EMHSD Publication 103 (2020 Supplement)
November 2020
Emergency Management and Homeland Security Division
Michigan Department of State Police

Michigan Hazard Analysis

Supplement to the 2019 Michigan Hazard Analysis

TABLE OF CONTENTS

INTRODUCTION

(2020 supplement)

Emergency incidents can result from hazards as varied as chemical spills, power outages, tornadoes, and forest fires. Michigan is vulnerable to a wide range of such hazards, categorized in this publication as **natural hazards**, **technological hazards**, and **human-related hazards**. Examples include the ongoing COVID-19 pandemic, the 2010 Enbridge oil spill, the Great Blackout of 2003, the 1987 crash of Northwest Airlines Flight 225, and the 1927 Bath school bombing. While not always leading to catastrophic disasters, hazards frequently cause incidents that result in the loss of life, property damage, environmental harm, and economic hardship.

This 2020 supplement to the 2019 Michigan Hazard Analysis (MHA) includes both technological hazard and human-related hazard chapters, whereas the primary 2019 edition includes chapters for the state's natural hazards. Taken together they give emergency managers, state and local administrators, and the general public a more complete view of the many emergency management related risks that are present in their communities.

While this document focuses on Michigan hazards, events outside of the state may still create local impacts. When New Orleans was struck by hurricanes in 2005, Michigan used its resources to provide assistance and house evacuees. The terrorist events of September 11 led to subsequent anthrax attacks that affected the entire country. A major earthquake in California could still have significant impacts on Michigan's economy. Even international events can affect our energy needs, supply of goods, and the wellbeing of our state's residents.

Hazards may also be exacerbated by shifts in population, changes in climate, and technological advancements that bring new consequences and greater interconnection. A computer hacker across the world may launch an attack against a utility company on Thanksgiving Day, resulting in blackouts for several hospitals and gas stations in the midst of a pandemic and holiday travel. Without proper planning and mitigation efforts, such incidents can quickly cascade and spiral out of control into full-blown disasters.

Addressing these varied hazards presents a great challenge to our communities. To meet it, emergency managers must first obtain a thorough understanding of the array of hazards they confront, especially at the local level. Through the process of conducting a detailed hazard analysis, communities can become aware of the frequency and magnitude of past emergency management related hazards that have impacted their region. Analyzing the evolving nature of these risks, as well as emerging trends, can be used for setting hazard mitigation goals and resource allocation priorities.

The Michigan State Police, Emergency Management and Homeland Security Division (MSP/EMHSD) is the coordinating agency for emergency management and homeland security activities in the state. In conjunction with other governmental agencies and private organizations, the MSP/EMHSD plays an active role in prevention, mitigation, protection, response, and recovery efforts related to local, state, and national emergencies.

The MSP/EMHSD revises the MHA on a scheduled basis, making select interim changes between full updates as needed (Appendix A). Associated documents include the Michigan Emergency Management Plan (MEMP), which outlines response related emergency management responsibilities within the state, and the Michigan Hazard Mitigation Plan (MHMP), which further analyzes risks and vulnerabilities in order to produce mitigation goals and objectives. These are coordinated with the MHA and may serve as a basis for the development of other state plans.

CHAPTER ORGANIZATION:
The hazard chapters in this edition may be presented in slightly different ways due to the variable nature of their risks. Each will be generally organized with similar header/section formatting:

Hazard Definition
A broader definition of the hazard and its scope as covered in the chapter.

Hazard Analysis
A discussion on the topic and relevant statistics designed to give the reader a greater understanding of the vulnerabilities and risks associated with the hazard. Significant analysis may also be present in other parts of the chapter.

Specific Impacts *(Consequence Analysis)*
A summary of specific considerations and impacts regarding hazard risks as they pertain to:

Impact on the Public, Property, Facilities, and Infrastructure
Impact on the Economic Condition of the State
Impact on Responders, Continuity of Operations, and Continued Delivery of Services
Impact on the Environment
Impact on Public Confidence in State Governance

Hazard Mitigation Opportunities
- A non-comprehensive listing of practices designed to lessen, address, or otherwise ameliorate the hazard. Readers are encouraged to read the Michigan Hazard Mitigation Plan (EMHSD PUB-106) for in-depth study.

Incident Examples
Brief examples of actual incidents caused by the hazard, organized by date and location. Examples are for educational purposes and are not meant to be exhaustive. While most are Michigan specific, incidents from other states or countries may be included to better illustrate the full breadth or scope of a hazard's potential.

Select Laws, Agencies, or Programs
Brief descriptions of relevant regulations or initiatives that are designed to oversee, prevent, or mitigate a hazard. An emphasis is placed at the state and federal levels and is not meant to be comprehensive or construed as legal advice. General educational resources may also be provided.

Supplemental Material
The end of a chapter may contain full sized maps, glossaries, or other additional information, including topics that are otherwise difficult to place.

II. TECHNOLOGICAL HAZARDS

Industrial Hazards

The following chapters are covered in this subsection on industrial related technological hazards, chiefly stemming from a variety of hazardous materials and flammable substances:

1. Hazardous Materials: Fixed Site Incidents
2. Nuclear Power Plant Emergencies
3. Hazardous Materials: Transportation Incidents
4. Pipeline and Wellhead Incidents: Petroleum and Natural Gas
5. Structure Fires (general, urban conflagration, scrap tires)

These topics cover a wide array of hazardous substances that are present in both urban industrial settings and the most rural parts of our state. Nuclear power plant emergencies carry unique considerations and have their own chapter.

Hazardous materials travel throughout our communities so frequently that the average person may not give much thought to the products moving past them on the highway or while stopped at a railroad crossing. Materials are also transported underground where they go largely unseen. A separate chapter is presented on petroleum and natural gas networks, including originating wellheads and service line distribution endpoints.

Many of these materials have the potential to create fires. A frequent cause of structure fires in industrial settings involves flammable chemicals, oil fires, and natural gas explosions. Although isolated residential fires are more common, the MHA focuses primarily on larger-scale risks that have a greater potential to affect an entire community—either through the size of a structure, the vital nature of a facility, or the number of occupants. A chapter on such select structure fires is therefore included, as is supplemental material related to scrap tire fires.

Scrap tire fires are difficult to categorize in that stored tires aren't at risk for "accidental release" and are frequently placed outside. Their fires do, however, create toxic smoke and chemical residues that have much in common with hazardous material incidents once started.

<u>Overlap Between Industrial Related Technological Hazards and Other Chapters</u>
Lightning strikes and wildfires have a clear potential to ignite structures, and large-scale disaster events (e.g., tornadoes, earthquakes) often lead to structure fires. An indirect link also exists with cold weather, as various methods of indoor heating may increase fire risks, as do transportation accidents and certain kinds of human-related hazards (e.g., arson, terrorism, riots).

Inversely, some structure fires have the potential to cause a wildfire. Fires at critical facilities may lead to communications failures, power outages, nuclear power plant emergencies, and even dam failures.

Beyond fires, hazardous material incidents of any type may lead to long-run public health emergencies if they are large enough, particularly if contamination becomes ubiquitous or persistent in the environment. See the associated chapters for more details.

HAZARDOUS MATERIALS: FIXED SITE INCIDENTS

An uncontrolled release of hazardous materials from a specific location capable of posing a risk to life, health, safety, property, or the environment.

Hazard Description

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. The Environmental Protection Agency (EPA) has made two classifications that are most important to this chapter: (1) “extremely hazardous substances” (EHS, and (2) “CERCLA hazardous substances.” A consolidated listing of these materials and other hazardous substances are registered on the “List of Lists,” which can be found at https://www.epa.gov/epcra/consolidated-list-lists. Also considered a fixed site location, nuclear plants are covered under their own chapter.

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 (see the associated chapter). 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.

Hazard Analysis

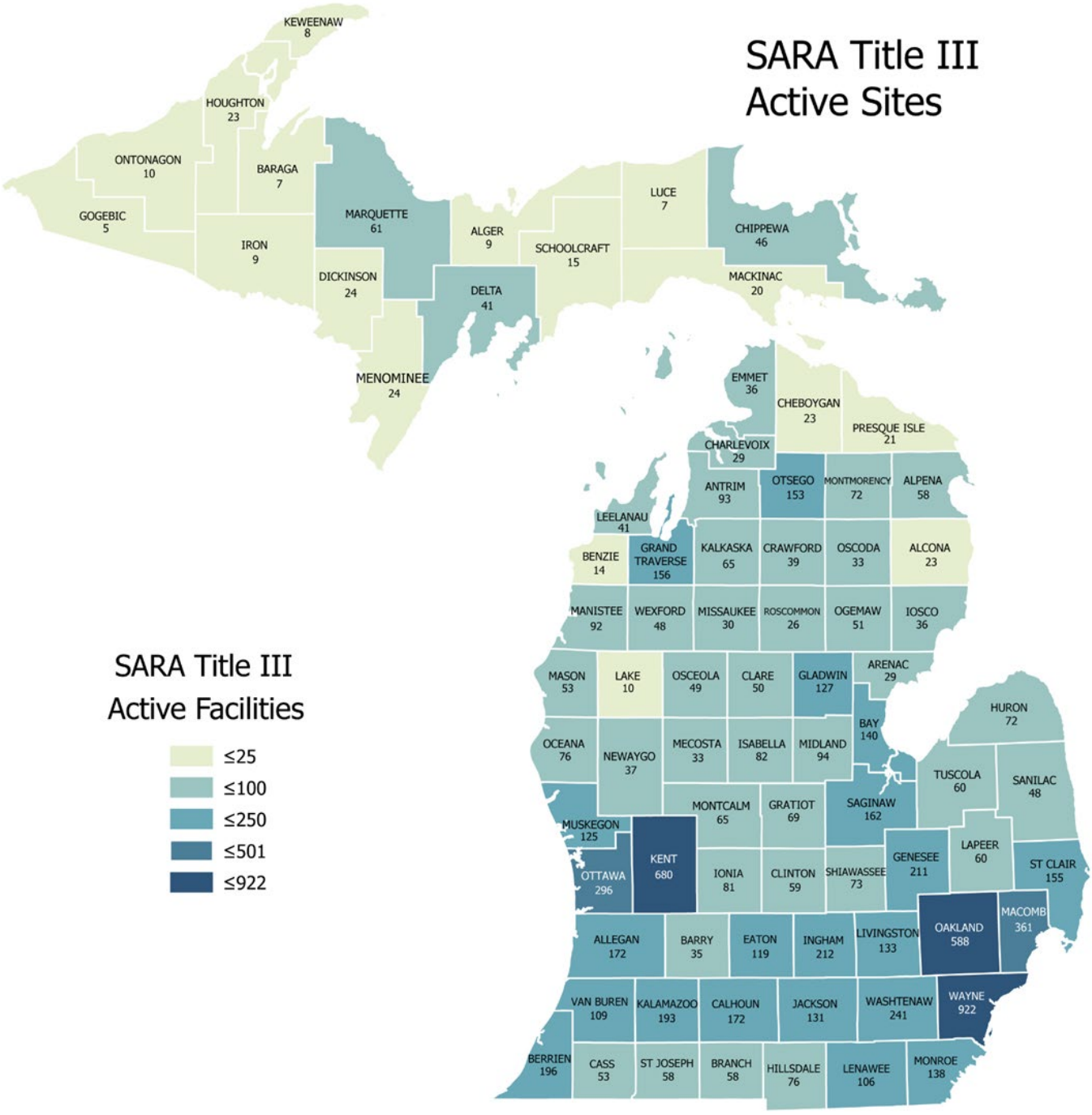
An analysis of the most dangerous hazardous materials can best be done within the context of the programs designed to regulate them. The Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), or “Superfund,” was enacted by Congress in 1980. It was designed to clean up the nation's hazardous waste sites and to also provide for emergency response to potential future releases of hazardous materials.

The Superfund Amendments and Reauthorization Act (SARA) expanded CERCLA. Local emergency managers will want to familiarize themselves with SARA Title III, the Emergency Planning and Community Right-To-Know Act (EPCRA). The purpose of SARA Title III 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. This is especially true in regard to the aforementioned EHS and CERCLA designated hazardous materials. Chemical companies and other facilities must monitor their materials and the quantities of those materials they have on site (https://www.michigan.gov/documents/deq/deq-ead-sara-saraiiiflochrt_305997_7.pdf). Federal guidance is given regarding proper evacuation zone sizes based on the characteristics of the hazardous substances.

A risk assessment 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). 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.

The following map of SARA Title III facilities shows their greatest concentration located in the southeastern part of the state and other more urbanized counties. While these are generally the areas with more resources to prepare for and respond to a hazardous materials incident, the greater population concentrations also put more people at risk.

SARA Title III Sites in Michigan (2019)



(source: EGLE)

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), granting them authority from the time of generation through transportation, treatment, storage, and disposal. Michigan's RCRA Work Plan for Fiscal Years 2020 and 2021 can be found on its Hazardous Waste and Liquid Industrial By-Products website. In other cases, the department may have administrative rules for specific substances, including EGLE's Ionizing Radiation Rules that cover certain radioactive materials, such as Particle Acceleration Installations present in some university research settings.

Rural portions of the state are not free from hazardous materials and may not be as well equipped to handle them. Michigan's farming community uses fertilizers, pesticides, and other chemicals, although typically in much lower amounts than would be found at production facilities. Large distributors serving these rural areas may store greater quantities. Such materials are regulated in a variety of manners. The Michigan Department of Agriculture and Rural Development (MDARD) oversees one such program for agricultural chemicals. Reports for its Bulk Storage Program show that over 1.4 million tons of fertilizer are manufactured or distributed in the state, with roughly 80 million gallons in storage at over 220 registered locations. Three different MDARD regulations exist as part of the program:

- Regulation 640 – Commercial Pesticides (registration required annually)
- (N/A) – On farm Pesticides (not regulated by the program)
- Regulation 641 – Commercial Fertilizer (registration required annually)
- Regulation 642 – On farm Fertilizer (no registration required)

Whether urban or rural, local emergency managers need to focus on the hazards present in their unique communities, as well as those of neighboring regions. This should include facilities that are typically upwind from their location or that have rivers or groundwater that flow into their area. 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.

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.

Specific Impacts

Impact on the Public, Property, Facilities, and Infrastructure
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.

Impact on the Economic Condition of the State
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 (covered under separate chapters). 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.

Impact on Responders, Continuity of Operations, and Continued Delivery of Services
Additional risks to 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 schedule of exercise activities needs to be maintained for staff preparedness, and larger budgets are needed to accommodate the staffing, training, exercising, and equipment needed.

Impact on the Environment
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.

Impact on Public Confidence in State Governance

Mixed attitudes towards businesses that manufacture or use hazardous materials may be common. State government's attempts to effectively regulate companies that also provide jobs and other economic benefits may be seen by the public as being overly strict or lenient. However, when a damaging release occurs, most public attention will be focused on what could have been done to prevent the incident, and governments will be held highly accountable regardless of the reason for the release. An inability to rapidly "fix" a release will also cause frustration with the public regardless of initial fault.

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.

Selected Fixed-Site Hazardous Material Incidents in Michigan (with a reference to Bhopal)

Michigan has not had a large hazardous materials release with mass fatalities, such as the one that occurred in Bhopal, India. However, numerous fixed-site hazardous material incidents have happened that required a response by local fire departments and hazardous materials teams. These may result in evacuation, in-place sheltering, and other protective measures. The list is not meant to be comprehensive and is provided to show the variety of such incidents.

January 22, 1976 – Saginaw (Saginaw County)
An explosion and fire at a farm supply shipping plant and grain tower killed five persons and injured 12 others. Grain storage areas often contain air that becomes loaded with flammable dust and has a high risk of an explosion being triggered from a spark or flame.

October 7, 1977 – Midland (Midland County)
A chlorine gas leak valve burst on a tank at a chemical plant, producing a vapor cloud that incapacitated several schools. A total of 1,500 students and another 5,000 residents were evacuated.

May 3, 1979 – Adrian (Lenawee County)
Curene 442 (a chlorinated hydrocarbon) leaked into nearby sewers within a five-block area of an industrial plant and entered into the connected Raisin River.

April 23, 1981 – Swartz Creek (Genesee County)
A court-ordered hazardous waste site cleanup forced the evacuation of 60 residents for one month. The possibility of cyanide and acid mixing had prompted the evacuation.

April 28, 1983 – Benton Harbor (Berrien County)
A chemical spill at a manufacturing plant (involving 6,500 gallons of toluene di-isocyanate) forced the closure of M-139. Many fixed site incidents have the potential to close nearby roadways.

August 6, 1984 – Hamtramck (Wayne County)
A chemical plant's anhydrous ammonia tanks exploded. Several firefighters were injured; 300 people evacuated.

December 3, 1984 – Bhopal, India
The world's worst hazardous materials release occurred when a cloud of methyl isocyanate gas (an extremely irritating chemical that can cause severe acute injury) escaped from a Union Carbide chemical plant killing 2,500 persons and injuring tens of thousands more. Many of the injured suffered permanent disabilities. Over 30 tons of the chemical were released. The exact cause of the incident was not firmly established, but several safety systems designed to prevent a

major release were either inoperative, under maintenance, or not activated by workers. Some theories involved intentional employee sabotage, although there is no proof that mass fatalities were intended. Warning systems for the community were not activated in a timely manner and many individuals died in their sleep. The nature of the gas and the atmospheric conditions at the time kept the toxic cloud close to the ground, increasing inhalation for children and others of shorter stature. Many animals, such as goats, also died and their carcasses created additional hazards. Nearby trees became barren and local fishing was prohibited. Supplies, including food, became scarce due to distributors avoiding the area.

The Bhopal incident helped to highlight many important points. First, it was not caused by a single factor but rather a number of contributing events that needed to occur together. Second, human error and lack of adherence to safety rules and procedures played a substantial role in the incident. Third, fatalities would have been significantly lower had the location of the plant not been near such a densely populated area. Lastly, the deadly release proved that worst-case scenarios do occur and that robust emergency planning, training, and community involvement is necessary.

November 29, 1988 – Flint Township (Genesee County)
A fire at a plastics plant created a toxic plume that forced the evacuation of 75 homes. A total of 97 firefighters were injured while fighting the blaze, and 20 required hospitalization.

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

July 1999 – Webberville (Ingham County)

Nitrogen fertilizer was spilled when a storage tank weld failed at the Anderson Facility. Workers heard a booming sound and saw a wave of liquid nitrogen coming at them. A worker escaped injury as a million gallons of liquid pushed the forklift he was riding over a containing wall. Two workers cutting grass outside the protective dike were hospitalized after they were swept up and knocked into equipment. A secondary containment ditch in conjunction with quick clean-up activities prevented the material from leaving the property.

The weld failures became common at the time with that specific brand of tank, and several incidents occurred across the country. The two companies that made the tank, Carolyn Equipment Co. and Nationwide Tanks, Inc, went out of business. Their other tanks located in Michigan were dismantled as a precautionary measure.

October 29, 1999 – Livonia (Wayne County)
An explosion and flash fire at a chemical plant released a plume of chromic acid over a nearby residential area and freeway, forcing 40 people to seek medical treatment at nearby hospitals. Persons within a quarter-mile radius of the plant were advised to stay indoors and keep doors and windows closed. A 1.5-mile stretch of Interstate 96 was closed for several hours to allow for air monitoring and testing.

January 12, 2000 – Livonia (Wayne County)
An ammonia leak inside a food processing plant caused an explosion and fire that tore out the side of the building, injured three persons, forced the evacuation of 12 employees, and closed nearby roads for approximately 9 hours. Cleanup was complicated by the discovery that the leaked ammonia had mixed with water, creating a solution of ammonium hydroxide that can cause severe burns to skin and eyes, and in some cases death.

April 12, 2000 – Egelston Township (Muskegon County)
A chemical plant explosion that injured 10 people was believed to be caused by tetranitromethane, once used to make rocket fuel. Although the plant never produced the chemical, it may have been an unintended by-product of the company's herbicide production. The explosion shook buildings more than a mile from the plant and hurled sections of steel I-beams onto the roof of a nearby factory more than 200 yards away. The cleanup operation forced the evacuation of businesses within a one-half mile safety zone.
July 14, 2001 – Riverview (Wayne County)

An explosion at a chemical plant killed three plant workers, injured nine others, and forced the evacuation of 2,000 nearby residents. Methyl mercaptan–a colorless flammable gas used in the manufacture of additives for chicken feed and pharmaceuticals and as an additive to natural gas–seeped from a 25,000-gallon rail car at the plant and exploded. The chemical is a foul-smelling gas that can be toxic to humans. Officials at the scene noted the situation could have been worse had nearby tankers containing chlorine also ignited. Favorable winds helped push the fumes away from surrounding communities, reducing the need to evacuate more residents.

August 27, 2001 – Detroit (Wayne County)
A fire at a metal plating plant injured eight firefighters, forced the evacuation of residents within a five-block radius, and completely destroyed the plant. The fire, which continued to smolder for more than 24 hours, consumed large tanks of cyanide, sulfuric acid, and other chemicals. Toxic fumes from the fire forced a one-week closure of a local elementary school.

July 7, 2003 – Linwood (Bay County)
A large industrial fire occurred at the American Recycling Company in Linwood. The fire involved butyl rubber (approximately 1,000 bags of 1,000 lbs. each) and 200 barrels of fuel additives. Residents of a mobile home park were evacuated to a safe location.

February 1, 2004 – Sarnia, Ontario (St. Clair River)
Over 39,000 gallons of toxic chemicals leaked into the St. Clair River near Sarnia, Ontario. Methyl ethyl ketone and methyl isobutyl ketone, which are low toxicity solvents, leaked into the river from an Imperial Oil plant. Local residents were urged to refrain from using the tap water for cooking, bathing, or drinking, until the water could be tested.

October 16, 2007 – Melvindale (Wayne County)
Three schools and additional area residents were evacuated after a leak was reported at a Melvindale chemical company, totaling nearly 3,000 evacuated residents. Hydrochloric acid was released into an overflow container, so it was not a direct spill. It was released into a container and was contained by Hazmat.

September 15, 2007 – Lowell (Kent County)
A fire and explosion destroyed several factory buildings that contained between 5-10 thousand gallons of sulfuric acid solution. The blaze created billowing black smoke visible at least 10 miles away, bringing hundreds of onlookers to the site. A half-dozen fire departments aided local responders. The release of sulfuric acid solution created groundwater contamination concerns.

July 18, 2008 – Grand Blanc (Genesee County)
Residents and businesses near a chemical plant were evacuated when several tanks filled with sulfuric acid caught fire. Most of the fires were quickly controlled, but one tank continued to burn from the inside and proved difficult to fully extinguish.

September 25, 2008 – Grand Haven (Ottawa County)
A small leak from a faulty plug in a one-ton sulfur dioxide tank, delivered to the Grand Haven wastewater treatment plant, forced authorities to evacuate about 75 homes for three hours. The plug had a faulty thread, allowing the liquid substance to escape and immediately turn to gas. There were no reported injuries or effects from the gas release.

February 15, 2012 – Edwardsburg (Cass County)
An old fertilizer and bulk chemical facility burned down in Edwardsburg, with thick clouds of smoke billowing out for several hours. The building was a total loss, but no one was injured. Two men were subsequently charged with arson.

June 27, 2011 – Leonidas Township (St. Joseph County)
A 1,000-gallon tank containing two tons of anhydrous ammonia was stolen from an agricultural supplier. The empty tank was found down the road and was most likely a theft associated with the making of methamphetamine. While such thefts still occur, the fertilizer is currently dyed bright pink and criminals have mostly moved on to other production techniques for making the drug.

March 10, 2012 – Adrian (Lenawee County)
A large fire occurred at a plastics recycling facility, with residents asked to shelter indoors due to the amount of smoke generated by the 8,000 square-foot structure. A Siena Heights University game was also called off at half-time. High winds complicated the fire, which took more than a dozen fire departments several hours to extinguish. One firefighter suffered a minor injury.

June 24–25, 2013 – Plainwell (Allegan County)
An operational process within the Drug & Laboratory Disposal plant created a chemical reaction and fire. Staff activated their contingency plans and contacted 911, with several fire departments responding. The fire was extinguished by late afternoon. That evening, chemical reactions caused the fire to rekindle. An evacuation ordered was issued for the nearby residents and businesses. The second fire was extinguished during the early morning hours of June 25, with the evacuation order lifted later that afternoon. The EPA and EGLE took part in the response and investigation.

February 20, 2014 – Napoleon (Jackson County)
Heavy snow caused a roof to collapse at the Cloverleaf Cold Storage facility, causing pipes containing ammonia to rupture and leading to an evacuation. Eleven people were treated and evaluated at the scene for ammonia exposure, with three transported to a hospital. The ammonia lines fed into cooling units inside the building used to store meat and poultry. In addition to the interior hazard, a cloud of ammonia escaped the building and rose 300 feet into the air. The gas can be immediately life threatening, depending on its concentrations. The leak was contained after 40 minutes.

February 2016 – Livonia (Wayne County)
Ford Motor Company was forced to test residential areas around the Livonia Transmission Plant after discovering vinyl chloride in groundwater on plant property. Vinyl chloride is known to cause cancers in humans, with elevated risks of liver, brain, and lymphatic tumors. Testing showed concentrations as high as 28 parts per billion in some areas; most tested between 12 and 13 parts per billion. The EPA sets a limit of two parts per billion for drinking water. The contamination came from trichloroethylene, a degreasing agent that had been used at the plant up until the 1980s and that breaks down into vinyl chloride. EGLE sued Ford, alleging the waste had “migrated” under the ground to nearby residential properties. Groundwater and basement air level monitoring was instituted.

June 2019 – Belding (Ionia County)
A mishandling of trichloroisocyanuric acid (TCICA) caused a fire and chemical gas release at Kassouni Manufacturing Inc. (KMI) on June 22. TCICA is a toxic substance that catches fire and releases chlorine gas when subjected to small amounts of water. No one suffered significant injury, but the fire produced a visible cloud and awoke some residents in the middle of the night with the smell of strong chlorine. A subsequent dumpster fire on July 19 was again associated with TCICA. While the fire was small, a cease and desist order was issued given the cumulative track record of KMI’s handling of the chemical. A $115,000 fine was issued.

December 2019 – Madison Heights (Oakland County)
Michigan officials closed portions of I-696 on December 2 after a hazardous, greenish-yellow liquid was found oozing onto the highway from a crack in a roadside barrier. The material was discovered to contain a cancerous chemical called Hexavalent Chromium. Due to the time of the year and having mixed with groundwater, the substance was quickly freezing as it oozed into the open air. This limited the amount of the chemical being transferred to lanes and tires. A nearby commercial business that had closed in 2016 had been leaking the chemical, which ran from the basement of the building into the ground and exited through a drain that emptied onto the highway. The incident would have been more severe if it had occurred during warmer temperatures. The owner was prosecuted.

Select Laws, Agencies, or Programs

Superfund Amendments and Reauthorization Act (SARA), Title III
The emergency planning provisions of SARA Title III require each state to establish a State Emergency Response Commission (SERC, see below), emergency planning districts, and a Local Emergency Planning Committee (LEPC, see below) for each district to ensure that the public can access information on the hazardous materials stored in their communities (as well as the quantities of any such material releases). Affected facilities must send “Tier II” hazardous substance reports to the SERC, LEPCs, EGLE and local fire departments. The SERC and LEPCs are responsible for preparing and implementing emergency plans, as well as disseminating copies of material safety data sheets, chemical inventories, and other reports and forms necessary for compliance under the Act. In Michigan, the SARA Title III program is jointly administered and implemented by MSP and EGLE.

Michigan Citizen-Community Emergency Response Coordinating Council
The Michigan Citizen-Community Emergency Response Coordinating Council (MCCERCC) is the name for the state’s official SERC under SARA Title III. The MCCERCC consists of 19 members appointed by the Governor, with membership including several state agencies, local government, various groups, and the general public. It works in conjunction with LEPCs and is divided into the Citizen’s Corps Committee, the Hazard Mitigation Committee, and the Emergency Planning and Community Right to Know Committee.

Local Emergency Planning Committees

Local Emergency Planning Committees (LEPCs) are designated planning districts responsible for developing emergency response plans for communities that have facilities in their jurisdiction subject to SARA Title III emergency planning requirements. The LEPC is the primary mechanism through which local SARA Title III planning, training. and exercising activities are implemented. A facility is subject to SARA Title III provisions if extremely hazardous substances (as determined by the U.S. Environmental Protection Agency) are present at the facility in quantities at or above the minimum threshold quantities established in Section 302 of the Act. The map at the end of this section provides a breakdown of Title III (Section 302) sites by county.

Hazardous Material Response Planning

Each Section 302 site must be covered by a community response plan that addresses the emergency planning requirements of SARA Title III. Inclusion of Michigan Firefighter Right-to-Know provisions of the Michigan Occupational Health and Safety Act (1986 PA 80) is also encouraged in the planning guidance provided by MSP/EMHSD. Assistance typically includes provision of written planning guidance, interaction with the planning team, plan reviews, and limited financial assistance (via federal grant funds) to offset the costs of preparing the plans. Each plan must address the following critical areas: 1) hazard identification (to include chemical inventories, locations, release detection, and chemical-specific response information); 2) vulnerability map and analysis (to include a vulnerability zone, special populations affected, and other facilities and areas that may contribute to risk); 3) population protective actions (to include warning, access control, evacuation and in-place sheltering); 4) response procedures (to include both on-site and off-site expertise and equipment); and 5) a training and plan exercising program. Plans are reviewed and commented on by MCCERCC, with EGLE and MDARD providing technical assistance in the areas of community-right-to-know, material safety data sheets, chemical inventories, incident reporting, and (on a limited basis) incident cleanup.

Hazardous Material Response Training

MSP/EMHSD provides hazardous material response training programs through the Emergency Management and Homeland Security Training Center (EMHSTC). The EMHSTC provides training courses for individuals and companies responsible for planning, inspection, response, mitigation, and cleanup activities involving hazardous materials. Specific subjects include: 1) Hazmat Technician Program (Pro Board certified); 2) hazardous materials chemistry; 3) hazardous materials emergency response; 4) hazardous waste worker compliance; 5) incident management; and 6) other specialized hazardous materials-related courses such as highway and rail cargo tanker and storage tank handling. Many courses are conducted with simulation aids available in the EMHSTC Training Yard. Some mobile courses are available.

Federal/State Hazardous Material Response Resources

Groups include the National Response Team (NRT), Regional Response Teams (RRTs), and state and local hazardous material response teams. The Chemical Manufacturers Association established the Chemical Transportation Emergency Center (CHEMTREC) to provide 24-hour technical advice to emergency responders. The National Response Center (NRC), which operates much like CHEMTREC, was established to provide technical advice and to coordinate federal response to a hazardous material incident. In Michigan, a 24-hour statewide notification system called the Pollution Emergency Alerting System (PEAS) was established for reporting chemical spills directly to EGLE.

State Fertilizer and Pesticide Regulation

Regulations for these products are governed in part by the Michigan's Natural Resources and Environmental Protection Act (NREPA), Act 451 of 1994. Michigan's Fertilizer Program and Pesticide Program give broad consideration to not just farming but also sites such as golf courses and lawns. Excessive fertilizer run-off into waters can lead to harmful algal blooms. MDARD oversees several mitigation initiatives and has established a 24-hour Agriculture Pollution Emergency Hotline for reporting fertilizer and pesticide spills.

U.S. EPA Chemical Emergency Preparedness and Prevention Office (CEPPO)

CEPPO provides assistance to states, local governments, and private industry to: 1) prevent and prepare for chemical emergencies; 2) respond to environmental crises; and 3) inform the public about chemical hazards that may be present in their community. The CEPPO works closely with several Michigan state agencies to implement and coordinate a number of regulatory and non-regulatory programs designed to protect human health and the environment in Michigan from chemical accidents, including the SARA Title III program.

Chemical Awareness Week

This annual public information campaign focuses on: 1) the hazards associated with the manufacture, transport, storage, use, and disposal of chemicals; 2) the programs and systems in place to protect the public from accidental chemical releases; and 3) community emergency response procedures for chemical incidents.

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NUCLEAR POWER PLANT EMERGENCIES

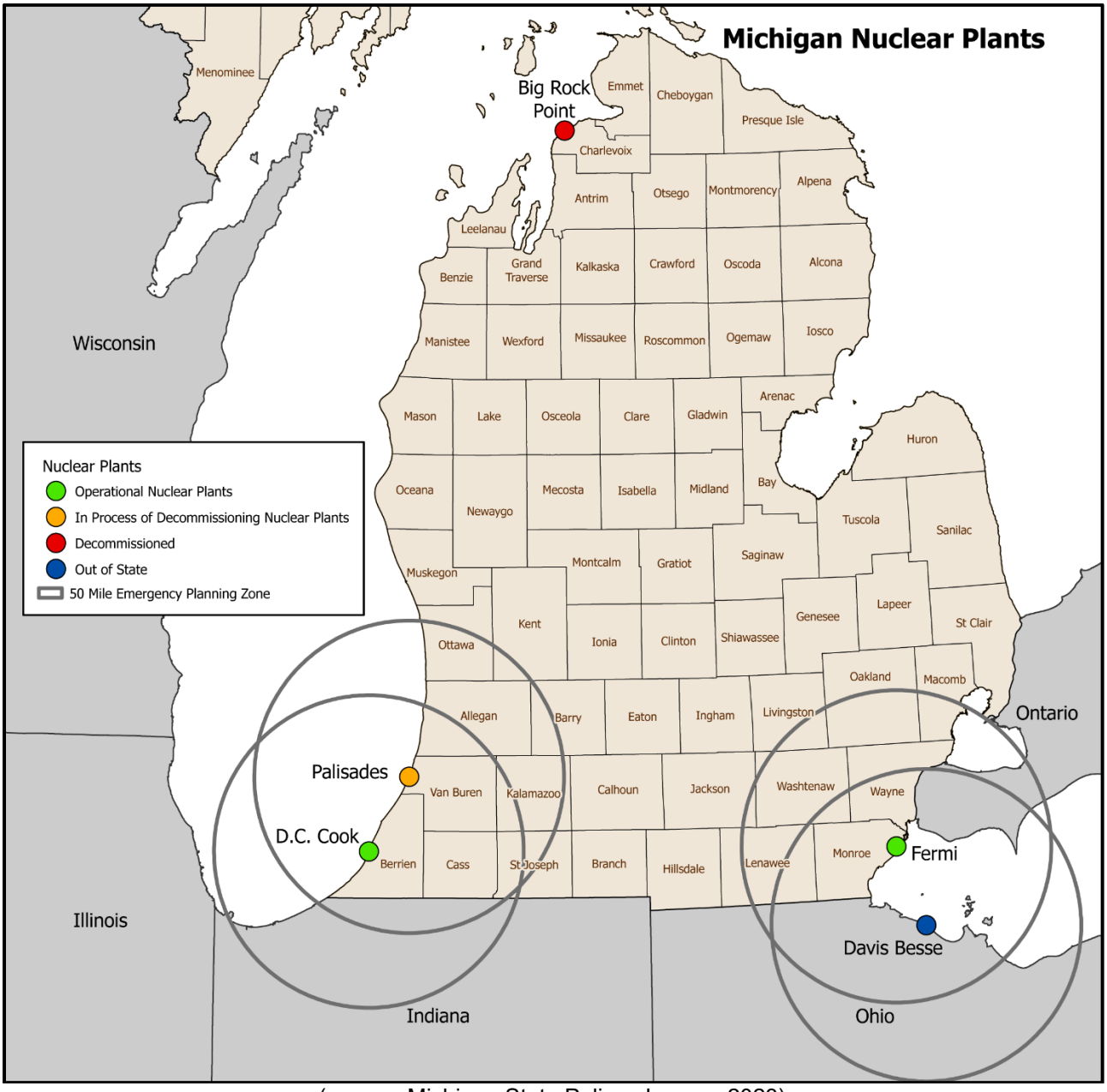
A potential or actual release of radioactive material at a commercial nuclear power plant that would constitute a threat to the health and safety of the off-site population and environment.

Hazard Description

Nuclear plants supply reliable baseload electricity but are closely monitored due to the dangers associated with radiation. Released materials could contaminate not only facility grounds but also nearby communities during worst-case events. The extent of contamination from an incident would vary greatly depending on weather conditions and the amount/type of release. Michigan's nuclear power plants are also located near the shorelines of the Great Lakes for cooling purposes.

Hazard Analysis

Michigan has two operating nuclear power plant facilities (Enrico Fermi-2 and Donald C. Cook). Plants carry with them designated primary (10-mile radius) and secondary (50-mile radius) Emergency Planning Zones (EPZs) to highlight where varying degrees of impacts would be most likely to occur. The 50-mile EPZs are shown on the map below.



(source: Michigan State Police, January 2023)

The potential impacts of this well-known hazard have been extensively studied and vigorously prepared for. Federal, state, and local governments and utility personnel employ a variety of precautions, including the development of emergency plans, training of personnel, coordination of response, and public alert procedures. A regular series of mandated interagency drills and exercises also occurs as further described below.

Some risks still exist after a plant has been closed due to the need for long-term onsite radioactive materials storage. The end of this chapter includes supplemental material on facilities that have been removed from service, out of state risks, and information concerning nuclear accident severity scales.

Specific Impacts

Impact on the Public, Property, Facilities, and Infrastructure
A typical power plant accident at a United States facility would tend to pose limited threats, directly involving the environment and public over a distance no greater than 10 miles away (even in the most severe U.S. events). Evacuation and contamination may occur within this limited distance from the plant, and any more far-reaching effects, such as food chain contamination, would vary with weather conditions and the extent and type of radioactive release. The fear associated with such an accident can be pervasive, however, and disproportionate panic could ensue.

Impact on the Economic Condition of the State
Depending on the nature of the accident and the length of any associated shut down, the effects of a typical nuclear plant accident on the economy would be minor to moderate. Industries that use extensive power could be impacted if the area's electric baseload was substantially affected by a plant going offline. In most cases the overall strength of the grid would make up for any shortfalls as long as other energy supply issues were not present. Energy costs could still rise. Clean up costs in worst case scenarios would be substantial, and some areas of land (including agriculture) could need to be removed from use for a lengthy period of time. Contaminated water or even the perception of any accident could have a negative impact on broader state tourism.

Impact on Responders, Continuity of Operations, and Continued Delivery of Services
Nuclear reactors produce "high level waste" in the reactor core that is dangerously reactive and thermally hot, presenting handling, transportation, and storage issues. Due to pre-planning and training exercises, a nuclear power plant accident would likely use designated staging areas from which to handle equipment, protective clothing, medical treatment, decontamination, and sheltering needs. Responder exposure to radiation should not need to exceed amounts that have been mandated by law and by workplace safety regulations. Given the location of Michigan's nuclear power plants, a typical accident would not present a significant danger to continuity of operations but could result in the substantial rerouting of delivery services.

Impact on the Environment
A power plant accident could result in the release of potentially dangerous levels of radioactive materials (e.g., gases, liquids, particles) that may spread outwards by factors such as the weather. A large release of contamination would make portions of impacted land unusable for humans, wildlife, and crops/vegetation. While some isotopes can decay quickly, the effects of extreme accidents could be long-lasting because radioactive materials decay over extremely long periods (plutonium can remain hazardous for thousands of years). Radioactive contamination has the potential to seep into the water table or spread into nearby water bodies.

Impact on Public Confidence in State Governance
A nuclear power plant emergency may severely affect public confidence in state government if it results in significant environmental harm, displacement, or casualties. Although the odds of this happening are very low, nuclear power, as used in the United States, is not always well understood and even temporary minor issues that produce extremely low-level risk may be viewed as being highly dangerous. The involvement of terrorists would severely compromise public confidence, especially in the case of lax security.

Hazard Mitigation Opportunities for Nuclear Power Plant Emergencies

- Arrangements for designated shelters and accident warning systems.
- Increased coverage and use of NOAA Weather Radio (which can provide notification to the community during any period of emergency, including plant accidents).
- Strong community relationships and educational opportunities with area residents.
- Potassium Iodide distribution.

Significant Nuclear Power Plant Accidents Around the World

Worldwide, four nuclear power plant accidents rank as the most significant in the history of the nuclear power era:

September 29, 1957 – "Kyshtym Disaster," Russia
The Mayak Nuclear facility was a nuclear fuel reprocessing plant located in Kyshtym (now Ozyorsk). An exploding chemical tank blasted radioactive materials skyward, which then drifted along the winds to the northeast. Materials from this blast were scattered for about 200 miles along a line where the winds blew and contaminated the area with caesium-137 and strontium-90. An estimated 270,000 persons were exposed to radioactive materials as a result, and 20 communities were eventually resettled away from the contamination zone. The full extent of this event was only revealed to the public decades later, starting in the 1970s.

March 28, 1979 – Three Mile Island, Harrisburg Pennsylvania
On March 28, 1979, the most serious nuclear reactor accident ever to occur at a commercial power plant in the United States took place at the Three Mile Island nuclear power plant near Harrisburg, Pennsylvania. This incident resulted from a plant malfunction, combined with operator overrides of automatic safety systems. These errors resulted in a partial meltdown of the reactor core. Utility, state, and local personnel implemented response plans to protect the public in the area around the plant, while on-site efforts were undertaken to cool the reactor and prevent any possible release of radioactive material. While this accident did not result in any off-site health consequences, it had a major impact on emergency planning regulations in the United States. Following the accident, new federal regulations were written to mandate specific activities by both on-site and off-site emergency response organizations. These more stringent federal regulations aimed at improving emergency planning efforts at nuclear power plants and providing for additional plant safety systems. Among the new regulations was NUREG 0654/FEMA REP-1, which forms the basis for state and local government planning, training, and emergency exercises.

April 26, 1986 – Chernobyl, Ukraine (then part of the Soviet Union)
On April 26, 1986, a Soviet nuclear reactor at Chernobyl, Ukraine suffered a steam explosion while conducting experimental testing. This explosion, and the ensuing fire in the graphite core of the reactor, released radioactive debris into the upper atmosphere where wind currents dispersed it around the world. Other radioactive material was deposited in areas around the plant site, contaminating the land and food. The high levels of radiation on-site killed 32 plant workers and firefighters.

The area within a 20-mile radius around the plant is heavily contaminated with radioactive material, and most of those who had previously resided there have not returned. Soil contamination does not allow the consumption of crops grown in these areas. Because residents had consumed contaminated crops and milk, studies have indicated significant increases in childhood thyroid cancer in the region around the plant. Over 4.5 million persons continued to live in less-severely contaminated areas in Ukraine, Russia, and Belarus.

While an event of this nature is not physically possible at a U.S. reactor due to differences in reactor design and safety systems (for example, the Chernobyl reactor did not have a containment building), the event did impact U.S. emergency planning regulations. One of the major lessons learned from this accident is the need for early impoundment of suspected food and milk that may have been contaminated. The EPA has revised its guidelines for environmental monitoring in affected areas as a result of the Chernobyl experience (i.e., EPA 400 Ingestion Pathway Protective Action Guidance).

March 11, 2011 – Japan
A 9.0 magnitude, undersea, mega-thrust earthquake occurred near Tohoku, Japan, with a hypocenter at an underwater depth of approximately 20 miles. It was one of the five most powerful earthquakes in the world since modern record-keeping began in 1900. There were multiple foreshocks, as well as hundreds of aftershocks of a 4.5 magnitude or greater. The earthquake triggered extremely destructive tsunami waves of up to 40.5 meters high, and in some cases, traveling up to six miles inland in Tohoku. The Japanese National Police Agency confirmed (as of 2012) 15,854 deaths, 26,992 injuries, and 3,155 people missing. The earthquake and tsunami caused extensive and severe structural damage in Japan, heavy damage to roads and railways, fires in many areas, and a dam collapse. These included 129,225 buildings destroyed and 945,970 damaged. Around 4.4 million households were left without electricity.

A total of eleven reactors were automatically shut down following the earthquake. The tsunami still caused meltdowns at three reactors at the Fukushima I Nuclear Power Plant complex, with reactors suffering explosions due to hydrogen gas built up within their outer containment buildings. At Fukushima I and II, tsunami waves overtopped seawalls and flooded the entire plant, including low-lying generators, electrical switch gears, and external pumps for supplying cooling seawater. The plant's connection to the electrical grid was broken, as the tsunami destroyed the power lines. All power for cooling was lost and the reactors started to overheat from the natural decay of the fission products created before

shutdown. The flood destroyed diesel backup power systems, leading to severe problems at Fukushima I, including three large explosions and radioactive leakage. Flooding with radioactive water also prevented access to basement areas where repairs where needed. Japanese officials reported that radiation levels inside the plant were up to 1,000 times normal levels, and that radiation levels outside the plant were up to eight times normal levels. Residents within a 12-mile radius of the Fukushima I Nuclear Power Plant, and a 6-mile radius of the Fukushima II Nuclear Power Plant, were evacuated. There were associated evacuation zones that affected hundreds of thousands of residents. An aftershock on April 7 caused the loss of external power to two plants, with backup generators functional, but another plant lost three of four external power lines and its cooling function for 80 minutes.

Analysis indicated that three reactors had suffered meltdowns and continued to leak coolant water three months later. Radioactive strontium was detected in the soil in some parts of Fukushima, with radioactive iodine and cesium detected in the tap water in several nearby areas. Food products were found to be contaminated in several places, and food grown in the area was banned from sale. It was estimated that the release of dangerous radioactive isotopes of iodine and cesium reached almost the same emission levels as those from Chernobyl. Estimates placed insured losses from the earthquake alone at $14.5–$34.6 billion (U.S. dollars), along with a cleanup time that will stretch into decades.

Nuclear Power Plant Incidents In and Near Michigan

Nuclear power plant incidents in Michigan have been notably less severe than the above examples.

October 5, 1966 – Enrico Fermi-1, Monroe County, Michigan
Detroit Edison's Enrico Fermi Atomic Power Plant (commonly called Fermi-1) was a new reactor designed to demonstrate the feasibility of new breeder reactor technology. An internal release of radioactive material occurred when a metal flow guide inside the reactor broke away, blocking the flow of sodium coolant. Approximately one percent of the fuel melted as a result. The fuel damage caused the release of some radiation into the reactor containment building, although no true off-site release occurred. The plant was eventually repaired, and it operated for a short period until it was permanently shut down in 1972. The fuel and related materials were removed and sent to a federal government facility in the mid-1970s. The Enrico Fermi-2 nuclear plant opened nearby in 1988.

March 5, 2002 – Davis-Besse, Oak Harbor, Ohio
Damaged material was discovered at the Davis-Besse Nuclear Power Station in Oak Harbor, Ohio (near Toledo). The plant's secondary EPZ overlays with some southeast Michigan counties. Maintenance workers discovered that corrosion had created a football-sized hole as a result of a boron leak that had been dripping onto the plant's reactor vessel head. The corrosion did not lead to a radioactive accident, but the Nuclear Regulatory Commission kept the plant shut down until March 2004. The U.S. Justice Department investigated and penalized the owner of the plant $28 million in fines for safety and reporting violations related to the incident. The NRC also imposed its largest fine ever, more than $5 million, against First Energy for the actions that led to the corrosion. During the time the plant was off-line it was also the victim of a cyberattack. The plant is currently operational.

Select Laws, Agencies, or Programs

Since the Three Mile Island accident in 1979, federal, state, and local governments have developed detailed radiological emergency response plans for each nuclear power plant based on NUREG 0654/FEMA REP-1 and subsequent federal regulations and guidance. These plans are exercised on a biennial basis and are reviewed by the Federal Emergency Management Agency (FEMA) and the Nuclear Regulatory Commission (NRC).

Ownership and use of radioactive materials are strictly regulated by the federal government. Nuclear power plants must follow strict building and safety codes. Material storage, use, and waste management practices are closely monitored. In 1977, President Carter placed a moratorium on the shipping of spent fuel from commercial nuclear power plants to burial sites or spent-fuel reprocessing centers. Spent fuel is now stored at the plant site in spent fuel pools or dry cask storage facilities until the issue of permanent nuclear waste disposal is resolved.

Response to a nuclear power plant accident in Michigan is the joint responsibility of the plant owner/operator and the federal, state, and local government. State and local governments implement protective actions and other preparedness and response activities based on the Nuclear Accident Emergency Action Level Classification System. As previously mentioned, the primary EPZ around a nuclear power plant is typically 10 miles. The area within the primary EPZ, for which protective actions are implemented, will depend on the type and amount of radioactive material released and on

weather conditions. Within this zone, plans are developed to protect the public through in-place sheltering and evacuation in the event of an accident. The secondary EPZ, consisting of a 50-mile radius around most plants, exists for planning considerations which aim to prevent radioactive contamination of the food chain.

Radiological Emergency Preparedness (REP) Program

The REP Program is responsible for the development and implementation of Michigan's Nuclear Facilities Emergency Management Plan, and for the nuclear accident aspects of the Michigan Emergency Management Plan, including EGLE's radiological responsibilities to respond to accidents or emergencies at any of Michigan's commercial nuclear power plants. These efforts are conducted in cooperation with other state agencies and under the overall emergency response coordination responsibilities of the Michigan Department of State Police. Program staff also interacts with nuclear plant utility staff, FEMA, and personnel from the U.S. Nuclear Regulatory Commission, concerning the day-to-day operations of nuclear power reactors to ensure radiological protection for the public and the environment.

Potassium Iodide (KI) Distribution

Thyroid cancer is a concern where radioactive iodine (radioiodine) is released by an incident. Taking potassium iodide (KI) pills in the immediate aftermath of radioiodine exposure can reduce such risks. The pills protect the thyroid from poisoning for 24 hours, which is usually enough time to evacuate. The pills do not protect against other harmful effects of radiation exposure. People living or working within 10 miles of any of these power plants can receive a voucher for a free pack of potassium iodide.

Supplemental Material

International Nuclear Event Scale (INES)

The INES describes event severity in terms of a logarithmic scale that ranges from 1–7. Level 0 (below scale) indicates the event has no safety significance. There are then three levels of "incident" and four levels of "accident," with the most serious being classified as Level 7 (major accident). The level for a given event is based on three parameters: effect on people or the environment, loss of protective radiation barriers, and loss of any layers of safety systems. There have only been two Level 7 accidents (Chernobyl in 1986 and Japan in 2011) and only one Level 6 accident (Mayak, 1957, in the Soviet Union). Three Level 5 accidents have also been classified—the Windscale Pile (United Kingdom, 1957), the Three Mile Island accident in 1979, and the Goiânia accident (Brazil, 1987). The Goiânia accident is also discussed in the Terrorism chapter of this document.

Additional Locations for Consideration

Michigan's Palisades facility was removed from service in 2022 but it still subject to many safety regulations as part of a lengthy decommissioning process. The Big Rock Point nuclear plant near Charlevoix was closed in 1997 but still has spent fuel stored at its location.

The Davis-Besse nuclear plant near Toledo has several Michigan counties within its secondary EPZ radius. More information on a 2002 incident at this facility is included in the nuclear incident section of this chapter.

HAZARDOUS MATERIALS: TRANSPORTATION INCIDENTS

An uncontrolled release of hazardous materials cargo during transport, capable of posing a risk to life, health, safety, property, or the environment.

Hazard Description

All modes of traditional transportation—highway, rail, air, and marine—carry hazardous materials throughout our communities on a regular basis. Pipeline transportation is also common and covered under its own chapter. 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.

Hazard Analysis

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. 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.

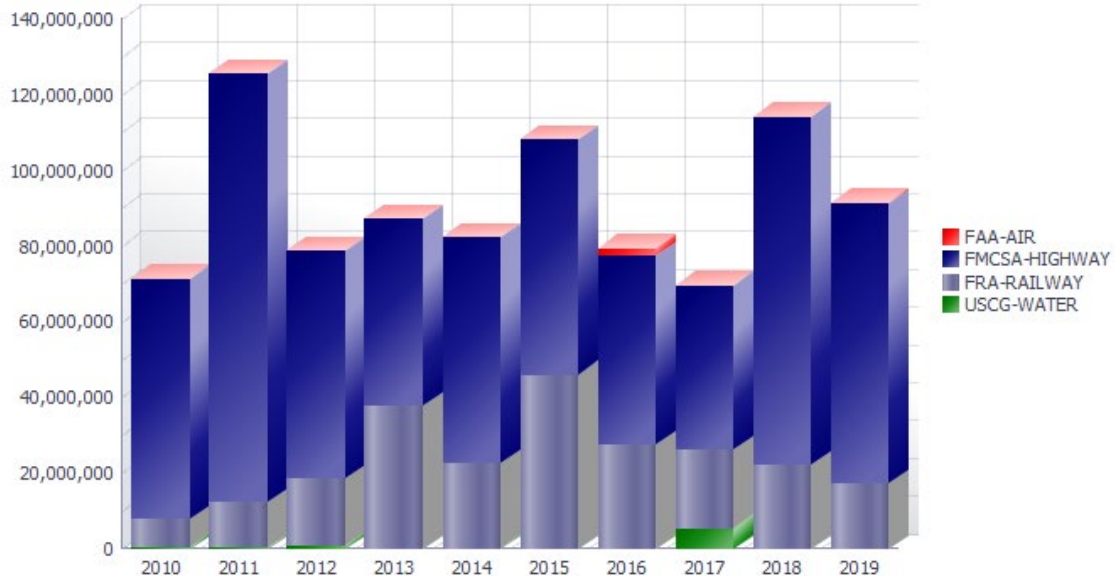
Hazardous Material Incidents by Mode and Incident Year

Mode Of Transportation	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	Grand Total
FAA-AIR	2	2	2	3	3	3	4	15	5	10	**49**
FMCSA-HIGHWAY	320	335	363	333	330	280	245	252	292	226	**2,976**
FRA-RAILWAY	35	40	33	31	18	33	23	24	27	26	**290**
USCG-WATER	1	0	0	0	0	1	1	0	0	0	**3**
Grand Total	**358**	**377**	**398**	**367**	**351**	**317**	**273**	**291**	**324**	**262**	**3,318**

(source: https://www.phmsa.dot.gov/hazmat-program-management-data-and-statistics/data-operations/incident-statistics)

The following chart highlights that the greatest amount of total damages due to transportation related hazardous materials incidents comes from highway and rail shipments.

Nationwide Hazardous Materials Transportation Damages



(source: https://www.phmsa.dot.gov/hazmat-program-management-data-and-statistics/data-operations/incident-statistics)

Large maritime spills are less frequent but can produce costly individual events. This concern is partially lessened for Michigan because the vast majority of waterborne cargo does not involve fast spreading petroleum or chemicals, and many of these shipments begin or end at the Port of Detroit without needing to traverse the entirety of the state's Great Lakes. See the map on Michigan Commercial Ports in the supplemental materials section for additional details.

Highway incidents also represent the most fatalities, typically from the occupants of involved vehicles and not secondary to persons harmed by the release of poisonous gasses or other toxic chemicals. The transportation of some hazardous materials is restricted or regulated to help mitigate against mass casualty events. MDOT is the authorized agency responsible for Non-Radioactive Hazardous Materials routing designations, restrictions, and requirements in the state. Regulations may result in outright prohibitions for certain materials, time of day restrictions, the need for escort vehicles, or other measures.

The Federal Motor Carrier Safety Administration maintains information on all of the states' hazardous materials route registries. Michigan has nine restricted routes, relatively short in length and impacting major bridges and tunnels, as well as portions of some highways in southeast Michigan. Several of the routes can accept at least some level of hazardous materials. A commercial truck ferry in southeast Detroit is another available option. Additional information on the state's restricted routes can be found in the supplemental materials section at the end of this chapter, or at https://www.fmcsa.dot.gov/regulations/hazardous-materials/national-hazardous-materials-route-registry-state.

The Pipeline Hazardous Materials Safety Administration, in consultation with the Federal Railroad Administration, issued a rule requiring railroads to share information regarding High-Hazard Flammable Train (HHFT) operations with State Emergency Response Commissions (SERCs) to improve preparedness (see the fixed-site hazardous materials chapter for more information on SERCs). The Michigan Citizen-Community Emergency Response Coordinating Council (MCCERCC) is such a SERC. For security reasons, specific HHFT routes and shipments are not generally made available to the public. Local emergency managers and governmental planners may choose to contact the MCCERCC. A frail map highlighting the state's most active chemical freight corridors is available at the end of this chapter.

While the use of airplanes for the transportation of hazardous materials does occur, these are not likely for large quantities of liquid cargo or flammable substances. Most airplane crashes occur upon take-off or landing, so impacts are more commonly confined to airports and their surrounding areas. Jet fuel itself can be extremely hazardous. In most cases it is not an airplane's primary cargo, but fuel may be dumped inflight as an emergency measure in advance of an anticipated crash. Local emergency managers need to familiarize themselves with the airports and military bases in their area. See the Major Transportation Incidents chapter for Michigan's airport map.

The Nuclear Regulatory Commission works with the federal Department of Transportation to oversee the transportation of radioactive materials. Millions of such shipments travel throughout the country each year. They typically contain small amounts of radioactive material that are used in industry and medicine (e.g., smoke detectors, watch dials, nuclear medicine equipment, syringes used with radioactive medicines). High level radiation materials used by nuclear power plants and the military are less common and require the use of specialized transport casks or other measures. Additional information can be found at https://www.nrc.gov/waste/spent-fuel-transp.html.

Michigan's comprehensive freight plan offers an excellent summary of the various materials moving throughout the state. It is an official supplement to the 2040 MI Transportation Plan.

Specific Impacts

Impact on the Public, Property, Facilities, and Infrastructure
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. Typically impacted infrastructure includes highways, overpasses, and rail crossings. Large airports are an area of concern, but often include highly trained, embedded response teams.

Impact on the Economic Condition of the State
Only the severest of such incidents would have a significant impact on the economic condition of the state. Although multiple occurrences could drain state budgets in the aggregate, such a pattern is unlikely to emerge. 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.

Impact on Responders, Continuity of Operations, and Continued Delivery of Services
The impacts on these considerations 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.

Impact on the Environment
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.

Impact on Public Confidence in State Governance
Confidence could be impacted o the extent the public feels a lack of regulation was involved in an incident. In many instances the public may have a "not in my backyard mentality" that extends even to materials simply traveling via nearby roads. Despite efforts to focus on the greatest overall safety methods, members of the public may feel that any transportation of these necessary goods in their communities is unacceptable.

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.
- 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).
- Proper planning, design, maintenance, and enhancements to designated truck routes.
- Locating schools, nursing homes, and similar facilities away from major hazardous materials routes.
- 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.

Selected Significant Hazardous Materials Transportation Incidents

Michigan has not had a hazardous materials transportation incident causing a high level of devastation such as what was seen in Texas City (see below). However, the state has had numerous smaller-scale incidents requiring response by fire departments and hazmat teams, evacuations, and other protective actions. Highway incidents are by far the most common, but the vast majority are not listed here to avoid duplication.
April 16, 1947 – Texas City, Texas – Out of State Example

One of the worst explosions in United States history occurred when 2,300 tons of ammonium nitrate detonated onboard the SS Grandcamp as it lay in port in the Gulf of Mexico. The incident started with a mid-morning fire leading to a massive explosion, sending a 15-foot wave across the water to the shoreline. Almost 1,000 buildings were destroyed, including a Monsanto Chemical Company plant, as fires ignited refineries and chemical tanks on the waterfront. The incident resulted in at least 581 fatalities and over 5,000 injuries. Windows were shattered 40 miles away in Houston and people reported feeling the shock 250 miles away.

August 27, 1978 – Farmington Hills (Oakland County)
A commercial van containing radioactive material (iridium 192) was involved in a crash. The van caught on fire, prompting fears of a serious radiological incident. Traffic was rerouted around the incident site until it was determined that no leakage of radioactive material had occurred.

February 18, 1981 – River Rouge (Wayne County)
A freight train carrying 56,000 gallons of liquid propane gas derailed, resulting in the evacuation of over 6,000 people.

February 27, 1981 – Dayton Township (Tuscola County)
A derailed train spilled hydrochloric acid, liquid petroleum gas, isobutane, and butylene. Sixty residents were evacuated.

August 7, 1981 – Bridgman (Berrien County)
A freight train derailment resulted in a spill of fluourosulfonic acid, which formed a vapor cloud that forced the evacuation of 1,000 persons. The toxic fumes led to the death of a State Police trooper.

December 28, 1982 – Chesterfield Township (Macomb County)
A tanker truck leaked nitric acid, resulting in 12 injuries and the evacuation of 1,200 people due to toxic fumes.

February 1, 1983 – Coopersville (Ottawa County)
A gasoline tanker truck rolled over on I-96, resulting in a spill of 9,000 gallons of gasoline. The gasoline then caught fire, forcing the closure of I-96 for several hours until the fire could be suppressed and the site cleaned.

October 12, 1983 – Fraser (Macomb County)
A tanker truck overturned, spilling 5,000 gallons of methyl amyl ketone. The spill forced the evacuation of 600 persons, and M-97 and 14 Mile Road were closed until the spill could be cleaned up and the site restored.

October 12, 1984 – Thompson Township (Schoolcraft County)
A gasoline tanker truck swerved to avoid hitting a school bus and rolled over, spilling approximately 7,000 gallons of gasoline and 1,000 gallons of diesel fuel. Thirty persons were evacuated until the spill could be cleaned.

July 22, 1989 – Tittabawassee Township (Saginaw County)
A freight train carrying a variety of hazardous materials derailed near Freeland, causing two rail cars to catch on fire and forcing a weeklong evacuation of 1,000 residents. One home near the incident site was destroyed. After the fire was fully extinguished one week later, the site was cleared and the contaminated soil surrounding the site was excavated and transported to a hazardous waste landfill.

July 29, 1989 – Otsego/Bailey Townships (Otsego County)
A semi-trailer carrying acetic acid, potassium hydroxide, and ammonium thiocyanate rolled over on I-75, just south of Gaylord. The incident caused the evacuation of approximately 150 people from nearby homes and businesses. Traffic on I-75 had to be rerouted for the duration of the 12-hour event. No injuries were reported.

January 12, 1990 – Buena Vista Township (Saginaw County)
A semi-tanker carrying 10,000 gallons of mixed fuel overturned due to icy roads and high winds. Approximately 2,500 gallons of diesel fuel spilled into the drain system and traveled nearly a mile before it could be diked and removed by an environmental cleanup contractor. The spill prompted the evacuation of approximately 520 persons in a half-mile radius. The evacuated area was re-opened 12 hours later.

March 12, 1990 – Dearborn and Detroit (Wayne County)
A copper chloride leak from a delivery truck prompted the evacuation of several homes and businesses. No injuries were sustained in the incident, but the roadway was closed for several hours while cleanup operations were completed. Copper chloride can cause respiratory problems and is corrosive to touch.

September 16, 1990 – Bay City (Bay County)
The tanker vessel MV Jupiter exploded while moored in Bay City's harbor. Greater tragedy was averted when the Buffalo, a freighter measuring 635-feet long, was heading up the Saginaw River to unload coal but just missed the blast zone. According to an incident report by the National Transportation Safety Board, the Jupiter broke away from its berth and its stern swung out into the river, rupturing the hose that was discharging gasoline and damaging the pipeline.

Gasoline spilled onto the pier and deck of the Jupiter. Electrical cables that closed off the pipelines were torn apart, causing a spark that ignited the gas. More than a dozen crew members were injured; most treated for mild cases of hypothermia and minor burns. One drowned while trying to swim to safety after the vessel exploded. Carrying two million gallons of gasoline, the resultant fire lasted for several days. After it was extinguished, the remaining product was pumped out of the cargo hold—a difficult and risky task—and sent to a treatment facility. This incident created great concern for the safety of residents in the vicinity of the fire, for response personnel, and the environment. In addition, river commerce was disrupted for an extended period of time. A Governor's Emergency Declaration was granted to provide supplemental state assistance in the containment and suppression of the fire, as well as required environmental monitoring.

March 24, 1993 – Sylvan Township (Washtenaw County)
A semi-truck carrying an acidic chemical drove off I-94, one mile west of M-52, and struck a tree. The collision caused approximately 220 gallons of the material to leak from the vehicle onto an area on and near the roadway. Two police officers and two motorists were injured due to exposure to the product, and all were hospitalized for a brief time. I-94 was closed for several hours to avoid any further exposure to the chemical.

November 16, 1994 – Morrice and Perry (Shiawassee County)
A fire aboard a freight train carrying sodium isopropyl xanthate prompted an evacuation of residents in the vicinity of the railroad tracks near the outskirts of Morrice. The fire burned for 10 hours before it was completely extinguished, and area residents were allowed to return to their homes.

April 5, 1995 – Detroit (Wayne County)
A tractor trailer transporting 8,500 gallons of gasoline overturned on a ramp at I-94 and I-75. The driver was killed in the crash and ensuing fire. A one-half mile area around the crash scene was evacuated, due to the risk of explosion from seeping gas that washed down into the sewer.

