Hazard Mitigation Plan
Dickinson County, Michigan
2015

Dickinson County Hazard Mitigation Plan

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Introduction

Hazard Mitigation is defined as any action taken before, during, or after a disaster to permanently eliminate or reduce the long-term risk to human life and property from natural and man-made hazards. Dickinson County has experienced various natural and man-made hazards such as the tornado that swept through the southern portion of the county in 2002 and the 1999 mineshaft cave-in near the Cornish Pump Museum in Iron Mountain.

Hazard mitigation planning is a process that assesses risks and evaluates the community vulnerability from potential hazards. Deficiencies are identified and strategies are developed that help mitigate problem areas. By developing an effective hazard mitigation plan a community can potentially reduce the effects of a future disaster. Potential effects of a disaster include loss of lives and property, environmental and economic concerns, and reduced essential services and quality of life. The result of this plan process is an Action Plan that identifies the appropriate steps to help mitigate present and future hazards.

Background

The Federal Emergency Management Agency (FEMA) provides hazard mitigation assistance to state and local governments and to individuals through programs under the Robert T. Stafford Act, Section 404 (Disaster Relief and Emergency Assistance). The Disaster Mitigation Act of 2000 (DMA2K) amended the Stafford Act, to require communities to have an approved Hazard Mitigation Plan in order to receive FEMA funding assistance for hazard mitigation projects.

FEMA established project funding to develop local hazard mitigation plans. Some federal funds were received by the Michigan State Police/Emergency Management and Homeland Security Division (MSP/EMHSD), which then re-granted funding to Michigan counties and major municipalities to develop local hazard mitigation plans.

Programs that provide federal assistance are: the Hazard Mitigation Grant Program (HMGP), Flood Mitigation Assistance Program (FMAP), and Pre-Disaster Mitigation Program (PDMP). Publication 920-Hazard Mitigation Grant Handbook-describes these three grant programs in detail.

Plan Process

The Dickinson County Hazard Mitigation Plan process was guided by FEMA requirements and the (MSP/EMHSD) document – Pub 207, Local Hazard Mitigation Plan Workbook. The plan process is outlined below:

Public Input is essential to the plan process in order to accurately understand the hazards faced by communities. Input into the plan was achieved through regular meetings and discussions with the County LEPC, Emergency Management Coordinator, local officials, and various agency personnel. Public participation takes place throughout the entire plan process and is described in more detail in the plan.

Public Input
(Obtained throughout the process)
↓
Identify Hazards and Risks
↓
Define Goals
↓
Identify Strategies
↓
Select Evaluation Criteria
↓
Select and Prioritize Mitigation Strategies
↓
Draft Plan
↓
Adopt Final Plan and Begin Implementation

The **hazards and risks** were identified through extensive research, meetings, surveys, and mapping. A community profile was first compiled to summarize the main components of the county and is explained in the community profile section. Risks in the local units of government were described under three hazard categories: natural, technological, and social. A workgroup then rated the individual hazards to determine a high, moderate or low level of risk. The section on hazards explains what went into the process and Table 7 shows the results.

The **goals and strategies** focus on the higher-risk hazards determined in part by the hazard identification process. The most significant hazards addressed are: tornadoes, severe weather (winds, lightning, and hail), public health emergencies, bioterrorism, hazardous materials transportation accidents, subsidence/earthquakes, general transportation accidents, and flooding. Meetings and discussions with the LEPC, local officials, and agency personnel helped to suggest possible strategies to mitigate these hazards. The identify and prioritize strategies section illustrates the issues, goals and strategies for each high-risk hazard.

The Emergency Management Coordinator then **selected evaluation criteria** to weight the possible mitigation strategies**.** The criteria in the evaluation criteria section address strategies affecting large and small groups of people, recurring hazards, property damage, cost effectiveness, and natural resources. A subcommittee of the LEPC used the criteria to assign points and "weight" the **mitigation strategies-** the mitigation strategies section shows the results.

The **adoption of the plan and implementation** of strategies are addressed in action plan section. Each strategy or action to be taken is listed along with the responsible agency and possible funding source. This section also addresses future plan maintenance through evaluating, monitoring and participation in the plan.

Public Participation

Public participation in hazard mitigation is both a needed and required step in the plan process. Hazard mitigation is inherently a local issue. Therefore, local input about a community's risks

can help in pinpointing projects to mitigate those risks. Also, FEMA requirements state that local jurisdictions that want to apply for federal mitigation funding must:

- Participate in the plan process
- Suggest potential projects
- Adopt the Hazard Mitigation Plan

Public participation in the Dickinson County Hazard Mitigation Plan was achieved in many different ways.

The Dickinson County Emergency Management Director along with the Local Emergency Planning Committee (LEPC) gave regular plan guidance. Some of the ways in which the committee assisted: issues were brought forward for discussion, a workgroup was formed to propose and discuss strategies, and a subcommittee prioritized strategies. This committee meets monthly and is open to the public. The LEPC consists of the following community representatives:

•Dickinson County Emergency Services
•Dickinson County Healthcare System
•Dickinson Conservation District
•American Red Cross
•Breitung Township Fire Chief
•Dickinson-Iron District Health Department,
•Dickinson County Road Commission,
•Dickinson-Iron ISD
•Beacon Ambulance
•Iron Mountain Fire Chief

Other meetings and input opportunities were accomplished through various local organizations where the public is always welcome and encouraged to participate. Meetings were arranged with the Dickinson County Fire Training Association, Infrastructure Committee and Township Association. During each meeting the draft County Hazard Mitigation Plan would be presented and input requested regarding additional or specific community risks and possible mitigation projects.

The Dickinson County Fire Training Association is represented by a combination of full-time and volunteer employees from each jurisdiction in the county. The Dickinson County Infrastructure Committee is a joint committee of the urban areas of Breitung Township, City of Iron Mountain, City of Kingsford and the City of Norway. The Dickinson County Township Association is represented by all the townships in the county. In addition, various local government meetings took place with the City of Iron Mountain and Kingsford.

Phone discussions also took place with local government officials in Felch, Norway, Waucedah, and West Branch Township. Discussions focused on specific or unique issues experienced in that jurisdiction and ideas on potential mitigation projects. Additional phone discussions took place throughout the plan process with various personnel associated with the County Emergency Services, Law Enforcement, Conservation District, Public Health Department, Road Commission, and Dickinson Memorial Hospital.

Every jurisdiction in Dickinson County is represented in the Dickinson County Hazard Mitigation Plan through the various meetings and phone discussions with the County LEPC, local governments, and other organizations described above.

Public review of the Draft Dickinson County Hazard Mitigation Plan was achieved through the following ways:

• A public informational open house held in May 2014 at the Dickinson County Library in Iron Mountain, Michigan.

• A copy was made available at the Dickinson County Library.

Public review notifications will be posted at the library and a notice published in the local newspaper. Useful comments received will be reviewed for consideration and incorporated into the final draft plan as needed.

Community Profile

This chapter provides a summary of Dickinson County and community information to give a better understanding of the area. Tables are provided to illustrate this information. Every attempt is made to consider existing conditions and emerging trends. (Appendix A supplements the text information in this section for individual jurisdictions.)

County Overview

Located in the south-central Upper Peninsula, Dickinson County encompasses a land area of 766.34 square miles or 490,458 acres. Dickinson was established in 1891 from parts of Iron, Marquette and Menominee counties. It is the youngest of Michigan's 83 counties. Most of the 267,168 residents reside in the southern portion of the county within a few miles of US-2 and the Menominee River. Iron Mountain, the county seat, is the most populous municipality. Extensive tracts of state-owned land, approximately half of the county's land area, are found in the northern half of the county- mostly within the Copper Country State Forest.

Trunk-lines US-2, US-141, US-8, M-69 and M-95 are the backbone of the county's transportation system with US-2 being the most heavily traveled. The driving distances to Lansing and Detroit are 427 miles and 486 miles respectively. Green Bay is just 98 road miles from Iron Mountain.

Paper and lumber products, which rely on local natural resources, and a diversity of manufacturing, transportation and service industries provide a solid economic base for the county. Dickinson County Healthcare System and International Paper Corporation are the county's biggest employers. Strong economic ties exist with neighboring Wisconsin.

Local Units of Government

Dickinson County's communities consist of three cities and seven townships. All jurisdictions within Dickinson County are represented in this plan. The local units of government are listed below. Appendix A gives more detailed information for each jurisdiction. In addition to these cities and townships, there are many unincorporated places within the County. These places are covered by township government, but often have a separate sense of community.

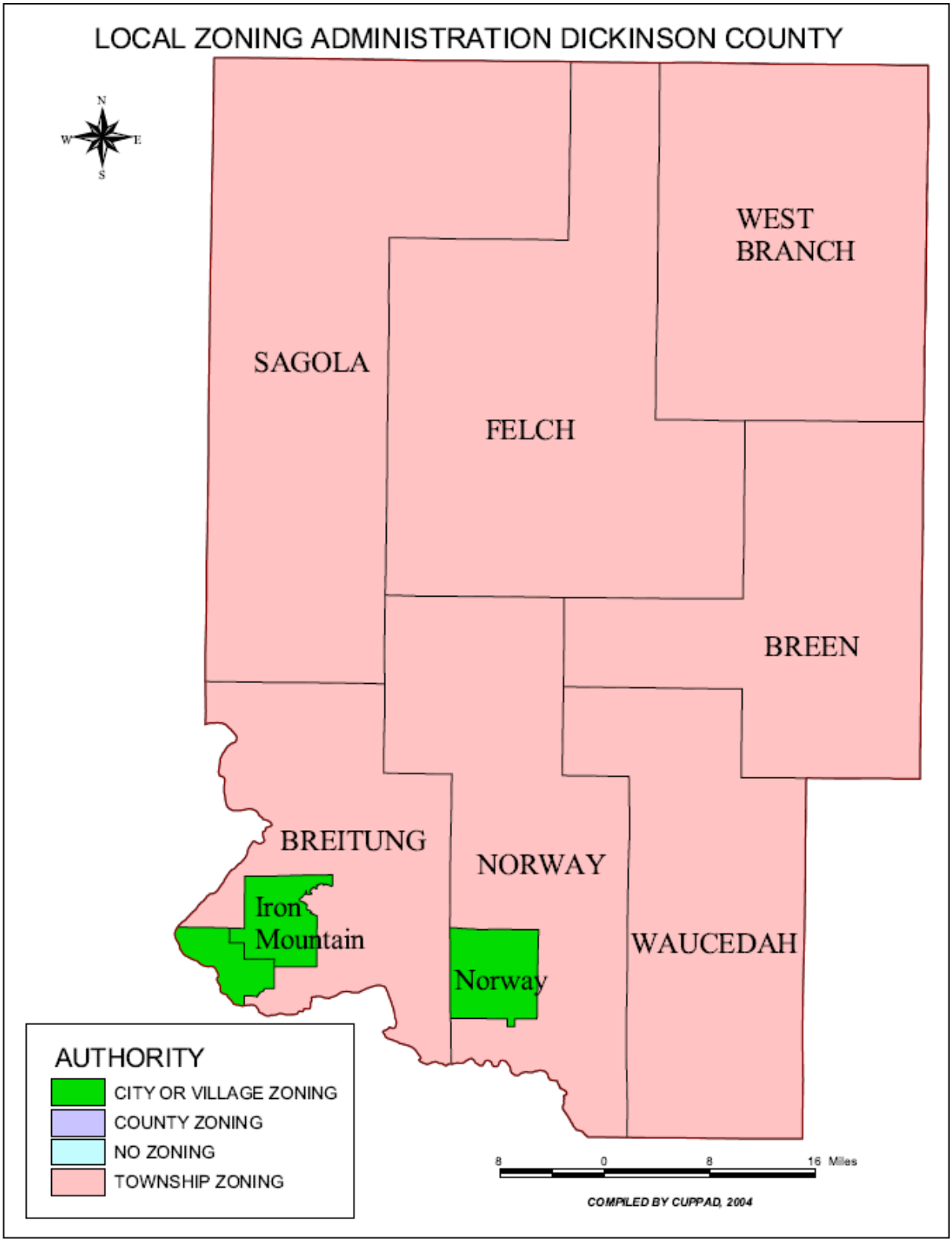
Cities:

•Iron Mountain •Kingsford •Norway

Townships:

•Breen •Breitung •Felch
•Norway •Sagola •Waucedah
•West Branch

Map 1: Dickinson County Jurisdictions and Zoning Authority



Geography

Dickinson County borders Iron, Marquette, and Menominee counties (plus Niagara, Wisconsin). The Menominee River forms much of its southern boundary. Several inland lakes, ponds and backwater areas are found throughout the county. In addition, the combined length of streams and rivers totals around 640 miles. Driving distances to Lansing and Detroit are 427 and 486 miles respectively.

Detailed soil information is available from the U.S. Department of Agriculture *Soil Survey of Dickinson County* published in 1989. The study recognizes eight soil associations in the county. Soil associations are groupings of soils that share a commonality and respond similarly to use and development.

Approximately 13 percent of the county's land area is classified as wetlands in the Michigan Resource Information System (MiRIS) as amended January 2001. Forestlands cover more than 80 percent of the land area.

Climate

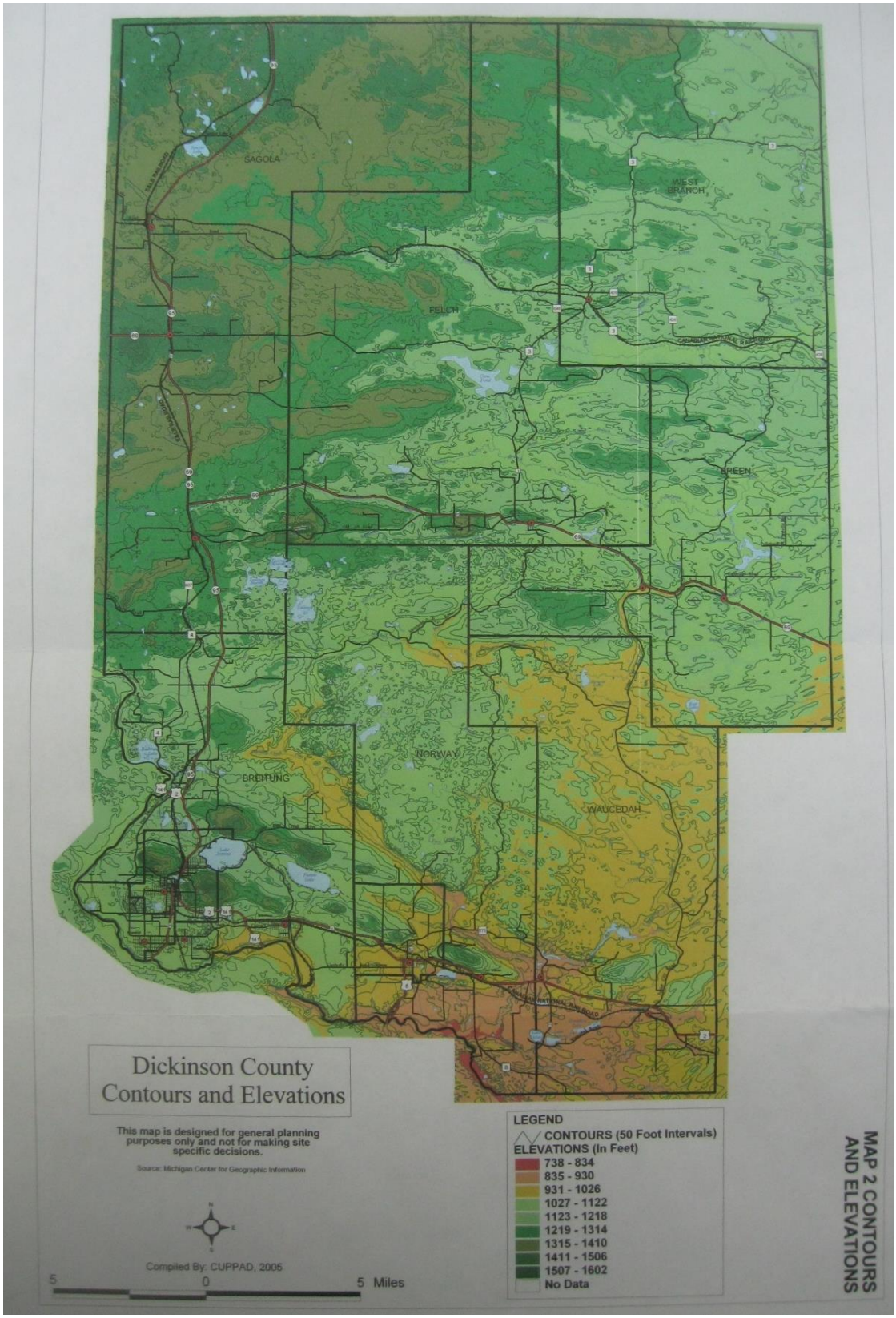
Weather influences of the Great Lakes in the county are tempered significantly by the inland location. Increased cloudiness in the fall and early winter months, however, is attributable to the lake effect. The growing season, or freeze-free period, averages 112 days at Iron Mountain. May 28 and September 17 are the average dates of the area's first and last freezing temperatures. January and July are the coldest and warmest months respectively. The mean annual temperature for the 1981 to 2010-period was 52.6 degrees Fahrenheit. July is the warmest month with an average daily maximum of 80.0 degrees Fahrenheit. January is the coolest month with an average daily high of 23 degrees and an average daily low of 3.2 degrees. These are averages recorded at Ford Airport, the only weather reporting station in the county.

August is the wettest month averaging 4.01 inches of precipitation; February the driest averaging 0.96 inches. An average of 61.6 inches of snow falls in Iron Mountain annually with the heaviest amounts coming in December and January.

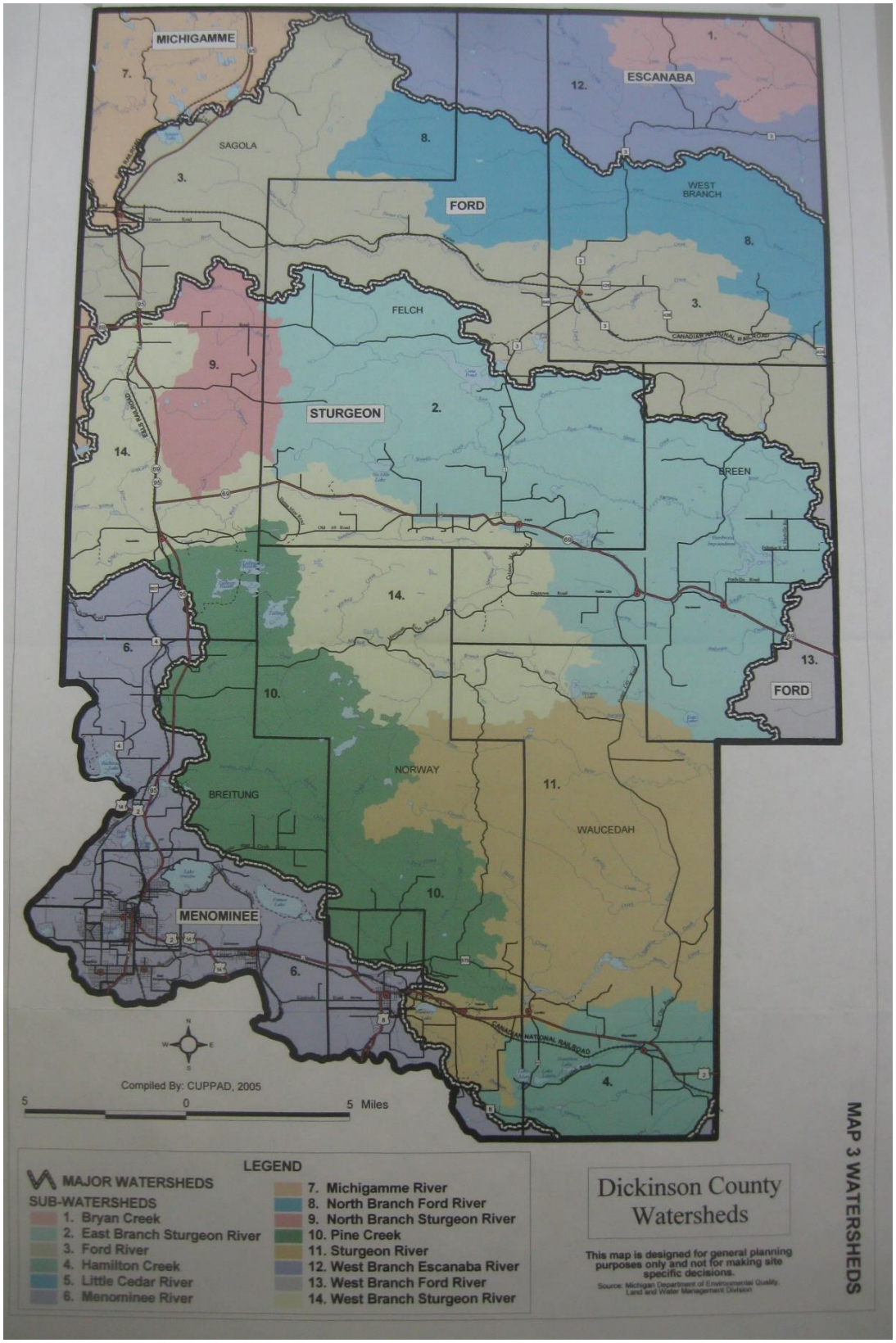
Housing

The Census Bureau counted a total of 13,990 housing units in Dickinson County in 2010. Occupied housing units accounted for about 81% of the total stock. Mobile homes make up just over 6 percent.

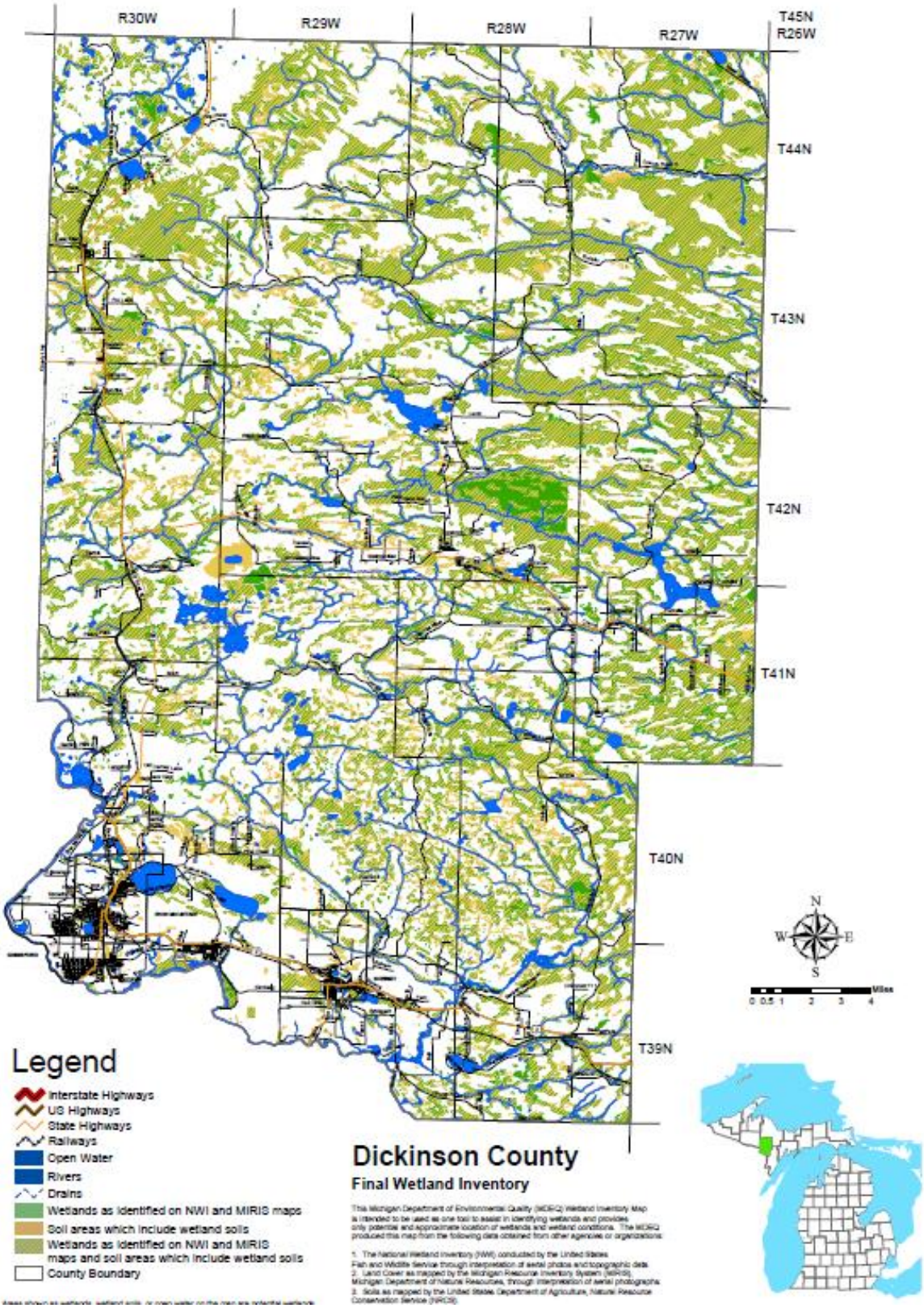
Map 2: Dickinson County Contours and Elevations



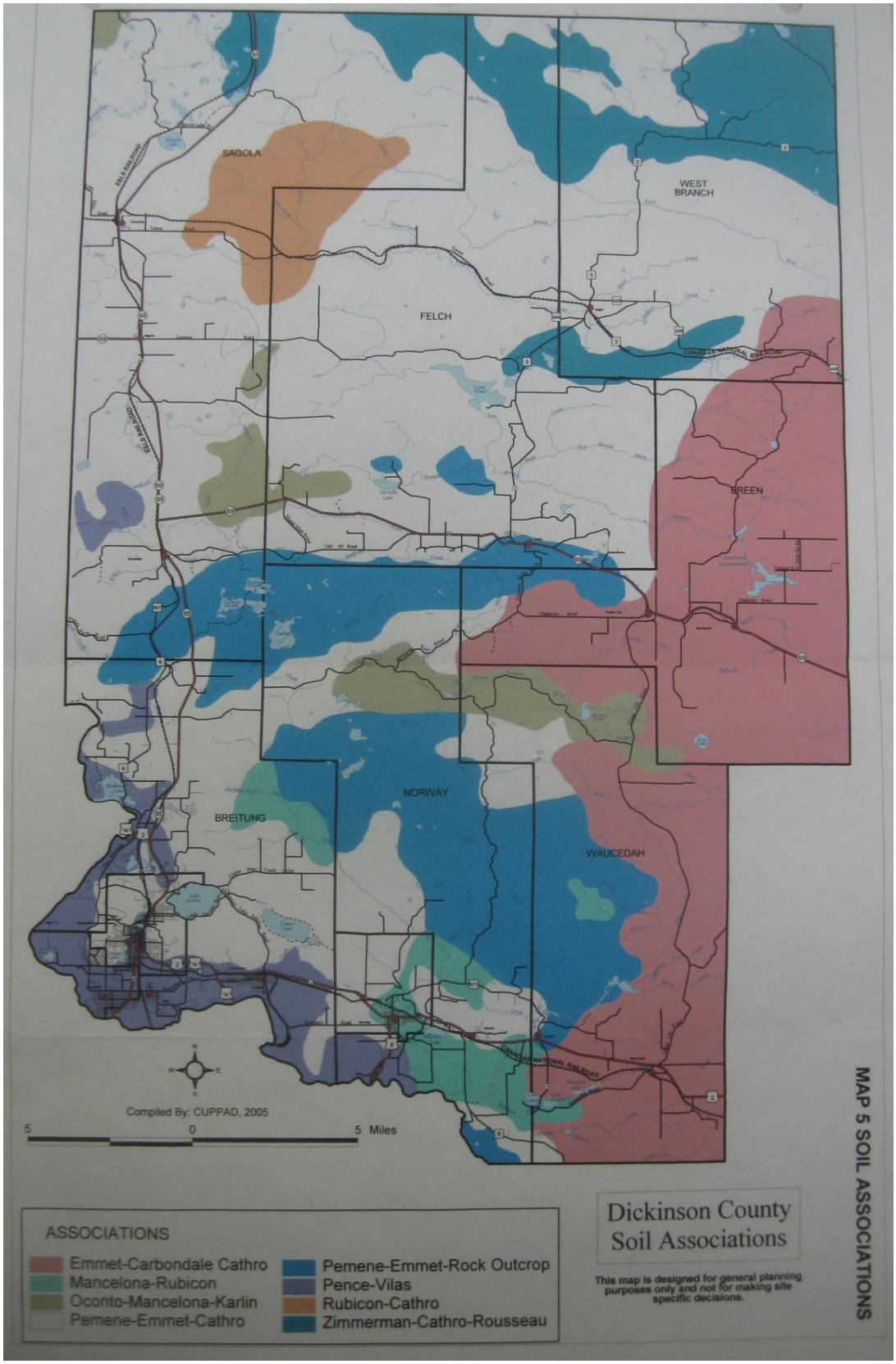
Map 3: Dickinson County Watersheds



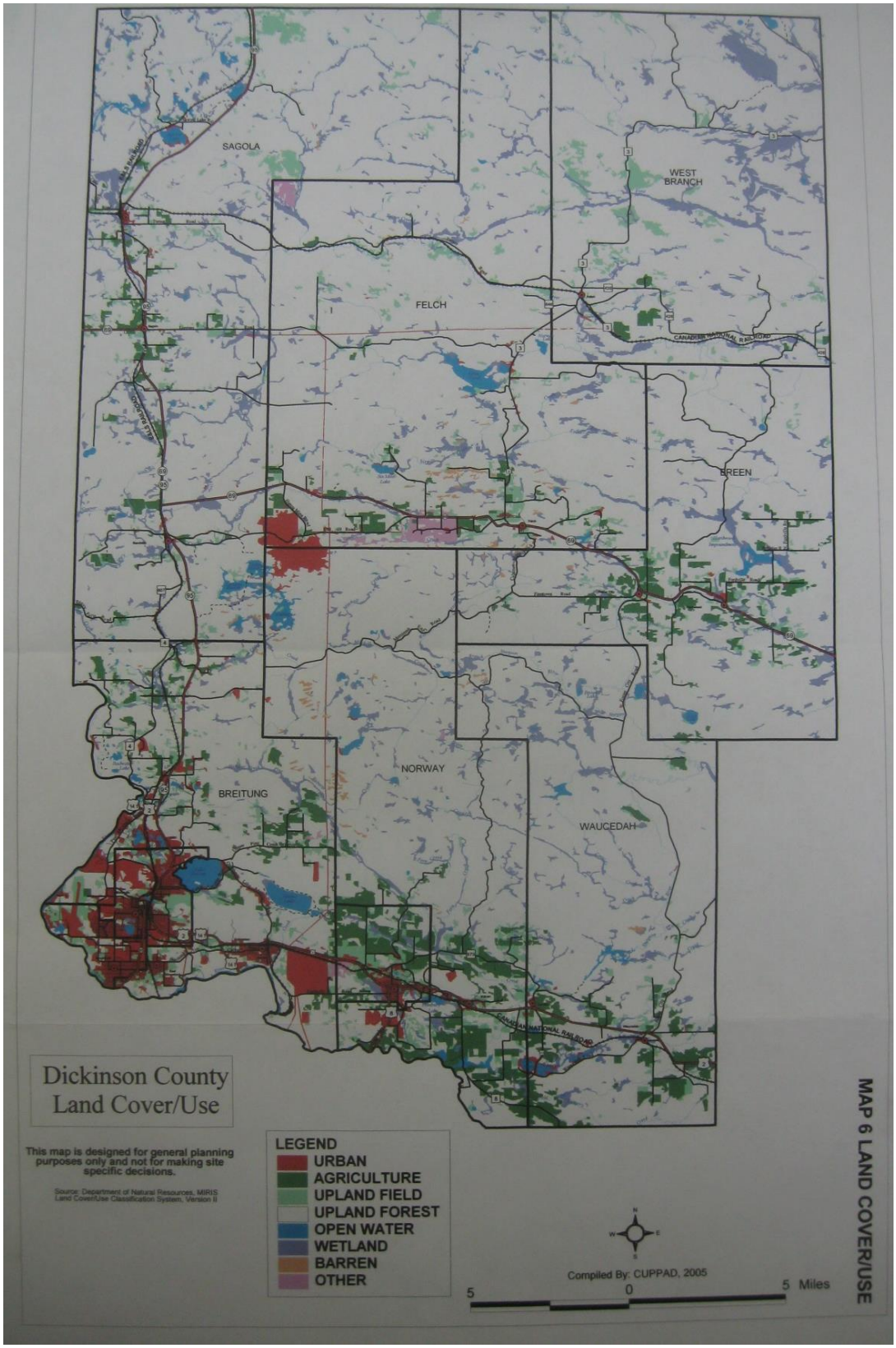
Map 4: Dickinson County Wetlands



Map 5: Dickinson County Soil Associations



Map 6: Dickinson County Land Use Cover



The Dickinson County Construction Code Commission issues building permits for all townships and cities. Over half (51.3 percent) of county housing structures were built before 1960. About 70 percent of all housing units are heated with natural gas; about 13 percent use propane. Fuel oil, electricity and wood are used to heat the balance of housing units.

