer systems.
	Spraying programs to properly control mosquito populations.
✓	Updated Continuity of Operations (COOP) plans and alternative "work from home" schedules.

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Hazard Mitigation Opportunities for Cyberattacks and Major Network Disruptions	
	Use of professional cybersecurity experts.
	Proper oversight of third party/vendor system access.
	Use of firewalls and anti-virus software.
	Use of Virtual Private Networks (VPNs).
	Frequent computer operating system updates/program versions/firmware updates/software patches.
	Effective password management (removal of default passwords, strong passwords, rotating passwords).
	Use of two-factor authentication or biometrics for computer or program access.
	Employee training on proper computer hygiene, particularly the treatment of outside emails.
	Consistent use of computer data back-up systems with secure offsite storage as appropriate.
	Use of uninterruptible battery supplies (UPS) and/or generators.
	Manual process plans in the case of complete network failure.

Hazard Mitigation Opportunities for Nuclear Attack	
	Designated fallout shelters and public warning systems.
	Construction of concrete safe rooms (or shelters) in houses, trailer parks, community facilities, and business districts.
	Using laminated glass, metal shutters, structural bracing, and other hazard-resistant, durable construction techniques in public buildings and critical facilities.
	Increased coverage and use of NOAA Weather Radio (which can provide notification to the community during any period of emergency, including enemy attack).

Hazard Mitigation Alternatives for Terrorism and Similar Criminal Activities	
	Using durable construction materials in public buildings and critical infrastructure/key resources.
	Layout design options for consideration for schools, factories, office buildings, hospitals, correctional facilities, stadiums, etc. that take into consideration emergency and security needs.
	Utilizing established avenues of reporting, such as the state Suspicious Activity Reporting system, MichTip, via phone or online application for information preventing terrorist incidents and sabotage.

Hazard Mitigation Opportunities for Civil Disturbances	
	Strong community relations with law enforcement.
	Volunteers and participant cooperation to monitor events and encourage peaceful conditions.
	Social media presences designed to counter inaccurate or intentionally misleading information, along with public education geared towards developing skills for recognizing poor sources of information.
	Blight reduction and neighborhood upkeep strategies in combination with anti-arson practices.
	Using durable construction materials in public buildings and critical infrastructure/key resources.
	Layout design options for consideration in schools, factories, office buildings, shopping malls, hospitals, correctional facilities, stadiums, etc. that take into consideration emergency and security needs.
	Structure and property insurance in high risk areas.

APPENDIX F: PARTICIPATION TABLE

APPENDIX G: PARTICIPATION DOCUMENTATION