June 4, 1999 – Whitehall (Muskegon County)
At a tannery, a tanker truck driver unknowingly unloaded a shipment of sodium hydrosulfide solution into a storage tank normally used exclusively for ferrous sulfate solution, creating a chemical reaction producing hydrogen sulfide—a poisonous gas. The truck driver was pronounced dead at the scene after having been overcome by the hydrogen sulfide gas. An employee of the tannery was rendered unconscious by the gas, but regained consciousness in time to avoid lasting injury. Eleven employees at the tannery were evacuated. Total property damage exceeded $411,000.

August 29, 1999 – Birmingham and Bloomfield Township (Oakland County)
More than 40 cars of a 98-car freight train carrying automobiles and some hazardous materials (yellow phosphorous) derailed in Birmingham and Bloomfield Townships, causing two rail cars to catch on fire and forcing police and fire officials to warn nearby residents and motorists to stay indoors and keep their windows closed due to possible toxic fumes. None of the cars containing hazardous materials derailed. Some local roads were closed for several hours. The derailment caused an estimated $6 million in damage.

September 7, 1999 – Ecorse (Wayne County)
A four-car freight train derailment that included a tanker car carrying 23,000 gallons of ethylene oxide forced an evacuation of 600 persons from nearby homes, businesses, and schools on the Ecorse-River Rouge border. The tanker car was inspected and determined not to be leaking. After several hours, the train cars were rerailed and the evacuated residents were allowed to return to the area.

January 21, 2000 – Flint (Genesee County)
A rail car with 33,000 gallons of liquid propane gas caught fire in the CSX rail yard in Flint, forcing the evacuation of 2,600 homes within a one-mile radius of the incident site. The danger of a potential explosion also shut down a section

of I-475 and closed two elementary schools near the scene. An estimated 3,500 evacuees were housed in three shelters and local motels until the incident was stabilized the next day. CSX railroad and local fire officials determined that the best course of action was to separate the burning tanker from the 54 other liquid propane tanker cars, vent the tanker, and allow the remaining product to burn off.

May 27, 2000 – Detroit (Wayne County)
A semi-tanker carrying 13,000 gallons of gasoline overturned, ignited, and exploded on I-75 in downtown Detroit, killing the driver and forcing the cancellation of the city's Memorial Day parade that was to be held nearby. The parade was cancelled because officials feared that fuel entering the sewer system could ignite and launch manhole covers into the crowd. Firefighters pumped foam and water into storm drains to prevent further explosions. The stretch of I-75 involved in the incident was closed for several hours to allow for cleanup activities.

July 14, 2001 – Riverview (Wayne County)
A pipeline attached to a fitting on the unloading line of a railroad tank car fractured and separated, causing the release of methyl mercaptan, a poisonous and flammable gas. Shortly after, the tank car ignited and sent a fireball 200 feet into the sky. Fire damage to cargo transfer hoses on an adjacent tank car resulted in the release of chlorine, a poisonous gas that is also an oxidizer. Three plant employees were killed in the incident. About 2,000 residents were evacuated from their homes for about 10 hours.

November 15, 2001 – Springfield Township (Oakland County)
Two freight trains, one carrying a tanker of chloride gas, collided head on and derailed in rural Springfield Township, killing two crewmen and critically injuring two others. The crash ignited swampland around the site, as three of the four locomotives derailed and caught fire. Over 100 homes were evacuated within a half-mile radius for several hours, with two nearby schools closed for the day. The chloride gas did not release.

May 27, 2002 – Potterville (Eaton County)
A horizontal break in a railroad track caused the derailment of 35 cars from a 58-car Canadian National Railroad freight train. Nine cars contained liquid propane, two of which leaked. About 2,200 citizens were evacuated for up to four days. The company reimbursed residents who could document losses, such as missed work, spoiled food, and hotel stays.

January 29, 2003 – Flint (Genesee County)
A truck hauling propane gas plunged from a freeway overpass and exploded on top of a set of railroad tracks, killing the driver and cutting off power to 1,100 people. I-69 was closed in both directions for several hours because of this incident.

February 24, 2003 – Holland Township (Ottawa County)
Four tanker trucks exploded at an oil company. The fire injured four people who were taken to the hospital for burns and smoke inhalation. A nearby warehouse also caught fire. Firefighters were able to extinguish the blaze within an hour.

August 8, 2003 – Pittsfield Township (Washtenaw County)
A stretch of I-94 was closed in both directions due to formaldehyde leaking from a tractor-trailer onto the freeway. Hazardous materials officials determined that a cap on the truck was loose and fell off, or had never been placed, causing the spill. Two people who had been exposed to the vapor were treated at the scene and released.

September 16, 2003 – Detroit (Wayne County)
A collision between a car and a tanker resulted in an explosion at an I-75 overpass. The tanker was carrying 22,000 gallons of gasoline and burned for several hours. The truck's driver was pulled to safety before the explosion.

October 6, 2003 – Detroit (Wayne County)
A tanker explosion and fire killed the tanker's driver and closed nearby expressway ramps for about six months. The fire was extremely intense (2400 degrees Fahrenheit), and gasoline leaked and burned over a stretch of about one mile, causing I-94 to be closed in the area.

March 15, 2004 – Taylor (Wayne County)
A collision between a pickup and a tanker truck caused an explosion at Telegraph Road and I-75. Flames reached 400 feet in the air, and the driver of the pickup truck was killed. Telegraph Road was closed for several hours while the scene was investigated and cleared.

August 13, 2004 – Coloma (Berrien County)
Hazardous materials crews closed an eight-mile stretch of both lanes of I-94 after two tractor-trailers collided and exploded. One of the trucks was transporting Drano, which spilled onto the freeway. One of the drivers was injured in the crash and taken to a hospital.

July 7, 2006 – Tustin (Osceola County)
A semi-truck overturned on US-131 in an incident involving ethanol fuel. Both lanes of the highway were shut down. Over 2,000 gallons of fuel contaminated the soil, resulting in 10,000 gallons of sludge being removed by the hazardous materials teams.

December 14, 2007 – Fraser (Macomb County)
A sulfuric acid spill of 550 gallons from a vacuum truck shut down an intersection during rush-hour traffic. The chemical leaked into a nearby field and potentially entered a sewer drain. Several businesses in the area were evacuated.

January 10, 2008 – Detroit (Wayne County)
A liquid propane tanker hauling approximately 7,200 gallons of butane plunged through an overpass guardrail. Its explosion damaged a section of northbound I-75, set nearby homes on fire, melted a school playground, and killed the driver. Two northbound lanes of I-75 were closed for several weeks due to severe structural damage to the concrete overpass pillars.

January 31, 2009 – Dearborn (Wayne County)
A hazardous materials situation occurred when a tanker truck slid on ice (created by a broken water main) and overturned. Fuel was spilled on the roadway and ran off into storm drains. Crews sprayed the fuel on the road with foam and took several hours to pump fuel out of the drains. Roughly 100 homes needed to be evacuated.

March 9, 2009 – Detroit (Wayne County)
The Detroit Fire Department handled a chemical spill clean-up after an undetermined amount of sulfur dioxide had leaked from a railroad car in southwest Detroit (the car carried 90 tons of the material). The leak happened at a city wastewater treatment plant just west of Zug Island.

July 15, 2009 – Hazel Park (Wayne County)
A collision between a car and a gasoline tanker on I-75 caused an explosion. The gasoline tanker contained 13,000 gallons of fuel, and the explosion caused the Nine Mile Road overpass to collapse, crushing a passing tractor trailer. The drivers of the three involved vehicles each suffered minor injuries. Thick smoke and flames shot up 150 to 200 feet in the air, melting components of the overpass structure. Investigators said that the temperatures reached 2,300 degrees. The debris was removed and surface repaired, with I-75 traffic reopened in five days. The Nine Mile Road overpass was replaced and reopened in five months.

May 19, 2010 – Brighton (Livingston County)
A semi-truck carrying a load of hazardous material overturned on I-96 after colliding with an automobile, spilling several barrels onto the roadway. The 18-wheeler was carrying Monolube 3400, a potentially hazardous lubricant that when shaken in unventilated containers can produce hydrogen gas. All lanes of traffic were closed, leading to significant traffic delays. The injured truck driver was sent to the hospital.

July 3, 2010 – Flint (Genesee County)
A semi-tanker and motorcycle collided on I-475, with the tanker exploding shortly afterwards. A huge fireball was sent into the sky that could be seen for miles. The heat from the explosion was so intense that it melted construction barrels and damaged concrete. Both sides of the expressway were shut down. The motorcycle driver was killed.

February 1, 2012 – Blackman Township (Jackson County)
An Amtrak train collided with a semi-truck, resulting in spilled acid and diesel fuel, as well as the derailment of the train. Ten people were injured.

July 19, 2012 – Lake Huron (two miles southeast of Lakeport, St. Clair County)
A dredge sank in about 22 feet of choppy water around 4:35 a.m., spilling diesel fuel that caused airborne odors and shut down about a dozen beaches. Officials organized a shoreline monitoring system and reported that the sheen of fuel stretched across an area one mile wide and two miles long. Although the odor was unpleasant enough to encourage people to stay indoors with their windows and doors shut, the fumes were not sufficient to cause serious health concerns.

No one reported any illnesses from these fumes, and the spill had no known effects upon downstream water plants. About 800 feet of absorbent boom were used to collect the fuel, with an additional 1,200 feet of boom made available as a backup in case it was needed for shoreline protection. Although the dredge had between 1,500 and 2,000 gallons of fuel on board, it is unknown how much went into the lake. The fuel that had reached the shore had mostly dissipated by the next day.

January 2, 2014 – Davison Township (Genesee County)
A truck crash and explosion caused I-69 to be closed for much of the day. About 12,000 gallons of crude oil had been transported by the truck, which after hitting a patch of ice went over a guard rail, crashing into Irish Road and subsequently exploding. Area citizens within a one-mile radius were advised to shelter-in-place, and an evacuation of some nearby homes and businesses occurred. The overpass was damaged, but the driver of the truck had only minor injuries.

January 9, 2015 – Kalamazoo County
A 193-vehicle pile-up that included 76 semi-trucks became a hazmat emergency requiring evacuation when a trailer spilled formic acid and caught fire. A separate truck laden with over 40,000 pounds of fireworks also exploded. One person died and at least 23 people were injured (among them two firefighters and a wrecker driver). An evacuation order was lifted when the formic acid burned off. I-94 was completely closed in both directions for almost two days.

Select Laws, Agencies, or Programs

Federal Hazardous Material Transportation Regulations
The Pipeline and Hazardous Materials Safety Administration (PHMSA), Office of Hazardous Materials Safety (OHMS), carries out a national safety and security program to protect against life and property risks inherent in the transportation of hazardous materials by all transportation modes. In addition to enforcing regulations, other OHMS programmatic areas include: research and development for improved containment/packaging, interagency coordination efforts in setting hazardous material transportation standards, management of data information systems pertaining to hazardous material transportation, and the development of safety training policies and programs. Regulations specify the type and size of containers utilized for shipping hazardous material, labels that must be on containers, placards for carrying vessels, and material quantities and loading requirements. Many materials are assigned a unique four-digit identification number that is located on the placard or container. The regulations also require a company involved with hazardous transport to maintain a manifest for material quantity, origin, and destination. Emergency contact numbers must be maintained in case of accidental release.

Hazardous Materials Transportation Uniform Safety Act
The federal Hazardous Materials Transportation Uniform Safety Act (HMTUSA) provides funding for the training of emergency responders and the development of emergency response plans for both fixed site facilities and transportation-related incidents. This funding mechanism under the HMTUSA is referred to as Hazardous Material Emergency Preparedness (HMEP) grants. In Michigan, the HMTUSA/HMEP program is coordinated and implemented by the Michigan State Police, Emergency Management and Homeland Security Division.

Hazardous Material Response Training
The Michigan State Police, Emergency Management and Homeland Security Division provides a wide array of hazardous material response training programs through the Emergency Management and Homeland Security Training Center (EMHSTC). The EMHSTC provides training courses for individuals and companies responsible for planning, inspection, response, mitigation, and cleanup activities involving hazardous materials. Specific subjects include: 1) Hazmat Technician Program (Pro Board certified); 2) hazardous materials chemistry; 3) hazardous materials emergency response; 4) hazardous waste worker compliance; 5) incident management; and 6) other specialized hazardous materials-related courses, such as highway and rail cargo tanker and storage tank handling. Many courses are conducted onsite in Lansing due to the unique simulation aids available in the EMHSTC Training Yard, but there are some mobile courses available as well.

Federal/State Hazardous Material Response Resources

There are numerous groups at the federal, state, and local levels, and in private industry, that are trained to deal with hazardous material fixed-site and transportation incidents. These groups include the National Response Team (NRT), the Region 5 Regional Response Teams (RRT), and state and local hazardous material response teams. The American Chemistry Council established the Chemical Transportation Emergency Center (CHEMTREC) to provide 24-hour technical advice to emergency responders. The National Response Center (NRC), which operates much like CHEMTREC, was established to provide technical advice and coordinate the federal response to a hazardous material incident. In Michigan, a 24-hour, statewide notification system called the Pollution Emergency Alerting System (PEAS) was established for reporting chemical spills to the Michigan Department of Environmental, Great Lakes, and Energy. As a companion to the PEAS, the Michigan Department of Agriculture and Rural Development (MDARD) has established a 24-hour Agriculture Pollution Emergency Hotline for use by agri-chemical users to report fertilizer and pesticide spills. Callers to the MDARD hotline gain immediate access to appropriate technical assistance and regulatory guidance.

U.S. EPA Chemical Emergency Preparedness and Prevention Office (CEPPO)

The U.S. Environmental Protection Agency's CEPPO provides leadership, advocacy and assistance to states, local governments, and private industry to: 1) prevent and prepare for chemical emergencies; 2) respond to environmental crises; and 3) inform the public about chemical hazards that may be present in their community. The CEPPO works closely with several Michigan state agencies to implement and coordinate a number of regulatory and non-regulatory programs designed to protect human health and the environment in Michigan from chemical incidents, including the SARA Title III program.

National Transportation Safety Board (NTSB)

The NTSB investigates all significant transportation incidents that occur nationwide and issues safety recommendations (to the transporter and to government regulators) aimed at preventing future incidents. Examples of such Michigan incidents include the November 15, 2001 freight train incident in Springfield Township, the June 4, 1999 cargo transfer incident in Whitehall, the September 16, 1990 Jupiter tanker fire in Bay City, the July 22, 1989 train derailment in Freeland, and an August 2, 1975 propane pipeline incident in Romulus (not listed in this analysis but available for further study). The NTSB also publishes a list of suggested safety improvements on its "most wanted" page.

Transportation Community Awareness and Emergency Response (TRANSCAER)

TRANSCAER is an industry outreach program coordinated by the American Chemistry Council and Michigan Chemistry Council to address hazardous material transportation concerns. The program offers free resources for hazmat and emergency response training, as communities develop their own emergency response plans.

Supplemental Material

Restricted Hazardous Material Routes (Michigan)

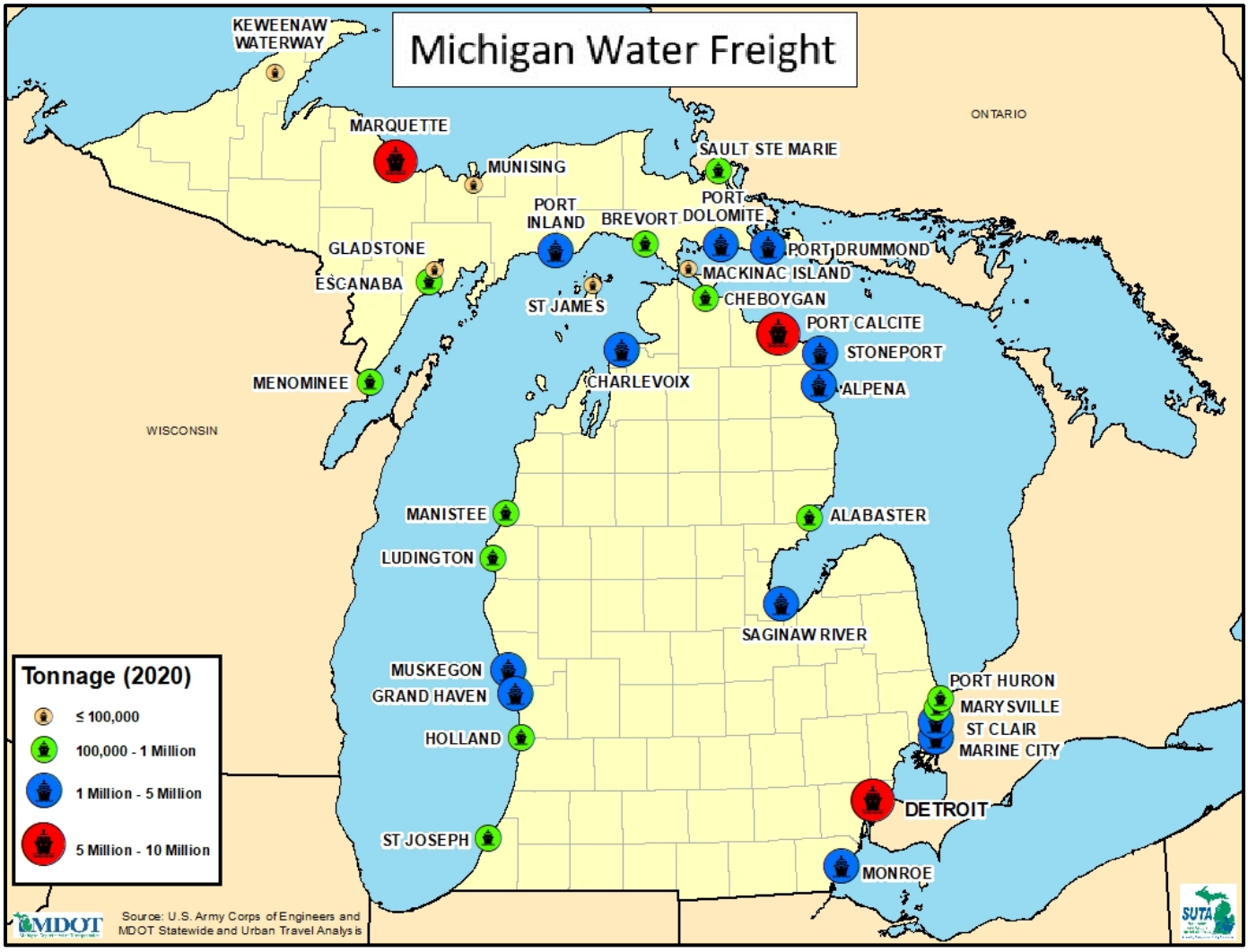
Michigan – Restricted HM routes

Desig-nation Date	Route Order	Route Description	City	County	Restriction(s) (0,1,2,3,4,5,6,7,8,9,i)
04/02/14	A	Ambassador Bridge [Detroit] from Porter St. to Canada [Windsor] [Phone (313) 849-5244]	Detroit	Wayne	1,3,6.2,7,8
04/02/14	B	State Route M-10/Lodge Freeway [Detroit] from Howard St. to Woodward Ave. [Under Cobo Hall (approximately one mile)]	Detroit	Wayne	0
04/02/14	C	Windsor Tunnel [Detroit] from Jefferson Ave. to Canada [Windsor] [Phone: (313) 567-4422]	Detroit	Wayne	0
04/02/14	D	State Route M-10/Lodge Freeway [Detroit] from 8 Mile Rd [South] to Wyoming St.	Detroit	Wayne	1,2,3,5,6,8
03/08/95	E	Blue Water Bridge [I-69] [Port Huron, MI to Sarnia, Ontario. NOTE: In addition to the listed restrictions, Pyrophoric Liquids prohibited. Contact Michigan Dept. of Transportation for specific restrictions. (810) 984-3131]	Port Huron	St. Clair	1,5,7,9
01/01/90	F	Interstate 696 [County of Oakland] from State Route M-10 to Interstate 75	Royal Oak	Oakland	1,3
10/03/98	G	State Route M-59 [Utica] [1.1 mile from either direction of the Mound Rd exit]	Utica	Macomb	1,3
03/08/95	H	Mackinac Bridge [I-75] [Mackinac City to St. Ignace. All placarded loads require an escort by the Mackinac Bridge Authority. Phone (906) 643-7600.]	Mackinac - St. Ignace	Emmet	0
03/08/95	I	International Bridge [I-75] [All placarded vehicles require an escort. Contact Operations Supervisor at (906) 635-5255 before crossing. Sault Ste. Marie, MI to Sault Ste. Marie, Ontario.]	Saulte St. Marie	Chippewa	0

(source: Federal Motor Carrier Safety Administration, accessed 2020, last updated 2018)

Restriction Codes:
0 - ALL Hazardous Materials
1 - Class 1—Explosives
2 - Class 2—Gas
3 - Class 3—Flammable Liquid
4 - Class 4—Flammable Solid
5 - Class 5—Organic
6 - Class 6—Poison
7 - Class 7—Radioactive
8 - Class 8—Corrosives
9 - Class 9—Dangerous (Other)
i - Poisonous Inhalation Hazard (PIH)

Commercial Ports in Michigan

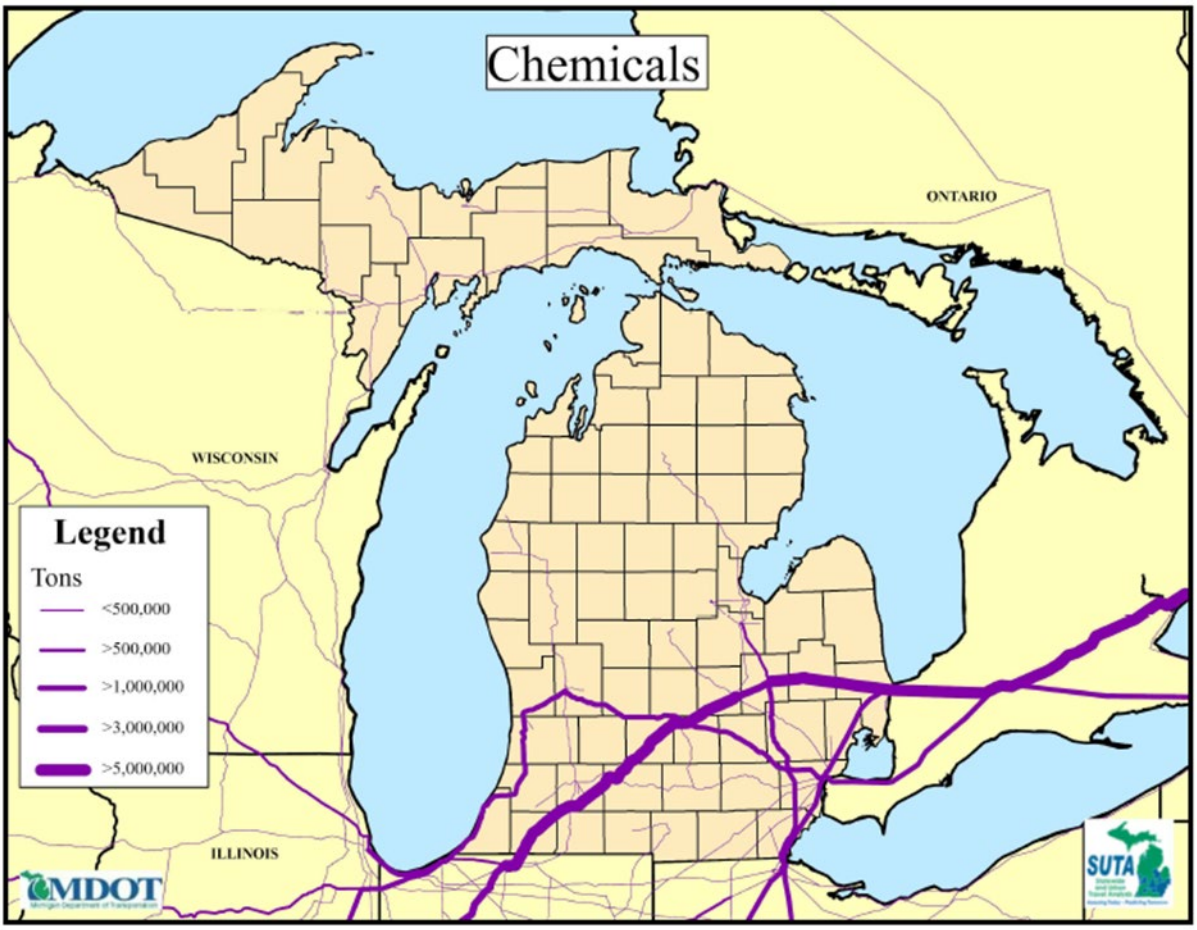


Commercial Port Top Commodities (Michigan, 2020)

Commodity	Total Tons	Inbound Tons	Outbound Tons
Sand, Stone or Salt	29,767,298	12,564,349	17,076,737
Iron Ore	8,337,956	2,219,783	6,118,173
Coal	5,954,572	5,954,572	0
Cement	4,902,123	1,743,838	3,158,285
Primary Metal Products	1,435,009	1,045,835	374,069
Petroleum or Coal Products	1,157,327	871,088	256,526
Chemical Products	291,017	98,029	192,988
All Commodities	**52,221,420**	**24,810,242**	**27,240,148**

(source: U.S. Army Corps of Engineers and MDOT Statewide and Urban Travel Analysis)

Freight Railroads in Michigan: Focus on Chemical Routes (2018)



(source: Michigan Department of Transportation)

MDOT's Office of Rail webpage maintains information on Michigan's rail assets throughout the state. Additional rail freight commodity maps, reports, and publications are also available.

Michigan Rail Tonnage (2018)

Inbound		Outbound	
Commodity	**Total Tons**	**Commodity**	**Total Tons**
Coal	14,872,298	Transportation Equipment	4,964,860
Chemicals	3,134,793	Agriculture	2,114,887
Petroleum or Coal Products	2,329,020	Primary Metal Products	2,083,304
Miscellaneous or Mixed Shipments	2,160,480	Waste or Scrap Metals	1,843,996
Primary Metal Products	2,081,520	Metallic Ores	1,806,846
Transportation Equipment	2,020,600	Nonmetallic Minerals	1,701,876
Logs, Lumber, and Wood Products	1,474,080	Chemicals	1,448,280
Clay, Cement, Glass or Stone Products	856,232	Miscellaneous or Mixed Shipments	1,313,520
Paper and Pulp Products	537,720	Paper and Pulp Products	1,219,200
Food Products	532,080	Petroleum or Coal Products	1,056,329
All Commodities	31,171,169	**All Commodities**	21,427,270

(source: MDOT Statewide and Urban Travel Analysis)

PIPELINE AND WELLHEAD INCIDENTS: PETROLEUM AND NATURAL GAS

An uncontrolled release of petroleum or natural gas from a pipeline or wellhead, including the release of poisonous hydrogen sulfide gas associated with the production, processing, or transportation of these materials.

Hazard Description

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 large pipeline in Calhoun County released heavy crude into the Kalamazoo River in 2010.

Hazard Analysis

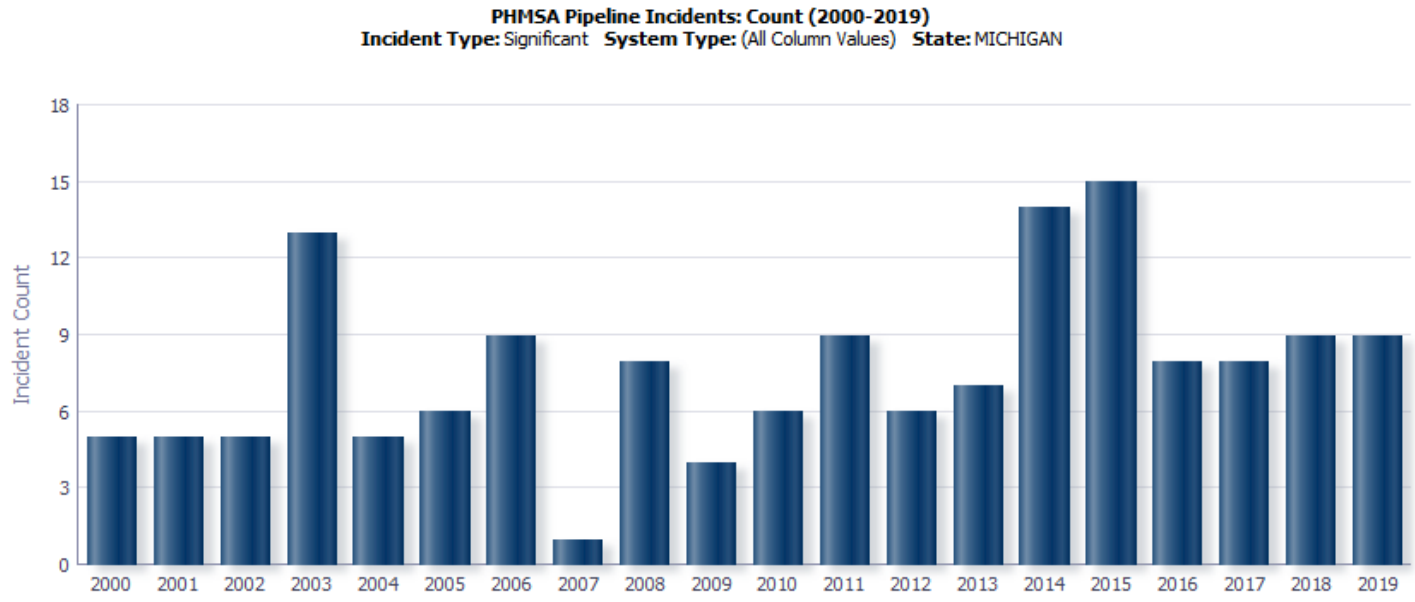
Michigan is a major consumer of petroleum and natural gas, with, for example, roughly four-fifths of Michigan households being connected to natural gas service lines for home heating. The pipeline networks used to transport these products is therefore highly extensive. The state also has the largest residential Liquified Petroleum Gas (LPG) market in the country due to high propane consumption, particularly in the northern parts of the state but also in other areas, typically rural, where natural gas lines have not been extended.

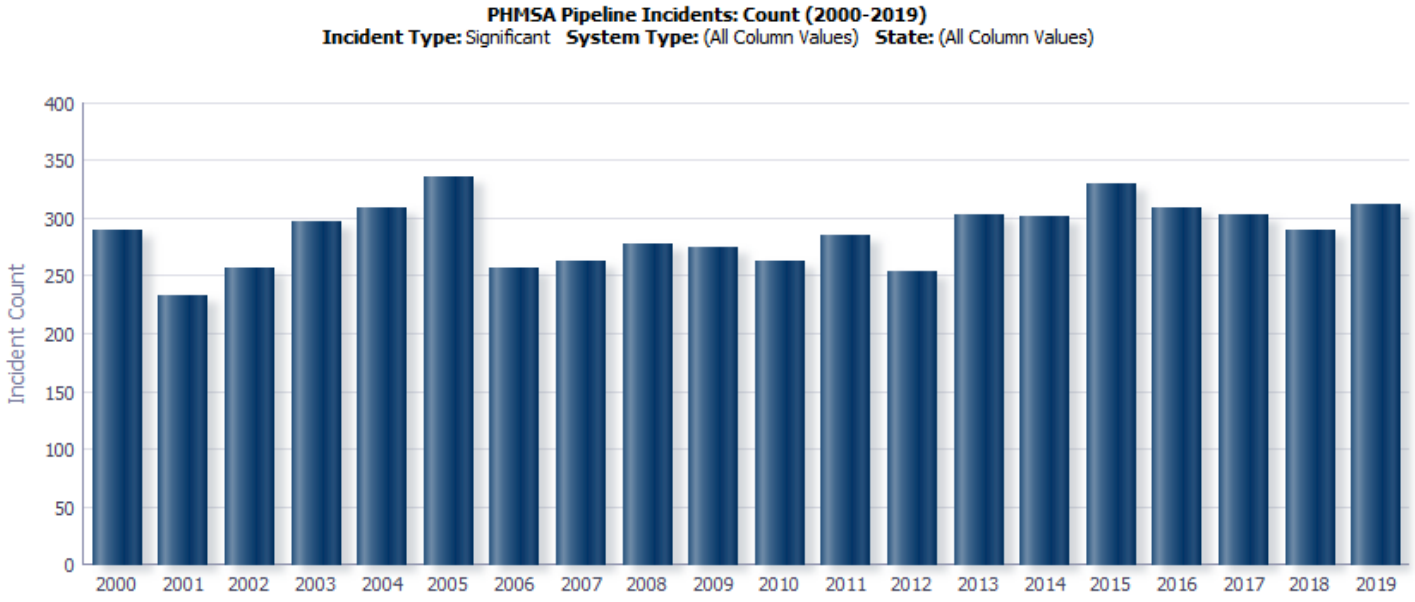
Larger petroleum pipelines carrying crude oil, fuel oil, propane, butane, gasoline, and other petroleum products have their heaviest concentrations in southeast Michigan. Many of the refinery, terminal, and storage areas are located in urban areas where the potential for extensive damage is greatest. The largest concentration of these facilities is found in the greater Detroit metropolitan area. General maps showing larger pipeline locations are available at the end of this chapter. Online GIS maps allow for data segregation by product type and feature.

Major compressor stations that receive and redistribute natural gas are also important parts of some pipeline networks. The stations monitor and maintain pressure levels within the pipelines, and in the event of a pipeline rupture, the compressor stations shut down to stop the flow of product. One such compressor station was the epicenter for a large-scale natural gas delivery crisis associated with the “Polar Vortex” of 2019 (see the chapter on Energy Emergencies for additional information).

The state also has the greatest underground natural gas storage capacity in the nation. Major storage facilities are located in the central part of the Lower Peninsula. These natural gas stores are often distributed to customers in other states, particularly during colder months. The U.S. Department of Transportation’s Pipeline and Hazardous Materials Safety Administration (PHMSA) is a good source for additional information. Their website offers a primer on pipeline and associated infrastructure basics.

Much of Michigan’s petroleum and natural gas pipelines were laid over 60 years ago, and distribution networks and associated service lines continue to expand as a result of population growth and urban sprawl. Minor petroleum and natural gas pipeline accidents can occur with regularity, but usually have a limited impact that is quickly and effectively addressed. More major concerns can be partially evaluated using trend analysis from data collected over the past two decades. The first chart on the next page details such events in Michigan, with the second chart representing all states. Data in the following charts is aggregated and not broken down by specific product type (e.g., petroleum, natural gas).





(source: https://www.phmsa.dot.gov/data-and-statistics/pipeline/pipeline-incident-20-year-trends)

For the purposes of these charts, significant pipeline distribution incidents are defined as those that resulted in either a fatality or injury causing hospitalization, $50,000 or more in total costs (1984 dollars), a highly volatile liquid releases of five barrels or more, a release of other liquids of 50 barrels of more, or releases that resulted in an unintentional fire or explosion. Incidents caused by an unrelated nearby fire that impacted the pipeline system are not considered primary pipeline events and are excluded.

Data collected from the PHMSA can be broken out in a variety of manners. Local emergency managers are encouraged to explore the information most relevant to their communities. To determine if a major transportation pipeline exists in your area, access the National Pipeline Mapping System (NPMS) website and search by your county or zip code at https://www.npms.phmsa.dot.gov/. The PHMSA also collects data regarding associated pipeline injuries, fatalities, and incident costs, as seen on the next page.

PHMSA Pipeline Incidents: (2000-2019)
Incident Type: Significant **System Type:** (All Column Values) **State:** MICHIGAN

Calendar Year	Number	Fatalities	Injuries	Total Cost Current Year Dollars
2000	5	2	4	$2,451,352
2001	5	0	3	$930,316
2002	5	0	4	$4,373,152
2003	13	0	4	$2,316,902
2004	5	0	0	$1,473,581
2005	6	0	2	$5,470,935
2006	9	1	0	$4,508,312
2007	1	0	0	$123,544
2008	8	2	4	$3,785,964
2009	4	0	2	$2,064,975
2010	6	2	2	$990,154,666
2011	9	1	0	$46,157,929
2012	6	0	0	$2,396,415
2013	7	3	1	$1,914,320
2014	14	0	9	$11,718,908
2015	15	1	4	$12,572,123
2016	8	0	4	$8,360,588
2017	8	0	0	$9,575,690
2018	9	0	1	$3,703,323
2019	9	0	2	$18,800,031
Grand Total	**152**	**12**	**46**	**$1,132,853,026**

PHMSA Pipeline Incidents: Multi-Year Averages (2000-2019)
Incident Type: Significant **System Type:** (All Column Values) **State:** MICHIGAN

(source: https://www.phmsa.dot.gov/data-and-statistics/pipeline/pipeline-incident-20-year-trends)

Note the high cost for Michigan in 2010 related to the Enbridge Line 6b Disaster on Kalamazoo River. Other estimates place expenses at well over $1 billion. Pipelines crossing near or through water bodies pose the possibility of high costs and extensive environmental damage because of their tendency to spread. Such spread can happen rapidly in fast moving waters. Components of different product types may either float or sink in water, a factor that may change over time as product breaks down. Sinking material that can't be skimmed may take months or years to completely clean.

Other challenges associated with pipelines near water include soft sloping ground that can be susceptible to erosion or lateral spreading, leading to pipeline displacement. Maintenance and repair of underwater infrastructure is also more challenging, one reason why the Enbridge Line 5 pipe under the Straits of Mackinac has garnered significant attention. Line 5 is a 645-mile, 30-inch-diameter pipeline that originates in Wisconsin, goes through Michigan's peninsulas, and terminates in Canada. As it travels under the Straits of Mackinac, the line splits into two smaller pipelines that are buried onshore and taper off deep underwater, crossing near the Mackinac Bridge for 4.5 miles.

Regarding oil and natural gas production, there have been over 60,000 commercial wells drilled in Michigan going back to roughly 1925. A speculative industry, only an estimated half ever ended up producing significant amounts of oil or natural gas. The state has experienced varying upward and downward drilling trends as new reservoirs are discovered, older ones become depleted, and the cost structures of the market change. I n general, production in Michigan is down from its historic highs, in some cases significantly so. Existing production wells remain important to the state.

The Upper Peninsula contains few oil or gas wells, with most of the state's productive wells scattered across 63 counties in the Lower Peninsula. A large number are located to the north, as well as to the west and bordering on Lake Michigan. The middle of the state is dotted with several locations, as well as a strong concentration in Macomb County.

A very high concentration of natural gas wells, in particular, exists in the north, concentrated in Alpena, Montmorency, Otsego, and Antrim counties before continuing to a lesser extent southwest down into Manistee County.

Drilling Unit Maps from EGLE's Oil, Gas, and Minerals Division are available for most counties in the state and contain details by fuel type, drilling methods, activity status, and other factors. Gas storage fields are also indicated. EGLE's separate GIS mapping service contains additional layers for further analysis. See their GeoWebFace website for additional information.

Oil and Natural Gas Fields in Michigan (source: EGLE)

Hazards associated with wellheads are very similar to those for pipelines, with occupational hazards being higher due to the increased use of personnel. Although also a danger with pipelines, many of Michigan's oil and gas wells contain poisonous hydrogen sulfide (H2S) gas, frequently referred to as "sour gas." Hydrogen sulfide is a naturally occurring gas mixed with natural gas or dissolved in oil or brine and released upon exposure to atmospheric conditions. Over 1,300 wells in Michigan have been identified as having H2S levels exceeding 300 parts per million. At concentrations of 700 ppm, even as little as one breath of hydrogen sulfide can be deadly. Although hydrogen sulfide can be detected by a "rotten egg" odor in concentrations from .03 ppm to 150 ppm, larger concentrations paralyze a person's olfactory nerves so that odor is no longer an indicator of the hazard. Within humans, small concentrations can cause coughing, nausea, severe headaches, irritation of mucous membranes, vertigo, and loss of consciousness. Hydrogen sulfide forms explosive mixtures with air at temperatures of 500 degrees Fahrenheit. The Agency for Toxic Substances and Disease Registry provides more information at https://www.atsdr.cdc.gov/mmg/mmg.asp?id=385&tid=67.

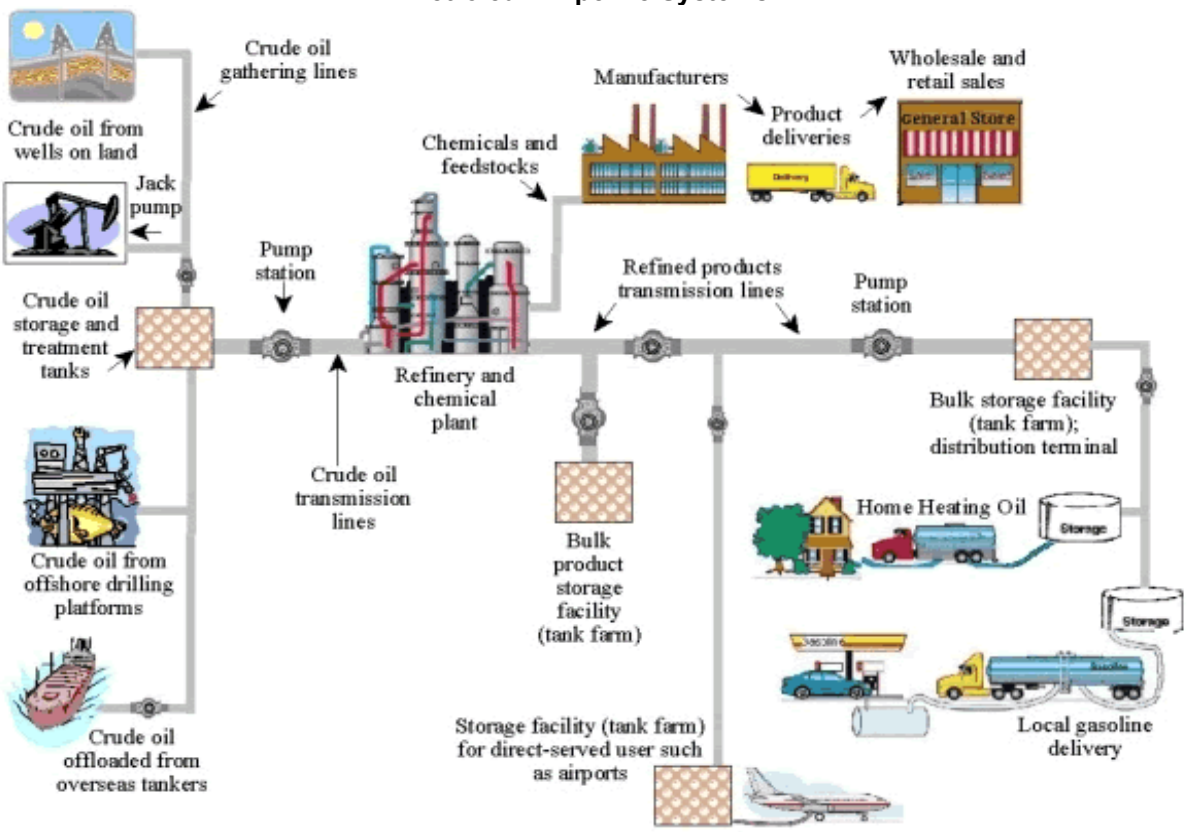
NFPA 704

Hydraulic fracturing, frequently referred to as "fracking," has been a controversial well completion practice used to extend the production life of a well. The process has been implicated with an increased likelihood of groundwater contamination vs. conventional practices, with some asserting it is a significant cause of subsidence or even earthquakes. An analysis by the U.S. Geological Survey can be found at https://www.usgs.gov/faqs/does-fracking-cause-earthquakes?qt-news_science_products=0#qt-news_science_products. An in-depth analysis of hydraulic fracturing or drilling methods is beyond the scope of this text, but Michigan has a history of using the process that dates back to 1952, involving more than 12,000 wells without notable environmental damage as compared to other drilling practices. More information can be found at https://www.michigan.gov/egle/0,9429,7-135-3311_4231-262172--,00.html. While the practice is a source of active debate that bears further scrutiny, there is no reason to consider that this method of extraction poses any greater risk specific to the state. Michigan has many impermeable formations in its bedrock, which can provide extensive separation between wells and groundwater.

While there are obvious risks associated with active wells, those that are no longer being used can also pose concern if they were not decommissioned properly. An abandoned oil or gas well, also known as an "orphan well," can remain a hazard by leaking and contaminating nearby water wells. An old well might also be a conduit for salt brine from deeper formations to discharge or pollute fresh groundwater. A damaged casing in a gas well could let natural gas flow underground and accumulate in the basement of a nearby building. In the vicinity of coal mines, an old well can be a conduit for explosive gas to likewise enter a mine, or to push acidic mine water to discharge at the surface. More information on Michigan's Orphan Well Program, which properly shutters such wells, is available later in this chapter. The program's 2019 report details six wells which were properly capped, but others remain on their list. Action priority for wells is ranked on such factors as the potential for future contamination, proximity to drinking water, degree to which ground water is protected by geology, and the presence of hydrogen sulfide gas. People "discovering" what they believe to be an old well on their property can contact the program.

Regardless of where pipes and wellheads are located, local communities should institute necessary protective actions, be prepared to respond to accidents, and coordinate with stakeholders in order to effectively manage and recover from incidents. That can be best accomplished through the collaborative planning, training, and exercising of emergency procedures with all potentially involved parties. The following graphic, which shows a typical petroleum transportation and distribution system with its many related "touch points," highlights just some of the potential stakeholders that are involved in such whole community efforts.

Petroleum Pipeline Systems



(source: https://primis.phmsa.dot.gov/comm/PetroleumPipelineSystems.htm?nocache=1260)

Specific Impacts

Impact on the Public, Property, Facilities, and Infrastructure

Some pipeline and wellhead accidents result in fires that cause extensive damage, injury, and loss of life. Gas leaks can cause surprisingly large explosions without advanced warning to those nearby. Those in the general vicinity of a spill may also suffer from unpleasant odors or health problems. Even if a resident's property isn't directly damaged or contaminated, they may be forced to evacuate until the problem is under control. The public may hurt themselves when trespassing on active or closed wells.

Impact on the Economic Condition of the State

Costs borne by Michigan in association with events and their cleanup can impact state budgets. Depending on the location of a spill, a decline in tourism would also have both direct and indirect fiscal impacts. Severe events may cause shortages of, and higher prices for, petroleum and other fuels. Some residents with low incomes or fixed budgets may find higher prices to be unaffordable and may face problems involving heating used to maintain their homes. Transportation and fuel costs may also impact the economy.

Impact on Responders, Continuity of Operations, and Continued Delivery of Services

Special expertise is often needed, and the cooperation of the utility provider is often critical to an efficient and successful response. Enclosed areas may be involved in these incidents (e.g., those occurring in a densely populated urban area) and thus may require special equipment, personnel, and training in search and rescue. Hydrogen sulfide can be especially poisonous and is an important concern.

Impact on the Environment
Petroleum and natural infrastructure may pose a threat in many Michigan communities because of potential leaks, fractures, fires, explosions, ruptures, and spills that cause environmental contamination to the land and water. Spills in water have the potential to spread rapidly. Pollution created by burning petroleum is quite noxious. Particulate pollutants may consist of metals, soot, or similar small substances. Adverse local consequences to ecological systems can result. Depending on severity, environmental damage may require lengthy clean up times.

Impact on Public Confidence in State Governance
There may be a sense that inadequate regulation is required by the state if there is an event of significant size or impact, regardless of how much federal involvement is involved. Persistent problems, particularly linked to the same company, can lead to perceptions of impotent or collusive government.

Hazard Mitigation Opportunities

- 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.

Petroleum and Natural Gas Pipeline and Wellhead Incidents

Historical examples display the breadth of hazards associated with both ends of the pipeline system (originating wellheads and end-user industrial, commercial, or home use). The list should not be considered as comprehensive.

May 16, 1967 – Dearborn (Wayne County)
A pile driver ruptured a gas line near an underground storage cavern, causing a fire and trapping seven men in a pit at Ford Motor Company's River Rouge Plant. Two of the men were killed and four more were injured. It took firefighters two hours to bring the blaze under control, and police routed traffic away from the area.

April 1973 – Williamsburg (Grand Traverse County)
Pressure within a well forced gas through surrounding porous rock formations and up to the surface. This eruption of natural gas caused craters of bubbling muddy water that flowed into nearby streams and Grand Traverse Bay. The townspeople of Williamsburg were evacuated due to the threat of explosion. Damage was confined to building foundations (from ground settling) and environmental damage to trees and streams. The incident was resolved without death or injury. Subsequent regulatory changes were made to require improved well casings and sealing.

August 2, 1975 – Romulus (Wayne County)
An 8-inch pipeline owned by the Sun Pipeline Company ruptured in Romulus. Propane escaped from the rupture, sprayed into the air, vaporized, and then ignited. Flames 500 feet high engulfed an area 600 feet in diameter. The blast created a 12-foot diameter, 7-foot deep hole in the ground. The fire injured nine persons, destroyed four houses, burned 12 vehicles, and consumed 2,389 barrels (100,338 gallons) of propane. The National Transportation Safety Board (NTSB) investigated this accident and determined that the probable cause was the propagation of surface cracks on the pipe, caused by abnormally high pressure within the pipeline at the leak site. The NTSB further found that inadequate inspection during construction had contributed to the accident.

April 16, 1984 – Bay County
A sour gas well in Hampton Township developed a leak at its surface casing, emitting sour gas for several hours. Residents within a half-mile radius were evacuated for approximately 24 hours until the well could be completely repaired. There were no injuries or property damage.

February 22, 1986 – Muskegon (Muskegon County)
A pipeline break occurred when an 8-inch high-pressure Marathon Oil pipeline ruptured, spilling thousands of gallons of gas into Ruddiman Creek. Vapors also caused minor explosions that forced dozens of residents to flee. No one was injured, although the environment suffered damage.

February 24, 1988 – Buckley (Wexford County)
A gas leak occurred in a well located near the village of Buckley in Wexford County. Several children in a nearby school complained of nausea from the strong odor, and the school was evacuated as a precaution. It was determined that the wellhead site had suffered a deck blow-off and was emitting gas directly into the atmosphere.

January 9, 1989 – Arenac County
A natural gas well blew out in Au Gres Township. Although there was no fire, methane, butane, and hydrogen sulfide leaked from the wellhead. The surrounding area was evacuated while attempts were made to seal the leak with mud and concrete. A new valve was installed two days later.

February 23, 1989 – Gratiot County
A Michigan Consolidated Gas Company (MICHCON) underground natural gas pipeline in rural Gratiot County exploded and caught on fire, releasing a vast quantity of gas into the atmosphere. The huge fire necessitated the evacuation of several families from the immediate area. No deaths or injuries occurred. Company officials shut off valves on either side of the break and allowed the remaining gas to burn off.

July 17, 1991 – Freeland (Saginaw County)
Workers were removing a corroded segment of a Consumers Power Company's 10-inch-diameter transmission line pipeline. As a segment of the pipeline was being removed, natural gas at high pressure exerted about 12 tons of force on an adjacent closed valve (H-143), causing it and a short segment of connected pipe to move and separate from an unanchored compression coupling. The force of the escaping gas killed one worker, injured five other workers, and collapsed a steel pit that housed valve H-143. Fortunately, there was no explosion from the natural gas leak.

May 20, 1992 – Rochester (Oakland County)
A natural gas explosion occurred in a two-story commercial building in Rochester, killing one person and injuring 17 others. Estimated property damage was nearly $1 million. The explosion occurred when the gas service line to the building was damaged during excavation of a sidewalk. The service line separated under the sidewalk and gas migrated into the building where it was ignited by an unknown source, causing the explosion.

June 15, 1993 – St. Clair County
A natural gas explosion occurred at a Michigan Consolidated Gas Company (MICHCON) underground storage facility in Columbus Township. One worker was injured in the explosion, two vehicles were burned, and several homes in the immediate vicinity of the facility were evacuated.

May 13, 1994 – Manistee and Mason Counties – Hydrogen Sulfide (H2S) Incident
An accident occurred when a blown gasket released hydrogen sulfide emissions after a seal in a compressing station in Victory Township failed. The incident resulted in 11 people requiring emergency hospital treatment (four of them children) and the death of 10 cattle. Another similar incident occurred two years later when a release of 5,500 cubic feet of natural gas containing 900 ppm of poisonous H2S occurred in Manistee Township. The release, which happened while workers were attempting to plug a well, caused several citizens in the neighborhood to lose consciousness and collapse. Eleven victims were treated at the hospital; at least one of them sustained serious lung damage. Others were treated for symptoms of asthma, skin irritations, and neuropsychological problems.

December 15, 1998 – Galesburg (Kalamazoo County)
A natural gas leak caused an explosion in downtown Galesburg, destroying two businesses and damaging a third. One person in an automobile sitting at a nearby red light was injured when a Christmas tree and other debris flew through his windshield. Fortunately, the downtown area was not crowded when the explosion occurred. An eight square block area was evacuated as a precaution, but utility workers were able to shut off the gas supply to avert further damage.

January 15, 1999 – Whitmore Lake (Livingston County)
A natural gas explosion at a home in Green Oak Township killed one person, injured four others, and forced the evacuation of 17 residents. The explosion and resulting fire destroyed two homes and damaged several others and a business. Subsequent investigation of the incident indicated that a steel gas main in the area had been dented, bent, and cracked by third-party excavation a number of years before it eventually failed.

January 18, 1999 – Leslie (Ingham County)
A leaking gas main in Leslie forced the evacuation of two schools (over 1,000 students) and approximately 75 other nearby residents for several hours until utility workers were able to cap the leak. Such evacuations may create complex incidents even when no explosion or fire occurs.

February 1, 1999 – Dearborn (Wayne County) – Automobile Plant Boiler Explosion
An explosion in one of several large boilers at the Ford Motor Company Rouge Power Plant killed six workers, critically injured another 14, and caused extensive structural damage. State officials who investigated the accident concluded that human error played a major part in the explosion when a work crew failed to shut off one of two gas mains leading to the boiler's furnace. That error caused a buildup of natural gas in the boiler that was somehow ignited and caused the explosion. The force of the explosion split open the 60-foot-high furnace, blew off the roof of the power plant, ignited fires on five floors, and sprayed surrounding workers with super-heated water that caused severe burns. The blast, which forced the shutdown of the Rouge Complex and other Ford plants for several days, was the second worst industrial accident in Michigan in 20 years and the deadliest at an automobile plant in over 50 years. Final cost estimates were for at least $1 billion.

March 7, 1999 – Plainwell (Allegan County)
A ruptured natural gas transmission line near Plainwell caused an explosion and fire that could be seen for 20 miles away. The incident occurred in a primarily rural area. Fortunately, there were no structures nearby, and the explosion and fire did not cause any injuries. The fire, which spread to over 400 feet wide and 100 feet high, burned for nearly two hours before utility workers were able to shut down the gas supply to the line.

June 15, 1999 – Battle Creek (Calhoun County)
A natural gas pressure surge caused fires in 24 homes in a 20-block area in Battle Creek, resulting in major damage to eight structures and injuries to two people. Gas service for 1,500 homes need to be stopped for two to three days. Construction work by the natural gas utility was believed to the cause of the gas surge.

June 25, 1999 – Howell (Livingston County)
A ruptured gas main set off an explosion and fires in Howell, destroying one business, severely damaging three homes, and forcing the evacuation of more than 60 households. Three firefighters were injured while responding to the fires. A contractor had accidentally bored through the gas main and the sewer line.

January 13, 2000 – Madison Heights (Oakland County)
A natural gas explosion destroyed a Madison Heights home shortly after a utility service person had visited to check on a report of a possible natural gas leak. The service person corrected what was believed to be the problem and then left. Less than three hours later, the home was destroyed by the blast. The house was empty at the time of the explosion and no injuries were reported.

June 7, 2000 – Blackman Township (Jackson County) – Large Gasoline Spill and Shortage
A Wolverine Pipeline Company gasoline pipeline ruptured in Blackman Township, releasing 75,000 gallons of gasoline into the environment, forcing the evacuation of more than 500 homes in a one square mile area around the spill. The leak was detected when a drop in pressure was recorded at a metering station along the 80-mile pipeline that runs from Joliet, Illinois to Detroit. The spill posed significant public safety and environmental concerns. Wolverine worked with federal, state, and local regulatory agencies to implement a plan for pipeline repair, cleanup, and long-term environmental restoration and monitoring. Evacuees were allowed to return to their homes within five days. The company spent more than $10 million in response to the incident. Because the pipeline carried approximately seven million gallons of gasoline per day, its estimated that 30 percent of the state's gasoline supplies were impacted for more than a week.

September 7, 2000 – St. Clair (St. Clair County)
A propane explosion destroyed a house in downtown St. Clair and killed an elderly occupant and a repairman who was working on the house. A second repairman sustained injuries when he was blown across the street. The explosion also damaged nearby neighborhood homes.

August 31, 2002 – Dansville (Ingham County)
An apparent natural gas explosion destroyed an apartment complex, killing a woman who was moving into the building and injuring four other people. The explosion forced a nearby road to be closed while debris was removed. It took several days for the road to reopen.

September 3, 2005 – Caledonia Township (Shiawassee County)
A home exploded while relatives were gathered for a family reunion over the Labor Day weekend. A total of six children were killed, and three more were seriously injured from the blast. Witnesses claimed that they felt the blast up to 10 miles away. Analysis showed that there was something wrong with the copper tubing that had carried propane gas to the Copas Road home. It was reported that the copper tubing was too thin and that proper tests had not made certain that the tubing wouldn't leak. Large amounts of liquid propane seeped into the ground, gas filled the basement, and any spark could have triggered the blast.

September 15, 2002 – Bangor Township (Van Buren County)
An apparent natural gas explosion destroyed a farmhouse, killing five family members. The one-story home was completely flattened by the blast, with small pieces of debris scattered up to a quarter mile away.

December 12, 2006 – Mason Township (Cass County)
A natural gas explosion occurred at US-12 and Tharp Lake Road. Homes within a half mile of the incident were evacuated, and traffic was also diverted. The explosion occurred when a Midwest Energy employee operating a trencher struck a pipeline. One fatality occurred.

February 26, 2008 – Grand Rapids (Kent County)
A natural gas explosion occurring at 3:30 p.m. resulted in the collapse of a two-story building. Seven persons were injured, and five neighboring businesses suffered damage. A fire burned well into the night, due to an inability to shut off the natural gas until 9:30 p.m., as the fire wouldn't allow access. Three quarters of the city's firefighters were involved in the effort, with neighboring departments covering calls in the city. A gas leak was also detected under the road.

February 28, 2008 – Flint (Shiawassee County)
A man was injured in a house explosion that was an apparent suicide attempt. The man disconnected a gas line in his house and then intentionally sparked the blast, resulting in the explosion of his Linden Place manufactured home. The park's maintenance manager kicked in the door to the home and pulled the man to safety just before a major fire broke out. The incident serves as an example that not all explosions are due to pipe failures.

August 6, 2008 – Hastings (Barry County)
A house explosion near Hastings blew out the home's windows and caused severe structural damage. Two teenage boys were inside the home but managed to leave without injury. An investigation found that the explosion was a result of a build-up of leaking propane gas that ignited in the home's basement. The explosion did not cause a fire but did blow the house about six inches off its foundation.

December 5, 2008 – Colon (St. Joseph County)
A man was killed in a one-car crash that ruptured a gasoline pipeline valve and caused a massive explosion and fire in St. Joseph County. The pipeline, which spilled 14,322 gallons of oil, was shut down for more than a week, and authorities routed traffic around the area as the fire continued to burn out.

December 13, 2008 – Maple Grove (Saginaw County)
A natural gas leak caused an explosion and fire that burned down a home. Two residents escaped without injury. Freezing winds, icy conditions, poor accessibility, and a lack of water made it difficult for neighborhood firefighters to stop the blaze. The gas was shut off at the meter, and a 3,000-gallon tanker was sent in to help eliminate the hazard.

August 4, 2009 – Clio (Genesee County)
A small fire was being reported at an electric utility meter outside the White Oil Co. Storage Facility when a massive fire erupted, shooting heavy plumes of black smoke into the air as several 50-gallon oil storage barrels ignited and exploded. Twenty-five fire departments responded, sending over 100 firefighters to battle the blaze. Emergency officials contacted 4,000 residential and business telephone numbers to notify them of the two-mile radius evacuation. Around 150 people were sent to a shelter, and motorists were asked to avoid the area. Two minor injuries were reported.

May 16, 2010 – Kentwood (Kent County)
A natural gas leak caused a four-unit apartment to explode, resulting in four injuries. The gas leak occurred in a vacant apartment in the complex. The scene resembled that of a tornado, with debris scattered nearby, shards of broken window glass littered on the ground, lumber lodged into a neighbor's garage, and siding propelled through a neighbor's window.

May 29, 2010 – Constantine (St. Joseph County)
A 12-inch gasoline distribution pipeline owned by BP Oil spilled 89,000 gallons of fuel on farmland west of Constantine. The underground rupture sprayed a three-foot-high plume of gasoline into the air, saturating the surrounding corn field. BP Oil drilled 70 temporary monitoring wells and set up 40 water extraction points in an effort to keep the fuel from contaminating groundwater in areas of southern St. Joseph County. Thousands of gallons of contaminated water were "vacuumed" daily from underground aquifers. No injuries were reported, but 12 people from four nearby homes were evacuated from the area for nearly 48 hours.

July 26, 2010 – Calhoun and Kalamazoo Counties – Enbridge Pipeline Disaster (Line 6B)
A large crude oil incident near the city of Marshall is one of the worst such inland spills to have occurred in the United States. Enbridge Line 6B is a 30-inch pipeline that normally transported 190,000 barrels per day between Griffith, Indiana and Sarnia, Ontario, passing through Calhoun and several other Michigan counties along the way. Oil from a pipeline breach leaked into the Talmadge Creek, flowing into the Kalamazoo River and then further downstream towards Battle Creek. Initial low-pressure alarms were misinterpreted to mean that only a temporary bubble existed in the pipeline. Enbridge officials eventually shut down pumps and closed valves located upstream and downstream from the leak site to stem the flow of additional oil. Based on initial company estimates, up to 19,500 barrels of crude had flowed out of the pipeline (approximately 800,000 gallons). Later EPA estimates placed the volume at over one million gallons. The rupture was caused by a failure in unrepaired pipe lining, allowing corrosion to occur. Calhoun County declared a local state of emergency and several downstream communities took emergency response actions. The State Emergency Operations Center was activated to help coordinate governmental response activities with company officials. Federal Agencies, such as the Environmental Protection Agency, Fish and Wildlife Service, and National Transportation Safety Board, were part of an ICS Unified Command structure to develop a protection strategy for spill containment and recovery. Roughly 50 households were evacuated until air quality in the area could be improved, and more were informed to stop drinking water from area wells. A command center was established in the city of Marshall, and contractors where brought in for product clean-up. Wildlife rescue and rehabilitation operations were also implemented to save wildlife that had been hurt in the spill and to protect aquatic life from further harm.

Additional health advisories were issued, and sections of the area were closed to the public. The type of heavy crude involved in the spill, diluted bitumen (also known as dilbit), had some of its components start to sink to the bottom of the river, as other components continued to float on top or evaporate. The EPA later ordered Enbridge to dredge the bitumen out of hundreds of acres along the bottom of the Talmadge Creek and the Kalamazoo River. A state of Unified Command remained operational for an extended period due to the long-term nature of product recovery and environmental clean-up. The repaired oil pipeline is currently in operation after receiving the approval of the U.S. Department of Transportation, initially being run at a reduced pressure level. Authorities reopened the 35 miles of the river that had been closed to recreation beginning in 2012. Cleanup occurred in various stages, some stretching for as long as five years. Total costs are estimated to have exceeded over $1 billion. In 2016, Enbridge was assessed $62 million in civil penalties stemming from the incident.

December 29, 2010 – Wayne (Wayne County)
An aging, natural gas pipeline exploded under a furniture store, destroying the building and resulting in two fatalities and one injury. Rescue workers spent the day and into the night combing through piles of drywall, twisted metal, and broken furniture. The explosion also shattered windows at nearby businesses and hospitalized one person who had been driving by when the building exploded. Police evacuated homes and businesses near the store, and a local state of emergency was declared. Residents in the area had reported the smell of gas to the utility company three hours before the explosion. A second leak was discovered in the same area after the explosion but was successfully capped without further incident.

January 12, 2011 – Columbus (St. Clair County)
One person was hurt during a natural gas explosion at a gas storage company. Residents within a five-mile radius of the facility said they first heard a loud boom and then saw a large fireball. The company sells natural gas and stores it in a two-mile-long cavern underground. The explosion occurred during a separation of gas and oil. The facility's safety valve kicked in, preventing the fire from spreading further until it burned out.