The construction standards of many seasonal units are not known. Roads to such structures are generally constructed to meet the needs of occasional use. Road widths, curves, grades and base sufficiency may be problematic for emergency vehicles.

Population

As Table-1 shows, the county population has not changed much over the past 70 years. Although more spread out due to lifestyle preferences and ease of mobility, the county population remains concentrated along and near US-2 from Vulcan to the M-95 junction. Overall, the county population decreased by 4.8 percent between 2000 and 2010. In the 30-year period ending in 2000, the median age of county residents increased by 14 percent. Generally, median age rises with distance from population centers. This is largely attributable to the living preferences of persons with no children, many of whom are retired.

Table - 1
Population History, Dickinson County

Year	Population
1900	17,890
1910	20,524
1920	19,456
1930	29,941
1940	28,731
1950	24,844
1960	23,917
1970	23,753
1980	25341
1990	26,831
2000	27,472
2010	26,168

Source: U.S. Bureau of the Census for years cited

Map 7: Dickinson County Population Distribution

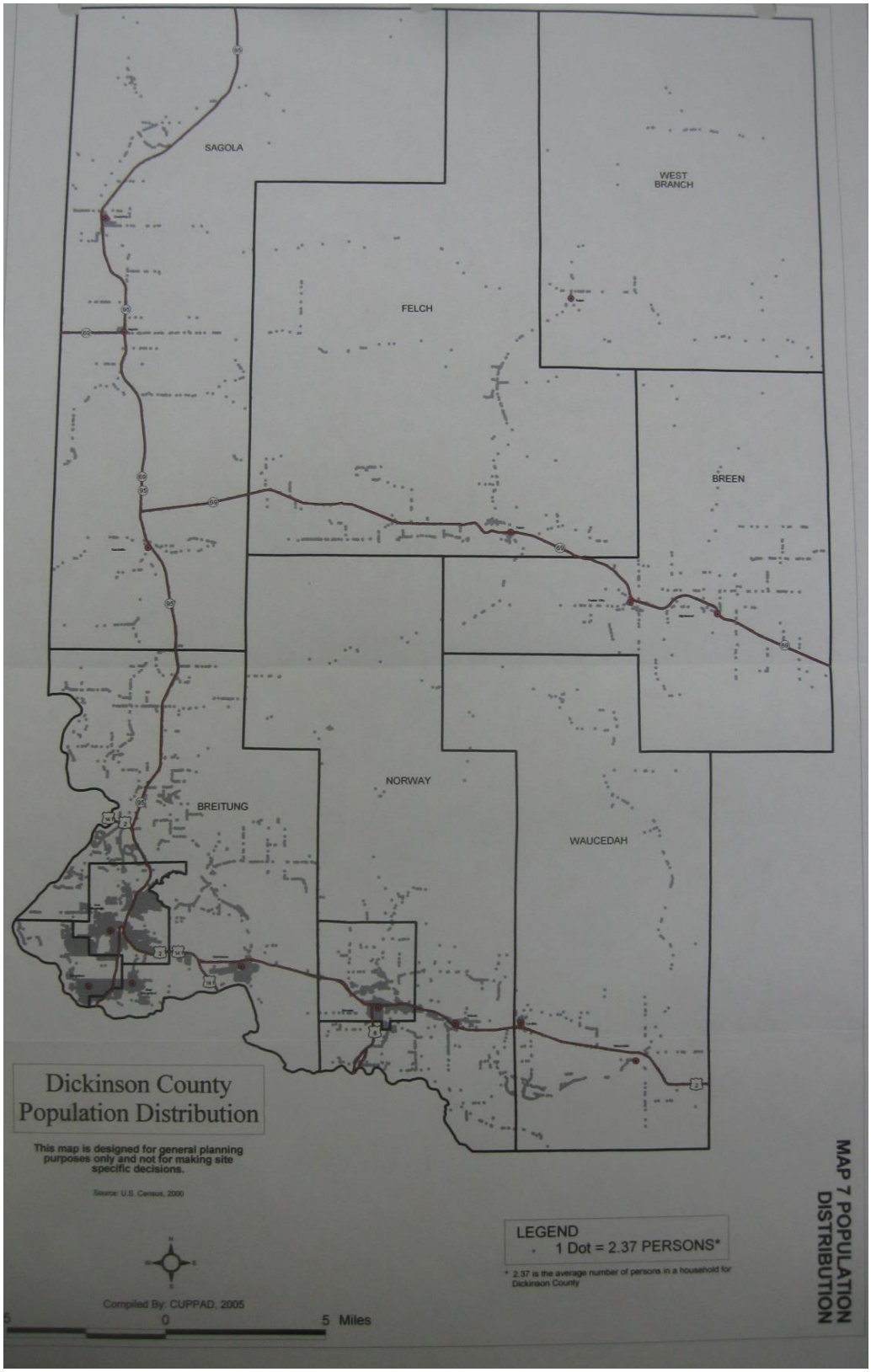


Table – 2 Population 1940-2010, Dickinson County Civil Divisions										
Township	1940	1950	1960	1970	1980	1990	2000	2010	1940-2010 Change	1940-2010 Percent Change
Breen	825	584	492	462	471	464	479	499	326	-39.6
Breitung	2,937	2,739	2,860	3,392	4,669	5,483	5,930	5,853	2,916	100.2
Felch	848	678	509	444	615	705	726	752	-96	-11.3
Norway	1,272	1,102	1,022	966	1,257	1,325	1,639	1,489	217	14.6
Sagola	1,561	1,184	952	918	1,146	1,166	1,169	1,106	-455	-29.1
Waucedah	583	497	475	503	577	693	800	804	221	27.5
West Branch	126	85	53	57	56	80	67	63	-63	-50.0
City										
Iron Mountain	11,080	9,679	9,299	8,702	8,341	8,341	8,154	7,624	-3,456	-31.2
Kingsford	5,771	5,038	5,084	5,276	5,290	5,480	5,549	5,133	-638	-11.1
Norway	3,728	3,258	3,171	3,033	2,919	2,910	2,959	2,845	-883	-23.7
COUNTY TOTAL	28,731	24,844	23,917	23,753	25,341	26,831	27,472	26,168	-2,563	-8.9
Percent Change by Decade	-	-13.5	-3.7	-.07	6.7	5.9	2.4	-4.7	-	-

Source: U.S. Bureau of the Census for years cited

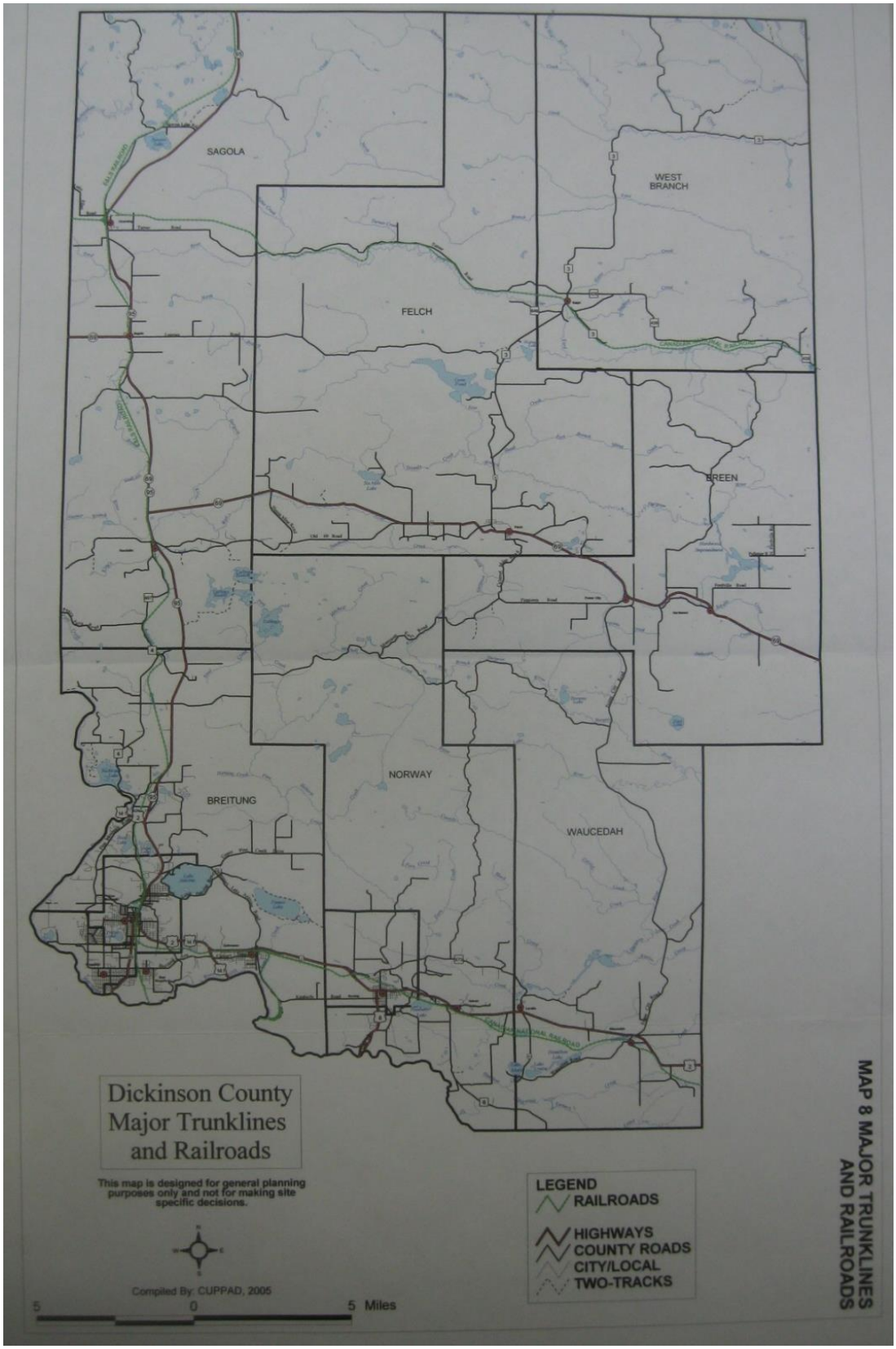
Transportation

Highways US-2 and M-95 are the most heavily traveled trunk-lines in the county. Other trunk-lines include M-69, US-141, and US-8. Their collective in-county distance is 84.4 miles. Roads within the jurisdictions of the cities, county and state combine for 769.7 miles. County primary roads total 176.8 miles and there are 357.8 miles of county local roads. The county road system is managed and maintained by the Dickinson County Road Commission and includes 22 bridges, some with load restrictions.

The Canadian National Railroad, Wisconsin Central Division, extends for approximately 20 miles from the Menominee County border south of US-2 to Iron Mountain. A spur runs from Quinnesec to Niagara, Wisconsin. The Escanaba and Lake Superior Railroad's Green Bay to Ontonagon line passes through the county from southwestern Breitung Township to Channing. A branch line runs north from Channing to Republic. Tracks remain in place along the Channing to Wells (Delta County) route but their use is limited to car storage. The same is true for a spur that served the Groveland Mine south of Randville.

Dickinson County Ford Airport in Kingsford (elevation 1,182 feet) has runways of 6,500 and 3,812 feet. Daily commercial passenger service is also available. The facility dispenses several types of aviation fuel. Private landing strips are found in East Kingsford and near Ralph. Major trunk lines and railroads are identified on Map-8.

Map 8: Dickinson County Major Trunk-lines and Railroads



Economic Characteristics

Most employment in the county is found in service industries. Almost one-fourth of all employed persons are engaged in educational, health and social services. The hospitality industry (entertainment, recreation, lodgings and food service) employs about 7 percent of the county workforce with another 17 percent involved in retail and wholesale trade.

Approximately 15,000 persons - employed and unemployed – make up the county labor force. Unemployment rates in Dickinson County are typically among the lowest in the Upper Peninsula. Detailed employment information by industrial category is presented in Table-3.

According to the US Census the per capita income in 2010 was $22,583; the statewide figure was $25,238. Median household income was $42,331 compared to $48,519 for Michigan overall. The percentage of county residents with incomes below the poverty level was 10.7 percent in 2010 while the statewide rate was 16.8 percent.

Table – 3
Percentage of Employed Persons by Industry, 2013

Industrial Category	Dickinson County	Michigan
Agriculture, forestry, fishing and mining	1.2%	1.4%
Construction	5.1%	4.8%
Manufacturing	17.8%	16.9%
Wholesale trade	2.8%	2.5%
Retail trade	15.7%	11.6%
Transportation and warehousing, and utilities	6.5%	4.1%
Information	1.9%	1.6%
Finance, insurance, and real estate	3.7%	5.5%
Professional, scientific, management, administrative, and waste management services	6.9%	9.2%
Educational, health, and social services	22.9%	24.2%
Arts, entertainment, recreation, accommodations and food services	7.1%	9.4%
Other Services	5.1%	4.9%
Public administration	3.3%	3.8%

Source: Table DP-3 Profile of Selected Economic Characteristics, 2013 Census Estimates

Major Facilities

The following facilities are crucial to carry out daily services, respond to an emergency or assist with recovery from an emergency event. Maps-11A, 11B, 11C, and 11D (located at the end of this section illustrate facilities found countywide and in the three cities: Iron Mountain, Kingsford and Norway.

Educational

Elementary and Secondary Area Schools
Public school district boundaries are shown on Map-9. Table-4 lists the public and private schools located in Dickinson County.

Vocational Schools
The Dickinson-Iron ISD at the Technical Education Center in Kingsford provides vocational instruction for high school students.

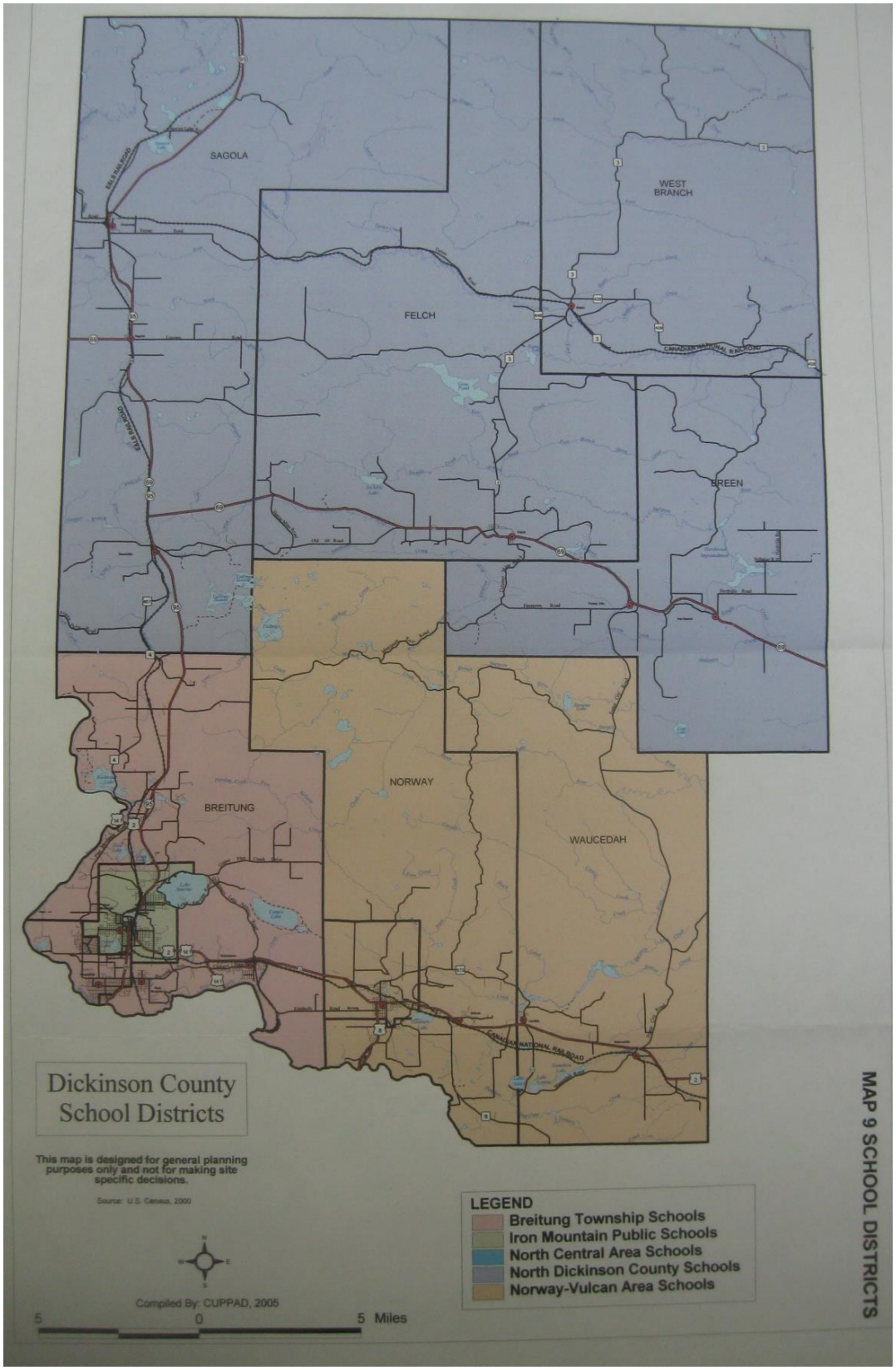
Headstart
The Early Childhood Education Department of the Dickinson-Iron Intermediate School District administers the Headstart Program. Educational activities are provided through facilities in Kingsford, Norway and Felch.

Post-Secondary Schools
Bay de Noc Community College provides a limited range of classes through its Dickinson County facility in Iron Mountain. Northern Michigan University also offers some classes at facilities of the D-I ISD in Kingsford.

Table - 4
Public and Private Schools, Dickinson County

Name	Location	Type/Grades	2001-02 Enrollment
Breitung Township School District	Kingsford	Public, K-12	2,160
Iron Mountain School District	Iron Mountain	Public, K-12	1,496
Norway-Vulcan Area School District	Norway	Public, K-12	1,045
North Dickinson County School District	Felch	Public, K-12	425
Dickinson Area Catholic Schools	Iron Mountain	Private, K-8	163
Holy Spirit Catholic School	Norway	Private, K-8	112
Pine Mountain Christian Academy (SDA)	Breitung township	Private, K-8	25

Map 9: Dickinson County School Districts



Medical

Hospitals

Dickinson County Memorial Hospital provides acute care to medical, surgical, pediatric, obstetric and emergency patients. The 96-bed facility, found along US-2 in Iron Mountain, was completed in 1996.

The Veterans Affairs Medical Center in Iron Mountain was first opened in 1950. Its service area includes the entire Upper Peninsula and eleven northeastern Wisconsin counties. The six-story, 63-bed facility was expanded with new ambulatory units and a 40-bed Nursing Home Care Unit. Most services are provided on an outpatient basis.

Emergency Medical Services

One privately owned Paramedic Ambulance Services provide emergency medical services to all of Dickinson County, and also northern Marinette and Florence counties in Wisconsin.

Basic life support service is provided by: Star Ambulance Service in Sagola Township, Nordic Ambulance Service in West Branch, Breen and Felch townships, and NorthAlert Ambulance Service in the City of Norway, Norway Township and Waucedah Township. Mutual aid agreements exist among Beacon, Star, and Nordic Ambulance Service. NorthAlert does not have a mutual aid agreement at this time. Disaster response capability is strengthened by agreements with adjacent counties through the Dickinson County Medical Control Authority. An air lifeline service is available at Ford Airport.

Law Enforcement and Fire Protection

Local law enforcement agencies have joined together to support special countywide activities through K.I.N.D. (drug interdiction) and C.I.R.T. (critical incident response team). Regional drug investigations are done through the UPSET program. In addition, bomb detection and drug detection dogs are available through the Michigan State Police in Negaunee and the Escanaba Public Safety Department.

There are eight separate fire departments in the county and a Department of Natural Resources field office fire management personnel. Several mutual aid agreements exist among departments but there is no countywide agreement. Breitung Township has agreements with the Iron Mountain, Norway, Sagola and Florence, Wisconsin departments. Sagola Township has agreements with the townships of Felch, Breen, West Branch, and Crystal Falls (Iron Co.). Iron Mountain, Norway, and Breitung Township have thermal imaging cameras, while Felch, Breen, and West Branch Townships share one. Kingsford Public Safety will soon be acquiring a thermal imaging camera. All departments participate in fire education programs.

Force strengths and services of local police and fire agencies are shown in Tables-5 and 6.

Table - 5 Police Agencies, Dickinson County			
Name	Area of Coverage	Agency Force	Comments
Dickinson County Sheriff Office.	County	57	Road, marine, snowmobile patrol; search and rescue; investigations; court services; operation of 68-bed jail
Iron Mountain Police Dept.	City	14	Local law enforcement
Kingsford Public Safety Dept.	City	18	Local law enforcement and fire protection
Norway Police Dept.	City	5	Norway City Manager/Acting Chief
Michigan State Police Post #85, Iron Mt.	County	18	Road patrol, investigations

Table - 6 Fire Departments, Dickinson County			
Name	Area of Coverage	Agency Force	Comments
Breen Twp. VFD	Township	16	-
Breitung Twp. VFD	Township	40	Fire halls in Quinnesec, E. Kingsford and M-95
Felch Twp. VFD	Township	15	-
Sagola Twp. VFD	Township	15	-
West Branch Twp. VFD	Township	9	-
Iron Mountain FD	City	14	-
Kingsford DPS	City	19	Fire and police
Norway VFD	Norway and townships of Norway and Waucedah	30	-

County

Emergency Management

Multi-hazard mitigation planning, protection of public health and safety, preservation of essential services, prevention of property damage, preservation of the local economic base, and response to community disasters is assigned to the Dickinson County Emergency Services office. A full-time Director and two part-time Deputy Directors report directly to the county board.

Public Health

The Dickinson-Iron District Health Department is headquartered in Iron River and maintains facilities in Kingsford. The agency provides programs and services aimed at prevention and control of disease and environmental health hazards.

Solid Waste

County residential and commercial waste is transferred through the Dickinson County Solid Waste Management Authority facility in Breitung Township for transport and disposal at the Wood Island landfill in Alger County. Collection is done through private and municipal services.

Public Works

Water

Iron Mountain draws water from 4 wells and distributes citywide and to Breitung township along US-2 near the east city limit. The system includes a 2.5 million gallon storage capacity. Approximately 8,200 persons rely on the system for potable water.

Kingsford's water supply comes from 4 wells. Storage is accomplished with tanks of 2 million and 150,000 gallons. Water is supplied to the East Kingsford and Skidmore areas in Breitung Township. The system serves the daily water requirements of approximately 6,000 persons.

Kingsford and Iron Mountain water systems are interconnected at five locations. Valves at any of these points can be opened to ensure a continuous potable water supply should a problem arise in either system.

Norway utilizes 3 wells to supply most of the city and some areas of Norway Township. Township areas include Vulcan and development along US-8 at Norway's southern city limit. About 3,000 persons utilize the system for their water requirements. The system includes storage tanks with capacities of 750,000 gallons and 178,000 gallons.

The community of Quinnesec provides municipal water service to an estimated 800 persons. A 100,000-gallon storage tank is used with the three-well system.

All other areas of the county obtain water from private wells.

Wastewater

The wastewater collection systems of Iron Mountain and Kingsford are treated at a jointly owned plant along the Menominee River in Breitung Township. The East Kingsford and Skidmore areas

of Bruiting Township are included in the collection system. The number of persons served by the individual systems and the wastewater treatment plant nearly mirror water users.

Norway and Norway Township established a sewer treatment authority in 1977 to manage a collection and treatment system. The service area is essentially the same as the water distribution system and, thus, serves about the same number of persons.

Wastewater is collected and treated within the communities of Channing and Sagola. A lagoon system serves about 200 households in Channing; a community septic system services about 35 households in Sagola.

Utilities

AT&T provides phone service across the western and southern parts of the county. The balance of the county is served by the Upper Peninsula Telephone Company (map 10).

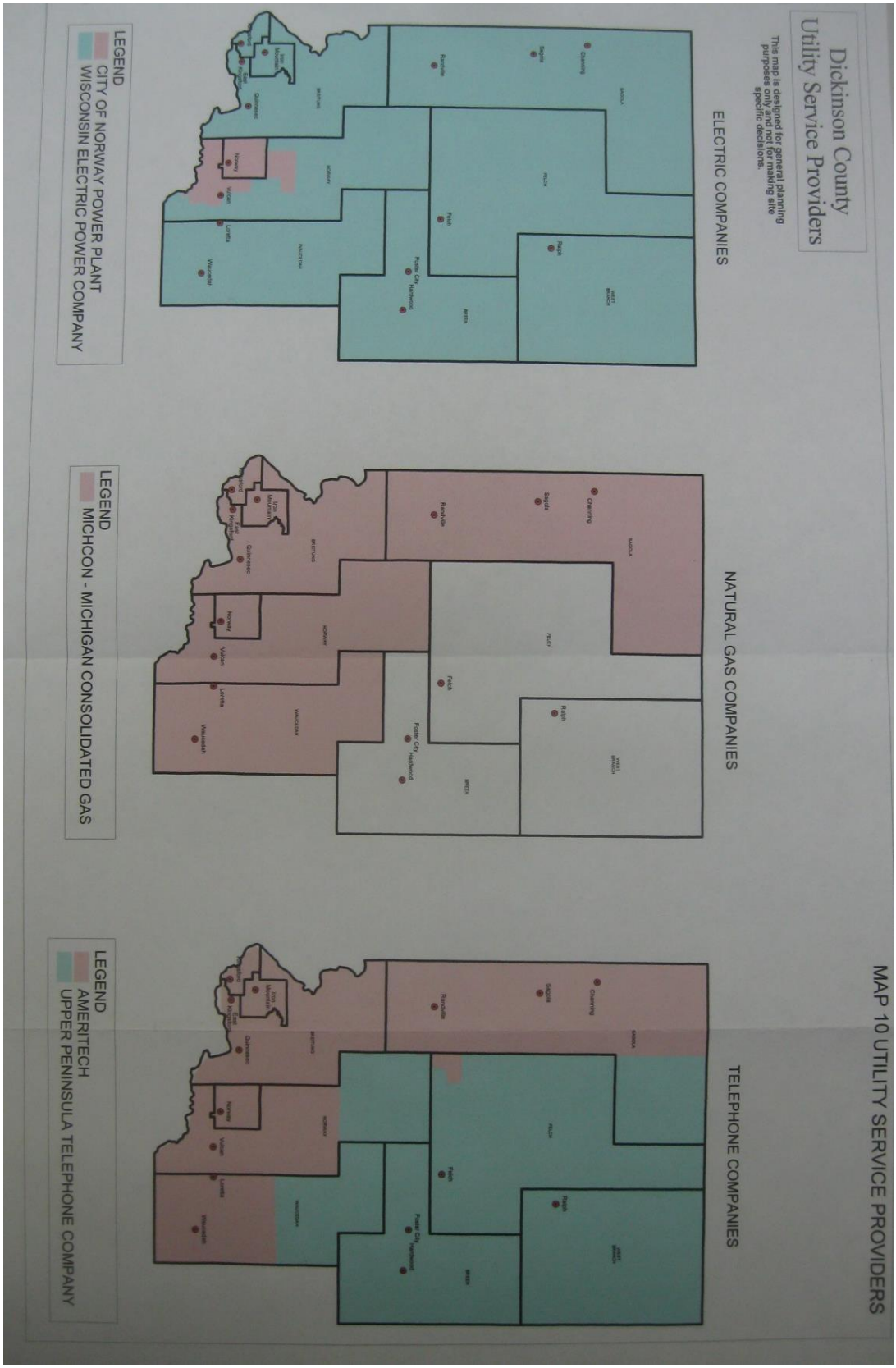
Natural gas service is available in the cities and western and southern portions of the county. These are areas adjacent to or near trunk-line highways.

Four large diameter (up to 48 inches) petroleum transmission pipelines cross the northern part of the county in an east-west direction. These pipelines carry petroleum products of several types including natural gas, natural gas liquids (NGL), crude and fuel oil.

WE Energies serves the entire county except the city of Norway and portions of Norway Township. The company owns and operates 12 hydro projects in the U.P. The municipally owned and operated Norway hydro project supplies electricity to an estimated 5,000 persons.

Major power transmission line routes include areas along M-95 and from Arnold (Marquette County) to Breitung Township.

Map 10: Dickinson County Utility Service Providers



Other

National Guard

The National Guard Armory on Carpenter Avenue in Kingsford is home to the 46 MP Company, a military police unit. At present, the unit's roster includes 142 guard members.

Michigan Department of Natural Resources

Firefighting equipment and trained personnel are located at the Michigan DNR Field Office in Norway.

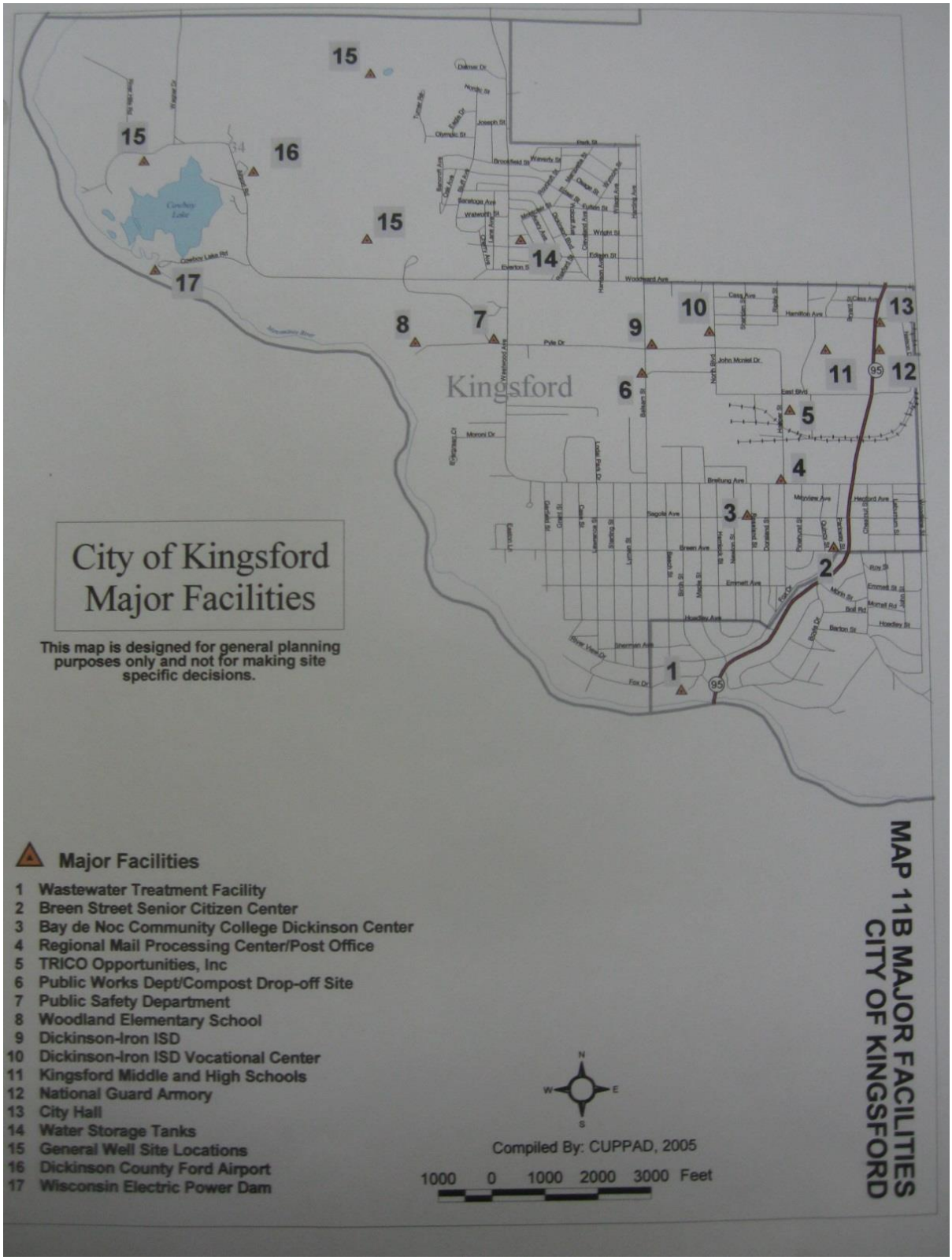
Future Land Use Trends

The overall land use trend appears to involve the expansion of residential and commercial development in the Iron Mountain-Kingsford-Norway urban corridor, along with gradual growth in the outlying areas of the county. Waterfront development on lakes and rivers is increasing and some of the residential development near the urban corridor is occurring in areas served by gravel roads and at some distance from services. There will be conversion of farmlands to residential development.