April 13, 2011 – White Oak Township (Ingham County)
A gas leak occurred when between 294,000 and 462,000 gallons of gasoline escaped from a faulty Marathon pipeline in mid-Michigan. The company originally estimated that 126,000 gallons had leaked into the soil before it was detected by a man in Ingham County's White Oak Township whose farm backed up to four fuel storage tanks. Advisories were issued, but environmental experts said the gasoline leak ultimately didn't end up harming residents' drinking water.

May 4, 2011 – Warren (Macomb County)
A natural gas explosion in a commercial laundromat leveled the building and injured two passers-by. The blast was felt several miles away, and nearby residents reported seeing a large cloud of smoke. The fire commissioner called the explosion the most powerful he had dealt with in 33 years of fire service. After an investigation, officials determined the caps on three natural gas lines in the interior of the building had been uncoupled and lighted candles were left on the floor. A grand jury indicted the laundromat owner on six charges, including using explosives to commit a felony and bankruptcy fraud. The incident highlights the destructive force criminals or terrorists can use in repurposing gas lines.

November 2012 – Sri Lanka – Hydrogen Sulfide (H2S) Incident
Workmen engaged in repair work at an oil refinery in Sri Lanka were accidentally exposed to toxic fumes following a pipeline leak. Hydrogen sulfide was the primary established noxious effluent carried in the damaged pipes. The victims were exposed to the fumes for approximately 10 minutes before rescue was attempted. The victims were immediately taken to a hospital, with two declared dead on admission. For another victim, antidote attempts were administered within 15 minutes of admission, which was 90 minutes post-exposure. Despite these measures, he developed recurrent seizures and deepening unconsciousness and was ultimately intubated and artificially ventilated. He was discharged 20 days after admission with residual symptoms and continued to have retrograde amnesia of the event. This out-of-country incident serves as an example of the highly poisonous effects of this flammable gas.

February 27, 2013 – Royal Oak (Oakland County)
A natural gas leak explosion killed a man and destroyed three homes. The explosion also resulted in the evacuation of two streets in the neighborhood for multiple days. The utility company was fined $340,000 by the Michigan Public Service Commission, since their work crew was aware of the leak but left the scene prior to the blast. Multiple employees related to the incident were also terminated. In addition to the fines, the utility company will give $1 million to a new fund that will help victims of natural gas disasters and fund improved training and safety practices for utility workers.

May 5, 2015 – Lyndon Township (Washtenaw County)
Residents in Lyndon Township were jolted by an explosion that sounded like an airplane crashing, followed by continuous loud noise. The incident was caused by a Consumers Energy gas line that burst at 10:30 p.m. The county hazmat team was called, and an underground utility crew arrived from Kalamazoo to cap the break. The 20-inch high velocity pipe lost 48,000,000 cubic square feet of natural gas. No fire or injuries were reported despite a resultant 50-foot crater made in the ground. According to federal records, the blast caused $5.4 million in damage to Consumers Energy property and $358,080 in product loss. The pipe had received partial inspection in 2013, but a corrosion induced fracture on the outside of the pipeline had not been detected. Electromagnetic Acoustic Transducer testing was performed to ensure other sections of the pipe held their integrity.

November 20, 2016 – Orion Township (Oakland County)
A gas explosion shot a fireball several hundred feet in the air that lit up the sky over Oakland County for two hours before burning itself out, producing a 20-foot-deep crater in its wake. The 22-inch diameter pipeline involved in the blast was 65 years old, and Consumers Energy detected a sudden loss of pressure shortly before the explosion. Due to the time of night and taking place in an area still under development, there were no injuries reported despite the blast being seen from as far away as Detroit. The utility indicated that 21 feet of fill material had been placed on the ground above the pipeline by a third party. The extra weight combined with swampy soils caused the pipe to compress and break.

April 1, 2018 – Great Lakes/Straits of Mackinac
A release of dielectric fluid into the Great Lakes 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.

Select Laws, Agencies, or Programs

Pipeline and Hazardous Materials Safety Administration (PHMSA), Office of Pipeline Safety (OPS)

The Pipeline and Hazardous Materials Safety Administration (PHMSA), part of the U.S. Department of Transportation, is the nation's chief administrator for pipeline safety and hazardous materials transportation safety operations. The Pipeline Safety Improvement Act of 2002 requires each pipeline operator to prepare and implement an integrity management program that requires operators to identify High Consequence Areas (HCAs) on their systems and to conduct associated risk analysis. Companies are required to identify all HCAs and submit specific integrity management programs to the PHMSA's Office of Pipeline Safety (OPS), among others. Because of the complexity of HCAs for hazardous liquid pipelines, the OPS identifies and maps HCAs for hazardous liquids on its National Pipeline Mapping System (NPMS). These maps are revised periodically by OPS based on new and updated information.

Additional pipeline safety requirements are contained in the Federal Safety Standards (Parts 191, 192, 193 and 195), as administered by the PHMSA/OPS. Interstate gas and liquid petroleum pipeline operators must develop and maintain written emergency procedures similar to those required under the Michigan Gas Safety Standards (see below). In addition, they are required to coordinate both planned and actual response actions with local officials and response agencies. Part 195 contains a continuing education requirement to keep the public informed about risks associated with the transportation of hazardous liquids via pipeline

Michigan Jurisdiction and Oversight

Pipeline jurisdiction and oversight in Michigan is complex, determined primarily by the type and function of a pipeline and its location. Agencies involved include the (1) Michigan Public Service Commission (MPSC), (2) Michigan Department of Environment, Great Lakes, and Energy (EGLE) and their Oil, Gas, and Minerals Division (OGMD), and (3) the federal PHMAS/OPS.

Pipeline Safety Regulation in Michigan

Pipeline Type	Jurisdiction	Applicable Code	Inspected By
Inter-state Natural Gas	PHMSA	49 CFR Part 192	MPSC
Intrastate Natural Gas	MPSC	Michigan Gas Safety Standards	MPSC
Liquid Petroleum	PHMSA	49 CFR Parts 193/195	PHMSA
Gathering Lines*	MPSC/EGLE/OGMD	Oil/Gas Administrative Rules under PA 451 (1994) & PA 165 (1969)	MPSC/EGLE/OGMD

(source: Michigan Public Service Commission)

*Note: Gathering lines run from a production facility (e.g., well) to a processing plant (e.g., dehydration facility, separator, compression station). Gathering lines in non-rural areas are regulated under the Michigan Gas Safety Standards. All other gathering flow lines fall under the jurisdiction of the EGLE/OGMD.

Michigan Gas Safety Standards

Pipeline operators are regulated under the Michigan Gas Safety Standards, Act 165 (1969) and its implementing Administrative Rules (the Michigan Gas Safety Standards) to help ensure public safety. Gas pipeline companies (operators) must develop and maintain written procedures to minimize the hazards resulting from a gas pipeline emergency. The procedures in general require the identification and classification of any events, notification/coordination with local response agencies and public officials, response plans (including emergency shutdown and pressure reduction procedures), and processes associated with the restoration of services. Operators must ensure that personnel are properly trained regarding emergency procedures. If an incident occurs, the operator must review response actions to determine whether procedures were followed and, if necessary, take samples of failed equipment for laboratory examination. Mitigation actions are taken as necessary to help minimize recurrence.

MPSC Pipeline Safety Inspections

MPSC safety engineers are certified to conduct inspections on natural gas pipelines to ensure their structural and operational integrity. If violations are found, the pipeline company can be ordered to take corrective actions and face fines. MPSC safety engineers also respond to incidents involving natural gas or other gas pipelines.

Oil and Natural Gas Wells

Oil and natural gas well-development activities are regulated in Michigan by the Natural Resources and Environmental Protection Act, 1994 PA 451 (NREPA), Part 615 (Supervisor of Wells), and its Administrative Rules. Rule revisions have clarified its authority to address public safety and protection measures, such as with Hydrogen Sulfide (H2S) gas.

At high concentrations, H2S gas is toxic and extremely irritating to the eyes, lungs, and respiratory system. A well is considered an "H2S well" if it contains a hydrogen sulfide content in the gas of not less than 300 ppm. H2S wells are then divided into classes I through IV based upon the potential radius of exposure of H2S gas around the wellhead (should there be an uncontrolled release). Class I wells have the highest concentration of H2S gas within the radius of exposure for an uncontrolled release (100 ppm at more than 300 feet).

Negative health effects can begin to occur at concentrations above 10 ppm, and levels above 500 ppm may lead to loss of consciousness and possibly death in 30 minutes to one hour. H2S wells and associated facilities have setback requirements from structures, water wells, roads, and areas used for recreation. Surface facilities for H2S wells cannot be located in residentially zoned areas and the well sites must have warning signs indicating the H2S potential.

Class I and Class II wells must additionally provide an H2S contingency plan that documents all emergency procedures, briefing areas, and specific training necessary for on-site personnel. H2S contingency plans are divided into two parts. Part I contains general procedures that must be implemented by company personnel in an emergency when H2S is released. This includes assigned responsibilities, notification and evacuation procedures for the general public, and procedures for igniting a well. Part II contains site-specific information, including permittee representatives, emergency contacts, and a detailed map of the area. Part II contingency plans must be filed with an application for a drilling permit, and a copy of this plan must sent to the local emergency preparedness coordinator.

Part 616, Orphan Well Fund, of Act 451 (NREPA) deals with the Orphan Well Program which is a fund created within the State Treasury for the primary purpose of plugging abandoned or improperly closed oil or gas wells. The fund can be used when no owner or operator is known, when all owners or operators are insolvent, or when the supervisor determines there is an imminent threat to public health and safety. Revenue for the Orphan Well Program comes from a severance tax on the oil and gas industry. Two percent of the severance tax revenue, but not less than $1 million, is credited to the fund annually. Since its inception, almost 400 sites have been restored and wells have been plugged from this fund.

National Transportation Safety Board

The National Transportation Safety Board (NTSB) investigates all significant pipeline accidents in the U.S. and provides pipeline company and government regulators with safety recommendations aimed at preventing future accidents. The NTSB also publishes a list of "most wanted" safety improvements for pipelines and other modes of transportation for nationwide implementation by appropriate entities. Although these safety improvement recommendations are not mandatory and the NTSB has no regulatory or enforcement powers, it nonetheless has been successful in getting more than 80 percent of its recommendations adopted. Many safety features currently incorporated into pipelines and other transportation modes had their genesis in NTSB recommendations.

The Protection of Underground Facilities Act / MISS DIG Program

Michigan's first line of defense against pipeline (and other utility line) breaks from construction excavation is the "MISS DIG" 811 Program. The free 24-hour phone and utility communications system helps contractors comply with state law (Act 53) that requires the notification of utilities at least three working (but not more than 21 calendar) days before starting the excavation, tunneling, demolishing, drilling/boring, or use of explosive charges for a project.

American Petroleum Institute (API) Recommended Practice (RP) 1162

The API Recommended Practice (RP) 1162, "Public Awareness Programs for Pipeline Operators" has regulations for pipeline operators to provide public information about how to recognize, respond to, and report pipeline emergencies. The importance of using the one-call notification system prior to excavation is to be emphasized for all stakeholders. Emergency officials and local public officials must be provided with information about the location of transmission pipelines to enhance emergency response and community growth planning.

Michigan Propane Gas Association (MPGA) and Michigan Oil and Gas Association (MOGA)
The MPGA is a trade and membership service organization that represents propane marketers throughout the state. The MPGA's primary purpose is to maintain high standards of practice within the industry and, in so doing, protect and expand the ability of its members to compete in the marketplace.

The MOGA is a trade association representing oil and natural gas interests within the state. Members include major oil companies, independent oil companies, and the exploration arms of various utility companies. The organization works with the public on any ongoing issues in the field. It has a useful education page with industry fact sheets.

Nonprofit Pipeline Safety Organizations
There are several nonprofit organizations and agencies that provide information encouraging pipeline safety in Michigan. These organizations can work to educate the public by organizing meetings, seminars, and workshops to improve pipeline reliability, operational efficiency, and the regulatory environment. These organizations can support the safe delivery of pipeline products; research pipeline operational problems; act as a common ground forum where members can discuss and seek solutions to industry problems; promote underground facilities, damage prevention, and implementation of damage prevention best practices to all stakeholders; and represent industry interests before Congress, federal agencies, and other energy-related stakeholders by developing regulatory and legislative policies. These particular organizations include the National Association of Pipeline Safety Representatives (NAPSR), Association of Oil Pipe Lines (AOPL), American Public Gas Association (APGA), Pipeline Research Council International, Inc. (PRCI), and the Common Ground Alliance (CGA).

Interstate Oil and Gas Compact Commission (IOGCC)
Michigan is a member of Interstate Oil and Gas Compact Commission (IOGCC) that represents the governors of oil and natural gas producing states. In 1935, six states endorsed, and Congress ratified, the Interstate Compact to Conserve

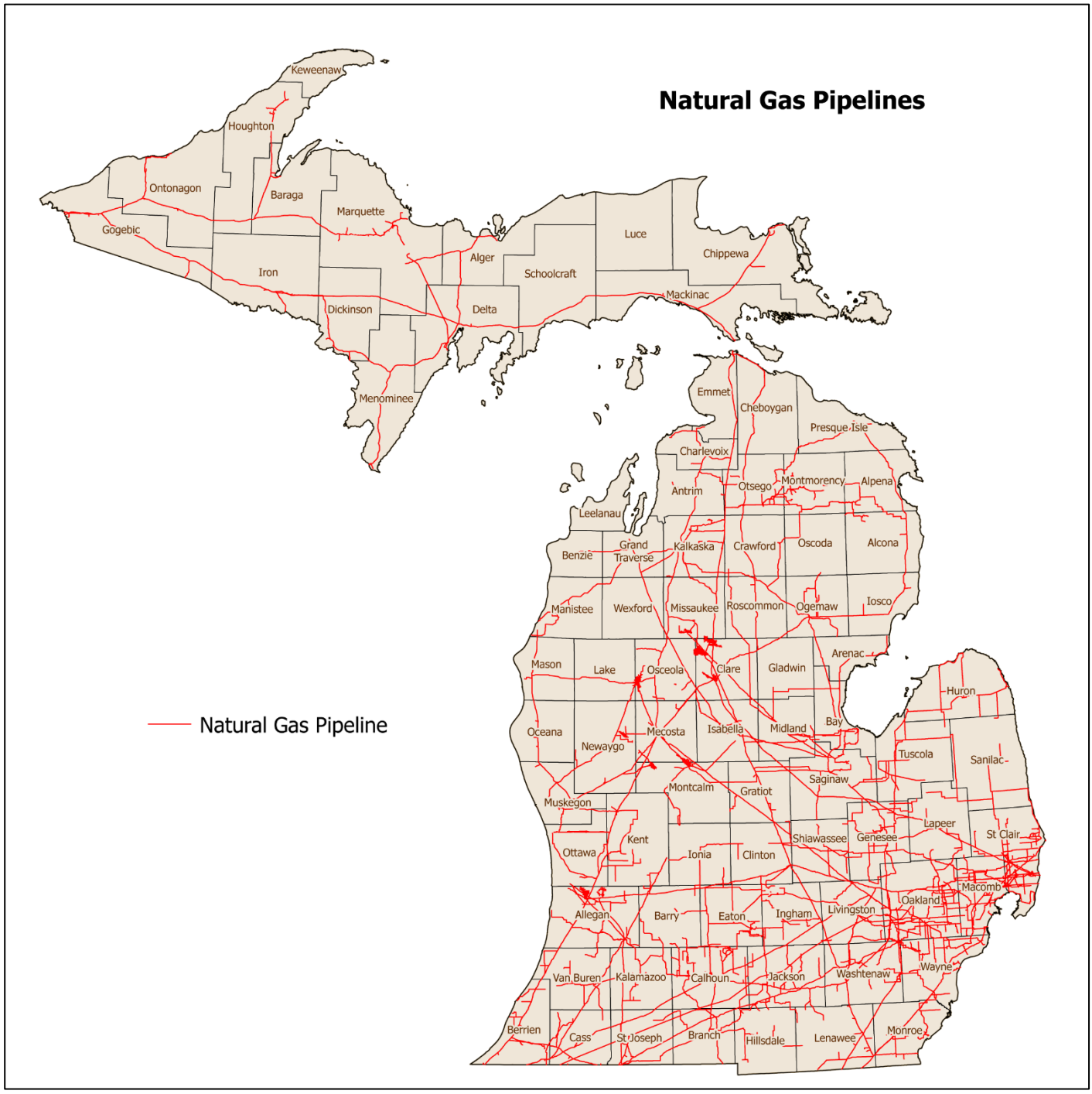
Oil and Gas, resulting in the formation of the unique governmental entity now known as the Interstate Oil and Gas Compact Commission. The IOGCC has helped states to establish effective regulation of the oil and natural gas industry through the sharing of information, technologies, and regulatory methods. The IOGCC advocates for environmentally sound ways to increase the supply of American energy. This can be accomplished by providing governors of member states with a clear and unified voice to Congress, while also serving as the authority on issues surrounding these vital resources.

Michigan Oil and Gas Producers Education Foundation (MOGPEF)
MOGPEF assists in supporting educational projects and programs about the industry. It is a tax-exempt organization under Section 501(c) (6) of the United States Internal Revenue Service code. Its mission is to provide financial support for programs that will inform the people of Michigan about the importance of the local oil and natural gas industry and about the environmental safeguards that are employed. Materials and programs developed by MOGPEF are available for use by members of petroleum, energy, and allied industries and by the general public.

Oil and Gas Advisory Committee
The Oil and Gas Advisory Committee advises EGLE on matters of regional or state-wide significance relating to oil and gas exploration and production. The Committee provides input on policy, rules, orders, instructions, technical reviews, and hearings. The Committee is composed of members from the oil and gas industry and the public, with background or expertise in oil and natural gas, and related environmental and resource issues.

Supplemental Material

(source: Michigan Public Service Commission; pipeline company maps)



(source: Michigan Public Service Commission; pipeline company maps)

STRUCTURE FIRES

A fire that ignites one or several buildings, spreading to cause injury or loss of life, property damage, or the loss of important services.

Hazard Description

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 materials, etc.) are often the most straightforward for emergency personnel to respond to. This is especially true for small residential fires. Unique risks posed by scrap tire fires are covered at the end of this chapter.

Structure fires can be defined in different ways. The National Fire Protection Association (NFPA) is a source for many of the statistics that follow. Their 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."

For the sake of simplicity, and due to wildfires, chemical/industrial fires, petroleum fires, natural gas explosions, and transportation fuel fires having already been covered separately, this chapter's primary focus will be geared towards more typical structure fires. While some small home residential statistics will be reviewed, an emphasis will be placed on fires involving larger structures, especially those with a greater capacity as designed for occupants. 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.

Hazard Analysis

Fires have been deemed by some as the "universal hazard" because they are common in comparison to other incidents and can often be the result of so many other hazards. Looking at fires due to *all* causes in the United States, the country experienced roughly 1.3 million fires, with over 15,000 injuries and nearly 4,000 deaths in 2018. Estimated property losses for that period were over $25 billion. Looking specifically at structure fires, they represented roughly 39 percent of the total fires in the United States (30 percent residential, 9 percent non-residential). *Source: NFPA.*

Similar structure fire patterns can be seen when examining the state's fire casualties, as broken down by general incident type. The following table uses data compiled by the National Fire Incident Reporting System (NFIRS) during 2018. Residential structure fire data is shown, both individually and as part of overall structure data (results do not total 100 percent).

Incident type	% of deaths		% of injuries	
	Michigan	**Nation**	**Michigan**	**Nation**
Structures*	78.8	78.5	90.4	85.3
Structures/Residential	76.8	75.0	83.6	77.1
Vehicles	17.9	17.8	5.3	6.7
Outside	1.3	1.9	2.9	5.0

In the aggregate, small structure fires account for the majority of fire deaths and injuries, with most fatalities occurring in single-family homes and duplexes. While an in-depth analysis of these fires is beyond the scope of this text, over 50 percent of these deaths occur in homes without working smoke detectors. Cooking related accidents are by far the most common cause of structure fires. When fatalities are factored in, causes more likely to occur when people are sleeping become the most common (such as electrical malfunction, smoking in bed, etc.).

Local emergency managers will also want to inventory larger structures in their communities, some of which may not be strictly residential. Hospitals, 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.

Number of Structure Fires Reported to Local Fire Departments in the U.S. by Property Use: 2014-2018 Annual Averages

Major Property Class	Fires	Civilian Deaths	Civilian Injures	Property Loss
1 - Assembly	15,984	14	176	$333,380,930
2 - Educational	4,763	1	50	$64,628,767
3 - Health Care, Detention & Correction	6,719	5	156	$56,766,860
4 - Residential	382,399	2,746	11,477	$7,561,851,557
5 - Mercantile or Business	18,972	15	282	$849,120,202
6 - Industrial, Utility, Defense, Agriculture, Mining	2,925	2	36	$230,102,755
7 - Manufacturing, processing	5,270	3	167	$509,513,456
8 - Storage	22,401	32	299	$637,147,702
9 - Outside or special property	27,418	19	113	$135,960,099
Unclassified or unknown property	6,946	7	56	$80,039,075
Grand Total	**493,797**	**2,844**	**12,812**	**$10,458,511,401**

(source: NFPA)

National data on Catastrophic Multi Death Fires can be found at: https://www.nfpa.org/News-and-Research/Data-research-and-tools/US-Fire-Problem/Catastrophic-multiple-death-fires. Full reports are available beginning in 2003 and are broken down to include categories, such as apartment buildings and retail malls. The deadliest structure fire of 2018 occurred in a two-family house in Illinois that killed 10 people.

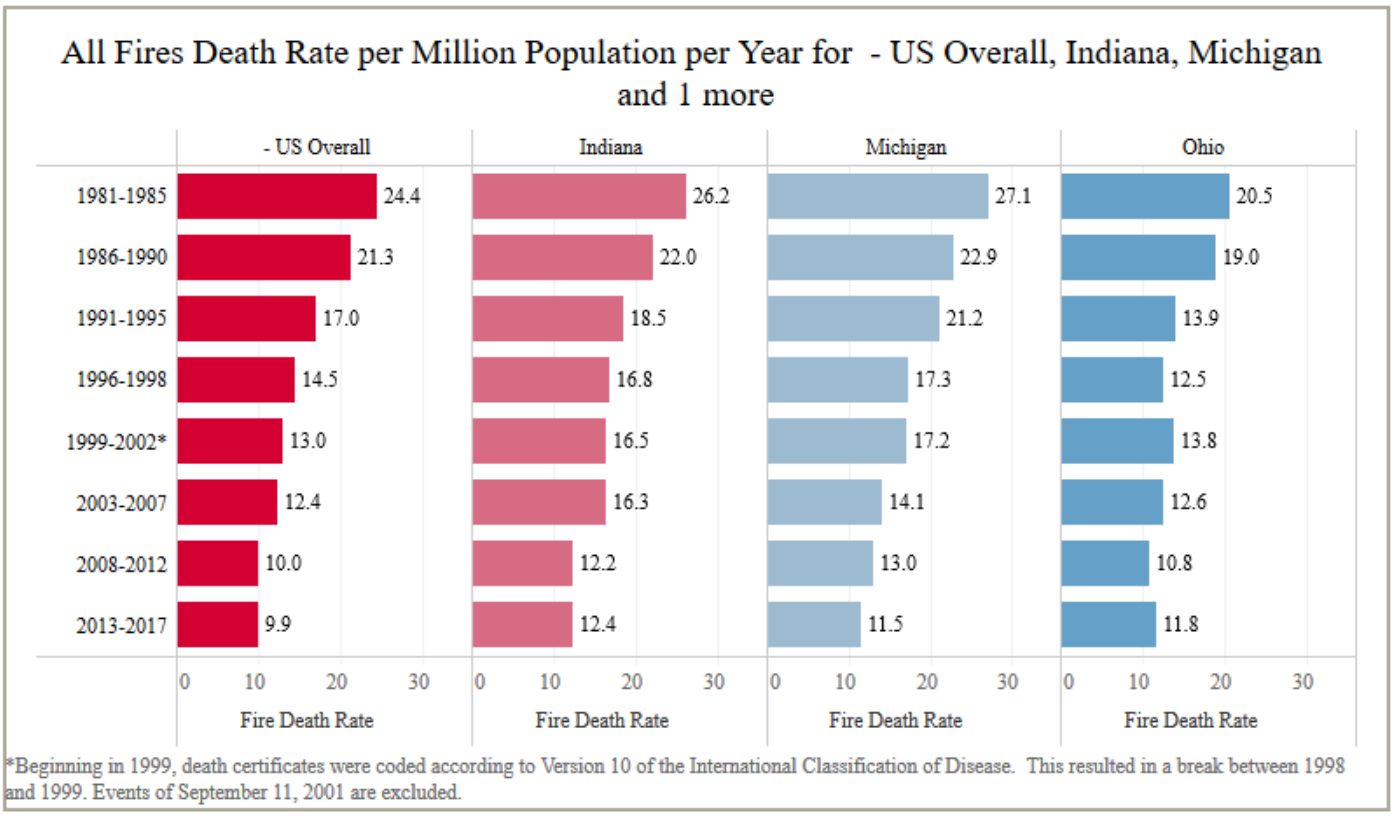
During 2018, Michigan saw 10.9 deaths and 32.7 injuries per 1,000 structure fires. This compared with an average of 6.1 deaths and 32.7 injuries per 1,000 structure fires from aggregated data at the national level.

While potential reasons for state-to-state variations are many, a September 2019 Analysis conducted by the NFPA found that higher state fire death rates are positively correlated with a larger percentage of people within a state who:

- Have a disability.
- Have incomes below the poverty line.
- Are current smokers.
- Live in rural areas.
- Are either African American/Black or are Native American or Alaskan Native.

Nine of the ten states with the highest overall fire death rates in 2013–2017 were in the South (Alaska was the exception). The analysis found that five of the ten states with the highest death rates were also among the states with the largest percentage of residents living in rural areas. This may be due to many rural areas having fewer full-time firefighters with less specialized equipment, less stringent local fire codes, or a combination of other factors. It is important to note that the above analysis only examined correlation (and not causation).

Michigan typically ranks towards the middle of the pack nationwide when examining *all* fire-related deaths. The graph below compares Michigan to the U.S. average and the nearby states of Indiana and Ohio.



Looking at the makeup of Michigan's fire services, the state has 964 fire departments registered with the National Fire Department Registry as of 2018 (with 893 fire departments reporting data). Based on the departments that have registered, roughly 64 percent of those departments would classify themselves as all volunteer, 30 percent as mostly volunteer, 4 percent as mostly career, and 9 percent as fully career. This largely mirrors what is seen across the country, although the national average for "all volunteer" departments was 7 percent higher as compared to Michigan. Most were also not involved with ambulance transport, with only 14.7 percent providing the service (42 percent were still trained in basic life support, and 10.7 percent in advanced life support). While over 80 percent had equipment for vehicle extrication, less than 5 percent had a fireboat.

Local emergency managers and planners will find that the level of fire services, regulations, and code enforcement may vary greatly from local community to local community. This may be due to the rural nature of some counties but also because of factors, such as regional alliances, budgetary constraints, and proximity to other services.

While historical events, such as the Great Chicago fire (1871) and San Francisco's earthquake-related fire (1906), are now exceedingly rare in the United States, their potential for immense devastation still requires that they be mentioned. Older sections of some cities may still be more vulnerable in part from being built before fire codes were put into place. The threat of such fires still puts densely populated areas at risk for urban conflagrations. Emergency managers should network with stakeholders to get as complete a picture as possible of their local communities.

Specific Impacts

Impact on the Public, Property, Facilities, and Infrastructure
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, emergency management authorities are primarily focused on disaster-level events involving multiple or major structures such as nursing homes, dormitories, hospitals, hotels, and other locations that 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.

Impact on the Economic Condition of the State
The state economy would not be majorly affected due to the types of structure fires discussed in this chapter except in the most extreme cases. Because of advances in fire safety, such a fire would be unlikely unless it was secondary to another large-scale hazard that had already overwhelmed the capabilities of regional fire services. Such primary hazards would be covered under their own chapters. The location of any such fire, and its secondary impacts upon transportation and trade, would be important factors in determining the impact of fires on the state. The effect on individual counties, and especially cities or villages, could be much greater.

Impact on Responders, Continuity of Operations, and Continued Delivery of Services
While special training and equipment is still necessary to deal with structure fires, more "routine" fires that are not secondary to other major hazards are more likely to be effectively controlled and dealt with, resulting in only minor impact on operations. Government buildings themselves can be the focus of structure fires, however, potentially because of arson. This may be the case with administrative buildings, law enforcement, or even fire stations themselves. Continuity of Operation Plans would be necessary. Any large fire has the potential to overwhelm local resources. The capability of area fire services, particularly in rural areas, may require outside assistance.

Impact on the Environment
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.

Impact on Public Confidence in State Governance
Structural fires may raise questions about code enforcement and other regulations that may be connected with state government or budgetary shortfalls. Most structure fires would be viewed as a local matter, depending on the cause of the fire. Some regulatory controls may still have state legislation, rules, or agents (such as the State Fire Marshal) called into question.

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 each 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).

- 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.

Select Structure Fires in Michigan

Michigan has not had a truly catastrophic structure fire in recent years that has produced an exceptionally high number of fatalities. However, many smaller residential fires occur each year. The following list of select incidents attempts to highlight a variety of past structure fires. It should not be considered comprehensive, and many additional smaller structure fires have resulted in fatalities throughout the state.

February 19,1954 – Hartford (Van Buren County)
Seven elderly people died with another left in critical condition after a late-night fire at the two-story Shimer Convalescent Home. Not all the residents were ambulatory. A portable electric heater was blamed for the fire.

July 23, 1967 – Detroit (Wayne County)
A large civil disturbance that took place from July 23–30 resulted in an estimated 150 fires that consumed much of a 15-block area. Though not all directly related to the fires, 43 people were killed and over 1,000 injured. Some buildings that were either set or otherwise caught on fire were as much as six to seven miles away from the epicenter of the incident. Many firefighters were forced to withdraw after objects were thrown at them. Roughly 5,000 people were left homeless and 400 structures were burnt and demolished. Over $50 million in damage was incurred due to fires and looting.

October 29–31, 1984 – Detroit (Wayne County)
The Halloween tradition known as “Devil’s Night” reached its peak destruction level in 1984, as 810 fires were intentionally set over a period of three days. The arson from this time-period had roots dating back to the 1930s, and it had become common to have hundreds of fires started each year. In the late 1990s, city officials successfully created “Angel’s Night” to help volunteers and law enforcement monitor abandoned buildings and patrol neighborhood areas.

February 10, 1987 – Ithaca (Gratiot County)
Four businesses were destroyed by fire with two others damaged. Total losses were estimated at $750,000.

March 12,1987 – Detroit (Wayne County)
A spread of fire involving two nearby warehouse complexes killed three fire fighters. The buildings in the north complex were abandoned, while the south complex was occupied by a paper product distributing company. The abandoned complex had been protected by an automated sprinkler system at one time that had since been dismantled. A wiping cloth distributor that had gone out of business left significant inventory behind. Parts of the complex had been built around 1920 with old timber and weak brick walls. Several firefighters were injured because of structural collapse. The fire was caused by arson.

March 2, 1988 – Webberville (Ingham County)
A fire destroyed a business, along with the city’s public library, resulting in about $200,000 in damage.

June 2, 1988 – Corunna (Shiawassee County)
Four businesses were destroyed, and one other was damaged, resulting in total losses of about $2.4 million.

March 9, 1989 – Ypsilanti (Washtenaw County)
A massive fire gutted the interior of 70 percent of Sherzer Hall at Eastern Michigan University. The building was entirely rebuilt in 18 months. Originally constructed for $55,000 (1903), the cost of the new building was $5.5 million.

January 20, 1991 – Perry (Shiawassee County)
One business was destroyed, and three others were damaged by fire, resulting in total losses of about $225,000.

February 28, 1993 – Ludington (Mason County)
Two apartment complexes were damaged, causing nine fatalities and $50,000 in damage.

July 18, 1993 – Grand Ledge (Eaton County)
Three businesses were destroyed, and four others were damaged, totaling roughly $525,000 in losses.

February 1999 – Lansing (Ingham County)
A fire in the G. Mennen Williams Building (which housed the Michigan Department of Attorney General) caused $4.2 million in damage and forced the temporary relocation of many employees. It was believed to have started in a photocopy machine. The fire occurred over the Presidents Day holiday when the building was mostly vacant, and no injuries occurred. The Williams Building, like many state facilities, was built before sprinkler systems were routinely recommended as a fire safety measure.

November 10, 1999 – Flint (Genesee County)
A convalescent home burned to the ground, resulting in the fatalities of five residents.

March 16, 2000 – Kalamazoo and Big Rapids (Kalamazoo and Mecosta Counties)
An early-morning fire at a Western Michigan University dormitory in Kalamazoo destroyed a first-floor room and forced the evacuation of more than 400 students. No one was injured in the fire. Three days later, on March 19, a separate fire in a third-floor room at a 175-student Ferris State University dormitory hospitalized one person and left two others with minor injuries. The building's second and third floors sustained extensive fire and water damage.

December 1, 2000 – Detroit (Wayne County)
An apartment complex was damaged, with six fatalities reported from the fire.

April 2, 2001 – Detroit (Wayne County)
A 50-unit apartment complex was destroyed by a fire, which also injured three people.

June 6, 2001 – Highland Park (Wayne County)
Three houses, two buildings, and one apartment were all significantly damaged by fire.

October 26, 2001 – Detroit (Wayne County)
An industrial structure fire destroyed a building, injuring nine people.

April 16, 2002 – Detroit (Wayne County)
An apartment complex was destroyed, resulting in two injuries and more than 100 people left homeless.

December 29, 2003 – Detroit (Wayne County)
A 34-unit apartment complex was destroyed, resulting in one injury.

January 6, 2004 – Grosse Pointe (Wayne County)
Three businesses were destroyed, along with six apartment units.

August 10, 2005 – Ionia (Ionia County)
A large and densely populated livestock building was destroyed by fire, causing $3,000,000 in damage and resulting in 250,000 chickens being consumed in the flames.

December 7, 2006 – Detroit (Wayne County)
One apartment complex was destroyed, causing one fatality, and leaving 51 families homeless.

February 8, 2007 – Ypsilanti (Washtenaw County)
One apartment complex was damaged, destroying six of its units and causing three fatalities.

January 20, 2008 – Grand Rapids (Kent County)
Two large buildings were destroyed, involving more than 100 destroyed condominiums and the evacuation of over 200 people.

February 6, 2008 – Detroit (Wayne County)
An apartment complex was destroyed, leaving 100 people homeless and causing one death and two injuries.

August 31, 2008 – Ontonagon (Ontonagon County)
Seven buildings were destroyed resulting in $250,000 in damages.

August 21, 2008 – Harrison Township (Macomb County)
One 37-unit apartment complex was destroyed.

May 20, 2009 – Marquette County (Marquette County)
Wildfire destroyed 33 structures, with 500 people evacuated. Such fires are detailed in the Wildfires Chapter.

July 25, 2009 – Hancock (Houghton County)
One building and two additional apartment floors were destroyed by fire. Four people were killed.

October 25, 2009 – Ann Arbor (Washtenaw County)
Four apartments were damaged and one business destroyed. More than 600 people were evacuated during the fire.

September 7, 2010 – Detroit (Wayne County)
At least 85 fires within a four-hour period razed more than 70 homes in Detroit. Strong winds gusting up to 40-50 mph downed power lines, starting and then fueling fires that were exacerbated by hot and dry conditions. A shortage of equipment and manpower, as well as potential copycat arson, led to multiple neighborhoods in the city being affected.

November 12, 2013 – Lapeer (Lapeer County)
A fire in the historic downtown area destroyed several businesses and left 15 residents of apartments without their homes. Some limited damage from smoke and water affected surrounding structures.

January 3, 2014 – Plainfield Township (Kent County)
A fire erupted in a building that was built into the baseball stadium for the West Michigan Whitecaps, an affiliate of the Detroit Tigers. A whole section of the building collapsed under the effects of the intense fire.

March 16, 2019 – Grand Rapids (Kent County)
A flash fire caused by a small residential methamphetamine lab started in a multi-unit single building complex before being extinguished by automatic sprinklers. A man was treated with burns to his face and hands. In addition to the fire damage, the sprinklers left three inches of water on the floor, with additional water running into lower units. A hazardous materials team was called.

April 30, 2020 – Escanaba (Delta County)
A fire at the Delta Inn motel killed two people and injured three (including one critical injury due to burns and another for a fractured back sustained while jumping from the roof). Smoking and a portable home oxygen device may have contributed to the cause.

July 6, 2020 – Eastpointe (Macomb County)
Two separate homes in the same block caught fire due to large amounts of errant fireworks being launched from neighborhood streets. No one was seriously injured, but one of the residents did not carry fire insurance. Local police had responded to more than 150 fireworks complaints leading up to the 4th of July holiday, compared to only 23 during the same period in 2019.

October 7, 2020 – Pinconning (Bay County)
A weekend fire heavily damaged a pickle manufacturer and major employer (with approximately 175 employees in the Pinconning area). It took 60 firefighters and 400,000 gallons of water to stop the blaze. Nearby residents were evacuated for two hours because of deteriorating air quality in the area. The manufacturing facility was a total loss. The cause of the fire had not been determined.

October 15, 2020 – Elmira (Otsego County)
Fire engulfed the local post office, torching most of the building. A burn pattern on an electrical outlet inside the wall and other evidence was consistent with an electrical fire. Much of the contents within the post office were destroyed.

Select Laws, Agencies, or Programs

Michigan Fire Prevention Act

The Michigan Fire Prevention Act (1941 PA 207), the state's primary fire enabling legislation, provides for the prevention of fires and the protection of persons and property from exposure to the dangers of fire and explosion. The Act gives the State Fire Marshal (Michigan Department of Licensing and Regulatory Affairs) and local fire chiefs broad authority to take actions necessary to prevent fires and stop the spread of fires once they have started. This includes: 1) requiring the razing, repair, alteration or improvement of buildings and premises that constitute a fire hazard; 2) controlling the use and occupancy of such buildings and premises; and 3) engaging in public education activities aimed at preventing or mitigating the effects of fire and explosion.

Michigan Department of Licensing and Regulatory Affairs

The Michigan Department of Licensing and Regulatory Affairs (LARA) conducts a number of important fire-related initiatives, including: 1) statewide public education programs aimed at preventing fires; 2) investigating fires, explosions and hazardous material incidents; 3) collecting, compiling, and analyzing fire-related data (through the National Fire Incident Reporting System) to determine fire frequency, causes, and impacts; and 4) membership organizations for fire fighters and fire chiefs. LARA's Michigan Fire Fighters Training Council also develops standards for firefighter selection and training, instructor requirements, courses of study, and evaluation. LARA's public education outreach program, MI Prevention, provides fire safety tips, escape plan templates, and other prevention/mitigation resources.

Michigan's Bureau of Fire Services

The Bureau of Fire Services is responsible for conducting fire safety and prevention inspections in state-regulated and other certain facilities. Services include: 1) fire safety inspections of adult foster care; correctional and health care facilities, and hotels/motels; 2) plan review and construction inspections of the regulated facilities in item (1), as well as schools, colleges, universities, and school dormitories; 3) coordination of fire inspector training programs; and 4) coordination of fire alarm and fire suppression system installation in regulated facilities. These important mitigation activities are designed to save lives and protect property from structure fire hazards. The Bureau of Fire Services also works in conjunction with State Fire Safety Board and Bureau of Construction Codes to promulgates rules covering the construction, operation, and maintenance of schools, dormitories, health care facilities, and correctional facilities.

National Fire Protection Association

The National Fire Protection Association (NFPA) conducts research on fires, develops codes and standards for fire prevention and protection, and disseminates fire safety information to fire departments and the public. A consensus standards development system resulted in the creation and maintenance of the National Fire Codes, over 300 codes and standards covering all areas of fire safety. Used throughout the world, virtually every building and construction process in place today is affected, in one way or another, by the codes and standards developed through the NFPA system.

U.S. Fire Administration

Established by P.L. 93-498, the Federal Fire Prevention and Control Act of 1974, the U.S. Fire Administration (USFA) provides leadership, coordination and support for the nation's fire prevention and control, fire training and education, and emergency medical services activities. The USFA, a branch of the federal Department of Homeland Security, conducts training for firefighters through the National Fire Academy (NFA), located in Emmitsburg, Maryland. Many Michigan firefighters have attended those training courses. In addition, the USFA administers a number of national fire programs aimed at fire prevention, with a particular emphasis on structural fire prevention. The USFA also supports the National Fire Incident Reporting System (NFIRS), administered and implemented in Michigan by the State Fire Marshal (Department of Licensing and Regulatory Affairs). The NFIRS data is used by the State Fire Marshal and other state and local fire agencies to assess and combat the fire problem in Michigan.

Supplemental Material

Scrap Tire Fires

Hazards posed by scrap tire fires don't neatly fit into a specific category but bear mention in this analysis due to their unique nature. The Environmental Protection Agency (EPA) does not consider scrap tires a hazardous waste. However, when a tire fire occurs, they break down into compounds including gases, heavy metals, and oil. The average passenger car tire is estimated to produce over two gallons of oil when burned. Tire fires often become major hazardous incidents affecting entire communities, producing toxic smoke and frequently requiring area evacuations. Oil that exudes into ground and surface water because of tire fires is a significant environment pollutant. In some cases, this may trigger Superfund cleanup status. For every million tires consumed by fire, roughly 55,000 gallons of runoff oil is generated.

Scrap tires are difficult to ignite, but once tire fires start, they are generally very hard to control and extinguish. Using water and/or foam to extinguish a tire fire is often futile. Water is best used to keep adjacent, unburned tires from igniting. Smothering a tire fire with dirt or sand is usually the best option for extinguishing fires.

Scrap tire sites exist in many areas of the state. Those that are unburied pose the greatest fire danger, frequently stored in outdoor stockpiles. A Michigan Scrap Tire Program begun in 1991 has greatly reduced their number, pegged at that time at roughly 31 million tires.

Reported Scrap Tires by Michigan County: October 2020

County	Tires	County	Tires
Allegan	7,300	Lapeer	4,100
Antrim	3,500	Leelanau	2,000
Berrien	7,900	Lenawee	3,500
Branch	4,600	Livingston	1,550
Calhoun	47,100	Macomb	1,000
Cass	40,000	Marquette	724
Cheboygan	4,000	Menominee	1,760
Clinton	40,000	Midland	64,080
Dickinson	317	Missaukee	2,000
Eaton	800	Monroe	1,200
Genesee	100,350	Newaygo	700
Grand Traverse	10,000	Oakland	3,562
Hillsdale	2,699	Oceana	19,000
Ingham	11,000	Osceola	6,500
Ionia	12,000	Sanilac	17,838
Jackson	3,400	Shiawassee	1,300
Kalamazoo	500	St. Clair	17,500
Iosco	4,800	St. Joseph	44,500
Ionia	3,000	Van Buren	23,000
Jackson	6,600	Wayne	125,241
Kalamazoo	2,499	Wexford	60,000
Kent	475		
Lake	600	**TOTAL**	**699,595**

(source: Department of Environment, Great Lakes, & Energy)

Select Scrap Tire Fire Examples

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

December 29, 1995 – January 20, 1996 – Grand Traverse County
A tire fire burned at a retreading facility in Grawn. Initial fire response was delayed due to attempts by employees at the recycling center to extinguish the blaze on their own. Surrounding subdivisions were evacuated. The fire engulfed 100,000 tires spread over a three-acre site. Personnel from numerous area fire departments, as well as the U.S. Environmental Protection Agency (EPA) and Coast Guard, were involved in the containment and suppression effort. In all, 451 responders from 30 separate agencies assisted with the fire over its 22-day duration. The long duration of this fire is testimony to the difficulty of extinguishing fires of this nature.

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

March 26, 1998 – Monroe County
A grass fire spread to a scrap tire pile in London Township, setting fire to between 3,000 and 5,000 tires. The pile was 50'x 30' and about 6 to 10 feet high. Soil samples were obtained afterward, showing no signs of contamination and no surface or ground water effects. The fire was put out by local fire departments.

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

January 24, 2008 – Saginaw County
A fire consumed an abandoned house and hundreds of scrap tires. Over 50 firefighters from the Watertown Township, Mayville, Caro, North Branch, Deerfield Township, and Millington-Arbela fire departments worked for more than five hours to extinguish the flames and the smoldering embers, which had erupted just after noon. The fire destroyed the house and an attached garage, while the burning tires created a lot of thick smoke. Bitter temperatures also caused the water run-off to freeze quickly, presenting an additional hazard for firefighters.

December 31, 2010 – Muskegon County
An early morning fire destroyed a Twin Lake tire business with damage estimates of over $325,000. A fire started in a pole barn which had several tires inside it, providing extra fuel for the fire once it started. City water was not available on the scene so responding fire crews set up reservoirs at three sites and used tanker trucks to shuttle water in from other areas. Ten fire departments were used to battle the blaze.

Scrap Tire Advisory Committee (STAC)
The STAC was created by the Waste and Hazardous Materials Division of EGLE to foster interaction between the department and other stakeholders to continually improve the state's scrap tire program (administered under Part 169 of the Natural Resources and Environmental Protection Act). STAC Annual Reports and a Michigan map for scrap tire sites can be found on the STAC's webpage

II. TECHNOLGICAL HAZARDS

Infrastructure Hazards

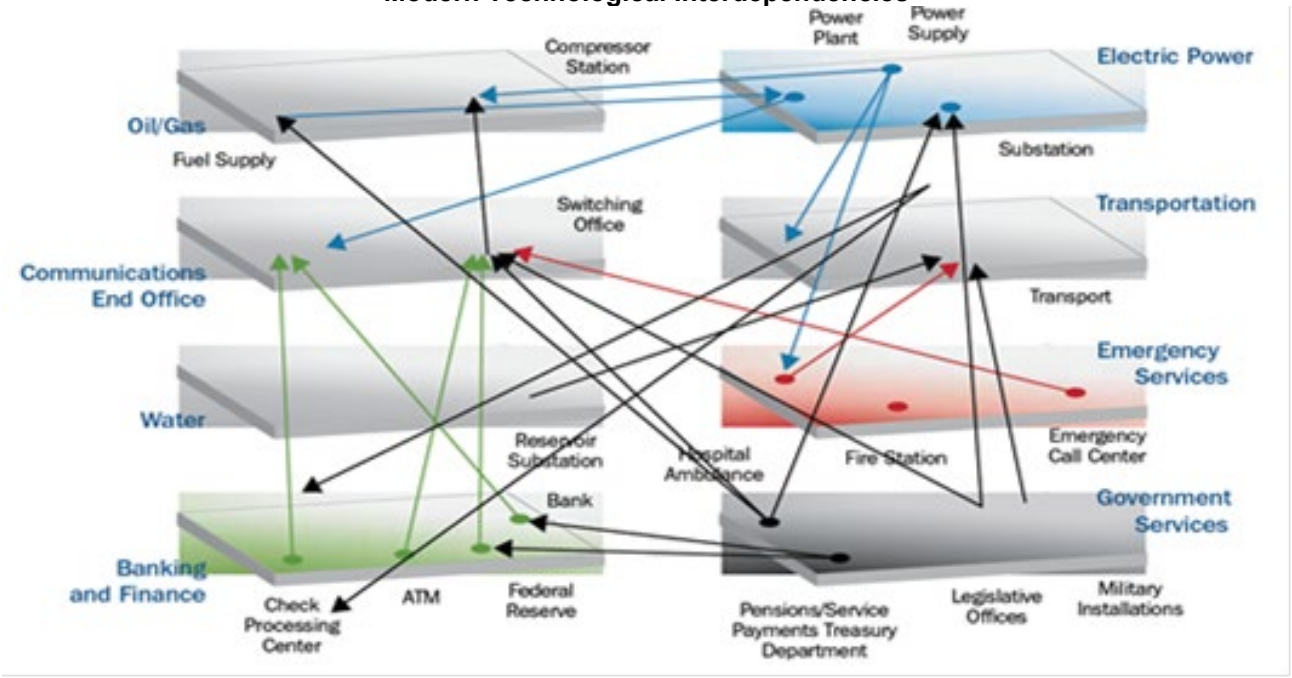
The following chapters are covered in this subsection on infrastructure related technological hazards:

1. Built Infrastructure Failures (water, sewer, bridges, communications)
2. Major Transportation Incidents (air, rail, highway, marine)
3. Energy Failures and Shortages (electric, natural gas, propane, gasoline)

The Built Infrastructure Failures chapter primarily focuses on hazards affecting water supply infrastructure, sewer systems, and bridges. Communications infrastructure is also touched upon. The Major Transportation Incidents chapter addresses mass casualty crashes that can also gridlock roadways or otherwise impede our ability to travel. The subsection's last chapter deals with vulnerabilities to our energy infrastructure, as well as potential supply disruptions to key energy sources.

Common to all these hazards, modern technology has a strong interface with today's built infrastructure. While providing many important advancements, its added complexity has also created a new set of risks. This has led to the recognition of dependency creep and risk migration: "As systems become more complex, and as they grow in size, understanding and oversight become more difficult. Subsystems and dependencies may evolve that escape the close scrutiny of organization operators. Dependencies allow risk present in one part [of the] overall system to 'migrate' to others, with potentially damaging results." (quote obtained from "Severe Space Weather Events—Understanding Societal and Economic Impacts: A Workshop Report – Extended Summary," the National Academies Press, Washington DC, 2009)

Modern Technological Interdependencies



Source: Department of Homeland Security, through the National Academies Press

Within these technical systems also exists a tradeoff between efficiency and vulnerability. For example, having excess capacity within an electric system can serve as backup in the case of an emergency. But in most energy markets these systems tend to operate closer to only the levels needed for maximum efficiency during routine operation.

Many infrastructure hazards will be discussed under different chapters of this document. Dam failures, for example, appear in the Hydrologic Hazards chapter since they are a direct cause of major flooding. While communications systems have historically relied on traditional phone line networks, today's communications are more likely to utilize orbital satellites and broadband Internet. Their hazards are highlighted in chapters on Space Weather and Cyberattacks.

BUILT INFRASTRUCTURE FAILURES

The failure of critical public infrastructure that results in a temporary loss of essential services. For purposes of this chapter, this primarily includes water supply infrastructure, sewer systems, bridges and communication systems.

Hazard Description

Michigan's citizens are dependent on built infrastructure to provide essential life-supporting services. such as potable water, sewer systems, and roadway networks. 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.

Multiple types of infrastructure systems exist, not all of which will be extensively covered here. As noted in the Technological Hazards introduction, energy related infrastructure failures have their own chapter. Certain major drinking water emergencies are covered in the chapter on Public Health Emergencies when contamination is involved. The collapse of underground structures may also lead to sinkholes, covered more thoroughly under the Subsidence chapter. Other types of infrastructure (dams, satellites, etc.) will be found in different sections of this document as well.

Hazard Analysis

Infrastructure failures represent significant hazards because they can affect hundreds of thousands of Michiganders at a time. Antiquated water facilities, ruptured pipes, crumbling bridges, and aging roads can cause mere inconvenience or havoc depending on the severity of an incident.

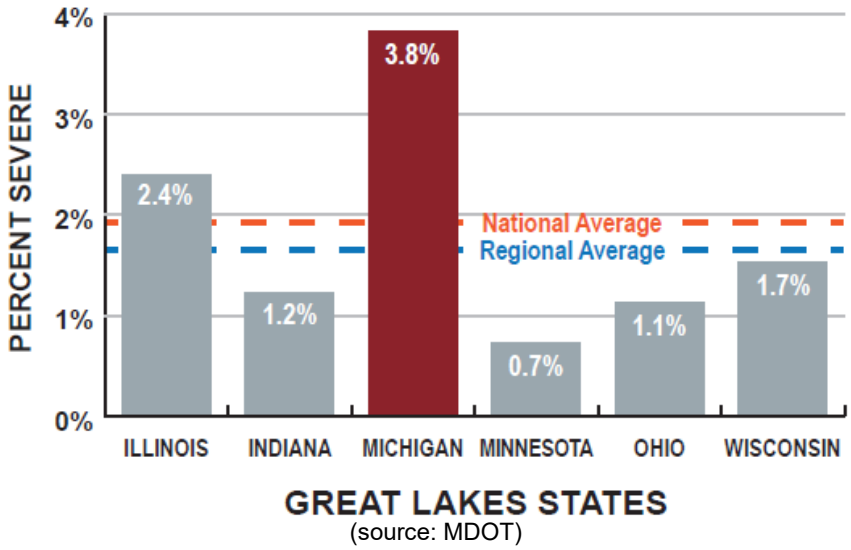
Budgetary constraints, combined with physical structures near the end of their useful service life, means that many types of infrastructure are suffering from a lack of support. Routine maintenance and repairs may be delayed, increasing risk and creating more expensive situations in the future. Worst-case 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.

Infrastructure failures can occur anywhere, but metropolitan areas may be currently more susceptible because they experience higher use volumes and additional wear and tear. Rural regions of the state 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 Detroit, but ultimately fewer individuals and businesses are affected. On the other hand, a relative lack of infrastructure in more remote areas may put such communities at higher risk for other incidents. Arsenic levels in well water may go undetected compared to more routine testing standards that occur at major water facilities.

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 (see accompanying chapter).

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. The following chart is taken from the Michigan Transportation Asset Management Council's 2019 report, which contains a broad overview of the state's roadways: https://www.michigan.gov/documents/tamc/2019_TAMC_Roads_Bridges_Annual_Report_WEB_688758_7.pdf.

Severe Bridges by Percentage (2019)



(source: MDOT)

Such bridges are candidates for high priority or major rehabilitation and need to be monitored for emergency repairs. In some cases, they may need to be closed to traffic until corrective action can be taken. Aside from serious life safety consequences, bridge failures or closures can create significant transportation related bottlenecks in areas where nearby substitutes do not exist to cross over rivers, lakes, or major highways.

A complete analysis of Michigan's road network is beyond the scope of this document. It is worth noting, however, that recent analysis shows for that state's paved "federal aid" roads that 21 percent are rated as being in good condition, 40 percent in fair condition, and 39 percent in poor condition. This contrasts with "non-federal aid" roads, which are in 16 percent good condition, 33 percent fair condition, and 51 percent poor condition (2017–2019). While a mix of such roads exist in each county, the data infers that Michigan's more rural roads, on average, may be in worse condition than its urban counterparts. The data does not include non-paved roads. Significant variation from road to road can be expected in each county.

Michigan's historical communications infrastructure, for much of the 20th century, consisted primarily of traditional telephone systems. While most Michigan residents no longer have a "land-line" phone, the importance of their existing network and infrastructure should not be discounted. In some more rural areas of the state, such landlines provide an important alternative to cell phones where coverage areas are sparse. Although diminishing, traditional landlines remain a source of many 9-1-1 calls, and also provide for some Internet connectivity via Digital Subscriber Lines (DSL). While slower than other forms of Internet, their use can still be vital. When viewed broadly, consideration for communication networks should also examine traditional broadcast radio and television stations. Emergency managers need to spend particular attention to their own specialized radio communication systems and interoperability (such as with police, fire, EMS, and amateur radio).

Codes and standards govern the design, construction, and operation of many types of infrastructure. Such standards may be inadequate to protect infrastructure from all types of disaster-related damage, especially those uncommon to Michigan (e.g., earthquakes). In many cases, these standards call for the minimum level of structural integrity and operational performance recommended in accepted engineering practice. Routine cost-benefit analysis may not always take hazards fully into account. While it is possible to design facilities that are virtually "disaster-proof", it is not economically feasible to do so, especially when opportunity costs are considered. In cases where recurring damage and system downtime is frequent, it is worth exploring the possibility of enhancing infrastructure design, construction, and operational standards.

Specific Impacts

Impact on the Public, Property, Facilities, and Infrastructure

Our built infrastructure provides the public with the essential components for modern life. The supply of fresh water (for drinking, cleaning, washing, cooking, and other uses) may sometimes be interrupted by pipe freezes, breaks, or water main failures. In addition to the need for citizens to find alternative sources of water, there is the potential for certain types of system failures to allow contaminated water to sicken the public. Water main failures may also cause localized damage, erosion, and flooding.

Drainage infrastructure failures may cause normally safe areas to become flood-prone, causing impacts in locations beyond those that are recognized as floodplain and wetland areas. Urban flooding results when drainage capacities of the area are exceeded, and polluted water backs up into streets, yards, and basements. This can cause transportation and access issues, property damage, contamination, cleaning costs, and the loss of important family possessions.

Communication systems are heavily used for residential and business purposes but are also vital for emergency response and operations. Failure of systems may include a region's mass media (conveying important public awareness and emergency information), its land-based and/or cellular telephone systems, and its public emergency 9-1-1 system access. During times of mass emergencies, it is possible for an excess of attempted calls to overwhelm a system. Situations may exist where cell phone calls may not work for everyone, but texting may still be possible.

Impact on the Economic Condition of the State

Infrastructure construction and maintenance is often considered an investment in communities and a sign of economic progress. Residential water wells lead to water utilities, septic fields are abandoned as homes connect to sewer systems, and two-lane dirt roads become multi-lane highways with bridges. In general, these types of investments lead to higher population densities, expanded tax bases, and more jobs providers in a given area. The opposite also tends to be true, with residents and business fleeing regions with poor infrastructure. The impact of specific emergencies can vary in the short and long run, depending on the success of mitigation efforts, robustness of recovery programs, and the resilience of a community. Strong correlations exist between state economies and the condition of their infrastructure.

Impact on Public Confidence in State Governance

Routine minor failures in water systems, including low pressure and "boil water" advisories, may have a disgruntling effect on some residents' confidence in government and their regulatory powers. Issues of major contamination for which government is responsible will be particularly deleterious. Drainage and sewage infrastructure are most associated with local/county governments, and any dissatisfaction with the capacity of those systems is likely to be directed toward the appropriate agencies at that level (rather than state or federal government). Failure of communication systems may relate to confidence in government because of its regulatory role of the private firms involved. The effectiveness of public warning systems will have a high association.

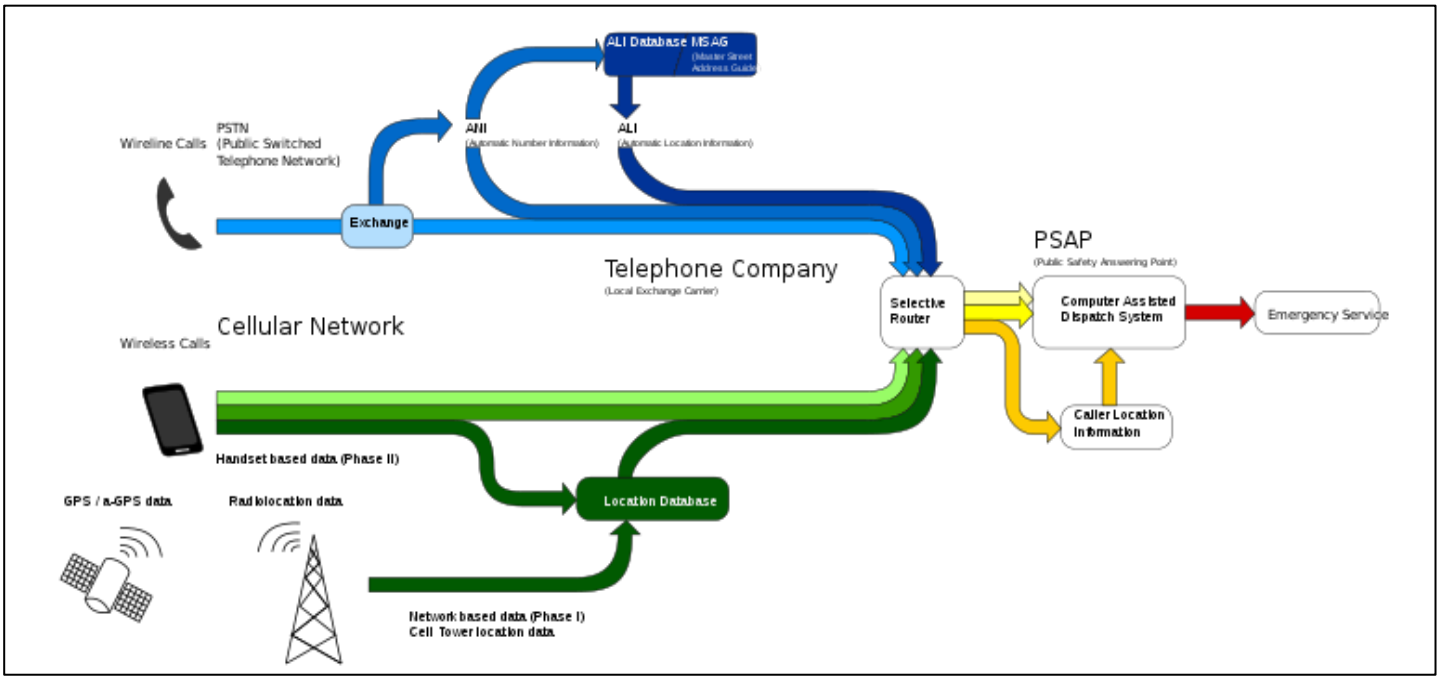
Failure of transportation systems is generally considered to be an area of governmental responsibility. Road maintenance can have local, state, and federal components. Transportation planning tends to involve both local and regional decisions, overseen by state and federal guidelines and regulations. When the safety of major bridges, highways, airports, and railroads comes into question, significantly more weight tends to be placed upon the role of higher-level (e.g., state and federal) agencies than local ones. A major bridge collapse, such as the one that occurred in Minnesota (2007), would be expected to result in substantial amounts of dissatisfaction with government. Otherwise, the public is probably more focused upon road conditions and individual driving behavior, rather than larger-scale transportation-related systems and regulatory issues (e.g., airlines, trains, ferries).

Impact on Responders, Continuity of Operations, and Continued Delivery of Services

Many forms of infrastructure are used by responders before, during, and after an emergency event. A good supply of water is needed for firefighting and for certain types of hazardous materials response operations. Clean water is also used in the provision of emergency medical care, but special reserves of such water may have to be transported to the response sites or special staging areas if the local water supply is insufficient or contaminated. Water infrastructure failure may severely impede the normal operation of medical facilities. Failures in drainage infrastructure may cause normally safe areas to become flood-prone, thus potentially causing flood hazards to interfere with responders' effectiveness, safety, and efficiency.

Poor transportation systems can impede first responders' abilities to arrive at a scene. Areas separated by rivers may have only so many bridges that connect them in each region. The loss of even one significant bridge can severely hamper emergency operations on sides that are opposite of hospitals, police headquarters, and fire stations. Communication systems are vital for first responders, especially Michigan's Public Safety Communications System. An inability to convey messages between responders, officials, and the public may cause response and recovery operations to be severely handicapped. An emphasis should be placed on interoperability of networks and backup communications methods. Newer 9-1-1 systems are multi-faceted and are best operated by aggregating a variety of networks.

9-1-1 SYSTEM



(source: Modern 9-1-1 Systems, courtesy: egmason)

Emergency managers should give attention to their own communication devices. Services exist with cell phone carriers to give phones belonging to first responders a higher connection priority during times of mass tower congestion.

Impact on the Environment

Infrastructure failures can negatively impact the environment, with wastewater collection and treatment facilities discharging various pollutants, contaminants, and raw sewage into the natural environment. Surface water and groundwater discharge facilities can negatively harm the environment with suspended soil sediments, dissolved chemical substances, or biological material. Sewage disposal systems can back up or overflow, causing basement flooding. When sewage processing capabilities cannot be adequately maintained, it may result in the deposition of untreated sewage into some part of the local environment, such as an area river. Pollutants can lead to the poisoning of aquatic wildlife or the creation of vast “dead zones” where there isn’t enough oxygen for marine life to survive.

County and watershed drainage systems, and water conveyance and treatment systems, range from small agricultural drains to massive urban storm and sanitary sewer systems. These can contaminate the environment in the event of an infrastructure failure. Detention and retention basins, dams, flood pumps, irrigation diversions, and erosion control structures are also part of the infrastructure. These facilities vary from rural open channels, with drainage areas of several hundred acres, to large river systems with drainage areas of several hundred square miles.

Some telecommunication facilities and systems can have environmental impacts stemming from tree trimming and clearance, the installation and maintenance of overhead lines, or when placing new distribution systems underground. Cell towers or equipment may be considered a form of visual blight by some members of the community.

Hazard Mitigation Opportunities for Infrastructure Failures

- Proper location, design, and maintenance of water and sewer systems (to include insulation of critical components to prevent damage from ground freeze).
- Protection of built infrastructure (roads, bridges, utilities) from erosion, particularly around lakeshores or riverbanks with rising water levels.
- Redundancies in utility and communications systems, especially "lifeline" systems; to increase resilience (even if at the cost of some efficiency).
- Separation and/or expansion of sewer system to handle anticipated stormwater volumes.
- Use of generators for backup power at critical facilities.
- "Rolling blackout" strategies for electrical systems that will otherwise fail completely due to overloading.

- Replacement or renovation of aging structures and equipment (made hazard resistant as economically feasible).
- Physical protection of communications systems from lightning strikes.
- Tree-trimming programs to protect equipment from branches. (Ideal: Establishment of a community
- forestry program with a main goal of creating and maintaining a disaster-resistant landscape in public rights-of-way.)
- Increasing public awareness and use of the "MISS DIG" utility damage prevention service (800-482-7171).

Infrastructure Failure Examples

A complete listing of built infrastructure failures in Michigan is beyond the scope of this document. A partial listing can be helpful to show the variety of causes and outcomes. Many incidents are because of natural disasters, such as snow, severe cold, windstorms, tornadoes, and floods. However, poor maintenance and design flaws are also to blame. Examples have been organized into three parts: (1) water supply/sewer failures, (2) vehicle bridges, and (3) a short listing of building related issues such as pedestrian bridges and balconies.

Water Supply, Sewer, and Related Failures in Michigan

Between 2012 and 2018, water main break rates increased by 27 percent nationwide. This increase meant going from roughly 11 breaks a year to 14 breaks for every 100 miles of pipe (2018 Utah State University report, "Water Main Break Rates in the USA and Canada: A Comprehensive Study"). While most such breaks are not catastrophic, they do point to a troubling trend. Michigan's cold temperatures put it more at risk.

1978, 1980 – Macomb County, Oakland County – Sewer Main Collapse

In 1978, and again in 1980, a large sewer main that served nearly 300,000 residential and business users in northern Macomb and Oakland counties partially collapsed. The collapses were of such magnitude that continued sewer service to 300,000 users was in peril. Fortunately, officials were able to install temporary sleeves within the damaged main until it could be properly repaired. However, in order to relieve the backpressure and keep basements from filling with sewage, officials were forced to divert millions of gallons of raw sewage into the Clinton River, fouling miles of Lake St. Clair beaches. Eventually, the damaged sections of sewer main were repaired, but this unfortunate incident caused tremendous disruption and environmental damage to the area. It showed how serious a large-scale sewer infrastructure failure in a densely populated area could be.

December 1989 – Monroe County – Water Supply Infrastructure Failure

A water emergency in Monroe was the result of a water intake in Lake Erie being blocked by ice build-up and Zebra Mussel crustaceans. Officials issued water conservation and boil-water advisories, and schools and most large businesses were closed. Local hospitals limited their activity to emergencies only and referred new patients to out-county hospitals. The hospitals operated on bottled water for the duration of the incident. The fire service was also adversely impacted, invoking mutual aid and stationing tankers throughout the city in case a fire occurred. The city eventually completed an emergency hookup with the Toledo, Ohio water system, which helped alleviate most of the water supply problems. The city also had three pumps drawing water from the River Raisin and pumping it to the water treatment facility. Emergency measures continued for three days. By December 18, the flow of water was back to normal. This incident showed how a vast public infrastructure system can be made inoperable—and thousands of people inconvenienced or even imperiled—by something as small as an aquatic mollusk.

November 1992 – Lansing – Water Supply Infrastructure Failure

A Lansing water emergency occurred when a transformer exploded, causing a power outage to sections of the city. Because a water pumping station was affected, officials were concerned about the loss of pressure and possibility of contamination within the water distribution system (which served Lansing and Delhi Township). Officials issued a boil-water advisory, and bottled water was distributed at four locations in the city. Local hospitals also had to be supplied with bulk supplies of fresh water to meet their normal operational needs. The water emergency was terminated the next day when tests indicated no contamination in the water supply.

Winter of 1993/94 – Northern Michigan – Water Supply and Sewer Infrastructure Failures

An underground freeze disaster in northern Michigan provided an indication of how vulnerable our public water and sewer infrastructure can be to the adverse effects of natural phenomena. Due to a prolonged period of severe cold weather that caused ground frost to greatly increase beyond normal depths, municipal water and sewer systems in ten counties partially failed, disrupting service to over 18,000 homes and businesses and causing over $7 million in infrastructure damage. Some of the homes and businesses were without normal water and sewer service for several weeks. At final count, over 3,200 water and sewer lines had been frozen and/or broken, making this infrastructure failure

not only unusual but also unprecedented in U.S. history in terms of scope and magnitude. This disaster showed how vulnerable our underground infrastructure can be when the "right" set of natural conditions occurs. Furthermore, these types of disasters may occur with greater frequency in the future, as our public infrastructure ages and thus becomes more fragile (and since most systems are not built to be "disaster resistant/disaster proof" in the first place).

June 1996 – Thumb Area – Drainage Infrastructure Failure
A flood resulted in a Presidential Disaster Declaration for seven counties, severely impacting the region's drainage system. Flat topography had led to the extensive use of sub-surface tile and open drainage channels to make the land more usable. The flooding proved just how critical these drainage channels were to the local economy (both agricultural and non-agricultural) and to the citizens of the area. When the drains overflowed, surrounding farm fields were flooded—many for days—killing the crops that had just been planted. Hundreds of culverts were damaged or destroyed and many roads and bridges were washed out. The cumulative effects of these events included severe economic losses to both agricultural enterprises and supporting businesses. Infrastructure repair and replacement costs impacted the budgets of local jurisdictions.

December 1998 – Detroit – Water Supply Infrastructure Failure and Cascade
Sometimes, failure of one type of utility infrastructure is directly caused by a failure in another type of utility infrastructure. That was the case in Detroit when a 30-inch water main in the downtown area burst, crushing a nearby 12-inch gas main and flooding it with water. Approximately 200,000 gallons of water flooded nearly 20 miles of gas line, shutting down gas service to hundreds of downtown Detroit businesses and residents on both sides of I-375. Officials estimated that 600 buildings (including hotels, offices, restaurants, shops, and residences) were affected by the gas service shutdown. Crews from Michigan Consolidated Gas worked around the clock for the next four days to drain water from the gas lines, and hundreds of gas meters, to get gas service restored. Even after restoration was complete, problems and service interruptions continued to plague some structures for several days until more permanent repairs could be made. Michigan Consolidated Gas called the water contamination incident the worst in the company's 150-year history. Economic losses for the affected hotels, restaurants, and other businesses were substantial because the incident occurred during the normally profitable pre-Christmas holiday period.

June 1999 – Oakland County – Water Supply Infrastructure Failure
A drilling company, hired to relocate fiber optic cable for a new highway interchange, accidentally broke a water main in the city of Auburn Hills, setting off a week-long water emergency that closed hundreds of businesses and schools and forced thousands of residents to boil water, or drink bottled water, until repairs could be made. Local officials estimated that 118,000 residents in over 44,000 households in Auburn Hills, Orion Township, Lake Orion, and Rochester Hills were affected by the water emergency. The crisis forced the closure of several major business enterprises, including the DaimlerChrysler headquarters and technology center, the Palace of Auburn Hills sports arena, and the 200-store Great Lakes Crossing Mall, idling thousands of workers. Businesses outside Oakland County were also affected because of a shortage of parts from suppliers with plants in Auburn Hills and Rochester Hills. Economic losses associated with the water emergency were so extensive that local officials gave up trying to calculate the costs. However, officials estimated that the weeklong ordeal caused losses in the tens of millions of dollars.

September 2000 – Genesee County – Drainage Infrastructure Failure
Heavy rainfall in Genesee County on September 22–23, 2000, caused the Thread Creek to flood and inundated the city of Grand Blanc's storm and sanitary sewer systems, as well as Genesee County's secondary sewer system. The city of Grand Blanc received 4.5 inches of rain in 11 hours, and the resulting flooding damaged nearly 50 homes and businesses. The Governor requested and received an SBA Disaster Declaration for this event, making available low-interest disaster loans to affected residents in Genesee County and the contiguous counties of Lapeer, Livingston, Oakland, Saginaw, Shiawassee, and Tuscola.

September 2000 – Oakland and Wayne Counties – Drainage Infrastructure Failure
Unusually heavy rainfall occurred in southeast Michigan, overwhelming municipal storm drainage systems and causing damage to 130,000 homes and businesses in Wayne and Oakland counties. Most of the flooding was due to sewer backups into homes and businesses, caused by short-term power failures at pumping stations, and by the capacity of the stormwater collection system being exceeded. As a result, raw sewage backed up into basements in at least 15 Wayne County communities, creating serious public health and safety concerns and causing widespread property losses. Due to the extensive damage and public health and safety threats, a Governor's Disaster Declaration was granted to Wayne County on September 20. On October 17, a Presidential Major Disaster Declaration was granted to Wayne County, making available disaster assistance to individuals and businesses that had incurred flood damage. On October 27, Oakland County was added to that Major Disaster Declaration.

February 2001 – Genesee County – Pump Station Failure
A pump station in Genesee County went down for 34 hours, causing 2.5 million gallons of raw sewage per hour to go into the Swartz Creek and Flint River. A health advisory was issued for high bacterial counts in the water. Power was lost, homes were evacuated, and nearly 1,000 reports were received regarding flooding. About 60–100 roads and bridges were temporarily closed and impassible due to the flood waters. There was nearly $2 million in damage from pump station failures. A total of over $213 million in disaster relief assistance was provided to individuals to pay for temporary housing, to repair flood related damages and replace essential household items, and for other necessary disaster related expenses. An additional $30 million in hazard mitigation assistance was also made available to the state, bringing the total costs to nearly $250 million.

March 2002 – Wayne County – Emergency Dispatch Failure
A small construction vehicle operated by a waterproofing worker accidentally ruptured a water line in the garage of a police headquarters. The water drained into the basement, where it shorted out electricity and the telephone system in the dispatch center. Callers could not get help through the city's 9-1-1 police-and-fire dispatch for more than two hours until a back-up call-in system was activated at Detroit City Airport.

September 2002 – Oakland County – Water Main Failure
A five-foot diameter water main ruptured, lowering pressure to several thousand homes in southern Oakland County. A 20-by-20-foot section of pavement collapsed on 12 Mile Road in Farmington Hills, as the water washed away the supporting soil. The pavement fell on top of a gas main, forcing the evacuation of a dozen nearby homes. Nearby trees were washed away, and several utility poles were destabilized by the rushing water.

May 5, 2003 – Wayne County – Underground Explosions
In the city of Detroit, a massive explosion occurred just before noon, sending manhole covers flying above ground in the vicinity of Michigan and Griswold. It was believed that methane gas had leaked from a sewer line and accumulated, until ignited by a spark. Underground line insulation burned under the streets at Shelby and Lafayette. A firefighter who had been parked in a nearby fire truck was injured when the blast shattered the truck's windshield and side window and caused punctured eardrums. The explosions were at least four in number, and some electrical power had to be turned off in the area to aid in extinguishing the fire.

May 2004 – Macomb County – Water Main Failure
A 36-inch water main broke leaving thousands of customers without water. It was the fourth time that the same main had broken in four years. The break forced 20 schools to close and shut down restaurants and other businesses. A boil-water advisory was put into effect for several days.

July 2004 – Marquette County – Water Main Failure
One of two pipes, 16 inches in diameter, ruptured lengthwise just inches from the footing of the city's water treatment center. Water gushed out of the city's grid at a rate of 9,000 gallons per minute, drained both of the 500,000-gallon water towers, and eliminated pressure in all 85 miles of city pipeline. Electric service was not interrupted, although the city briefly shut down its power units, which are cooled with water, and reverted to a backup generator. A boil-water advisory was put into effect for several days.

March 2007 – Muskegon County – Sewer Main Break
A break occurred in a 66-inch underground sewer main in Muskegon Township, resulting in flood damage to several homes and sending 25 million gallons of raw sewage into Muskegon Lake. The county hired crews to repair the ruptured pipe as soon as possible. Around 30 homes had to be evacuated. The county spent $38 million to replace eight and a half miles of underground sewer main.

September 2008 – Genesee County – Sewage Flooding
A weekend of pounding rain in Genesee County sent water and sewage flooding into hundreds of area homes and caused large-scale discharges into rivers. There were 400 calls of flooding and sewage backups in basements, as well as concerns about Escherichia coli (E. coli) bacteria in the water.

January 2009 – Gogebic County – Water Main Failure
A 16-inch water pipe (a main that supplied the city) cracked due to pipe degradation. All schools in Ironwood were closed. Local health officials issued an advisory to conserve and boil drinking water, due to the water main break. Potable and non-potable water was available through Ironwood Public Safety for delivery and pickup, and Gogebic Community College was open for assistance as well. Water returned to normal four days later.

December 2010 – January 2011 – Highland Park – Wayne County Water Main Failure
Seventeen thousand residents of Highland Park lost running water over the New Year's weekend. A key water pump failed in the Highland Park treatment system, and that triggered the backup system, which draws from nearby Lake St. Clair. The inundation of water caused a massive rupture, leading to the loss of water pressure throughout the city. Residents were left without water for cooking, cleaning, or flushing toilets. Those with water boiler systems lost their heat during the frigid temperatures. Spontaneous protests erupted in front of the city hall that afternoon, as residents became aware of the lack of water. A "boil water alert" was issued, warning residents that the water could be contaminated, and a state of emergency was declared in the city. The public schools were closed on the following Monday to avoid health concerns from the boil water advisory.

April 2014 – Flint – Water Quality Failure
The Flint Water Crisis highlights that not all infrastructure failures are directly related to crumbling concrete or engineering design flaws. While the lead content of aging pipes played a pivotal role in the emergency, decisions made over where the city should source its water supply from, as well as errors made in how to chemically treat the water, led to the full blown crisis. The financial state of the city also played a role in water supply decisions, with the city itself in a designated state of financial emergency at the time. The impact of the failure was large enough that the incident became a full-blown public health crisis and is also covered under the Public Health Emergency chapter. While the water quality has been restored to regulatory approved levels, the long-term health impacts on the city's residents, particularly its children, is unknown. In 2018, the State of Michigan passed a set of stricter standards for lead, shifting to a lower 12 ppb standard and requiring that communities replace 5 percent of lead service lines annually. Lead pipes are still in the process of being removed, not just in Flint, but throughout the state.

December 2016 – Macomb County – Drain System Failure and Subsidence
The Macomb Interceptor Drain collapsed in Fraser, causing a 100-foot wide and 250-foot long sinkhole. The football field-sized hole resulted in several houses being damaged. The threat of collapse prompted the evacuation of 22 homes in the area. Damage estimates were around $75 million, and the area was declared a disaster area by Governor Snyder. The sinkhole was eventually determined to have resulted from an operational error made in 2014 when pipe maintenance work required a gate to be closed to hold back sewage while workers were in the pipe. Afterward, the gate was supposed to be gradually raised, allowing materials to be released into the pipe over the course of several hours. The pipe was instead allowed to refill all at once, causing fractures through which surrounding material could enter and erode the pipe. This led to a large enough gap that eventually caused a complete collapse. See the chapter on subsidence for related information.

January 2019 – Detroit – Water Main Failure
A weekend water main break forced a boil water advisory for downtown Detroit. This occurred as the annual Auto Show was getting underway, with several thousand tourists in town. Area hotels, filled with auto industry executives and journalists from around the world, found themselves not only having to tell guests not to drink the water, but in some cases had to apologize because low pressure made taps on higher floors totally inoperative. The boil-water advisory was in effect through Thursday. The pipes in question dated back to the 1800s.

February 2020 – Ingham County – Water Main Failure
Cold weather caused a water main break that affected 55 homes near a public school. Residents around the area experienced water coming in through windows and flooded basements. A representative from the Lansing Board of Water and Light indicated that during times of extreme cold weather the breaks become more frequent and they may experience one break per day on average during that time of year.

May 2020 – Traverse City – Sewer System Failure
A series of three major rain events overwhelmed Traverse City pipes and caused raw sewage to flow into a nearby river. Saturated ground and a mechanical failure at a lift station were to blame. It was noted that modernizing the city's overall aging infrastructure could take years and cost millions of dollars. The city said the undertaking was exacerbated by climate change, high waters, illegal basement pump systems, and more than seven miles of city pipes now buried lower than lake levels, increasing their risk of submersion.

Bridge Failures in the United States
Bridges and overpasses are critical pieces of infrastructure in continual need of maintenance and repair. The state possesses several large-scale bridges traversing over water, including the 8-lane, 8,000 foot-long Zilwaukee bridge and the 26,372-foot-long Mackinac Bridge. Several international bridges also either operate or are under construction between Michigan and Canada and are important to the economy. By their very nature, the loss of such bridges can create significant bottlenecks in our transportation system and also impact national security. Most true bridge failures in Michigan have occurred on a smaller scale, often caused by truck collisions that involve simple highway overpasses.

December 1967 – Point Pleasant, West Virginia – Bridge Failure
The Silver Bridge collapsed while it was full of rush-hour traffic, resulting in the death of 46 people. The bridge, constructed in 1928, connected Point Pleasant, West Virginia, and Kanauga, Ohio, over the Ohio River. Investigation of the wreckage identified the cause as the failure of a single eye-bar in a suspension chain, due to a small defect 0.1 inch deep. The bridge had been poorly maintained and was carrying heavier loads than it had originally been designed for.

May 1980 – Tampa, Florida – Bridge Failure
A freighter rammed into the Sunshine Skyway bridge, knocking out a 1,200-foot section across the mouth of Tampa Bay. Fatalities included 35 people, mostly on a Greyhound bus. Poor visibility because of a storm was partly to blame.

October 1989 – Oakland, California – Bridge Failure
The Cypress Street (Viaduct) Freeway bridge in Oakland, California collapsed as a result of the Loma Prieta earthquake. The braces that held the upper-level to the lower-level broke in two and then fell outward, dropping the upper level down on top of the lower level with a force of approximately two million tons. Autos, trucks, and buses were crushed, along with their occupants. The collapse started in the northern sections of the freeway, and like a domino effect, each adjacent section began to collapse in turn. The collapse resulted in 42 fatalities.

September 2001 – South Padre Island, Texas – Bridge Failure
During the early morning, four loaded barges crashed into one of the Queen Isabella Causeway's support columns, resulting in three 80-foot sections of the bridge falling into the water and leaving a large gap in the roadway. The collapsed sections were near the highest point of the causeway, making it difficult for approaching drivers to notice. Eight people were killed, as cars fell 85 feet into the water. Five vehicles were recovered from the water, along with 13 survivors.

August 2007 – Minneapolis, Minnesota – Bridge Failure
The I-35W Mississippi River steel truss arch bridge collapsed during evening rush hour (killing 13 people and injuring 145). The bridge was Minnesota's fifth busiest, carrying 140,000 vehicles daily. The NTSB cited a design flaw as the likely cause of the collapse and asserted that additional weight on the bridge at the time of the collapse contributed to the failure. Immediately after the collapse, help came from emergency response mutual aid within the seven-county Minneapolis-Saint Paul metropolitan area, and from charities and volunteers. City and county employees managed the rescue, using post-9/11 techniques and technology that may have saved additional lives.

<u>Building Collapses (not terrorist or criminally motivated)</u>
Collapses of part or all of a building is considered a structural failure. The severity of damage is dependent on factors, such as the type and size of the building, the number of occupants, day of week/time of day, stored materials, and weather conditions. Along with misuse, accidents, and weather-related loads, the causes of failure may be found in deficiencies of design, detailing, material, workmanship, or inspection. Detroit is an area of high risk, as it is home to some of the oldest skyscrapers in the nation (with many buildings over 300 feet tall that were constructed before 1930). Fortunately, there has not yet been a major mass-casualty event in Michigan due to a building collapse.

July 1981 – Kansas City, Missouri – Walkway Collapse
The Hyatt Regency hotel walkway collapse was a major disaster, killing 114 people and injuring more than 200 others during a dance. Approximately 2,000 people had gathered in the atrium to participate in and watch a dance contest. At 7:05 p.m., the walkways on the second, third, and fourth floor were packed with visitors. The fourth-floor bridge was suspended directly over the second-floor bridge. A critical connection failed and both walkways crashed—one on top of the other—and then into the lobby below. The cause of the accident was a flawed design change that doubled the load on the connection between the fourth floor walkway support beams and the tie rods carrying the weight of both walkways. This new design could barely handle the dead load weight of the structure itself, much less the weight of the spectators standing on it. The design had been accepted without performing calculations that would have revealed its serious flaws.

April 1987 – Bridgeport, Connecticut – Building Collapse
Nearly 30 construction workers were killed as they worked on a 16-story residential project. Its partially erected frame completely collapsed, likely due to high concrete stresses on the floor slabs which resulted in cracking and punch-through failures.

June 2003 – Chicago, Illinois – Balcony Collapse
The deadliest balcony collapse in United States history occurred when 13 people were killed and another 57 injured as an overcrowded balcony failed. The second-floor balcony fell onto the first floor, which itself collapsed into the basement

below (30-foot total drop), carrying a total of around 100 people between them. Initial inquiries blamed the collapse on excessive weight, but it was ultimately determined that poor construction was to blame. The balcony was one foot wider than codes had permitted, giving it too large an area. The balcony also had inadequate supports, was floored with undersized lengths of wood, and was attached to the walls with short screws. Age also played a role.

Select Laws, Agencies, or Programs

While it is beyond the scope of this document to include regulations related to all infrastructure, protecting Michigan's water is an especially critical task. Following are brief synopses of some of the laws aimed at reducing hazards to the state's water system infrastructure.

Water Distribution Systems

Michigan's public water supplies are regulated under the Federal Safe Drinking Water Act. The Michigan Department of Environment, Great Lakes, and Energy (EGLE) provides supervision and control of Michigan's public water supplies (including their operation and improvements) under the Michigan Safe Drinking Water Act (1976 PA 399). The Drinking Water and Radiological Protection Division of EGLE regulates, through a permit process, the design, construction, and alteration of public water supply systems. Water supply construction must be conducted within the framework of the Michigan Safe Drinking Water Act, as well as the Architecture, Professional Engineering and Land Surveying Act (1937 PA 240). Most communities in Michigan have developed water system master plans that conform to the requirements of the Michigan Safe Drinking Water Act.

Wastewater Collection and Treatment Systems

The Federal Clean Water Act regulates discharge from community wastewater collection and treatment systems. The regulatory aspects of the Act that pertain to municipalities have been delegated to the EGLE Surface Water Quality Division (for surface water discharge facilities) and the EGLE Waste Management Division (for groundwater discharge facilities). Authority for the oversight of planning, design review, and construction permitting of sewage systems and treatment facilities, is derived primarily from Part 41 of the Michigan Natural Resources and Environmental Protection Act (1994 PA 451). EGLE monitors and assists local communities with the development and maintenance of their wastewater collection and treatment systems.

Surface Water Drainage Systems

The Michigan Drain Code provides for the maintenance and improvement of a vast system of county and inter-county drainways to help prevent flooding. Each drain is part of a tax assessment district, and new drains can be established by a petition of the affected landowners and/or municipalities. County drains, with a special assessment district entirely within a county, are administered by the locally elected county drain commissioner. Inter-county drains are administered by a larger drainage board. Drains may be constructed of large pipes ranging in size from 12–16 inches in diameter, while others are simple open ditches that may be dry during part of the year. Floodwater-retarding dams, flood pumps, erosion control structures, and storage basins may also be used. Natural retention ponds are sometimes incorporated into parks or use to create natural areas for wildlife.

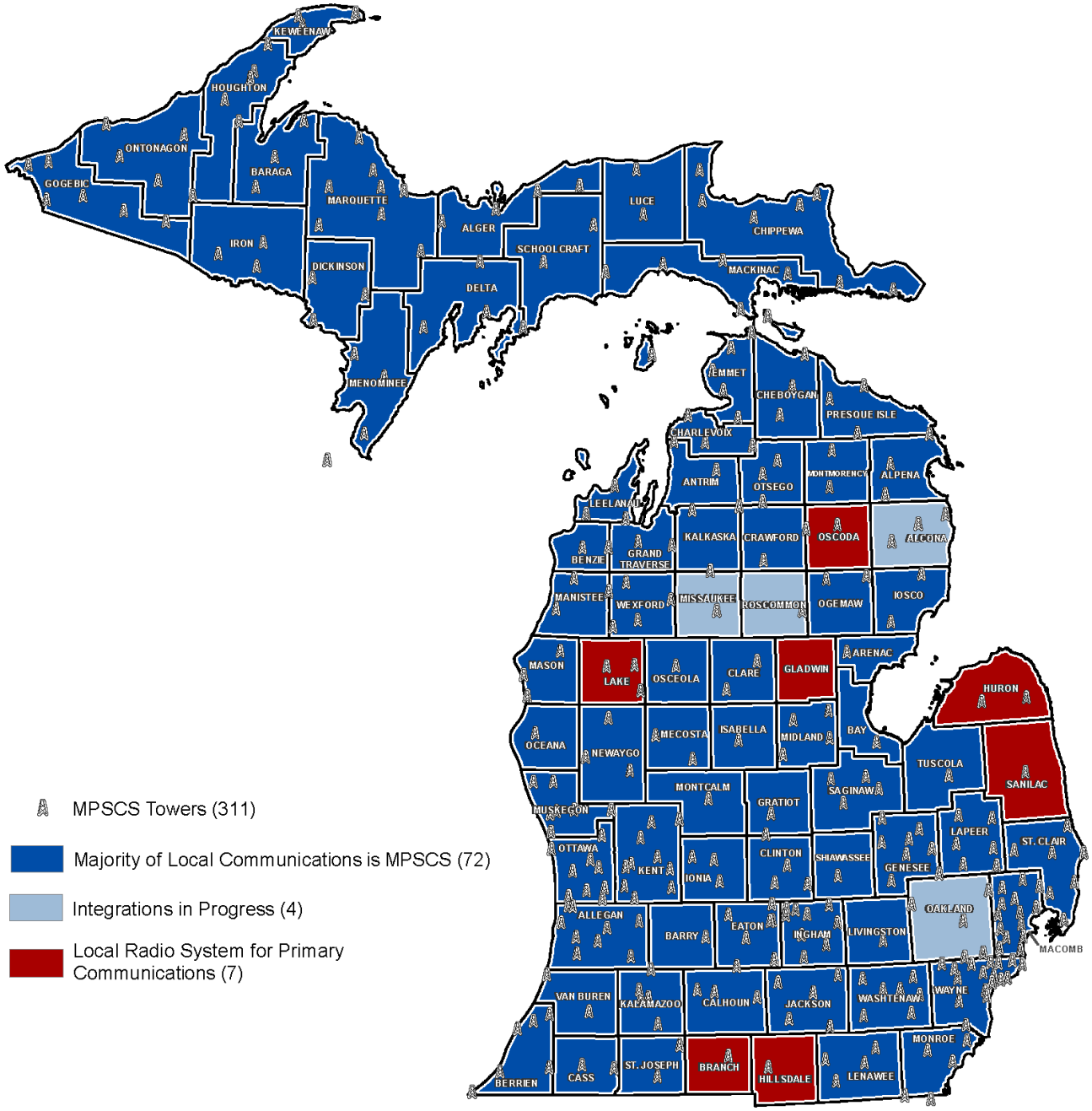
U.S. Army Engineer Research and Development Center (ERDC)

As part of the Army Corps of Engineers, the ERDC's mission is to provide scientific knowledge, technology, and expertise in engineering and environmental sciences to support the Armed Forces in their missions. ERDC laboratories collaborate to address research in five major areas, including water resources, and is leading a collaborative effort to address the legacy issues of PFAS contamination at military installations. ERDC has a featured service section specifically dealing with infrastructure-related issues, including programs to benefit sewer and water pipelines. such as the Concrete Technology Information Analysis Center (CTIAC), High-Performance Materials and Systems Selection, Materials Testing Center (MTC), and the Soil Mechanics Information Analysis Center (SMIAC).

Office of Michigan's Public Safety Communications System (MPSCS)

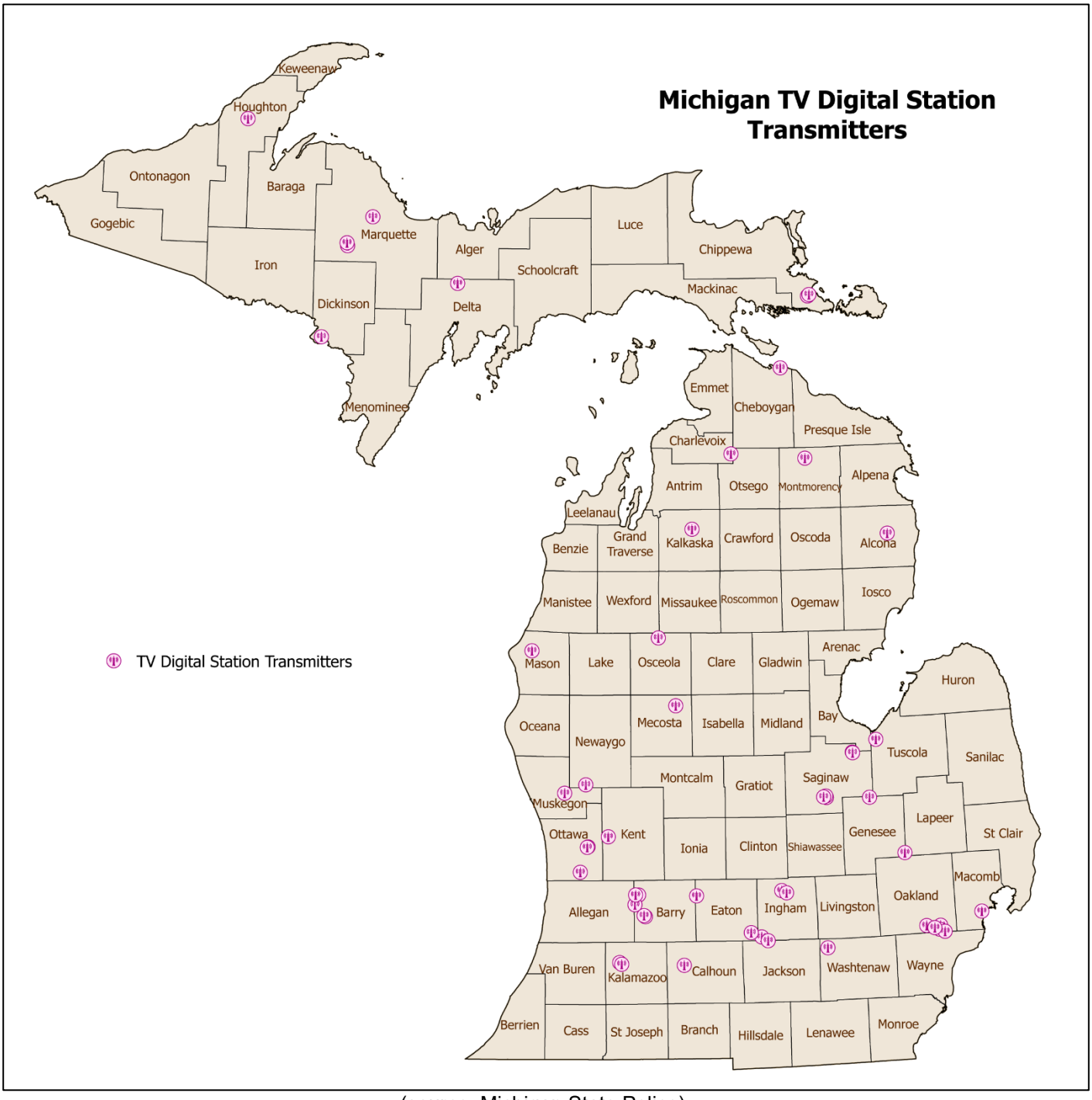
The MPSCS ensures a stable and secure framework of interoperable communications for all state, federal, tribal, and private first responders. A list of related policies and procedures is available on their website. A map of system towers is included at the end of this chapter.

Michigan's Public Safety Communications System

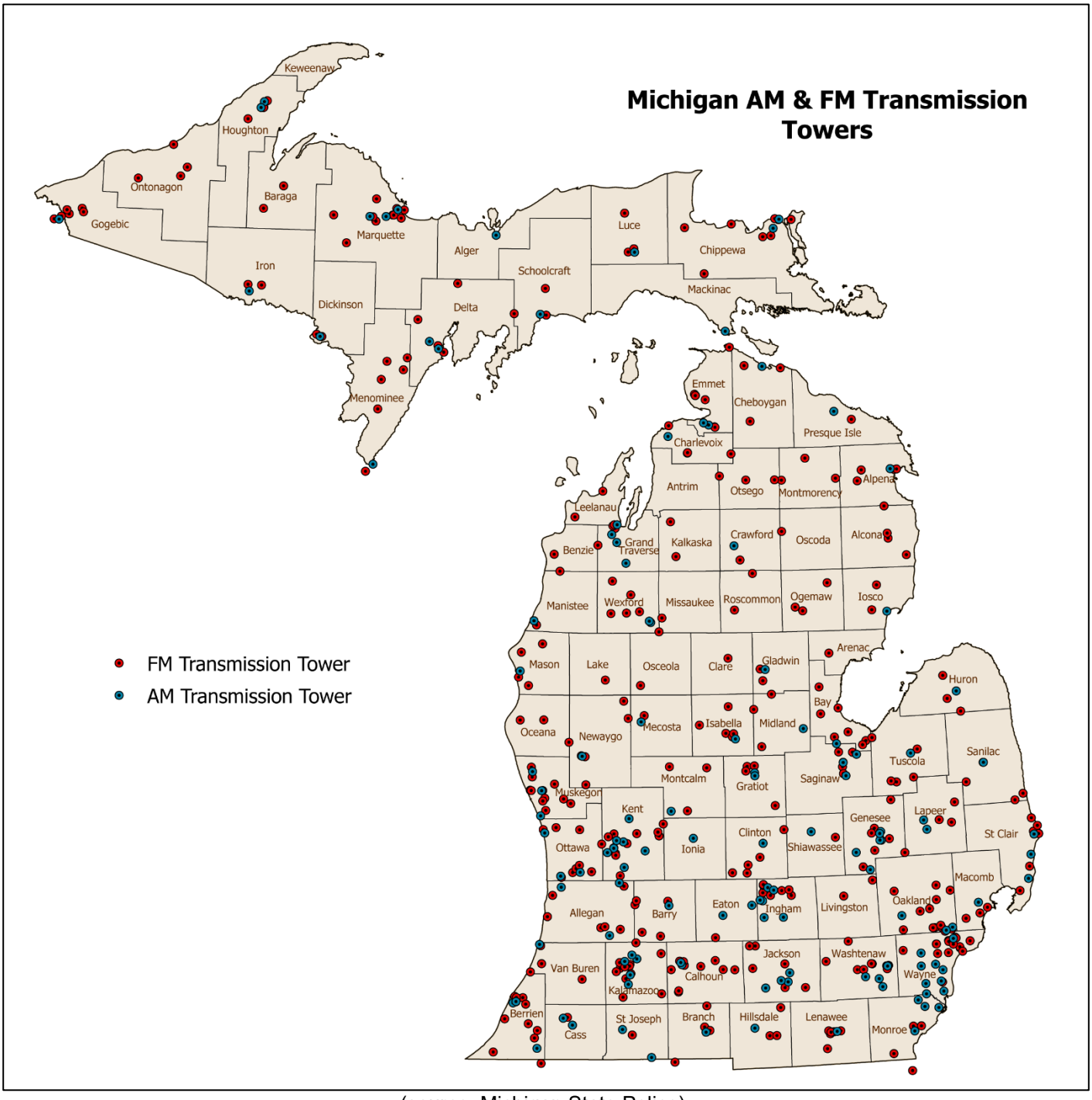


*State, federal, tribal, and private first responders utilize MPSCS communication in all 83 counties.

1/6/2023



(source: Michigan State Police)



(source: Michigan State Police)

MAJOR TRANSPORTATION INCIDENTS

A major crash or incident of air, land, or water-based vehicles, predominantly involving commercial passenger carriers. Other transportation related incidents may also create significant impacts and the need for large-scale response based on the number of vehicles involved, affected infrastructure, and other factors.

Hazard Description

This chapter primarily addresses *major* transportation incidents where large numbers of passengers are injured or killed at the site of a crash. This is especially true for events involving such commercial transportation (e.g., airliners, buses, passenger rail, ferries). More routine traffic "accidents" that tend to happen every day across the state, while still resulting in tragedy, typically only cause great public harm in they escalate to massive "chain reaction" type automobile events. Transportation incidents involving hazardous materials are covered under their own chapter.

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 cause multiple injuries and result in lengthy closures of major highways. Passenger rail, such as Amtrak, carry risk due in part to the greater number of people they carry. Light-rail systems, or Detroit's elevated track "People Mover," may also crash or derail.

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.

Hazard Analysis

One commonality that major transportation incidents share, whether on land, air, or water, is that they can quickly result in mass casualties with little warning. Commercial airline crashes can especially result in tremendous numbers of deaths due to high speeds and devastating ground impacts. Water transportation incidents, which bring with them the added specter of drowning, may kill many who would otherwise survive. Emergency personnel may be confronted with a number of tasks, including: 1) suppressing fires; 2) rescuing survivors and providing emergency first aid; 3) establishing mortuary facilities for mass-casualties; 4) detecting the presence of explosive, radioactive, or other hazardous materials; and 5) providing for crash site security, crowd and traffic control, and protection of evidence.

Air Transportation Incidents

Statistics show that most airline passenger crashes occur during the takeoff or landing phases of a flight. Outside of the airports themselves, adjacent developed areas are the most vulnerable to this hazard. A major focus for jurisdictions with such passenger air carriers is to develop procedures in partnership with the airport to handle a nearby mass casualty event.

A map at the end of this chapter shows the locations of Michigan's airports. The largest of such airports would tend to experience a higher probability for commercial passenger crashes due to the nature of their flights and overall traffic volume. Beyond the number of flights, additional factors such as location and runway layout may also impact the degree of risk for each individual airport. General aviation, freight, and military use airfields also exist and may be comingled with other airports. Military aircraft may carry large numbers of personnel or carry risks associated with aerial refueling and munitions.

While airport size, volume, and location are static risk factors in the short run, other crash influences are more variable and include pilot error, equipment malfunction, sabotage, and weather. The state's largest airport, Detroit Metropolitan Airport (DTW), is a large transportation hub with more than 1,100 flights per day. It was one of the airports analyzed by the National Weather Service (https://www.weather.gov/abq/avclimate_cover), which showed it as having visibilities less than one mile about 5 percent of the time in the winter. Visibilities are likely hampered in other areas of the state, due to frequent snow showers and lakeshore fog that comes with proximity to the Great Lakes. The accumulation of ice on

plane wings is a risk in Michigan, although also mitigated for with modern day deicing techniques. Generally higher wind speeds exist in the northern parts of the state, as do minor topographical undulations that may contribute to turbulence.

Most crashes involve smaller planes, sometimes resulting in only one fatality (that of the pilot). A full review of Michigan incidents involving these typically non-commercial, small propeller planes is beyond the scope of this document but depending on crash location, may still result in full emergency management activation. Helicopters are also sometimes used to conduct tours, provide medical evacuation, or transport between hospitals. Hot air balloons are not contemplated in this chapter, but local emergency managers should become aware of any associated festivals that may take place in their communities. An increased use of military, delivery, and even small passenger drones is a topic for future consideration in which skies become increasingly congested.

Higher fatality events with commercial airlines typically see deaths limited to passengers and crew. but impacts on highways or buildings can be a source of ground mortality. As shown in the following table, the worst crash in the United States inflicted mass casualties in this manner (the 9/11 Terrorist Attacks). A Michigan flight is also highlighted.

Top 10 Worst Aviation Disasters (United States)

Fatalities	Date	Location	Carrier	Type
2907*	9/11/2001	New York, New York	American / United Airlines	B767 / B767
273	5/25/1979	Chicago, Illinois	American Airlines	B747
265	11/12/2001	Belle Harbor, Queens, New York	American Airlines	A300
230	7/17/1996	off of East Moriches, New York	Trans World Airlines	B747
217	10/31/1999	off of Nantucket, Massachusetts	Egypt Air	B767
189	9/11/2001	Arlington, Virginia	American Airlines	B757
156	**8/16/1987**	**Romulus, Michigan**	**Northwest Airlines**	**MD82**
153	7/09/1982	Kenner, Louisiana	Pan American World	B727
144	9/25/1978	San Diego, California	Pacific Southwest / Private	B727 / C172
135	8/02/1985	Fort Worth-Dallas, Texas	Delta Air Lines	L1011

Fatality estimate includes passengers, crew, and those killed in the buildings and on the ground.
*Two separate planes hit the World Trade Center. (source: planecrashinfo.com)

Terrorism is covered in its own chapter. It bears noting, however, that great tragedy was averted in 2009 at Detroit Metro Airport with the failure of the so-called “underwear bomber” on Northwest Airlines Flight 253.

Land Transportation Incidents

The Michigan Department of Transportation (MDOT) has seven Region Offices, each of which have several smaller Transportation Service Centers with their own Traffic & Safety Engineer. Local planners seeking more information or wanting to sign up for traffic notifications can visit their website.

Most statewide crash statistics are not germane to this analysis and are largely a function of route location, population centers, and vehicles miles traveled. The Michigan Traffic Crash Facts website contains a wealth of information in this area. The 2018 fatality rate of 0.95 deaths per 100 million miles traveled is a decrease from the 2017 fatality rate of 1.01. It is also lower than the 10-year average of 0.97 (2009–2018). Some Michigan speed limits tend to be higher than other states, although most traffic engineers believe that artificially lowered speed limits, as a rule, are not safer and may actually be counterproductive. Many other competing factors (e.g., weather, deer population, alcohol) play a role in crash frequency and severity, but statistically the largest number of fatalities occur July through September. As a reflection of crash-related fatalities per 100 Million Vehicle Miles Traveled (VMT), Michigan ranks slightly below the national average and roughly on par with most neighboring states.

Fatalities per 100 Million VMT 2009-2018

YEAR	U.S. (NSC*)	U.S. (NHTSA**)	MICHIGAN	OHIO	INDIANA	ILLINOIS	WISCONSIN	MINNESOTA
2009	1.2	1.2	0.9	0.9	1.0	0.9	0.9	0.7
2010	1.2	1.1	1.0	1.0	1.0	0.9	0.9	0.7
2011	1.2	1.1	0.9	0.9	1.0	0.9	1.0	0.6
2012	1.2	1.1	1.0	1.0	1.0	0.9	1.0	0.7
2013	1.2	1.1	1.0	0.9	1.0	0.9	0.9	0.7
2014	1.2	1.1	0.9	0.9	0.9	0.9	0.8	0.6
2015	1.2	1.1	1.0	0.9	1.0	0.8	0.9	0.7
2016	1.2	1.2	1.1	1.0	1.0	1.0	0.9	0.7
2017	1.3	1.2	1.0	1.0	1.1	1.0	0.9	0.6
2018	1.2	1.1	1.0	0.9	-	1.0	-	0.6

(source: Michigan State Police)

Crashes typically involve the hitting of vehicles or stationary objects. Incidents involving pedestrians can also result in high casualties under unusual circumstances, such as a terrorist ramming a 5K race or a drunk driver hitting a dense grouping of bicyclists.

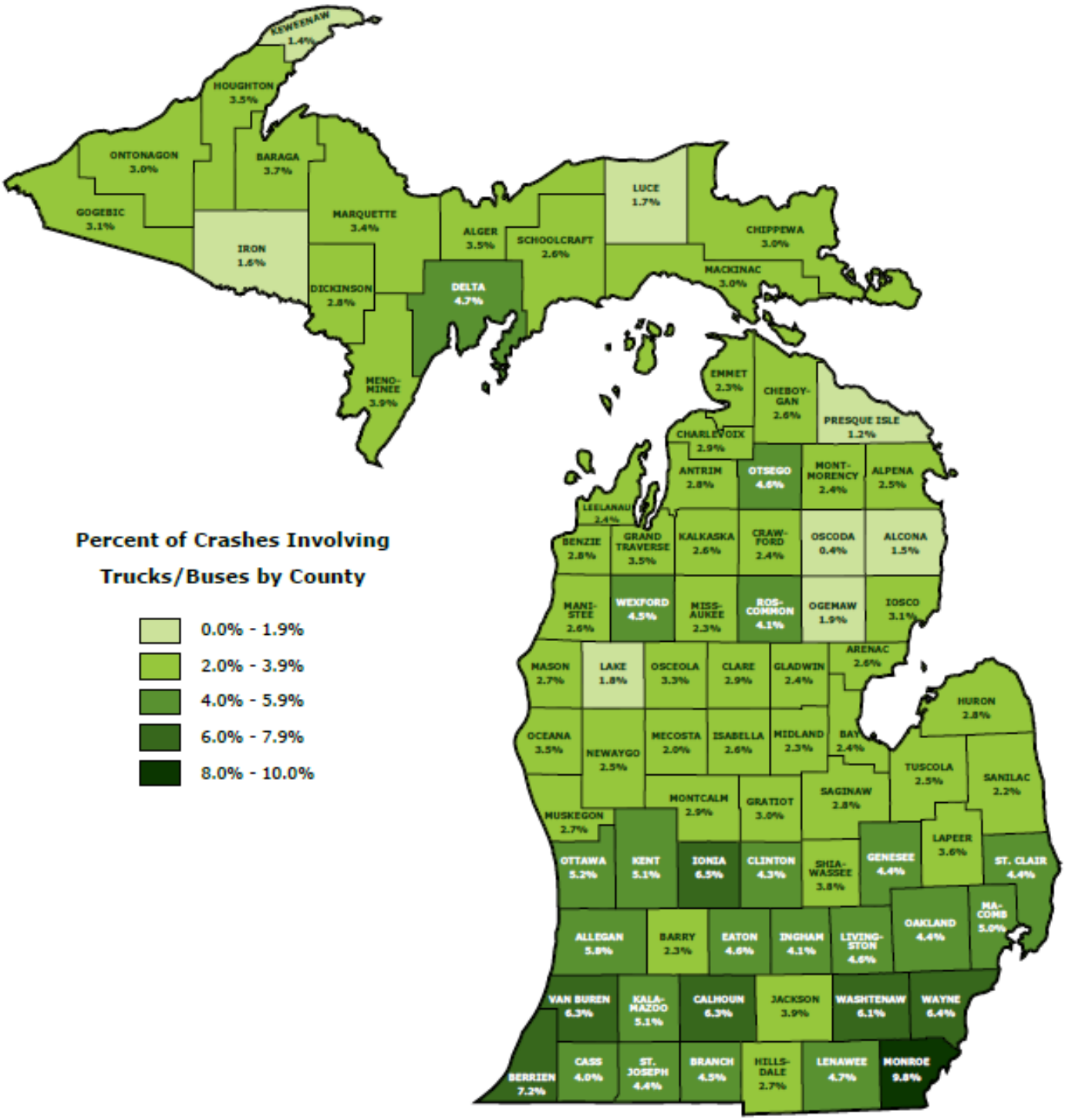
The remainder of this crash analysis will focus on incidents involving heavy vehicles like commercial trucks and buses. In addition to their ability to carry more passengers, these vehicles have a greater ability to block roads and create gridlock on highways. Because of their ability to "jack knife," semi-trailers are often associated with these types of incidents. The length of time a highway may be shutdown will vary based on many factors, just as multiple factors will also impact the success of any subsequent rerouting efforts. The location of the incident itself may play a major role, especially if it is at a bottleneck. Incidents on bridges can be especially problematic if they are one of the limited options available to traverse a body of water. Planners will want to look for such bottleneck areas in their communities and examine other challenging road segments that include tunnels, hilly areas, or tight corners. Although not a focus for this chapter, hazardous materials may cause or exacerbate gridlock events. As an example, a July 2010 city of Flint tanker incident and fire caused I-475 to be closed down for many hours in both directions.

School bus safety is an important hazard consideration because of the young age of passengers. A mix of commercial and governmental bus services also provide intercity passenger, charter, commuter, and shuttle operations. These may be direct services or used to augment rail or airline transportation. While not meant to be exhaustive, emergency managers should examine the routes of major intercity carriers, such as Dean Trailways, Greyhound, Indian Trails, and Miller Transportation. A map showing major intercity bus terminals is available at the end of this chapter. Many organizations, such as sports teams and churches, operate private buses.

Looking at aggregated data for buses and similar vehicles for Michigan's public transit agencies, 2017 saw 81,634,059 total passengers, with 242 injuries and three fatalities. In 2018 there were 81,040,924 total passengers, with 194 injuries and two fatalities. Data from 2019 is not yet available. Trends were difficult to assess given the low numbers, but there did not appear to be much variation beyond increased incidents in more populous areas.

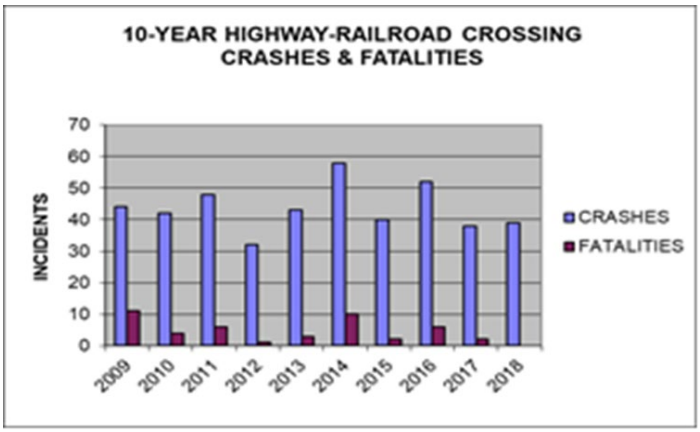
Heavy truck/bus crashes differ from overall vehicle crashes in a number of ways, mainly reflecting passenger use, cargo considerations, and vehicle size (defined here as a Gross Vehicle Weight Rating of over 10,000 lbs.). As compared to all incidents, these large vehicle crashes occur more often between the hours of 6:00 a.m. and 2:59 a.m., with fewer crashes between 3:00 p.m. and 5:59 a.m. Their incidence is also higher Monday through Friday. Roughly 15,000 such crashes occurred in 2018, led by Wayne County with 3,468. Some areas had more crashes than might otherwise be expected. For example, the following map highlights the percent of crashes that involved buses and heavy trucks for each county. While Monroe County led the pack at 9.8 percent of all its crashes involving a heavy truck or bus, it still had only 365 such crashes overall. As is frequently the case, it can take several layers of data for emergency managers to get a complete understanding of the hazards in their area.

Heavy Truck / Bus-Involved Crashes (2018)



(source: Michigan State Police)

Turning to rail transportation, it is important to note that major train collisions, where two separate trains impact each other head-on, are very rare in the United States. Most fatal crashes occur instead between trains and vehicles at railroad crossings. The data on such incidents remains relatively flat for the state, with roughly 40 crashes occurring every year. By way of national comparison, this is not an alarming number, but communities with active rail corridors should be prepared for such events. For the purposes of this chart, a "highway" railroad crossing is defined as *any* public road that crosses a railroad track at-grade (as opposed to overpasses) and is not limited to only major state or federal roads. Crossings may also occur on private roads, long driveways, and across agricultural fields.



(Michigan data. Source: MDOT)

Casualties may be the highest when passenger trains are involved. Michigan does not yet have "true" high-speed rail service, although the feasibility of greater speeds is continually being assessed. Chicago is a major station for Amtrak's passenger service, and its trains currently travel as high as 110 mph from New Buffalo (where it enters the state) to Kalamazoo. It is widely anticipated this speed will also be achieved from Kalamazoo to Battle Creek sometime in 2021. Depending on location and track ownership, speed in other areas generally averages between 60–79 mph. Derailments in high urban areas may impact nearby buildings and pedestrians. Semi-trucks and farm equipment have the potential for the most destruction, but even intentional events involving suicide may occur.

Amtrak uses incident data and computer simulations designed to analyze significant rapid deceleration scenarios (as would be seen with a train to highway vehicle crash). The likelihood of significant injury for *rail passengers* is generally low. However, any strong collision between a train and an occupied vehicle has a high potential for serious road passenger fatalities. The Michigan Office of Rail is a source for additional information, as is the Federal Railroad Administration's Office of Safety Analysis. A map of the state's intercity passenger rail system appears at the end of this chapter. With miles of unguarded track, the efforts of terrorists should also be considered.

Water Transportation Incidents

The St. Lawrence Seaway and the Great Lakes form a maritime transportation system extending more than 2,000 miles from the Gulf of St. Lawrence on the Atlantic Ocean to the western end of Lake Superior. Michigan has roughly 3,200 miles of shoreline and more than 100 ports serving commercial and recreational navigation. A map highlighting ferry service is available at the end of this chapter.

The Great Lakes are prone to sudden and severe storms, especially from late October to early December, and hundreds of ships have sunk over time. While the vast majority of these incidents are so long ago that their "sail and mast" history is largely no longer relevant, certain high-risk areas may present challenges even today. The greatest concentration of historic shipwrecks lies near Thunder Bay, on Lake Huron near the point where eastbound and westbound shipping lanes converge. The vicinity of Whitefish Point became known as the "Graveyard of the Great Lakes" because more vessels have been lost there than in any other part of Lake Superior. Neither of Michigan's two largest passenger ferries operate in these areas, but instead travel to Wisconsin (whose waters are not part of this analysis).

Nonetheless, the possibility of a commercial passenger incident needs to be considered given what has occurred elsewhere. For example, the sinking of the ferry MV Sewol in South Korea (2014) resulted in over 300 fatalities. If such an incident were to occur in Michigan, the often-turbulent Great Lakes could present tremendous obstacles in carrying out water rescue and recovery operations. Hypothermia is of great concern even during the summer. The U.S. Coast Guard, local law enforcement marine safety units, and the ferry operator would provide primary rescue response to a Great Lakes passenger ferry incident. These agencies are highly trained and skilled in water rescue operations, but their resources may become severely stretched based on the nature of these dangerous incidents.

Other similar hazards exist with inland lake areas, especially where trained responders may not be operating on standby and risks are not typical. For example, several lakes and rivers operate "old time" ferry paddleboats used for dinner theatre, weddings, and other purposes. These may carry well over a hundred people at a time. The Genesee Belle paddleboat "sank" in Lake Mott during the mid-1990s but was in extraordinarily shallow water and bottomed out with no major injuries. In other lakes, large number of pontoon boats may ties themselves together and create "virtual islands,"

which create dense pockets of people that would have trouble moving in the case of unforeseen inclement weather, a sister boat catching fire, or the flotilla being rammed by a jet boat. Alcohol usage, young families, and other factors may further complicate such an incident.

Regardless of the mode of transportation, the National Transportation Safety Board offers useful data summarizing national fatality data by detailed category. A summary sheet for 2018 is provided at the end of this chapter.

Specific Impacts

Impact on the Public, Property, Facilities, and Infrastructure
In terms of the greatest potential for per-incident loss of life, airline crashes present the largest threat, with ability to create mass casualties from both passengers and those on the ground. Facilities can be destroyed at or near the point of impact, potentially damaging infrastructure or knocking out power to an area. Major highway incidents involving passenger buses or multiple cars may block roadways or bridges for significant periods of time. Passenger rail has the potential for mass casualties, although a lack of true high-speed rail in Michigan somewhat lessens this hazard for passengers. It is worth noting that most rail incidents occur at road crossings, where cars are much more vulnerable.

Impact on the Economic Condition of the State
The economic impact of any one incident for the state is likely to be small for most transportation incidents. The location of an incident would be a determining factor, with, for example, a plane crash in the middle of the city of Grand Rapids being more financially disruptive than the same plane crashing in the Great Lakes. Destroyed roads or bridges along major trade routes would carry a greater impact. Commercial passenger crashes of any kind may result in a temporary reduction in tourism.

Impact on Public Confidence in State Governance
There may be a sense that improper regulation, authorization, or oversight was maintained by the state following a major transportation incident, particularly when weather was not involved.

Impact on Responders
The impact on responders will vary significantly based on the nature of the incident. Highway events are usually limited to risks of being in and around moving traffic streams. A bridge or tunnel collapse, or huge interstate pileup involving dozens of vehicles, may create challenges in terms of getting to the incident. In the case of large plane crashes or train derailments, responders may be exposed to fires and hazardous materials, although this may also occur on the highway or even with ferries. With marine passenger incidents, special rescue operations may occur under dangerous water conditions, with a time-sensitive effort to rescue persons stranded in cold water. Responders will be exposed to the elements, including extreme temperatures, rain, winds, or lightning for extended periods of time for any of these events.

Impact on the Environment
Transportation events on land, air, or water may impact the environment if toxins or chemicals are released. The burning of petroleum, in an incident that involves an explosion, will quickly release sulfur dioxide, oxidized nitrates, and carbon monoxide into the air. An aircraft crash will result in a debris field and contamination. Incidents on the Great Lakes may also cause hazardous releases to occur that can quickly spread (see the hazardous materials chapters).

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.

Significant Transportation Incidents

The following examples are presented for educational purposes and are not meant to be comprehensive. Such incidents occurred more frequently in the past before the advent of modern safety considerations and technology. Multi-car “pile ups” that can shut down highways are numerous enough that only a select few are provided for illustrative purposes.

October 28, 1942 – Hamtramck (Wayne County) – School Bus and Passenger Train Collision
A major transportation incident occurred in the morning when a school bus collided with a passenger train. The incident resulted in 16 fatalities and 27 injuries, and of the total of 45 bus passengers, only three were not injured. The driver of the bus claimed he did not see the approaching train because of an overcrowded doorway blocking clear visibility. The majority of the fatalities occurred near the back of the bus, and many of them were children headed for school.

September 17, 1949 – Lake Ontario – Passenger Ship Fire
The SS Noronic was one of the largest passenger ships to have sailed the Great Lakes at the time. Its last voyage originated in Detroit, where it embarked and then took on more passengers in Cleveland as it traversed Lake Ontario.

The ship docked in Toronto and later became engulfed in flames in the middle of the night. The fire originated in a locked linen closet but quickly spread to the rest of the ship, reportedly accelerated due to the wood polish oils placed on its walls. At least 118 people were killed. The high death rate was attributed to many factors, including most passengers being asleep at the time of the fire, the stairwells rapidly catching fire, and a defective fire control system with largely inoperable hoses.

Most died due to burns or suffocation, with some being trampled and others falling to their death as they attempted to jump from the ship to the dock. Out of all fatalities, only one was attributed to drowning, as most were trapped below deck. Of the four passenger levels, none had direct gangplank access to the dock. The only exits were located on the lowest deck. Only two gangplanks were operational at a time of the fire.

January 14, 1950 – Gaylord (Otsego County) – Passenger Bus Incident
A collision during a snowstorm killed five persons and injured several others when a chartered bus carrying Michigan Tech hockey players from East Lansing to Houghton crashed head-on with a Greyhound bus as they drove through an "S" curve. Both buses had bad damage, with the sides of each ripped open and some passengers thrown. All available ambulances, area Michigan State Police cars, and neighboring first responders were rushed to the scene.

August 19, 1951 – Alpena (Alpena County) – Passenger Bus Incident
A Greyhound bus, filled with 40 vacationers bound from Mackinac City to Detroit, crashed head-on with a large beer truck in the outskirts of Alpena on highway US-23. The crash resulted in 10 fatalities and 27 injuries, and many of the bodies were so mangled that identifications proved difficult.

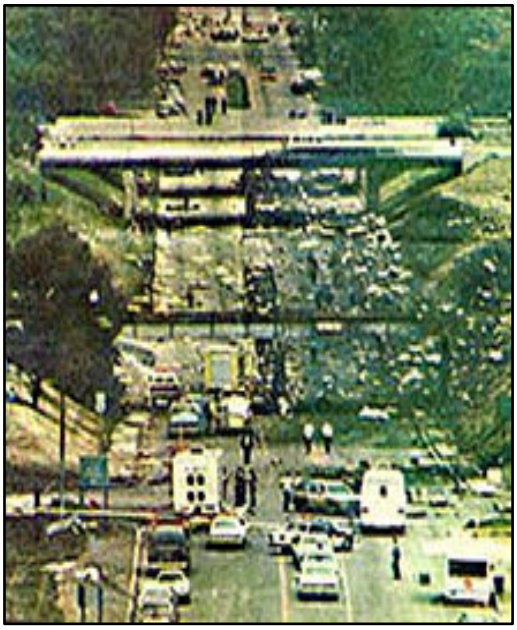
Easter Sunday, 1958 – Saginaw (Saginaw County) – Passenger Airplane Crash
Prior to the August 1987 crash of Northwest Airlines Flight 255, Michigan's worst commercial passenger airplane crash occurred on Easter Sunday 1958, at Saginaw Tri-City International Airport. In that incident, which resulted in 47 fatalities, ice had built up on the plane's directional systems and the pilot was unable to reach the runway on the landing approach.

November 10, 1975 – Lake Superior – Large Ship Sinking
The SS Edmund Fitzgerald was not a commercial passenger ship, but the notoriety of its sinking bears a mention here. The tragic loss of life of all 29 crew members is also significant. A large carrier of iron ore, she was en route to a steel mill near Detroit alongside another ship when they became caught in a severe winter storm with near hurricane force winds and waves up to 35 feet high. While the ship reported significant weather impacts, no distress signals were sent before the ship sank. No exact cause of sinking has been determined, and the captain's last message was reported at being "we are holding our own." Theories include structural failure, "rogue waves," cargo hold flooding, and reef-raking. Increased ship inspections took place in the aftermath of the disaster.

September 1976 – Alpena (Alpena County) – Military Airplane Crash
A military airplane tanker on a routine training mission crashed in a densely wooded swampy area. The violent crash had an explosion described as a large ball of fire, followed by several more explosions which pulverized the plane into hundreds of pieces ranging from mere inches to ten feet in length. The incident resulted in 15 fatalities with five survivors.

March 4, 1987 – Detroit (Wayne County) – Passenger Airplane Crash
A plane bound from Cleveland to Detroit crashed and skidded into three ground vehicles and caught fire. The cause of the incident was the captain's inability to control the airplane while descending on the final approach for landing. Nine of the 22 passengers died from a post-crash fire, lack of fire-blocking material, and poorly designed aircraft components.

August 16, 1987 – Romulus (Wayne County) – Passenger Airplane Crash
Michigan's worst commercial passenger airplane crash, and the seventh worst in U.S. aviation history, occurred in 1987 at Detroit Metropolitan Airport. The pilots of Northwest Airlines Flight 255 were considered to be experienced pilots but forgot to conduct their pre-flight checks to ensure the plane's flaps were extended. They had also been assigned to a short runway. As the plane accelerated for takeoff it lifted only 40 feet off the ground. Without sufficient altitude but still at high velocity it crashed into nearby I-94, impacting seven times as it skidded across the highway and crashed into a rail overpass. Killed were 156 passengers and crew, with a small child who suffered serious injuries as the lone survivor. A large debris field was created in its wake, with two people in an automobile also killed.



The National Transportation Safety Board determines that the probable cause of the accident was the flight crew's failure to use the taxi checklist to ensure that the flaps and slats were extended for takeoff. Contributing to the accident was the absence of electrical power to the airplane takeoff warning system that did not warn the crew that the airplane was not configured properly for takeoff. The reason for the absence of electrical power could not be determined. A Governor's Disaster Declaration was granted to the city of Romulus and numerous state resources were mobilized to assist in the recovery.

December 3, 1990 – Romulus (Wayne County) – Passenger Airplane Collision
An example of an airliner ground collision occurred when two Northwest Airlines aircraft (Flight 1482 and Flight 299) collided with one another in heavy fog on a runway at Detroit Metropolitan Airport. Flight 1482 accidentally entered an active runway as Flight 299 was cleared for takeoff. The accelerating plane's wing hit the right-hand side of Flight 1482, cutting through the fuselage just below the windows, then continued aft, finally cutting off the DC-9's engine. The impacted plane caught fire and was destroyed. Eight persons died and 21 were injured. The NTSB cited pilot error and inadequate training, tower communication error, poor surface markings, and a faulty escape exit.

March 10, 1993 – Comstock (Kalamazoo County) – Passenger Train Incident
An Amtrak passenger train with 45 passengers collided with a liquid propane tanker truck in Comstock Township, killing the driver of the truck and injuring the train's engineer. The truck had been exiting a private drive when it slid into the path of the train, which was traveling at approximately 62 miles per hour. Upon impact, the liquid propane tank exploded with a large fireball. The train engine received considerable damage from the impact and explosion. The windows were blown out, causing the train engineer to receive second degree burns from the fireball. One passenger was transported to a nearby hospital for treatment.