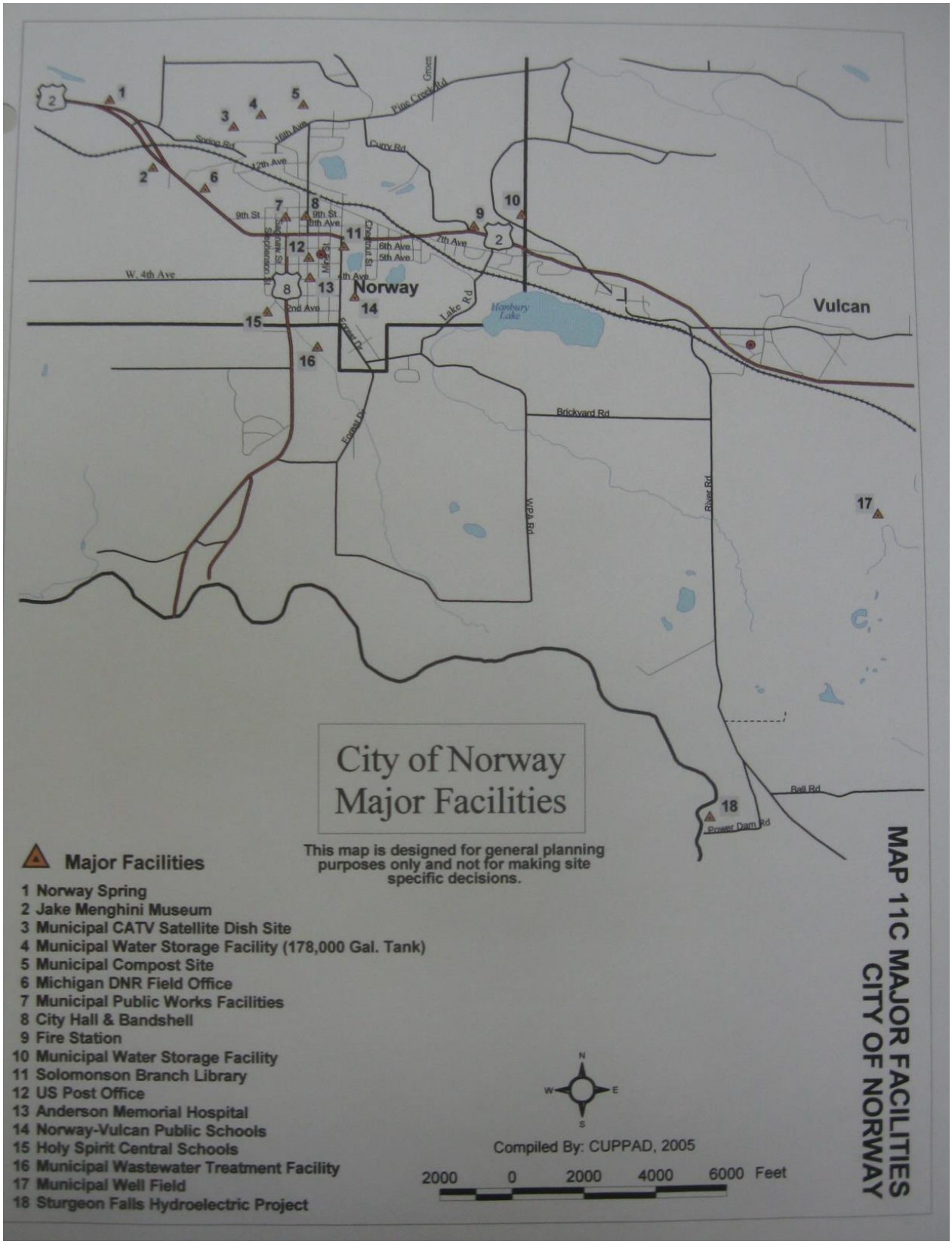
Map 11A: Dickinson County Major Facilities, City of Iron Mountain

City of Iron Mountain
Major Facilities
This map is designed for general planning purposes only and not for making site specific decisions.
1000 0 1000 2000 3000 Feet
Compiled By: CUPPAD, 2005
Major Facilities
1 Timberstone Golf Course
2 Michigan State Police Post #86
3 Boat Launch
4 Public Works Department
5 North Elementary School
6 Cornish Pump
7 Police and Fire Departments
8 High School Football Stadium
9 Pine Grove Country Club
10 City Park
11 High School
12 Central Elementary and Middle Schools
13 Dickinson Area Catholic School
14 Crystal Lake Community Center
15 Dickinson County Road Commission
16 Mid-Town Mall
17 Dept. of Veteran Affairs Medical Center
18 Cemetery
19 Dickinson County Memorial Hospital
20 East Elementary School
21 Dickinson County Courthouse
22 Sheriff Department and Jail
23 City Hall
24 County Library
25 Menominee Range Historic Museum
26 Mountain View Arena
27 In-Ground Water Storage (1,000,000 Gal.)
MAP 11A MAJOR FACILITIES
CITY OF IRON MOUNTAIN
Iron Mountain
Quinnesec Lake Antoine
Lake Antoine
Crystal Lake
Lehman Ave
Railroad St
Pine St
Spring St
Antoine St
Lincoln St
Campagnola Rd
Grand Blvd
Grand St
Stanton St
Blaine St
Smith St
Margaret St
Main St
7th St
6th St
5th St
4th St
3rd St
2nd St
Tall Pines Dr
Northview Dr
Kramer Dr
Spencer Ct
Lower Pine Mountain Rd
Kimberly Ave
Walker St
Fairbanks St
Kent St
Houghteling St
Wells St
Fleshiem St
Brown St
Ludington St
Hughitt St
Ludington St
Parkview Dr
D St
C St
B St
E St
F St
G St
H St
I St
J St
Cook St
Woodward Ave
Detroit Ave
Adom Ln
Terminal Ave
Railroad Service Dr
Apollo Dr
Heather Ln
Phil Rahol Cir
East Side Cutoff Ave
Lake Antoine Rd
Frank Pino Rd
Quinnesec St
Norway St
Aragon St
Broadway St
Crowell St
Dickinson St
Wyatt St
Woodward St
William St
Carolina St
Hamilton Rd
Iron Mountain St
Stephenson Ave
Stockbridge Ave
Carpenter Ave
Prospect Ave
Merritt Ave
Jackson St
Adams St
Jackson St
Van Buren St
Park Ave
Ridge Rd
Osio Ave
Birch Dr
Oak Dr
Michigan Avenue
Beech St
Birch St
Maple St
Hemlock St
Spruce St
Tamarack St
Pine St
Forest St
Lake St
Foster St
Pyle Ct
Evanson Dr
Carolina Dr
Elizabeth St
Spring St
Antoine St
Iron Mountain St
Stanton St
Tall Pines Dr
Spencer Ct
Railroad St
Pine St
Quinnesec St
Quinnesec St
Norway St
Aragon St
Broadway St
Crowell St
Dickinson St
Wyatt St
Woodward St
William St
Carolina St
Hamilton Rd
Iron Mountain St
Stephenson Ave
Stockbridge Ave
Carpenter Ave
Prospect Ave
Merritt Ave
Jackson St
Adams St
Jackson St
Van Buren St
Park Ave
Ridge Rd
Osio Ave
Birch Dr
Oak Dr
Michigan Avenue
Beech St
Birch St
Maple St
Hemlock St
Spruce St
Tamarack St
Pine St
Forest St
Lake St
Foster St
Pyle Ct
Evanson Dr
Carolina Dr
Elizabeth St
Spring St
Antoine St
Iron Mountain St
Stanton St
Tall Pines Dr
Spencer Ct
Railroad St
Pine

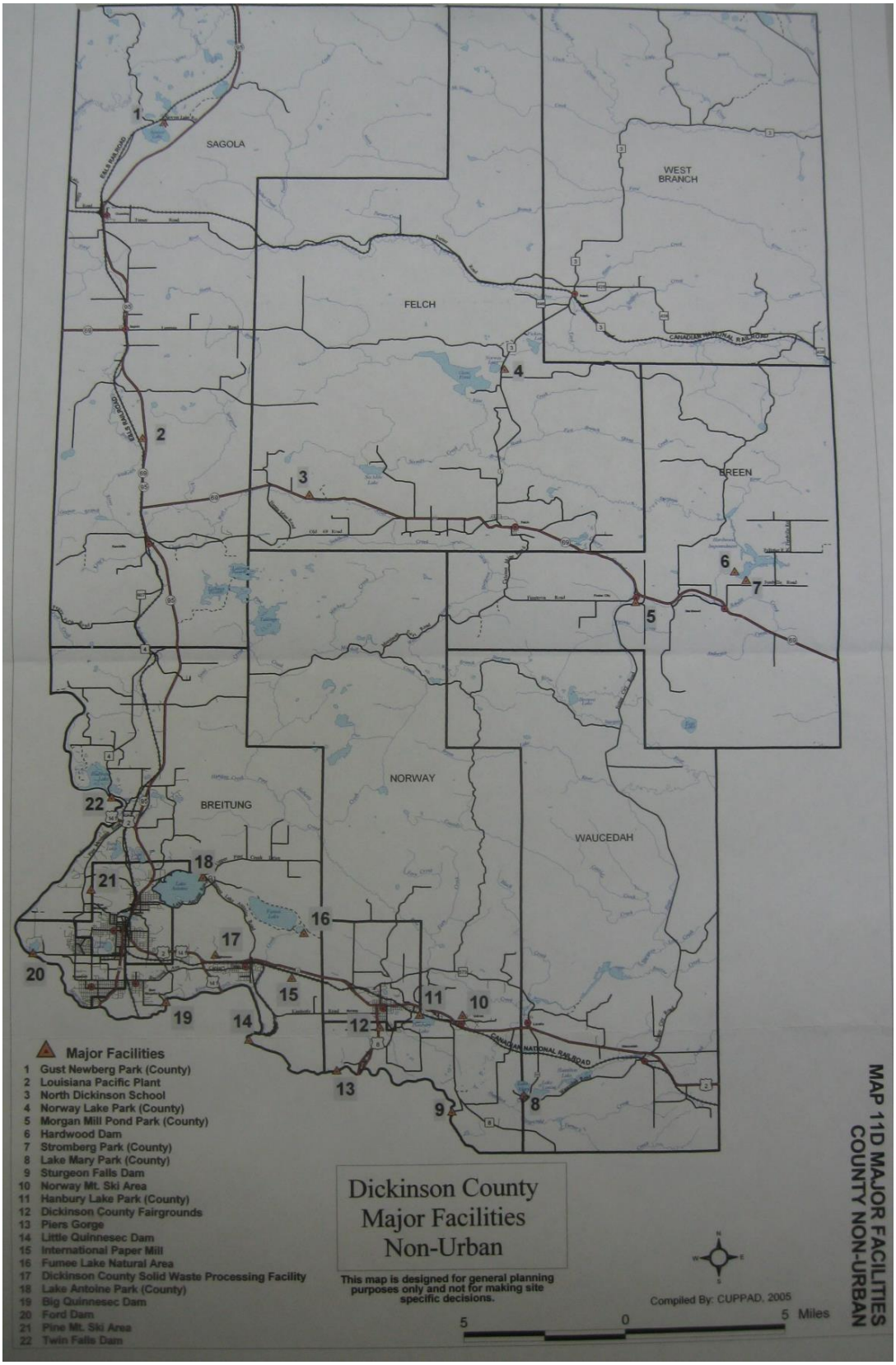
Map 11B: Dickinson County Major Facilities, City of Kingsford



Map 11C: Dickinson County Major Facilities, City of Norway



Map 11D: Dickinson County Major Facilities, County Non-Urban



Hazards

Dickinson County is subject to a wide range of natural and man-made hazards every year, therefore, an all-hazards approach was taken with mitigation planning. Research and identification of hazards was an extensive process, which gathered input from local officials and residents of Dickinson County.

The section on Hazard Rating and Ranking describes the hazard rating and ranking process. The results of this process guided the determination of risk and vulnerability. The section on Risk and Vulnerability Assessments describes what risk and vulnerability assessments are and why they are done. And last in this chapter, the Hazard Analysis section describes each hazard with corresponding risk/rank and vulnerability statement.

Hazard Rating and Ranking

Hazards of all types were evaluated according to six weighted measures:

1. Casualty Potential
2. Percent of Population Affected
3. Likelihood of Occurrence
4. Capacity to Cause Physical Damage (Severity)
5. Size of Affected Areas (Location)
6. Corollary Effects

Local residents from business and industry, police and fire agencies, emergency services, education, public health, medical services, transportation, planning and zoning, and local elected officials participated in a series of reviews and discussions. Hazards were ranked according to aspects and values determined by local evaluators. Some two-dozen residents in all participated in the process. The county hazard rating, ranking and risk are shown in Table-7.

The rating points reflect an order of importance as a threat within the County - the higher the points, higher the risk. This ranking is based on the most current information available at the time and many hours of deliberation, but it should not be assumed that lower ranked hazards would not occur. (Appendix B gives more detail about the methodology of the hazard rating and ranking.)

Risk and Vulnerability Assessments

The risk and vulnerability assessments are closely related steps in the hazard analysis process. Both assessments were used in analyzing hazards in Dickinson County.

Risk Assessment → is a description and/or map of the location, probability, extent/impact where hazards exist in the community to gain some idea of how often they arise and how much harm they might do in the future. Through risk assessment each hazard is addressed to some degree and there are three basic degrees of assessment: cursory, standard, and advanced.

> Cursory Assessment – is a short statement explaining why a particular hazard is not considered a threat. This type of statement is applied to low-risk hazards.
>
> Standard Analysis – is one in which readily available information is gathered, evaluated, and explained using text and maps as appropriate but for which no special evaluation

techniques were used. Explanations of this type are applied to moderate or high-risk hazards.

Advanced Analysis – includes application of theoretical or expert knowledge that requires significant time, expense, and training to be applied. This type of analysis is reserved for the highest-risk hazards and is used if the appropriate expertise is available.

Vulnerability Assessment → gives quantitative estimates of the people and property in the community that are vulnerable to each hazard. Examples would be the number of people at risk, structures vulnerable to damage, key services affected, and estimates of cost.

In mitigation planning, professionals have not been able to reach agreement on where risk assessments end and vulnerability assessments start. Often these two types blend together. The risk and vulnerability assessments for Dickinson County hazards were combined and entered under the heading *Vulnerability*.

DICKINSON COUNTY HAZARD RATING/RANKING	TABLE - 7		
Hazard	Rating Score	Ranking	Risk
Tornadoes	6.50	1	
Public Health Emergencies	6.10	2	
Hazardous Materials Accident - Transportation	5.65	3	
Earthquakes	5.50	4	
Transportation Accidents	5.40	5	
Snowstorms	5.00	6	**HIGH**
Structural Fires	4.95	7	
Hazardous Materials Accident - Fixed Site	4.95	8	
Terrorism, Sabotage, WMD	4.80	8	
Lightning and Thunderstorms	4.30	10	
Infrastructure Failures	3.70	11	
Dam Failures	3.70	12	
Nuclear Power Plant Accidents	3.70	12	
Wildfires	3.70	12	
Severe Wind	3.40	12	
Ice & Sleet Storms	3.35	16	
Temperature Extremes	3.10	17	
Drought	3.00	18	
Other Environmental (invasives, exotics, diseases, etc.)	2.80	19	
Workplace Violence	2.60	20	
Scrap Tire Fires	1.65	21	**MODERATE**
Riverine Flooding	1.60	22	
Hail	1.60	23	
Subsidence	1.55	24	
Petroleum Pipeline Failures	1.50	24	
School Violence	1.15	26	
Public Assembly Events	1.05	27	
Civil Disturbance	1.00	28	
Economic Recession/Adversity	1.00	29	
			LOW

Hazard Analysis

The following hazards are those considered most likely in Dickinson County. Others received a cursory review, but are potential issues in other parts of the country – such as volcanoes, landslides, and avalanches. Hazards in the following sections are divided into three categories: natural, technological and human related. Most of the following information is taken from the 2014 Michigan Hazard Mitigation Plan. An analysis of each hazard is presented with the corresponding risk/rank located next and followed by a vulnerability statement.

Natural

Hazards caused by severe meteorological events, wildfires, flooding, and unstable ground will be addressed in this section. Unstable ground includes areas affected by mining and excavation.

Severe Weather

Hazard description: Any of several extreme weather events occurring singly or in combination with a potential to damage property and compromise human safety.

The National Weather Service, a division of the National Oceanic and Atmospheric Administration, disseminates information by several means. NOAA weather radio is a readily available source for severe weather warnings, providing up-to-the-minute information. The eastern half of the county receives a reliable signal from transmitters in Escanaba (1,000 watts), Marquette (300 watts), Crystal Falls (1,000 watts), and Wausaukee, Wisconsin (1,000 watts). Although other portions of the county can receive NOAA weather broadcasts, the signal is not reliable. NOAA weather radio coverage maps are included as 12A, 12B, and 12C.

The Emergency Alert System replaced the Emergency Broadcast System in 1996 and is used to transmit emergency information targeted to a specific area. Terms used in weather forecasts reflect the anticipated timing and severity of an approaching storm. A "watch" is issued if a particular hazard is possible because conditions are more favorable than usual for its occurrence. Planning and preparation is the recommended courses of action when a weather watch is issued. A "warning" indicates that a particular weather hazard either is imminent or has been reported and action to protect life and property is recommended.

Other warning systems such as sirens are located with one in Iron Mountain on top of the fire hall and one located near the fire hall in the city of Norway. Neither siren covers their cities.

Dickinson County has experienced severe weather events in all seasons. The most damaging weather events were caused by tornadoes and high winds. The following descriptions break down individual severe weather events. However, it should be noted that severe thunderstorms are associated with damaging winds, hail, and heavy rains capable of causing flash flooding, tornadoes and lightning. Moreover, individual severe cold season weather events can interact to cause many hazards. The difference between rain, ice or snow can be a matter of a few degrees. Severe thunderstorms can occur at any time in Dickinson County, although they are most frequent during the warm spring and summer months of May through September. The potential thunderstorm threat is often measured by the number of "thunderstorm days" – defined as days in which thunderstorms are observed. Dickinson County, in general, is subject to approximately 24-26 thunderstorm days per year.

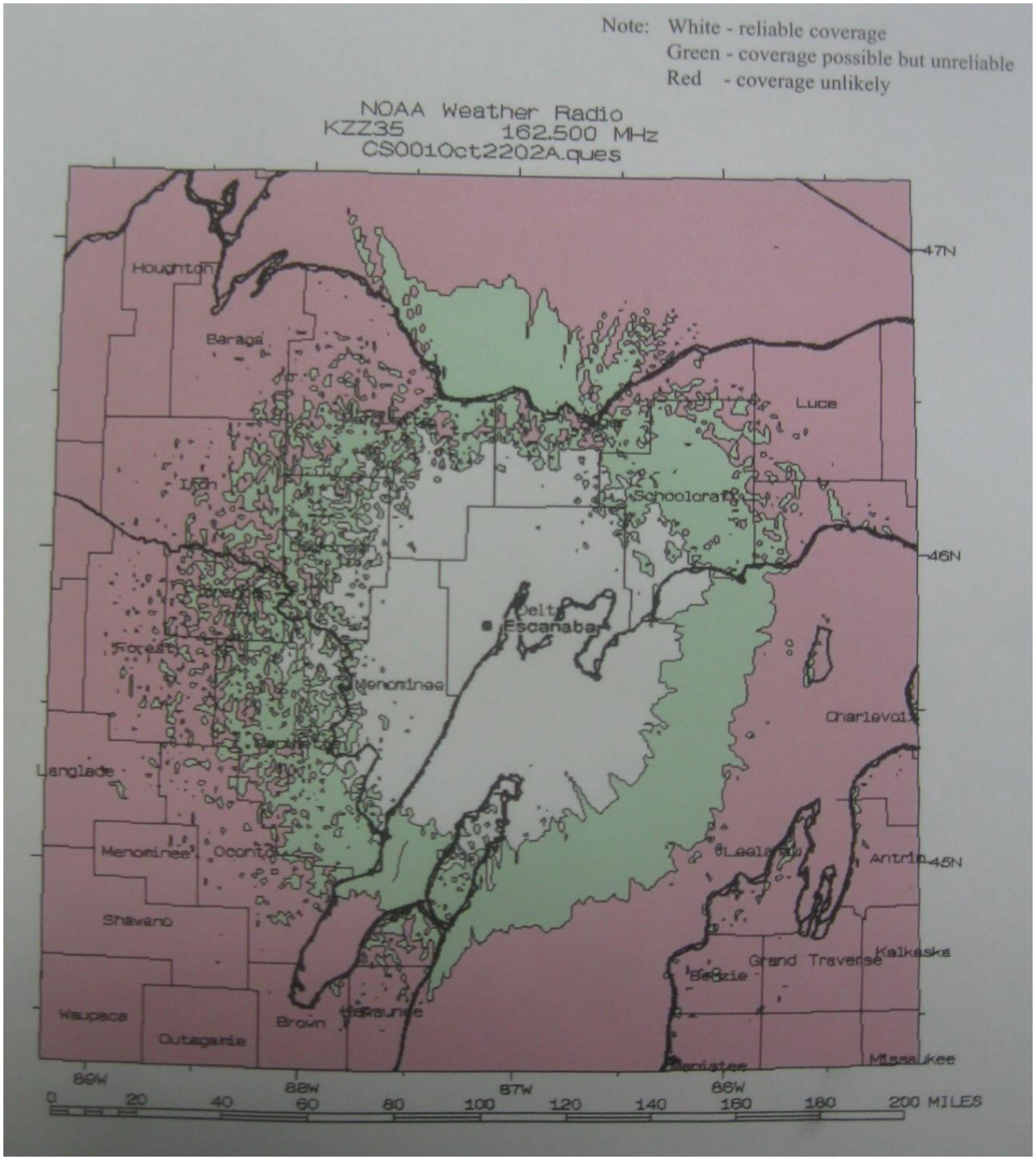
Thunderstorms form when a shallow layer of warm, moist air is overrun by a deeper layer of cool, dry air. Cumulonimbus clouds, frequently called "thunderheads," are formed in these conditions. These clouds are often enormous (up to six miles or more across and 40,000 to 50,000 feet high) and may contain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

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

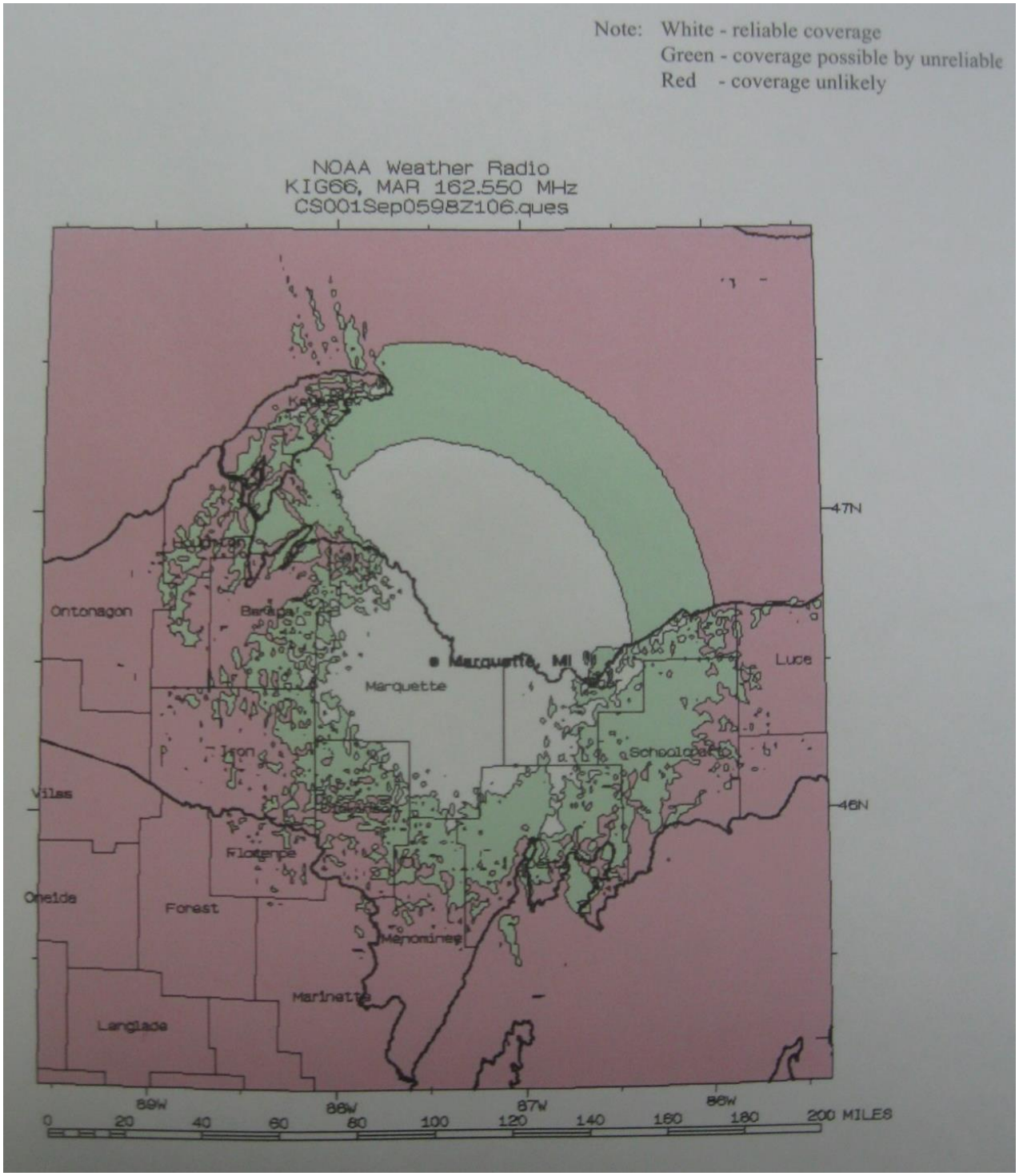
One positive aspect of assessing thunderstorm risks comes from the fact that thunderstorm hazards have some degree of predictability and are closely monitored by the National Weather Service. In addition to daily forecasts, which predict the probability of rainy or stormy weather, the NWS system of Watches and Warnings helps communities understand when there is a potential risk of severe thunderstorms, or if severe thunderstorms are imminent. When the NWS issues a "Severe Thunderstorm Watch," it means that thunderstorms with large hail and damaging winds are possible in your area. When the NWS issues a "Severe Thunderstorm Warning," it signifies that severe thunderstorms (with the damaging winds and hail) are in your area or are imminent.

The NWS has an office in Marquette (http://www.crh.noaa.gov/mqt/) that covers Dickinson County and is responsible for monitoring and providing predictions and bulletins for that portion of the state. The station provides information on severe weather watches and warnings, but also provides useful Doppler Radar images that track the movement of thunderstorms in the area. Since thunderstorms bring the potential for dangerous hail, lightning, straight-line winds, and tornadoes, it is necessary to further examine each of those hazards. Useful historical information on hail, severe winds, lightning, and tornadoes for the county can be found through the National Climatic Data Center's Storm Data website.

Map 12A


Note: White - reliable coverage
Green - coverage possible but unreliable
Red - coverage unlikely
NOAA Weather Radio
KZZ35 162.500 MHz
CS0010ct2202A.ques
Houghton
Baraga
Luce
Iron
Schoolcraft
Delta
Escanaba
Forest
Menominee
Charlevoix
Langlade
Menominee
Oconto
Leelanau
Antrim
Shawano
Grand Traverse
Kalkaska
Benzie
Waupaca
Brown
Outagamie
Manistee
Mason
Mackinaw
47N
46N
45N
89W
88W
87W
86W
0 20 40 60 80 100 120 140 160 180 200 MILES

Map 12B


Note: White - reliable coverage
Green - coverage possible by unreliable
Red - coverage unlikely
NOAA Weather Radio
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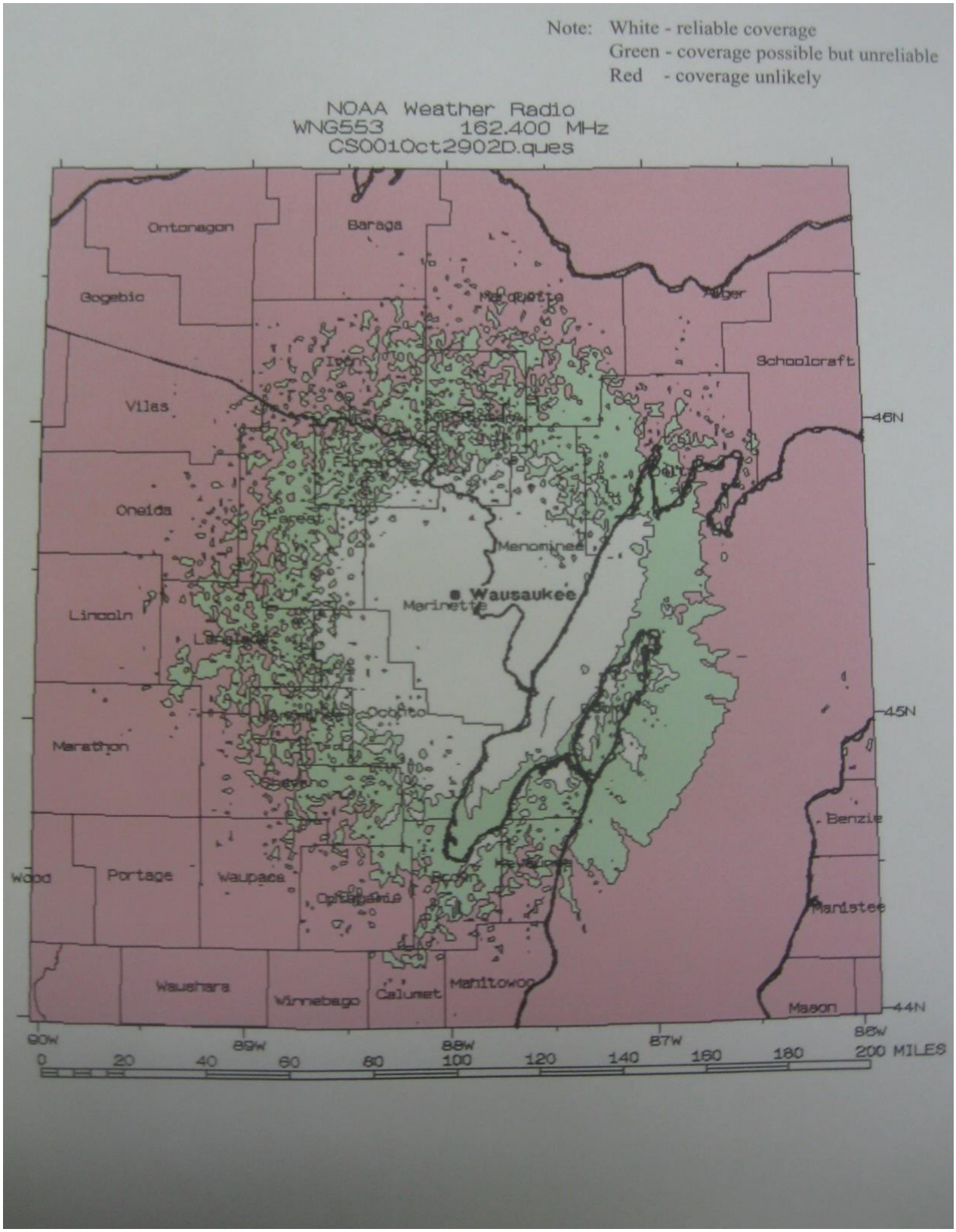
Baraga
Marquette, MI
Marquette
Luce
Iron
Schoolcraft
Vilas
Florence
Oneida
Forest
Menominee
Marinette
Langlade
47N
46N
89W
88W
87W
86W
0
20
40
60
80
100
120
140
160
180
200 MILES

Map 12C


Note: White - reliable coverage
Green - coverage possible but unreliable
Red - coverage unlikely
NOAA Weather Radio
WNG553 162.400 MHz
CS001Oct2902D.ques
Ontonagon
Baraga
Gogebic
Marquette
Alger
Schoolcraft
Iron
Vilas
Florence
Oneida
Forest
Menominee
Wausaukee
Marinette
Lincoln
Langlade
Oconto
Marathon
Shawano
Benzie
Wood
Portage
Waupaca
Outagamie
Brown
Manistee
Waushara
Winnebago
Calumet
Manitowoc
Mason
46N
45N
44N
90W
89W
88W
87W
86W
0 20 40 60 80 100 120 140 160 180 200 MILES

Tornadoes

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

A tornado may have winds up to 300+ miles per hour and an interior air pressure that is 10-20% below that of the surrounding atmosphere. The typical length of a tornado path is approximately 16 miles, but tracks much longer than that – even up to 200 miles – have been reported. Tornado path widths are generally less than one-quarter mile wide. Typically, tornadoes last only a few minutes on the ground, but those few minutes can result in tremendous damage and devastation. Historically, tornadoes have resulted in tremendous loss of life, with the mean national annual death toll being 87 persons. Property damage from tornadoes is in the hundreds of millions of dollars every year.