January 9, 1997 – Monroe County – Passenger Airplane Crash
Comair Flight 3272, a commuter jet from Cincinnati, Ohio, bound for Detroit Metropolitan Airport, crashed on final approach in Monroe County, killing its 26 passengers and three crew. The plane was flying at approximately 4,000 feet on its approach when it suddenly and inexplicably did a barrel roll and nose dived, striking the ground 17 seconds later. The cause of the crash was determined by the National Transportation Safety Board to be failure to adequately manage ice buildup on the wings.

July 9, 1999 – Harrison (Clare County) – Passenger Bus Incident
A tour bus filled with international exchange students slid off of rain-slicked highway US 27 near Harrison, injuring 40 passengers. Most of the injured were treated and released at a nearby hospital. One passenger was hospitalized overnight with an eye injury.

July 31, 1999 – Marine City (St. Clair County) – Passenger Airplane Crash
A commercial skydiving plane crashed shortly after its takeoff from Marine City Airport, killing all 10 persons aboard. The plane was carrying its pilot and nine skydivers who were about to make an early morning jump. The plane cleared a 90-foot power line on takeoff, then sharply veered left before crashing and exploding in a hay field adjacent to the end of the runway. The National Transportation Safety Board determined that pilot error as the probable cause.

September 14, 2000 – Wixom (Oakland County) – School Bus Incident
A Northville High School bus carrying 34 football players, 14 cheerleaders, and several coaches collided with an automobile. The car's driver was killed, and the car's passenger was injured. Ten bus passengers suffered injuries.

October 16, 2000 – St. Clair County – Passenger Bus Incident
A semi-trailer smashed into the rear of a charter bus on I-94, injuring 44 senior citizens (three critically).

December 17, 2000 – Battle Creek (Calhoun County) – Passenger Train Incident
An Amtrak passenger train with 161 passengers partially derailed near a train station, forcing the closure tracks in both directions for an extended period. The train, composed of a locomotive and five coach cars, was traveling at a low rate of speed when the locomotive and first coach car ran off the tracks a half mile away from station. The entire train remained upright, and the derailed cars were lifted by crane back onto the track. No injuries were reported.

October 10, 2002 – Monroe County – School Bus Incident
A school bus on a field trip, carrying 43 children and 17 adults, pulled in front of a steel-hauling truck, causing a major collision. Almost all of the passengers were sent to a nearby hospital, five in critical condition.

August 15, 2006 – Kincheloe (Chippewa County) – Passenger Airplane Crash
A plane crash occurred outside the Chippewa Correctional Facility, resulting in four fatalities. Federal officials say that pilot error caused the twin-engine plane to crash. This incident is more significant than many similar small airplane crashes due to the fact that it had hit the outer perimeter fence of the Chippewa Correctional Facility.

June 4, 2007 – Lake Michigan – Passenger Airplane Crash
A plane carrying a team of surgeons and technicians from Milwaukee to Ann Arbor crashed into Lake Michigan. All passengers died, including two surgeons and two technicians due to prepare an organ for transplant surgery at a hospital in Ann Arbor. The National Transportation Safety Board indicated the pilots had reported severe difficulty steering the plane due to trouble with its bank and pitch system.

October 9, 2008 – Washtenaw County – Passenger Bus Incident
An incident on highway US-23 occurred when a tractor-trailer crashed into an overloaded bus carrying members of an Amish church, leaving 14 of the 21 total passengers, including a number of children, needing medical care. Six passengers from the bus, that had tipped over on its side, were hospitalized in serious condition.

March 1, 2010 – Detroit (Wayne County) – Passenger Train Incident
A Chicago-bound Amtrak train with 76 people aboard struck a Detroit fire truck that had stopped on the tracks in southwest Detroit. The fire truck was responding to a previous crash involving a car and a semi-truck. Several passengers sought treatment for minor injuries and whiplash. There was $600,000 damage to the ladder truck.

February 1, 2012 – Leoni Township (Jackson County) – Passenger Train Derailments
October 21, 2012 – Niles (Berrien County)
An Amtrak train collided with the trailer of a semi-truck stuck on the tracks. The 68-passenger train saw its engine flipped on its side and a dining and passenger car derailed. None of the injuries were life-threatening, and included 11 passengers, four Amtrak employees, and the truck driver. Rail service was restored in less than 48 hours, with total damage of roughly $2.3 million.

In a separate incident, an Amtrak train derailed near Niles. Of the 174 passengers and four crew members, a dozen people were taken to a hospital with only minor injuries. Equipment error was to blame. The train had a proper green signal, allowing it to proceed at maximum speed as it traveled the 110 mph, high-speed corridor. A switch leading off the main track just beyond the signal was reversed, directing the train into a rail yard instead of the main track.

January 31, 2013 – Detroit (Wayne County) – Shut Down Highway Pursuant to Jackknife
A 30-vehicle incident occurred on southbound I-75, resulting in three deaths and more than a dozen injuries. Blinding snow, strong winds, and slick road conditions had made driving hazardous. The involved vehicles included multiple semi-trucks, as well as numerous passenger vehicles.

August 1, 2013 – Kalamazoo County – Passenger Bus Incident
A semi-truck collided with a Greyhound bus that was carrying 48 passengers on westbound I-94. A total of 22 persons were injured, including one front-seat passenger (serious condition) and the driver (also hospitalized). Most other injuries were minor.

February 21, 2014 – Isabella County – Shut Down Highway Pursuant to Jackknife
Because of winter storm whiteout conditions, a jackknifed semi-truck and multiple vehicle incidents caused U.S. Highway 127 to close in both directions, from the Gratiot/Isabella county line to the interchanges south of Mt. Pleasant.

June 7, 2016 – Kalamazoo County – Major Bicyclist Incident
Five bicyclists were killed, and four others were seriously injured, when their cycling club group was struck by a pickup truck. The driver was charged for operating a motor vehicle while impaired, and with five counts of second-degree murder. He had purportedly ingested pain pills and muscle relaxants prior to rear ending the bicyclists.

March 27, 2020 – Detroit (Wayne County) – Pedestrian Bridge Collisions
A large truck with a high load collided with a pedestrian bridge at 5:00 a.m., sending a portion of the span onto the freeway and temporarily closing traffic in both directions along a heavily traveled thoroughfare. The remaining portion of the bridge was demolished and removed at a cost of roughly $86,000. Unlike a similar 2014 incident, no one was injured in the collapse. In that incident, a different pedestrian bridge was torn down by a trash truck. That truck driver died, and two other vehicles were struck by debris when that bridge fell onto the Southfield Freeway. No pedestrians were on the bridges at the time.

Select Laws, Agencies, or Programs

National Transportation Safety Board (NTSB)
The NTSB is an independent federal agency responsible for promoting aviation, highway, railroad, marine, and hazardous materials transportation safety. It is mandated to investigate significant transportation events, determine their probable cause, issue safety recommendations, and evaluate the effectiveness of government agencies involved in transportation. The NTSB makes public its actions and decisions through incident reports, safety studies, special investigation reports, safety recommendations, and statistical reviews.

Although the NTSB has no regulatory or enforcement powers, it has nonetheless been successful in seeing the adoption and implementation of the majority of its recommendations. A past example of an implemented recommendation was the agreement between the Federal Aviation Administration (FAA) and the Boeing Aircraft Company to redesign and replace the rudder system for their entire fleet of 737 jetliners. The retrofit program cost Boeing nearly one-quarter of a billion dollars. The rudder system had come under the scrutiny of the NTSB after crashes of 737s in 1991 and 1994 resulted in over 150 fatalities.

State Commercial Vehicle Enforcement Division (CVED)
MSP's CVED is responsible for conducting road patrol activities focused on commercial vehicle enforcement and the operation of 14 scale facilities. Officers at these locations monitor vehicles for compliance with size and weight requirements, perform driver/vehicle safety inspections, verify driver's credentials, enforce regulatory violations, hours-of-service requirements, and promote homeland security. Every year it also publishes the Michigan School Bus Inspection Report. The buses are inspected on a cycle beginning each September and ending each August.

Farmer's Transportation Guidebook
Michigan Farm Bureau, in partnership with the MSP, publishes the Michigan Farmer's Transportation Guidebook to keep farmers apprised of laws and regulations pertaining to transportation and road safety. Topics include driver standards, vehicle standards, motor carrier standards, traffic regulations, and federal hazardous materials regulations.

State Air Transportation Regulation
MDOT's Michigan Aeronautics Commission administers several programs aimed at improving aviation safety and promoting airport development. The Commission's safety programs include: (1) registering aircraft dealers, aircraft, and engine manufacturers, (2) licensing airports and flight schools, (3) inspecting surfaces and markings on airport runways, and (4) assisting in the removal of airspace hazards at airports. The Commission's airport development program includes the provision of state funds for airport development and airport capital improvements, contributing to upkeep and safety. The FAA contracts with MDOT for the inspection of the state's public-use airports on an annual basis. The FAA has regulatory jurisdiction over operational safety and aircraft worthiness.

Airport Zoning Act of 1950

Plane crash concerns are analyzed by airports or local planners in accordance with the Airport Zoning Act of 1950. A copy of the law is available on the MDOT Office of Aeronautics website, as well as its Airport Zoning Handbook, Michigan Zoning Enabling Act, and Michigan Airport Directory.

Michigan Operation Lifesaver (MOL)

The MOL is part of a non-profit education and awareness program dedicated to ending tragic collisions, fatalities, and injuries at highway-rail at-grade crossings and on railroad rights of way. The coalition is spearheaded by the MSP and MDOT and is composed of state and local government officials, law enforcement, and other industry stakeholders. Any improvements to reduce vehicle-train crashes at railroad crossings lessens the likelihood of a major passenger transportation incident involving buses and trucks. Its website contains several railroad safety related links of interest.

U.S. Coast Guard (USCG) District 9

The USCG enforces many commercial and recreational maritime laws and is a source for useful information related to boating safety. The USCG presence in Michigan waters, as part of District 9 and the Atlantic Command Center, is divided between three sectors: Sector Lake Michigan (yellow), Sector Detroit (red), and Sector Sault Sainte Marie (blue).

USCG Sector Map

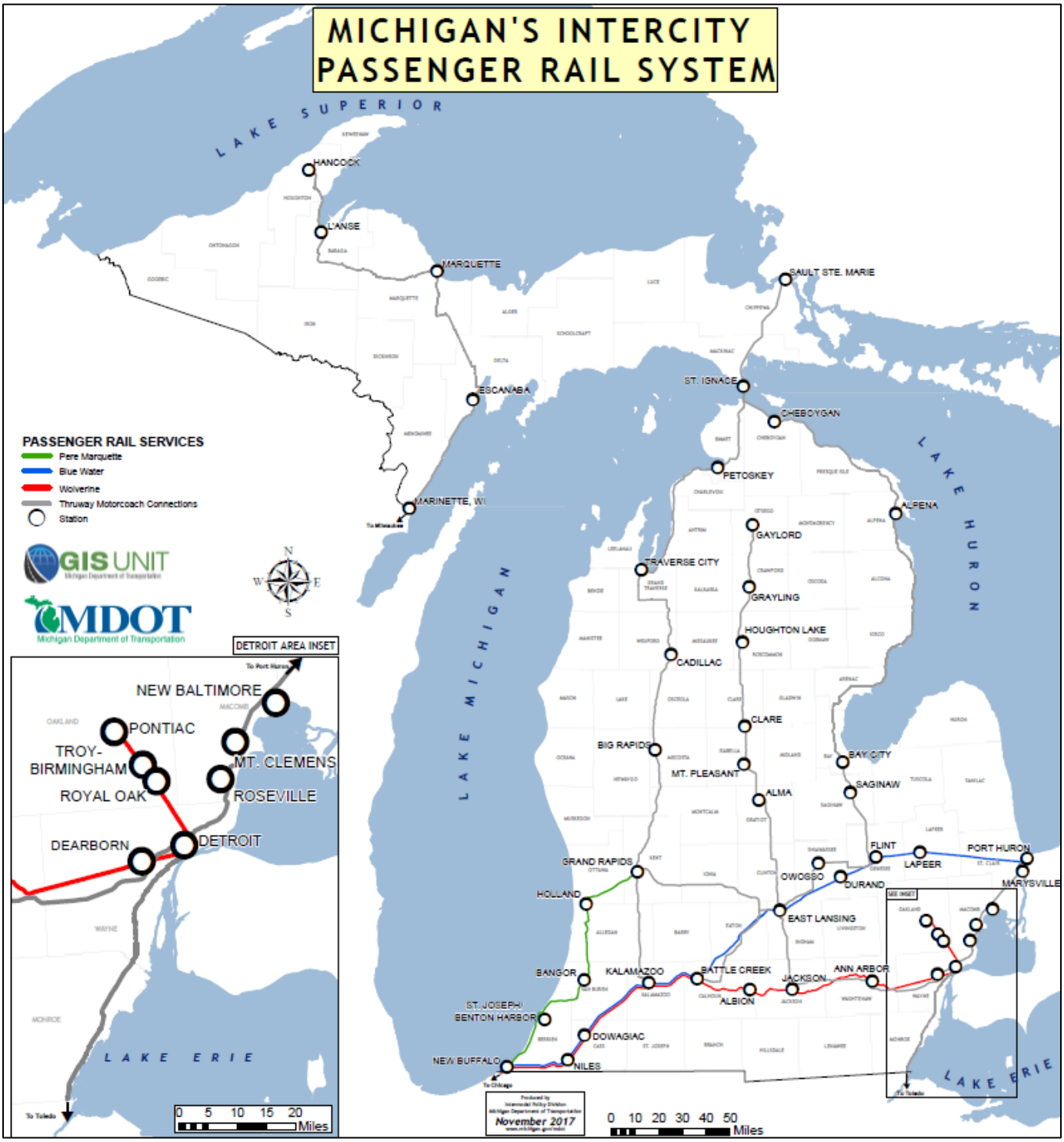
USCG Great Lakes Stations

(source: United States Coast Guard)

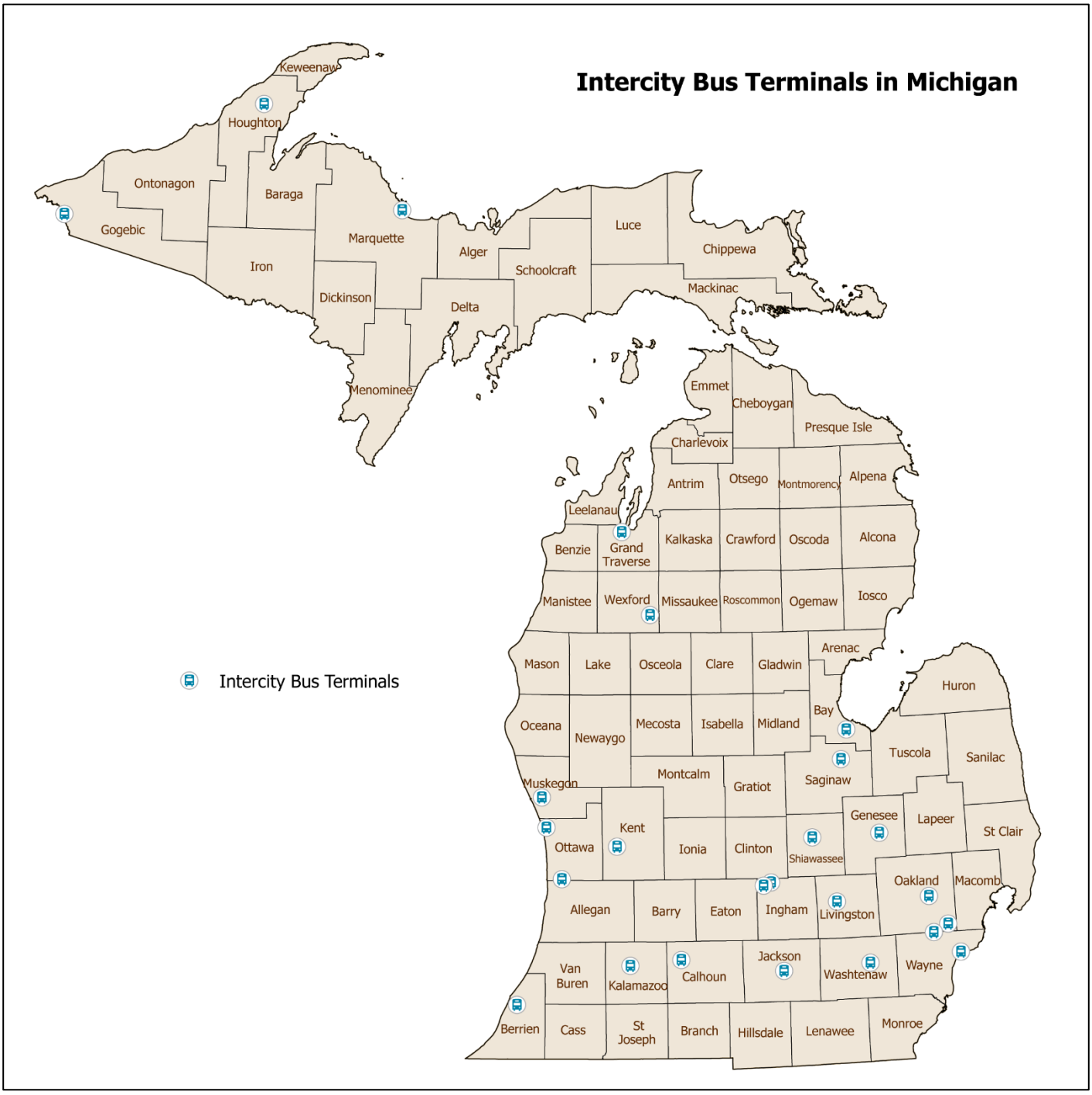
District 9 predominantly serves duties such as search and rescue, ship inspection, maritime law enforcement, safety and security, navigational aid, environmental protection, and icebreaking. Additional maps and information regarding its air stations, Marine Safety Units (MSU), Aids to Navigation Teams (ANT), and cutter ships is also available on its website at https://www.atlanticarea.uscg.mil/Atlantic-Area/Units/District-9/Ninth-District-Units/.

Supplemental Material

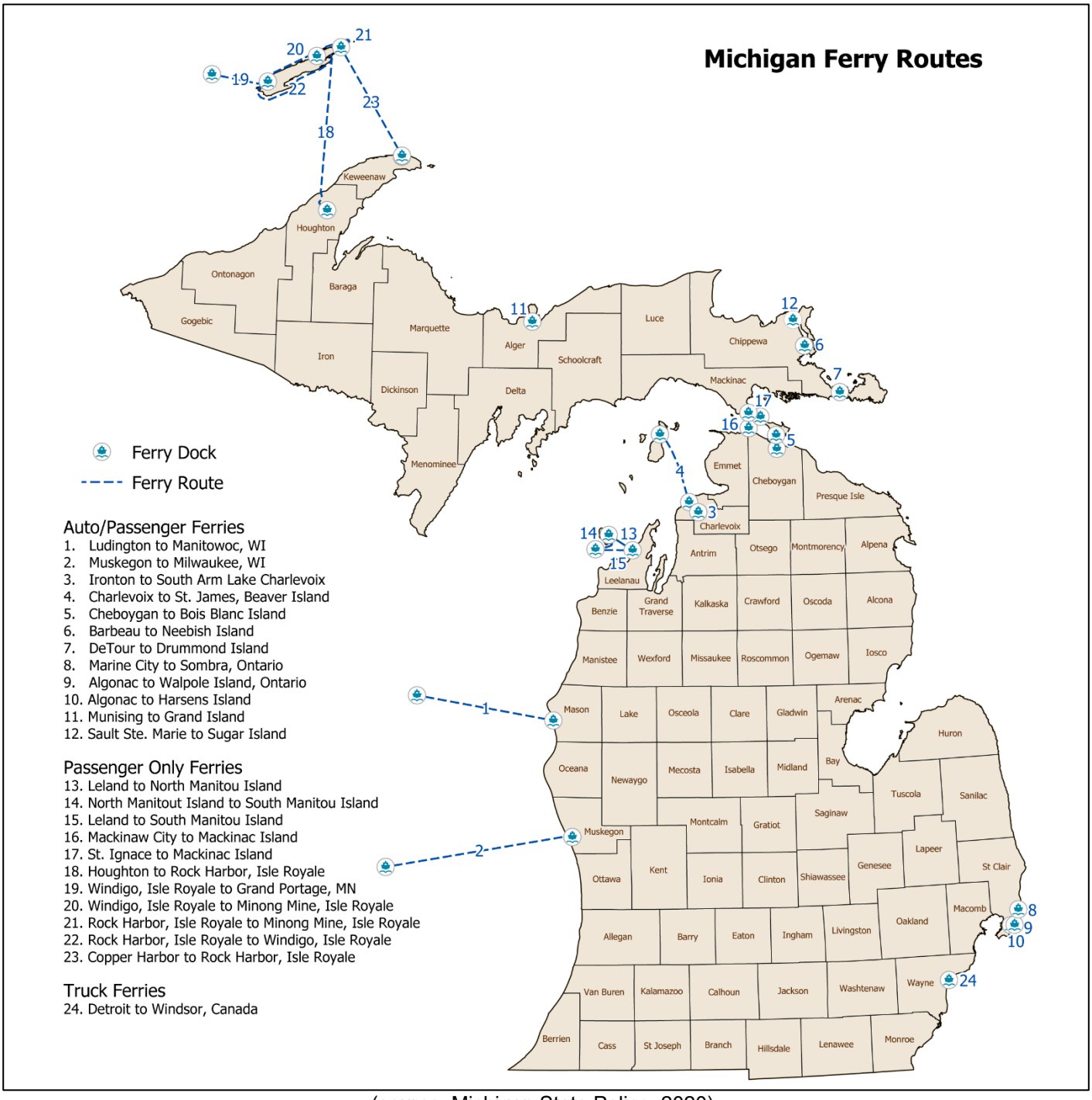
(source: Michigan State Police, 2020)



(source: Michigan Department of Transportation, 2017)



(source: Michigan State Police, 2020)



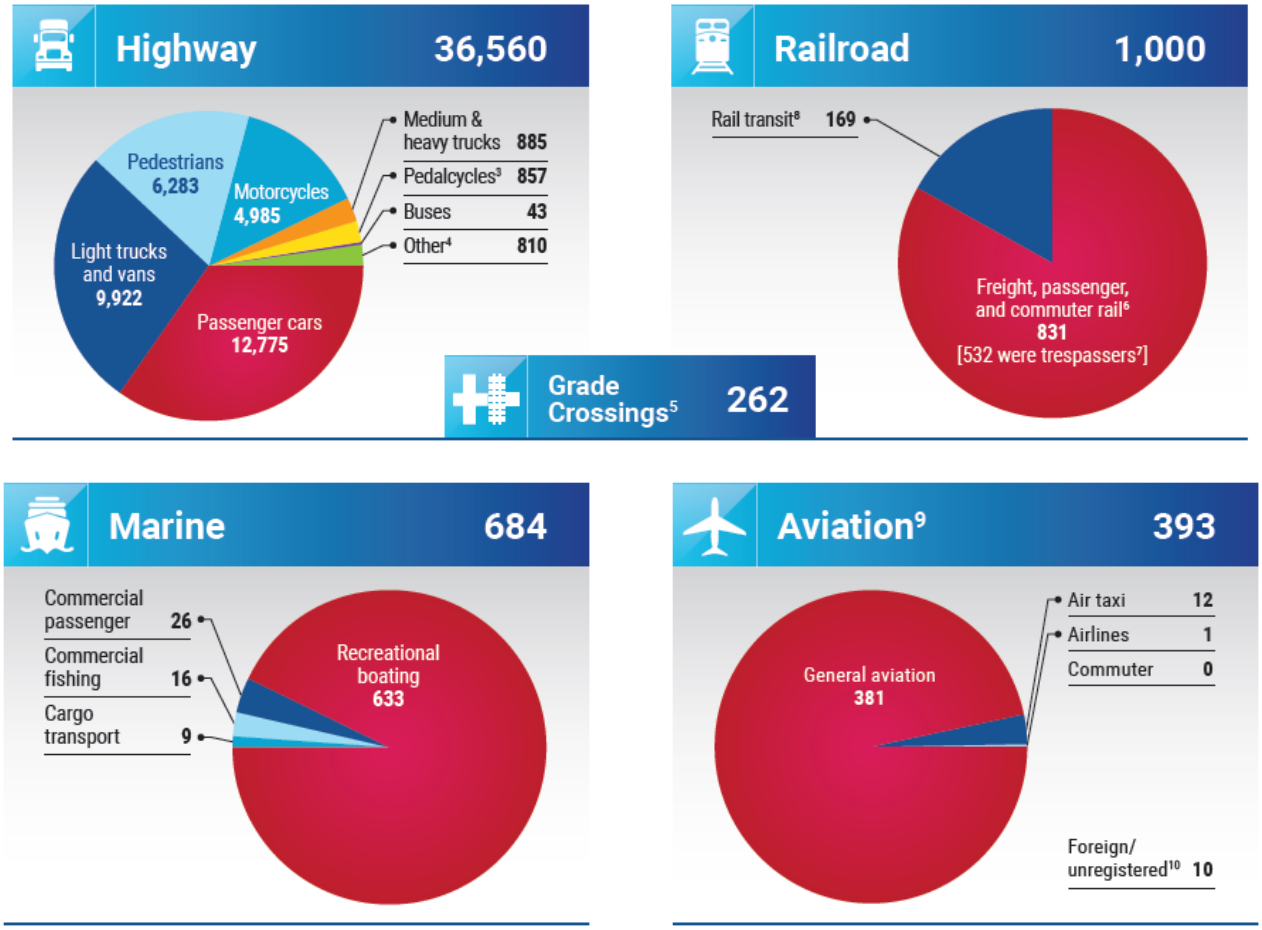
(source: Michigan State Police, 2020)

National Transportation Safety Board

US Transportation Fatalities in 2018[1] – by Mode

Total: 38,515[2]

Aviation data is sourced from the NTSB's 1999–2018 Preliminary Aviation Statistics. For other transportation modes, the NTSB used data from the Bureau of Transportation Statistics, Transportation Fatalities by Mode.



Please Note: embedded hyperlinks within the above graphics have been deactivated.

CLICK HERE to redirect to the original NTSB webpage.

Footnotes

1. Numbers for 2018 are preliminary estimates. Aviation data are from the NTSB. Marine data are reported by the US Department of Homeland Security. All other data are reported by the US Department of Transportation.
2. To reduce double counting, BTS excludes railroad fatalities involving motor vehicles at public highway-rail grade crossings and transit fatalities involving non-rail modes from the overall total fatalities.
3. Pedalcycles include bicycles and other cycles.
4. Other refers to occupants of other vehicle types and other non-motorists.
5. Grade crossing fatalities are reported as a separate category but should not be added to the total because they are included in highway and rail fatalities, as appropriate.
6. Freight, passenger, and commuter rail data are reported by the Federal Railroad Administration and do not include suicides.
7. Trespassing fatalities are reported as a separate category but should not be added to the total because they are included in freight, passenger, and commuter rail fatalities. Trespassing fatalities are not included for rail transit.
8. Rail transit data are reported by the Federal Transit Administration and count fatalities (including suicides) involving heavy rail, light rail, cable car, inclined plane, monorail/automated guideway, streetcar rail, and hybrid rail.
9. Total fatalities may not equal the sum of all categories because some accidents may be counted in multiple categories.
10. Foreign/unregistered includes non-US-registered aircraft involved in accidents in the United States.

ENERGY FAILURES AND SHORTAGES

A lack or shortage of electric power, natural gas, fuel oil, propane, or gasoline of a sufficient magnitude and duration to threaten public safety, technological capabilities, or economic stability.

Hazard Description

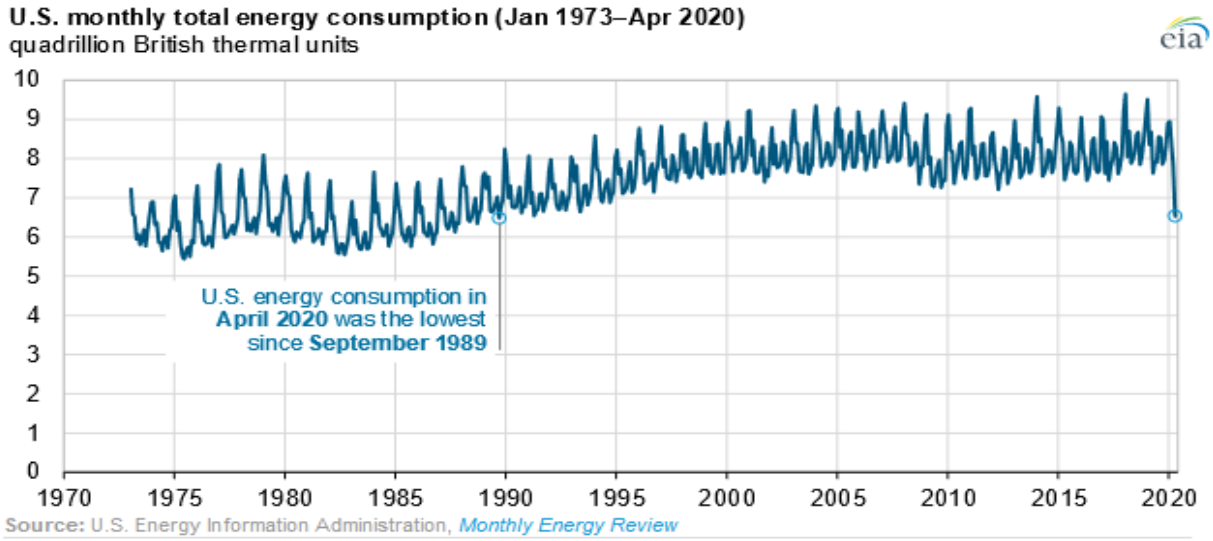
A reliable and adequate energy supply is critical to economic and social well-being, and the United States has become accustomed to uninterrupted and relatively inexpensive power. Transient energy disruptions caused by weather damage (downed power lines) or temporary shortages (brownouts) have a relatively 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.

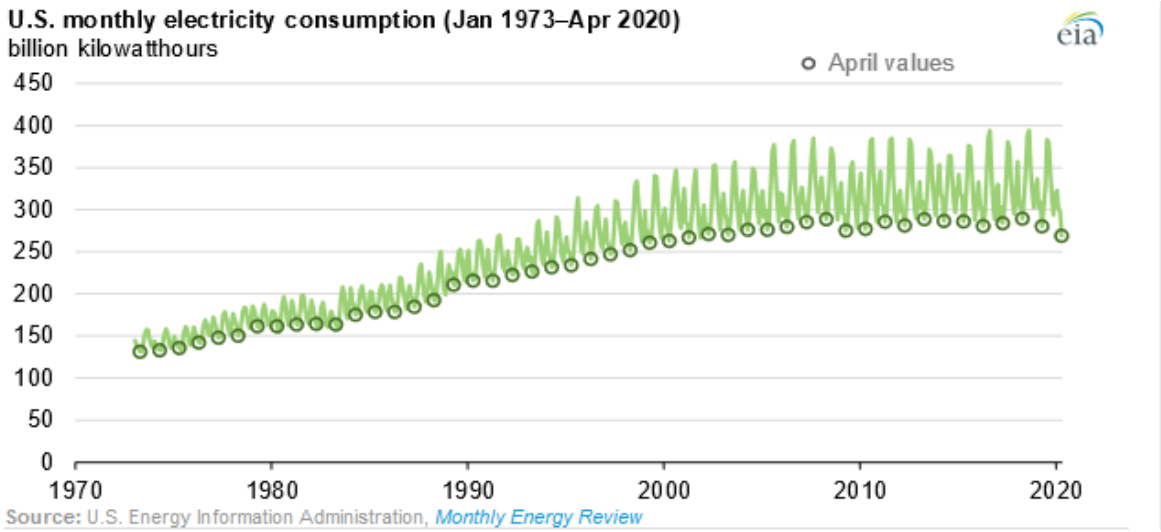
Hazard Analysis

Many modern energy concerns can be best analyzed beginning in the 1970s. The 1973-74 OPEC Oil Embargo and the natural gas shortages of 1976-77 stirred significant public outcry, with long lines at gas stations and high heating prices. Since that time, many important steps have been taken to improve the nation's energy security. Our dependence on foreign oil imports has decreased due to the Strategic Petroleum Reserve and additional domestic production. Energy mixes have been broadened with wind and solar. There have been marked improvements in energy efficiency for homes and appliances, along with the use of automobile fuel standards. Technological changes with "distributed generation" (net-metering) and "smart grids" is relatively newer and ongoing.

Despite this, population sizes have increased, and more people are building larger homes, using more air conditioning, and powering additional devices. Mass transit is being emphasized, but drivers may also tend to purchase sports utility and other larger vehicles. The net effect of these various actions can be complex. In 2018, the United States consumed more energy than ever before but saw consumption slightly decrease in 2019. The effects of COVID-19 have recently driven many of these energy usage patterns lower in the near term. It is impossible to predict, at the time of this writing, what the net impact of new work patterns and modern energy production will be in the long run.

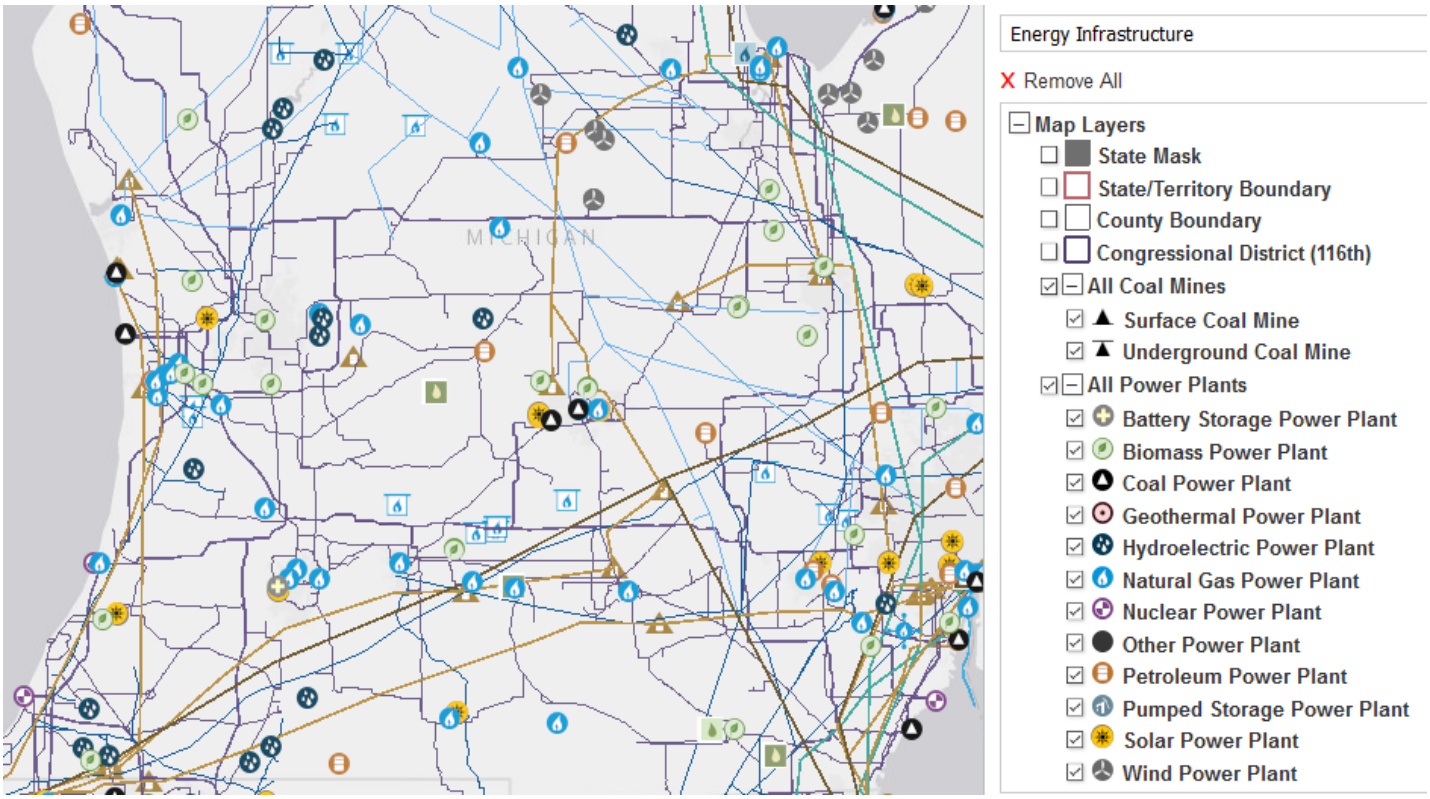


The dramatic decrease in total energy consumption seen in early 2020 was predominantly due to a decrease in gasoline and other travel related fuels. The impact on electricity as a subset of data was still significant although less profound.



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. See: https://www.eia.gov/state/analysis.php?sid=MI for more information.

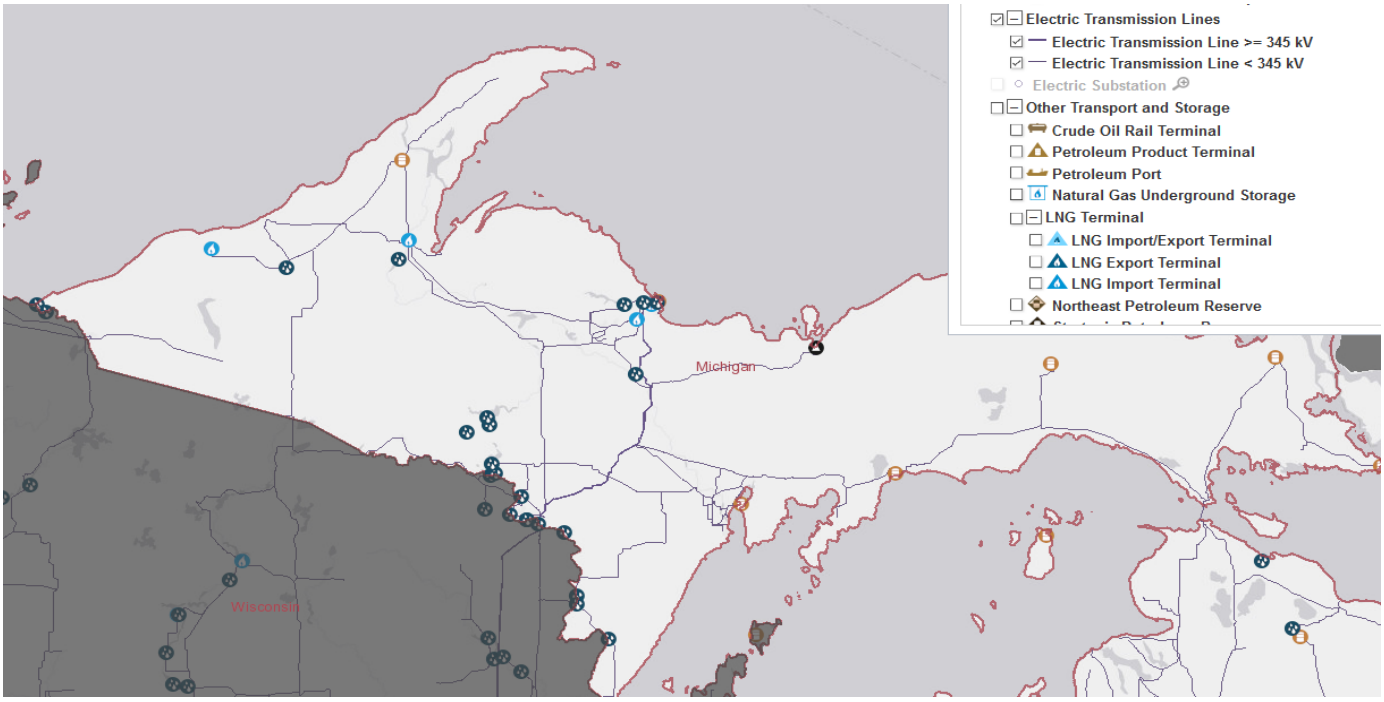
Electric generation varies greatly by region, although the nature of modern electric grids means that energy created in one corner of the state (or outside of it) can be widely used elsewhere, most generally within a specific Independent System Operator (ISO) region. Michigan resides almost entirely within the Midcontinent Independent System Operator (MISO) region (some southwest areas are part of the PJM Interconnection LLC). These organizations work together during emergencies to adjust generation and balance loads. Despite these partnerships, the geographic placement of generation and transmission assets can matter, as highlighted in the following map.



(Source: eia.gov; screenshot of mid and southern Michigan taken August 2020)

Additional detailed mapping can be found at https://www.eia.gov/state/?sid=MI. Note the location of Michigan's nuclear power plants located in both bottom corners of the state. These plants contribute reliable baseload power but are part of an industry under increasing pressure due to competitive forces and safety concerns. See the Nuclear Power Plant Emergencies chapter for more information.

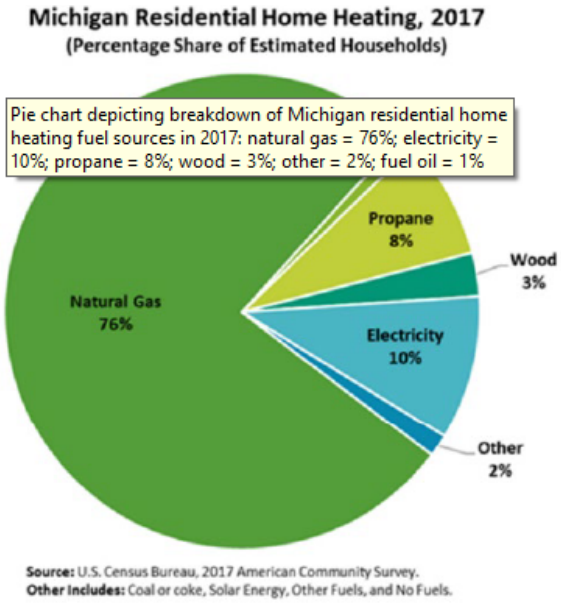
The state also carries geographic risks as a pair of bifurcated peninsulas largely surrounded by water. Upper Peninsula planners need to pay particular attention to their area sources of electric supply and transmission, recognizing the heavy reliance on out-of-state generation coming from limited transmission directions.



(Source: eia.gov, screenshot taken August 2020)

With less coal being used to generate electricity, the importance of natural gas as a fuel has become more critical for industrial, commercial, and residential electric use. This is in addition to its critical role in home heating. Recent census data shows that residential heating in Michigan is accomplished primarily through natural gas.

Natural Gas:
Consumption of natural gas in Michigan is greatest in the residential sector, where it is used as the primary heating fuel in more than 75% of Michigan households.



Despite this predominance of natural gas, emergency managers should note that Michigan still ranks as the number one state in terms of propane usage by residential volume (2017). This can be much higher by region, where it represents an 18 percent share, for example, in the Upper Peninsula. Information is available on a specialized task force created to address their unique energy challenges. The task force develops formal contingency plans for the continued delivery of propane and power alternatives in the event of supply disruptions. This would include any temporary or permanent shutdowns of Enbridge Line 5 in the Mackinac straits. The controversial pipeline helps to fulfill roughly 50 percent of Michigan's statewide propane needs, transporting light crude oil, light synthetic crude, and natural gas liquids (which are refined into propane).

Michigan is home to only one major gasoline refinery, owned by Marathon and located in southwest Detroit. The refinery is capable of processing crude oils into gasoline, distillates, asphalt, fuel-grade coke, and other products. These are then distributed via pipeline, transport truck, rail, and barge. Much of Michigan's gasoline arrives from refineries on the U.S. Gulf Coast, which is one factor in Michigan's higher than average gasoline prices. Cross-country transport frequently dead ends as it nears or enters Michigan, decreasing flexibility and raises costs.

Whether due to infrastructure failure or energy shortages, every energy emergency presents unique challenges. Planning is necessary but preparing for emergencies taking place during times of extreme temperatures may be the most important. Electric failure during the Great Blackout of 2003 saw 50 million electric customers lose power during a time of high air-conditioning need. Michigan's "polar vortex" of 2019 saw frigid temperatures and demonstrated that natural gas reliability cannot be taken for granted. These and other examples are discussed more fully later in the chapter.

Specific Impacts

Impact on the Public, Property, Facilities, and Infrastructure

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. A great many community events, business operations, and tourist attractions are similarly reliant upon electrical infrastructure.

Most energy emergencies do not impact physical property itself from a structural standpoint, unless the nature of the emergency is secondary to other hazards that may have damaged buildings. An increased fire risk from overload or faulty energy infrastructure is possible. Extreme failures such as those seen in the case of nuclear accidents is covered in its own chapter. 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.

Impact on the Economic Condition of the State

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 a state.

Impact on Responders, Continuity of Operations, and Continued Delivery of Services

Energy emergencies may potentially affect response capabilities due to resource shortfalls and/or resource costs. An example could be a shortage of fuel that is needed to operate fire trucks. The budgets of involved agencies may become burdened, and resources may need to be shared between agencies. Government facilities may be subject to power outages and require backup energy considerations if they want to effectively maintain delivery of services.

Impact on the Environment

The impact of energy emergencies on the environment may be mixed. In the short run. they may result in an improvement of pollution levels, as less energy may be being produced (inoperative plants) and people may drive less (fuel shortages). Depending on the nature of the energy emergency, however, extreme environmental damage may result. An example would include a gasoline shortage that was associated with a refinery fire, the contaminated smoke of which would produce significant pollution. Such industrial accidents are covered under separate chapters.

Impact on Public Confidence in State Governance

The price of energy, particularly kinds that can fluctuate wildly such as gasoline, is an area where the public turns to the government for answers. Most Michigan ratepayers have little or no choice as to which utilities they can purchase electricity from, so state regulators will be held accountable for increases in costs. With energy being an essential service, the public will look to the government to take aggressive action to rectify problems and will quickly lose confidence in their elected officials if problems persist.

Hazard Mitigation Opportunities for Energy Failures and Shortages

- Burying electrical lines, where appropriate, to resist damage from severe winds, lightning, ice, and other hazards.
- Energy portfolios based on a diverse 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.

Energy Failures and Shortages Affecting Michigan and Other States

November 9, 1965 – Northeast United States – “Great Northeast Blackout”

The largest electrical blackout in U.S. history at the time occurred in the Northeastern United States when a single transmission line tripped near Niagara Falls, New York, setting off a series of failures that ultimately left 30 million people without power for as long as 13 hours. The outages occurred throughout New York, Ontario (Canada), most of New England, and parts of New Jersey and Pennsylvania. The lessons learned from this single event changed the way electric utility systems are designed and operated today.

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. The OPEC embargo put the term “energy crisis” in the forefront of the news for months and forced the United States to seriously reevaluate its reliance on foreign oil imports and overall use of energy.

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. President Carter did not mince words in his address to the nation on April 18, 1977 when he declared that combating the energy shortage was the “moral equivalent to war.” Carter went on to urge the country to learn to prudently manage its shrinking energy supplies or be faced with potential future disaster. Carter proposed a plan that included strict conservation of fuel supplies, higher prices for oil and natural gas to reduce consumption, penalties for wasteful use of energy, and tax credits for the installation of solar energy devices. Carter also suggested that expansion of nuclear power should be the nation’s last resort in seeking solutions to its energy problems.

July 13, 1977 – New York City – Electrical Blackout

During the night, New York City and parts of Westchester County were plunged into darkness when four lightning strikes knocked out vital power lines feeding the city’s power grid. Neighboring electric utility companies in New Jersey, New

England, and Long Island were automatically disconnected from the Con Edison power grid that served the city in order to prevent damage to their own systems, leaving the city as an “island” of electricity separated from all outside sources of generation. The blackout, which lasted in some neighborhoods for 25 hours, came at a troubled time for New York City, and the reaction of the city’s residents varied. In many areas, neighbors helped neighbors and strangers helped strangers. However, other neighborhoods exploded into violence. Dubbed by some in the media as the “night of terror,” the blackout brought out the worst in many of the city’s residents, as stores were ransacked, looted, and destroyed, buildings were set on fire, and cars were stolen. Police made over 3,700 arrests, but most accounts indicate that thousands of perpetrators escaped before being caught. At the height of the blackout, over 1,000 fires burned throughout the city—six times the average rate—while at the same time the fire department was responding to 1,700 false alarms.

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. Longer lasting, and ultimately more serious, was its role in the “double dip” economic recession of 1980 and 1981–1982 in which many lost jobs and manufacturing output was seriously depressed.

President Carter proposed plans which included conservation of existing fuel supplies, a long-range decrease in foreign oil imports, the development of new sources of energy, and the deregulation of domestic oil prices in order to stimulate domestic oil production. However, Carter’s deregulation plan didn’t work as planned and instead resulted in American oil companies significantly raising gasoline prices. 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.

July 7, 1991 – Portions of North America – Electric Power Infrastructure Failure
One of the major electrical blackout events due to storms was on July 7, 1991 when a powerful wind storm affected a large portion of central North America and knocked out power to over one million customers from Iowa to Ontario. Almost the entire lower half of the Lower Peninsula of Michigan was affected by the intense windstorm, with gusts of 65–85 mph. Electrical power was cut off to around 850,000 customers in Michigan alone, which was the largest number of customers to lose power from a single storm up to that time.

May 31, 1998 – Southern Michigan – Electric Power Infrastructure Failure
On May 31, 1998, a derecho (severe, widespread windstorm) with winds averaging 60–90 mph (the highest being 130 mph) raced across lower Michigan, causing about 860,000 customers in Michigan to lose electrical power (impacting roughly two million across the United States). The 860,000 customers represented a new record for Michigan, slightly exceeding the number of customers that lost power during the Southern Great Lakes Derecho of 1991. Some would not get power back for 10 days. For the Consumers Energy utility company, this event was considered to be the most destructive weather-related incident in its history.

December 1998 – Detroit – Natural Gas Main Failure
On December 12, 1998 in Detroit, a 30-inch water main burst in the downtown area, crushing a nearby 12-inch gas main and flooding it with water. Approximately 200,000 gallons of water flooded nearly 20 miles of gas line, shutting down gas service to hundreds of downtown Detroit businesses and residents on both sides of I-375. Officials estimated that 600 buildings (including hotels, offices, restaurants, shops, and residences) were affected by the gas service shutdown. Crews from Michigan Consolidated Gas worked around the clock for the next four days to drain water from the gas lines and hundreds of gas meters and restore gas service. Even after restoration was complete, problems and service interruptions continued to plague some structures for several days, until more permanent repairs could be made. Michigan Consolidated Gas called the water contamination incident the worst in the company’s 150-year history. Economic losses were substantial for the affected hotels, restaurants, and other businesses because the incident occurred during the normally profitable pre-Christmas holiday period.

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.

June and August 2000 – Detroit – Electric Power Infrastructure Failure
Detroit experienced two significant power outages in 2000—one that began on June 13 that lasted for four days and another that impacted upon two. Both caused significant disruptions to city services during unrelated wind, storm, and flooding events. The first outage arose after one of three main lines connecting Detroit Edison to the Detroit Public Lighting Department failed. During the process of repairing the line, the remaining two connections became completely disabled. The outage cut power to 1,250 traffic lights, 42,000 street lights, Detroit Receiving Hospital, four senior housing complexes, all public housing, Detroit City Airport, the Renaissance Center, Wayne State University, Wayne County Community College, the Detroit Institute of Arts, the U.S. District Courthouse, the City-County Building, and most city buildings and schools. The outage affected a total of 4,500 buildings, idled over 167,000 school children, caused significant business and parking revenue losses, and forced the city to pay out millions in overtime costs for city workers. The power outage also left some public schools without their electronic alarm systems, which resulted in four being broken into and vandalized.

A separate August 31 outage occurred when the Detroit Public Lighting Department cut electrical service to parts of the city (to avoid a widespread outage like the previous incident) after two generators failed during high demand in hot weather. Power to municipal buildings and services was lost on much of the city's west side, and large portions of the east side, including schools, police stations, street and traffic lights, government offices, hospitals, and Wayne State University. Power was restored the next day. Follow up investigation revealed that a squirrel jumping on an electrical conductor may have caused an explosion at a substation that eventually led to the power failure.

June 2000 – Jackson County – Petroleum Product Pipeline Rupture
On the morning of June 7, a Wolverine Pipeline Company pipeline ruptured in Jackson County's Blackman Township, releasing 75,000 gallons of gasoline into the environment, forcing the evacuation of more than 500 homes in a one square mile area around the spill. The leak was detected when a drop in pressure was recorded at a metering station along the 80-mile pipeline that runs through Blackman Township from Joliet, Illinois to Detroit. In addition to causing significant environmental and public safety problems, the spill shut down 30 percent of the state's gasoline transportation capability for nine days. The ruptured pipeline could carry approximately seven million gallons of gasoline per day. (This is equivalent to having 467 tanker trucks with a capacity of 9,000 gallons, each making daily round trips from Jackson to Detroit). While the pipeline was being repaired, tanker trucks from several surrounding states were brought in to help make up for the loss of the pipeline. As truck deliveries could not fully replace the pipeline transportation capacity, drivers began falling behind on deliveries, and a growing number of gas stations were without one or more grades of gasoline for periods of time. The pipeline was not returned to service until June 17, and then at only 80 percent of capacity.

The pipeline rupture caused short-term supply problems in Southeast Michigan and, along with other factors, contributed to an increase in gasoline prices from an average of $1.68 per gallon, when the pipeline broke, to over $2.00 per gallon in the ensuing weeks of June. One of the major contributing factors to the shortages and price increases was that Michigan had very low gasoline inventories going into that summer. In some areas of the Midwest, inventories were 13.5 percent below average in May 2000—their lowest levels since 1981. The closing of the Total Refinery in Alma in December 1999 also contributed to the supply problem. The Alma refinery's capacity of just under one million gallons per day had satisfied approximately eight percent of Michigan's average daily gasoline demand. The closing of the refinery increased Michigan's reliance on the Chicago area gasoline markets, thereby increasing the dependence on the Wolverine pipeline. A final contributing factor was a reduction in transportation capacity caused when one of the two barges supplying petroleum products to marine terminals in Traverse City, Cheboygan, and Bay City was in dry dock for repairs. Supply problems in northern Michigan and Bay City were eased once the barge returned to service in early June 2000. All these factors combined to make gasoline supplies tight, even before the Wolverine pipeline ruptured.

July 2000 – Mackinac Island – Electrical Blackouts
Beginning on July 22, 2000, Mackinac Island began to experience intermittent power outages that escalated two days later into a complete power blackout. The outage continued until July 28 when several large generators were brought to the island by Edison Sault Electric Company to provide temporary power until the island's electrical infrastructure could be repaired. The cause of the outage was later determined to be overheating damage to five of the seven underwater cables that provide power to the island from the mainland. The damaged cables were subsequently replaced to mitigate future problems. The outage occurred at the height of the tourist season and during a popular yacht race.

2000 – 2001 – State of California – Electrical Blackouts
Energy deregulation efforts in California took a negative turn in late 2000 when the state began to experience power shortages and blackouts caused by the state's inability to purchase sufficient electric power supplies. The blackouts often affected hundreds of thousands of customers at a time and created havoc for homeowners and other electric users. One cause of the energy emergency was the way in which California had designed and administered its deregulation plan. Under the plan, private utilities in the state had to sell their power plants and buy electricity on the open market, an approach that that can sometimes lead to lower electric rates. However, the state's two largest private utilities—Pacific Gas and Electric Company and Southern California Edison—had lost at least $10 billion because of soaring wholesale prices for electricity, but rate caps imposed under deregulation prevented them from passing those costs on to customers. As a result, both utilities were consistently short on power, as well as cash to pay their bills, and teetered on bankruptcy. California's Governor declared a "state of emergency" in January and ordered the state Water Resources Department to temporarily buy up to $1 billion in power from electric wholesalers and provide it to the two utilities. The Governor also signed a bill to amend the requirement that utilities sell their power plants under the state's deregulation plan.

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.

February 2003 – Western Lower Peninsula – Electrical Blackout
A break in a major transmission line caused a 60-mile electrical blackout that stretched over parts of six counties. The break cut electricity to tens of thousands of customers in the counties of Montcalm, Mecosta, Oceana, Newaygo, Muskegon, and northern Kent. The customers included hospitals, retirement homes, and schools. The power outage apparently started in the Croton-Hardy Dam area in Newaygo County. The power line that was cut normally supplies electricity to about 70 substations in the affected counties.

August 14, 2003 – Northeastern United States – Electrical Blackout

The northeast United States and Ontario were hit by the largest blackout in North America's history when 50 million people lost power. While some essential services remained in operation with backup generators, large swaths of many cities were almost completely without electricity. Phone systems remained largely operational, although increased demand by people calling home strained the system. Cellular telephones experienced significant loss of service as their transmission towers became overloaded. Television and radio stations remained on the air with some disruption, aided by backup generators or by relaying broadcasts through transmission towers in Grimsby, Ontario (which stayed online throughout the incident). Many gas stations were without power, with some Amtrak service shut down or flights grounded to avoid hitting darkened towers. Looting was minimal compared to such previous large blackouts.

Power was restored to many places within seven hours, but for others took much longer. Near the edge of the affected region, 2.3 million households were still impacted in and around Detroit. Isolated portions of Ann Arbor and Lansing were also affected. Some water supplies were disrupted due to the failure of electric pumps, with a four-day boil advisory

keeping several schools closed. An oil refinery suffered a small explosion from gas buildup, resulting in a closure of I-75. Subsequent heavy rains, coupled with the lack of sewage pumps, closed other expressways, and untreated sewage flowed into rivers in Lansing and Metro Detroit as emergency contingency solutions.

An interim report placed the cause of the blackout on a utility's failure to trim trees, coupled with a computer error. What should have been a manageable, local problem instead introduced a large power surge into the regional system. The report found that First Energy did not take remedial action or warn other control centers in time, ultimately forcing the shutdown of more than 200 other utilities/generators in reaction to the surge. Total costs of the blackout were estimated at between $4–10 billion.

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.

June 9–10, 2011 – Wayne County – Electrical Blackout
Aging power transmission lines failed under the stress of high demand for electricity due to multiple days of at least 90-degree heat. Some of Detroit's public buildings (including the municipal and court offices, a convention center, and Wayne State University) were blacked out June 9–10, 2011. Traffic signals were also blacked out, causing traffic issues, especially during the evening rush hour. The blackout provided a stark reminder of deteriorating infrastructure in a city already struggling to provide basic services.

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.

Winter 2019 – Major portions of Michigan – Natural Gas System Failure
January 30–31 saw a major portion of Michigan's natural gas system jeopardized despite an ample supply. The state's delivery capabilities were severely strained during an extreme weather event that came to be known as the "Polar Vortex," or PV19. Temperatures dropped below -25° F, having already caused high demand for natural gas when a fire ignited at Consumers Energy Ray Compressor Station. The station is the utility's largest natural gas storage facility, contributing up to 64 percent of their daily average of 2.5 billion cubic feet of natural gas to customers (supplying over one third of customer needs at peak times). The station sits above an underground natural gas storage area with a capacity of 41.2 billion cubic feet. Before the gas can be put into the pipeline system for delivery, however, it needs to be compressed. The station can compress 117 million cubic feet of gas per day, reaching pressures of 1,800 pounds per square inch. The fire ultimately caused a significant decline in pressure, which was only stabilized when customers lowered their thermostats and other natural gas suppliers pumped additional gas into the state's interconnected system. Given the temperature, a sustained loss would have been catastrophic. The fire at the Ray Compressor Station was caused by grounding interference on the facility's electrical system, leading to an automated procedure in which natural gas is released to the atmosphere. Instead of dispersing, the natural gas came in contact with nearby plant equipment that was hot, causing the gas to ignite.

Select Laws, Agencies, or Programs

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.

Department of Energy (DOE)
The Department of Energy Organization Act of 1977 brought the federal government's various energy entities into a single agency, including the Federal Energy Administration, the Energy Research and Development Administration, and the Federal Power Commission. Its directives and guidance are DOE's primary means of establishing energy policies and requirements, as well as non-mandatory strategies for fulfilling those requirements and goals. Its missions include energy security, nuclear security, cybersecurity, environmental cleanup, and emergency response. DOE's State and Local Government webpage provides resources for energy efficiency and weatherization programs.

State Energy Conservation Program Improvement Act
States are required to create and submit an energy supply emergency planning program to the DOE under the State Energy Conservation Program Improvement Act of 1990 (P.L. 101-440). The contingency plan provided by this program must include implementation strategies (including regional coordination) for dealing with energy emergencies. In Michigan, this energy emergency planning requirement falls under the purview of the MPSC.

Michigan Public Service Commission (MPSC)
The MPSC is the primary liaison to the electric and natural gas industry operating within the state. It is responsible for the state's energy emergency planning and response and deals with issues related to service disruptions and restoration, system damage, and emergency services. As part of these duties, the MPSC:

- Develops, administers, and coordinates energy emergency contingency plans.
- Acts as the communications focal point for federal, state, and local activities related to energy emergency planning and management.
- Monitors Michigan's energy supply system for the purpose of detecting unusual imbalances that may indicate the potential for an energy emergency and advises appropriate state officials of such events.
- Maintains ongoing contact with the petroleum, natural gas, and electric industries concerning the state's energy status.

Michigan Energy Emergency Plans

The MPSC develops and maintains two energy emergency preparedness and response plans pertaining to electricity, natural gas, and petroleum: (1) the Michigan Energy Assurance Plan is a comprehensive, all-hazards plan that outlines state regulatory authority, roles and responsibilities, energy monitoring, emergency curtailment measures for electric and natural gas, and communication procedures, and (2) the Michigan Petroleum Shortage Response Plan concentrates solely on the petroleum sector and provides a comprehensive set of demand and supply management measures along with regulatory waivers which can be used in the event of a fuel disruption/shortage or a declared energy emergency.

The plans outline the roles and responsibilities of local, federal, and state governments during an emergency. State involvement typically occurs when a local government's capacity to address an emergency is exceeded, with federal government involvement occurring when the state's capacity is exceeded. In these latter two instances, an Energy Emergency or a Disaster is declared, and the agency leading the response and recovery efforts change.

LEVEL 1 – Monitoring / Stand-By
Conditions: Routine monitoring uncovers current or potential impacts to Michigan's energy supply and/or systems. Although an impact to Michigan's communities has been observed, it is relatively low and likely in the initial stages.
Lead Agency: MPSC
LEVEL 2 – EERT Activation
Conditions: The impact on Michigan is moderate/limited compared to a more catastrophic event, however conditions are unstable or likely to worsen and additional information is required.
Lead Agency: MPSC
LEVEL 3 – State Energy Emergency Declaration
Conditions: The anticipated impact within the State of Michigan is moderate to high. Conditions have sufficiently deteriorated to the degree that the state has declared, or is considering declaring, an Energy Emergency under PA 191. The emergency is limited in scope to energy issues.
Lead Agency: MPSC / LARA
LEVEL 4 – State Disaster Declaration
Conditions: It is determined that the event involves more than an energy supply disruption, and that the impacts within Michigan are so severe that the governor has declared a State Disaster under PA 390. Governor directs necessary response actions led by Michigan State Police.
Lead Agency: MSP / EMHSD
LEVEL 5 – Federal Disaster Declaration
Conditions: The consequences of the event are extreme, the governor has requested, and/or the president has declared a National Disaster under the Robert T. Stafford Disaster Relief and Emergency Assistance Act.
Lead Agency: FEMA /DOE

(source: Michigan Public Service Commission)

Energy Supply Monitoring

The MPSC monitors energy supply and demand as a part of its emergency preparedness program, tracking energy developments affecting Michigan, the region, and the nation via the DOE Energy Information Administration, industry partners, and various trade publications. Historical and forecast data are published by the MPSC semi-annually in its Michigan Energy Appraisal reports. In the event of an actual or anticipated energy emergency, special updates to this basic publication can be issued as required to aid in decision-making during the response.

Public Information and Crisis Communications

The MPSC maintains a public information program designed to inform and enlist support from the public during an actual or anticipated energy emergency. The program provides the public with two basic sets of information: 1) an educational campaign to inform citizens about ways to minimize their use of energy and address issues resulting from a disruption, and 2) an informational campaign to provide clear information on the problems and the steps being taken in response. Public information activities will be coordinated through a Joint Information Center (JIC).

The Declaration of a State of Energy Emergency Act (1982 PA 191)

This law provides the Governor with the authority to declare a State of Energy Emergency in response to an actual or anticipated event. It remains in effect for the duration of the emergency or for 90 days, whichever is shorter. The State of Energy Emergency may be extended with the approval of the Legislature and may be terminated by a majority vote of both chambers. While the declaration is in effect, the Governor is authorized to:

(1) Order specific restrictions on the use and sale of energy resources, which may include:
- Restrictions on the interior temperature of buildings.
- Restrictions on the hours and days during which buildings may be open.
- Restrictions on the conditions under which energy resources may be sold.
- Restrictions on lighting levels and the use of display and decorative lighting.
- Restrictions on the use of privately owned vehicles, or a reduction in speed limits.
- Restrictions on the use of public transportation, including directions to close a public transportation facility.
- Restrictions on the use of pupil transportation programs operated by public schools

(2) Direct an energy resource supplier to provide an energy resource to a health facility; school; public utility; public transit authority; fire or police station or vehicle; newspaper or television or radio station (for the purpose of relaying emergency instructions or other emergency message); food producer, processor, retailer or wholesaler; and to any other person or facility which provides essential services for the health, safety, and welfare of Michigan residents.