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

The Enhanced Fujita Scale of Tornado Intensity

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

EF5	Incredible tornado	Over 200	Incredible damage. Strong frame houses lifted off foundations and carried considerable distances to disintegrate; automobile-sized missiles fly through the air in excess of 100 meters; trees debarked; steel reinforced concrete structures badly damaged; incredible phenomena will occur.

NOTE: When describing tornadoes, meteorologists often classify the storms as follows:
EF0 and EF1 = weak tornado; EF2 and EF3 = strong tornado; EF4 and EF5 = violent tornado

(Source: The Tornado Project; Storm Data, National Climatic Data Center)
According to the National Weather Service (NWS), since 1950 the vast majority of tornadoes that occurred in the United States (approximately 74%) were classified as weak tornadoes (EF0 or EF1 intensity). Approximately 24% were classified as strong tornadoes (EF2 or EF3 intensity), and only 3% were classified as violent tornadoes (EF4 or EF5 intensity). Unfortunately, those violent tornadoes, while few in number, caused about 65% of all tornado-related deaths nationally. Strong tornadoes accounted for another 33% of tornado-related deaths, while weak tornadoes caused only 1% of tornado-related deaths. If the data prior to 1950 is examined, the percentage of deaths attributable to violent tornadoes climbs drastically. That is largely due to the fact that tornado forecasting and awareness programs were not yet established. As a result, it was much more likely for death tolls from a single tornado to reach several hundred.

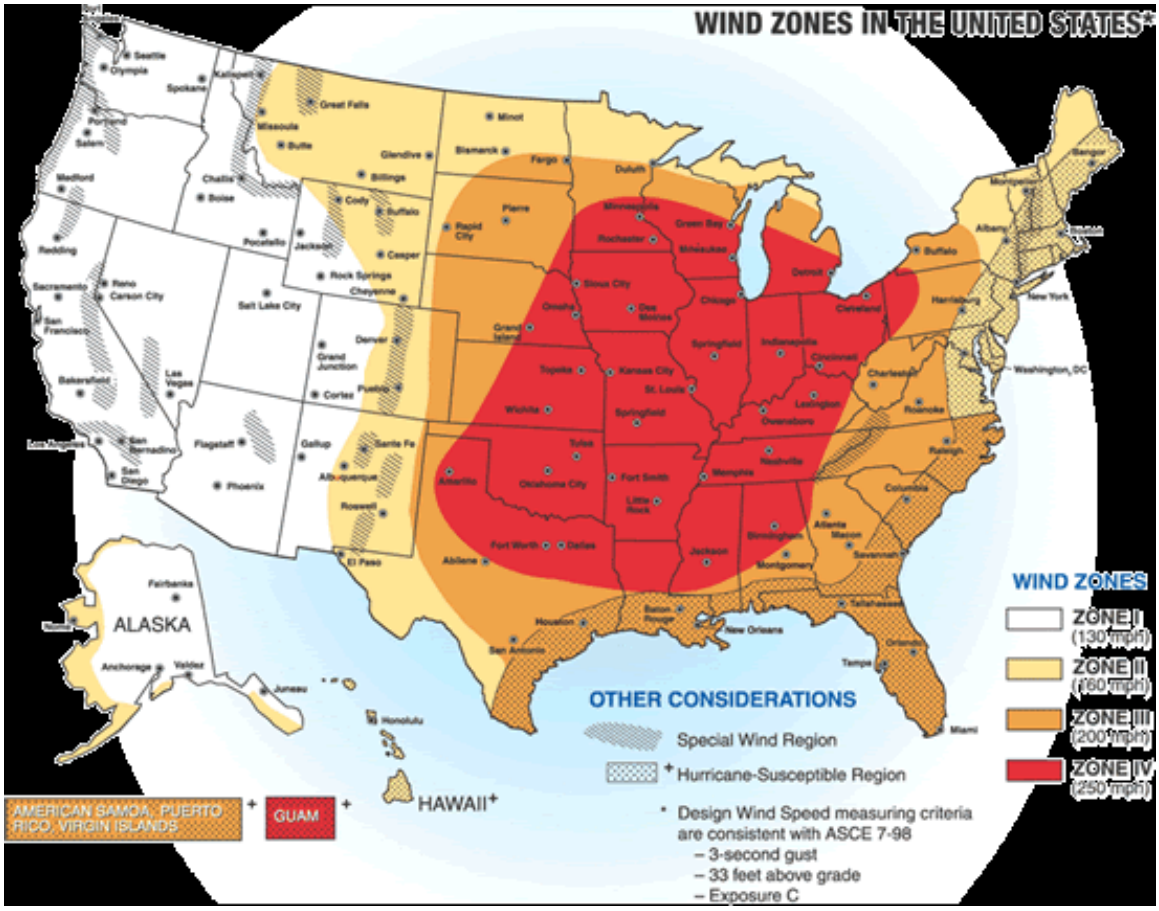
Although tornadoes cannot be predicted, prevented or contained, their potential impacts on Dickinson County's citizens and communities can certainly be reduced. In general, improved surveillance and warning systems implemented by the National Weather Service and emergency management agencies, coupled with extensive public education campaigns, have been very effective in keeping the death toll down in recent years. However, this is not to say that a major death toll could not occur again if a strong tornado should strike a highly populated area. History has clearly shown that tornadoes must always be treated with the utmost respect and caution. Other initiatives, such as structural bracing, urban forestry practices, manufactured home anchoring, and strengthening electrical system components, can help to reduce public and private property damage.

Like severe straight-line wind events, tornado disasters require that communities plan and prepare for the mass care of residents left without electrical power and the clearance and disposal of tree and construction debris from roadways. The planning and preparedness effort should include the identification of necessary mass care facilities and supplies, as well as debris removal equipment and services. In addition, communities should develop debris management procedures (to include the identification of multiple debris storage, processing and disposal sites) so that the debris stream can be handled in the most expedient, efficient, and environmentally safe manner possible.

Tornadoes are dangerous violent rotating columns of winds that can produce wind speeds from 73 to more than 300 miles per hour, and can cause severe environmental damage. Damage to the environment includes debris, fires, and chemicals from damaged and destroyed structures, vehicles, and infrastructure, which can be scattered for miles. Building materials, chemicals, smoke, sewage, and machinery can land in and cause harm to forests, valleys, streams, lakes, rivers, and wildlife species. Animals (including domesticated livestock) and other organisms can be killed or injured in the event of a tornado. Trees can easily be uprooted, branches broken off, and entire woodlands can be destroyed by tornado impacts. Rural settings can be damaged and plants can be carried to different parts of land for seeding where they otherwise would not have been. There is also an increased threat of fire in areas where dead trees are not removed in a timely matter.

The most dangerous type of environmental impact would be when a tornado strikes a facility that contains potentially hazardous or toxic materials, farm chemicals, trash in a local landfill, medical waste awaiting disposal, or radioactive materials. Not only can material be spread around the immediate site where the tornado strikes, a small (but important) fraction can be carried aloft and transported a great distance down streams or rivers. There is also a possibility that tornadoes can cause the spread of diseases, or fungi found in certain soils. Gas lines can also be ruptured and harm local air quality as well as cause environmental damage by seeping into the soil, rivers, lakes, and streams.

Map 13: Wind Zones in the United States



Killer Tornadoes: Selected Top Ten Lists

Rank	Single Killer Tornadoes (Date, State, # Deaths, F-Scale)	Tornado Deaths Per 10,000 Sq. Miles	Killer Tornadoes as % of all Tornadoes
1	March 18, 1925, MO-IL-IN, 695 deaths, F5	Massachusetts	Tennessee
2	May 7, 1840, LA-MS, 317 deaths, F?	Mississippi	Kentucky
3	May 27, 1896, MO-IL, 255 deaths, F4	Indiana	Arkansas
4	April 5, 1936, MS, 216 deaths, F5	Alabama	Ohio
5	April 6, 1936, GA, 203 deaths, F4	Ohio	Alabama
6	April 9, 1947, TX-OK-KS, 181 deaths, F5	**Michigan**	Mississippi
7	May 22, 2011, MO, 161 deaths, F5	Arkansas	North Carolina

8	April 24, 1908, LA-MS, 143 deaths, F4	Illinois	**Michigan**
9	June 12, 1899, WI, 117 deaths, F5	Oklahoma	New York
10	**June 8, 1953, MI, 115 deaths, F5**	Kentucky	Massachusetts

Source: The Tornado Project / National Weather Service

Dickinson County is on the northern fringe of the Midwest tornado belt Weather records from 1950 through April 2015 reflect 11 tornadic events in the county. Tornadoes are rated according to an intensity table and the most intense one was an F3 that occurred in July 1987 with only a small amount of property damage.

Significant Tornado Events Affecting Dickinson County
Following are brief synopses of some of the more significant tornado events that have affected Dickinson County in recent decades:
April 21, 1974 – Dickinson County
An F1 tornado struck Dickinson County, causing slight property damage.
June 14, 1981 – Dickinson County
An F2 tornado struck Dickinson County, causing slight property damage.
July 11, 1987 – Dickinson County
An F3 tornado struck Dickinson County, causing approximately $25,000 in property damage.
June 10, 2000 – Dickinson County (Ralph)
An F1 tornado struck Dickinson County in the Ralph area, causing approximately $120,000 in property damage.
September 30, 2002 – Dickinson County (Kingsford)
An F1 tornado struck Dickinson County and resulted in the declaration of a local state of emergency. The tornado crossed the Menominee River from Wisconsin and ripped down trees and power lines from Kingsford to Quinnesec. Property damage exceeded $7 million.
July 27, 2010 – Dickinson County (Vulcan)
Two EF0 tornados struck Dickinson County in the Vulcan area, causing approximately $13,000 in property damage.

Risk : high
Rating : 1st

Vulnerability: Tornadic events are occasional in Dickinson County. 11 tornadic events (9 tornados and 2 funnel clouds) were reported in the county in the past 65 years (see Appendix C, Table 1). The chance of a tornadic event occurring per year in the county is 30 percent, which is relatively low. The NCDC data shows no injuries or deaths from the tornadic events but there is a high incidence of property damage. Property damage totals were estimated at $7.041 million.

The entire County (26,168 people) is equally susceptible to a tornadic event. However, a tornadic event in an intensively developed area such as southern Dickinson County would cause the most property damage and affect the most people. The majority of the population, critical facilities and utilities are found in the southern portion of the county. The cities of Kingsford and Iron Mountain and Breitung Township alone, located in the extreme southwest, contain 50 percent of the County's population with approximately 13,000 people.

The F1 tornado that occurred in September 2002 is an example of the destruction that can be done in an urban area. An estimated $7 million in property damage was endured when it moved through Kingsford, Iron Mountain and Breitung Township. NCDC data recorded: (Numerous trees and power lines were knocked down, blocking the major transportation route US-2 and

disrupting electric power and telephone service. Gas lines were ruptured and several commercial buildings sustained substantial roof damage).

Table - 8 Tornadic Events, Probability, and Estimated Damage						
Timeframe	**# of Events**	**Injuries**	**Casualties**	**Property Damage**	**Crop Damage**	**Damage Total**
1950 – April 2015	11	0	0	$7.041 million	$120,000	$7.161 million

Average events/year (11 / 65)	0.17
Average injuries/year (0 / 65)	0
Average casualties/year (0 / 65)	0
Estimated annual property damage ($7.041 million / 65)	$108,323
Estimated annual crop damage ($120,000 / 65)	$1,846
Estimated annual damage ($7.161 million / 65)	$110,169

Snowstorms

A snowstorm is a period of rapid accumulation of snow often accompanied by high winds, cold temperatures, and low visibility. Blizzards are the most dramatic and perilous of all snowstorms, characterized by low temperatures and strong winds (35+ miles per hour) bearing enormous amounts of snow. Most of the snow accompanying a blizzard is in the form of fine, powdery particles that are wind-blown in such great quantities that, at times, visibility is reduced to only a few feet. Blizzards have the potential to result in property damage and loss of life. Just the cost of clearing the snow can be enormous.

The Upper Peninsula (including Dickinson County) experiences heavy snowfall and a relatively large number of snowstorms. One reason for this is the "lake effect," a process by which cold winter air moving across Lake Michigan and Lake Superior picks up moisture from the warmer lake waters, resulting in larger snowfall amounts in the western and northern part of the state. Fortunately, Dickinson County does not receive as much snow as other counties in the Upper Peninsula since Dickinson County is in the southwestern portion of the Upper Peninsula farther away from the lakes. In general, the snowstorm season of Dickinson County runs from November to April each year. (Although snow occasionally does fall outside of this “season,” such snowfall would be comparatively light, rather than the sort of snowstorm event that is here being considered as a hazard.) This does not mean that all of these months necessarily receive significant snowfall each year. Instead, the “season” denotes the part of each year when a significant snowstorm may occur. A significant snowstorm is here defined as at least several inches of snow accumulation in a single event.

By observing winter storm watches and warnings, adequate preparation can usually be made to reduce the impact of snowstorms on Dickinson County communities. Providing for the mass care and sheltering of residents left without heat or electricity, and mobilizing sufficient resources to clear blocked roads, are the primary challenges facing community officials. Therefore, every community should plan and prepare for severe snowstorm emergencies. That planning and preparedness effort should include the identification of mass care facilities and necessary resources such as cots, blankets, food supplies and generators, as well as snow clearance and removal equipment and services. Pre-planning for snow storage areas will be helpful. In addition, communities should develop debris management procedures (to include the identification of multiple debris storage, processing and disposal sites) so that the tree and other storm-related debris can be handled in the most expedient, efficient, and environmentally safe manner possible.

Michigan sees a major regional or statewide snowstorm approximately every 5 years. Local events are more frequent. Casualties are difficult to assess because many deaths are caused by automobile accidents, heart attacks from overexertion, and other secondary impacts that may be difficult to distinguish as weather-related.

Heavy snows can shut down towns and cities for a period of a few days if snow is persistent and cannot be cleared in a timely fashion. Roof failures may occur as the weight and volume of snow cause damage to homes and buildings. Urban areas are especially susceptible to outages and problems with snow removal, while rural areas may have inaccessible roads for some time but have residents that are more prepared to handle power outages and temporary isolation. Motorists and passengers in cars can be stranded in rural areas and die of exposure because of inadequate preparation for conditions.

101 heavy snow/winter storm events are recorded from 1950 through 2015. Heavy snow and/or blowing snow (blizzards) events are expected each winter season. Generally, injuries and

property damage do not result. Inconveniences - normally short-term - such as institutional and business closings or delays, treacherous driving and walking conditions with low visibility, and additional snow removal costs are caused by snowstorms. Area school closings due to winter storms average about two days per year.

Significant Snow Storm Events Affecting Dickinson County
Following are brief synopses of some of the more significant snow storm events that have affected Dickinson County in recent decades:

Winter 1888 – Northern U. S. (including Dickinson County)
The fabled Winter of 1888 was devastating to much of the northern United States, with snow, freezing temperatures, and severe winds responsible for the deaths of hundreds of people and thousands of cattle across the Dakota Territory, Minnesota, Wisconsin, and Michigan's Upper Peninsula. As bad as conditions were in the Midwest, however, one single snowstorm will forever characterize that brutal winter. The famous Blizzard of 1888 struck the eastern seaboard on March 12, 1888, dumping 40-50 inches of snow in New York and creating 30-40 foot snowdrifts in parts of southern New England. Snowdrifts were reported over the tops of houses from New York to New England, including some three-story houses. One town in New York had a snowdrift that measured 52 feet in height. Over 400 people died in the blizzard, including 200 in New York City alone. Wind gusts up to 80 miles per hour were reported, which contributed greatly to the tremendous drifting and high number of deaths.
January 26-27, 1978 – Statewide
On January 26-27, 1978 a severe snowstorm struck the Midwest, and Michigan was at the center of the storm. Dubbed a "white hurricane" by some meteorologists, the storm measured 2,000 miles by 800 miles and produced winds with the same strength as a small hurricane and tremendous amounts of snow. In Michigan, up to 34 inches of snow fell in some areas, and winds of 50-70 miles per hour piled the snow into huge drifts. At the height of the storm, it was estimated that over 50,000 miles of roadway were blocked, 104,000 vehicles were abandoned on the highways, 15,000 people were being cared for in mass care shelters, and over 390,000 homes were without electric power. In addition, 38 buildings suffered partial or total roof collapse. Two days after the storm, over 90% of the state's road system was still blocked with snow, 8,000 people were still being cared for in shelters, 70,000 vehicles were stranded, and 52,000 homes were still without electricity. This storm resulted in a Presidential Emergency Declaration for the entire state, to provide assistance with snow clearance and removal operations.
April 1, 1993 – Upper Peninsula (including Dickinson County)
A heavy snow storm occurred throughout much of the Upper Peninsula that resulted in $50,000 in property damage in Dickinson County.
January 27, 1994 – Upper Peninsula (including Dickinson County)
A heavy snow storm combined with freezing rain occurred throughout much of the Upper Peninsula resulting in about $5,000,000 worth of property damage in Dickinson County.
January 26-27, 1996 – Upper Peninsula (including Dickinson County)
28 inches of snow fell in nearby Marquette County at Champion and Skandia. Most locations across the west and central Upper Peninsula had storm totals between 8 and 14 inches. Wind gusts up to 50 mph created blizzard conditions that closed major highways and most businesses. Several motorists were stranded for a few hours in nearby Marquette County due to blowing and drifting snow.
March 13-15, 1997 – Upper Peninsula (including Dickinson County)
Beginning on the afternoon of March 13, 1997 and continuing until the morning of March 15, a snowstorm moved across the Upper Peninsula, dumping 20-30 inches of heavy snow in many communities. Although the Upper Peninsula is accustomed to heavy snows throughout the winter, this storm produced snowfall totals that were significant even for that region. In nearby

Marquette, nearly 33 inches of new snow fell. In a 24-hour period between March 13-14, Marquette received 28 inches of snow, breaking the 24-hour snowfall record set back in March 1986. The storm also produced a record snow depth of 63 inches at Marquette County Airport, eclipsing the previous record of 59 inches recorded in March 1976. Dickinson County received between 16 and 20 inches of new snow.

January 8-9, 1998 – Dickinson County

A band of heavy snow extended through Dickinson County and nearby Marquette County. Foster City received the highest amount of snow in Dickinson County with 11 inches, while Iron Mountain received 10 inches.

January 2, 2000 – Upper Peninsula (including Dickinson County)

A winter storm brought heavy snow throughout the Upper Peninsula. Kingsford received up to 12 inches and Iron Mountain received up to 11 inches of snow.

November 26-28, 2001 – Western Upper Peninsula (including Dickinson County)

Heavy snow occurred across the western Upper Peninsula, including in Dickinson County that resulted in downed trees and power lines from the weight of the snow. Northwest Dickinson County near Channing received 10 inches, Iron Mountain received 9 inches, and nearby Stambaugh received 12 inches.

February 4, 2003 – Upper Peninsula (including Dickinson County)

High winds with wind chill readings in the 10 to 20 below zero range combined with heavy snow produced near blizzard like conditions throughout much of the Upper Peninsula. Channing received 11 inches of snow. Sands Township in nearby Marquette County received 17 inches of snow, and nearby Crystal Falls received 12 inches of snow.

March 3, 2004 – Upper Peninsula (including Dickinson County)

A winter storm brought heavy snow throughout much of the Upper Peninsula. Hardwood received up to 12 inches of snow and nearby Marquette received up to 15 inches of snow.

February 25-26, and March 1-2, 2007 – Western/Central Upper Peninsula (including Dickinson County)

Near blizzard conditions occurred throughout the western and central Upper Peninsula from heavy snow accompanied by 35mph winds. The storm forced the closer of numerous schools throughout the region. Iron Mountain received 14 inches of snow. Less than a week later from March 1-2 Channing received an additional 14 inches of snow. The situation was worse for nearby Marquette County since the National Weather Service office in Negaunee Township reported the most additional snow in the region with 31 more inches. Numerous schools and businesses were closed again from the second wave of snow across the region.

April 1, 2008 – Dickinson County

A snow storm with winds gusting over 30 mph resulted in 14 inches of snow at Felch and 10 inches at Ralph. All schools throughout the area were closed and numerous minor accidents were reported.

February 28-29, 2012 – Dickinson County

Heavy snow fell that resulted in 17 inches of snow at Norway and 16 inches of snow at Iron Mountain. The snow storm also had wind gusts around 25 mph that caused blowing and drifting of the snow. Most schools in the county were closed due to the storm.

Winter 2014 – Statewide (including Dickinson County)

The winter of 2014 was an unusually challenging one for the whole state of Michigan and not just Dickinson County. Roadway sections were left in poor condition by the effects of a series of thaws and re-freezes during early winter. In addition to below-average temperatures (see the extreme temperatures section), an above-average amount of snowfall gave many Dickinson County communities trouble in clearing roadways and finding places to store the snow. In Iron Mountain, December through February snowfall was above normal, measuring 52.9 inches, which was 16.6 inches above the normal amount and the 12th-highest on record. A late season snow blizzard also occurred on April 16th in Dickinson County with a high of 12 inches at

Channing. Many traffic accidents took place during icy and blizzard conditions throughout much of the winter. The term “polar vortex” had become popular amongst the media to describe these winter events. Even though all of the U.P. had rough winter conditions, nearby Marquette County was the only county that tried to request a Presidential Disaster Declaration but was denied.

Risk	**:**	**moderate**
Rating	**:**	**7th**

Ice and Sleet

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

The table below illustrates the frequency distribution of ice and sleet storms in Michigan for the period 1970-July 2007. Approximately 81% of those storms occurred during the months of January, February, March and April, when conditions are most conducive for the development of ice and sleet. One-quarter of all ice and sleet storms in the period occurred during the month of March, and more than a quarter occurred in January.

By observing winter storm watches and warnings, adequate preparations can usually be made to reduce the impacts of ice and sleet conditions on Dickinson County communities. Providing for the mass care and sheltering of residents left without heat or electricity, and mobilizing sufficient resources to clear broken tree limbs from roadways, are the primary challenges facing community officials. Ice storms usually have a regional effect and groups of communities are usually affected instead of just one community. Therefore, every community should plan and prepare for these emergencies. Planning and preparedness efforts should include the identification of mass care facilities and necessary resources such as cots, blankets, food supplies and generators, as well as debris removal equipment and services. In addition, communities should develop debris management procedures (to include the identification of multiple debris storage, processing and disposal sites) so that the tree and other storm-related debris can be handled in the most expedient, efficient, and environmentally safe manner possible.

Frequency Distribution of Ice and Sleet Storms

in Michigan: 1970 – July 2007

JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC	TOTAL
17	10	14	6	0	0	0	0	0	0	3	9	59
29%	17%	24%	10%	0%	0%	0%	0%	0%	0%	5%	15%	100%

Source: National Weather Service; Storm Data, National Climatic Data Center (percentages are rounded off)

Many ice storm deaths are actually caused by automobile accidents, heart attacks from overexertion, downed power lines, carbon monoxide poisoning, and other secondary effects that may be difficult to distinguish from other causes. Ice and sleet storms tend to cause power or other infrastructure failures that interfere with residents' activities, comfort, and safety (often through the impact of infrastructure failures on needed medical and emergency response capabilities). Direct physical effects may include frostbite, hypothermia, and other medical conditions, and thus require some citizens to be provided with warm clothing and shelter. Certain types of building designs are susceptible to structural failure from the accumulation of ice or snow on their roofs. Traffic efficiency and road capacity tends to be impeded by these weather

events, which cause a large increase in the risks involved in all modes of travel. Injurious accidents may include simple pedestrian falls (due to the difficulty of balancing and walking on ice-coated surfaces), or large-scale transportation accidents (such as multi-car interstate pileups).

Freezing rain drops (sleet) and dangerous ice storms coat surfaces with layers of ice and can also affect the environment. Ice storms can damage trees, as the weight of accumulated ice brings down limbs and branches, or even entire trees. When soil is not frozen, ice loads can cause root damage to forest trees. An ice coating over widespread forest lands can destroy natural forest vegetation and disrupt species' habitats, species composition, and forest land diversity. Dried dead trees may be more prone to fire, contributing to wildfires in other seasons if not removed properly. Dead trees can become breeding areas for beetles and other pests that can harm the healthy green trees. Floods often occur when ice melts, and can cause environmental effects.

There were 16 reported Ice and sleet storm occurrences average once per year in the state. Moist, warm air brings higher temperatures and rainfall, often turning to snow as temperatures drop. Such systems are unstable and are sometimes accompanied by strong winds. These are very dangerous conditions and often cause power outages, closings and extremely hazardous conditions for road crews.

Significant Ice and Sleet Storm Events Affecting Dickinson County
Following are brief synopses of some of the more significant ice and sleet storm events that have affected Dickinson County in recent decades:

March 9, 2002 – Dickinson County
An ice storm resulted in ¼ inch thick ice in Felch and nearby Menominee County had even more ice at up to 1 and ½ inches. Ironwood also received 8 inches of snow. Winds between 40mph and 60mph produced white out conditions in the area that resulted in numerous minor traffic accidents. There were downed power lines from the weight of the ice as well.
December 18, 2002 – Dickinson County
An ice storm resulted in 1/3 inch thick ice in Iron Mountain. Many schools were closed and numerous minor traffic accidents occurred.
March 13, 2006 – Dickinson County
A sleet storm resulted in ½ inch thick sleet accumulations in Iron Mountain. Nearby more northern locations received up to two feet of snow, such as the 21 inches that the National Weather Service site in Marquette County received. The weather conditions caused power outages, road closures, school closures, and numerous minor traffic accidents throughout the area.

Risk : moderate
Rating : 17th

Vulnerability (Snowstorms and Ice & Sleet): Winter storms in the form of snowstorms or a mixture of ice and snow can be expected to occur in any year in any part of the county. Storms, or blizzards, may necessitate the closing of businesses, institutions and roadways. Power outages and other utility interruptions can affect the entire population. Property damage would occur from removal, storm-induced accidents, and heavy snow-loads on structures. Widespread property damage to utility lines, trees, and light duty coverings such as awnings, canopies, and carports could be anticipated. The probability of property damage could be assumed to be higher in more urban areas of Dickinson County such as the Cities of Iron Mountain, Kingsford and Norway and Breitung Township.

There were no reported human casualties. The storm events cover a regional-sized area. Although some local damage likely occurred, recorded storm event descriptions place property damage in southern areas of the state.

Table – 9
Snow/Winter Storm Events, Probability, and Estimated Damage

Timeframe	# of Events	Casualties	Property Damage	Crop Damage	Damage Total
January 1st, 1950 – April 1st, 2015	101	0	$5.07 million	0	$5.07

Average events/year (101 / 65)	1.55
Average injuries/year (0 / 65)	0.00
Estimated per event Property Damage ($5.07 / 101)	$50,198
Estimated Annual Property Damage ($5.07 / 65)	$78,000
Estimated Annual Crop Damage ($0 / 65)	$0
Estimated Annual Damage ($5.07 / 65)	$78,000

Lightning

Lightning is the discharge of electricity from within a thunderstorm. Lightning is a random and unpredictable product of a thunderstorm's tremendous energy. The energy in the storm produces an intense electrical field like a giant battery, with the positive charge concentrated at one end and the opposite charge concentrated at the other. Lightning strikes when a thunderstorm's electrical potential (the difference between its positive and negative charges) becomes great enough to overcome the resistance of the surrounding air. Bridging that difference, lightning can jump from cloud to cloud, cloud to ground, ground to cloud, or even from the cloud to the air surrounding the thunderstorm. Lightning strikes can generate current levels of 30,000 to 40,000 amperes, with air temperatures often superheated to higher than 50,000 degrees Fahrenheit (hotter than the surface of the sun) and speeds approaching one-third the speed of light.

Globally, there are about 2,000 thunderstorms occurring at any given time, and those thunderstorms cause approximately 100 lightning strikes upon the ground each second. In the United States, approximately 100,000 thunderstorms occur each year, and every one of those storms generates lightning. It is not uncommon for a single thunderstorm to produce hundreds or even thousands of lightning strikes. However, to the majority of the general public, lightning is perceived as a minor hazard. That perception lingers despite the fact that lightning damages many structures and kills and injures more people in the United States per year, on average, than tornadoes or hurricanes. Many lightning deaths and injuries could be avoided if people would have more respect for the threat lightning presents to their safety.

Lightning deaths are usually caused by the electrical force shocking the heart into cardiac arrest or throwing the heartbeat out of its usual rhythm. Lightning can also cut off breathing by paralyzing the chest muscles or damaging the respiratory center in the brain stem. It takes only about one-hundredth of an ampere of electric current to stop the human heartbeat or send it into ventricular fibrillation. Lightning can also cause severe skin burns that can lead to death if complications from infection set in.

As an indicator of the circumstances involving lightning fatalities, injuries and damage in the United States, consider the following statistics compiled by the National Oceanic and Atmospheric Administration (NOAA) and the National Lightning Safety Institute (NLSI) for the period of 1959-1994:

<u>Location of Lightning Strikes</u>

- 40% are at unspecified locations
- 27% occur in open fields and recreation areas (not including golf courses)
- 14% occur to someone under a tree (not including golf courses)
- 8% are water-related (boating, fishing, swimming, etc.)
- 5% are golf-related (on golf course or under tree on golf course)
- 3% are related to heavy equipment and machinery
- 2.4% are telephone-related
- 0.7% are radio, transmitter and antenna-related

Gender of Victims

- 84% are male; 16% are female

Months of Most Strikes

- July (30%); August (22%); June (21%)

Most Likely Time Period of Reported Strikes

- 2:00 PM – 6:00 PM

Number of Victims

- One victim (91%); two or more victims (9%)

The NLSI has estimated that 85% of lightning victims are children and young men (ages 10-35) engaged in recreation or work-related activities. Approximately 20% of lightning strike victims die, and 70% of survivors suffer serious long-term after-effects such as memory and attention deficits, sleep disturbance, fatigue, dizziness, and numbness.

Lightning can be especially damaging for electrical infrastructure, causing localized power outages and damage to phone lines and communication systems. Computers are also especially vulnerable to lightning strikes. In terms of property losses from lightning, statistics vary widely according to source. The Insurance Information Institute estimates that lightning damage amounts to nearly 5% of all paid insurance claims, with residential claims alone exceeding $1 billion. Information from insurance companies shows one homeowner's damage claim for every 57 lightning strikes. The NLSI has estimated that lightning causes more than 26,000 fires annually, with damage to property exceeding $5-6 billion. Electric utility companies across the country estimate as much as $1 billion per year in damaged equipment and lost revenue from lightning. The Federal Aviation Administration (FAA) reports approximately $2 billion per year in airline industry operating costs and passenger delays from lightning. Because lightning-related damage information is compiled by so many different sources, using widely varying collection methods and criteria, it is difficult to determine a collective damage figure for the U.S. from lightning. However, annual lightning-related property damages are conservatively estimated at several billion dollars per year, and those losses are expected to continue to grow as the use of computers and other lightning-sensitive electronic components becomes more prevalent.

Because it is virtually impossible to provide complete protection to individuals and structures from lightning, this hazard will continue to be a problem for Dickinson County's residents and communities. However, lightning deaths, injuries, and property damage can be reduced through a combination of public education, human vigilance, technology, proper building safety provisions, and simple common sense.

Large outdoor gatherings (e.g., sporting events, concerts, campgrounds, fairs, festivals, etc.) are particularly vulnerable to lightning strikes that could result in many deaths and injuries. This vulnerability underscores the importance of developing site-specific emergency procedures for these types of events, with particular emphasis on adequate early detection, monitoring, and warning of approaching thunderstorms. Early detection, monitoring, and warning of lightning hazards, combined with prudent protective actions, can greatly reduce the likelihood of lightning injuries and deaths. In addition, close coordination between event organizers, local emergency management officials, and response agencies (i.e., police, fire, emergency medical care) can help prevent unnecessary (and often tragic) delays and mistakes in rendering care should a lightning incident occur

There were 1,298 thunderstorms and lightning events in Dickinson County from 1950 through 2010.They are most common during summer months. Only floods and flash floods cause more weather-related deaths.

Areas affected by such storms range from local to regional in size. A moderate to high risk is associated with these storms for human life and property. Most lightning damage is to property - especially electronic equipment. Lightning-induced structural and forest fires represent a significant hazard. A thunderstorm originating in Iron Mountain in June 1998 produced lightning that started a total of 16 house and tree fires. Human injuries from lightning strikes are infrequent, deaths rare.

Significant Lightning Events Affecting Dickinson County
Following are brief synopses of some of the more significant lightning events that have affected Dickinson County in recent decades:

June 25, 1998 – Dickinson County
Thunderstorms brought heavy lightning in Iron Mountain, Kingsford and Vulcan. There were a total of 16 minor house and tree fires started by lightning from the storm. Total property damage was about $100,000.
October 5, 2005 – Dickinson County
One home in Breitung Township was destroyed by a lightning-strike induced fire. Another home in the area sustained major damage when lightning struck a nearby pine tree. Total property damage from the lightning strikes was $140,000.
May 20, 2012 – Dickinson County
A lightning strike from a thunderstorm caused major damage to a house in Iron Mountain resulting in $30,000 in property damage.

Risk	**:**	**moderate**
Rating	**:**	**11th**

Severe Winds

Severe winds are non-tornadic winds of 58 miles per hour or greater. Severe winds spawned by thunderstorms or other storm events can have devastating effects on Dickinson County, resulting in deaths, injuries, and millions of dollars in damage to public and private property and agricultural crops. Severe wind events are characterized by wind velocities of 58 miles per hour or greater, with gusts sometimes exceeding 74 miles per hour (hurricane velocity), but do not include tornadoes. (Please refer to the Tornadoes section which follows, for more information on that hazard.)

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

Another dangerous aspect of straight line winds is that they occur more frequently beyond the April to September time frame than is seen with the other thunderstorm hazards. It is not rare to see severe winds ravage parts of the state in October and November. Stark temperature contrasts seen in colliding air masses along swift-moving cold fronts occur regularly during those months.

National Weather Service forecasts of severe winds usually give sufficient warning time to allow residents to take appropriate action to reduce, at least to some degree, the effects of wind on structures and property. Little can be done to prevent damage from flying objects. However, proper structural bracing techniques can help minimize or even eliminate major damage due to the loss of a roof or movement of a building off its foundation.

In terms of response to a severe wind event, providing for the mass care and sheltering of residents left without heat or electricity, and mobilizing sufficient resources to clear and dispose of downed tree limbs and other debris from roadways, are the primary challenges facing communities. In addition, downed power lines present a public safety threat that requires close coordination of response efforts between local agencies and utility companies. Therefore, every community should adequately plan and prepare for this type of emergency. That planning and preparedness effort should include the identification of necessary resources such as cots, blankets, food supplies, generators, and debris removal equipment and services. In addition, each community should develop debris management procedures (to include the identification of multiple debris storage, processing and disposal sites) so that the stream of tree and construction debris can be handled in the most expedient, efficient, and environmentally safe manner possible.

To mitigate the effects of severe winds, communities can: 1) institute a comprehensive urban forestry program, 2) properly brace and strengthen vulnerable public facilities, 3) ensure compliance with manufactured home anchoring regulations, 4) coordinate with utility companies on local restoration priorities and procedures, 5) improve local warning systems, and 6) amend local codes to require structural bracing, where appropriate, in all new residential and commercial construction.

<u>Derecho</u>

A Derecho, also called a bow echo, is a widespread and long-lived windstorm that is associated with a fast-moving band of severe thunderstorms. Derechos are usually not associated with a cold front, but instead with a stationary front. They occur mostly in July, but can occur at

anytime during the spring or summer. The following map gives an indication of the pattern of Derecho frequency across the Midwest.

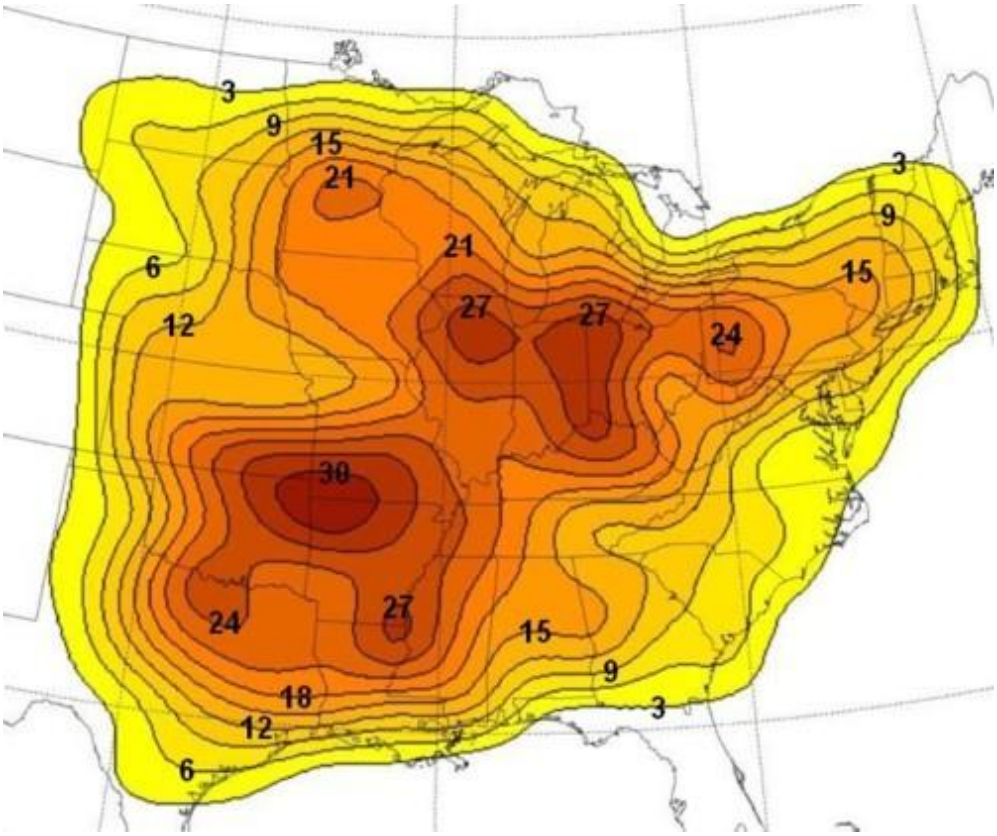
There are three types of Derechos:

- Serial Derecho - Multiple bow echoes embedded in a massive line typically around 250 miles long. This type of Derecho is usually associated with a very deep low pressure system. Also because of embedded supercells, tornadoes can easily spin out of these types of Derechos.

- Progressive Derecho - A small line of thunderstorms take a bow-shape and can travel for hundreds of miles.

- Hybrid Derecho - Has characteristics of a serial and progressive Derecho. These types of Derechos are associated with a deep low pressure system like serial Derechos, but are relatively small in size like progressive Derechos.

Moderate and High Intensity Derechos
1980-2001



Note: Numbers on map indicate the number of Derechos that occurred during the period. Source: National Oceanic and Atmospheric Administration

Non-tornadic winds of at least 58 mph are classified as severe winds and/or derechos. Some of the harmful effects of wind on the environment include full-grown trees being completely

uprooted and knocked down, or large acreage of forest land being destroyed. Large amounts of debris, elements from collapsed structures, and destroyed natural vegetation can result from severe winds. Wildlife species can be harmed. Collapsed structures can contain combustible building materials, debris, chemicals, machinery, smoke, sewage, or other elements that can damage the environment. Lakeshore beach erosion can occur, along with rip currents in the water, as a result of severe winds. Winds can stir up sediments in waterways that can also disrupt the ecosystem.

National Weather Service Doppler Radar

The National Weather Service (NWS) has completed a major modernization program designed to improve the quality and reliability of weather forecasting. The keystone of this improvement is Doppler Weather Surveillance Radar, which can more easily detect severe weather events that threaten life and property – including severe winds. Most important, the lead time and specificity of warnings for severe weather have improved significantly.

Doppler technology calculates both the speed and the direction of motion of severe storms. By providing data on the wind patterns within developing storms, the new system allows forecasters to better identify the conditions leading to severe weather such as tornadoes and severe straight-line winds. This allows early detection of the precursors to severe storms, as well as information on the direction and speed of storms once they form.

High winds frequently accompany thunderstorms and can be expected each year. Dickinson County has recorded 47 high wind events (50 mph or greater) from 1950 through 2010, half of them causing significant property damage. Most of all damaging high wind events were recorded within the May-November period.

Wind zones reflect the number and strength of recorded wind events per 1,000 square miles. These designations were established for engineering design purposes. Areas along and near the southern border are within the northern limits of Zone III. Only southern Dickinson, most of Menominee, and southern Delta counties in the Upper Peninsula are within Zone III with the remainder within Zone II. The strongest wind potential is found in Zone IV that extends as far north as Minneapolis and Green Bay.

Significant Severe Wind Events Affecting Dickinson County

Following are brief synopses of some of the more significant severe wind events that have affected Dickinson County in recent decades:

July 13-15, 1995 – Statewide (including Dickinson County)

From July 13-15, 1995 severe thunderstorms damaged numerous areas of Michigan, including in Dickinson County. These storms, which produced winds up to 100 miles per hour with damaging golf ball-sized hail and severe lightning, damaged many structures and downed many trees and power lines. Damage was widespread, but the impacts were not severe or extensive enough in any one location to require supplemental disaster assistance. The strong winds produced widespread power outages. Many trees blocked the highway on US-2 for 10 miles in Dickinson County.

June 25, 1998 – Dickinson County

Thunderstorm winds of up to 60 mph downed trees up to 12 inches in diameter in Iron Mountain, Kingsford and Vulcan. Traffic signs were also knocked down in Norway. There were a total of 16 minor house and tree fires started by lightning from the storm. Vehicles were also damaged. Total property damage was about $100,000.

November 10-11, 1998 – Statewide (including Dickinson County)

One of the strongest storms ever recorded in the Great Lakes moved across Michigan on the 10th and 11th of November, 1998, producing strong, persistent winds that damaged buildings, downed trees and power lines. Wind gusts of 50-80 miles per hour were common, and a peak gust of 95 miles per hour was reported on Mackinac Island. Damage was widespread but relatively minor for a storm of that intensity. However, there were pockets of damage across Dickinson County. Total property damage was about $450,000 with an additional $10 million in crop damage. Coincidentally, this storm system occurred on the anniversary of the storm system that had sunk the freighter Edmund Fitzgerald in Lake Superior in 1975.

July 4-5, 1999 – Several Northern States and the Upper Peninsula

The Boundary Waters-Canadian Derecho, also commonly called the Boundary Waters Blowdown, was an international Derecho that occurred during the afternoon and evening hours of July 4 and the early morning hours of July 5, 1999. It was classified as a progressive Derecho and it traveled over 1300 miles in 22 hours through Minnesota, Wisconsin, Michigan, Ontario, Quebec and Maine. There was also a tremendous amount of lightning associated with this Derecho, around 6,000 lightning strikes per hour. This event was one of the northernmost progressive Derechos to have ever been recorded. It caused $100 million in damage, killed 2 people and injured 70. Over 700,000 homes and businesses lost power from the event.

July 30, 1999 – Dickinson County

A countywide thunderstorm caused trees to be knocked down scattered throughout the county. Part of the roof on the North Dickinson School was torn off and carried several hundred yards east over the football field. The bus garage was destroyed but only one bus inside the garage was slightly damaged. Two vehicles were destroyed in the county, two houses suffered roof damage, and a shed and a van were also damaged. Total property damage was about $500,000.

July 31-August 2, 2002 – Central Michigan and Upper Peninsula (Dickinson County)

During the last day in July, severe weather hit central Michigan and the Upper Peninsula, including Dickinson County. Golf ball-size hail fell in nearby Escanaba. About 14,000 Upper Peninsula Power Company customers lost electricity for several days due to 70 mile per hour winds that toppled trees and power lines in the western Upper Peninsula. From Tuesday night through midday Thursday, the National Weather Service issued 44 severe weather warnings for various parts of the Upper Peninsula. Numerous trees and power lines were blown down across the Iron Mountain, Hardwood and Foster City areas.

August 28, 2007 – Dickinson County

A severe thunderstorm with heavy winds caused numerous trees and power lines to be knocked down in Breitung Township. A home also sustained damage when a tree fell on it. Property damage from the event was $12,000.

July 20, 2010 – Dickinson County

Severe thunderstorms brought down numerous trees and power lines. Damage also occurred to homes and cars. Total property damage was about $75,000.

July 30, 2011 – Dickinson County

Maybe the worst thunderstorm event of 2011 in Dickson County was on July 30th when widespread damage occurred throughout the area. A 40 foot by 70 foot section of the airport in Iron Mountain was torn off by winds exceeding 60 mph. Total property damage was about $36,000.

July 4, 2012 – Dickinson County

A thunderstorm caused a four mile path of straight line wind damage across the Sawyer and Edey Lake area east of Channing. The straight line “gustnado” wind speeds were around 60 to 70 mph with gusts up to 90 mph. There was also a waterspout on Sawyer Lake that moved onshore toward Woodlawn Lane. Numerous large trees were uprooted with smaller trees snapped off from the strong winds. Within the area of the strongest wind damage several large trees fell on houses and vehicles and knocked down power poles/lines. Total property damage was about $70,000.

June 10, 2015 – Dickinson County
Severe thunderstorms occurred overnight that resulted in fallen trees, downed power lines and small structural damage primarily in Iron Mountain. Between 100 and 120 trees were blown over at Lake Antoine Park.

Risk : moderate
Rating : 16th

Vulnerability (Lightning & Thunderstorms and Severe Wind): The entire county (26,168 people) is equally subject to thunderstorms and high wind events, however, they tend to be localized (see Appendix C, Table-3). On average one severe thunderstorm and high wind event can be expected each year. A direct impact on a small population occurs when structures suffer damage. Damage to utility networks with service interruptions could be expected. The impact can be direct through structural damages or it can be indirect in the form of electrical or other service interruptions. Structural damage will result from a severe storm with few, if any, human casualties. Annual property and crop damage from these hazards are estimated at $173,523.

Table – 10
Thunderstorm/High Wind Events, Probability, and Estimated Damage

Timeframe	# of Events	Casualties/ Injuries	Property Damage	Crop Damage	Damage Total
January 1, 1950 – April 30, 2015	77	0	$1.28 million	$10.00 million	$11.28 million

Average events/year (77 events / 65 years)	1.18
Average casualties/ injuries/ year (0 / 65 years)	0
Estimated annual property damage ($1.279 million / 65 years)	$19,677
Estimated annual crop damage ($10.00 million / 65 years)	$153,846
Estimated annual damage ($11.28 million / 65 years)	$173,523

Temperature Extremes

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

Extreme Summer Heat is characterized by a combination of very high temperatures and humid conditions. When persisting over a long period of time, this phenomenon is commonly called a heat wave. The major threats of extreme summer heat are heat exhaustion and heatstroke. Heat exhaustion is a less severe condition than heatstroke, but it causes problems involving dizziness, weakness and fatigue. Heat exhaustion is often the result of fluid imbalance due to increased perspiration in response to the intense heat. Treatment generally consists of restoring fluids and staying indoors in a cooler environment until the body returns to normal. If heat exhaustion is not addressed and treated, it can advance to heatstroke, so medical attention should be sought immediately.

Heatstroke symptoms include a high body temperature, dry skin, inadequate perspiration, paleness or reddening, confusion or irritability, and seizures. The victim may become delirious, unconscious, or even comatose. Cooling is essential to preventing permanent neurological damage or death. Other, less serious risks associated with extreme summer heat are often exercise-related and include heat cramps (an imbalance of fluids that occurs when people unaccustomed to heat exercise outdoors) and heat syncope (a loss of consciousness by persons not acclimated to hot weather). Periods of hot weather also entail risks of dehydration, even for those who are not engaged in demanding physical activities.

A useful set of general principles to recognize is that evaporation is a cooling mechanism for our bodies. Evaporation of moisture (i.e. perspiration) doesn't occur as rapidly when the surrounding air already has a relatively high moisture content (humidity). Thus, humidity inhibits evaporation and produces a feeling of greater heat, while winds assist the evaporation of perspiration from skin and thus tend to produce a feeling of greater coolness. A period of extreme heat is more debilitating when the air humidity is high, and a period of extreme cold is similarly more dangerous when coupled with strong winds. For these reasons, temperature alone is usually only a limited indicator of the weather's likely threat to human health, and additional factors should also be considered. The additional factors of humidity and wind speed have provided the basis for two additional means of describing the extent of extreme temperatures' impact—the Heat Index (HI) and the Wind Chill Temperature Index (WCT).

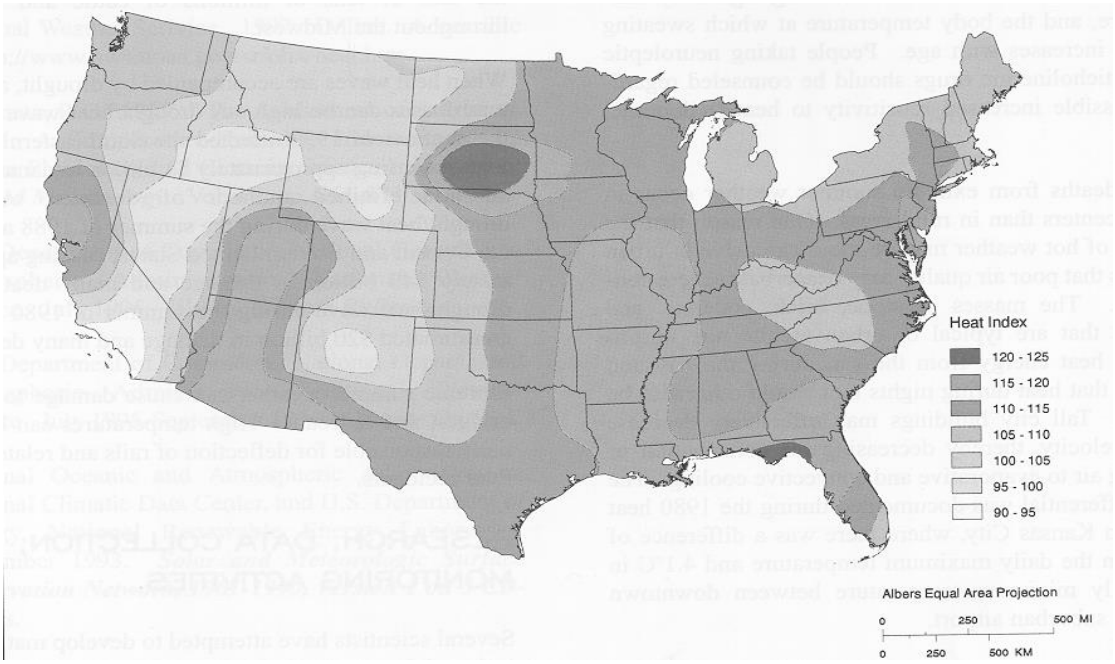
The following tables indicate the way that temperature, humidity, and wind speed probably feels to the human body, and suggest the types of temperature effects relevant to Dickinson County's climate. Although some of the resulting heat numbers may at first seem outrageous to describe Dickinson County temperatures, some of the extremes are actually comparable to what is felt in a sauna, which is often set at more than 140 degrees.

HEAT INDEX	Actual Temperature (degrees Fahrenheit)									
Rel. Humidity	**90**	**92**	**94**	**96**	**98**	**100**	**102**	**104**	**106**	**108**
40%	91	94	97	101	105	109	114	119	124	130
45%	92	96	100	104	109	114	119	124	130	137
50%	95	99	103	108	113	118	124	131	137	144
55%	97	101	106	112	117	124	130	137	145	
60%	100	105	110	116	123	129	137	145		
65%	103	108	114	121	128	136	144			
70%	106	112	119	126	134	143				
75%	109	116	124	132	141					
80%	113	121	129	138						
85%	117	126	135	145						
90%	122	131	141							
95%	127	137								

Source: formulas obtained from the National Climatic Data Center

WIND CHILL	Actual Temperature (degrees Fahrenheit)									
Wind speed (mph)	**40**	**30**	**20**	**10**	**0**	**-10**	**-20**	**-30**	**-40**	**-50**
5	36	25	13	1	-11	-22	-34	-46	-57	-69
10	34	21	9	-4	-16	-28	-41	-53	-66	-78
15	32	19	6	-7	-19	-32	-45	-58	-71	-83
20	30	17	4	-9	-22	-35	-48	-61	-74	-88
25	29	16	3	-11	-24	-37	-51	-64	-78	-91
30	28	15	1	-12	-26	-39	-53	-67	-80	-94
35	28	14	0	-14	-27	-41	-55	-69	-82	-96
40	27	13	-1	-15	-29	-43	-57	-71	-84	-98
45	26	12	-2	-16	-30	-44	-58	-72	-86	-100
50	26	12	-3	-17	-31	-45	-60	-74	-88	-102
55	25	11	-3	-18	-32	-46	-61	-75	-89	-104
60	25	10	-4	-19	-33	-48	-62	-76	-91	-105

Severity and Extent of Extreme Summer Heat in the United States



Heat advisories will tend to be announced when the heat index is calculated to exceed 105 degrees in an area for a period of at least 3 hours in duration. It should be noted, however, that the temperature inside of vehicles without air conditioning can be dozens of degrees hotter than the outdoor temperature—an outdoor temperature might be "only" 100 degrees Fahrenheit, but people may then get into a car that exceeds 130 degrees. Extreme summer heat is also hazardous to livestock and agricultural crops, and it can cause water shortages, exacerbate fire hazards, and prompt excessive demands for energy. Roads, bridges, railroad tracks and other infrastructure are susceptible to damage from extreme heat. Scorching weather also puts a strain on the energy demands for an area, as the use of air conditioning increases greatly. Possible shutdowns of schools, colleges, and industries can occur during these times.

Air conditioning is probably the most effective measure for mitigating the effects of extreme summer heat on people. Unfortunately, many of those most vulnerable to this hazard do not live or work in air-conditioned environments. The use of fans to move air may help some persons feel more comfortable, but when the temperature reaches the high 90s, fans will not prevent heat-related illness. Bathing with cool water is more effective, but moving to a cooler environment (a basement or air-conditioned location) is most effective—even if only for a few hours per day.

To mitigate the extreme heat of summer, communities within Dickinson County should have a contingency plan in place to protect those people who are most vulnerable to the heat. These contingency plans should include: setting up "cooling stations" where people can go to get out of the heat; a hierarchy of closings for industries, businesses, and schools during shutdown periods; and a means of explaining the dangers of heat conditions, such as pamphlets and local broadcast and print media. Monitoring of dangerous conditions can also be done through the National Weather Service website. A risk assessment should calculate the likelihood of such incidents and the number of days of extreme temperatures likely to be experienced in the community each year. It should also take account of past losses and harm caused by such events, and determine who or what is still vulnerable to such conditions today.

Because of its geographic location in relation to the Great Lakes, Dickinson County is somewhat less susceptible to prolonged periods of extreme hot temperatures than are many other locations. However, the Upper Midwest, in which Dickinson County is located, is definitely vulnerable to extreme temperature events. As a result, Dickinson County communities must always be prepared to respond to heat events in an organized, coordinated and expedient manner. Approximately once or twice per decade, extreme temperature waves tend to cause human and infrastructure impacts across the county (including power failures). Their frequency may be increasing, due to climate change. However, above-average summertime temperatures are normally short-lived and a low risk to human life and property in Dickinson County.

Extreme Winter Cold periods can, like heat waves, result in a significant number of temperature-related deaths. Each year in the United States, approximately 700 persons die as a result of severe cold temperature-related causes. This is substantially higher than the average of 175 heat-related deaths each year. It should be noted that a significant number of cold-related deaths are not the direct result of "freezing" conditions. Rather, many deaths are the result of illnesses and diseases that are negatively impacted by severe cold weather, such as stroke, heart disease and pneumonia. It could convincingly be argued that, were it not for the extreme cold temperatures, death would not have occurred at the time that it did due to the illness or disease alone.

Hypothermia (the unintentional lowering of core body temperature), and frostbite (damage from tissue being frozen) are probably the two conditions most closely associated with cold temperature-related injury and death. Hypothermia is usually the result of over-exposure to the

cold, and is generally thought to be clinically significant when core body temperature reaches 95 degrees or less. As body temperature drops, the victim may slip in and out of consciousness, and appear disoriented. Treatment normally involves warming the victim but frostbitten areas should not be rubbed. Although frostbite damage itself rarely results in death, in extreme cases it can result in the amputation of the affected body tissue.

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

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

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

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

The special vulnerability of elderly persons to hypothermia has become apparent. Over half of the hundreds who die each year due to cold exposure are 60 years of age or older, even though this age group only represents about 20% of the country's population. This remarkable statistic may be due, in part, to an impaired perception of cold as well as the voluntarily setting of thermostats to relatively low temperatures. In addition, high energy costs and the relative poverty among some elderly people may discourage their setting thermostats high enough to maintain adequate warmth.

It is known that every winter season, the Dickinson County area is exposed to prolonged periods of below-freezing temperatures that may cause frostbite, hypothermia, and other health effects. Dickinson County temperatures even go below 0 degrees F several times per year (on average). Temperatures reaching minus 20 degrees Fahrenheit are common during the months of January and February. Temperatures have eclipsed 30 degrees below zero on rare occasions with wind chills of -70 degrees. Frozen pipes, broken pipes, and other freeze damages are counted among the physical impacts of this hazard. A prolonged period of sub-zero temperatures blanketed the Upper Peninsula in the winter of 1993/94 causing water line and sewer damage in excess of $1 million. Twenty years later in the winter of 2013/14 the conditions were even worse. December through February was the coldest winter period in more than a century of record-keeping in Dickinson County. The average temperature for the bitter three-month span was 7.2 degrees, which was 8.8 degrees below normal and the coldest on record, according to the National Weather Service. Iron Mountain had 68 days of sub-zero weather, eclipsing the mark of 61 set in the 1995-1996 winter of a database of 114 years.

Significant Temperature Extreme Events Affecting Dickinson County

Following are brief synopses of some of the more significant temperature extreme events that have affected Dickinson County in recent decades:

February 9, 1934 – Vanderbilt (Otsego County)

The coldest recorded temperature in Michigan was at this location in the northern Lower Peninsula—at 51 degrees below zero!

July 1936 – Michigan (including Dickinson County)

During the second week of July 1936, a terrible heat wave struck Michigan, including Dickinson County, with temperatures exceeding 100 degrees for up to seven days in a row (this varied by location). The temperature peaked at 112 degrees in Mio in Oscoda County, setting the all-time state record that still stands today. The extreme heat was an "equal opportunity" killer, causing many healthy adults to succumb to the heat at work or in the streets. Also, because most people relied on iceboxes to keep their food fresh, many heat-related deaths and illnesses occurred when the ice melted, causing the food to spoil. Nationally, the heat wave caused 5,000 deaths.

February 17, 1979 – Northern Michigan (including Dickinson County)

This was one of the coldest days that ever occurred in Michigan, in terms of the widespread presence of top-ten coldest temperatures. The coldest location in the Upper Peninsula was at Trout Lake (Chippewa County) when the low was -43 degrees.

Summer 1988 – Central and Eastern U.S. (including Dickinson County)

The 1988 drought/heat wave in the Central and Eastern U.S. also greatly impacted Michigan, including Dickinson County. Nationwide, the drought caused an estimated $40 billion in damages from agricultural losses, disruption of river transportation, water supply shortages, wildfires, and related economic impacts. The heat wave that accompanied the drought conditions was particularly long in Michigan – 39 days with 90 degree or better heat – eclipsing the previous record of 36 days recorded in the "dust bowl" days of 1934. Nationwide, the 1988 drought/heat wave caused an estimated 5,000 to 10,000 deaths. (Again, the range of estimates is due largely to varying interpretations of "heat-related" death.)

December 1993 to May 1994 – Upper Peninsula (including Dickinson County)

A deep freeze disaster was federally declared as a Presidential Disaster Declaration (#1028) and can be read about in the Michigan Hazard Mitigation Plan. Dickinson County didn't receive a disaster declaration but nearby counties did receive one. The ten counties that were declared disasters areas where Gogebic, Ontonagon, Houghton, Marquette, Delta, Schoolcraft, Chippewa, Mackinac, Cheboygan, and Charlevoix; when record low temperatures caused the freezing and breakage of more than 3,200 water and sewer lines. Service to 18,700 homes was disrupted. Public costs were estimated at more than $12 million.

July 1995 – Central and Eastern U.S. (including Dickinson County)

During the period from July 11-27, 1995, the Central United States and many East Coast cities experienced a devastating heat wave. According to the National Oceanic and Atmospheric Administration, that heat wave caused 1,021 deaths - 465 of those occurring in the Chicago metropolitan area alone. Many of the deaths were low-income elderly persons living in residential units not equipped with air conditioning. Local utilities in Chicago were forced to impose controlled power outages because of excessive energy demands, and water suppliers reported very low levels of water in storage. In Milwaukee, Wisconsin, 85 heat-related deaths were reported during the July 11-27 period. Michigan experienced 28 heat-related fatalities in 1995, most of them occurring during the intense heat period in July. In addition to this tremendous human toll, the intense heat also caused the loss of tens of millions of cattle and poultry throughout the Midwest. This was the hottest summer on record for Southeast Michigan, in terms of having the highest average temperature in Detroit (74.5 degrees). The average August temperature was even higher, at 77.1 degrees, which also set a new record.

January 31st – February 5, 1996 – Menominee County/ Dickinson County

There were multiple days in a row with record low temperatures in the area. The temperatures went down to -45, -44, and -41 at a spot 8 miles west-northwest of nearby Stephenson, near the southern tip of the Upper Peninsula. Dickinson County had similar temperatures but not as bad as Menominee County. The temperature was -33 at Iron Mountain on January 31st and February 1st. Then the temperature was -30 at Iron Mountain on February 2nd and -39 there on February 4th.

June-August 2001 – Midwest and Central Plains (including Dickinson County)

Extreme heat and humidity in the Midwest and Central Plains during parts of June, July and August sent heat stress index readings soaring well above 100 degrees Fahrenheit on many days. Communities across the region were forced to open “cooling centers” and take other steps in an attempt to avoid heat related deaths among vulnerable segments of the population. Despite those efforts, heat-related deaths occurred in many areas – and unfortunately Michigan was no exception.

June 2003 – Upper Peninsula

Summer heat was part of the reason that Red Flag warnings were issued for two counties in the Upper Peninsula, warning of extreme wildfire risk. This was the same summer that saw a massive heat wave strike Europe and caused an estimated 21,000 deaths there. Paris, France recorded its highest temperatures since records had begun in 1873. Fortunately, Michigan did not experience those sorts of extreme problems.

February 17-18, 2006 – Dickinson County

Blizzard like conditions brought wind chill values in between 35 to 45 degrees below zero in Iron Mountain from February 17th-18th.

February 3-6, 2007 – Dickinson County

Wind chills values were recorded at 35 to 40 below zero degrees across portions of the area. The Iron Mountain Fire Department responded to calls of sprinkler systems bursting.

August 2007 – Upper Peninsula

Red Flag warnings were issued for many Upper Peninsula counties, with extreme heat one of the main causes of the wildfire risk.

February 9-11, 2008 – Upper Peninsula (including Dickinson County)

Temperatures of 5 to 15 below zero combined with around 35 mph wind gusts drove bitterly cold wind chill values down to 25 to 40 below zero over much of Upper Michigan from the night of the 9th into the morning of the 11th. The powerful Arctic cold front pushed through the Upper Great Lakes on the afternoon and evening of the 9th and also produced blizzard conditions with lake effect snow and blowing snow over portions of Upper Michigan into the 10th. Many schools were either canceled or delayed on the 11th. AAA Michigan reportedly responded to numerous motorists' calls of dead batteries or fuel line freezes during the extreme cold.

January 13-16, 2009 – Dickinson County

Wind chill values dipped from the 20 to 40 degree below zero range from the late evening of the 13th through the morning of the 16th in the area. There was also some lake effect snow in the area.