(3) By Executive Order, suspend a statute or an order or rule of a state agency, or a specific provision of a statute, rule, or order, if strict compliance with the statute, rule, or order, or a specific provision of the statute, rule, or order will prevent, hinder, or delay necessary action in coping with the energy emergency.

North American Electric Reliability Council (NERC) and Reliability First

A non-profit organization overseen by the Federal Energy Regulatory Commission, NERC works to ensure that electric utilities and other suppliers maintain an adequate electric supply that meets the nation's needs. Its primary responsibilities include working with stakeholders to develop/enforce power system operation standards, assess resource adequacy, and provide for accredited training programs. Composed of eight separate regional reliability councils, Reliability First covers almost all Michigan areas. They and NERC's other regional partners should not be confused with Independent System Operator Regions, such as the previously mentioned Midcontinent Independent System Operator (MISO).

Strategic Petroleum Reserve (SPR)

The SPR represents the largest supply of emergency crude oil in the world, stored in large underground salt caverns at four sites in Louisiana and Texas along the Gulf of Mexico. As of August 31, 2020, U.S. government holdings were:

- Bryan Mound site – 231.7 MMB in 20 caverns (68.1 MMB sweet and 163.6 MMB sour)
- Big Hill site – 148.1 MMB in 14 caverns (67.1 MMB sweet and 81.1 MMB sour)
- West Hackberry site – 193.7 MMB in 22 caverns (102.2 MMB sweet and 91.1 MMB sour)
- Bayou Choctaw site – 73.7 MMB in 6 caverns (21.6 MMB sweet and 52.0 MMB sour)

This is equivalent to the supply of roughly 1,000 days of total U.S. petroleum net imports. Decisions for emergency withdrawal are made by the President under the authorization of the Energy Policy and Conservation Act. Oil would be distributed by competitive sale in the case of an emergency. Additional information is available at SPR Quick Facts.

III. HUMAN-RELATED HAZARDS

The following chapters are included in this section:

1. Terrorism and Similar Criminal Incidents
2. Cyberattacks and Major Network Disruptions
3. Nuclear Attack (military and terrorist)
4. Public Health Emergencies (contagions, food and water contamination)
5. Civil Disturbances

As used in this document, *human-related* hazards may also be sometimes viewed as *human-caused* hazards. They may share overlap with components of technological hazards (and even natural hazards in some instances).

Terrorism has evolved significantly as it intersects with technology. The primary chapter on terrorism focuses on brute force tactics such as mass shootings and explosives. However, terrorists are also using technology (e.g., cyberattacks, social media) to cripple infrastructure, steal money, and recruit members. This has become a convenient way to damage computer capabilities, cripple response, and access sensitive data for purposes of surveillance or ransom. Government at all levels, including law enforcement, are common targets.

The specter of nuclear destruction has changed significantly since the Cold War. Even as more nations have gained stronger nuclear missile capability, the threat of smaller, tactical nuclear attacks should also be considered. The proliferation of radiological equipment in our society has additionally meant that terrorists may try to coopt such materials to augment more conventional explosives by creating so called “dirty” bombs.

Terrorists have thus far not successfully employed nuclear missiles but have used bioweapons. There is also concern that valid bacterial or viral research could unintentionally introduce dangerous new pathogens. Despite this, the most common infectious disease public health emergencies can also be dually considered as natural hazards when dealing with threats such as influenza. Travel and other human-related activities do however greatly augment infectious spread. Foodborne pathogens associated with improper food processing and storage are also considered.

Non-infectious contaminants introduced into the food supply chain or drinking water supply, such as chemicals or heavy metals, can also be spread/disseminated throughout the general public. For this reason, it has been helpful to group certain *transmissible* diseases alongside the concept of *transmittable* contaminants. While transmissible disease is more closely associated with infectious organisms, the broader term transmittable is used in the Public Health Emergencies chapter to allow for a more comprehensive analysis of incidents caused by dissemination through infectious, contaminated, or unsanitary means (e.g., vectors, fomites, food, water). Public health emergencies related to the weather, such as extreme heat advisories, are covered under different chapters.

The final chapter in this section deals with civil disturbances. These mass gatherings include street demonstrations that have turned violent, prison riots, and credible attempts to topple a government through force. In practice, most mass gatherings are uneventful and safely monitored by local authorities. Even the most peaceful demonstrations have the potential to turn violent, however, especially if lawful gatherings are coopted and taken over by people with extreme agendas. The Civil Disturbances chapter differentiates between several types of mass gatherings while focusing on major incidents that are at the core of emergency management.

In comparing the human-related hazards of this section to other hazards, such as those dealing with the weather, emergency managers and community planners have more opportunities for preventative efforts that may stop certain incidents from happening in the first place. Practitioners may wish to explore intelligence-based methods to identify nefarious behavior that may lead to the mass loss of life or damage to critical infrastructure/resources.

TERRORISM AND SIMILAR CRIMINAL INCIDENTS

"Activities that involve violent…or life-threatening acts…that are a violation of the criminal laws of the United States or of any State and…appear to be intended (i) to intimidate or coerce a civilian population; (ii) to influence the policy of a government by intimidation or coercion; or (iii) to affect the conduct of a government by mass destruction, assassination, or kidnapping" (Excerpts from Federal Criminal Code. 18 U.S.C. §2331)

Hazard Description

Terrorism is the use of violence to achieve political goals by physically attacking people or otherwise creating fear. The political motives of terrorism distinguish it from ordinary crime. It is generally carried out for a cause and not for personal financial gain. The United States is threatened not only by international terrorists such as Al Qaeda, but also by domestic terrorist groups motivated by a wide range of ideologies.

Terrorists may employ assassination, bombings, arson, and kidnapping to gain media exposure. One goal of terrorists is to frighten as many people as possible, not necessarily to inflict the greatest physical damage. Staging attacks in a spectacular fashion results in media coverage that allows terrorists to affect a much larger population.

Some criminal activity may resemble terrorism but lacks a primary political objective. Emergency management is typically not concerned with routine crimes but does need to prepare for incidents that impact large portions of the population. Such attacks may require resources typically not available to local law enforcement agencies, such as those dealing with mass shootings, sniper attacks, or sabotage. The criminal attacks considered here are those that resemble terrorism or are part of large incidents that cause widespread disruption. Cyberattacks have their own separate chapter.

Hazard Analysis

The United States has suffered from terrorist attacks for more than a century: U.S. President William McKinley was assassinated by an anarchist terrorist in 1901, the Los Angeles Times building was destroyed in 1910, and Wall Street was bombed in 1920. Racial and religiously motivated terrorism continued throughout the 20th century. A new wave of terrorism was instigated in the 1960s by left-wing radicals. This was followed by right-wing extremist terrorism in the 1980s and 1990s. All these attacks were conducted by American domestic terrorists against other Americans.

The country has also been the target of terrorists from other countries. Conflict in the Middle East led to many attacks on American targets overseas, primarily by Palestinian nationalist terrorists, as well as groups supported by Libya and Iran. Hijackings, kidnappings, and bombings of Americans occurred throughout the 1970s and 1980s, and into the 1990s. By the mid 1990s, the danger had shifted toward attacks by violent Islamic extremist groups such as al-Qaeda and the Islamic State groups. Al-Qaeda successfully moved their terrorist campaign inside of the United States homeland with the World Trade Center bombing (1993) and the devastating attacks of September 11 (2001).

The most effective terrorists tend to operate in groups of like-minded individuals. Such groups range from a few committed amateurs to sophisticated international paramilitary organizations. Even in the larger organizations, terrorist groups are structured into small cells with a handful of members. This structure, combined with intense personal commitment makes these groups difficult to discover, infiltrate, and disrupt. Some "lone-wolf" terrorists operate on their own and aren't officially part of a formal group.

<u>Types of Terrorists</u>
Terrorists groups may resist labeling but typically fall into one or more general categories. Some may not articulate a coherent agenda outside of encouraging instability and anarchy for its own sake.

Nationalist terrorists act in support of a cultural or ethnic group. They typically fight on behalf of populations of people that seek to create an independent government and see themselves as being illegitimately ruled by another country. They tend to direct their attacks against an "occupying power," but may also attack those that support their enemies. While claiming to speak for an entire people, they usually only represent a small extremist minority.

Religious extremist terrorists are violent adherents of a specific religion. They may be extremists within a large, generally peaceful faith such as Islam or Christianity, or members of a small "cult" religion in which the entire group is extremist. These terrorists tend to be especially committed because they believe their violent actions are divine in nature.

Left-wing and right-wing terrorists use violence in an attempt to force society to adopt their goals and values, fighting for a collection of issues generally labeled on the far end of either the liberal or conservative political spectrum (in an unacceptably extreme manner). They may eschew traditional political parties or lean towards being primarily a "single issue" terrorist. Both target the government (including certain government employees), but for different reasons.

Left-wing terrorists tend to attack capitalism, large businesses, and financial institutions. They may be strongly against religion. Socialists and Communists, who were also terrorists, were a threat in the late 1960s and 1970s but have weakened in recent decades. Right-wing terrorists tend to attack minority races, immigrants, and other religions. Some may be very devout and attempt to use their interpretation of religion to justify their actions. Others believe themselves as patriots where violence is necessary to restore founding governmental principles.

Single-issue terrorists may not be fully committed to one all-encompassing belief system but are intensely concerned with a particular cause. These causes may be of interest to many members of society, but only a small number of individuals commit to terrorist activity. Examples of single-issue terrorist causes include animal rights, abortion, or environmental extremists. With some exception, they tend to target property or individuals rather than mass casualties.

Non-terrorist Criminals

Terrorism is a crime, but not all criminals are terrorists. Most crimes impact only a small number of victims and are appropriately handled by local law enforcement. Rarely, a criminal event will impact a large number of people. Examples include mass shootings at schools or workplaces, infrastructure sabotage, and cyberattacks. Such major criminal events may resemble terrorist attacks, but there are important differences between terrorists and other criminals. The main difference is often one of motivation. Terrorists are motivated primarily by a political cause, not by personal gain. This is an important distinction because it explains other characteristic differences between terrorism and non-terrorist crimes. Significant debate may occur over whether certain illegal acts should be treated as terrorism by the courts.

Non-terrorist criminals may be driven by a wide variety of purposes. Most criminals avoid major crimes with widespread impact because the chance of monetary gain is low and the risk of punishment is high. Major criminal events have been conducted for reasons of personal revenge, monetary gain, desire for fame, and due to mental illness. While terrorists tend to prioritize their mission over their personal safety and will risk capture or death to achieve their goals, criminals typically value their lives and freedom unless they are under the influence of drugs or mentally ill.

Possible Targets and Methods

The specific type of selected targets varies widely based on the goals of the attackers. Nationalistic terrorists, in particular, may display a broad range of targets, including government officials and buildings, public monuments, schools, airports, mass-transportation systems, or sporting events. Single-issue terrorists tend to target facilities or individuals directly associated with their specific cause. For example, anti-abortion terrorists might target abortion clinics and animal rights terrorists may target animal research centers. Religious extremist terrorists may target places of worship (a frequent target for many types of terrorists).

Most terrorists will usually seek targets that are poorly defended by law enforcement, security screening, or other protective measures. Such "soft" targets offer the opportunity to do the maximum possible damage. Even terrorists who do not intend to survive their attack want to accomplish their mission, with well-protected targets presenting lower chances of success. Multiple targets or methods will be explored in trying to identify a vulnerability. Criminals are generally more likely to choose targets that they are personally connected with, as when criminal employees target their workplace or criminal students target their own school building.

The specific effects of an attack and corresponding emergency response are largely determined by the methods used. Case examples are provided in the historical examples section below in the categories of explosives, incendiaries, shooting attacks, vehicle ramming attacks, chemical weapons, biological weapons, radiological weapons, nuclear weapons, and general sabotage.

Specific Impacts

Impact on the Public, Property, Facilities, and Infrastructure

The specific impact of terrorism, or similar criminal incidents, would depend on the nature of the 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 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 teleconferencing and telecommuting.

Impact on the Economic Condition of the State

Generally, terrorism is not intended or designed to cause economic impacts. Although large events, such as the 9/11 attacks, do have such an impact, in that case it was felt most keenly in specific sectors most closely related to that event, such as air travel. Terrorism in wealthy democratic countries does not usually involve economic motives or targets. The main concern would involve potential disruptions to important areas and facilities, and the potential economic impacts of terrorist acts that cause a public health emergency.

Impact on Responders, Continuity of Operations, and Continued Delivery of Services

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.

Impact on the Environment

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 or a metropolitan water treatment system disabled by cyberattack. Please refer to the chapters on dam/levee failures, energy emergencies, structural and industrial fires and explosions, hazardous materials, infrastructure failure, nuclear attack, oil and natural gas pipeline and well accidents, public health emergencies, and transportation accidents for more examples of the type of impacts that may result from terrorism or major criminal incidents.

Impact on Public Confidence in State Governance

Public reaction to terrorist attacks would vary depending on the effectiveness of the attack and the type of target. It is possible that state government would be held accountable for failing to stop a terrorist plot, though counterterrorism is generally considered to be a federal government responsibility. 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.

Hazard Mitigation Alternatives for Terrorism and Similar Criminal Incidents

- Using durable construction materials in public buildings and critical infrastructure/key resources.
- Layout design options for consideration for schools, factories, office buildings, shopping malls, 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, website, or mobile application for information preventing terrorist incidents and sabotage.

Historical Examples of Terrorist and Similar Attacks

The examples listed below are broken out into categories based on the primary methods used in actual attacks. The methods are briefly analyzed, with specific cases highlighting each category. Additional examples for study are listed in the supplemental material section of this chapter, including an unsuccessful plot against a Michigan Governor (2020).

Explosive attacks

These are one of the most common terrorist tools and have also been used by particularly violent criminals. Bombs have many advantages for an attacker, including flexibility, availability, and ease of use. Explosives can be delivered in many ways, including massive car bombs, hidden suicide vests, assassination devices, and letter bombs sent through the mail. Bombs are effective at both destroying property and harming people. Explosive attacks also produce dramatic images of destruction guaranteed to receive the media coverage terrorists seek.

A wide variety of explosive materials are available. Military explosives are the most powerful but may be difficult to obtain. Commercial explosives, on the other hand, are widely available for use by mines, farms, and businesses. Several million tons of such legitimate explosives are used in the United States each year and may be stolen. Effective bombs can also be built from commonly available materials, such as farm fertilizer, diesel fuel, and hydrogen peroxide.

Explosives are relatively easy to use, allowing even untrained bombers to launch attacks. Common terrorist tactics include anti-personnel bombs, packed with metal objects to increase injuries, and suicide bombs that can be set off at the most harmful possible time and place. For non-suicidal attackers, bombs can be left in place to explode long after the bomber has made an escape. One common explosives technique of particular importance to emergency responders is a "secondary device." This tactic uses a pair of bombs, the first of which brings rescuers and bystanders to a scene, and then a second, hidden bomb detonates to kill those who were drawn in.

Explosive attacks can be countered by careful law enforcement work to identify and disrupt possible attacks before they occur. Alert and properly educated citizens can provide assistance by observing and reporting signs of a possible attack, such as an unwarranted purchase of explosive materials or the presence of a suspicious package in a public place. Some high-risk areas, such as airports, can be equipped with explosives screening devices. Particularly high-risk facilities, such as government buildings, may be physically hardened to limit the damage from attack by explosives.

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: Oklahoma City Federal Building Bombing (1995)

On April 19, the Alfred P. Murrah Federal Building in Oklahoma City, Oklahoma, was attacked by a large truck bomb. The attack killed 168, injured more than 680, destroyed the building, and caused widespread destruction over a 16-block area. Although initially suspected of being carried out by international terrorists, the attackers were in fact anti-government domestic terrorists, one of whom had Michigan connections. This attack is an example of right-wing, anti-government terrorism. It also demonstrates the extensive destruction that can be caused to large buildings which lack adequate target hardening and security measures.

Case: Bali Bombing (2002)

On October 12, terrorists bombed the tourist district of Kuta on the Indonesian Island of Bali. The targets were several nightclubs frequented by Western tourists. An initial backpack suicide bomb was directed against patrons inside a dance club. Shortly thereafter, a large car bomb detonated on a busy street near the first attack, killing survivors of the initial bomb and would-be rescuers. The second bomb weighed over a ton and devastated several blocks of buildings. In total, 202 persons were killed, with a further 209 injured. The attack was carried out by Jemaah Islamiyah, an Indonesian extremist Islamist organization. This case is an example of the versatility of terrorist explosives used at Bali, as both a small suicide weapon and a massive remotely detonated car bomb. It is also an example of a large secondary device intended to kill those responding to the initial bomb.

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 device was small and easy to conceal but was capable of damaging or destroying the airliner. The explosive failed to detonate properly and instead ignited and burned Mr. Abdulmutallab, who was then subdued by the plane's passengers and crew. This attack demonstrates the potential effectiveness of even small bombs when used against vulnerable targets such as aircraft. It also demonstrates that international terrorism may be directed at targets in Michigan.

Case: Boston Marathon Bombings (2013)
The finish line of the Boston Marathon was targeted by two improvised explosive devices. Three persons were killed and up to 260 others injured, including many with amputated limbs. The two men who delivered the bombs were quickly spotted on security camera video and were soon identified as brothers Dzhokhar and Tamerlan Tsarnaev. An extensive manhunt resulted in the closure of a portion of downtown Boston, a temporary halt to air travel, a shelter-in-place advisory, and extensive armed searches of residential neighborhoods. The Tsarnaev bothers committed several additional crimes during their flight, including the murder of a police officer, before Tamerlan was killed and Dzhokhar captured by law enforcement. The Boston Marathon Bombing appears to have been a terrorist attack motivated by Islamic religious extremism, though the brothers had very limited direct contact with international Islamic terrorist groups. Dzhokhar Tsarnaev was convicted of numerous federal terrorism charges. This case is an example of the large number of casualties which can be inflicted by even primitive explosives in crowded public areas. It also demonstrates that effective bomb attacks can be carried out by individuals without extensive training or support from established terrorist groups. Finally, this case illustrates the widespread social disruption caused both by fear of terrorists on the loose and by aggressive law enforcement pursuit of those terrorists.

Incendiary attacks
These materials are used to start fires rather than to destroy through explosion. Generally, incendiaries are targeted at structures and property rather than directly against people. This makes them appealing to groups such as single-issue terrorists that seek to minimize casualties. The devices can be as simple as a can of gasoline ignited on a porch, or as sophisticated as a military thermite bomb. The use of fuel-laden jetliners as suicide missiles in the 9/11 attacks represents a massive application of improvised incendiary devices.

Countermeasures against incendiary attack are very similar to those against explosive attacks. Effective law enforcement, good intelligence on potential attackers, surveillance of critical sites, and hardening of particularly vulnerable targets can all be helpful. Note that the construction of simple incendiary devices can be very difficult to prevent since there are no legal restrictions on incendiary materials such as gasoline and matches. Prompt fire detection and effective firefighting can limit the damage once an attack occurs.

Case: Michigan State University Agriculture Building Arson (1999)
On December 31, environmental terrorists affiliated with the Earth Liberation Front (ELF) set fire to the Agriculture Biotechnology Support Project, located in a classroom and office building at Michigan State University. The university was targeted because of its work on genetically modified crops. The fire was set when there were few people in the building. Damages to the building and research equipment totaled approximately $1 million. Four domestic terrorists from Michigan and Ohio were later tried and convicted in federal court for carrying out this attack. This attack, a similar attack against Michigan State in 1992, and an attempted attack against the Michigan Technological University Forestry Center in 2001 are all typical of attacks by environmental terrorist groups. These attacks generally are designed to cause property damage but few deaths and injuries. These attacks also demonstrate the vulnerability of universities and research centers to terrorist attack.

Case: 9/11 Airliner Attacks (2001)
Terrorists hijacked four commercial airliners on September 11 and subsequently flew them into the New York World Trade Center and the Pentagon. Approximately 3,000 persons were killed along with billions of dollars in property damage. The attack would have been worse had the fourth aircraft hit its intended target, presumed to be the White House in Washington, D.C. Instead, passengers attacked the hijackers, leading to the aircraft crashing into an open field in a rural portion of Pennsylvania.

Although the incident began with knife attack hijackings, it may be classified as an example of incendiary terrorism because most of the damage was caused by large fires started by the crashing airliners and their spilled jet fuel. It was these fires that caused the collapse of the three largest buildings at New York's World Trade Center and of portions of the Pentagon building. The attacks caused major disruption to airline travel, including a temporary ban on all civilian

flights in the United States. Significant changes were made to improve security at airports and aboard aircraft. Substantial direct and indirect costs affected the overall economy. The 9/11 attacks served as an impetus for the United States and its allies to launch major military campaigns in Afghanistan, Iraq, and Pakistan that led to substantial loss of life and trillions of dollars in cost.

This coordinated attack, conducted by 19 men armed only with knives, is the deadliest act of terrorism in history and continues to have global repercussions to this day. The 9/11 attacks demonstrate the ability of terrorists to seek out vulnerabilities and to creatively exploit them. The attacks were incredibly effective because the tactics were novel and unexpected.

Shooting attacks

The use of firearms is a popular tactic for both terrorists and criminals. They can be used to target a specific individual or to attack many people in a crowded place. Small arms, such as pistols, rifles, and shotguns, are easily available in the United States, including semi-automatic weapons with magazine capacities of more than 10 rounds of ammunition. Shootings at schools and workplaces are among the most common types of major criminal attack. An important drawback to the use of firearms, particularly in a mass shooting, is that the attacker is not likely to escape. Therefore, shootings are usually carried out by suicide attackers, those expecting to be arrested, or criminals who are acting impulsively and without thought to consequences.

Countermeasures against shooting attacks are difficult since attackers usually choose unprotected public areas. Protection against attacks must be balanced against the public's need to use their schools, shopping malls, government buildings, and workplaces. Appropriate security measures and effective lock-down training can limit casualties in high-risk buildings. Rapid response by well-trained law enforcement officers and emergency medical personnel is important.

Case: Columbine School Shooting (1999)

On April 20, 1999, two students staged an attack at Columbine High School near Denver, Colorado. Although the criminals attempted to use explosives, all the casualties were inflicted with small arms. Using a variety of handguns and shotguns, the criminals killed 13 teachers and students and wounded 24 others. By targeting crowds of students during lunch, the attackers were able to inflict all of the casualties within 23 minutes. The criminals expected to die during the attack and took their own lives at the end of their assault. This attack demonstrates the vulnerability of facilities, such as schools, where large numbers of victims can be found in proximity. It also illustrates the short duration of most mass shooting attacks and the need for a very rapid law enforcement response.

Case: Mumbai Attacks (2008)

On November 26, 2008, terrorists attacked the Indian city of Mumbai. The primary weapons employed were rifles and handguns, though small explosives were also used. Ten terrorists attacked six targets across Mumbai's downtown area, including hotels, a railway station, a hospital, a restaurant, and a Jewish community center. There were also shootings on the city streets and several diversionary attacks. In total, more than 160 persons were killed and more than 290 injured. Sixteen of the dead and many of the injured were law enforcement officers. The attack was conducted by Lashkar-e-Taiba, a Pakistani extremist Islamist group. The attackers intended to die during their mission, though one man was taken alive. This case demonstrates the large number of casualties that can be inflicted by firearms in a crowded environment. It also demonstrates the significant challenge for law enforcement when suddenly confronted with multiple heavily armed and suicidal gunmen, and the substantial police casualties which may result.

Case: Fort Hood Shooting (2009)

On November 5, 2009, a single gunman launched a shooting attack at the Fort Hood military post located near Killeen, Texas. The attacker was Major Nidal Malik Hasan, a U.S. Army psychologist. Using a single handgun, Hasan killed 13 military personnel and wounded 29 others before being subdued. Hasan is accused of terrorism; acting for political reasons related to his extremist Islamist beliefs. It is believed that he was radicalized though the Internet and specifically through contact with Anwar al-Awlaki, a member of the terrorist group "Al Qaeda in the Arabian Peninsula." This case demonstrates the potential lethality of a highly trained and well-equipped gunman. Major Hasan made far more effective use of his weapon than other mass shooters, which can be attributed to his high level of training and preparation. It also demonstrates the danger posed by "lone wolf" attackers (self-radicalized and acting outside of the direct control of an established terrorist organization). Finally, it is an alleged example of an American citizen acting on behalf of a cause typically identified with international terrorists. As an American and a member of the military, Major Hasan does not fit the expected terrorist profile, which may have enabled him to avoid detection as a deadly threat.

Case: Highway Shootings (2012)
During October 2012, a man shot at cars as they drove along and near a Michigan highway corridor in Oakland, Ingham, Shiawassee, and Livingston counties, over the span of several days. The first car was shot in Commerce Township on October 16. On that same day, four more shootings occurred in Wixom. On the next day, another Commerce Township shooting took place near the same location as the first day. The northernmost shooting occurred in Perry on October 18. On that same day, there were eight shootings near the I-96 exit in Webberville. There was also an October 18 shooting in Howell, and six shootings in Wixom. About a week later, on October 27, two shootings occurred along Grand River and I-96 in the area of Fowlerville, and a driver on I-96 reported being injured by a bullet (the only such instance reported). During his trial, the shooter claimed that shooting at vehicles was connected to a condition of mental illness. Investigators connected him with 24 shooting incidents in the area. In 2014, a Livingston County jury convicted him of terrorism, and he was sentenced to 16–40 years. This was in addition to a sentence of at least six years received in Oakland County. NOTE: Media headlines often simplified these incidents by referring to them as involving "The I-96 Shooter," even though most incidents did not involve Interstate traffic.

Case: Sandy Hook School Shooting (2012)
On December 14, 20-year old Adam Lanza killed his mother in their shared home in Newtown, Connecticut. He then proceeded to Sandy Hook Elementary School where he murdered students and staff members. The attacker entered by shooting through a school window, bypassing the building's locked doors. Using a semi-automatic rifle, he killed 20 children and six adults in less than 10 minutes. Two other adults were wounded. When police responded, the killer ended the attack by taking own life. No motive has been established for the crimes. This case demonstrates the vulnerability of facilities, such as schools, where large numbers of potential victims can be found in a small area. It also illustrates the short duration of most mass shooting attacks and the need for very rapid law enforcement response. The Sandy Hook Shooting demonstrates the limitations of passive defenses, such as locked doors, when facing an armed attacker. Finally, this case illustrates the willingness of some violent criminals to target even the most innocent and vulnerable victims.

Case: Las Vegas Shooting (2017)
On October 1, Stephen Paddock attacked the outdoor "Route 91 Harvest Music Festival" in Las Vegas, Nevada, with gunfire. Using multiple rifles configured for rapid fire, he killed 58 persons and wounded 413. Over 456 others were injured in trying to escape the attack. By firing on the crowd from an elevated position in the Mandalay Bay Hotel, approximately one-quarter mile from the festival, Paddock was able to target a very large number of potential victims and to delay police response. All the casualties were inflicted within about 10 minutes, after which time the shooter killed himself. No motive, terrorist or otherwise, was ever determined. This case demonstrates the ability of a mass shooter to inflict numerous casualties under optimal circumstances. It is also an example of a long-range attack, in contrast to most mass shootings conducted only at close range.

Vehicle Ramming Attacks
These are a relatively newer development in terrorism, using vehicles to simply plow through pedestrians. Typical targets are crowded areas and outdoor events. The attacks may be conducted by long-wolf terrorists, as they require little training or organization. They may also be conducted on short notice, even impulsively. Countries and communities that strictly control access to firearms still allow easy access to vehicles, making the attack difficult to prevent. Countermeasures include security barriers and bollards placed to protect the most important and vulnerable targets. Because of the large number of streets, sidewalks, bridges, and bike paths, it is impossible to cover all possible targets. Armed security personnel stationed during major events can provide some level of protection, but large vehicles such as trucks, can be very difficult to stop with light weapons such as handguns.

Case: Nice (2016)
Terrorist Mohamed Lahouaiej-Bouhlel attacked a holiday gathering in Nice, France, on July 14. Ramming a large cargo truck through barricades, he ran down and killed 86 persons, injuring 458. While he fired several shots from a handgun during the attack, all of the casualties were caused by his vehicle or by the rush of pedestrians attempting to escape. The attack lasted approximately five minutes, after which Lahouraiej-Bouhel was killed by police. The driver was motivated by extremist Islamic ideology, and several accomplices were arrested following the attack. The case provides an example of the large number of deaths and injuries that can be caused in a short time by a ramming attack in a crowded area. It also demonstrates the difficulty of defeating a heavy vehicle that can destroy barricades, such as the portable barriers and police cars that had been shoved aside by the attacker's truck.

Case: Charlottesville (2017)
Following a clash between right-wing groups and counter demonstrators on August 12, James Fields, Jr., a right-wing extremist, deliberately drove his car into a group of pedestrians walking away from the scene of the demonstrations.

One person was killed and 19 were injured. The driver was arrested, convicted, and sentenced to life in prison. This case demonstrates that while vehicle ramming attacks are often associated with radical Islamic terrorists, they can be used by other violent individuals as well. It also demonstrates the vulnerability of pedestrians after leaving an event, but while still crowded together on streets and sidewalks. Event security measures might not protect nearby crowds from this type of attack.

Case: New York City (2017)
On October 31, Sayfullo Saipov used a rented pickup truck to strike runners and cyclists on the bike path of the Hudson River Park in New York City. Eight persons were killed and 11 were injured during the attack, which ended when the driver rammed a school bus. Saipov was shot and captured shortly afterward and is accused of multiple terrorism-related offenses. The attack was reportedly motivated by extremist Islamic ideology, and Saipov apparently acted alone. This case demonstrates that vehicle ramming attacks can be directed against normal civilian traffic, as well as against crowded events. The attack against the school bus demonstrates that ramming attacks can target vehicles, as well as pedestrians, though pedestrians and cyclists are far more vulnerable.

Chemical Weapon Attacks
These attacks involve the use of poisonous materials, usually toxic gases, and may have an effect similar to the accidental release of hazardous materials. Commercial gases, such as chlorine and hydrogen cyanide, can be produced in mass quantities but can be difficult to use effectively due to unreliable dispersal. Military agents, such as nerve gases, are more deadly but are difficult to acquire or manufacture. Despite their theoretical effectiveness, few terrorists or criminals have attempted to use chemical weapons and most of their attacks have failed. One possible terrorist tactic would be to target chemical storage facilities to harm the surrounding communities.

Case: Tokyo Sarin Attack (1995)
On March 20, Japanese domestic terrorists launched a poison gas attack on the Tokyo subway system. The perpetrators were members of Aum Shinrikyo, a religious cult with extensive financial and scientific resources. The terrorists manufactured their own supply of the military nerve gas Sarin. This attack demonstrates that while it is difficult to create mass casualties with terrorist chemical weapons, it is comparatively easy to cause mass panic.

Although the nerve gases used in Tokyo were highly lethal and the attackers intended to cause many casualties, the terrorists had difficulty in spreading the gas effectively. Twelve people died in the attack, approximately 50 were severely injured, and more than 1,000 suffered more limited health effects. The attacks did cause considerable alarm, and medical facilities were overwhelmed by uninjured but frightened citizens. One lesson learned from this attack was the importance of preparing first responders and emergency room personnel to deal with chemically contaminated victims.

Biological Weapons
This type of attack may also be referred to as germ warfare. Some organisms, such as smallpox and plague, can spread from one victim to another, allowing an initially small attack to eventually infect many people. Other weaponized biologicals, such as anthrax, will sicken victims who contact the materials, but they don't themselves become directly contagious to others in the traditional sense. This attack resembles that of a chemical contaminant. Biological weapons may be attractive to terrorists and criminals because some varieties are relatively easy to produce. A widespread disease outbreak could potentially sicken many people and cause widespread panic. In addition, biological terrorism can be targeted against crops or livestock if the attacker wishes to cause significant economic damage.

Biological weapons also possess drawbacks for potential attackers. The effects are hard to control, and a disease released against a terrorist's enemies might very well spread to infect the attacker's friends and allies. Another problem is that the deadliest germ warfare agents, such as smallpox and breathable anthrax, are quite difficult to manufacture. Standard infectious disease control techniques, such as patient isolation, antiseptics, hand washing, and antibiotics may be very effective countermeasures against some biological attacks.

One major consideration for potential biological attacks is that germ warfare is often not recognized as an attack. Victims may not show symptoms for several days and may be initially dismissed as a naturally occurring disease. This may be an advantage for certain criminals who want their attacks to go unrecognized but could be a drawback for terrorists.

Case: Rajneeshee Salmonella Attack (1984)
During September and October 1984, followers of the fringe religious leader Bhagwan Shree Rajneesh deliberately attacked residents of The Dalles, Oregon, with the salmonella organism. Salmonella was spread by means of contaminated glasses of water and by spraying the organism on restaurant salad bars. A total of 751 people became ill and 45 were hospitalized with no fatalities.

The attack was an attempt to reduce voter turnout in a local election, allowing the Rajneeshee religious community to gain control of the Wasco County Circuit Court. The perpetrators did not intend for their attack to be recognized. They hoped that it would be mistaken for an accidental outbreak of food poisoning. Only after the group was investigated for other crimes was the outbreak recognized as a deliberate biological attack. This attack is a creative example of the criminal use of biological agents. It demonstrates the difficulty in identifying a biological event as a deliberate attack.

Case: "Amerithrax" Anthrax Attack (2001)
In October 2001, several letters contaminated with anthrax were mailed to locations in Florida, New York, and Washington, DC. The intended targets were politicians and members of the media, but most of the victims were accidentally exposed. Twenty-two victims suffered a confirmed anthrax infection and five died. Several structures, including government office buildings and postal facilities, were contaminated by anthrax and required expensive decontamination before they could be reoccupied. Fortunately, anthrax does not spread easily from person to person and the disease outbreak was quickly contained.

The Amerithrax attack was the subject of considerable media coverage and caused great national concern in the wake of September 11. The written content in the letters had initially suggested that Islamic terrorists were responsible for the anthrax. Many "copycat" incidents followed over the next several months, though fortunately all of these proved to be mere hoaxes. Eventually federal investigations determined that the attack was conducted by a domestic criminal posing as a foreign terrorist. In 2008, a U.S. government anthrax researcher was identified as the likely source of the attacks. An indictment was sought by the United States Attorney's Office, but the suspect committed suicide before his arrest. A potential motive was professional gain, as the attacks increased funding for the researcher's anthrax vaccine project. The incident is an example of the criminal use of biological weapons that demonstrates the difficulty in determining the motive for an attack. It also shows that not all attackers are foreigners or members of the radical political fringe, but in this case, a highly trusted government employee.

Radiological Weapons
Sometimes called "dirty bombs," Radiological Dispersal Devices (RDDs) are weapons designed to spread radiological materials. These devices do *not* create a nuclear explosion. The most standard design for a RDD involves conventional explosives, such as dynamite or gunpowder, with radioactive materials in the form of powder or scraps of metal. Such a bomb would do the same damage as a normal (non-radiological) explosive, in addition to the radioactive contamination. Radioactive materials could also be used by terrorists in manners besides bombs, such as poisoning.

No RDD has ever been used in an actual attack. However, based on U.S. government tests of dirty bomb designs, the health effects of this type of weapon would likely be quite limited. It is difficult to create enough contamination to make victims seriously ill and even more difficult to cause deaths through radiation. It is likely that more people would be killed by the normal explosives in a dirty bomb than would be seriously hurt by the effects of radiation. However, cleaning up an area once it has been contaminated by radioactive materials would be extremely difficult and expensive. Radioactive threats tend to cause great fear in the public. This makes radiological weapons potentially useful for terrorists.

RDDs are also considered a threat because the components for a dirty bomb have legitimate civilian uses and are available in the larger community. Hospitals, university research centers, and even many food processing facilities all possess radioactive materials that could be weaponized if stolen. There is a proven black market in radioactive materials, particularly involving sources stolen from Eastern European countries. Plans for radiological weapons have been discovered in the hands of several potential terrorists, including U.S. domestic terrorists.

Case: Goiânia Accident (1987)
Medical equipment was stolen from an abandoned hospital in Goiânia, Brazil. The thieves were seeking metal for salvage and were unaware that they had taken a powerful radioactive source. The protective casing for the equipment's cesium chloride source was cracked open with a hammer and the deadly material dispersed through homes and businesses. The victims, some of whom were children, and none of whom were aware of the danger, handled the radioactive cesium and, in some cases, painted it on their bodies or ate it. The danger was not recognized for more than two weeks. When the incident was made public, local medical facilities were then overwhelmed by approximately 130,000 persons seeking medical care. Eventually, 249 victims were found to be contaminated, four of whom died. Extensive clean-up work required widespread radioactive monitoring, demolition of buildings, excavation of contaminated soil, and disposal of large amounts of radioactive waste.

The Goiânia accident represents nearly a worst-case example of radioactive contamination. The material involved was especially dangerous, and the danger was undetected for several weeks. Victims had ongoing close contact with the radioactive material, including ingestion. A dirty bomb attack would likely be detected immediately, and a much timelier and more effective response conducted.

Nuclear Weapons

Unlike the radiological “dirty bombs” described above, nuclear weapons create large explosions capable of creating widespread damage and many casualties over a great area. The destructive potential of these devices makes them desirable for terrorist groups that wish to cause mass casualties. Nuclear weapons are difficult to build, however, requiring the use of rare and carefully guarded materials. Although several terrorist groups have actively sought to acquire nuclear weapons, no terrorist organization is known to have succeeded in doing so. The importance of the terrorist nuclear threat is not that such an attack is very likely, but that it is possible, and that the damage caused by such an attack would be immense. See the Nuclear Attack chapter for full details.

Case: Bombings of Hiroshima and Nagasaki (1945)

Although the atomic bombs used against Japan during World War II were military strikes and not terrorism, they are mentioned here because these are the only examples of nuclear weapons used against populated areas. The attacks, each using one bomb, destroyed the centers of the cities of Hiroshima and Nagasaki, though not their outskirts. At Hiroshima, 4.7 square miles of the city were destroyed and approximately 100,000 residents died. At Nagasaki, 1.8 square miles were destroyed and approximately 60,000 died. Their greatest cause of damage and destruction was intense heat and fire. The weapons were weak by modern military standards but were approximately the strength of the most likely types of terrorist nuclear weapons. The attacks may provide a rough guide as to what could be expected from a terrorist nuclear attack against a medium-sized city.

Intentional Sabotage

The destruction of property or the disruption of operations can greatly harm a business, government, or other entity. Sabotage often overlaps with, and can be difficult to distinguish from, other terrorist or criminal tactics. For example, explosives can be used to destroy vehicles or infrastructure, or chemical poisons can be used to contaminate food and medicine. A principal identifying characteristic of some sabotage is that the attack may not be intended to hurt large numbers of people, but rather to cause economic harm or embarrassment to the target. Where deaths or injuries do occur, they may be incidental and not the main purpose of the attack. Past sabotage tactics have included the toppling of electrical pylons, the burning of vehicles, and the destruction of railroads and bridges.

Many single-issue terrorists, including ecological extremists and anti-abortion radicals, employ property sabotage in attempting to burn down facilities or close operations. Most other terrorists tend to avoid sabotage unless it results in mass casualties. Sabotage by non-terrorist criminals is difficult to characterize, as it ranges from planned campaigns by organized labor groups, to one-time extortion plots, to attacks by mentally disturbed individuals.

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: 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 had no specific interest in harming the poisoning victims, except to use them to embarrass a personal enemy.

Select Laws, Agencies, or Programs

In addition to the information below, please refer also to the Weapons of Mass Destruction Attack Procedures section of the Michigan Emergency Management Plan for a comprehensive list of federal and state response assets.

Presidential Decision Directive 39 (PDD-39)
In 1995, and in response to the World Trade Center, Oklahoma City, and Tokyo Subway incidents, PDD-39 directed federal agencies to prepare for nuclear, biological, and chemical attacks from inside the country, as well as abroad. Although many presidential administrations have issued similar directives, PDD-39 was the first to make terrorism a top priority and to recognize that significant terrorism threats exist from within. PDD-39 designated the Federal Bureau of Investigation (FBI) as the lead federal agency for the crisis management of terrorism incidents and Federal Emergency Management Agency (FEMA) for post-incident consequence management.

Homeland Security Act of 2002
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.

Michigan Penal Code Act 328 (1931)
Although the federal definition of terrorism is used as a definition for the beginning of this chapter, the state penal code was significantly updated in 2002 with the signing of the Michigan anti-terrorism act into law. While similar, a link to the state law is provided here as a point of comparison and study for those looking to learn more on the topic.

Homeland Security Presidential Directives (HSPDs)
Many important HPSDs have been issued, including HSPD-5 (2003) to enhance the ability of the country to manage domestic incidents, such as terrorist attacks, major disasters, and other emergencies. This was done in part by establishing a single, comprehensive National Incident Management System (NIMS). This is now a part of Michigan's response framework. HSPD-7 was issued to identify, prioritize, and protect critical infrastructure. HSPD-8 required a national all-hazards preparedness goal, establishing mechanisms to improve federal preparedness assistance to states and local governments. More information can be found at the Homeland Security Digital Library.

National Operations Center (NOC) and National Counterterrorism Center (NCTC)
The NOC is the primary national-level multi-agency hub for domestic incident management. Part of the Department of Homeland Security, the NOC is a standing 24/7 interagency fusion center for law enforcement, national intelligence, emergency response, and private sector reporting. The NOC facilitates homeland security information sharing and operational coordination with other federal, state, local, tribal, and nongovernmental Emergency Operations Centers. The NCTC is the primary federal organization for analyzing and integrating all U.S. governmental intelligence pertaining to terrorism and counterterrorism. It serves as a central shared knowledge bank on known and suspected terrorists.

Michigan Intelligence Operations Center (MIOC)
The 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.

Michigan School Safety Initiatives
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.

Metropolitan Medical Response System (MMRS)
The MMRS supports the integration of emergency management, health, and medical systems into a coordinated response to mass casualty incidents. Successful MMRS grantees reduce the consequences of an incident by augmenting their existing local operational response systems. MMRS sub-grantees collaborate with local, regional, and health partners for strategic planning, including the continuity of government/operations, supply procurement, and emergency triage services. Additional programs are available on FEMA's Homeland Security Grant Program webpage.

Michigan Regional Response Team Network (RRTN)
The 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. The RRTN in Berrien County is one example.

51st Weapons of Mass Destruction Civil Support Team (WMD CST)
Stationed at the Michigan National Guard's Fort Custer Training Center, the 51st WMD CST augments local terrorism response capabilities for attacks known or suspected to involve Chemical, Biological, Radiological, Nuclear, and high yield Explosives (CBRNE). The 51st CST is deployed to (1) assess a suspected CBRNE event in support of a local Incident Commander, (2) advise civilian responders regarding appropriate response actions, and (3) facilitate requests for assistance to expedite the arrival of additional state and federal assets to help save lives, prevent human suffering, and mitigate property damage. Working in support of the Incident Commander, the CST can verify the perimeter of the exclusion zone and send teams into a "hot zone" to conduct reconnaissance, survey, detection, and sampling missions. The Team is on-call 24 hours-a-day, seven days-a-week and is designed for rapid deployment. The 51st WMD CST is activated through the State Emergency Operations Center (SEOC), or through a lead emergency response organization's Request for Assistance (RFA) submitted to the Michigan National Guard's Joint Operations Center (JOC).

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.

Strategic National Stockpile (SNS)
The U.S. Centers for Disease Control (CDC) Strategic National Stockpile—a national repository of pharmaceuticals and life-saving medical materials—can be delivered to states at times of national need. It was used in 2020 in response to the COVID-19 pandemic to deliver gloves, face masks, hospital gowns, and other supplies.

Michigan Department of Health and Human Services (MDHHS) Bioterrorism Efforts
MDHHS's 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.

Terrorism Risk Insurance Program (TRIA)
TRIA provides for a transparent system of shared public and private compensation for insured losses resulting from acts of terrorism. This protects consumers by addressing market disruptions and ensuring the widespread availability and affordability of property and casualty insurance for terrorism risks. Although technically established as a temporary program, it has been extended through 2027.

Public Health Security and Bioterrorism Preparedness Act of 2002
The Act, Public Law 107-188, provides the Food and Drug Administration (FDA) with information on the origin and distribution of food and feed products and aids in the quick response to potential threats to the U.S. food supply. Its primary components include National Preparedness for Bioterrorism and Other Public Health Emergencies, Enhancing Controls on Dangerous Biological Agents and Toxins, Protecting Safety and Security of Food and Drug Supply, and Drinking Water Security and Safety.

The Maritime Transportation Security Act (MTSA) of 2002
The MTSA, Public Law 107-295, is designed to protect the nation's ports and waterways from terrorist attacks. The law is the U.S. equivalent of the International Ship and Port Facility Security Code. It requires vessels and port facilities to conduct vulnerability assessments and develop security plans that may include passenger, vehicle, and baggage screening procedures, security patrols, and installation of surveillance equipment. The MTSA also requires Area Maritime Security Committees tasked with collaborating to deter, prevent, and respond to port-related terror threats.

Supplemental Material

Additional cases for further study

- 1955 – Flight 629 insurance bombing (demonstrates a criminal attack against an airliner; related cases include Flight 967 of 1959, Flight 2511 of 1960, and Flight 11 of 1962).

- 1974 – "Alphabet Bomber" Muharem Kurbegovich (example of multiple incendiary attacks as part of an individual's terror campaign).

- 1982 – Tylenol cyanide poisonings (an example of a major impact on industry and an unknown perpetrator with an undetermined motive).

- 1993 – World Trade Center bombing (demonstrates the importance of terrorist planning).

- 2002 – Washington D.C. area Beltway Snipers (example of random attacks, the effectiveness of a small team, long-range shooting, and widespread public fear).

- 2004 – Madrid train bombings (demonstrates political benefits for terrorists). Also, the 1978-1995 Unabomber attacks and the 2016 New York and New Jersey bombings both demonstrate terror bombing campaigns conducted by lone-wolf terrorists.

- 2004 – Beslan School attack (an example of massive casualties, terrorist targeting of young children, difficult rescue operations, and a large suicide team with military weapons).

- 2005 – London transit bombing (demonstrates the use of small, improvised devices).

- 2007 – Virginia Tech shooting (an example of heavy casualties caused by a single gunman of a university target).

- 2010 – Afghan girls' school attacks (an example of non-fatal uses of toxic gas with schools as targets; also 2015).

- 2013 – Nairobi, Kenya shopping mall attack (the mall setting may be relevant to American vulnerabilities).

- 2020 – Michigan Governor Whitmer attempted kidnapping (although no attack was ever made, the case is still included in the Michigan Hazard Analysis to demonstrate terrorism may be directed at high level targets within the state).

  Full details are not known at the time of this writing but include the following: On October 7, 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.

CYBERATTACKS AND MAJOR NETWORK DISRUPTIONS

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.

Hazard Description

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). Elements of cyberwarfare and electronic warfare are also touched upon in this chapter. 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, tornadoes, 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. A brief glossary of terms appears at the end of this chapter.

Hazard Analysis

Many early cyberattacks were primarily conducted by skilled amateurs operating individually for sport or entertainment. Currently, well-organized groups of profit-driven, ideological, and nation-state operators gain the most attention. Such hackers often operate globally, attacking targets anywhere in the world from a variety of locations.

Organized crime and terrorist organizations have become increasingly adept at using the technology, sometimes controlling large networks of coopted computers referred to as “botnets.” Such computers are taken over without the owners' knowledge and controlled remotely. The use of “ransomware” provides a platform for such hackers to hold sensitive data electronically hostage in exchange for payment, or the simple theft of sensitive data, such as social security or bank account numbers that can be sold on the dark web. Corporate espionage targets competitor’s research.

Other cyberattacks are done by “hacktivists” who are motivated by ideology or political causes. Several global networks of hacktivists have been created, including “Anonymous” and “Lutzsec.” These loosely organized groups include members in multiple countries who coordinate their efforts online. Hacktivists groups are difficult to disrupt, both because of the challenge in determining the real identity of members and because they may be in countries which refuse to cooperate with international law enforcement.

National governments are developing sophisticated cyberattack capabilities in order to support espionage programs, damage the computer networks of other nations, or simply to steal money. One cyberattack capability purportedly deployed by government-sponsored programmers is the ability to damage industry by taking over the software that controls machinery. Cyberattacks on these control systems can impact critical infrastructure, such as electrical grids, water treatment facilities, and fuel pipelines.

National cyberattack capabilities are also expected to include efforts to disrupt governmental networks, such as those used by law enforcement. It is important for emergency managers to realize that they themselves may also be a target. At its extreme, cyber and electronic warfare between nations with sophisticated capabilities could escalate to the physical destruction of large data centers, digital networks, and orbiting communications satellites.

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.

With technological advances increasing at an exponential rate, a constant cat and mouse game between hackers and cybersecurity efforts is constantly underway. Advancements that help to solve some problems (such as the use of the "cloud," or biometric passwords) in turn can create new risks and vulnerabilities. A thorough defense against cyberattacks requires equally strong technological capabilities on the part of those being attacked to detect security breaches and determine details about the attackers.

Specific Impacts

Impact on the Public, Property, Facilities, and Infrastructure

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. Specific case examples listed below demonstrate a breadth of hazards that impact a wide portion of the public's everyday lives.

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.

Impact on the Economic Condition of the State

Large cyberattacks can have varying effects on the state's economy to the extent of who is being targeted and to what ends. The cost of mounting an effective cyber-defense is now considered part of the cost of doing business within industries. However, increased prices are passed along to consumers when possible.

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 the state's economy.

Impact on Responders, Continuity of Operations, and Continued Delivery of Services

Cyberattacks do not typically have a direct impact on first responders at the scene of incidents. However, 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.

More governmental employees began working from home because of COVID-19 in 2020. While virtual private networks and other countermeasures can be used to mitigate against cyberattacks on such employees, some experts believe the broader public network footprint created from a work at home environment now puts governmental systems at greater risk.

Impact on Public Confidence in Governance

Government increasingly encourages its citizens to use online services to save money, but confidence can be shaken when local agencies find themselves unable to properly protect themselves or safely shepherd the data they are entrusted with. Government itself is frequently the target of cyberattacks.

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.

Reports of successful hacks against even large actors within the federal government further deteriorate confidence. The U.S. Defense Information Systems Agency (DISA) confirmed that computers under its control had been successfully hacked in 2019. The personal data of 200,000 people was compromised, including social security numbers. Tax returns, stimulus checks, and unemployment cards are other attractive targets for criminals buying information off the dark web or using a combination of computer hacks with other methods to conduct crime.

Impact on the Environment

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. In extreme situations, attacks on infrastructure, such as dams and hydroelectric facilities, could lead to flooding or other catastrophes. If computers that control machinery were successfully attacked and used to bypass safety control features at a nuclear plant, the results could devastating. With technology having become so pervasive, many such scenarios need to be contemplated and planned for.

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.

Cyberattack Examples

An increase in sensitive data exposure, hacking, ransomware, and a variety of other cyberattacks have become so common that a complete cataloging of even major incidents would be a difficult task necessitating daily updates. While Michigan-specific examples do exist, in many cases attacks originate from people who never set foot in the state, and their impact may be national in nature. Michigan residents "share" in the damage of such a breach, even if none of the compromised servers reside in the state. A non-exhaustive sampling for illustrative purposes includes:

Case: SQL Slammer Worm (2003)
On January 25, the Internet was hit by the fast-moving SQL Slammer worm. It spread via a vulnerability in the commonly used Microsoft SQL programming language and entered over 75,000 computers within a matter of minutes of release. It eventually infected over 250,000 computers. Almost all of Bank of America's 13,000 ATMs were temporarily knocked offline, and South Korea experienced an outage of Internet and cell phone coverage for 27 million people. Close to Michigan, the worm infected computers at the Davis-Besse Nuclear Plant near Toledo and disabled a safety monitoring system for nearly five hours. The infection failed to truly endanger operations due to the plant's operational status and redundancies. The worm entered the system through a contractor's backdoor that had been allowed to bypass the facility's firewall.

Case: July 2009 Cyberattacks (2009)
A series of cyberattacks was directed against computer systems in the United States and South Korea on the 4th of July. Targets included the U.S. State Department, Department of Defense, White House, numerous South Korean government agencies, and a bank, and were designed to shut down targeted websites by using a denial of service attack. This was accomplished with a "botnet" of computers infected by a computer virus. Thousands of computers were hijacked and used in these attacks without their owners' knowledge. Some experts believe North Korea was behind the attacks, perhaps with the help of criminal networks operating outside of that country. As with many cyberattacks, it was impossible to definitively prove who was responsible. This case demonstrates the significant economic and governmental disruption that can be caused by even relatively basic cyberattacks. It also demonstrates that the geographic locations of the attackers and their targets are largely irrelevant.

Case: Stuxnet (2010 – Present)
First discovered in June of 2010, Stuxnet is a highly sophisticated cyberattack program. This "computer worm" software has been designed to infect industrial control systems created by the Siemens Corporation. On most computers, the Stuxnet worm stays hidden and does no damage. However, if the Siemens control software is connected to certain types of motors, the worm conducts a cyberattack on the infected system. The targeted motor is ordered to rapidly change speeds, which will destroy certain types of connected industrial equipment. Meanwhile, the safety mechanisms on the equipment are disabled, with monitors reporting normal motor performance even as equipment is being destroyed. It is believed that Stuxnet was designed specifically to damage uranium processing equipment operated by the government of Iran, with substantial harm apparently inflicted on a processing facility in Natanz. The creators of Stuxnet are unidentified but given the sophistication of the software and the care with which certain systems were targeted, it is considered likely that at least one national intelligence service was involved in creating the worm. It also provides an early example of cyberattack software capable of causing physical damage and not just theft of data.

Case: Flame Malware (widely publicized in 2012)
Flame (also known as Skywiper) is complex, targeted malware which became widely known in 2012 (although the worm was already at least two years old). Used for espionage activities, it attacked computers that use the Microsoft Windows operating system. It can spread through local area networks and through USB memory sticks, and reportedly can record a user's keyboard activity, as well as the audio and visual output of the computer (such as Skype conversations). In addition to relaying this information to distant observers, it reportedly can delete large amounts of information from the infected system.

Case: CryptoLocker (2013 – 2014)
The CryptoLocker ransomware attack was a cyber extortion scheme that occurred in 2013 and 2014. It utilized a Trojan file delivered via infected email attachments and other methods. When activated, the malware encrypted local files using a private key unavailable to the computers' owners. The malware would display a message offering to decrypt the data in exchange for money (frequently through bitcoin accounts). If the blackmail was not met, the data would be kept encrypted (and unusable by the organization) or physically erased. Depending on the type of data encrypted, the threat was a serious one. The causative Trojan was not difficult to remove but breaking the encryption in a timely without the attacker's help was not practical. Many victims claimed that paying the ransom did not always lead to the files being decrypted. Although a definitive number is not known, some believe CryptoLocker successfully extorted at least $3-27 million and served as a template for several later copycat ransomware attacks. It was reported in the first half of 2017 that ransomware payments were as high as $2 billion worldwide.

Case: Jeep Cherokee Hack (2015)
Hackers will have more opportunities to breach vehicle systems as they become more computerized and wirelessly connected to the Internet. Hacking of car computers first gained wide attention in 2015 when a reporter for WIRED magazine allowed research hackers to demonstrate how they could remotely take control of his vehicle. In this case, software let the hackers send remote commands through the Jeep's entertainment system to functions that could include

steering, brakes, and transmission (most publicized previous hacking attempts had required the computer to be physically connected to a car's diagnostic port). Chrysler issued a recall for 1.4 million vehicles as a result of Miller and Valasek's research. Additional researchers, such as Thomas Holt at Michigan State University, continue research on how to prevent such cyberattacks from becoming real life situations resulting in loss of life or transportation gridlock. Holt believes that connecting a smartphone through a USB port could also give a hacker backdoor access to data from both the phone and the car, and that risks will increase as more vehicles gain autonomous vehicle capabilities.

Case: Central Bank of Bangladesh Heist (2016)
While state-sponsored North Korean hacking attacks are commonplace, one especially notable attack, with alleged North Korean involvement, attempted to divert over $1 billion. A Dridex malware attack was largely halted, but North Korea was purportedly still able to divert in excess of $80 million for which they were believed to be the ultimate recipient. A 2019 report on North Korea commissioned by the United Nations Security Council put an approximate cumulative figure of their takings at roughly $670 million. This was represented in a mix of foreign currency and cryptocurrency, such a bitcoin. The growing adoption of cryptocurrencies is notable as it relates to hacking because cryptocurrency transactions aren't processed by regulated financial institutions in most countries. Hacking attacks that garner cryptocurrency can be extremely difficult to trace.

Case: Equifax Data Breach (2017)
Equifax announced a data breach in September that exposed the personal information of 147 million people. The breach was considered especially significant as the company is one of only three major credit score reporting entities in the United States and by their very nature are designed to capture, update, and store sensitive credit histories. The company agreed to a global settlement with the Federal Trade Commission, the Consumer Financial Protection Bureau, and 50 U.S. states and territories. The settlement includes up to $425 million to help people affected by the data breach, although establishing causation was found difficult to prove and subsequent investigations led to the belief that the attack was more about espionage than theft. In February 2020, the United States Department of Justice formally charged four Chinese nationals for the attack. The four were allegedly members of the People's Liberation Army's 54th Research Institute, a component of the Chinese military.

Case: Capital One Hack (2019)
Capital One Financial Corporation determined that a hacker broke into its cloud-based server by exploiting a configuration vulnerability in a web application firewall. The person accessed personal information for more than 100 million Capital One customers in the U.S. and six million in Canada. This example was considered one of the biggest hacks of its kind at the time. The hacker attempted to share the stolen information with others. As a lesson learned, the case demonstrates that while cloud based servers run by professional companies can be more secure than typical "on site" servers in some regards, applications migrated to the cloud also carry with them an intrinsic danger associated with broader access from anywhere in the world.

Case: Biostar 2 Biometric Exposure (2019)
Biometric information for over 28 million users was compromised when information belonging to Suprema, whose Biostar 2 system is used to secure commercial buildings, was found in a relatively unsecured state and exposed to bad actors. The sensitive information included one million fingerprints, as well as facial recognition data and images. Access to usernames, passwords, and employee records were also uncovered, as well as a list of people who had entered secured areas. The lax security was considered significant for a variety of reasons, but primarily because of the biometric data involved. Passwords can be changed after hacking, but once fingerprints or a person's iris are publicly available, they are, for the most part, permanently compromised.

Case: Twitter Hack (2020)
The social media giant Twitter was the victim of a widely publicized attack that gained access to the accounts of notable figures such as Elon Musk, Joe Biden, and Barack Obama. Some of the compromised accounts made it appear as if real people were asking for bitcoin donations for charity, which were then siphoned to criminal accounts. Twitter claimed the attack happened with the use of social engineering to trick an employee into providing access to internal Twitter administrative tools. It was also reported that Twitter contractors had been taking advantage of lax security to be able to spy on public figures for many years prior. In a statement, Twitter admitted that fraudsters "took control of many highly-visible (including verified) accounts and Tweet[ed] on their behalf. We're looking into what other malicious activity they may have conducted, or information they may have accessed, and will share more here as we have it." Government entities who use Facebook, Twitter, and other social platforms as part of their messaging need to monitor their accounts to ensure only proper information is being disseminated.

Case: Michigan State University Hack (2020)
Michigan State University was the victim of a cyberattack by operators of NetWalker ransomware. A tweet appeared on May 27 with screenshots of a directory structure from the university's network, a passport scan for a student, and two scans of financial documents. The school was given a week to pay an undisclosed sum to decrypt the stolen files. Past victims of the NetWalker group include the Australian shipping company Toll and the government of Weiz, Austria.

Case: Garmin Cyberattack (2020)
The GPS company, Garmin Ltd., known for its navigational products and smart watches, was the victim of a ransomware attack in July that demanded $10 million. Complete details are unknown as of the time of this writing, and after online services for their products was restored, the company had not confirmed the nature of the attack or clarified if they had paid the ransom. In a statement, the company said, "We have no indication that any customer data, including payment information from Garmin Pay, was accessed, lost, or stolen," seeming to imply that the data had only temporarily been encrypted. The attack was believed to be due to a strain of ransomware called WastedLocker, which is associated with a known Russian hacking group. The Department of Justice had previously filed charges against the same Russian group in 2019, and the United States has issued sanctions and offered a $5 million reward leading to the capture of its leader.

Select Laws, Agencies, and Programs

Michigan Cyber Initiatives
The State of Michigan has made numerous advances in its preparedness and security initiatives, an overview of which can be found at http://www.michigan.gov/cybersecurity. It includes a copy of the state's Cyber Disruption Response Plan and links to the Michigan Cyber Civilian Corps (MiC3) and other sources of information on the topic.

The Michigan Cyber Disruption Response Team (CDRT) comprises members from several state departments and agencies and is the primary coordinating structure for the state's cyber disruption incidents. The MiC3 is a group of trained, civilian technical experts who individually volunteer to provide rapid response assistance to the state in the event of a critical cyber incident. Its mission is to provide mutual aid to state government, business organizations, and other partners in the event of a critical cyber incident. The Michigan Intelligence Operations Center (MIOC) within the Michigan State Police monitors online activities that may impact the state's security interests. The state also participates in National Cybersecurity Awareness Month (typically in October).

Cybersecurity and Infrastructure Security Agency (CISA)
Established in 2018, CISA is a standalone U.S. federal agency and operational component under the Department of Homeland Security. Its website includes the CISA Services Catalog, available to all levels of government, along with a secure web-enabled Incident Reporting System for forwarding computer security incidents to CISA in order help the agency monitor and analyze potential attacks (available for viewing on its recent alerts page). The alerts can also be subscribed to. Michigan is a part of CISA Region V, headquartered in Chicago.

National Cybersecurity and Communications Integration Center (NCCIC)
Housed within CISA, the NCCIC helps to coordinate the federal government's cybersecurity and cyberattack mitigation efforts through cooperation with various stakeholders, including state and local governments. The NCCIC includes the country's United States Computer Emergency Readiness Team (US-CERT) and Industrial Control Systems Cyber Emergency Response Team (ICS-CERT).

National Risk Management Center (NRMC)
Housed within CISA, the NRMC leverages sector and stakeholder expertise to identify the most significant risks to the nation and to coordinate risk reduction activities to ensure critical infrastructure is secure and resilient. Some of the top NRMC initiatives in 2020 included 5G, election security, electromagnetic pulses, national critical functions, and positioning navigation timing.

Computer Emergency Response Team Coordination Center / Software Engineering Institute
The Computer Emergency Response Team Coordination Center (CERT/CC) is located at the Software Engineering Institute, a federally funded research center. CERT/CC was established at the behest of the Defense Advanced Research Projects Agency (DARPA) to coordinate communication among experts during security emergencies and to help prevent future incidents. The CERT/CC publishes security alerts and develops training in network security. Its incident handling practices have been adapted by cyber response teams around the world.

Supplemental Material

Chapter Glossary

Backdoor: An Internet method used for bypassing normal authentication or encryption in a computer or network device. Backdoors have legitimate purposes and are often used for securing remote access to a computer or restoring user passwords. Many computer users are unaware of the backdoors that exist on their system, and unauthorized access due to poor vendor management or weak security can be exploited. Some backdoors may be secretly installed.

Botnet: Short for the words robot and network, the term often applies to groups of computer systems that have had malicious software installed by worms, Trojan horses, or other software that allows the botnet's originator to control the computers remotely.

Cloud computing: A broad term describing efforts to "export" computer programs or data onto off-premise servers located with a third party, typically at a datacenter. Rather than needing a program physically loaded on a computer, a computer with Internet access can interact with the program installed on a remote server. Likewise, data servers that had previously been located on premise have their servers located remotely, or simply rent storage space on other's servers.

Computer hygiene: A broad term for small but important steps that employees can take to ensure "clean" company computers and the prevention of data theft. This includes not sharing passwords, restarting computers after updates, not downloading unauthorized content, protecting laptops and memory sticks when off premise, and other similar actions.

Cookie: A small text file that is placed on a computer's hard drive by a website in order to allow that site to retain and use information about the user (and the user's activities) at a later time.