Early 2014 – Statewide

Several times during the 2013-2014 winter season very low temperatures were felt across the state, for periods of time that placed many persons at risk. This sometimes coincided with ice storms, power failures, propane shortages, and transportation blockages which caused the effects of the extreme cold temperatures to be more pronounced. The media made the term "polar vortex" popular during these extreme temperature events. Temperatures in Iron Mountain-Kingsford averaged 38.7 degrees in 2014, establishing a new mark for the coldest year on record, according to the National Weather Service. December through February was the coldest winter period in more than a century of record-keeping at Iron Mountain-Kingsford. The average temperature for the bitter three-month span was 7.2 degrees, which was 8.8 degrees below normal and the coldest on record, according to the National Weather Service. The previous record was 8.7 degrees, dating back to 1903-04, nearly five years before Henry Ford would introduce the Model T. According to the table below of Upper Peninsula weather through Mid-March 2014, Iron Mountain broke the record for the number of sub-zero days in a winter. Iron Mountain had 68 days of sub-zero weather, eclipsing the mark of 61 set in the 1995-1996 winter of a database of 114 years. That record may be tough to ever beat again. It goes in the same category of Joe DiMaggio's 56 game hitting streak. There was also several school closure days throughout the area that had to be made up in the early summer. The frost line had surpassed conditions evident during the storied winter of 1993-94, when bitterly cold temperatures gripped the region for weeks, causing the breakage of countless underground pipes. Nearby Marquette County requested a Presidential Disaster Declaration twice but were rejected both times. The entire Upper Peninsula plus three counties from the northern Lower Peninsula total $19,296,962 in damages.

WINTER 2013-2014 SUB-ZERO DAYS

Location	2013-2014 (through 3/13)	Record (year)	Years in Database
Houghton	47	47 (1916-17)	127
Ironwood	69	65 (1978-79)	113
Iron Mountain	68	61 (1995-96)	114
Iron River	74	73 (1995-96)	114
Manistique	56	45 (1958-59)	77
Marquette	51	57 (1962-63)	139
Munising	41	52 (1919-20)	103
Newberry	43	48 (1919-20)	117
NWS Marquette	58	57 (1962-63)	53

National Weather Service – Marquette, Michigan Created: 3/13/2014 9:56 AM
www.weather.gov/UP US.NationalWeatherService.Marquette @NWSMarquette

January 4-7, 2015 – Dickinson County
Very cold wind chills of 25 to 40 degrees below zero were common across the area. There was also drifting snow from a moderate snow storm that occurred.
February 2015 – Statewide
The month of February 2015 was very cold throughout much of the state but the conditions were not as bad as the 2014 winter season that was considered one of the worst winters in recorded MI history! There were numerous days during the second half of February 2015 when the wind chill values dropped between the minus 20 to minus 35 degree below zero range. There were multiple school closure days due to the bitter cold.

Risk : moderate
Rating : 18th

Vulnerability: Since temperature extremes impact wide areas, the entire population of the county would be affected at least indirectly. While both types of temperature extremes are possible in the county, extreme cold is more likely to occur. Mechanical equipment, water pipes (cold weather), livestock, and heating/cooling costs would be impacted by an extreme temperature event. Casualties would be limited, but property damage could be significant.

In the winter of 1993-94, extreme cold temperatures caused water and sewer line damage of over $1 million dollars across the Upper Peninsula, however, no damage costs specific to Dickinson County are known at this time. There is summarized data taken from the National Climatic Data Center (NCDC) for extreme cold temperatures in 1996. The NCDC shows that no costs were incurred from these events. Damages most likely did occur and are not known. In the winter of 2013-2014 the frost line had surpassed conditions evident during the storied winter of 1993-94, when bitterly cold temperatures gripped the region for weeks, causing the breakage of countless underground pipes. The entire Upper Peninsula plus three counties from the northern Lower Peninsula total $19,296,962 in damages. The damage costs in Dickinson County are not known.

Drought

A drought is a water shortage caused by a deficiency of rainfall, generally lasting for an extended period of time. Drought is the consequence of a natural reduction in the amount of precipitation received over an extended period of time, usually a season or more in length. Drought is a normal part of the climate of Dickinson County and of virtually all other climates around the world – including areas with high and low average rainfall. In low rainfall areas, drought differs from normal arid conditions in that the extent of aridity exceeds even that which is usual for the climate. The severity of a drought depends not only on its location, duration, and geographical extent, but also on the area's water supply needs for human activities and vegetation. This local variation of drought standards makes the hazard difficult to refer to and makes it difficult to assess when and where one is likely to occur.

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

Droughts can cause many severe impacts on communities and regions, including: 1) water shortages for human consumption, industrial, business and agricultural uses, power generation, recreation and navigation; 2) a drop in the quantity and quality of agricultural crops; 3) decline of water quality in lakes, streams and other natural bodies of water; 4) malnourishment of wildlife and livestock; 5) increase in wildfires and wildfire-related losses to timber, homes and other property; 6) declines in tourism in areas with water-related attractions and amenities; 7) declines in land values due to physical damage from the drought conditions and/or decreased economic or functional use of the property; 8) reduced tax revenue due to income losses in agriculture, retail, tourism and other economic sectors; 9) increases in insect infestations, plant disease, and wind erosion; and 10) possible loss of human life due to food shortages, extreme heat, fire, and other health-related problems such as diminished sewage flows and increased pollutant concentrations in surface water.

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

The U.S. Drought Monitor (http://www.drought.unl.edu/dm/monitor.html) uses four classifications of severity, from the least intense category (D1) to the most intense (D4), with an additional (D0) category used to designate a "drought watch" area in which long-term impacts such as low reservoir levels are probably present. The Drought Monitor summary map is available online, identifying general drought areas and labeling their intensity. While not the only

way to characterize droughts, the U.S. Drought Monitor is convenient and their classification levels have recently been used in various reports and assessments of drought conditions. Short-term indicators are on the level of 1-3 months, while long-term indicators focus on a duration of 6 to 60 months.

Palmer Drought Classification Categories

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

		and wells creating water emergencies.			

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

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

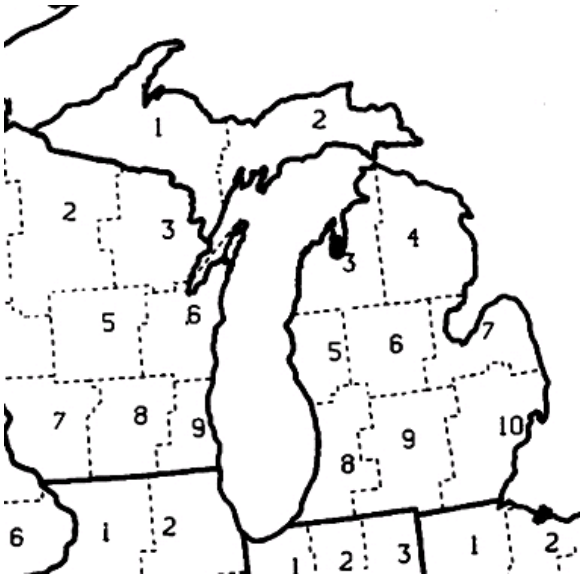
Drought impacts may include limited or restricted access to water, and higher prices for water and agricultural goods. There is a threat to public health and safety, as water shortages and decreased water quality raise threats of illness, land subsidence, and wildfires. Conflicts between water users can arise, especially when a river or lake has competing uses among municipal, agricultural, industrial, and recreational users. Water restrictions and limitations among residents can also change daily lifestyle patterns and create social unrest in severe cases. There is also the possibility of a substantial economic impact on an area's agricultural sector, both in terms of the local area's economics (export value) as well as its employment (proportion of the labor force). Drought may also cause erosion of topsoil (with an associated loss of productivity and land value) and exacerbate other types of erosion, involving associated costs for property owners.

A drought can have serious consequences for the environment if the length and severity of the event is great enough. The hydrological effects of drought can include a loss of wetlands, and lower water levels in lakes, ponds and rivers that are used for irrigating agricultural crops. Additionally, a deficit in rain for an extended period of time may cause ground water depletion and a reduction in the water quality. Drought may also impact plant and animal life by a reduction in drinking water and loss of biodiversity. Drought is also the cause of many wildfires, which destroy wildlife habitats and alter an area's ecosystem. Air quality is reduced by an increase of dust and pollutants in the air. Soil quality and quantity is also diminished due to enhanced erosion, especially around freshly exposed areas near lowered lakes and streams.

The U.S. Geological Survey (USGS) is the primary federal agency that collects and analyzes streamflow data, another good index of the relative severity of drought. The agency provides a handy "Drought Watch" web site at http://waterwatch.usgs.gov/. The site presents a map that is continually updated through an automated analysis of USGS stream gaging stations. Additional drought-related links can be accessed from the Michigan-specific web page (http://waterwatch.usgs.gov/new/index.php?m=dryw&r=mi) by clicking on the map (or proceeding directly to the specific web page at http://mi.water.usgs.gov/midroughtwatch.php).

Another available resource for historical data (usually the period from 1933 to 1988) is the USGS Hydro-Climatic Data Network, which is composed of 1,659 streamflow stations that have 20 years or more of streamflow records. These stations are present in all 50 states and U.S. territories. The USGS, in cooperation with over 600 other government agencies, operates some 7,300 stream gauges for data collection. In addition to streamflow data, the USGS collects data on water quality, reservoir levels and contents, and groundwater levels for each state. For Michigan up to the 2005 water year, this data was being published annually in a Water Resources Data for Michigan document. Since the annual report ceased publication, official annual summaries can be obtained on-line, on a site-by-site basis. These data can be accessed by visiting the Annual Water Data Reports site at http://wdr.water.usgs.gov/ or by visiting the web page for a specific stream gauge through http://waterdata.usgs.gov/mi/nwis/rt. The .pdf files present at these sites contain annual information about that stream location, including average daily flow rates that can be used to identify low and high water flow periods.

The process of drought monitoring involves having ready access to an ongoing supply of information regarding precipitation, stream flows, lake levels, etc. By examining one or more drought indices, encroaching or existent drought conditions can be monitored and adapted to. Drought-related scales include river and stream flows (expressed either as a percentage of normal or as a percentile), the Standardized Precipitation Index, Crop Moisture Index, Surface Water Supply Index, and the Drought Monitor. This type of information may be found through the National Drought Mitigation Center website, http://www.drought.unl.edu/index.htm, or the USGS Drought Watch web page at http://waterwatch.usgs.gov/?m=dryw&r=mi. Through these, an assessment of present conditions and forecasts are at your fingertips. Using the indicators given by these agencies, you can determine how close or how severe drought conditions may be for your area. Depending on the readings and predictions from the indices, you can determine how much risk and what kind of potential losses may arise from year to year. Heading into springtime in a given year with above average precipitation lessens the threat of impending drought (and its consequences) while dry fall and winter conditions lead to a heightened awareness of potential summer drought conditions.



Information from the National Climatic Data Center is available for the current tracking and historical research of drought events in Michigan, but since dry conditions in one region may be balanced (in a statewide average) by wet conditions in another region, it is necessary to look at specific regions rather than the state as a whole, to assess the presence and severity of drought conditions from the historical data.

To assist with Dickinson County planning efforts, only Dickinson County's climatic division of the 10 is listed. A summary of the most severe events from NCDC records have been included for Dickinson County's Climate Division (Division 1). Following this is an overarching description of incidents and trends shown in historical drought records for Dickinson County.

Division 1: Baraga, **Dickinson**, Gogebic, Houghton, Iron, Keweenaw, Marquette, Menominee, and Ontonagon Counties. The most extreme drought was in January 1997, when the Palmer index hit a record low of -6.67. Lengthy drought incidents took place in 1895-1896 (9 months), 1898-1899 (8 months), 1910-1911 (19 months), 1930-1931 (16 months), 1933-1934 (9 months), 1943-1944 (8 months), 1947-1949 (23 months), 1957-1958 (16 months), 1963-1964 (14 months), 1976-1977 (14 months), 1986-1987 (12 months), 1989-1990 (13 months), and 2006-2007 (16 months).

Significant Drought Events Affecting Dickinson County

Following are brief synopses of some of the more significant drought events that have affected Dickinson County in recent decades:

1895-1896 Statewide

The available NCDC drought records (those that use the Palmer drought index) began with a period of extreme drought throughout Michigan. Every one of Michigan's climate divisions

registered drought conditions for at least 8 months—some as long as 17 months—during this period. The drought was exceptionally severe in the Eastern Upper Peninsula and the Traverse Bay area. Recovery was spotty and temporary over the following few years, and it is probable that numerous areas felt little distinction between this drought event and the one that followed closely afterward.

1898-1902 Statewide

Some areas may not have even felt much of a recovery from the preceding drought event when things again took a turn for the worse as the new century arrived. Every one of Michigan's climate divisions felt lengthy droughts, and they tended to last even longer than the previous event had. The Upper Peninsula felt relatively short impacts, with no more than 8 drought months in a row, but the Lower Peninsula had an extremely rough time.

1908-1912 Northern Michigan (including Dickinson County)

Northern Michigan, including Dickinson County was struck by an exceptional drought event, and in the northernmost areas of the state, conditions was exceptionally severe, with the Palmer Index reaching levels almost as low as -6 during multiple months in climate areas 1, 2, 3, and 4.

1930s Midwest / Statewide

Without a doubt, the "Dust Bowl" drought of the 1930s was the most famous drought ever to occur in the U.S. That drought, which was the subject of John Steinbeck's 1939 Pulitzer Prize winning book The Grapes of Wrath, was an ecological and human disaster of huge proportions. It was caused by misuse of the land combined with years with lack of rainfall. As the land dried up, great clouds of dust and sand, carried by the wind, covered everything and the term "Dust Bowl" was coined. As a result of this drought, millions of acres of farmland became useless, forcing hundreds of thousands of people to leave their farms and seek an existence elsewhere. (Many migrated to California, which was featured prominently in Steinbeck's book.) Although exact figures were not kept, some researchers estimate that nearly $1 billion (in 1930s dollars) was provided in assistance to victims of the Dust Bowl drought. That event also ushered in a new era or farming and conservation programs and practices aimed at preventing a recurrence of a drought of the magnitude and impact of the Dust Bowl drought. In Michigan, this "dust bowl" period took the form of a most severe statewide drought condition from 1929 to 1932, followed by a less severe period from 1933 to 1937 in which the general pattern involved the south and western areas seeing the hardest conditions, and finally a period of limited spotty problems between 1938 and 1940.

The most extreme conditions ever seen in Michigan occurred in the period from 1929 to 1932. Nine out of Michigan's ten climatic divisions (the Western U.P. being the only exception) set their all-time drought records during the beginning of 1931, with Palmer Drought Index values varying from -6.57 (the southwestern tip of the Lower Peninsula) to the all-time Michigan record of -8.51 (in the Northeastern Lower Peninsula). Even if only the most exceptional drought levels are considered, these conditions were unusually long-lasting. Between 1930 and 1931, all nine of Michigan's most heavily affected climate divisions experienced this most unusual level of drought for at least 6 straight months. Nevertheless, the entire state was struck very hard—the Western Upper Peninsula had 16 straight months of drought, and most other areas had two straight years or longer in drought conditions. The mid-1930s saw the drought conditions markedly reduced in climate divisions 2, 4, and 5, although the other areas of the state were still plagued with a level of problems that still compare with practically any other drought period in Michigan. Although not extreme in the northern areas of the state, the drought was still severe during a significant portion of this time frame. During this period, the southeastern Michigan region at this time set an all-time state record for the longest number of consecutive months under drought conditions—the 42 months between August 1933 and January 1937. By 1938, the Thumb area was the only part of Michigan still experiencing serious long-term drought problems. Although the area had some months of relief in early 1938, drought conditions resumed by the end of the year for a period of 8 consecutive months, and then between 1939 and 1940, another

13 month period of drought followed. During that latter period, southeastern Michigan shared in the drought conditions for a full year, and these two regions did reach the extreme D3 level of severity.

1947-1949 Far Northern Michigan (including Dickinson County)

Climate divisions 1, 2, and 4 experienced lengthy drought conditions during these years. The mildest area this time was the Northeastern Lower Peninsula (9 months of drought, peaking at the extreme D3 level), while the Upper Peninsula was very heavily struck (more than 20 consecutive months of drought, peaking at the exceptional D4 level for two to three of those months).

1956-1958 Western Upper Peninsula (including Dickinson County)

By the late 1950s, the drought problem had shifted to be felt the hardest in the western Upper Peninsula climate division. The Western Upper Peninsula experienced 16 consecutive months of drought, peaking a couple of times at the severe D2 level.

1962-1965 Statewide

This was the only clear and serious statewide drought event to take place since the 1930s, which partially demonstrates a general trend of lessening drought problems in Michigan during the second half of the 20th Century when compared with the first half. Nevertheless, this was definitely the worst drought event to strike Michigan since the 1930s. In this event, only the Northwestern Lower Peninsula was significantly spared the extended and severe effects experienced throughout the rest of the state. In the Upper Peninsula, things were very bad—between 14 and 21 months of drought, which peaked at the exceptional D4 level, but for a period of 4 to 5 months. The middle years of 1963-1964 were the worst phase of this event, for most parts of the state.

1976-1977 National (including Northern Michigan)

The 1976-77 drought in the Great Plains, Upper Midwest, and West also severely impacted Northern Michigan. Climate divisions 1 through 7 all experienced drought conditions for a stretch of between 8 and 14 consecutive months. Extreme drought conditions in the Upper Peninsula also contributed heavily to the large wildfire that struck the Seney area in July of 1976, even though this was not the most severely impacted area of the state. The fire was started by a lightning strike that ignited dry grasslands and eventually burned over 74,000 acres over a 1½ month period, costing $8 million to contain. Drought had involved a significant reduction in rainfall (6-8 inches below normal) in the area, and the water table in the 95,455 acre Seney National Wildlife Refuge had dropped one foot, exposing old vegetation, peat and muck to the drying forces of the intense sunlight. Eventually, that material became a tinderbox that helped fuel the destructive fire. Fortunately, injuries and damage to improved property were minimal, although the loss of forest resources was staggering. The drought itself reached exceptional D4 levels in climate divisions 1, 2, 3, 4, and 6—sometimes more than once or enduring for multiple months. For example, the Western Upper Peninsula saw Palmer Drought Index values of -5.92, -6.45, -6.67, and -6.11 for the four consecutive months between November of 1976 and February of 1977. In these terms of measurement, it was the hardest-hit region of the state.

Late 1980s Central U.S. (including Michigan); Eastern U.S.

First, Michigan's Upper Peninsula experienced from 8 to 12 consecutive months of drought during 1986-1987, peaking at the extreme D3 level for one month in the Western U.P, while the Eastern U.P. reached the severe D2 level. Next, a 1988 heat wave and drought impacted the Central and Eastern U.S. and caused an estimated $40 billion in damages from agricultural losses, disruption of river transportation, water supply shortages, wildfires, and related economic impacts. In response, Michigan took several steps to combat the impact of the drought on businesses, natural resources, and individual citizens. Numerous Michigan communities instituted temporary water use restrictions to ensure an adequate water supply for human consumption and other essential uses such as firefighting. To stem the potential for wildfire in Michigan, the Governor issued (in June, 1988) a statewide outdoor burning ban, which remained in effect until the end of July, 1988 (and longer in some Upper Peninsula counties). The State also formed a

task force to study issues related to the drought and formulate appropriate strategies for dealing with those drought-related concerns. Fortunately, Michigan's drought conditions were not consistently severe during that summer, although they would be seen to worsen in some of the state's northern areas over the next couple of years. The final events in the chain of drought conditions took place when the Upper Peninsula again suffered a lengthy period (between 9 and 13 consecutive months) of drought between 1989 and 1990, peaking at the severe D2 level, and the Northeastern Lower Peninsula joined them in suffering 8 months in a row of drought conditions, also peaking at D2.

1998-2003 Northeast; Mid-Atlantic; South-Central; Southeast; Michigan

Droughts / heat waves in recent years have caused considerable damage to agriculture and related industries in several areas of the U.S. The summer of 1998 drought / heat wave from Texas to the Carolinas caused an estimated $6-9 billion in damage. The summer of 1999 drought / heat wave caused over $1 billion in damage – mainly to agricultural crops in the Eastern U.S. The summer of 2000 drought / heat wave in the South-Central and Southeastern U.S. resulted in over $4 billion in damages and costs. The drought / heat wave that struck Michigan during the summer of 2001 damaged or destroyed approximately one-third of the state's fruit, vegetable and field crops, resulting in a U.S. Department of Agriculture Disaster Declaration for 82 of the state's counties. In 2002, moderate to extreme drought affected more than 45 percent of the country during the months of June, July and August. Nationwide, the summer was the third hottest on record, following only 1936 and 1934. The summer of 2002 was also very hot and dry in Michigan. During the first half of the month, hundreds of communities across the area were under water restrictions. Hardest hit from the drought was the agricultural industry. The severely dry weather was classified as a drought until mid 2003. In terms of the Palmer Drought Index, the most severe problems in Michigan jumped around from year to year. The start was actually in the Eastern U.P. during 1997, with 21 drought months then following in a row until mid-1999, but resuming the next year for another 14 consecutive drought months until more than half of 2001 had passed. The extreme D3 level was reached there more than once.

2005-2007 – Northern Michigan (including Dickinson County)

The Upper Peninsula suffered from drought conditions for between 16 and 22 months starting in 2005, peaking at the exceptional D4 level in the West, and with severe D3 levels across the East. By 2007, severe drought conditions (rated D2) were noted for the Eastern Upper Peninsula and also the tip of the Northern Lower Peninsula. The hay crop in the Eastern U.P. was only 50 to 70 percent of normal, and the resulting lack of feed led some farmers to downsize their cattle herds A burning ban was also issued for most of the state (the first such ban since 1998) to reduce the risk of wildfires. Significant rains in September eventually alleviated the drought.

Risk : moderate
Rating : 19th

Vulnerability: Tourism and forest production are mainstays of the county economy. Major droughts occur on an average of every 20-25 years. The NCDC (National Climatic Data Center) website found zero past drought events. A drought would have an immediate and potentially long-term economic impact in all areas of the county. However, if the drought was sustained for long periods, there would be an increased risk to water supplies from underground wells. The Cities of Iron Mountain and Kingsford and portions of Breitung Township use wells for their municipal water supply (an estimated 14,200 customers. Elevated wildfire danger would threaten dwellings, especially in rural, forested areas in the northern portions of Waucedah, Norway, Breitung and Sagola Townships and large portions of Breen, West Branch and Felch Townships. Agricultural production would be severely affected.

Hail

Hail is a condition where atmospheric water particles from thunderstorms form into rounded or irregular lumps of ice that fall to the earth.

Hail is a product of the strong thunderstorms that frequently move across Dickinson County. As one of these thunderstorms passes over, hail usually falls near the center of the storm, along with the heaviest rain. Sometimes, strong winds occurring at high altitudes in the thunderstorm can blow the hailstones away from the storm center, causing an unexpected hazard at places that otherwise might not appear threatened.

Most hailstones range in size from a pea to a golf ball, but hailstones larger than baseballs have occurred with the most severe thunderstorms. Hail is formed when strong updrafts within the storm carry water droplets above the freezing level, where they remain suspended and continue to grow larger until their weight can no longer be supported by the winds. They finally fall to the ground, battering crops, denting autos, and injuring wildlife and people. Large hail is a characteristic of severe thunderstorms, and it may precede the occurrence of a tornado.

The National Weather Service began recording hail activity in Michigan in 1967. Statistics since that time indicate that approximately 50% of the severe thunderstorms that produce hail have occurred during the months of June and July, and nearly 80% have occurred during the prime growing season of May through August. As a result, the damage to crops from hail is often extensive. The National Weather Service forecasts of severe thunderstorms usually give sufficient warning time to allow residents to take appropriate action to reduce the effects of hail damage on vehicles and some property. However, little can be done to prevent damage to crops.

NOAA data indicates 68 hail events occurring in Dickinson County between June 1950 and June 2015. Hail events can be expected about every year. Hail of up to 2.75 inches caused $225,000 damage in the Iron Mountain area in June 2000. Risks associated with hailstorms tend to be lower than those of thunderstorms. With the right weather conditions, hail can occur in any month, though late spring and summer are the most common times of year.

Significant Hail Events Affecting Dickinson County
Following are brief synopses of some of the more significant hail events that have affected Dickinson County in recent decades:

June 9, 2000 - Randville-Grand Bluff (Dickinson County)
In the early morning hours of June 9, 2000 a line of thunderstorms moved through the area producing ping-pong ball sized hail in the Randville-Grand Bluff area in Dickinson County and caused $225,000 in damage to 20 homes and 20 vehicles. The storm also moved through nearby Iron County, producing 1.75” hail that damaged approximately 575 homes and 700 vehicles in a two-mile wide swath across the northern two-thirds of the City of Iron River. The hail caused approximately $2.3 million in roof and siding damage. Total hail damage in Iron and Dickinson Counties was $4.1 million. An eye-witness reported hail falling so hard that it seemed like it was a snowstorm.
July 28, 2006 – Western Upper Peninsula (including Dickinson County)
Thunderstorms occurred throughout much of the central and western Upper Peninsula resulting in damaging winds and large hail. There was just under $1 million in property damage but the majority of the property damage occurred in Gogebic County.

June 20, 2007 - Marquette (Marquette County)
One of the most significant hailstorms in memory pummeled nearby downtown Marquette and Harvey during the afternoon of June 20, 2007. While most of the hail was less than golf ball size, there were a few reports of hail that was three inches in diameter. The hail accumulated to several inches deep in downtown Marquette, and storm drains clogged from shredded leaves caused melting hail to result in street flooding. Hundreds of houses sustained significant damage to roofs and sidings. In addition, thousands of cars were damaged. Damage estimates from the storm for Marquette and surrounding areas were reported to total over $60 million.

Risk : low
Rating : 24th

Vulnerability: Hail is associated with thunderstorms and is generally confined to a small geographic area. All areas of the county (26,168 people) are equally susceptible to hail events every year. Hail itself is seldom of a size that is dangerous to people. If large enough, hail can damage equipment, buildings, and agricultural crops. Damages of only $225,000 are estimated through NCDC records over the past 65 years (Appendix C, Table-4).

Subsidence

Hazard description: Downward movement of land surface caused by human-induced activities that have weakened or removed subsurface support.

Subsidence is the lowering or collapse of a land surface, caused by natural or human-induced activities that erode or remove subsurface support. It can be caused by a variety of natural or human-induced activities. Natural subsidence occurs when the ground collapses into underground cavities produced by the solution of limestone or other soluble materials by groundwater. Human-induced subsidence is caused principally by groundwater withdrawal, drainage of organic soils, and underground mining. In the United States, these activities have caused more than 17,000 square miles of surface subsidence, with groundwater withdrawal (10,000 square miles of subsidence) being the primary culprit. In addition, approximately 18% of the United States land surface is underlain by cavernous limestone, gypsum, salt, or marble, making the surface of these areas susceptible to collapse into sinkholes.

Mine subsidence is a geologic hazard that can strike with little or no warning and can result in very costly damage. Mine subsidence occurs when the ground surface collapses into underground mined areas. In addition, the collapse of improperly stabilized mine openings is also a form of subsidence. About the only good thing about mine subsidence is that it generally affects very few people, unlike other natural hazards that may impact a large number of people. Mine subsidence can cause damage to buildings, disrupt underground utilities, and be a potential threat to human life. In extreme cases, mine subsidence can literally swallow whole buildings or sections of ground into sinkholes, endangering anyone that may be present at that site. Mine subsidence may take years to manifest. Examples of collapses occurring decades after mines were abandoned have been documented in several areas of the country.

Compaction of soils in some aquifer systems can accompany excessive ground-water pumping and cause subsidence. Excessive pumping of such aquifer systems has resulted in permanent subsidence and related ground failures. In some systems, when large amounts of water are pumped, the subsoil compacts, thus reducing in size and number the open pore spaces in the soil that previously held water. This can result in a permanent reduction in the total storage capacity of the aquifer system. More than 80% of the identified subsidence in the United States is a consequence of human impact on subsurface water. Three distinct processes account for most of the water-related subsidence: compaction of aquifer systems, drainage and subsequent oxidation of organic soils, and dissolution and collapse of susceptible rocks.

Groundwater in the pore spaces of an aquifer supports some of the weight of the overlying materials. When groundwater is depressurized or even removed from aquifers, where the materials are very compressible and pore pressures can be high, compaction may occur. This subsidence may be partially recoverable if pressures rebound, but much of it is not. Thus the aquifer is permanently reduced in capacity, and the surface of the ground may also subside.

In the past there has been pressure for the Great Lakes states to export bulk quantities of water to various locations in the United States. If these plans to withdraw large amounts of water from the Great Lakes ever took place, it may have a major effect on the level of the ground water tables in Michigan, which may possibly make subsidence a more common occurrence. Currently, broken water pipes and the improper discharge of rainwater are the most common causes of water-related subsidence in Michigan. It most commonly occurs on sandy or silty ground when the water from the leak washes out the fine particles beneath the foundation, causing voids that result in collapse or subsidence.

Overall, subsidence is not a very well-known hazard in most parts of Dickinson County. The impacts of subsidence in Dickinson County tend to be limited in scope to individual sites and structures. Unlike some other areas in the country, such as Illinois, Ohio, Kentucky, West Virginia, Florida, Louisiana, and Pennsylvania, where subsidence is a serious concern, Dickinson County does not devote a great deal of resources to the problem. Subsidence simply does not have the widespread impact potential of other natural and technological hazards that are prevalent in the county.

Because subsidence tends to be a more sporadic hazard, and because it poses a greater hazard to property than to life, it does not receive much attention from government agencies or the public. Other natural hazards, such as tornadoes, floods and severe storms receive much more attention because of their more widespread and severe impacts. However, subsidence will continue to be a hazard that a segment of the Dickinson County population will have to deal with in the future. Major incidents that lead to catastrophic damage are nearly unknown, but smaller incidents occur with some regularity in old mining areas.

Most incidents of subsidence in Dickinson County are the result of underground mining. Underground mining along the Menominee Iron Range began in the 1870's and ended in the 1930's. Iron ore tonnage in the hundreds of thousands was mined and shipped to Great Lakes steel mills. Subsidence is evident at many locations from Vulcan to Iron Mountain. Chapin Pit in Iron Mountain and Strawberry Lake in Norway are extreme examples of subsidence. The county employs a mine inspector to monitor safety conditions around former underground mining sites.

The Groveland Mine in Randville was an open pit operation and closed in 1981. Surface mining of sand and gravel is found at numerous pit locations within the county. While subsidence is not a concern in excavation pits, the activity does cause instability in the soil structure at the site.

Other human-induced activities resulting in subsidence are groundwater withdrawal and drainage of organic soils. The dissolution of soluble materials such as limestone by groundwater can create underground cavities that weaken subsurface support enough to cause a lowering or collapse of the ground surface. Subsidence of this nature is unknown in the county.

Significant Subsidence Events Affecting Dickinson County
Following are brief synopses of some of the more significant subsidence events that have affected Dickinson County in recent decades:

July 1999 - Iron Mountain (Dickinson County)
On July 27, 1999 an abandoned mineshaft in Iron Mountain caved in, exposing a 50-foot diameter by 1,600-foot deep shaft. The cave-in occurred directly adjacent to the Cornish Pumping Engine and Mining Museum, a popular tourist attraction in the downtown area. The structure was in danger of collapsing into the opening until temporary stabilization measures were taken. Officials were also concerned that further subsidence could have damaged nearby infrastructure, including a roadway. Because the cave-in posed a significant threat to public safety, a Governor's Emergency Declaration was granted to provide state assistance in securing the site and permanently capping the opening.

Risk	**:**	**low**
Rating	**:**	**30th**

Earthquakes

Hazard description: A shaking, trembling, or upheaval of the earth's surface caused by volcanic action or bedrock shifting and breaking.

The probability of an earthquake event occurring in Dickinson County is extremely low. Seismic hazard mapping prepared by the U.S. Geologic Survey projects the likelihood of ground motion at 2 percent in 50 years. This probability rating applies to all areas of Upper Michigan except the Keweenaw Peninsula where the projected probability is 4 percent in 50 years. Tremors have been recorded in parts of southern Michigan but are rare and have done little damage. Moderate seismic activity was recorded in Menominee in 1905 and the Keweenaw in 1905, 1906 and 1909. A 1925 earthquake in Quebec was felt as far away as Whitefish Point and Newberry. An Ontario-centered earthquake was felt in Sault Ste. Marie in 1944.

Significant Earthquakes Affecting Dickinson County
Following are brief synopses of some of the more significant earthquakes that have affected Dickinson County in recent decades:

In recent history, there are no known earthquakes that have affected Dickinson County.

Risk	**:**	**moderate**
Rating	**:**	**5th**

Vulnerability (Subsidence and Earthquakes): Subsidence in the initial hazard analysis was ranked low but as discussion on this hazard progressed it was evident that it warranted a higher-risk designation. A hundred year history of underground mining has made subsidence a local concern. There are extensive networks of underground mines running through southern Dickinson County- from Iron Mountain and Kingsford to Norway, Loretto and Waucedah in the east. A higher risk to property and human safety exists in these areas. An estimated 60 percent of the population is at risk from subsidence (using population figures for the City of Iron Mountain, Kingsford and Norway only).

Local officials have knowledge of some mine shafts and areas of concern, however, technical data and mapping is not readily available. There is a need for this hazard to be studied in more depth by first gathering and combining all known mine information. Mapping of mine shafts and tunnels should be done to show the extent of possible subsidence risk and solutions to reduce the risk. Flooding of inactive mine shafts, especially the Hamilton and Aragon mine shafts, is another issue connected to underground mining and subsidence but will be discussed in more detail under the section on "Flooding".

There have been no earthquake events recorded in Dickinson County and the probability of one is considered quite low according to the U.S. Geologic Survey. Earthquakes were still considered a high risk by the community when combined with the hazard of subsidence from underground mines. It is believed that even a small tremor could cause significant property damage and endanger human lives (over 60 percent of the county population) due to the instability of the area. Studies would have to be done to prove or disprove this assumption.

Wildfires

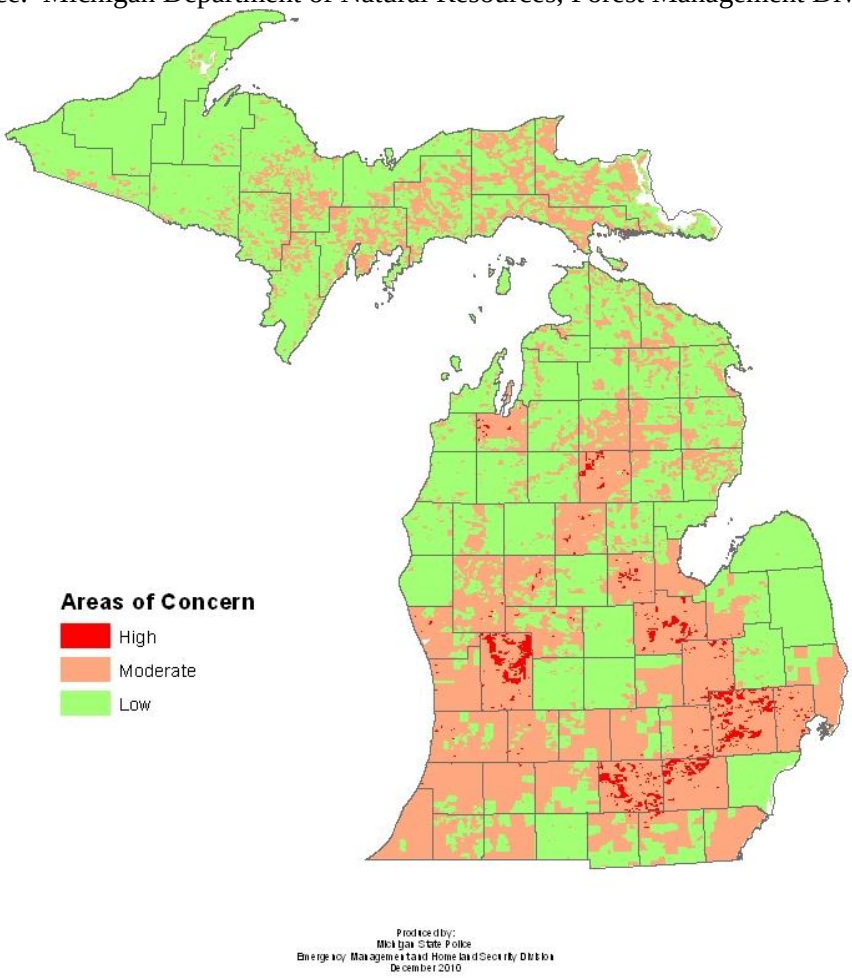
Hazard description: An uncontrolled fire in grasslands, brushlands or forested areas.

A wildfire is an uncontrolled fire in grasslands, brushlands, or forested areas. The majority of Dickinson County's landscape is rural with thousands of acres of forests across the County's 777 square miles. That vast forest cover is a boon for both industry and recreation. The County has resort style living areas around the County's many lakes; the largest being Lake Antoine, Fumee Lake, Gene Pond, and four separate ponds that are geographically very close to one another. The County has seven state game areas, many golf courses, many parks and campgrounds. However, this also makes many areas of Dickinson County highly vulnerable to wildfires.

Although Dickinson County's landscape has been shaped by wildfire, the nature and scope of the wildfire threat has changed. Dickinson County's landscape has changed over the last several decades due to wildland development, and so the potential danger from wildfires has become more severe. Increased development in and around rural areas has increased the potential for loss of life and property from wildfires. (The map below shows the wildland / urban interface areas of highest concern in Michigan.) According to the map, about a quarter of Dickinson County is of moderate wildfire concern, and the other 75 percent is of low concern.

Michigan Wildland/Urban Interface Map

Source: Michigan Department of Natural Resources, Forest Management Division



Contrary to popular belief, lightning strikes are **not** the primary cause of wildfires in Dickinson County. Recently, only about 7% of all wildfires in all of Michigan were caused by lightning strikes, and most other causes have been attributed to human activity. Outdoor debris burning is the leading cause of wildfires in the State of Michigan. Most wildfires occur close to where people live and recreate, which puts both people and property at risk. The immediate danger from wildfires is the destruction of property, timber, wildlife, and injury or loss of life to persons who live in the affected area or who are using recreational facilities in the area.

According to 2011 MDNR information, the leading causes of wildfires from 2001 to 2010 were:

1. Debris burning (32%)
2. Equipment (17%)
3. Miscellaneous (11%)
4. Unknown (10%)
5. Campfires (9%)
6. Lightning (7%)
7. Incendiary activity (5%)
8. Children (5%)
9. Railroads (3%)
10. Smoking (3%)

Even though many fires occur close to where human residences are located, they are a normal ecological phenomenon and serve long-term functions for vegetation and the natural environment. Wildfires burn excess brush, maintain large savannah-like openings, and restore wetlands by forcing out various unwanted brush and plants. The natural function of fires within the environment can be considered a renewal or "cleansing process" as long as the fire is not too severe.

With an ever-increasing number of rural homes being built in wildland areas, there is a greater potential for life and property loss. Moreover, fire protection can become much more difficult due to resources being deployed to protect structures. Structures built at the wildland interface should implement a common sense fire defense strategy. Dickinson County participates in the "Firewise Communities: Wildfire Protection Program, a program designed to educate governmental officials, builders, bankers, architects, etc. on ways to design, build, and site wildland/urban interface structures to be more resistant to wildfires.

Between 1981 and 1999 in Dickinson County, a total of 348 wildfires burned 2,310 acres within the jurisdiction of the Michigan Department of Natural Resources. Dickinson County continues to have wildfires every year with varying degrees of severity. They are too numerous to tabulate. A comparable number of fires were recorded in Menominee County (373), more in Marquette County (483), and fewer in Iron County (163). The ratio of acres burned to number of fires was about the same across the counties.

Springtime before "green up" is typically the busiest time for firefighters with grass and brush fires. The threat in forested areas increases during summer months; weather is a critical factor. Fire ignition sources are abundant - trains, off-road vehicles, farm equipment, trees falling on power lines, human activities and many others.

The National Weather Service provides fire weather forecasts to federal agencies in the region. During periods of high fire danger, the NWS prepares a daily Wildfire Potential Statement.

Significant Wildfires Affecting Dickinson County
Following are brief synopses of some of the more significant wildfires that have affected Dickinson County in recent decades:

October 1871 – Michigan, Wisconsin, and Chicago
The State's first recorded catastrophic fire occurred in the fall of 1871, after a prolonged drought over much of the Great Lakes region in the summer of 1871. The drought had left debris from logging and land clearing tinder dry, and as a result numerous fires burned throughout the state. These fires continued to smolder until, on October 8th of that year, gale and hurricane force winds fanned a series of fires across much of the northern Lower Peninsula. Because this tremendously destructive wildfire occurred at the same time as the great wildfires that struck Peshtigo, Wisconsin (which killed 1,300 people in a single night, and also affected nearby Menominee County and the Great Chicago Fire (which destroyed much of central Chicago), the Michigan wildfire received little publicity. However, the 1871 Michigan wildfire killed 200 people and burned 1.2 million acres. When the winds finally subsided, the fire's swath stretched from Lake Michigan across to Lake Huron. The worst of the fire was over by October 19, although the fire wasn't completely extinguished for over a month.
September 21, 1908 – Dickinson County (Foster City)
A forest fire broke out in and around Foster City burning farm houses and timber spread by high winds in Dickinson County. Approximately 30 dwellings, a saw mill, and a large store were destroyed by the wild fire. There were also six fatalities throughout the area. Several small towns in nearby Iron County were in danger of the wildfire, resulting in residents fleeing to other areas.

Risk : moderate
Rating : 12th

Vulnerability: Dickinson County contains vast tracts of forestland-an estimated 80 percent (see Map 6). Coniferous species (lowland and upland) dominate and are of greater concern because of their flammability. An increased risk from wildfire would be experienced in the northern portions of Waucedah, Norway, and Breitung Townships and large portions of Breen, West Branch, Felch and Sagola Townships. About 50 percent of the county is state owned land, largely in its north. State ownership limits residential development within high-risk forest areas. Moreover, residential development within forested areas is generally dispersed. Critical facilities are fairly well isolated from forested areas and have good fire protection nearby.

Other Environmental

Hazard description: A species that has been introduced by human action to a location where it did not previously occur naturally, becomes capable of establishing a breeding population in the new location without further intervention by humans, and becomes a pest by threatening local biodiversity and causing human health impacts, significant economic costs, and/or harmful ecological effects.

An invasive species is defined as a species that is (1) non-native (alien) to the ecosystem under consideration and (2) whose introduction causes or is likely to cause economic or environmental harm, or harm to human health. Invasive species can be plants, animals, and other organisms (e.g., microbes). Human actions are the primary consideration here as a means of invasive species' introduction (thus distinguishing the situation from natural shifts in the distribution of species). Nationally, the current environmental, economic, and health costs of invasive species were estimated as exceeding the costs of all other natural disasters combined.

Invasive species can be transported in many ways, such as on animals, vehicles, ships, commercial goods, produce, and clothing. Although non-native species are the foundation of U.S. agriculture, and also are used to prevent erosion, to provide fishing and hunting opportunities, and as ornamental plants and pets, occasionally a non-native organism flourishes too well and causes unwanted economic, ecological, or human health impacts. The terms "invasive" or "nuisance" are used to describe such species. New environments may affect rates of reproduction, susceptibility to disease, and other features that affect a species' success. Consequently, a plant or animal that causes little damage to agriculture or natural ecosystems in one area may cause significant problems in another. Certain nonnative species are very successful in their new habitats because they out-compete native plants or animals and have no natural controls (predators, diseases, etc.) in the new area. At least 200 well-known, high-impact, non-native species presently occur in the United States. They range from the European gypsy moth and emerald ash borer to crabgrass, dandelions, and German cockroaches, annually costing well over a billion dollars to control. Some even pose human health risks. Others, like the zebra mussel, threaten widespread disruption of ecosystems and the displacement or loss of native plants and animals.

Hundreds of new species from other countries are introduced intentionally or accidentally into the United States each year. These invasive species may arrive on our shores in a variety of ways. Transportation efficiencies that make it possible to travel around the globe in hours rather than weeks make it possible for organisms to survive transportation from one continent to another.

As more adaptable and generalized species are introduced to environments already impacted adversely by human activities, native species are often at a disadvantage to survive in what was previously a balanced ecosystem. There are many examples of decreased biodiversity in such areas. One of the primary threats to biodiversity is the spread of humanity into what were once isolated areas, with land clearance and habitation putting significant pressure on local species. Agriculture, livestock, and fishing can also introduce changes to local populations of indigenous species and may result in a previously innocuous native species becoming a pest, due to a reduction of natural predators. This threat intensifies the need for scientists, managers, and stakeholders to cooperate to build better systems to prevent invasion, improve early detection of invaders, track established invaders, and to coordinate containment, control, and effective habitat restoration.

Although invasive species, in most cases, primarily cause environmental damage and degradation, there are situations in which serious threats to public health, safety, and well-being

can occur due to animal disease or plant/animal infestations. For example, certain diseases could wipe out large segments of an animal population, creating a potentially serious public health emergency and the need to properly (and rapidly) dispose of the dead animal carcasses.

Similarly, a widespread insect infestation, such as that of the Emerald Ash Borer, can create serious public safety threats (especially in densely populated urban areas) due to dead and dying trees being fire prone (because of their dry, brittle nature) or to partial/total collapse due to high winds or ice/snow accumulation. The falling trees or limbs can also bring down power lines, cause damage to public and private structures, and cause injuries or even death.

These are very important issues in natural resource-based Dickinson County.

Forest Infestations

There are many pathogens and insects that threaten native tree species. Each introduces some change to the forest ecosystem. Among the most prominent insect pests affecting area forests are the pine shoot beetle and gypsy moth. Beech bark disease and oak wilt are among the region's most important exotic forest diseases.

Exotic Aquatic Plants

Exotic and invasive plants such as the prolific purple loosestrife threaten native wetland vegetation throughout the Great Lakes region. It has no food value for wildlife. Massive beds of Eurasian water milfoil make boating and swimming impossible and significantly change the habitat of fish and invertebrates. These are perhaps the best known of exotic aquatic plants that are affecting native ecosystems.

Exotic Fish, Mollusks and Crustaceans

Non-indigenous species have been increasing in numbers and populations throughout the Great Lakes and some inland waters. Shipping (ballast water) and unintentional releases are considered the major entry routes. Exotics compete with native fish stocks for food and habitat. Among the species that impact native fish populations are Eurasian ruffe, white perch, sea lamprey, common carp, and several varieties of goby. The zebra mussel, a prolific mollusk, is well established in Lake Michigan and is perhaps best known for clogging surface water supply intakes. Crustaceans such as the spiny water flea thrive on the normal food sources of juvenile fish.

Bovine Tuberculosis

Bovine TB is a lung disease that can be transmitted among animals through breathing or nose-to-nose contact. The disease has been found in cattle, goats, bison, elk, and moose. It is believed that this infectious disease is close to being eradicated in the United States; no cases have been verified in the U.P.

Chronic Wasting Disease

It is known that white-tailed deer, elk and mule deer can be infected with this disease. CWD is related to diseases such as scrapie in sheep, mad cow in cattle, and Creutzfeldt-Jakob in humans. Creutzfeldt-Jakob is a rare and fatal neurodegenerative disease of unknown cause. There is no current evidence that the disease can infect humans or livestock. It is not yet known how the disease is spread, although saliva, urine and feces are considered the most likely means.

Wisconsin has confirmed a large number of white-tailed deer with CWD. None, however, have been detected in Michigan. The extent to which this disease will affect deer and other wild animals is not known. Consuming meat from infected animals is not recommended.

West Nile Virus

Humans, horses, and many types of birds and some other animals are susceptible to infection by mosquito bites. Humans usually exhibit mild symptoms or none at all. In rare instances, infected humans can become severely ill and even die. As far as is presently known, the virus cannot be spread from human to human or from animal to human. Michigan had 26b positive human cases in 2013.

Lyme Disease

Lyme disease is a bacterium passed to dogs (and humans) by the bite of a deer tick. Deer ticks are quite small - about the size of a sesame seed. Portions of the northeast United States and southwestern Wisconsin are considered high-risk areas. The risk in the U.P. is considered low to moderate, however, Dickinson County has a higher risk according to the Michigan Department of Community Health. Just about any outdoor activity poses some risk.

More than 16,000 infections are recorded in the United States annually. Evidence of infection first appears as a rash and is often difficult to detect. Infected humans will experience joint pain, nervous system or cardiac symptoms as the disease progresses.

Examples of Potentially Threatening Invasive Insects
(Note: Not all of these species currently occur in Dickinson County.)

Balsam Woolly Adelgid (Adelges piceae)
Hosts: All true firs.
Symptoms: Small white masses on tree, stunted shoots, formation of galls, tree crown turns red.
Damage: Feeding on the branches of the crown and main stem, causing mortality in 2-6 years.
Control/Treatment: Spraying of individual trees from the ground with lindane has proved effective for control. The spray, prepared by mixing 2.5 pints of 10% emulsifiable concentrate per 100 gallons of water, is applied as a bark drench with a hydraulic sprayer from May through June and September through October to control crawlers. Treatment will reduce populations to below the tree-killing level, and some treated trees may remain generally free from aphids for at least 2 years. Spraying is warranted only in accessible areas supporting relatively high-value trees.

Hemlock Woolly Adelgid (Adelges tsugae)
Hosts: Eastern Hemlocks.
Symptoms: Small white cottony masses at the base of the needles. Needles turn grayish green and drop off. There is a lack of new buds, and low vigor.
Damage: Feeding on twigs by nymphs cause the trees to die within 1-4 years.
Control/Treatment: Horticulture oils that smother the insects have been the best insecticidal treatment. The oils are non-toxic to the trees, as opposed to soap, which is an otherwise effective treatment. However, the least harmful cure may be the introduction of Japanese ladybugs.

Asian Long-Horned Beetle (Anoplophora glabripennis)
Hosts: Several species of hardwood trees found in Michigan. Its favorite host is the Norway maple, although it has been found in other maple species, horse chestnut, elm, box elder, mulberry and poplar trees.

Symptoms: Dark, wet areas on branches and trunks or white foamy sap are often the first symptoms seen in infested trees. The sap often attracts bees, wasps and hornets.
Damage: Trees infested are first weakened, and then die. Damage from these insects and secondary pests will kill a tree within a few years.
Control/Treatment: The only known way to eradicate the beetle is to cut down and burn infested trees.

Japanese Cedar Long-Horned Beetles (Callidiellum rufipenne)
Hosts: Nest in white cedar, eastern red cedar, and cypress trees.
Symptoms: Oval exit holes on tree bark, or deep irregular galleries in wood.
Damage: Larvae bore into wood and weaken the tree. Heavily infested trees may die.
Control/Treatment: None at this time.

Emerald Ash Borer (EAB) (Agrilus planipennis)
Hosts: White, black, and green ash trees.
Symptoms: Typically the upper third of a tree will die back first, followed by the rest during the next year. This is often followed by a large number of shoots or sprouts arising below the dead portions of the trunk. The adult beetles typically make a D-shaped exit hole when they emerge. Tissue produced by the tree in response to larval feeding may also cause vertical splits to occur in the bark. Distinct S-shaped tunnels may also be apparent under the bark. Adults are dark metallic green in color, 1/2 inch in length and 1/16 to 1/8 of an inch wide and are only present from mid-May until late July. Larvae are creamy white in color and are found under the bark.
Damage: The adult beetles feed on ash foliage but cause little damage. The larvae feed on the inner bark of ash trees, disrupting the tree's ability to transport water and nutrients. Many trees appear to lose about 30 to 50 percent of their canopy in one year and the tree is often killed after 2-3 years of infestation. Most of the devastation in Michigan has occurred in the southeastern Lower Peninsula, where about 20 million trees have been killed. Fallen trees have caused extensive property damage.
Control/Treatment: Treatment options for controlling infected or at risk trees include systemic insecticides applied as soil injections, systemic insecticides applied as trunk injections, noninvasive systemic sprays, and protective cover sprays. If properly applied, these treatment options can prevent EAB larvae from taking over the ash tree about 70% of the time. Treatment also proves to be successful when managing at-risk trees in areas where EAB has been identified. In continuing efforts to halt the expansion of the EAB, the Michigan Department of Agriculture and Rural Development (MDARD) has placed restrictions on the movement of firewood throughout the state and has taken other appropriate response measures. More information on the EAB can be found on the MDARD's website: www.michigan.gov/eab.

Gypsy Moth (Lymantria dispar)
Hosts: Tree foliage.
Symptoms: The egg mass is usually laid within a few feet of the female pupa casing. They are covered by a dense coating of hairs.
Damage: During high population levels, total defoliation can occur. During the months of June and July, defoliating populations cover sidewalks, homes, children's play equipment and other objects, making outdoor activity in residential and recreational areas almost impossible.
For Michigan's nursery industry, additional expense and pesticide use are required. For the forest products industry, high gypsy moth populations mean the potential loss of wood fiber from reduced production (due to tree stress or mortality).
Control/Treatment: Counties may get involved in the Michigan Cooperative Suppression Program. The only pesticide used in the Cooperative Suppression Program is Bacillus thuringiensis, most commonly referred to as Bt.

Khapra Beetle (Trogoderma granarium)
Hosts: The beetle prefers hot, dry conditions and can be found in areas where grain and other potential food is stored, such as pantries, malt-houses, grain and fodder processing plants, and stores of used grain sacks or crates.
Symptoms: Destruction of grains and seeds. They can multiple quickly in stored items such as crackers, wheat, flour and baby cereal and rapidly spread to warehouses, storage bins, and mills.
Damage: The beetles can potentially cause severe harm to the agriculture crop industry such as grains and seeds including wheat, soybean, barley, corn and rice.
Control/Treatment: Fumigation with methyl bromide in containers to quarantining shipments until treatment. Powdered neem has been used to control the beetle in wheat stores in India.

Examples of Potentially Invasive Microbes
(Note: Not all of these species currently occur in Dickinson County.)

Dutch Elm Disease
Hosts: Elm trees
Symptoms: Trees infected by elm bark beetles first show wilting, curling, and yellowing of leaves on one or more branches in the upper portion of the tree, as a fungus from the beetles progressively affects the tree's health.
Damage: Large trees may survive and show progressively more symptoms for one or more years. Trees infected through root grafts wilt and die rapidly; this frequently occurs in the spring, soon after the trees have leafed out, and progresses from the base of the tree upward.
Control/Treatment: Dutch elm disease control has involved two different but related programs: (1) community-wide sanitation programs designed to reduce the level of elm bark beetles (principal carriers of the Dutch elm disease fungus); and (2) prevention of the spread of the disease through natural root grafts from infected trees to adjacent healthy trees. There are probably no community-wide programs being used any more, with a shift toward disease management involving the planting of different species of trees. There is no way to eliminate Dutch elm disease once it begins, but different species such as Siberian elms are resistant to the disease.

Plum Pox Virus
Hosts: Peach, plum, nectarine, apricot, almond, cherry.
Symptoms: Discolored viral rings on leaves and fruit.
Damage: Smaller deformed fruit and reduced fruit production.
Control/Treatment: Control and prevention measures include field surveys, use of certified nursery materials, use of virus-resistant plants (when available), control of aphids, and the elimination of infected trees in nurseries and orchards. A team of scientists from the United States and France has genetically engineered a PPV-resistant plum (known as C5), and this resistance can be transferred through hybridization to other plum trees. This provides a source of germplasm for future breeding programs worldwide. Similar success has not yet occurred in attempts to genetically modify other Prunus species.

Thousand Canker Disease of Walnut
Hosts: Black walnut and other walnut species.
Symptoms: Infected trees show wilting, curling, and yellowing of leaves on one or more branches in their upper portions, as a fungus from the walnut twig beetles progressively affects the tree's health.
Damage: Causes thousands of small cankers on and under the bark, disrupting the flow of nutrients to the branches. Tree mortality is directly proportional to the number of feeding sites present on the tree.

Control/Treatment: There is no practical treatment, once infected. Landowners should remove affected trees to prevent spread to nearby trees.

Examples of Invasive Water Species
(Note: Not all of these species currently occur in Dickinson County.)

Sea Lamprey (Petromyzon marinus)
Hosts: Found in both fresh water and salt water habitats, they breed in freshwater streams and lakes and were first discovered in the Great Lakes in the 1800s.
Symptoms: Sea lampreys prey on a wide variety of fish. The lamprey uses its suction-cup like mouth to attach itself to the skin of a fish (possibly for days) and rasps away tissue with its sharp probing tongue and many hooked teeth, arranged in numerous rows. Secretions in the lamprey's mouth prevent the victim's blood from clotting, and the lamprey sucks the victim's blood. Victims (usually smaller ones) typically die.

Dreissenid Mussels (including Zebra Mussels and Quagga Mussels) (family Dreissenidae)
Hosts: Freshwater lakes and streams
Symptoms: By firmly attaching to hard surfaces, dreissenid mussels have clogged water-intake pipes and fouled hard-shelled animals such as clams and snails. In addition, zebra mussels have reduced plankton populations, as colonies of mussels filter large volumes of water for food, potentially depleting food resources of larval and planktivorous fishes such as smelt, chub, and alewife. Transfer of suspended material to the lake bottom in mussel waste products also leads to increased water clarity and increased growth of aquatic plants. Although clear water is often considered aesthetically pleasing, this clarity indicates that drastic changes have occurred at the base of the food web and that energy flows through the ecosystem has been altered. The mass media has given a great deal of attention to the zebra mussel, but quagga mussel infestations are actually far more extensive in the Great Lakes. Both zebra and quagga mussels belong to the same genus, dreissenid mussels, but quagga mussels are more tolerant of colder and deeper waters than zebra mussels are. Quagga mussels were first spotted in the Great Lakes around 1990, and have devoured so much plankton that the food web is being altered.
Damage: Communities along the affected lakes and rivers rely on these waters for drinking, industrial water supplies, transportation, commercial fishing and shelling, and recreation. Rapidly expanding populations of dreissenid mussels could ultimately affect many of these activities, in addition to changing the structure of the ecosystem.
Control/Treatment: Applications of hot water and bleach have been used. A new method involving bacteria is being refined.

Example of a Terrestrial Animal Species that Poses a Threat to Dickinson County
Boar or Wild Hogs (Sus scrofa)
Feral swine are defined as free-ranging pigs and are considered to be an aggressive public nuisance. They have been known to attack and chase humans. They can become infected with, and may transmit, diseases that affect human health, domestic livestock, and wildlife, such as brucellosis, tuberculosis, bubonic plague, tularemia, anthrax, and trichinosis. In Michigan, pseudorabies-positive feral swine were removed from private land in 2008. Feral swine have the potential to cause great economic harm to the domestic swine industry, if they were to transmit such disease to commercial swine. The appearance of feral swine may vary greatly, as they can originate from several subspecies, including the Russian Boar, the wild Eurasian boar, escaped domestic swine, and quite often a mix of domestic and wild-type breeds. These animals can weigh up to 400 pounds, may be covered in coarse hair, may have tusks, and are known to travel in groups. Females in warm states produce two large litters of 8 to 10 piglets per year. In Michigan, feral swine are known to survive the harsh winters. Feral swine tend to follow creeks

and drains between food sources. They favor agricultural crops, but when the crops are harvested in the fall, they turn to wildlife food plots, acorns, and other mast foods. Feral swine are known to eat ground nesting birds, small mammals, and grubs.

Damage: Feral swine can tear up the landscape, killing wildlife and pets, damaging farm crops and wildlife habitats, and scavenging uncovered garbage. Their devastating effect on crops accounts for up to $1.5 billion in annual damages nationally. Unlike most animals, feral swine don't stop at just eating crops. They also root holes in the ground as deep as a foot, destroying the crops. Wild hogs can damage as much as 10 percent of a farmer's crop. To date, the Department of Natural Resources has logged 288 unofficial feral swine sightings by residents in almost every county in Michigan. Since 1999, national experts have estimated that, if unchecked, the feral swine population could become established statewide and cause economic hardship for farmers, and for businesses that cater to wildlife enthusiasts.

Control: On May 13, 2010, the Michigan Legislature amended Public Act 328 of 1976 (Domestic Animals Running at Large) by allowing people to pursue and harvest feral swine at any time. The law does the following: (1) declares swine running at large on public or private property to be a public nuisance, (2) permits a local animal control officer or a law enforcement officer to kill swine running at large on public or private property, (3) permits a person with a concealed weapon permit or a valid hunting license to kill swine running at large on public property, and (4) permits a property owner or other authorized person to kill swine running at large on private property. In the last case, the landowner does not need a hunting license. Michigan residents who see or shoot a feral pig are asked to report it to the Michigan Department of Natural Resources at (517) 336-5030. USDA Wildlife Services (517-336-1928) and the Wildlife Conservancy (517-641-7677) have feral swine traps available for the use of landowners who are experiencing feral swine damage. The animals will be trapped, removed, and tested for disease, then euthanized and disposed of. In December, 2010, the Michigan Department of Natural Resources classified feral swine as an invasive, exotic or prohibited species under Public Act 451, the state's Natural Resources and Environmental Protection Act of 1994, but the Director's order does not go into effect until April of 2011.

Partners: The Feral Swine Working Group is an interagency team of veterinarians, biologists, and policy personnel within the state and federal governments, Michigan State University, and from numerous stakeholder groups, including the Michigan Animal Control Association, Michigan Farm Bureau, Michigan Pork Producers Association, Michigan United Conservation Clubs, Michigan Corn Growers Association, the Nature Conservancy, United Deer Farmers of Michigan, the Michigan Hunting Dog Federation, and the Michigan Wildlife Conservancy.

Animal Diseases

There are many animal diseases that have the potential to impact Dickinson County. Diseases from outside Michigan or the United States have the potential to cause widespread mortality in livestock, wildlife, and companion animals. They could result in huge economic losses (primarily through trade restrictions), require significant resources to be allocated for response, and in some cases could also threaten public health. For more information, please refer to the Reportable Animal Diseases documents of the Department of Agriculture and Rural Development. Foot and Mouth Disease is an example of a foreign animal disease that would require a heightened response from Michigan agencies.

Example of a Livestock Disease That Poses a Threat to Dickinson County Foot and Mouth Disease

Hosts: This infectious virus spreads on surfaces and in the air, and impacts cattle, swine, sheep, goats, deer, and other cloven-hoof ruminant animals. It does not currently exist in Michigan or the United States and has not existed in the U.S. since 1929. However, the disease is of great concern

because it is highly contagious and would have grave economic consequences for Michigan's livestock industry.

Symptoms: In cattle, blisters inside the mouth that lead to excessive secretion of stringy or foamy saliva and to drooling; and blisters on the feet that may rupture and cause lameness. Adult animals may suffer weight loss from which they do not recover for several months, as well as swelling in the testicles of mature males. In cows, milk production can decline significantly.

Damage: Though most animals eventually recover from FMD, the disease can lead to myocarditis (inflammation of the heart muscle) and death, especially in newborn animals. Some infected animals do not suffer from or show signs of the disease, but they are carriers of FMD and can transmit it to others.

Control/Treatment: The Michigan Department of Agriculture and Rural Development (MDARD) licenses and regulates Michigan's 500 livestock dealers, truckers, livestock sales, and auction markets to help monitor animal health and ensure the safe and humane handling of animals. The MDARD also monitors and controls the interstate and intrastate shipment of animals and animal products, to eradicate and control the spread of disease. If this disease were discovered in the United States, it would trigger national and state response plans and require rapid and coordinated response in order to control the disease and protect the nation's livestock industry.

Wildlife Diseases that Pose a Threat to Dickinson County

Chronic Wasting Disease (CWD)

This is a prion disease of the brain. The infectious agent contaminates the environment and is transmitted from one animal to another.

Hosts: Deer and elk are affected by this brain disease that is present in several western states and in Minnesota and Wisconsin. Mule deer, white-tailed deer, and Rocky Mountain Elk are the only three species of the family Cervidae that are known to be naturally susceptible to CWD. However, it is very likely that other subspecies of C. elaphus are susceptible to the disease. Although no other deer in Michigan have tested positive for CWD, it remains a major concern due to the large wild population of deer in the state.

Symptoms: Emaciation, wide stance, lowered head, droopy ears and excessive salivation.

Damage: Animal fatalities

Control/Treatment: Chronic wasting disease is both transmissible and infectious, but most details of its transmission remain to be determined. No treatment is available for animals affected with CWD. Once clinical signs develop, CWD is invariably fatal. Affected animals that develop pneumonia may respond temporarily to treatment with antibiotics, but ultimately the outcome is still fatal. Similarly, no vaccine is available to prevent CWD infection in deer or elk. Two threatening animal diseases: Chronic wasting disease and foot and mouth disease.

Risk	**:**	**moderate**
Rating	**:**	**20th**

Vulnerability: These hazards are broad in scope and impact, though forest infestations would be high concern due to the large amount of forest land (80 percent) and state land-(over 50 percent). An increased risk from forest infestations would be experienced in the northern portions of Waucedah, Norway, and Breitung Townships and large portions of Breen, West Branch, Felch and Sagola Townships. As a natural resource-based area, Dickinson County would absorb an economic impact from any alteration or destruction of natural habitat and natural resources.

Flooding

Hazard description: A rising or overflowing of a body of water caused by rapid snowmelt, excessive precipitation, ice buildup, storm surges, wind or sustained high water levels.

A riverine flood is the overflowing of rivers, streams, drains and lakes due to excessive rainfall, rapid snowmelt or ice. Flooding of land adjoining the normal course of a stream or river has been a natural occurrence since the beginning of recorded history. If these floodplain areas were left in their natural state, floods would not cause significant damage. Development has increased the potential for serious flooding because rainfall that used to soak into the ground or take several days to reach a river or stream via a natural drainage basin now quickly runs off streets, parking lots, and rooftops, and through man-made channels and pipes. Some developments have also encroached into flood plain areas and thus impeded the carrying capacity of the drainage area.