Dark web: The content of the World Wide Web that exists on darknets. Such networks use the Internet but require specific software, configurations, or authorization to access and is often associated with nefarious activity (also used for non-criminal activities where privacy is of a concern). The dark web is a small part of the deep web.

Deep web: The content of the World Wide Web that is not generally public nor indexed (made searchable) by search engines. Typically used for web mail, online banking, restricted access social-media pages, and content protected by paywalls (video on demand, some online newspapers).

Internet of Things (IoT): The interconnection, via the Internet, of everyday devices, such as eyeglasses, watches, pace-makers, house doors, automobiles, and other items that historically did not have computer components that allowed for the wireless transfer of electronic data or remote operation.

Keystroke logger: Any method that allows the recording or interpretation of which keys have been pressed by a user on the person's computer keyboard, typically without the person's awareness or consent. The methods include software or hardware that records all typed information and then makes use of the computer to relay information to a remote person.

Malware: A broad term for software, often installed on a user's computer without their consent, that performs unwanted actions. These may be relatively benign and used for targeted advertising, but may also result in poor computer performance, data corruption, or system crashes. Some can be used to send email through another person's account or used for surveillance purposes (see spyware).

Pharming: Arranging for a website's traffic to be redirected to a different, fraudulent site, either through a vulnerability in an agency's server software or using malware on a user's computer system.

Phishing: The attempt to trick someone into providing confidential information or doing something that normally wouldn't be done. As an example, phishing could involve sending an e-mail that falsely claims to be from an established legitimate enterprise, to scam the user into surrendering private information to be used for identity theft.

Ransomware: An attack where a hacker encrypts or otherwise locks the legitimate user out of portions of their computer system. Sensitive or necessary data is reenabled only after the computer's owner pays the hacker money (frequently in cryptocurrency such as bitcoin).

Social engineering: In the context of cybersecurity, an effort to psychologically manipulate a person, especially through deception and misrepresentation. Schemes can be complex and may involve several stages of confidence manipulation over a period.

Spear phishing: A form of phishing that targets a specific individual or organization, usually relying on an accumulation of information to make subsequent ruses more effective when further probing the target, until a successful breach occurs.
Spoofing: (1) Attempting to gain access to a system by posing as an authorized user. Synonymous with impersonating, masquerading, or mimicking; (2) Attempting to fool a network user into believing that a particular site was reached when actually the user has been led to access a false site that has been designed to appear authentic, usually for the purpose of gaining valuable information, tricking the user into downloading harmful software, or gaining money.

Spyware: Software that allows others to gain private information about a user without that person's knowledge or consent, such as passwords, credit card numbers, social security numbers, or account information.

Trojan (or Trojan Horse): A program that appears to be for one purpose but performs different and illicit activity when run (often behind the scenes). Can be used for a variety of illegitimate purposes.

Virus: A code or program that attaches itself to a legitimate, executable program and then reproduces itself when that program is run. The primary difference between a virus and a worm is that viruses must be triggered by the activation of their host, whereas worms can stand alone and propagate independently as soon as they have breached a system.

Worm: A self-contained code, program, or set of programs that is able to replicate copies of itself and spread to other computer systems via network connections. See also "virus."

NUCLEAR ATTACK

A hostile action taken against the United States or its citizens involving nuclear weapons and resulting in the loss of life and/or destruction of infrastructure and environment.

Hazard Description

Nuclear weapons are explosive devices that manipulate atoms to release enormous amounts of energy. Compared to normal chemical explosives, such as TNT or gunpowder, nuclear weapons are far more powerful and create harmful effects not seen with conventional bombs. A single nuclear weapon is able to devastate an area several miles across and inflict thousands of fatalities.

Hazard Analysis

The threat of nuclear attack has primarily been associated with the adversarial relationship between the United States and the Soviet Union in the last half of the 20th century. Although the historical Cold War is over, the relationship between the United States and the Russian Federation has been severely strained by the invasion of Ukraine. Beyond war between countries there is also the possibility of nuclear terrorism.

Understanding Nuclear Weapons

The following information about nuclear weapons is important for understanding the full dynamics of such an attack: (1) types of nuclear weapons, (2) measures of weapon power, (3) forms of attack, and (4) types of delivery systems.

Nuclear weapons have been built in a wide variety of types for several different purposes. The first weapons relied on nuclear fission, or the splitting of heavy atoms, to release energy and create an explosion. Later, new weapons were invented that used a combination of fission and fusion, which involves the creation of heavier atoms from lighter ones. Fusion bombs are also referred to as hydrogen bombs or H-bombs. For emergency planning purposes, the most important differences are that fusion bombs are more difficult to build and can be much more powerful. Otherwise, all types of nuclear weapons create the same types of general effects.

The power of nuclear weapons is measured by comparing the energy released by the weapon to the energy released by large amounts of conventional high explosive. The strengths of smaller weapons are measured in kilotons (or thousands of tons) of TNT explosive. A 20-kiloton bomb produces as much energy as 20 thousand tons of TNT exploded at once. The strength of larger weapons is measured in megatons or millions of tons of TNT. A two-megaton bomb produces as much energy as two million tons of high explosive.

Smaller nuclear weapons are generally designed to be used against military targets on the battlefield. These are called tactical nuclear weapons. Larger devices designed to attack cities, infrastructure, and military bases are called strategic nuclear weapons.

Bombs can be set off at varying heights above the target. If the bomb is set off high in the air, its effects are spread out over a wider area and generally cause more damage. This is called an air burst. Terrorists may be unable to detonate their weapons high enough to create an air burst. A bomb that is set off instead, at or near the Earth's surface level, wastes much of its energy against the ground. This is called a ground burst, which still has some strategic uses.

Like any weapon, a nuclear device must be carried to its target by a delivery system. The first nuclear weapons were bombs dropped out of aircraft. Later, tactical weapons were made small enough to fire out of cannons or carry in large backpacks. Intercontinental ballistic missiles (ICBMs) are rockets that can carry nuclear weapons across thousands of miles in less than an hour. Terrorists may lack sophisticated missiles but could create effective delivery systems by transporting a nuclear weapon in the back of a truck, aboard a cargo plane, or within a shipping container.

Effects of Nuclear Weapons

The effects of nuclear weapons are more complicated than those of conventional explosives. Nuclear devices cause damage through six major effects: (1) thermal pulse, (2) blast, (3) prompt radiation, (4) electromagnetic effects, (5) mass fire, and (6) residual radiation.

THERMAL PULSE is an intense flash of light and heat released within the first few seconds of a nuclear explosion. The damage from thermal pulse is almost instantaneous and covers a wide area. People and animals exposed to

the pulse can be badly burned. Flammable objects, such as buildings, vehicles, and trees, may be set on fire. The flash is strongest close to the bomb and becomes weaker with distance. Even people located far away from the explosion may still be blinded by the intense light of the pulse.

BLAST is a powerful wave of force that moves out from the center of the explosion through the air and the ground. The farther the blast travels, the weaker it becomes. Very close to the bomb, the blast will destroy even the most strongly built buildings and will kill everyone not hidden deep underground. Farther away, buildings may survive, but with severe damage, and people will be injured by being picked up and smashed against objects. At still greater ranges, buildings will be less damaged, and injuries will largely result from shattered glass and thrown debris. At all distances, a powerful wind follows the initial blast wave and adds to the destruction. The blast from a ground burst will dig a large crater into the ground, but this cratering will not occur with an air burst.

PROMPT RADIATION is the harmful blast of high energy radiation given off at the same time as the thermal pulse. Prompt radiation includes gamma rays and neutron radiation. This radiation is capable of killing or injuring living beings by damaging tissues and organs. Prompt radiation is quickly absorbed by the atmosphere and does not impact as wide an area as other nuclear weapons effects. In most instances, a person close enough to receive a harmful dose of prompt radiation is also close enough to be immediately killed by the explosion's thermal pulse or blast. A person who survives this exposure may sicken or die days later from radiation poisoning.

ELECTROMAGNETIC EFFECTS occur immediately after a nuclear explosion and may damage communications equipment, computers, and electronics. Radios, cell phones, and power lines are especially vulnerable. In most cases, the effects are limited to an area near to the explosion. Some equipment may recover after a period, while other devices will need to be replaced. One special type of nuclear attack might cause more widespread electromagnetic effects. A very large nuclear weapon carried high into the atmosphere by a missile is capable of damaging communications and electronics over a very large area.

MASS FIRE results from the ignition of thousands of individual fires by a bomb's thermal pulse, combined with widespread destruction from its blast. Over a period of hours, small fires merge and feed on damaged buildings and debris. Controlling these fires would be very difficult, due to damaged water mains, destroyed firefighting equipment, and blocked roads. The result is an extremely intense fire that can spread quickly and reach very high temperatures. Mass fire may significantly expand the area devastated by a bomb, destroying areas that might otherwise be only lightly damaged by other types of effects.

RESIDUAL RADIATION is unlike prompt radiation in that it lasts well after the nuclear explosion has ended. The ground immediately underneath the center of the explosion will be dangerously radioactive for several days due to "induced radiation." There will also be some radioactive dust and debris that will drift downwind of the explosion. This radioactive dust is called "fallout," which has a smaller effect in the case of an air burst explosion but is very intense with ground bursts. The danger from fallout will tend to be greatest closer to the site of the attack. Its effect weakens over time and the farther it travels.

Note that the effects of a nuclear attack will depend on the size of the weapon, with different types of damage incurred. Large strategic nuclear weapons will create most of their damage through thermal pulse and mass fires, while with small tactical bombs, the blast effect and prompt radiation will be relatively more important. Nuclear attack against the United States would originate either as a strike by an enemy military or as a terrorist attack. Fortunately, nuclear devices are very difficult to build and limits the availability of the weapons. Careful engineering and extremely rare materials are needed to make a working nuclear weapon.

Scenario #1: Military Missile Nuclear Attack

At the end of World War II, only the United States possessed nuclear weapons. Several countries now openly possess these devices, while others may have secret nuclear weapons programs. Some of these "nuclear powers" are American allies but others remain potential adversaries. While unlikely, it is possible that an international crisis in areas such as Ukraine, the Persian Gulf, the Taiwan Straits, or the Korean Peninsula could escalate into a nuclear attack. There is also a risk from accidental or unauthorized nuclear launches.

A strike by a nuclear power could consist of a single weapon or thousands, depending on the strength and intentions of the attacker. The most likely form of military attack would be the launch of intercontinental ballistic missiles fired from thousands of miles away. A very small attack or an accidental launch might be possibly intercepted and stopped, but a sufficiently large attack would minimally be able to strike at least some portions of the United States.

A nuclear power would have the ability to attack several locations at once. Multiple detonations across the country would overwhelm national assets, forcing states or regions to rely on local resources. These attacks would probably be targeted

on large cities and military bases and would use strategic nuclear weapons—each with a power of 100 kilotons or more. Cities would usually be attacked with air bursts, and military bases using ground bursts.

The following map illustrates the effects of a typical military nuclear missile warhead. This example represents a 750-kiloton air-burst detonation at an altitude of 8,000 feet on a clear day above a mid-sized American city. Such an attack would be representative of an attack on Michigan cities, such as Grand Rapids, Lansing, Flint, or Ann Arbor. The rings in the illustration show distances from the center of the nuclear explosion.

Outer Ring: 6.3 miles across
At this distance, the exposed skin of persons outdoors will suffer immediate third-degree burns (8 kcal/cm^2). With medical services destroyed or overwhelmed, almost all severely burned victims die. Mass fires can be expected to develop within hours. Eventually, most of this area will be destroyed by fire.

Second Ring: 3.3 miles across

At this distance, the blast wave will totally destroy light frame structures, such as most homes (5psi). Sturdier buildings will be severely damaged, with their interiors destroyed. Winds at 160 mph would follow the blast wave.

Third Ring: 3.0 miles across
At this distance, exposed persons will be affected by intense prompt radiation (5Gy). Between 50 percent and 80 percent of victims will eventually die from this exposure, unless first killed by blast or thermal effects.

Inner Ring: 1.6 miles across
At this distance, the blast wave will totally destroy even reinforced concrete buildings (20psi). Winds of 230 mph will follow the blast wave. Essentially everyone within this ring will be immediately killed. Lighter damage will extend well beyond the area depicted in the map, mostly because of the thermal pulse.

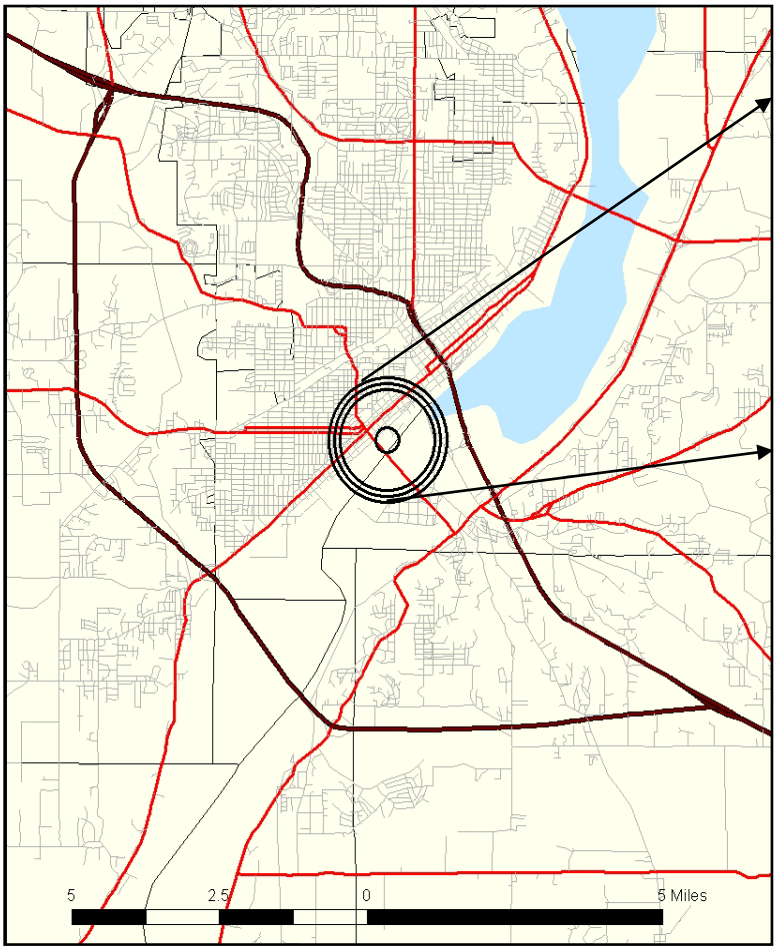
Scenario #2: Terrorist Nuclear Weapon
As far as publicly known, no terrorist organization has ever managed to gain access to nuclear weapons. However, the great destructive potential of these devices makes them very desirable for terrorist groups that wish to cause massive and indiscriminate casualties. It is known that several terrorist groups have actively pursued nuclear weapons.

Terrorists could acquire nuclear weapons as gifts from friendly governments by stealing them from military stockpiles, or by building a crude device on their own. Each of these approaches is considered unlikely, but not impossible. A determined and well-financed terrorist group, such as Al-Qaeda, may eventually be able to acquire a working nuclear weapon. A nuclear attack by a terrorist organization would likely involve only a single weapon.

Because powerful strategic bombs are more difficult to steal or build, it is likely that a terrorist device would be of the less powerful tactical type. A rough estimate for the strength of this kind of nuclear weapon would be 25 kilotons or less. Importantly, even such a 'small' device would be approximately as powerful as the bombs that destroyed the Japanese cites of Hiroshima and Nagasaki at the end of World War II.

A terrorist nuclear weapon would be unlikely to arrive aboard a missile. It is much more probable that the bomb would be smuggled to the target, hidden inside a truck or cargo container. Even a bulky improvised weapon could be easily carried in this manner. The bomb could be detonated from inside its hiding place, creating a ground burst. There is a lesser possibility that terrorists could use a cargo plane to deliver a nuclear weapon as an air burst.

This map illustrates the effects of a possible terrorist nuclear bomb. This example shows the effects of a 25-kiloton nuclear weapon detonated at ground level on a clear day in a mid-sized American city. Such an attack would be representative of an attack on Michigan cities, such as Grand Rapids, Lansing, Flint, or Ann Arbor. The rings in the illustration show distances from the center of the nuclear explosion.



Outer Ring: 1.0 miles across
At this distance, exposed skin will suffer immediate third-degree burns (8 kcal/cm2). With medical services destroyed or overwhelmed, most severely burned victims will die. Mass fires can be expected to develop within hours. Eventually, most of this area will be destroyed by fire.

Second Ring: 0.9 miles across
At this distance, the blast wave will totally destroy light frame structures, including most homes (5psi). Sturdier buildings will be severely damaged, with their interiors destroyed. Winds at 160 mph would follow the blast wave.

Third Ring: 0.8 miles across
At this distance, exposed persons will be affected by intense prompt radiation (5Gy). Between 50 percent and 80 percent of victims will eventually die from this exposure, unless first killed by blast or thermal effects.

Inner Ring: 0.2 miles across
At this distance, the blast wave will totally destroy even reinforced concrete buildings (20psi). Winds of 230 mph will follow the blast wave. Essentially everyone within this ring will be immediately killed. Lighter damage will occur out to approximately two miles, or twice the diameter of the outer ring on the map. This damage will be caused by a combination of blast and thermal pulse effects.

The arrows in the map represent the area covered by a moving cloud of radioactive fallout. This cloud will drift downwind from the site of the explosion, but the size and direction of the area affected by the fallout will depend considerably on wind and weather conditions. For example, in clear weather with winds blowing at 15 miles per hour, lethal levels of radiation will be encountered several miles downwind from the site of the explosion and harmful levels will occur for up to six miles downwind. Fatalities are expected in persons continuously exposed for four days in the contaminated area. People finding shelter or evacuated immediately will suffer substantially less harmful effects.

Note the significant differences between these two scenarios. The terrorist bomb directly impacts a much smaller area but creates a dangerous cloud of radioactive fallout. The lethal thermal pulse from the air burst missile explosion covers an area much greater than the area of heavy blast damage, while in the case of the terrorist bomb those two effects are more equal. With the missile explosion, the area of effect for prompt radiation is much smaller than that for blast and thermal effects; but in the case of the terrorist bomb, lethal radiation extends almost as far as the other effects.

Specific Impacts

Impact on the Public, Property, Facilities, and Infrastructure

Nuclear attack is an unlikely hazard, but even a single weapon could cause catastrophic damage over wide regions. Attacks on populated areas would inflict massive loss of life, destruction of property, environmental damage, infrastructure failure, and public health impacts. In the case of a ground burst weapon, some areas would remain uninhabitable for decades. A nuclear war, even if occurring far from the United States, would have serious economic consequences, resulting in additional harm to the public, as supplies and transportation capacity could become inhibited. Communications, transportation, and other infrastructure would probably be completely disrupted for miles around a blast site. Enormous property losses would result, involving businesses, residential homes, and agency facilities. Most types of key facilities and services are present in urban areas that would be the likeliest target for an attack.

Impact on the Economic Condition of the State

Even a single detonation within the state would cause a severe economic impact, in part because of the effects of uncertainty and anxiety upon markets and investments. Even a detonation that occurs outside of the country could result in strong economic impacts to the global economy, and therefore to Michigan's economy. The most likely targets would involve critical economic assets, many of which are in densely populated areas that would affect vital workers. Any events involving multiple detonations would be likely to have unprecedented economic impacts within the state, involving production, trade, and finance. In the case of a Michigan event, extensive efforts would be required just to supply essential goods and services to the most heavily affected areas of the state.

Impact on Responders, Continuity of Operations, and Continued Delivery of Services

A nuclear attack would pose extensive risks and challenges for responders. In any attack on a populated area, many responders would be immediately killed or injured in firehouses, police stations, hospitals, etc. affected by the explosion. Surviving responders would face serious and unfamiliar challenges, including widespread infrastructure failure, high levels of radiation, mass urban fires, and the disruption of command and communications systems. Responders would also face an unprecedented level of need from thousands of injured or dying citizens. In the short term, emergency resources would unavoidably fall far short of requirements. Help could only be provided to a limited percentage of the total number of victims. Extensive casualties would be expected among responders.

In the long term, responders and emergency managers would face massive challenges in sheltering, evacuation, medical care, and public order. Many likely nuclear targets would involve city centers, where governmental operations tend to be located and well-designed continuity of government plans would need to be implemented for operations to continue. Communications, transportation, and other infrastructure might be completely disabled for miles around the blast site, and the traditional NIMS model of locally led response would need to be replaced with an alternative. The remaining capacity for the delivery of services would have to be dedicated entirely to essential services, such as food, clean water, medical care and decontamination, clothing, and the sheltering or relocation of the population. In the event of a ground burst, a part of the impacted area would be uninhabitable for decades because of radioactive contamination. Services and operations would need to be reconstructed around the destroyed and contaminated areas. Additional services would be needed for clean-up and monitoring for many years afterward.

Impact on the Environment

A nuclear attack would cause extreme environmental impacts and concerns. In addition to the immediate destruction from blast and thermal effects, continuing damage would be expected due to toxic smoke clouds from mass urban fires, hazardous materials released from damaged storage facilities, and waste from wrecked water treatment systems. Radioactive contamination would occur, with the extent depending on the specific details of the attack. At worst, large areas would be poisoned by fallout, and a crater at the site of an explosion could remain heavily contaminated for years. Use of numerous nuclear weapons might cause environmental damage on a regional or global scale, far beyond the effects created by a single weapon or small number of weapons. Such damage could occur during an extensive nuclear war. Specific effects would depend on the size and number of weapons used, as well as their specific targets. Global environmental impacts might include a drop in global temperature, reductions in food production, damage to the Earth's protective ozone layer, and an increase in background radiation levels.

Impact on Public Confidence in State Governance

Public confidence in state government following a nuclear attack is difficult to predict. It is likely that public reaction would depend on the perceived effectiveness of government response to the disaster. Given the extensive damage caused by nuclear weapons, and the limited available resources, it is very likely that government services would be overwhelmed. An especially serious problem would be insufficient medical resources for the treatment of injured victims.

It is conceivable that the unmet needs of survivors could result in a significant loss of confidence in state government. On the other hand, anger at the perpetrators of the attack and a feeling of patriotic solidarity might increase popular support of government, at least in the short term. A widespread attack is likely to mean that political structures would no longer operate in a traditional fashion and would need to temporarily reorganize to emphasize grassroots and local authorities within areas that are still inhabitable.

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).

Select Resources

Ready.gov
The website for Ready.gov contains actions and advice to help U.S. citizens prepare for a wide contingency of disasters, including nuclear explosions. Information is provided on important steps that can be taken before, during, and after a nuclear attack, including sheltering, decontamination, and long-run survival considerations.

FEMA Media Library
Publication V-1015 provides a useful two-page fact sheet to help individuals be better prepared for a potential nuclear explosion. The document is designed to provide concise information that can easily be shared with family.

Radiation Emergency Medical Management (REMM)
The U.S. Department of Health and Human Service's REMM initiative provides technical information related to surviving nuclear detonations and improvised nuclear devices. Detailed sections regarding fallout, expected medical effects, and radiation detection systems is included.

Supplemental Material

Local Government Considerations
During the Cold War, the nuclear attack hazard was not customarily analyzed at the local level beyond "duck and cover" drills and fallout shelter locations. The large numbers of weapons available to the United States and Soviet Union threatened destruction on an enormous scale, and few plans could attempt to adequately address the hazard. Even communities not directly attacked would have been profoundly impacted by a superpower exchange. Today, the threat of nuclear attack is very different, and local planning may again be appropriate for this hazard. The possibility of a mass attack still exists, but the use of nuclear weapons in small numbers should also be considered. Not only are there far fewer nuclear weapons than in past decades, but there is an increased chance that less powerful tactical weapons might be used. Cold War planning scenarios may need to be updated to reflect the likelihood of changing targets due to closed military bases and new demographics. Large industry, power plants, oil refineries, and major population centers would continue to be areas of high danger.

Since there is no way to accurately assess the probability of nuclear war, most mitigation strategies would be prompted by, and originate from, federal initiatives and defense priorities. The "risk likelihood" aspect of a local hazard analysis on this topic would, therefore, probably be missing due to lack of clear information, but the "vulnerability" portion can still be assessed in terms of the presence of potential targets. For any nuclear attack planning, the presence of fallout shelters, or makeshift substitute shelters, may be a key factor for analysis, especially when considering mitigation and response strategies. The ability to maintain government functions and social services would be similarly important, as would the protection of critical computer and communications systems from the effects of an electromagnetic pulse. The improvement of transportation systems to handle mass evacuations, and the presence of redundancies to an area's infrastructure/critical services would be other means to increase local resilience to a nuclear attack
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PUBLIC HEALTH EMERGENCIES

Widespread or severe infectious disease, contaminated water or food supply chains, sanitation breakdowns, or similar hazards that transmit or threaten to transmit significant sickness within the general public.

Hazard Description

Naturally occurring infectious disease epidemics, man-made contamination incidents that affect drinking water/food supply chains, and the breakdown of public sanitation systems can all quickly spread sickness to a large number of people. The chapter groups certain *transmissible* diseases alongside the concept of *transmittable* contaminants. Significant emergencies may be statewide or localized in scope and magnitude.

Such emergencies can take many forms, occurring both as standalone incidents or secondary to other events, such as floods, hazardous material releases, or terrorism. As such, significant overlap between the chapters in this document can exist. For example, onsite industrial spills are discussed under the chapter on hazardous materials, and the potential use of anthrax as a bioweapon is part of the chapter on terrorism. Supplemental material on select animal disease is also covered, as it pertains to the potential risk for zoonosis or impacts on sanitation.

Hazard Analysis

Although now largely forgotten, a high prevalence of mosquito-borne malaria historically existed in Michigan. A rhyme from the 1800s warned *"Don't go to Michigan, that land of ills. The word means ague, fever, and chills."* While native malaria is no longer of major concern, the state still exhibits a variety of transmittable hazards that take many forms. Most recently, the COVID-19 pandemic (caused by the novel coronavirus SARS-CoV-2) and Flint water crisis (lead contamination in drinking water) have been massive public health disasters requiring large scale state response.

Because these hazards can be so different from each other, analysis on this topic may be best conducted by reading each historical example listed in the chapter. Michigan's 1973 PBB (polybrominated biphenyl) disaster contaminated much of the state. A 1994 northern Michigan water and sewer infrastructure emergency cascaded into a Presidential Disaster Declaration. In 2001, concerns over mosquitos reappeared with an outbreak of West Nile disease. 2010 saw increased awareness of PFAS (Per- and polyfluoroalkyl substances) chemical contamination when it was discovered in drinking water. In 2016, a large-scale Hepatitis-A outbreak occurred, considered the largest in the country at the time.

No area in Michigan is immune to these types of transmittable public health emergencies, but areas with high population concentrations tend to be more at risk to these threats. In addition, the more vulnerable members of society—the elderly, children, impoverished individuals, and persons in poor health—are populations more likely to be impacted. Communicable diseases can be transmitted by a variety of mechanisms, including droplets from coughs and sneezes, insect bites, contaminated food or water, and other vectors/fomites.

Epidemiology is the study of the incidence of disease and its population distribution and control. The following table defines a few terms helpful in understanding the cause and spread of transmissible disease.

Epidemiology Terms	
Cohort	A group of individuals sharing a common demographic, especially as used in a study.
Endemic	Continuously present in a region, but typically isolated and frequently found in low numbers.
Epidemic	More cases of a disease than would be expected in a community or region during a given period.
Pandemic	An epidemic that becomes very widespread and affects a whole region, continent, or the world.
Vector	The agent which carries and transmits an infectious pathogen into a living organism.
Zoonosis	An infectious disease that may be transmitted from animals to humans.

Specific Impacts

Impact on the Public, Property, Facilities, and Infrastructure

Disease epidemics and pandemics have the potential to cause widespread sickness and loss of life. These effects may be felt more acutely within certain population cohorts, such as those based on age or race. Interruptions to work-life schedules and productivity can occur as quarantines are put in place or parts of the economy/schools are shut down. Ensuring available testing, vaccinations, and treatments reach all potentially impacted populations, included minority cohorts that may be disproportionally impacted by certain diseases, is a necessity. Pandemic related population shifts (i.e., urban to rural) and chemical contamination may temporarily lower property values, sometimes permanently. Sanitation problems may require expensive or lengthy construction.

Industries, facilities, and businesses may be shut down as a means of preventing disease transmission or containing contamination. Medical resources may become overwhelmed and unable to deal with acute needs or routine services. Travel may become limited, either directly through governmental orders that limit movement, or indirectly through limitations placed on infrastructure, such as airports or other modes of mass transit. Depending on the nature and length of the emergency, preventative maintenance or repairs of infrastructure may be delayed if workers cannot be kept adequately safe or not enough workers exist (due to sickness, layoffs, or other issues).

Impact on the Economic Condition of the State

Costs associated with public health emergencies can be massive. The economic impact of COVID-19, for example, has been profound, not just in terms of direct costs associated with healthcare services but also as seen in high levels of unemployment, the numbers of bankruptcies, the interim effect on the stock market, and a multitude of other factors. Affected travel, including closed international borders, may affect the economy if trade is hampered. Foodborne illnesses can have a significant impact on restaurants and grocery stores. While healthcare costs are one of the greater economic impacts in this area, infrastructure costs, such as those needed to replace lead pipes as seen in the Flint water crisis, can also be substantial and may impact state budgets. An animal disease affecting cows or swine could not just cause sanitation issues related to carcass disposal but could badly damage the state's livestock economy.

Even prior to COVID-19, the impact of severe flu seasons was a significant factor when considering lost work time and economic efficiencies. Major chemical contamination, like that associated with Velsicol in St. Louis, Michigan, is also expensive and can take decades to clean. Damages to a community's reputation may impede local economies for just as long. While some of these factors are considered under the chapter on Hazardous Materials, necessary expenses to ensure safe water, or to compensate individuals for cancer, may also increase tax rates or bankrupt companies.

Impact on Responders, Continuity of Operations, and Continued Delivery of Services

Contagious disease tends to call for special response and precaution procedures. Even with special training and equipment, first responders will be at risk for contracting a contagious illness, a risk that occurs even while off-duty. Significant numbers of sick doctors and nurses will greatly hinder the effectiveness of hospitals. Public health emergencies dealing with contagions will also require some response efforts to be conducted virtually where possible, an added complication that necessitates the expanded use of technology.

Certain types of contamination issues are similar to hazardous materials in their impact on responders in that special measures and expertise may be required when dealing with an incident. This may also apply to sanitation issues. If elected officials and other leaders are sickened, steps will need to be contemplated and plans put into place to ensure continuity of operations. Governmental services at all levels may be stretched thin. This could be because of lack of workers (sickness, layoffs), loss of efficiency (remote/virtual work), or lack of funding (budgetary shortfalls).

Impact on the Environment

Contamination hazards may have significant impacts on the environment. While an infectious disease emergency tends to primarily affect people, in a severe event it is possible that decontamination centers, quarantine buildings, or additional medical facilities may need to be established regardless of land use laws. This may harm wildlife habitat or alter drainage patterns. Some diseases that impact humans may also have a direct impact on wildlife, such as West Nile disease and its impact on the bird population. Mass livestock fatalities could also contaminate water supplies. Chemical or bacterial contamination may also impact land, air, or water.

Impact on Public Confidence in State Governance

The PBB incident of the mid-1970s caused part of the population to perceive a "cover up" by the state, or suspicions of faulty research involving the amount and nature of PBB risks. Although it took time for the cause of the incident to be understood and the effects of long-term health risks to become clearer, the media's understanding of scientific research, as portrayed to the public, can be prone to misjudgments, hasty conclusions, and an abundance of speculation.

There are also cases (e.g., a cluster of lethal meningitis infections on a large university campus) in which the public is unfamiliar with epidemiological methods and believes that a large problem exists despite government assurances that there is not yet sufficient evidence to reach such conclusions. Unless offsetting information is proactively provided to the public, various persons may feel that abstract analysis techniques (or bureaucracy) are preventing government workers from seeing conditions that certain citizens consider to be "obvious." This mismatch in understanding and perception often results in citizen criticism of government.

A lack of personal protective equipment (PPE) during the COVID-19 crisis led to many assertions that government had not done enough to prepare for the pandemic. A lack in testing supplies also furthered this perception. Inconsistent messaging also hurts public confidence. This can be especially challenging when dealing with a new (novel) virus or other disease with which real time research and findings are underway.

Foodborne illnesses, including the contamination of products during manufacture, may also be associated in the public mind with the effectiveness of regulatory agencies. Widespread illness that is associated with public infrastructure (e.g., water, sewer), or with conditions that are overseen by government inspectors (e.g., air conditioning and ventilation systems), are more likely to cause a loss of public confidence. Maintenance-related environmental issues that may affect public health (e.g., insect/rodent infestations, contaminated brownfield sites) have a strong visual component favored by the media that may keep certain hazards in the public eye.

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 to help prevent vermin infestation.
- 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.

Historical Examples of Public Health Emergencies

This list of brief synopses of notable transmittable public health incidents places an emphasis on those impacting Michigan. Some are more significant than others and are included to provide a wide sampling of hazards and their impacts. The list is not meant to be comprehensive. Because some virus outbreaks (influenza, coronavirus) have the potential for massive loss of life, they will be discussed separately in their own subchapter below.

1970s – Present – Eastern Michigan – Dioxin and PCBs
The Saginaw watershed—including the Tittabawassee River (and floodplain) downstream of the city of Midland, the Saginaw River, and Saginaw Bay—is contaminated with dioxin and polychlorinated biphenyls (PCBs) because of industrial processes. These contaminants can cause health effects in humans and may be carcinogenic. Multiple state and federal agencies have been, and continue to be, involved with assessing the effects of exposure in humans and animals and studying environmental clean-up issues. In 2005, news media reported that an environmental firm had discovered a pool of PCBs under some sewer lines in St. Clair Shores, with concentrations that were “200,000 times above safe levels.” It was reported that more than $7 million had been spent since 2002 in canal clean-up near Lake St. Clair.

1973 – Statewide – Chemical Contamination (Polybrominated Biphenyl Contamination)
One of Michigan’s most serious contamination emergencies occurred when a chemical company inadvertently sent bags of a fire retardant containing PBB, a highly toxic chemical, along with a shipment of livestock feed to Farm Bureau Services. After being mixed with the feed, it was distributed statewide for use by farmers and their livestock herds. The result was an environmental and public health disaster of unprecedented magnitude. Thousands of cattle and other animals died from the poisoning, and serious questions were raised regarding the long-term effects of this contamination on all state residents.

1977 – Oakland County – Foodborne Pathogenic Contamination (Botulism Outbreak)
The worst outbreak of botulism in U.S. history was linked to home-canned jalapenos served at a restaurant that used 200 jars due to commercial shortages from crop failures. Fifty-nine restaurant patrons fell ill. Many of those affected required intensive care level treatment and horse serum botulism antitoxin. The supply of horse serum botulism antitoxin

is limited, and it must be transported from regional depots to a hospital. Botulism is caused by a bacterium that grows from spores in an atmosphere without oxygen. Improperly canned foods are a common source. It attacks the neuromuscular system and can have a high mortality rate.

Spring 1994 – Northern Michigan – Loss of Water and Sewer Service
Over 3,200 water and sewer lines broke or became frozen in northern Michigan due to unusually deep subterranean frost depths. The emergency conditions were present in some locations for up to five months. As a result, many communities had to provide shelter for those residents without water and/or sewer service for an extended period. Boil water advisories were also issued in many communities due to the potential for water contamination from poor system pressure. Fire safety hazards were exacerbated by the low system pressure when homeowners began using improper equipment to thaw frozen water or pipes (sometimes starting fires in the process). Because of the public health and safety risks associated with this unusual event, as well as the millions of dollars in infrastructure damage, Michigan was granted a Presidential Disaster Declaration in May of 1994. That declaration allowed for the immediate repair, restoration and/or replacement of the damaged water and sewer infrastructure. By the middle of summer, most of the repair work had been completed.

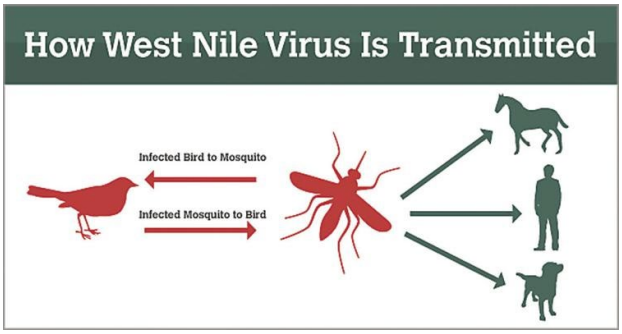
1997 – Statewide – Foodborne Pathogenic Contamination (Hepatitis A Outbreak)
2016-2020 – Southeast Michigan
In the spring of 1997, almost 300 cases of hepatitis A occurred in at least four Michigan school districts. A rapid epidemiological investigation by local, state, and federal epidemiologists linked this outbreak to frozen strawberries distributed through the national school lunch program. Tracing of the implicated strawberries identified 13 different lots sent to several states in addition to Michigan. Several hundred Michigan schools were potentially affected. A massive program was instituted to evaluate risk at schools that received the frozen strawberries, to inform parents about immune globulin prophylaxis, and to provide it to recently exposed children. The prompt and insightful epidemiological investigation, and the rapid, well-organized response of the Michigan local health department system, helped to prevent the occurrence of additional illnesses and to reduce community anxiety.

In 2016, Southeast Michigan experienced a significant Hepatitis A outbreak, which was considered one of the largest in the country. The state of Indiana issued a travel alert urging people to get vaccinated before visiting the state. As of February 2020, 920 cases had been reported. There were 30 deaths. A specific cause was not determined, but large international travel volumes at Detroit Metro airport were implicated. Subsequent restaurant spread was high, but by early 2020 no additional cases associated with the outbreak had been reported in the prior 100 days.

August 1998 – February 1999 – Multi-state Outbreak – Foodborne Pathogenic Contamination (Listeriosis Outbreak)
2002 – Nationwide Outbreaks – Foodborne Pathogenic Contamination (Listeriosis Outbreak)
A multi-state outbreak of Listeriosis, from August 1998 to February 1999, had its origin at a Bil Mar Foods meat plant in Zeeland. (Listeriosis is caused by the foodborne bacterium Listeria monocytogenes—commonly called Listeria—that can cause serious illness and death to pregnant women, newborns, older adults, and persons with weakened immune systems.) Health officials identified the vehicle for transmission of the Listeria bacterium as hot dogs and deli meats produced at the plant under numerous brand names. The exact source of the contamination was not determined. A total of 21 deaths and 100 illnesses nationwide had been linked to the contaminated meats. In December 1998, 35 million pounds of hot dogs and deli meats were voluntarily recalled by the manufacturer—the largest meat recall in U.S. history. Once the recall was instituted, the number of illnesses caused by the outbreak decreased dramatically. The Zeeland plant was allowed to resume meat production in March 1999, after more stringent food safety procedures were implemented. In 2002, at least 40 persons were sickened and 10 were killed in a nationwide listeria outbreak linked to the meat company Pilgrim's Pride Corporation. The company then recalled 27.4 million pounds of meat, after tests at a Pennsylvania plant revealed strains of Listeria monocytogenes that matched the outbreak strain.

1999 – Present – Statewide – West Nile Virus
The West Nile Virus is an arbovirus that can cause encephalitis (inflammation of the brain) and meningitis (inflammation of the lining of the brain and spinal cord). Outbreaks of the disease caused by the West Nile Virus historically occurred in Egypt, Asia, Israel, South Africa, and some parts of Europe and Australia. The virus was first detected in the U.S. in 1999 in New York City and has since spread across the U.S. to the Pacific Ocean. The virus was seen in Michigan in 2001 and has been found every year since, having peaked in 2002 (644 human cases were reported, including 51 deaths). In 2003, human cases in the state dropped to 19, with no fatalities (2019 saw 12 human cases, with one death). The West Nile virus lives in birds and other animals, and mosquitoes can transfer it from the animals to humans. Seniors, infants, and people with weakened immune systems are the most vulnerable to the disease. Experts urge residents to monitor bird deaths in their area and to take measures, such as reducing standing pools of water to reduce mosquito populations.

Veterinary services also recommend that pets be protected: https://cvm.msu.edu/vdl/news/2020/mosquito-borne-diseases-west-nile-virus-and-eastern-equine-encephalitis-activity-in-michigan.



November 2000 – Cadillac – Foodborne Pathogenic Contamination (Salmonella Outbreak)
A salmonella poisoning outbreak in Cadillac killed one person and sickened 17 others. Health officials were able to trace the likely source of the poisoning back to a caterer who provided food to four events on November 4. The suspected food item was served at the two events where people became ill, but not at the other two events.

March 2002 – Clinton Township – Foodborne Pathogenic Contamination (Salmonella Outbreak)
A salmonella poisoning outbreak in Clinton Township hospitalized at least 10 people. The source of the poisoning was traced backed to pastries at a local bakery. As many as 60 people may have eaten the pastries in one of Macomb County's worst outbreaks of salmonella poisoning. Many of the customers were sick in bed for several days after consuming the pastries.

September 2002 – Farmington, Michigan – Legionnaires Disease
Four people were killed and 30 others became ill from an airborne bacteria in vapor emitted from an air conditioning cooling unit at a grocery store. It was also reported that at least 16 people were sickened by the disease in Vermont around the same time. Legionnaires disease is spread when people inhale mist carrying the bacteria. People infected with the bacteria may develop pneumonia-like symptoms and high fevers within two weeks of exposure. The disease can be fatal, especially to the elderly, people with weakened immune systems, and children.

May 2003 – Byron Center, Michigan – Food Tampering
In one of the nation's largest reported cases of food tampering, a former supermarket employee admitted to poisoning about 250 pounds of the store's ground beef with insecticide, sickening at least 92 people who ate it. The employee had a dispute with a co-worker and had put the insecticide in the meat in an attempt to get him in trouble. The insecticide he used had a high concentration of nicotine as its active ingredient, and swallowing can be fatal. The disgruntled employee poured the insecticide on the meat before packaging it. Food tampering has also been attempted on a larger scale, as detailed in the chapter on Terrorism. The Byron Center case presented here is listed as a non-typical Michigan public health emergency example.

2003 – Washington – Foodborne Pathogenic Contamination (Mad Cow Disease)
2004 – Texas – Foodborne Pathogenic Contamination (Mad Cow Disease)
Mad Cow Disease is the name commonly used for Bovine Spongiform Encephalopathy (BSE), a slowly progressive, degenerative, fatal disease affecting the central nervous system of adult cattle. In humans, a rare and deadly form called variant Creutzfeldt-Jacob disease has been linked to eating infected tissue from cows. Mad Cow disease in Britain in the 1980s and 1990s had been blamed for the deaths of 150 people. Fortunately, there has never been a documented case of the human illness from eating contaminated beef in the United States. Since 1990, the U.S. Department of Agriculture (USDA) has conducted aggressive surveillance of the highest risk cattle going to slaughter, and 10,000-20,000 animals per year have been tested. The only documented case of the brain-destroying disease in U.S.-born and raised livestock was discovered in 2004 in Texas just days before Independence Day—one of the major grilling weekends of the year. The only other case of the disease in the United States turned up in 2003 in Washington State, in a dairy cow that had come from Canada. As soon as the BSE cases were identified, both the USDA and FDA had activated their BSE Emergency Response Plans, and the USDA immediately recalled the meat. Meat that did enter the food supply was quickly traced and removed from the marketplace.

November 2008 – Multiple States – Foodborne Pathogenic Contamination (Salmonella Outbreak)
Michigan joined a rapidly expanding investigation of a nationwide outbreak of Salmonella Typhimurium, which ultimately exceeded 700 cases from 46 U.S. States and from Canada. A total of 38 confirmed cases, with onset dates between October 2008 and February 2009, were identified in Michigan from 15 widely dispersed counties in the Lower Peninsula of the state. Of these, there were 12 reported hospitalizations. Two unusual features of both the Michigan and nationwide outbreak were noted very early in the investigation—the predominantly young distribution of the cases and the high frequency of exposure in institutional settings such, as elementary schools, colleges, long term care facilities, and correctional centers.

November 2008 – Holland, Michigan – Norovirus Outbreak
About 420 Hope College students, faculty, and staff reported coming down with an illness from a Noro-like virus in November 2008. Symptoms included diarrhea, nausea, and vomiting for 24-48 hours. The outbreak prompted the school and county health officials to close the campus and cancel activities starting November 7, with students who stayed on campus restricted from gathering. Campus security and Holland police were asked to break up any parties or other student gatherings, both on and off campus. The campus reopened four days later on November 11, and students were given a bag with plastic gloves, disposable wipes, and bleach-based cleaning spray for sanitizing their rooms. Hand sanitizer dispensers were placed in about 40 locations on the Hope College campus to aid in the attempt to stop the spread of the norovirus outbreak. Gastroenteritis caused by viruses is becoming a greater public health threat. These viruses are easily transmittable, are not treatable by antibiotics or antivirals, and can survive on surfaces for long periods of time. People suffering from infection-caused dehydration may require hospitalization; severe dehydration may prove fatal. Proper hygiene practices are a critical consideration in stopping outbreaks.

Spring 2009 – East Lansing, Michigan – Foodborne Pathogenic Contamination (E. coli Outbreaks)
In spring 2009, Michigan State University faced a food poisoning outbreak that closed a campus dining hall. Over 50 people were stricken with a stomach illness. About 28 students reported symptoms that included diarrhea, vomiting, nausea, and stomach pain, and were treated at a local hospital. Approximately 30 other students were treated at the student health center. During the fall semester at MSU, dozens of cases of E. coli, all containing the same genetic fingerprint, were reported and linked to contaminated lettuce from large commercial bags sold by Aunt Mid's. Twenty-one people were hospitalized.

2010 (and prior) Statewide variability – PFAS (Per- and polyfluoroalkyl substances)
2018 – Kalamazoo County
PFAS 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. 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). PFAS has been found to significantly alter immune and inflammatory responses.

In 2018, a state declaration of disaster was made for parts of Kalamazoo County after high PFAS levels were discovered in area water wells. The State Emergency Operations Center was activated to assist. Other PFAS "hot spots" in Michigan include a decommissioned Airforce base in Iosco county, as well as the former Wolverine Tannery in Rockford. Over 100 confirmed sites exist (the most in the United States). Executive Order 2019-03 made the Michigan PFAS Action Response Team (MPART) a permanent advisory body within the state. More information is available on MPART workgroups, public meetings, and actions is available on their website.

2014 – Present – Flint, Michigan – Flint Water Crisis (lead contaminated water)
The Flint water crisis is a public health emergency that began in 2014 after a major drinking water source was changed in the city. Sources from Lake Huron and the Detroit River were changed over to the Flint River, resulting in a new process where corrosion inhibitors were not applied. Lead from aging pipes leached into the water, exposing over 100,000 residents to elevated lead levels. The state declared a state of emergency in Genesee County and began a massive importation of bottled water into the area. A federal state of emergency was also declared. Although the water is currently considered potable, some community members still exhibit symptoms for those heavily exposed. The long-term health effects on the population, especially children, is currently unknown but could be significant. Additional information can be found here: https://www.michigan.gov/flintwater/.

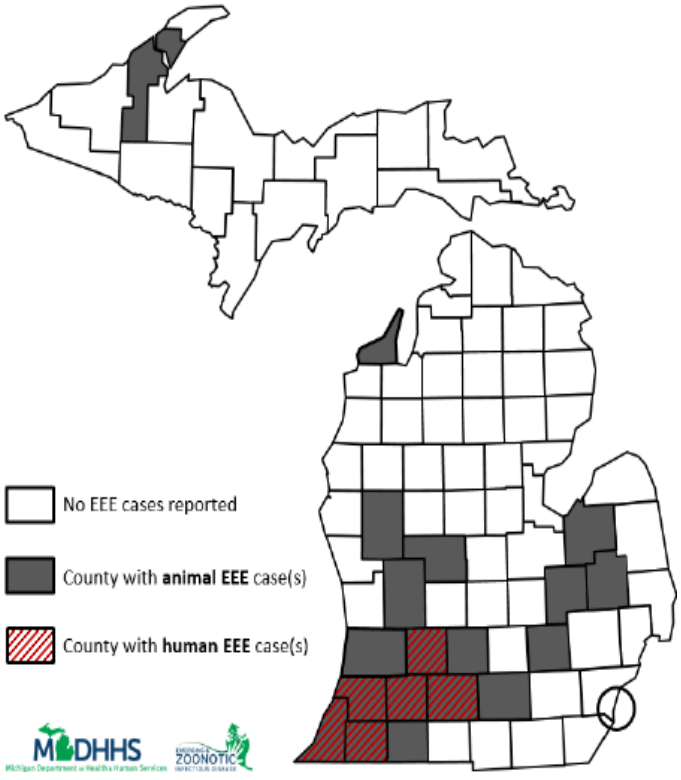
While problems associated with lead in Flint's drinking water is the most well-known, water in many other Michigan communities is also vulnerable. The Flint water crisis ultimately stemmed from corrosion inhibitors not being applied to the water system, allowing for the destruction of "protective scale" on older lead pipes, but high lead levels may exist even in areas where precautions are taken. While an undoubtedly important public health emergency, the Flint water crisis can also be viewed as an emergency associated with aging infrastructure. Readers may wish to consult the chapter on Built Infrastructure Failures for additional information.

2015-16 – Florida – Zika Virus
The Zika Virus (ZIKV) is an arbovirus spread by certain mosquitos. Its name comes from the Zika Forest of Uganda, where the virus was first isolated. From 2007–2016, the virus spread eastward across the Pacific Ocean to the Americas, leading to the 2015–2016 Zika virus epidemic that affected Florida in the U.S. The virus is able to spread through person-to-person unprotected sex, and infected women can give birth to babies that develop microcephaly (permanently decreasing the size of the head and brain). Only travel-related cases have been found in Michigan thus far. However, in 2017 the Asian Tiger mosquito began to be infrequently found in the state, a species known to sometimes carry Zika. Information on non-native insects, which can become hazards in Michigan, can be found in the chapter on Invasive Species.

2018-20 – Southwest Michigan – Eastern Equine Encephalitis (EEE)
Eastern Equine Encephalitis (EEE) is a rare disease caused by a mosquito-borne virus that can result in serious brain infections (encephalitis). Compared to other less deadly mosquito arboviruses, such as those producing West Nile, approximately 30 percent of people with EEE will die. Survivors may experience long-term neurologic problems, including losing the ability to walk or talk, and may not fully recover. For this reason, the spread of EEE is closely monitored and may result in aggressive mitigation measures. This may include the use of pesticides for mosquito control.

Michigan saw increased concern for EEE in 2018, with prevalence growing in 2019 with 10 human cases and six deaths. Fifty animal cases were also confirmed. Kalamazoo, Berrien, Barry, Cass, Calhoun, and Van Buren counties were the areas seeing the greatest activity, partially attributed to the high number of swamps and bogs located in southwest Michigan. While still relatively small, these figures expressed the largest ever outbreak of EEE in the state and resulted in aerial spraying programs to kill mosquitos in certain areas. The accompanying map shows EEE as seen in 2019.

Anticipated surveillance activities were severely hindered in early 2020 due to the diversion of agency resources and lab availability caused by COVID-19. Several horse cases were confirmed in 2020, initially in Clare and Montcalm Counties. Two human cases were confirmed at the time of this writing.

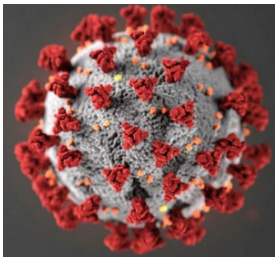


(source: MDHHS, 2019)

Influenza and COVID-19

Influenza viruses (commonly referred to as "the flu") are designated by letters and numbers. Three main types (A, B, and C) infect people, with influenza A and B capable of causing human *epidemics* and influenza A additionally capable of causing world-wide *pandemics*. Influenza A viruses are further differentiated into subtypes based on their various H and N proteins. For example, A(H1N1) and A(H3N2) have been involved in viruses confirmed to spread directly from person to person. Humans can be infected with some influenza viruses that exist in animals (e.g., swine, chicken).

Prior to 2019, influenza was the world's primary respiratory virus of concern. However, specific variants of coronavirus now rival, and in the near term still arguably surpass, influenza and all other viruses (the important Ebola virus for example has yet to see the world-wide spread or impact caused by COVID-19).



SARS-CoV-2 virus

The COVID-19 pandemic (caused by the novel coronavirus SARS-CoV-2) has become the most significant disease threat of the modern era. Such a pandemic is still ongoing at the time of this writing and continues to evolve over time. Fatalities from the disease have been greatly reduced, but it would be difficult to understate the world-wide health and economic toll caused by the virus. While some specific COVID-19 resources are included later in this chapter, much of the information on communicable disease epidemics presented here will continue to focus on influenza epidemics which are scientifically more settled by comparison. In many cases information is relevant to both viruses.

Despite the recent focus on COVID-19, influenza can still exact a terrible toll on communities. During a typical influenza season, roughly 1,200 deaths in Michigan can be expected. However, if a true influenza pandemic were to occur, as many as 10-100 times that many people may die without an adequate and well-organized public health care response. Influenza surveillance is conducted in order to provide the most advanced notice possible, but an influenza pandemic could still occur early in the season and spread rapidly. In the northern hemisphere, a *typica*l flu season starts in October/November and ends in April/May. Flu viruses spread more easily in cooler weather, and therefore predominate around the winter season in temperate climates. Contagion may also be assisted by persons spending more time indoors during this time. While this pattern holds true in general, it is not applicable for all viruses (e.g., warmer weather did not limit a rise in COVID-19 cases as much as anticipated).

Influenza impacts may be exacerbated in the near term by: (1) lowered flu vaccination rates that correlate with COVID-19 "vaccination hesitancy", (2) atypical flu surges caused by the ending of lengthy COVID-19 "stay at home" behaviors that re-expose people to influenza, and (3) similar factors influencing other viruses (e.g., respiratory syncytial virus) that may strain hospital and healthcare resources as they experience surges from several viruses at the same time.

History of Influenza Pandemics and the Emergence of Novel Viruses

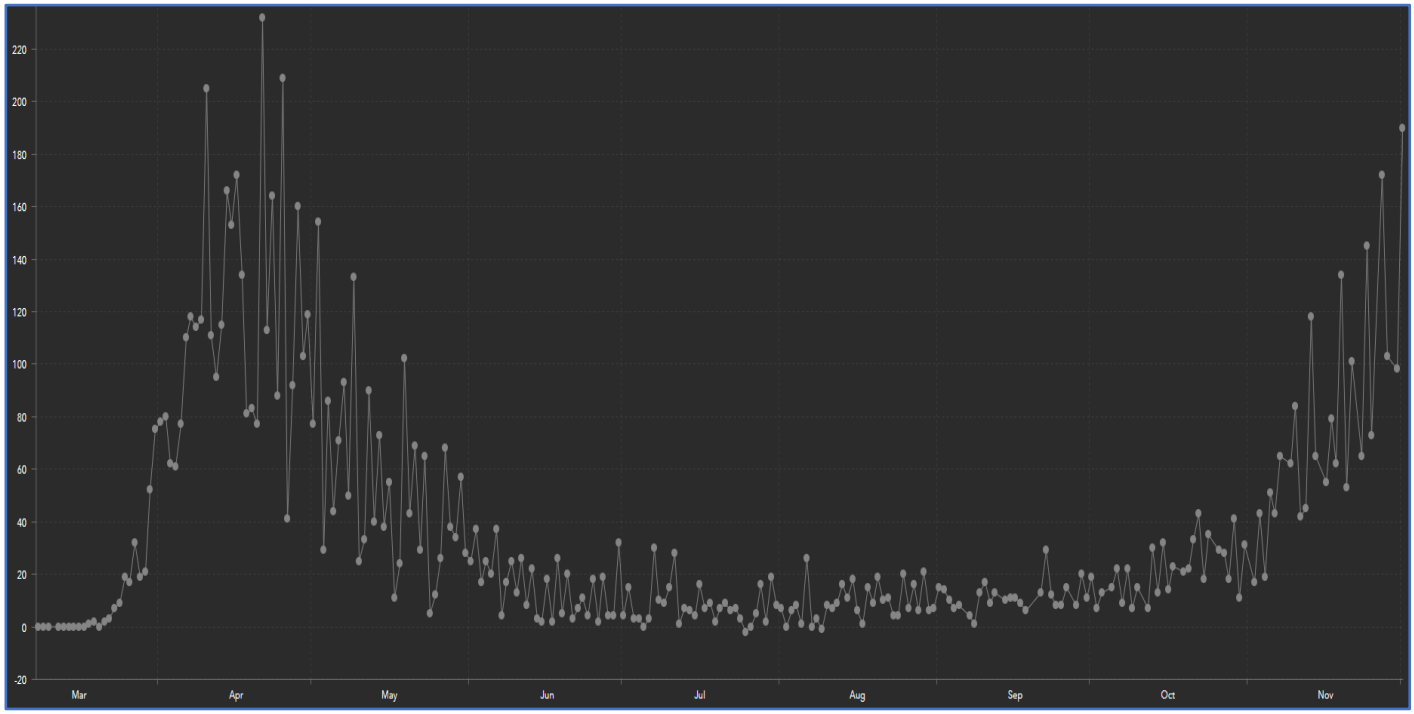
One of the world's worst influenza pandemics, the "Spanish flu" of 1918-19, resulted in 500,000-675,000 deaths in the United States and 20-40 million worldwide. More than 25 million Americans (nearly one quarter of the population at the time) fell ill. Scientists speculate that the virus that caused the pandemic may have percolated for several years within humans, or possibly pigs, until it grew strong enough to kill millions worldwide. The virus spread rapidly, moving around the world in a matter of months, all during a time in which there was much less movement of people than there is today. The spread of the illness was felt to be exacerbated in part by the slow reaction of officials who were concerned that an ensuing panic might be more harmful than the disease itself. In Michigan, it is estimated that around 15,000 people died of either influenza or pneumonia between October 1918 and April 1919, a number that would be much higher today based on modern population figures. The number of U.S. deaths from the pandemic exceeded the number of U.S. soldiers killed on the battlefield in World Wars I and II, the Korean War, and the Vietnam War combined. The pandemic was unusual in that many of those who died were otherwise young and healthy, while the normal pattern for influenza deaths involves the elderly or those with compromised immune systems. Two other major influenza pandemics occurred during the 20th century—the 1957–58 "Asian flu" that killed 70,000 in the United States, and the 1968–69 "Hong-Kong flu" that resulted in 34,000 U.S. deaths, each spreading with the same rapidness as the 1918–19 pandemic.

A 2004 outbreak of influenza A(H5N1) in birds, now commonly known as the avian flu, began in Thailand and Vietnam but eventually spread throughout much of Asia. Human cases were eventually reported in the disease's epicenter. An investigation could not determine if the avian flu was also being spread person to person, but the outbreak prompted the killing of more than 25 million birds in Asia. While this instance of H5N1 was not found in the United States, different strains of avian flu were detected there in 2004 among several flocks of U.S. birds, with hundreds of thousands being depopulated. The avian influenza strain found in Delaware was H7N2, in Pennsylvania H2N2, and H5N2 in Texas.

H1N1 (also called "swine flu") was identified in 2009. Studies showed that the virus was different from what had normally circulated throughout the world. Humans were especially vulnerable because their immune systems had not been previously exposed to the virus, allowing for limited immune response. Over 90 percent of detected cases were in persons under 65 years of age, an atypical presentation. In comparison to other flu viruses, hospitalizations and deaths associated with H1N1 were dramatically higher in children and young adults. Also of concern, the virus demonstrated the ability to develop resistance to anti-viral medications. A September 29, 2010, Associated Press report highlighting studies from the Centers for Disease Control and Prevention (CDC) indicated that the "swine flu" no longer represented a major U.S. threat because most people had come to show signs of immunity. Thousands of cases of influenza-like illness were still reported in Michigan during the last week of October 2009.

Coronaviruses differ from influenza and are named for the crown-like spikes on their surface. The subgrouping of coronavirus that would later be designated as SARS-CoV-1 was first active in 2002. It was the cause of severe acute respiratory syndrome (SARS), and because of its novel nature garnered significant concern but ended up being a relatively rare disease. At the end of its epidemic, as marked by June 2003, its incidence was 8,422 cases with a case fatality rate (CFR) of 11 percent. In 2019, the related virus strain severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) was identified. This new strain was the cause for COVID-19, which originated in China and quickly spread throughout the world. Cases rose in Michigan, with two mass treatment facilities and emergency morgue plans put into place. The state reached its first high peak in cases on April 3, 2020. There was a period of decline, followed by an increase in cases (and deaths) towards the end of the year.

New COVID-19 Confirmed Deaths Per Day (Michigan, March-November, 2020)



(source: MDHHS)

Sometimes referred to as a "second wave," for some rural parts of the state it marked the first time they experienced such high disease severity. Subsequent COVID-19 waves followed, often attributed to seasonality, an increase in public gatherings, or the introduction of new variants that were more transmissible. Vaccinations and acquired natural immunity eventually helped to mitigate against reinfection, as well as reducing the cases of severe disease that required hospitalization. This and newer treatments significantly lowered fatality rates during subsequent surges. While select treatments have lost their effectiveness over time, some later variants such as Omicron have in general produced milder symptoms. Medical intervention and virus mutation both continue to evolve.

Initial lessons learned included the immediate need for adequate personal protective equipment (PPE), disinfectants, and ventilators. Much of the early days of the COVID-19 crisis were described as a "logistics war" to replenish inadequate inventories, with many materials in limited supply and produced overseas. The widespread use of masks, bans on large gatherings, travel restrictions, and social distancing policies became commonplace tactics. Long-term care facilities such as nursing homes were especially impacted and saw special procedures put into place. Correctional facilities faced similar challenges. The need for widely available testing was identified as being important, as was whole community vaccination efforts once available. Mobile and "pop-up" facilities were employed to augment distribution. Contact tracing and self-quarantine were also used in mitigation efforts. General information specific to COVID-19 in Michigan can be found here: https://www.michigan.gov/coronavirus/. Detailed case charts are also available.

COVID-19 was also shown to impact general public health due to an increase in staff loss and burnout in the medical community, overwhelmed hospital resources, the delaying of non-essential medical procedures, impacts upon mental health, and the evolving effects of vaccination hesitancy on other diseases such as measles and polio.

Select Laws, Agencies, and Programs

Michigan Department of Health and Human Services (MDHHS)
The MDHHS and local district health departments across the state have a number of programs and initiatives to protect the health and safety of Michigan's residents. The MDHHS director and local public health officers have authority (under the Michigan Public Health Code–1978 PA 368, as amended) to take necessary steps to prevent epidemics and the spread of hazardous communicable diseases. They may issue written orders to implement these preventive steps and/or responses. State and local health departments also have detailed emergency operation plans in place to address other public health emergencies.

World Health Organization (WHO) and MDHHS Influenza Pandemic Planning
The WHO has established a pandemic preparedness webpage, and has established six levels of pandemic "phases" based upon observable phenomena and allowing for incorporation of recommendations and approaches into existing preparedness and response plans. Phases 1–3 concern preparedness activities, including capacity development and response planning, while Phases 4–6 indicate a need for response and mitigation efforts. After a first pandemic wave has occurred, particular "periods" are defined to facilitate post pandemic recovery activities.

COVID-19 has been classified as a Phase 6 pandemic at the time of this writing. During the early days of the disease, there was some debate over whether the disease was an epidemic or a pandemic, and how such definitions should impact policy decisions. Information on MDHHS's Pandemic Influenza Planning is also available. The state's official flu related website is https://www.michigan.gov/flu.

U.S. Centers for Disease Control and Prevention (CDC)
The CDC has federal responsibility and authority to investigate public health emergencies to determine their cause, probable extent of impact, and appropriate mitigation measures. It also has a webpage dedicated to pandemic influenza. The CDC can also assist state and local public health officials in establishing health surveillance and monitoring systems/programs, and in disseminating information on prevention and treatment to the public. The CDC has made dedicated funding available for bioterrorism response, and Michigan has strengthened its surveillance and intervention infrastructures with these funds.

Emerging Disease Information Website
Michigan's website for Emerging Diseases provides information on infectious diseases that may be transmitted among humans or between animals and humans. The site includes a GIS-based mapping tool to aid in analyzing zoonotic and vector-borne diseases. Additional information regarding avian influenza, rabies, ticks, mosquitoes, bed bugs, head lice, and scabies is also available.

Michigan Health Alert Network (MIHAN)
MIHAN is a secure, statewide, web-based disease alert system serving over 4,000 health care providers and other critical responders at local health departments, hospitals, clinics, and several state governmental agencies. MDHHS has implemented the MIHAN to enhance the State's emergency public health communications system and serve as a platform for health alerts, prevention guidelines, national disease surveillance, and electronic laboratory reporting. The MIHAN provides role-based alerting and permissions, secure web-based communication, and bi-directional alerting with message confirmation by telephone, email, and text pager, plus broadcast facsimile capabilities. The MIHAN serves as a foundation for the integration of public health and emergency response partners throughout Michigan, plus tribal health centers, border states, Canada, and federal agencies.

U.S. Food and Drug Administration (FDA) Food Code
The FDA Food Code is the national regulatory standard for retail food establishments. The FDA Food Code is neither federal law nor federal regulation but represents the FDA's best advice for a uniform system of regulation to ensure that food at retail establishments is safe and properly protected and presented. It may be adopted and used by agencies at all levels of government that have responsibility for managing food safety risks at the retail level.

Food Law (2000 PA 92)
The Food Law of 2000 was enacted to modernize, standardize, and consolidate Michigan's food laws, while adopting the FDA 1999 Food Code as a uniform regulatory standard for retail food establishments, such as restaurants, other food service facilities, groceries, and convenience stores. The law helps to protect consumers from serious foodborne illnesses, such as E. coli, salmonella, listeriosis, botulism, and hepatitis.

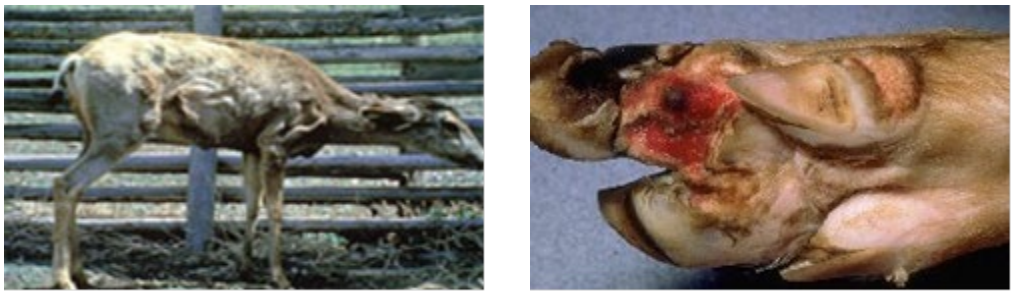
Supplemental Material

Animal Diseases (non-Zoonosis)

Many animal diseases have the potential to become public health emergencies, even if they have been largely eradicated in Michigan or don't represent a direct threat of zoonosis (such as Mad Cow disease). Significant monitoring occurs to prevent widespread mortality in livestock and wildlife should this threat profile change. Outbreaks could create large economic losses (primarily through trade restrictions), require significant resources to be allocated for response, and in some cases threaten public health. Please refer to the Michigan Department of Agriculture and Rural Development's (MDARD) webpage on Reportable Animal Diseases for more information. Two such diseases include:

(1) Chronic Wasting Disease (CWD) is a prion infection of the brain. This infectious agent contaminates the environment and is transmitted from one animal to another.

- Hosts: Deer and elk are affected by this brain disease that is now present in several states. It was detected in one Michigan location in 2008 and has since spread to other portions of the state. Mule deer, white-tailed deer, and Rocky Mountain Elk are the only three species of the family Cervidae that are known to be naturally susceptible to CWD. However, it is very likely that other subspecies of C. elaphus are susceptible.
- Symptoms: Emaciation, wide stance, lowered head, droopy ears, and excessive salivation.
- Damage: Animal fatalities.
- Control/Treatment: Chronic wasting disease is both transmissible and infectious among affected populations. No treatment is available for animals affected with CWD and it is invariably fatal once symptoms have been displayed. Affected animals that develop pneumonia may respond temporarily to treatment with antibiotics. No vaccine is available.



Two notable animal diseases: CWD and FMD

(2) Foot-and-Mouth Disease (FMD), also referred to as hoof-and-mouth disease, has been a significant threat to livestock in the past. Please note, the similarly sounding Hand, Foot, and Mouth Disease (HFMD) is a separate disease that affects humans but is not the same as FMD and does not transfer between the species.

- Hosts: This infectious virus spreads on surfaces and in the air, and impacts cattle, swine, sheep, goats, deer, and other cloven-hoof ruminant animals. It does not currently exist in Michigan or the United States and has not existed in the U.S. since 1929. Because of its historical impact, the disease is still heavily monitored, as it is highly contagious and would have grave economic consequences for the livestock industry.
- Symptoms: In cattle, blisters inside the mouth that lead to excessive secretion of stringy or foamy saliva and to drooling; and blisters on the feet that may rupture and cause lameness. Adult animals may suffer weight loss from which they do not recover for several months, as well as swelling in the testicles of mature males. In cows, milk production can decline significantly.
- Damage: Though most animals eventually recover from FMD, the disease can lead to myocarditis (inflammation of the heart muscle) and death, especially in newborn animals. Some infected animals do not suffer from or show signs of the disease, but they are carriers of FMD and can transmit it to others.
- Control/Treatment: The Michigan Department of Agriculture and Rural Development (MDARD) licenses and regulates Michigan's livestock dealers, truckers, livestock sales, and auction markets to help monitor animal health and ensure the safe and humane handling of animals. The MDARD also monitors and controls the interstate and intrastate shipment of animals and animal products to eradicate and control the spread of disease. If this disease were discovered in the United States, it would trigger national and state response plans and require rapid and coordinated response in order to control the disease and protect the nation's livestock industry. Large livestock carcass disposal and associated sanitation issues could become a concern.

CIVIL DISTURBANCES

An escalation of collective behavior by a group of people stemming from a desire for societal change or as a showing of mass support that may manifest as marches, demonstrations, or protests. Predominantly lawful and peaceful, events may escalate into a civil disturbance when there is a threat to public order, a disruption of essential services, or an outbreak of violence. Some civil disturbances may come about for the primary purpose of mass law breaking.

Hazard Description

All civil disturbances should not be thought of as similar and can be broadly classified into four types: (1) **protest** or demonstration, (2) **hooliganism**, (3) **riots**, and (4) **insurrection**. The descriptions that follow, while roughly organized by type of disturbance, provide information of interest in evaluating and understanding all types of civil disturbance. Because most of these disturbances share similarities with each other and the classifications presented here are not absolute or mutually exclusive, *it is strongly recommended that the chapter be studied as a whole.*

(1) **Protests** usually contain some level of formal organization or shared discontent that allows goal-oriented activities to be collectively pursued. This first category includes political protests and labor disputes. Many protest actions and demonstrations are orderly, lawful, and peaceful, but some may become threatening, disruptive, and even deliberately destructive or malicious (on the part of at least some of those involved either in the protest itself or in reaction to the protest). It is only the latter type of event that should properly be classified as a civil disturbance. The destruction of property, interruption of services, interference with lawful behaviors of ordinary citizens and/or emergency responders, the use of intimidation or civil rights violations, and threats or actual acts of physical violence may all occur during civil disturbances. Actual Michigan events have included the willful destruction of property and impeded property access during labor strikes, and heated conflicts between opposing participants at political rallies or issue-driven demonstrations. Different risks and forms of disturbance are connected with the nature and perceived importance of the cause, the degree of organization among those who are active in the protest, and the amount of group cohesion among those who are involved.

(2) **Hooliganism** is relatively unorganized and involves individual or collective acts of deviance inspired by the presence of crowds, in which the means (and responsibility) for ordinary levels of social control are perceived to have slackened or broken down. Certain types of events, such as sporting events, “block parties,” or concerts, become widely publicized and, in addition to normal citizens who merely seek entertainment, tend to also attract certain types of persons who seek situations in which anonymity, confusion, and a degree of social disorder may allow them to behave in unlawful, victimizing, or unusually expressive ways that would normally be considered unacceptable by most ordinary people. Examples include the disorder that has followed various sporting events and college parties. Although the majority of persons present are ordinary citizens (although many may have some level of intoxication), a minority of persons begins making itself known through unlawful or extreme acts of deviance, and it is from this part of the crowd that the hazard primarily stems. This minority may include persons affected by the use of illegal drugs and alcohol, and may include criminals and persons with mental illnesses (such as antisocial personality disorder) who may either be reacting with extreme hostility to the crowding, noise and disorder, or may have deliberately sought out such crowds and disorder so as to gain opportunities to behave in ways that ordinary circumstances would not allow. Common problems include the widespread destruction of property, numerous types of assault and disorderly conduct, and criminal victimization. It should also be noted that many persons who are normally law-abiding may temporarily behave in unusually aggressive ways during these events, often prompted by an understandably defensive anxiety about the disorder and behavior exhibited by the deviant minority, but also possibly exacerbated by a level of alcoholic intoxication, as well as the temptation by some to engage in appealing deviant behaviors that, under normal circumstances of social control, would not be selected. Many citizens remain law-abiding, but may remain in the area of a civil disturbance either because they live in the area, have activities (including social and recreational ones) that they wish to continue engaging in, have legitimate business to conduct, or because they are curious or concerned and wish to observe or witness the situation as it occurs. Most such law-abiding citizens will leave the area in an orderly way when given clear instructions by a legally recognized authority to do so. There are cases in which hooliganism may become combined with protest and thus complicate the situation for law enforcement personnel. In some circumstances, elements of protest might be added only by a small subset of participants after disturbances have already begun. In other cases, protest activity may arise out of concerns regarding the extent and nature of pre-emptive law enforcement activities that were intended to prevent a civil disturbance.

(3) **Riots** may stem from motivations of protest but lack the organization that formal protests include. Although legitimate and peaceful protests may spontaneously form when people gather publicly with the perception that they already share certain values and beliefs, riots tend to involve violent gatherings of persons whose level of shared values and goals is not sufficiently similar to allow their collective concerns or efforts to coalesce in a relatively organized manner. Instead, there tends to be a diffuse sense of shared discontent, but relatively few norms to shape these strivings into clearly coherent action. For example, widespread discontent within a cohesive community may quickly come together under a shared set of leaders, such as a march that is clearly in the form of an organized protest or demonstration; in an area that doesn't have the same cohesiveness and shared norms/values, a relatively chaotic form of expression may take place instead. This may lead to assaults, intimidation, and unlawfully destructive expressions of discontent, possibly including the victimization of innocent citizens or businesses. In addition to the sentiments of discontent that may have sparked the initial activities, elements of hooliganism may emerge and even come to predominate, as certain persons may attempt to exploit the social disorder for their own individual ends. In other cases, elements of legitimate protest may also form within this type of civil disturbance, and pockets of organized protest may help to channel and contain the negative elements of hooliganism, looting, etc. that might otherwise threaten all area residents. The complexity of these events for law enforcement can be very great, demanding carefully calculated efforts to analyze the nature of the disturbance, and difficult decisions about how to approach and possibly involve the numerous types of persons, gatherings, groups, and behaviors that may have the potential to either mitigate or exacerbate the situation.

(4) **Insurrection** involves a deliberate collective effort to disrupt or replace the established authority of a government or its representatives by persons within a society or under its authority. Some prison uprisings may fall into this category, although others may more properly be classified as riots or protests, depending upon the presence and extent of specific goals and organization, and the type of action used in achieving such goals. The map at the end of this section shows the locations of major correctional facilities in Michigan. An insurrection has the deliberate goal of either replacing established authorities with a new distribution of power, or with the destruction of established power structures in favor of (usually temporary) anarchy or a smaller-scale set of recognized criminal (gang), ethnic, or other group networks and power-structures. The latter circumstances tend to involve disturbances that exist on a relatively small scale, such as in a single local area or involving a prison network or "cult compound" (or any other similarly self-aware group or subculture with identified collective interests and a network that allows rapid communication and collective action). However, larger-scale insurrections are also possible, involving issues of class conflict or other widespread social inequalities, highly divisive political issues, or other important large-scale events that disrupt the social equilibrium because they illuminate areas in which cultural values are not sufficiently shared throughout the society or region that is experiencing the conflict, disruption, or strain. In many cases, this kind of large-scale social strain has developed gradually over time, and involves an entire series of compromises, concessions, and migrations that may temporarily relieve the disruptive social and value conflicts, only to re-emerge after another period of changes and population growth has caused a breakdown in previous arrangements. This description of the causes of social discontent applies to many protests and riots, as well as insurrection. In cases involving the formation or emergence of significant subcultures or counterculture, such as during the Vietnam era, or when dominant values break down or fail to be established on important key issues or mores, there is the potential for insurrection on a larger scale. The Civil War of 1861–1865 was one such instance in which the authority of the federal government was either accepted or rejected by various states which then aligned themselves in opposition to each other. Between these two extremes (of a purely localized civil disturbance and a national civil war) are numerous other possibilities for regional, political, class, or ethnic conflicts that may involve one or more categories of citizen in conflict with others. Examples could include prisoners versus law enforcement personnel, a countercultural group versus the establishment, or a violent political activist group in conflict with selected representatives of a contrary viewpoint. Some such actions may overlap with those of terrorism.

Hazard Analysis

Violent protests, disturbances, and riots have occurred throughout our nation's history. The Stamp Act Riots in the American Colonies in the 1760s, the "Boston Tea Party," and the Revolution itself involved riots and insurrection, as discontent escalated into organized international conflict. Though these events have occurred in the past, they are not considered an acceptable part of ordinary modern life.

Although destructive civil disturbances happen much less frequently than peaceful protests, the potential is always present for an incident to occur. Risks for disturbances may now be higher because of pervasive forms of electronic media (television images accessible on the Internet, cell phones with video capabilities, and various social media with

millions of accounts) to instantly relay information, in real time, to large numbers of people. This documentation is important and newsworthy but may be relayed without context or contain biased/purposefully inaccurate accounts. Whether factual or well intentioned, such coverage may spread awareness of riots or disorderly "parties" to other areas or interested groups of persons. This has also been seen historically, with even more traditional media coverage of past events spurring uprisings inside prisons. Even 20th century communications technologies were sufficient to help swell the numbers of "Cedar Fest" revelers in East Lansing's past sports-related disturbances. Today, ubiquitous real-time coverage of unfolding events is a fact of modern life, and emergency managers should monitor all forms of coverage to help anticipate potential incidents, as well as to encourage the proper visual documentation of incidents. To that end, many police departments have made use of video to routinely record their own activities for purposes of public transparency and training purposes. Such video can help determine an incident's initial cause, identify criminal perpetrators, document response actions, and follow important event progressions.

Handling legitimate protest events that (often unintentionally) include elements of civil disturbance is a difficult task. Normally, law enforcement personnel are heavily outnumbered and may be ill-equipped to monitor and respond to large, diverse crowds in an effective and sensitive manner. Proper training of law enforcement personnel, community involvement, adequate resources, and incident anticipation are the keys to successful incident management. Mutual aid agreements may be vital when facing civil disturbance events.

Crowd control techniques can be critical in the avoidance of injuries. For example, in December of 1979, inadequacies of event planning and crowd control led to the trampling deaths of 11 attendees at a rock concert in Cincinnati, Ohio. Ten others were injured, even though the crowd itself was not riotous or violent. The ability to quickly amass large numbers of people at an organized or impromptu event must be recognized as a source for heightened risk. Such mass gatherings can be separated into sub-categories of potential disturbance that can affect a community:

Disturbances that center around a particular facility:
The facility could be a prison, a courthouse or other center of government, a stadium or other public meeting place, where large numbers of people may at some point gather in a disruptive fashion that is threatening to the community, its businesses, residents, or quality of life. Typically, a risk assessment would examine the history of the facility and similar facilities in other communities. Such historical information might identify particular conditions that may cause collective behavior to get out of hand. The degree to which a community contains facilities and conditions that have been associated with civil disturbances will indicate the amount of risk that it faces from civil disturbances. The map at the end of this section shows the locations of major correctional facilities in Michigan.

Disturbances that arise in general areas experiencing conflict and hardship:
Regions or neighborhoods that have experienced one or more economic, social, or political stresses, such as poverty, ethnic intimidation, corruption, or the continual presence of illegal activities, can severely damage communities. These ongoing conflicts and challenges may sometimes flare into widespread unrest. Care should be taken to not inappropriately profile such events based on the people and demographics of an area. The right to lawful protest should be respected.

Disturbances that interfere with normal business functions:
Sometimes, protests are organized in a way that is deliberately designed to disrupt the normal operations of one or more businesses and may also happen to disrupt surrounding business operations or traffic flows nearby. Many such incidents are political and eventually addressed through court actions or legislative proceedings. Labor negotiations may have associated employee unrest, including strikes. Protesters may object to the existence of specific facilities or businesses, or their location in a specific area, and while seeking to make such a business or its associated activities illegal, may attempt to take more direct action against its employees or patrons. Typically, the perceived harm from such businesses are either from environmental impacts or injury to persons, or social impacts concerning the image or moral standards associated with an area. In other cases, a political demonstration may not have anything to do with the sorts of facilities or businesses in an area, but merely seeks the most crowded and inconvenient location to maximize the attention that it receives.

There is no specific "formula" recommended here for analyzing civil disturbance hazards, but it is generally helpful to include a historical approach that specifically addresses the social conflicts and political controversies affecting disturbance-prone areas of a community. The various costs of past events (crowd control, vandalism, arson, business disruption and closures, injuries, diverted traffic, negative economic impacts) can be estimated along with their past frequency so as to produce an estimated annual cost. The history of cities with similar conditions can also be analyzed in this way because the risk of a disturbance may be present, even though there have not yet been any historic local events. This is particularly true for communities with newly developed facilities in rapidly growing areas or experiencing significant social and economic changes.

Specific Impacts

Impact on the Public, Property, Facilities, and Infrastructure

Civil disturbance impacts may include deaths and injuries, disruption of services, and short- and long-term damage to a community's tranquility and reputation (which may also affect its property values). Temporary or permanent business closures may be caused by broken windows, looting, arson, etc. Fear (and its associated security costs) may discourage visitors, shoppers, and tourists, and further cause economic impacts on the area (and associated declines in its property values). Direct property damage can be expected to cause inconvenience, at the very least, to area residents and businesses, and there is a further problem of impeded access to the area's services, and to residents' own personal property, to the extent that roadways may be blocked or travel inhibited by an event. Lawful protests and celebrations can bring many visitors, shoppers, and money into an area, although some planning and organization needs to occur to ensure that public services and public safety are maintained. Property damage from civil disturbances has usually been limited to only a few specific locations, typically involving limited fires, destroyed vehicles, broken windows, and related loss of the goods inside cars and businesses. In worst case scenarios it may occur throughout the core of a city. Some government and other facilities may be affected, such as when a protest surrounds a police station and involves damage to police vehicles. Infrastructure impacts are usually limited to the temporary blockage of roadways, although some may involve important, high-volume roads in the state. Such blockages have placed lives at risk when drivers and pedestrians ignore general safety principles or there is a deliberate attempt to step in front of quickly moving vehicles.

Impact on the Economic Condition of the State

Economic conditions are more likely to be a cause of civil disturbances than a casualty of them, but there is no doubt that a sufficiently large level of disruption can cause businesses in the area to lose money and to permanently close down or move away. A civil disturbance that is not well-understood by persons outside of the immediate area may lessen the appeal of that area for visitors, tourists, business events, and residential location. To the extent it is understood that "sometimes the sports parties get a bit rowdy" or that "the Capitol building is of course a regular site for protest events," many persons might actually seek out and enjoy the settings that have a history of past occurrences. However, business costs and property values tend to ultimately take into account the overall effect that any such disturbances seem to have had, from the perspective of an overall market that may be wary of potential disturbances, potentially increasing insurance costs and lowering property values in the most heavily affected areas. Visitors from afar might not know which limited locations had been involved in a disturbance and may have had a generally negative or exaggerated impression from the media reports they had seen.

Impact on Responders, Continuity of Operations, and Continued Delivery of Services

Frustration and anger may be displaced toward responders, and many citizens may not understand the nature of the motivations, rights, or responsibilities involved in either protest or policing actions. Responders may face unwarranted hostility from citizens, for many reasons, and response activities may be impeded by disruptions taking place. Response, medical facilities, communications, or transport capabilities may be overwhelmed. Psychological impacts on responders may arise from role conflicts and the nature of some of the participants involved in the disturbance (which has some differences when compared with "ordinary crime"). The blockage of main roads, or inaccessibility of businesses and facilities, can become a problem for the delivery of services and the sustained operations of agencies in the area. Many of these effects were unintended and are only temporary, but in some cases, specific agencies and infrastructure might be deliberately targeted by vandals or saboteurs.

Impact on the Environment

Civil disturbances that stem from labor unrest (or other problems with industrial relations) may involve sabotage that causes the release of harmful substances or otherwise damages the ecosystem in an area. Civil disturbances that involve disruptive forms of collective behavior may include the lighting of fires that release toxins, especially when non-traditional manufactured items are used as fuels. Damage to property may, accidentally or deliberately, include sites that contain hazardous materials. Unruly crowds may disrupt or prevent needed maintenance activities by utility repairmen or industrial workers and thus inadvertently cause environmental problems to occur because of resulting infrastructure failures.

Impact on Public Confidence in State Government

If discontent underlies a disturbance, some persons may generalize, displace, or attribute the source of their discontent to local or state governments. Some discontent may be aimed toward government policies involving the environment, housing, land use, wealth distribution, taxation, military conscription, foreign affairs, labor issues, infrastructure provision, civil rights, or other issues. Although government programs often exist that attempt to address these types of concerns and to ensure that particular values (e.g., civil rights) are respected and supported throughout the jurisdiction, widespread or widely publicized disturbances or demonstrations may undermine the effectiveness of governmental programs and

thus weaken public confidence in government. Other types of civil disturbance, such as wild festivities after a sporting event, may undermine public confidence in government if a pattern develops in which illegal behaviors become repetitive and widespread.

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.

Significant Civil Disturbances in Michigan

As a heavily populated, politically active, and nationally-prominent industrial state with a long history (statehood was achieved in 1837), Michigan has seen many significant civil disturbances, including labor disputes, protests and political demonstrations, social strife, hooliganism and countercultural movements, rioting and prison uprisings. In the case of prison uprisings, the Michigan timeline contains two major points in which uprisings were observed in the modern prison system—the years 1952 and 1981. Event-related hooliganism appears to be a relatively recent historical phenomenon, appearing only after the urbanization of the state's population, the emergence of mass media, and the rise of the modern auto-oriented transportation network throughout the state (the Interstate Highway System started in the late 1950s). Following are brief synopses of some of Michigan's major civil disturbance events, organized by category:

<u>Protests</u>
Major labor disputes, in which workers protest and seek changes in their relations with employers, have occurred in virtually every decade in Michigan. However, some have been worse than others in their overall impact on the communities in which they have occurred. Unfortunately, some disputes have turned violent at times, requiring a response by law enforcement agencies to quell the disturbances and maintain order. Political protests also frequently occur. In cases involving violent protest, the distinction between a protest and a riot primarily involves the level of formal organization and planning behind the activities.

1874–1879, 1883–1885, 1893–1897 – Periods of Economic Recession, Depression, and Labor Unrest
One of the patterns evident from even the earliest of modern American industrial recession periods is that the competition for jobs can take on aggressive and illegal forms, especially when there is an oversupply of labor for lesser-skilled or unskilled jobs. Patterns of worker intimidation were reported under these conditions, in many cases organized along ethnic lines, and later leading into larger-scale patterns of violent and destructive means of assertion that came to be associated with some forms of labor organizations (varying with the industry and the time period). To the extent that legal and police powers were used to protect employers when using discriminatory hiring and firing practices, or not providing safe working conditions, or controlling their workers with exploitation and force, such workers might turn to underhanded and illegitimate means to even the odds and assert their rights to safe and reliable working conditions and wages. From these desperate and compelling circumstances of social conflict and inequality, organized crime started to develop and become entangled with legitimate parts of society's social, political, and economic institutions. In other cases, radical and socialist political ideology would eventually connect with violent activism and illegitimate funding mechanisms, some of which were international in scope.

Incidents of workers being intimidated or pressured to give up their jobs (so that their harassers could take them) are documented in Detroit during these time periods, but it is assumed that such activities were more widespread and were not limited to just the cities. Incidents usually occurred at a small or moderate scale, but employed physical violence both for offense and defense, and collectively amounted to large-scale patterns of discrimination and conflict. For example, on August 25, 1893, a group of unemployed men accosted some laborers and teamsters, and fighting led to arrests and injuries. At a meeting of Polish workers the following month, labor advocate Walter Kwiecinski saw 500 persons and heard claims that public works jobs were primarily being given to Italians and Canadians, while he himself had assembled a list of some 800 unemployed Polish residents seeking such jobs.

April 23, 1891 – Detroit
During a four-day strike, a violent riot erupted in protest against the strikebreaking efforts against the City Railway Company. A number of streetcars were burned. It was also reported that some of the disruption marked a general dissatisfaction with the streetcar services.

April 18, 1894 – Detroit "Connor's Creek" Labor Strike and Uprising
During the depression of the 1890s, an excavation project for a water main, just east of the city's boundary at the time, was manned by some 300 workers who revolted at the conditions for wage reimbursement that the city Water Board had set (estimated at only about one-third of already established wage rates). The workers demanded a higher wage and stayed on the site throughout that day, and the next, to prevent any other workers from being brought in to replace them. On the third day, men arrived from the Wayne County Sheriff's Office, but only succeeded in annoying the workers. A project foreman was attacked by a worker, and the scene quickly exploded into violent chaos when gunshots followed the attack. The mob of workers with picks and shovels surged around the armed lawmen and the project's foremen. Although the violence lasted only a few minutes (resulting in the beating of the foremen and law enforcement officers), there were about 20 serious injuries, and a total of three persons ended up dead from gunshot wounds. By the end of the day, 21 persons had been arrested. Mass meetings took place on April 22, at which many thousands of ethnic workers gathered to press for policy changes.

Spring 1911 – Grand Rapids
In a move of historic solidarity, more than 6,000 workers walked out of about 50 furniture factories in Grand Rapids on April 19, 1911, protesting pay and working conditions. Most worked six 10-hour shifts for less than $2 a day. After the walkout, factory owners did their best to maintain production by bringing in other laborers. Anger built among the striking workers and tensions exploded on May 15 when a company tried to drive strikebreakers in cars to the factory through a crowd of about 1,200 strikers and supporters gathered outside the building. That evening, people poured into the streets from the surrounding neighborhood where a riot began when the crowd grabbed rocks and pelted the factory company's cars. In the ensuing mayhem, firefighters and police were injured. Police responded by firing their pistols in the air and beating back the rioters with their billy clubs. The fighting drew more people into the streets to help the strikers, swelling the crowd to 2,000. It took firefighters with hoses and more police to rescue the car and the strikebreakers. When it ended at midnight, every window in the factory had been smashed. There were injuries and arrests but no deaths. The riot was one of the few violent confrontations in what was one of the largest strikes by a non-unionized workforce.

July 1913–1914 – Upper Peninsula
A copper miners' strike in the Upper Peninsula resulted in months of vandalism, murders, threats and intimidation, harassment, and violence, as strikers and unionists clashed with strikebreakers and law enforcement personnel. This conflict pervaded the entire copper mining region and did not merely occur at the work site locations themselves. Nearly all mines were closed in the area, and nearly 15,000 miners stopped work. Rioting and violence were involved in the initial July clashes that prevented non-striking miners from going to work. Things calmed for a while, until some mines attempted to re-open in August. Strikebreakers (often new immigrants to the country) were terrorized away from the mines, and gun battles also took place which resulted in deaths. Court cases ensued to reverse laws that had developed in opposition to the strike. By October, several larger mines had opened, and many former workers moved out of the area. A union-organized Christmas party in Calumet turned disastrous when someone yelled "Fire!" A long stairway led to inward-opening exit doors and in the stampede of persons leaving the building, people were pushed by the crowd and started falling down the stairs and being crushed in the crowding at the exit doors. In the end, more than 70 persons were killed, most of whom were young children. Following a disagreement about whether the victims' families should accept gifts, a local union headquarters was stormed and its leaders threatened with lynching. By early 1914, the union announced that it was giving up the strike.

August 5, 1919 – Muskegon
Muskegon residents protested when the Muskegon Traction & Lighting Company attempted to raise streetcar fares by 1 cent (from 6 cents to 7 cents) on the evening of August 5, 1919. Over 30 unarmed people assembled in the streets near city hall. An argument between a few factory workers and a streetcar conductor escalated into a citywide rampage by a mob of nearly a thousand. They obstructed the passage of streetcars, took streetcars off their tracks, overturned them, and destroyed the windows and the fixtures of the cars. By dawn on August 6, the Michigan Traction & Lighting Company's car barns were destroyed, and 13 streetcars were also destroyed. Warning shots fired by the police only further enraged the rioters, forcing the officers to flee for their lives. No determined or organized effort was made by the police force of the city to suppress the tumult or to arrest those engaged in the incident that lasted from about 6 p.m. until 4 a.m. Citizens called upon the fire department to assist in suppressing the riot, but the organization refused to respond; therefore, no arrests were made of any person engaged in the disturbance. The incident destroyed a sizable portion of the fleet, with property destruction estimated at $100,000–$125,000, (about $1.3–$1.5 million in 2011 dollars).

The streetcar service of the city was interrupted and suspended for a period of two weeks. The mayor and the common council took few steps to investigate or discipline the fire or police departments for failing to for suppress the riot and disperse the crowd. The mayor and eight aldermen of Muskegon were found guilty of official misconduct and willful neglect of duty in connection with the streetcar riots.

March 6, 1930 – National Protests
Widespread discontent organized into nationwide gatherings at the height of the Great Depression, including the involvement of communist groups. In Detroit, tens of thousands participated and violence resulted when protesters resisted police efforts to disperse them.

March 1932 – Dearborn
A "Hunger March" led by 10,000 demonstrators (most of whom were laid-off autoworkers) included a battle with police that left four marchers dead and dozens injured. The Detroit portion of the march was peaceful, but as Dearborn was reached, police tear gas was reacted to with the throwing of stones and mud clumps. Dozens of persons were arrested.

1936–1937 – Flint, Detroit, Dearborn, and other cities
A series of labor conflicts wracked the auto industry during these years. In a series of "sit down strikes" that started in Flint on December 30, 1936, industrial sites were occupied by workers who sought improvements in their wages and working conditions. Many picketers wielded sticks and other potential weapons, and many industries had their own teams of "muscle" and security men, as well as the general support of law enforcement personnel. At the time, the law gave more recognition to the right of factories to use force to protect their property than it did to unions and workers to organize and protest working conditions. On January 11, 1937, tear gas and fire hoses were used against picketers in Flint who employed various makeshift weapons, and the conflict then escalated to the use of firearms by police. Several dozen persons were injured on both sides of the issue. On May 26, 1937, union representatives were brutally attacked by company security men while meeting with news reporters in a widely publicized event known as the "Battle of the Overpass." Many nearby persons were also attacked, beaten, and driven away, including women who wanted to hand out leaflets. Various persons suffered severe injuries and were hospitalized. The reporters themselves were harassed and photographs of the event, that soon became world-famous, had almost been confiscated by company strongmen. Various issues involving union organization took decades of discontent, conflict, and legal and political action to be ironed out into the modern forms in which labor-industrial relations exist today. Although these issues became more stable by the second half of the 20th century, some of their aspects are still evolving even today.

1948 – Detroit
Protests by white residents of the Fenkell-Linwood area (Quincy and Baylis Streets) took place in an effort to discourage African American residents from living in the area. Although this incident was not itself considered to be a riot (see the subsection that follows), it was indicative of the potential for such disturbances to occur in the area. Among other problems in the area, at least one other serious disturbance occurred two years later (see the February 1950 entry in the Riots subsection that follows).

1964–1972 – Numerous Anti-War Demonstrations at Multiple Locations
Student-led, anti-war protest demonstrations across the country, beginning with a major uprising in Berkeley, California in 1964, spread to virtually every major university campus (including several in Michigan) by the late 1960s and early 1970s. Some protest demonstrations were very large and involved violence and rioting, sometimes increasing in response to the arrival of police. In Michigan, major demonstrations occurred in East Lansing, Ann Arbor, and other university communities. In East Lansing in May of 1972, thousands of student protesters blocked Grand River Avenue for several days in anger over escalating U.S. activities in the Vietnam War. Eventually, Michigan State Police and local law enforcement authorities ended the blockade.

1960s and 1970s – Detroit, Flint, Lansing
Strikes between the United Auto Workers Union and the major automobile manufacturing companies headquartered in the state (General Motors, Ford, Chrysler, and American Motors) occasionally led to clashes with police. These strikes primarily affected Metro-Detroit, Flint, and Lansing.

July 1995–1997 – Metro Detroit
The Detroit Newspaper Strike started in July 1995 and continued through 1997. The labor dispute officially ended in December 2000 when the involved unions ratified new contracts, five-and-a-half years after the strike began. The strike was marked by periods of sporadic violence and involved approximately 2,500 workers from Detroit's two daily newspapers. Many facets of the community were negatively impacted, at times requiring extensive use of law

enforcement resources to supervise strike-related activities and to maintain order. The most significant event occurred June 20–21, 1997 when a national union mass demonstration was held in support of the strikers, drawing over 100,000 people to Detroit.

April 2020 – Lansing and Additional Locations Statewide
Thousands protested at the State Capitol in Lansing in a series of demonstrations against emergency declarations and "stay-at-home" executive orders that had been issued by Gov. Gretchen Whitmer to control the spread of COVID-19.

Citing the authority of Section 1 of Article 5 of the Michigan Constitution of 1963, the Emergency Management Act, 1976 PA 390, as amended, MCL 30.401 et seq., and the Emergency Powers of the Governor Act of 1945, 1945 PA 302, as amended, MCL 10.31 et seq., the Governor declared a state of emergency for the public health crisis on March 10, 2020. On this basis were also issued the first in a series of executive orders restricting public gatherings and the operations of a wide variety of businesses and organizations. Workers identified as non-essential were required to stay at home, and travel was limited. Furloughs and unemployment claims increased significantly. The restrictions were treated as difficult necessities by many, but as government overreach by others.

On April 1, Governor Whitmer issued a new executive order, declaring both a state of emergency and state of disaster with additional restrictions in response to a growing number of COVID-19 fatalities. On April 15, a protest organized as "Operation Gridlock" disrupted traffic patterns in the city of Lansing around the State Capitol, as hundreds of people in vehicles disrupted normal traffic flow to demonstrate disagreement with the measures. Law enforcement worked to ensure that access to important facilities, like hospitals, were as unaffected as possible. Much smaller protests by other like-minded individuals occurred in other areas of the state.

Two weeks later on April 30, the Legislature assembled to vote on whether to allow Governor Whitmer to extend her emergency declaration beyond 28 days, as required by P.A. 390. Crowds of demonstrators assembled outside the Capitol, with some entering the building and the Senate gallery. While most of the protest was peaceful, some openly carried sidearms and semi-automatic rifles, leading some legislators to feel intimidated. It is noteworthy to point out that at least one armed protestor in the Senate gallery was later arrested in a plot to kidnap Governor Whitmer. A separate and much smaller demonstration took place outside the Capitol on May 14 and saw minor scuffling between protestors and counter-protestors. Some armed protesters sought entrance into the Capitol building but were denied by the Michigan State Police because the Legislature was not in session for the day. A later "free haircut" protest also occurred on May 20 as a result of barber shops and salons needing to close.

May 2020 – George Floyd Protests at State, National, and International Locations
Numerous national protests occurred after a pattern of occurrences involving controversial and sometimes fatal police actions that had been used upon members of minority groups. The key event occurred in Minneapolis, Minnesota, with a police officer physically subduing a man named George Floyd by kneeling on his neck for several minutes. Floyd died and the officer was charged with second degree unintentional murder. This was one in a series of incidents in which video-documented police methods were perceived as extreme. The protests grew into a national movement for greater civilian protections and police reform.

Michigan's protests were more peaceful and well organized than many other states, with documented cases in which participants stayed alert against vandalism or looting through their own collective action so that criminal activities would not mischaracterize the goals of the movement. Both protest organizers and law enforcement officials voiced intentions to stay aware of risks present during mass gatherings to avoid escalations inherent with past civil disturbances. Despite these efforts, property damage and casualties occurred, with some locations turning into riots during various parts of the protests. The protests took place during the COVID-19 pandemic, generating concern they could help spread the virus.

George Floyd's death occurred on the evening of May 25, and the initial protests in Minneapolis began the following day after citizen videos circulated online and in news stories. The Minneapolis protests included damaging riots. Organized protests in numerous locations were under way across the United States by May 28 and persisted daily for weeks in some communities.

In Michigan, although largely peaceful protest activities were predominant, some criminal activities occurred along with occasional violence and substantial destruction of property. In the Ann Arbor area, local protests also arose over shared videos involving the May 26 arrest of a woman and her husband in Pittsfield Township. Traffic disruptions were the main impacts in that area. Interpersonal tensions and heightened anxieties about the possibility of conflict between drivers and pedestrians reportedly led to an attack upon a vehicle in Lansing on May 31; but after the vehicle's occupant was escorted away by police, the vehicle was then looted and set on fire. Some additional Lansing hooliganism led to

property damage near the State Capitol, and some riotous behavior a block away involved smashed windows, police intervention, and a curfew imposed in the city. Some persons involved in an East Lansing protest march severely damaged a police vehicle, with other protesters reportedly helping to stop the behavior from escalating.

Where riotous behavior was observed, imposed restrictions sometimes involved the use of tear gas and curfews. Such circumstances temporarily arose in Detroit, Grand Rapids, Lansing, and Kalamazoo—cities in which property damage was the worst. Grand Rapids saw the most severe impacts in Michigan on May 30 and 31, with damages and associated costs estimated to amount to over $2 million from vandalism, vehicles destroyed and set ablaze, more than 100 businesses damaged in the downtown area, looting, traffic sign removal, and even damage to various exterior features of the city's art museum. Detroit-area impacts mainly involved obstructed traffic and some limited vandalism incidents, although tension was sometimes evident.

Hooliganism

1970s-1990s – Detroit – Arson and "Devil's Night" Disturbances

"Devil's Night" had traditionally been associated with youthful pranks on the night before Halloween, prompting delinquency and increasingly more serious instances of vandalism. During these decades, it also became an excuse for many arsonists to start fires, seriously challenging the resources of first responders. Although not solely an occurrence of hooliganism, as a reputation became established for the ongoing pattern of Devil's Night fires and disturbances, it attracted hooligans that compounded the problems caused by the arsonists. Only a portion of the arson events can be attributed to mere hooliganism. Rather, the loss of structures were, in many cases, caused by deliberate criminal acts, sometimes with the intention of removing vacant properties that in their cumulative disrepair had become dangerous to enter or be around, and that in other cases were perceived as attractive locations for illegal criminal enterprises. The problems were mitigated through a combination of concentrated law enforcement, community partnerships, volunteer activism ("Angel's Night"), and expanded demolition and clearance activities on the part of the city.

October 1984 – Detroit – Sports Championship Melees

The success of Detroit's professional sports teams is sometimes unfortunately marred by violence and rioting that can gain significant national attention. After the Detroit Tigers won the 1984 World Series, the ensuing celebration turned ugly when cars were overturned and burned, and nearby homes and businesses damaged. This was widely covered by the national media.

June 1990 – Detroit – Sports Championship Melees

After the Detroit Pistons won their second NBA Championship, the "celebration" following the victory resulted in eight deaths and numerous injuries. This was widely covered by the national media and tarnished Detroit's image at a time when it should have been able to peacefully revel in its sports success. Similar scenarios have played out in other major cities after professional sports teams have won a championship.

1980s–early 1990s – East Lansing and Mt. Pleasant – Civil Disturbances

Several clashes between large groups of students and police occurred in East Lansing at an annual street party known as "Cedarfest." Injuries and property damage were frequent, and also involved the use of tear gas to disperse rowdy and hostile crowds. Central Michigan University in Mt. Pleasant was also witness to a series of similar parties turned into riots in the 1980s and early 1990s, with the resulting clashes often involving hundreds of students and police.

September 1997 – East Lansing – Civil Disturbances

On September 6, 1997, over 500 revelers celebrating a Michigan State University football victory gathered on Gunson Street in East Lansing and set bonfires, destroyed trees and streetlamps, shattered glass, and hurled bottles at police.

May 1998 – East Lansing – Civil Disturbances

On May 1, 1998, a student protest against Michigan State University's decision to ban alcohol at a popular on-campus partying place for football games erupted into a riot that spilled onto the streets of East Lansing, ultimately involving over 3,000 people. The riot forced East Lansing police to use tear gas to disburse the crowd, but not before several large fires were set, traffic was blocked on Grand River Avenue, and rocks and bottles were hurled at police.

March 1999 – East Lansing – Civil Disturbances

On March 27, a serious disturbance occurred after Michigan State University's loss in the NCAA Final Four basketball tournament. The melee lasted for several hours before police were able to quell it with tear gas. Total property damage exceeded $250,000. Over 130 people were arrested and charged with various crimes stemming from their participation in the riot. Nearly 120 were convicted and ordered to serve jail time, pay fines, or both. Several students were also

expelled from the university. Follow-up investigations by police revealed that some of these incidents were spontaneous events, while others were pre-meditated riots with the sole purpose of wanton destruction of public and private property.

September 9, 2001 – Kalamazoo – Civil Disturbances
In the early morning hours of September 9, 2001, a riot broke out at a block party near the Western Michigan University and Kalamazoo College campuses in Kalamazoo. The crowd, which police estimated at 2,500, pelted officers with bottles and rocks, tore down street signs, broke windows, and set fires. Three police cars were heavily damaged, and two police officers were injured in the melee. Twenty-one people were arrested—many charged with felonies—and nearly 50 were ticketed for underage drinking and other misdemeanors.

March 17, 2002 – Kalamazoo – Civil Disturbances
On the night of March 17, 2002, a spring break party around a bonfire near Western Michigan University got out of hand as people clashed with police in riot gear trying to disperse them. A car was set on fire and several other parked cars were damaged. Rioters climbed telephone poles, pulled down traffic signs, and set several dumpsters on fire. About 30 officers moved in when someone threw a bottle through the windshield of a passing car. Three people were charged with unlawful assembly, and a fourth was accused of assault.

October 2006 – Saginaw – Arson and "Devil's Night" Disturbances
The 42 fires reported in Saginaw's two-day period before and during Halloween were well above what would normally be expected during an ordinary two-day period. The community responded seriously and quickly to mitigate this hazard, and subsequent years had only about a quarter (or less) of this number of fires on those two days.

December 8, 2013 – East Lansing – Civil Disturbances
Following a Michigan State University football victory, a peak crowd of between 2,000–3,000 people assembled on the streets of Cedar Village Apartment complex (numerous similar gatherings had occurred in the past). At least 57 fires were set and used to burn couches, mattresses, trees, and other available items. Fifteen persons were arrested. While the crowds mostly dispersed peacefully, there were other areas of the city in which officers had rocks, beer bottles, horseshoes, and other items thrown at them.

<u>Riots</u>
March 6, 1863 – Detroit – Faulkner Riot
False reports of the victimization of two girls led to the storming of black neighborhoods in Detroit by white mobs. Dubbed the "Faulkner Riot," extensive property damage took place, about 200 were left homeless, two persons were killed, and at least 20 were injured.

1914–1918 – World War I – Ethnic Hostilities
Ethnic hostilities increased as World War I started and progressed (American involvement in the war began in 1917). The loyalty of various Germans was questioned, as well as persons of other ethnicities, corresponding to the hostile Axis powers in Europe, and various pressures and hostilities resulted in the vandalism of homes and businesses.

1925 – Detroit – Ossian Sweet Property
An African American doctor purchased a home in an all-white Detroit neighborhood in 1925. On July 14, the neighborhood's residents protested his plans to move in, but on September 8, Dr. Ossian Sweet, his wife, and nine gun-carrying associates moved into the house under police escort. The next night, a large crowd of whites began pelting the house with rocks and bottles and then rushed the house. A volley of gunshots from the home killed one man and seriously wounded another. The Detroit police arrested Dr. Sweet and his companions and charged them with first-degree murder. After 26 hours of deliberation, the jury returned without a verdict. Judge Frank Murphy declared a mistrial and Dr. Sweet was released. Subsequent trials upheld the right of Sweet and his companions, regardless of race, to protect life and property in dangerous situations.

February 28, 1942 – Detroit – "Sojourner Truth" Housing Clashes
A riot took place when white residents protested the right of 200 African American defense workers to move into a new housing project (named after Sojourner Truth) in the northeast part of the city. An angry picket line was formed, and conflicts escalated when one of the new residents tried to cross the line in a car. More than 1,000 persons were in the area, participating in the conflict in some manner. More than 40 persons were injured and 220 were arrested.

June 20-21, 1943 – Detroit - Major Riot
A series of small, racially oriented skirmishes in Detroit escalated into a major riot, as about 100,000 persons massed near downtown Detroit (not all of whom were actively involved in violence, however). The riot quickly overwhelmed city

and state police, so federal troops in armored cars were brought in at Gov. Harry Kelly's request to help restore order. The riot was quelled after more than 36 hours, but not before it claimed 34 lives and caused over 700 injuries. More than 1,800 arrests were made.

February 1950 – Detroit – Ethnic Hostilities
Disturbances in the Fenkell-Linwood area (Princeton Street) involved white protesters stoning a house and vandalizing a car belonging to a new African American resident, followed by at least one antagonistic meeting (150 residents at a neighborhood association) that expressed a mixture of fears, bigotry, and protests over changing residential patterns and policies in the city.

August 30 – September 5, 1966 – Benton Harbor Riot
After a fatal shooting that had racial significance, street violence erupted in the city. The rioting included stones being thrown at cars. A man was arrested for the shooting, and things eventually quieted after the National Guard was called in on the order of Gov. George Romney.

July 23–29, 1967 – Detroit – Riots
One of the most historically prominent riots in the United States occurred in Detroit from July 23–29, 1967. The uprising resulted in the greatest loss of life and the largest destruction of property of any of the national riots of the 1960s. Looting, burning, and sniping reached a scale unknown to in a U.S. city in the 20th century, exceeded only by the 1863 New York City Draft Riot. The violence erupted when police raided an illegal after-hours drinking club (a "blind pig"), arresting numerous patrons and the bartender. Shortly thereafter, a crowd that had gathered began to loot nearby stores. Within an hour, the looting had spread to a 16-block area, with many stores having been plundered and set afire. Police estimate that over 5,000 persons were actively involved in the rioting, which quickly engulfed large sections of the city—as much as 6–7 miles out from the initial flash point. Over 150 fires consumed a 15-block area and burned uncontrolled when firefighters were forced to withdraw after being pelted by objects.

In response to the rioting, then-Governor Romney declared a state of public emergency, mobilized nearly 8,000 National Guardsmen and 700 Michigan State Police troopers to assist in restoring order, and requested supplemental federal military assistance. Nearly 5,000 Army paratroopers were dispatched to Detroit to assist the National Guard and state and local police units. Over 13,000 military troops, guardsmen, and police worked to quell the disturbance. Over 7,000 people had been arrested, 43 people killed, and over 1,000 injured. Five thousand had been left homeless. Over $50 million in damages resulted due to the fires and looting.

The riot was part of a series of riots that occurred in cities across the country in the mid-1960s. In 1967 alone, over 160 riots occurred in U.S. cities and towns, many in communities with less than 25,000 in population. Outside of the Detroit riot, the other mid-60s riots that gained most of the national attention were the August 1965 riot that occurred in the Watts section of Los Angeles (which resulted in 34 deaths, 1,000 injuries, 600 damaged buildings, 4,000 arrests, and $35 million in losses) and the July 1967 Newark, New Jersey, riot that caused 26 deaths, 1,500 injuries, and 1,400 arrests. More than 300 fires were reported in the latter disorder, and property damage was estimated at more than $15 million. Rioting continued in 1968 following the assassination of Martin Luther King, Jr. Disturbances occurred in over 130 cities, with the final tolls standing at 46 deaths, 7,000 injuries, more than 20,000 arrests, and nearly $100 million in damage (mostly from the more than 2,600 fires set). Over 80,000 military troops were used to quell those incidents.

April 4–5, 1968 – Detroit - Protest/Riots
Protests included some riotous elements following the assassination of Dr. Martin Luther King, Jr. About three dozen fires were reported and the National Guard was activated. Property damage to cars and storefront windows also occurred. The casualties included one youth in the city who was reportedly killed.

July 1975 – Detroit – Riot
Disorder followed the shooting of a black youth (who died the next day) by a white owner of a bar. Crowds numbering several hundred gathered and began to damage area businesses, causing tens of thousands of dollars' worth of property damage. Fighting broke out, focused on racial antagonisms. An uninvolved motorist, trying to drive through the area, ended up being pulled from his car and died three days later from injuries. Mayor Coleman Young brought in hundreds of law enforcement personnel, joining them in personally walking the area on two nights. The bar owner was charged with second-degree murder. About 100 people were arrested.

June 16–17, 2003 – Benton Harbor – Riot
The city of Benton Harbor erupted into riots on June 16–17, 2003, after a motorcyclist being chased by police crashed into an abandoned house and died. Two nights of violence brought hundreds of police to the area to calm the citizens

who felt exasperated with community conditions and circumstances. Rioters roamed a six to eight block area, setting fires and attacking passers-by, police officers, and firefighters. One person was shot in the shoulder and others were beaten and stabbed. In all, about 15 people were injured. It was estimated that about 23 homes were damaged or destroyed by fire. A total of about 10 people were arrested.

Insurrection

Early 1800s – Statewide – Battle of Tippecanoe/Native American Persecution

Viewed as insurrection by the U.S. Government, Native American resistance to pressured and duplicitous land cessions ultimately led the Shawnee Chief Tecumseh into direct military conflict. The Battle of Tippecanoe took place in Indiana on November 7, 1811, killing dozens and wounding several hundred on both sides. American suspicion that the British encouraged such hostilities was one of the reasons leading to the War of 1812. Subsequent harm to the native population was devastating. Various Native American migrations took place, often compulsory. A large part of the Potawatomi moved west in the 1830s. The final land cession in Michigan took place in 1842.

1952 – Jackson County – Prison Uprising

A prisoner uprising took place April 20–24 at the Southern Michigan Prison in Jackson. The five-day siege resulted in the death of one inmate and serious injury to nine others. More than a dozen guards were held hostage, eventually all released, though beaten or otherwise wounded. Officials estimated that approximately one-half of the prison's 6,500 inmates had participated in some way in the rioting. Numerous prison buildings had been severely damaged or burned to the ground. Official damage estimate was put at $2.5 million. The damage was not fully repaired for several months. Throughout the uprising, the Michigan State Police had provided critical assistance in containing and eventually controlling the riot. The last Michigan State Police trooper left the prison over four months after the uprising began. The incident was the worst in a string of 30 major prison riots that occurred across the country in the early 1950's.

1981 – Jackson, Marquette, and Ionia County – Prison Uprisings

Three separate prisons were involved in uprisings over the Memorial Day weekend: the State Prison of Southern Michigan (Jackson), Marquette Branch Prison (Marquette), and Michigan Reformatory (Ionia). The disturbances began May 22 when officials from the Michigan Corrections Organization attempted to take administrative control at the Jackson facility and began to lock down prisoners. Rioting broke out, which then spread to Ionia later that day (the events were thought to be related).

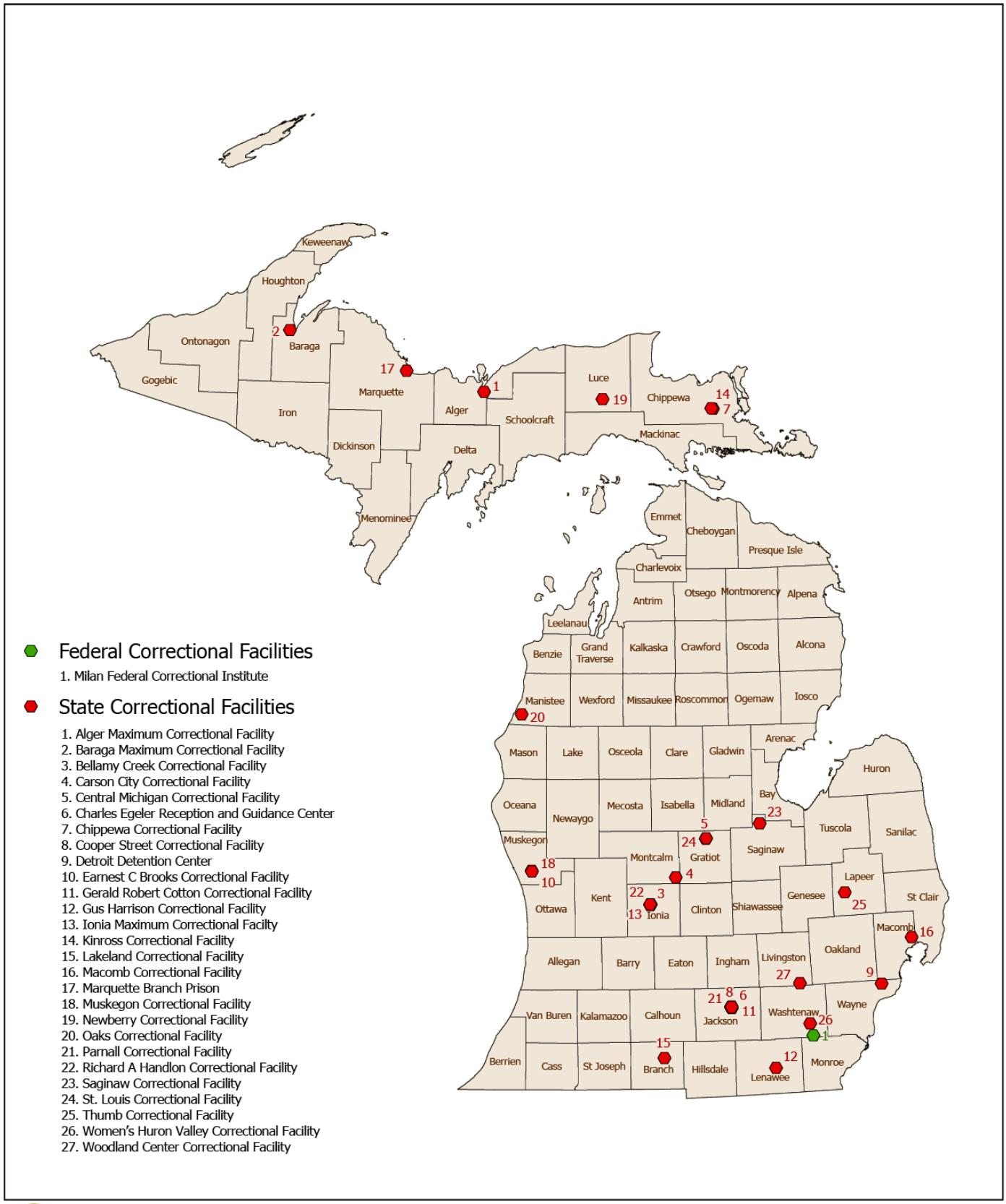
The situation temporarily settled over the weekend, but rioting began again on May 26 at the Jackson facility, spreading this time to Marquette. Both disturbances were quelled later in the evening, but only after mass injuries and major damage had been inflicted on the facilities. The May 22 disturbances resulted in 67 inmates and 27 staff members being injured, many requiring hospitalization. The May 26 disturbances saw an additional 44 staff members injured, along with 42 inmates. No lives were lost.

The physical damage to the three facilities totaled $5 million, with another $4.1 million in riot-related costs incurred. Damages at the State Prison of Southern Michigan included fire and smoke damage to eight cell blocks, destruction of eight modular units, and damage to the academic vocational building, inmate store, and food service facility. At the Michigan Reformatory, two cell blocks were damaged, in addition to the prison chapel, the food service building, and the school. The master key system needed to be replaced at the facilities. The Marquette Branch Prison experienced similar damage. It took several months for the facilities to be repaired and services brought back to normal. Legal and disciplinary actions were taken against 19 corrections personnel and numerous inmates.

August 13, 1995 – Lenawee County – Prison Uprising

Three housing units were taken over by prisoners at the Gus Harrison Correctional Facility during a power outage. Several correctional staff were assaulted, as well as some fellow prisoners. No lives were lost, as the housing units were eventually retaken by correctional gun squads. The facility was assisted by the Michigan State Police, Lenawee County Sheriff's Department, and the city of Adrian Police Department. A great portion of the housing units sustained heavy damage during the disturbance.

MICHIGAN CORRECTIONAL FACILITIES



Federal Correctional Facilities

1. Milan Federal Correctional Institute

State Correctional Facilities

1. Alger Maximum Correctional Facility
2. Baraga Maximum Correctional Facility
3. Bellamy Creek Correctional Facility
4. Carson City Correctional Facility
5. Central Michigan Correctional Facility
6. Charles Egeler Reception and Guidance Center
7. Chippewa Correctional Facility
8. Cooper Street Correctional Facility
9. Detroit Detention Center
10. Earnest C Brooks Correctional Facility
11. Gerald Robert Cotton Correctional Facility
12. Gus Harrison Correctional Facility
13. Ionia Maximum Correctional Facilty
14. Kinross Correctional Facility
15. Lakeland Correctional Facility
16. Macomb Correctional Facility
17. Marquette Branch Prison
18. Muskegon Correctional Facility
19. Newberry Correctional Facility
20. Oaks Correctional Facility
21. Parnall Correctional Facility
22. Richard A Handlon Correctional Facility
23. Saginaw Correctional Facility
24. St. Louis Correctional Facility
25. Thumb Correctional Facility
26. Women's Huron Valley Correctional Facility
27. Woodland Center Correctional Facility

Michigan State Police
Emergency Management and
Homeland Security Division

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Date: 1/10/2023

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Select Laws, Agencies, or Programs

Civil disturbances can be difficult to address, with officials needing to balance between the constitutional rights of individuals to assemble and air grievances, as compared to the overall needs of the community to provide essential services, public safety, secured property, and uninterrupted commerce. Most large public gatherings and demonstrations are held in a peaceful manner, but governmental resources are needed to respond to any escalations.

Michigan State Police and Michigan National Guard
In most civil disturbances, local law enforcement resources, augmented where necessary by the Michigan State Police, are sufficient to manage an incident. When such resources are not adequate, the Michigan National Guard may be activated to provide for the immediate preservation of public peace and safety. A Governor's Declaration of Emergency is necessary to activate the Michigan National Guard.

Prison Uprisings
Prison uprisings are first contained by Michigan Department of Corrections facility squads, composed of trained Correctional Custody personnel. Department Emergency Response Teams (ERTs) then resolve the situation. ERT members are specially trained personnel who respond to security needs or emergency situations which arise during daily institutional operations. ERTs also responds to situations which threaten the safety or security of any correctional institution, or which pose a threat to the community. Additional units may be brought in from other nearby facilities. If those resources are not sufficient, specially trained Michigan State Police officers can be activated to assist within the prison, provide perimeter security, or augment resource needs. In extreme cases, the National Guard may also be used.

College Campus Anti-Rioting Law
In the wake of the 1999 Michigan State University riot, a new state law (2000 PA 51) was passed aimed at curbing rioting on or near (within 2,500 feet of) Michigan's public colleges and universities. The law allows judges to ban campus rioters and others convicted of riot-related offenses, unlawful assembly, and civil disorder from all public college and university campuses in Michigan for up to two years for a felony conviction (one year for a misdemeanor).

Supplemental Material

Social Science and Civil Disturbances
Various racial and ethnic bigotries have been expressed at numerous times and locations throughout Michigan. As just one of many available examples, anti-German sentiments were frequently expressed during World War I. Some of these ethnic and racial antagonisms were institutionalized and enforced by laws, contracts, or other arrangements, such as "restrictive covenants" that prevented the sale of designated properties to those in specified minority groups. The use of restrictive covenants became unconstitutional because of a court decision (Shelley vs. Kramer) in 1948, but similar de facto patterns of residential pressures and segregation were still evident for many decades that followed.

During periods of increased social change, immigration, and economic turmoil, the challenges of these large-scale social patterns often correspond with the symptoms of social conflict—in the attitudes, behavior, and policies of individuals, groups, organizations, and institutions. The number of civil rights protection laws and programs have increased over time, with the Michigan Department of Civil Rights forming in 1965, but fear, mistrust, and racism still exist. Stereotyping, scapegoating, and discrimination not only leads to individual crimes against affected individuals, but also to a societal response that makes civil disturbances more common. It is possible for these tensions to endure and to form an ongoing pattern of social conflict if positive actions are not taken.

AFTERWARDS

A short commentary on catastrophic incidents

The Michigan Hazard Analysis (MHA) attempts to contemplate the most significant emergency management related risks our state and local communities may face. However, the MHA should not be considered all-encompassing. The document attempts to strike a balance between potential hazards and their ability to trigger requisite emergency response. Incidents are further seen through a lens of frequency and likely severity. The MHA focuses on Michigan hazards that through a combination of frequency and severity need to be routinely considered as part of state and local emergency management processes.

Some infrequent hazards may still be mentioned due to the sheer magnitude of their destructive potential. It is challenging when allocating scarce resources to determine how much effort should be spent to identify and analyze hazards with a remote chance of occurring within a given community. Incident severity needs to be considered in such situations. While a supernova Sun would be catastrophic, it would be of such devastating severity it would destroy the Earth. On the other hand, a solar storm that could create a nationwide blackout may not happen in our lifetime but has an outcome scope that still allows for some level of mitigation. In such low frequency/high severity circumstances, emergency managers should look for commonalities with other more frequent but less severe hazards. For example, not all “routine” blackout mitigation efforts would be helpful in the case of a severe solar storm, but some could be. The same types of shelters that may be of use in a nuclear attack could also help to mitigate against tornadoes. Such synergies, when dealing with scare resources, can be immensely helpful.

It is also important to acknowledge that even more benign hazards may become catastrophic under the right conditions. This can be because of interconnected impacts with other hazards, or simply be a matter of scale for the incident. For example, a typical forest fire can be relatively well controlled in many circumstances, but looking to recent forest fires in California shows great exceptions. While much of the material in the MHA is geared towards hazard levels that local communities are the most likely to face, this does not mean that outlier events won’t occur. Indeed, in the aggregate and given enough time, its statistically probable that some such catastrophic outliers will happen.

Catastrophes also deserve mentioning because those that don’t occur within our borders may still impact Michigan. As an example, even the worst Atlantic hurricane may result in only heavy rains for the state and an amount of flooding that has already been otherwise contemplated. That may still alter or exacerbate other planning efforts. Mutual aid agreements are also in place between states to provide one another with supplemental resources in the case of major incidents. Such events would most likely call for the coordination of emergency personnel between Wisconsin, Indiana, Ohio, and Ontario, but could involve any state or nation. Large numbers of evacuees may need to be sheltered.

While it is beyond the ability of local emergency managers to fully analyze all remote catastrophic events, putting complete blinders on towards such incidents is also undesirable. As parting food for thought, some events are listed below to remind Michigan communities that even “the unthinkable” can potentially still happen.

A “Supervolcano” Event

In 1980, the eruption of Mount St. Helens caused 540 million tons of volcanic ash to be scattered over an area of 22,000 square miles. The largest eruption in recorded history was that of Mount Tambora (Indonesia), which led to “the year without a summer” in 1816 and worldwide food shortages. Even bigger eruptions of a so-called “supervolcano,” estimated at occurring only three times in the past 2.1 million years, would emit billions of tons of ash into the air.

Invasion of the United States

Despite its military strength, the nation is still vulnerable to conventional attacks or invasion in the continental United States. Even in cases of a World War III type event not taking place at home, a general mobilization would require a reorganization of economic production and consumption patterns throughout the country. Michigan is also home to ethnically diverse populations who may be disproportionally impacted by such a war.

Ocean Tsunami Events

Whether it originates from a celestial impact or seismic event, an ocean tsunami impacting the North American continent could result in severe and widespread damage. An event of sufficient size and velocity has the potential to be a catastrophic incident, resulting in the type of water displacement seen in the 2004 Indian Ocean tsunami or the Japanese Fukushima disaster of 2011 (caused by an earthquake, but resulting in a nuclear emergency). Regional or even national economies would be affected, and Michigan emergency resources would need to be diverted and used.

APPENDIX A: CHANGE LOG

January 27, 2023 (note, page numbers refer to placement in this document version):

- Updated nuclear power plant map, page 14.
- Updated commercial port map and table, page 29.
- Insertion of the Dearborn natural gas incident (1999) that had been inadvertently removed during the document's last update process, page 38.
- Inclusion of the MI Public Safety Communications System map, page 68.
- Inclusion of Ukraine, pages 121-122.
- Updated COVID-19 chart on page 135, as well as updated virus narrative, pages 133-135.
- Updated correctional facilities map, page 150.
- Various minor narrative changes to reflect the above additions or to fix typographical errors. Supplemental material on radon was removed, as were obsolete/duplicative maps for nuclear plants and commercial ports.