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

Flood prone areas are found throughout the county, as every lake, river, stream and open drain has a floodplain. The type of development that exists within the floodplain will determine whether or not flooding will cause damage. Most riverine flooding occurs in early spring and is the result of excessive rainfall and/or the combination of rainfall and snowmelt. Ice jams are also a cause of flooding in winter and early spring. Log jams can also cause streams and rivers to be clogged up, and the backed-up waters to overflow the stream's banks. Either ice jams or log jams can cause dangerous flash flooding to occur if the makeshift dam-effect caused by the ice or logs suddenly gives way. Severe thunderstorms may cause flooding during the summer or fall, although these are normally localized and have more impact on watercourses with smaller drainage areas.

It is widely known that controlling floodplain development is the key to reducing flood-related damages. Although there are state and local programs to regulate new development or substantial improvements in flood-prone areas, floodplain development in many communities continues to increase, resulting in corresponding increases in potential future flood-related damages. The opportunity to mitigate flood hazards rests primarily with local government, since it controls the regulation or direction of land development. Proper land use management and strict enforcement of building codes can make communities safer from flood hazards and help reduce the high costs of flood losses.

Flooding may not always be directly attributable to a river, stream or lake overflowing its banks. Rather, it may simply be the combination of excessive rainfall and/or snowmelt, saturated ground, and inadequate drainage. With no place to go, the water will find the lowest elevations – areas that are often not in a floodplain. Flooding also occurs due to combined storm and sanitary sewers that cannot handle the tremendous flow of water that often accompanies storm events. Typically, the result is water backing into basements, which damages mechanical systems and can create serious public health and safety concerns. Other cases involve the ponding of waters across roads or in other low-lying areas. These additional types of flooding have not been given a separate chapter in this plan, but instead have been included in the descriptions of the Riverine flood hazards within this section.

The National Weather Service has completed a major modernization program designed to improve the quality and reliability of weather forecasting. The keystone of this improvement is Doppler Weather Surveillance Radar, which can more easily detect severe weather events that threaten life and property – including weather events that can lead to riverine flooding. Most important, the lead-time and specificity of warnings for severe weather have improved significantly.

The National Weather Service issues flood watches and flood warnings when conditions are right for flooding. A flood watch indicates meteorological conditions are conducive to flooding. People in the watch area are instructed to stay tuned to local radio or television stations for updates on flooding and weather conditions. When flooding is imminent, a flood warning is issued. The warning will identify the anticipated time, level and duration of flooding. Persons in areas that will be flooded are instructed to take appropriate protective actions, up to and including evacuation of family members and removal or elevation of valuable personal property.

Flood warnings issued by the National Weather Service include three response levels:

- Flood watch - flash flood or flooding possible within a specific area
- Flood warning - flash flooding or flooding has been reported or is imminent, necessitating precautions
- Flood advisory - flooding is occurring

The National Weather Service uses the following terms to describe flooding severity:

- Minor flooding - minimal or no property damage; possibly some inconvenience
- Moderate flooding - inundation of some secondary roads; suggest transfer to higher ground; some evacuation may be necessary
- Major flooding - extensive inundation and property damage; evacuation of people and livestock and closure of primary and secondary roads is likely

The State and local government agencies are warned via the Law Enforcement Information Network (LEIN), National Oceanic and Atmospheric Administration (NOAA) weather radio, and the Emergency Managers Weather Information Network (EMWIN). Public warning is provided through the Emergency Alert System (EAS). The National Weather Service stations in Michigan transmit information directly to radio and television stations, which in turn pass the warning on to the public. The National Weather Service also provides detailed warning information on the Internet, through the Interactive Weather Information Network (IWIN).

A watershed is defined as a ridge or stretch of high land dividing the area drained by different rivers or river systems. A watershed is more than a boundary drawn on a map, it is the water resource, such as a stream, river, lake, or aquifer, and all of the land encompassing the resource. To protect these resources, it is important to address the land areas within the watershed because as water drains off the land or leaches down into the groundwater it carries with it the effects of human activities throughout the watershed. Dickinson County has four watersheds: Michigamme, Menominee, Cedar-Ford, and Escanaba.

In regards to flooding, it is exacerbated in urban watersheds as a result of increased imperviousness. Impervious surfaces, such as buildings, driveways, and roads, prevent storm water from being absorbed in areas of the watershed most suited for infiltration. Instead storm water moves quickly to the floodplains. Increases in impervious surfaces generally equate to an increase in the frequency of flood events because the watershed systems methods for absorbing

storm events are being blocked. For many years, the strategy for reducing flood damages followed a structural approach of building dams and levees and making channel modifications. However, this approach did not slow the rising cost of flood damage, and did not provide an affordable opportunity for individuals to purchase insurance to protect themselves from flood damage. It became apparent that a different approach was needed.

The National Flood Insurance Program (NFIP) was instituted in 1968 to make flood insurance available in communities that have agreed to regulate future floodplain development. As a participant in the NFIP, a community must adopt regulations that: 1) require any new residential construction within the 100-year floodplain to have the lowest floor, including the basement, elevated above the 100-year flood elevation; 2) require non-residential structures to be elevated or dry floodproofed (the floodproofing must be certified by a registered professional engineer or architect); and 3) require anchoring of manufactured homes in floodprone areas. The community must also maintain a record of all lowest floor elevations or the elevations to which buildings in flood hazard areas have been floodproofed. In return for adopting floodplain management regulations, the federal government makes flood insurance available to the citizens of the community. In 1973, the NFIP was amended to mandate the purchase of flood insurance, as a condition of any loan that is federally regulated, supervised or insured, for construction activities within the 100-year floodplain.

All open watercourses have an associated floodplain. In a large precipitation event it is a natural occurrence for the water levels of streams, rivers, and lakes to rise above their banks onto the adjacent lands. In urban areas these occurrences are exacerbated by the alteration of the natural landscape by the built environment. Homes, businesses, roadways, and other types of fill reside within the path of a watershed systems overflow. In effect, during a flood event, these human structures act as dams and push the overflow even further out into the watershed affecting lands that would not be at risk otherwise.

FEMA provides Dickinson County with National Flood Insurance Rate Maps that outline the 100-year floodplain and flood way. These maps serve as a basis for understanding Dickinson County's risks and vulnerability to flood events. Risk analysis and vulnerability assessment are central steps to the success and eventual implementation of a mitigation plan. In order to make informed decisions about the implementation of mitigation activities decision makers and residents need accurate information about the risk the hazard poses and how vulnerable the county is to damage from the risk.

- Risk Analysis: What is the chance that a flood will occur in Dickinson County? What Areas of Dickinson County will be affected during a flood event?

- Vulnerability Assessment: If a flood occurs in Dickinson County how much damage can it potentially cause to property? How many buildings will be affected?

Riverine flooding is a hazard that has been modeled for many decades now, and has some of the clearest methods of detailed analysis. The 100-year floodplain is a starting point to understand the flood risk and conduct a flood risk analysis for Dickinson County. The 100-year floodplain has a 1% chance of flooding every year. All of the properties, including parcels of land and the associated structures or buildings within this area are located in an area with known flood risk. Communities that are members of the NFIP probably have floodplain maps (called Flood Insurance Rate Maps, or FIRMs) that show where the floodplain areas are in the community and provide Base Flood Elevation (BFE) measurements. These calculations are based on surveying

the topographical, hydrological, pedological, and land cover characteristics of the area's watershed. The result is a statistical model—a “100-year” floodplain area has a 1% chance of flooding in a given year, and the BFE is the water depth associated with an event of that probability. Some areas may flood less frequently, such as a 500-year floodplain which has a 1-in-500 chance of flooding in a given year. The names "100-year" and "500-year" can be very misleading. A "100-year" level flood may occur several times in a century, just as it is possible to flip a coin and get tails many times in a row. For detailed analysis of flooding, the basic principle of risk is that there is a 1% chance per year of flooding that is at the BFE level. For example, if BFE is 365' and the elevation of a structure's first floor is 363' above sea level, then the result would be floodwaters that are two feet over the ground floor of that structure. Lesser flooding is likely to occur with even greater frequency—if two feet of floodwaters hit that structure with 1% probability, the likelihood of getting just a few inches of floodwaters is even greater in a given year. Conversely, the likelihood of flooding that has three or four foot depths is far less than a 1% annual chance. FEMA models for flooding divide these events into different degrees of severity, based on their likelihood of annual occurrence. A few inches of water may be a "10-year" event in one area, but a "100-year" event somewhere else. Within the same floodplain area, a structure's elevation (and whether it has a vulnerable basement) may make all the difference between suffering severe damages, and experiencing no damages. Ideally, flood risk information can be combined with structural information (such as might be available through a building department or assessor's office) and a Geographic Information System (GIS) could make the analysis of such information easier.

Areas that have been determined through FEMA approved methodologies and designated, as a 100-year floodplain will eventually experience a large-scale flood event. During the course of a 30-year mortgage a house in a 100-year floodplain has a 26% chance of being flooded. Compare that to a 9% chance of fire. For this reason dollars invested in flood mitigation pay off greater than dollars invested in other types of mitigation activities. By investing in time and resources into flood mitigation Dickinson County will ensure the safety of its residents and prevent the damage and loss of property.

It is possible to further differentiate the risk by looking at other data. For instance, looking specifically at the floodway. The floodway describes the flow area of a flood event, which makes properties more susceptible to impacts from debris. It is also possible to examine the risk by using topology to look at where the flood is deeper. Properties are more vulnerable to the hydrostatic and hydrodynamic forces of floodwater in deeper flood areas. Lastly, it is possible to analyze potential risk based on what has happened before, if a property has been flooded, or repeatedly flooded, and no action has been taken to mitigate the risk, it is likely at risk to future flood events as well. These principles of flood risk were used to conduct a location assessment of flood risk.

Risk categories are used to conduct a vulnerability assessment. By calculating the number of parcels and buildings that fall into each risk category a measure of vulnerability is developed. We can further understand this vulnerability measure by land use or by watershed. The following risk categories form the basis for the vulnerability assessment. These categories should be used to prioritize the implementation of all the mitigation strategies and serve as the guiding factor in the implementation of this plan.

1. First - Repetitive loss structures: Properties that have received multiple payouts from the NFIP.

2. Second - Reported damage: Properties that have made claims to the NFIP.

3. Third - Location assessment: Properties located in the 100-year floodplain examined by location risk
    - 3a: 100-year floodplain: All properties in the 100 year floodplain.
    - 3b: 100-year floodway: Only properties in the floodway.
    - 3c: 2ft flood depth: All properties in the 100-year floodplain that will be in greater than 2 feet of floodwater. The depth at which cars can be swept along by hydrodynamic forces.
    - 3d: 3ft flood depth: All properties in the 100-year floodplain that will be in greater than 3 feet of floodwater. The depth at which hydrostatic forces can cause structures to collapse.
4. Fourth - Floodplain zone: All properties that are in floodplain zone.

Category 1 is the highest priority for flood mitigation activities and Category 2 is the second highest priority. Mitigating for properties that have a history of flood damage is proven to be a successful method for of preventing flood loss. Properties and structures that fall into Category 3 are vulnerable to future flood damage and could in the future move into one of the higher priority categories. The risk categories are not mutually exclusive. For prioritization of properties a point value of one is assigned to each category. Additive values for risk categories of individual properties yields a vulnerability index to further describe each property's vulnerability.

In addition to financial losses that can be incurred through property damage during a flood event, floods also pose a risk to human health. There are numerous tragic threats that can harm people caught in a catastrophic flood event including from drowning in aggressive waters, being trapped in vulnerable structures, or being struck by hazardous flood debris. One way to manage resident's exposure to these risks is to employ sound land use planning in flood prone areas. Different land uses have inherently different vulnerabilities. For instance, residential use is a 24-hour land use in which people are particularly vulnerable during sleeping hours. Comparatively, commercial and recreational uses may only be partial day uses, and many recreational uses have the added benefit of creating open spaces. Industrial uses may also be partial day uses, but they are also potential threats because industrial chemicals and toxins can be carried in floodwaters if facilities were to become compromised.

Flooding may also occur at low-lying areas due to quick rainfall events that inundate stormwater management system. These events generally coincide with slow moving storms that produce an enormous amount of rain in a short period of time. Most of the time, flooding can be considered as a temporary hazard, lasting from hours to days. The duration of the flooded area is dependent on the speed of the storm. Not every community in Dickinson County lies within a floodplain; however, a community may experience flooding problems by events that overwhelm stormwater drainage system capacity.

According to the Federal Emergency Management Agency Community Status Book Report communities participating in the National Flood Program in Dickinson County include: Breen, Breitung, Norway and Waucedah Townships and the cities of Iron Mountain and Kingsford as shown in Table-11.

Table - 11 National Flood Insurance Program Participants, Dickinson County, 2014			
Community Identification Number (CID)	Jurisdiction	Date of Entry	Current Effective Map
260389#	Breen Township	09/18/86(R)	09/18/86(M)
260063#	City of Iron Mountain	10/16/91(R)	10/16/91(M)
260064A	City of Kingsford	06/23/75	04/16/76
260986	Waucedah Township	03/11/97	
	Norway Township	04-2013	04-2013
	Breitung Township	04-2013	04-2013

Explanatory notes:
1. (R) denotes entry into the regular program
2. # identifies communities whose maps contain a 10-digit identification number, may be published as one or more parcels
3. (NSFHA) - all Zone C, no significant flood hazard area
4. (M) - minimally flood prone, no elevation on map

Flood hazard maps illustrate susceptible areas when a stream reaches base flood elevation level. These areas are subject to change as further development occurs and creates additional impervious surface and/or changes natural drainage patterns. The average Michigan floodplain map is 16 years old. Further, not all flood-prone areas have been mapped. Existing floodplain areas are shown on Map-14 and are discussed in the text below.

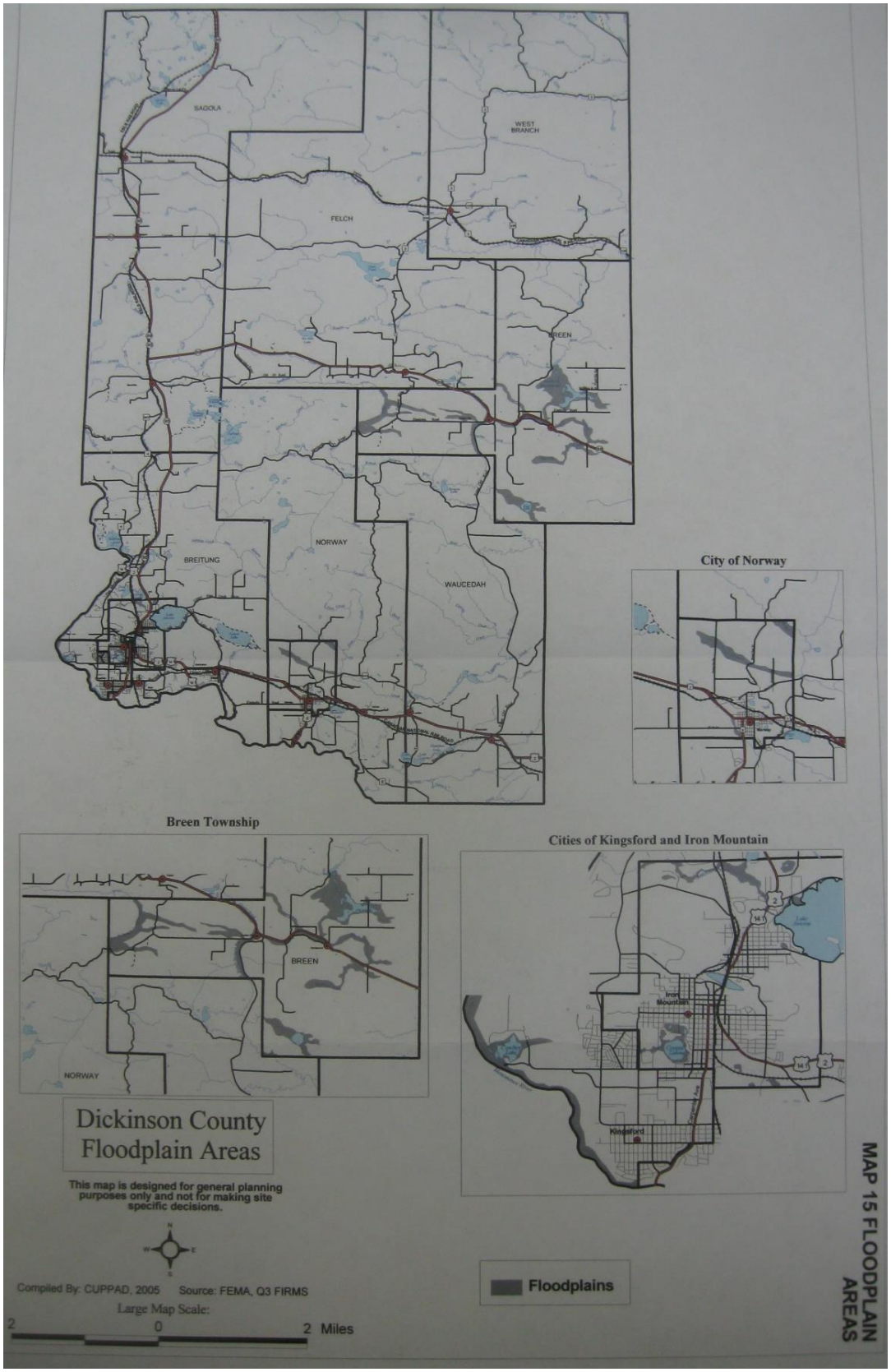
•Breen Township is considered minimally prone to flooding, although elevation mapping has not been completed. Areas along the Sturgeon River and Anderson, Hancock, and Quarry creeks are identified as susceptible to flooding.

•Several areas of Iron Mountain are considered minimally prone to flooding. These include the Crystal and Mud lakes. Antoine Creek, Chapin Pit, an area south of Wickman Drive, an area near the north corporate limit between US-2/41 and Frank Pipp Road, an area just west of Grant Street between Margaret and Blaine streets, an area immediately west of Terminal Avenue, and two small areas abutting Breitung Township south of Railroad Drive.

•Flood zone areas in Kingsford have been identified along the Menominee River including Cowboy Lake.

•The City of Norway has identified flood zone areas along the western corner of Hanbury Lake, along an abandoned railroad corridor west of Stephenson St. and along Pine Creek within the northern section of the city.

Map 14 – Dickinson County Floodplain Areas



There are several types of flooding issues that communities in Dickinson County need to be aware of: flooding on rivers, urban areas, inactive mine sites, and Repetitive Loss Properties (RLP's).

River Flooding

Excessive precipitation or runoff - especially in springtime - can cause streams to overflow their banks with resulting damage. All or portions of the Sturgeon and Menominee rivers and Anderson, Hancock, Quarry and Antoine creeks have an associated flood risk.

Urban Flooding

Heavy precipitation events can overwhelm storm sewers that can result in roadway flooding. Depending on the time of year, the underlying cause can be inadequate, frozen or otherwise clogged storm drains. Intersections and low-lying areas are the most commonly affected. Iron Mountain has experienced flooding in the Crystal Lake area due to excessive storm water. There are areas in Kingsford where storm water and sewer are not separated with resulting system overloads occasionally. Storm water runoff causing street and yard flooding has occurred at several locations. Localized flooding has occurred in Kingsford, Iron Mountain, Quinnesec, and Norway during periods of heavy runoff.

Inactive Mine Site Flooding

Discussions with local officials and the soil conservation district has shown that flooding associated with inactive mine sites is a local concern in Iron Mountain and Norway. During operation, mines used a system of sumps and pumps to remove groundwater from the tunnels and working areas. When the mines ceased operation the pumps stopped and groundwater levels rose, filling depressions and low lying areas.

When the Chapin Mine (Hamilton Mine Shaft) stopped operation the northeast section of Iron Mountain saw water levels rise high enough to cause flooding of basements and storm drains. In 1925, the City solved the problem by installing a pump 90 feet below the surface of the Hamilton Mine Shaft. The water was pumped to a new filtration plant that supplied drinking water to the City until the 1960's. Today the water filtration plant is not in service but groundwater from the mineshaft is still directed to Lake Antoine. Local officials state that pumping the Hamilton Mine Shaft discharge continues to be necessary to prevent basement flooding on the north and west sides of Iron Mountain.

A similar situation exists in the City of Norway from mining activity associated with the Aragon and Curry Mines. When mining operations ended, water levels rose to cause flooding in low-lying areas on the southwest side of the city. The flooding was remedied when a pump was installed in the Aragon Mine Shaft. Presently, two pumps, one an emergency backup, continue operation in order to control the area's water table and protect against basement flooding. Residents in and around Strawberry Lake, which is actually the collapsed Aragon iron ore mine, still experience basement flooding.

(The information above was referenced from the 2003 Fumee Creek Watershed Management Plan.)

Repetitive Loss Properties (RLP)

The term repetitive loss property is associated with the National Flood Insurance Program (NFIP) and for ease of understanding the NFIP Community Rating System (CRS) definition will be used: a repetitive loss property is any property, which the NFIP has paid two or more flood claims of $1,000 or more in any given 10-year period since 1978. The NFIP is concerned with repetitive loss properties because frequently flooded properties put a strain on flood insurance funding.

Dickinson County only has one repetitive loss property that is listed in the newest official NFIP "repetitive loss" list (2015). However, this property is classified as "mitigated," so there are no other properties left in the official list that are still considered to be at risk. The one repetitive loss property in Dickinson County is located in the City of Kingsford, and is a single family residential structure. The Privacy Act prohibits publishing the exact location of repetitive loss properties but Table-12 shows information on the property.

The property is located lower than the street level, and during times of heavy rains water will converge on and around the property. Flooding occurs when storm drains are at capacity and blocked with debris. The City has put in additional storm drains in hopes of further alleviating the situation. Public Works crews must monitor the area in times of spring thaw and heavy rain.

The City would like to research possible options to permanently mitigate this property. Possible structural mitigation measures include: raising the structure, elevating electrical equipment in basements, or property acquisition. Any mitigation strategy would only be implemented with the full cooperation of the current landowner.

Table - 12

Repetitive Loss Structure

Structure Use	Total Repetitive Loss	Date of Loss
1-Residential	An average of about $7,500 in damages.	September 2002 , July 1996

Risk : moderate
***Rating : 23rd**

*****(The initial hazard analysis split the flooding hazard into riverine and urban types. Both types of flooding were analyzed and rated separately: urban rated 22nd and riverine rated 24th. The flood hazard rating has been combined and averaged, therefore the rating of 23rd.)

Vulnerability: Initial hazard analysis pointed to a low flooding risk countywide but specific areas show a higher concern. Inactive mine site flooding is a localized concern in the City of Iron Mountain and Norway. Other areas of concern are possible but not known at this time. The overall issue with the two mine sites is the threat of flooding in the event of pump or power failure. It was determined that the Chapin Mine/Hamilton Mineshaft pump influences an area extending in a fan outward from the western portion of Chapin Pit to Crystal Lake. An estimated area of 129 acres could experience basement flooding if the pump failed. The Aragon Mine pump influences an estimated area of 367 acres north of US-2.

Dickinson County has one identified repetitive loss property that is a concern in the City of Kingsford. Repetitive loss damages only total $7,461 but Public Works crews have to continuously monitor the area. The City would like to find a permanent solution for the property.

River and urban flooding still affects County residents, but is not deemed a major problem at present. Most river flooding in the County occurs in undeveloped areas with little impact to people and property. It is usually an expected occurrence in the early spring due to ice jams, snowmelt or a combination of snowmelt and rainfall. Urban flooding has shown its potential to be a problem in areas that are intensively and moderately developed such as Iron Mountain, Kingsford, Quinnesec, and Norway. Historically though such events have been short-lived with a minimum amount of damage in an isolated area.

While a lower concern countywide, river flooding in the spring has caused annual road washouts along Browns Lake Road and Habammer Road in Waucedah Township. Browns Lake Road experiences flooding due to the West Branch of the Sturgeon River where an estimated twelve residents are affected. Habammer Road flooding is attributed to Hamilton Creek where only one resident is affected. Residents are obstructed from getting to and from their property during these times. The Road Commission must perform maintenance on these areas annually.

Flood damage costs are difficult to estimate. There are only three flood insurance policy holders in Dickinson County. Over $12,000 has been paid out for flood damages since 1978. All claims were from the City of Kingsford. The NCDC data can roughly estimate the property damage incurred from flooding in Dickinson County. Records indicate eleven flood events in the county between 1950 and 2015. Property damage estimates total over $23 million dollars.

Significant Floods Affecting Dickinson County
Following are brief synopses of some of the more significant flooding events that have affected Dickinson County in recent decades:

April 24-26 and May 7-12, 1960 - Upper Peninsula (including Dickinson County)
Record floods were widespread in the Upper Peninsula on April 24-26 and May 7-12, 1960. The April flood affected primarily the Montreal, Black and Presque Isle River basins in the western Upper Peninsula. The May flood affected the Manistique River basin in the central and eastern Upper Peninsula. Intense rainfall contributed to both flood events. Rainfall was 3-5 inches during April 24-26 and 4-6 inches during May 6-12. The size of the area covered by flooding was significant, but the damage was not. Because the area was neither densely populated nor developed, flood losses to residences, businesses, and public roadways and bridges were limited to $575,000.
April 1996 – Western/Southern Upper Peninsula (including Dickinson County)
The melting of a heavy snow pack combined with rain during the second half of April and caused many streams and rivers to flood—especially in nearby Menominee, Iron, and Delta Counties. The flooding inundated and washed out several roads and bridges, flooded many yards and basements, and caused nearly $2 million in public damages. Up to 24 roads were closed off at the height of the flood event.
July 14-15, 1999 – Dickinson County
Heavy rain from thunderstorms partially washed out several secondary roads and sections of highway US-2 in the Iron Mountain area. The event resulted in $20,000 in property damage in Dickinson County.
April 2002 – Western Upper Peninsula (Federal Disaster #1413 – 6 counties)
In 2002, record-setting snowfall in February and March set the stage for flooding in April. During February and March of 2002, the north-central and western parts of Upper Michigan received over 100 inches of snowfall. The snow pack held over 11 inches of water. The snow quickly melted during a six day period (April 11-17), releasing all that water into creeks, streams, rivers and lakes. To heighten the situation, over two inches of rainfall occurred between April 10-12 over much of Upper Michigan, and record high temperatures in the 70s and 80s were recorded on

the 15th and 16th. During those two days, a dramatic snow melt occurred with nearly two feet of snow melting away. To complicate matters further, moderate rain during the morning of the 18th and severe thunderstorms in the afternoon and evening dumped up to an additional 1½ inches of water over an already saturated and flooded Upper Peninsula. Following the rain and warm temperatures, streams and rivers began to rise and overflow. Many local and county roads were closed due to high water and several dams were in jeopardy of failing. Localized flooding of low-lying areas was common across the western and central Upper Peninsula. Major flooding on rivers and lakes occurred in eight Upper Michigan counties. Approximately 160 homes and businesses were affected by the rising waters. Major highways US-2, M-28, and M-64 were closed and 25 local and county roads were also closed due to high water. The Black, Montreal and Ontonagon Rivers all went above flood stage. A partial failure of the Presque Isle Wildlife Dam occurred on the Presque Isle River. Heavy rains and rapid melting of the snow pack contributed to the collapse of a 10 feet wide section of the earthen portion of the dam. The total cost of the flooding was estimated at $18.5 million. A Presidential Major Disaster Declaration was granted to six counties in the Upper Peninsula. However, Dickinson County was not one of the six counties that received a declaration even though other nearby counties did.

April-May 2013 – Western Lower and Upper Peninsulas (Federal Disaster #4121 – 16 counties)

Record flooding occurred during the month of April, most directly caused by an accumulation of heavy rains and resulting in disaster declarations for numerous counties across the western portions of the state. Hundreds of homes were flooded, more than 300 roads were closed, and the preliminary damage assessments totaled more than 32 million dollars. The flooding was exacerbated by the melting of significant snowpack—especially in the Western and Central Upper Peninsula. A Presidential Major Disaster Declaration was declared for 16 counties including nearby Marquette County which had $625,000 in damages. However, Dickinson County did not receive a federal declaration.

July 25-26, 2013 – Dickinson County

Thunderstorms that produced heavy rain caused flooding in Dickinson County, especially in Foster City. Total property damage in the county was $10,000.

September 9, 2014 – Dickinson County

A thunderstorm that produced heavy rainfall in less than two hours caused flash flooding in Dickinson County, particularly in the Iron Mountain and Norway areas. Several sections of US Highway 2 were flooded with up to 2.5 feet of water, causing several cars to stall. Several businesses in the area were also flooded and city streets were closed. Total property damage in Dickinson County was $50,000.

Technological

Transportation-related hazardous materials releases or fixed site, structural fires, and infrastructure failures are the most common technological hazards.

Hazardous Materials - Transportation

Hazard description: An uncontrolled release of hazardous materials or substances during air, land, or water transport.

A hazardous materials transportation incident is an uncontrolled release of hazardous materials during transport, capable of posing a risk to life, health, safety, property, or the environment. As a result of the extensive use of chemicals in our society, all modes of transportation – highway, rail, air, marine, and pipeline – are carrying thousands of hazardous materials shipments on a daily basis through local communities. A transportation accident involving any one of those hazardous material shipments could cause a local emergency affecting many people.

Dickinson County has had hazardous material transportation incidents that affected the immediate vicinity of an accident site or a small portion of the surrounding community. Those types of incidents, while problematic for the affected community, are fairly commonplace. They are effectively dealt with by local and state emergency responders and hazardous material response teams. Larger incidents, however, pose a whole new set of problems and concerns for the affected community. Large-scale or serious hazardous material transportation incidents that involve a widespread release of harmful material (or have the potential for such a release) can adversely impact the life safety and/or health and well-being of those in the area surrounding the accident site, as well as those who come in contact with the spill or airborne plume. In addition, damage to property and the environment can be severe as well. Statistics show that almost all hazardous material transportation incidents are the result of an accident or other human error. Rarely are they caused simply by mechanical failure of the carrying vessel.

A reportable hazardous material incident is one in which all three of the following conditions apply: 1) a material is present that is suspected to be something other than ordinary combustible by-product material; 2) the material is in such a state, quantity or circumstance that, if left unattended, it is presumed to pose a threat to life, health, property or the environment; and 3) special hazardous material resources were dispatched or used, or should have been dispatched or used, for assessing, mitigating or managing the situation.

Existing roadways are becoming more crowded in Dickinson County with increasing traffic volumes, a situation that increases accident probabilities. Trunk-lines converge in the extreme southwestern area of the county and contain approximately 80 percent of the population. Essential fuels and chemicals move over these routes daily via truck tankers and trailers.

Federal regulations pertaining to the transport of hazardous materials have been incorporated into state law thereby making it compulsory for both interstate and intrastate transportation. Employers are responsible to train, test and certify all employees involved with shipping or transporting of hazardous materials. All shipments must list product name, hazard class and emergency information on a manifest. Special permits are required for the transport of medical waste and hazardous waste (MDEQ) and, depending on quantity, U.S. Department of Transportation registration is necessary to transport hazardous material. Placarded vehicles are required to stop at railroad crossings; escorts are required at both the Mackinac and Ambassador bridges.

Hazardous materials being transported bear one of ten classification placards. It is likely that all pass through the county at some time, however records are not available. A brief description of each class follows:

•Class 1 represents explosives, which are further classified according to sensitivity, projection and fire hazard characteristics.
•Class 2 includes gases further defined as flammable, non-flammable and compression, and poisonous.
•Class 3 includes flammable and combustible liquids.
•Class 4 includes flammable solids further defined as flammable solids, spontaneously combustible material, and those that become dangerous if wetted.
•Class 5 includes oxidizers and organic peroxides further defined in to subcategories.
•Class 6 represents poisons and may be poisons or infectious substances.
•Class 7 represents radioactive material.
•Class 8 includes corrosives.
•Class 9 involves miscellaneous materials not included in other classes.
•ORM-D (other regulated material) has a limit hazard potential because of its form, quantity, or packaging; usually these are consumer commodities.

Trunk-lines (US-8, US-141, US-2, and M-95) are vital routes for tankers. Tanker trucks transporting fuel from the port of Green Bay to and through the county rely especially on the US-141/US-2/M-95 route. About 80 percent of county residents live along or near trunk-lines.

Commercial trucks sometimes carry multiple types of hazardous material in a single transport. In the case of an accident, first responders would likely not have knowledge of all hazards involved.

Proper maintenance, loading and operation of commercial vehicles is critical. Heavy trucks use air brakes exclusively and generate drum temperatures to 600 degrees F. Uneven loads or a faulty brake system can push drum temperatures as high as 1,000 degrees, which is extremely dangerous. Tankers less than three-fourths full are considered dangerous due to instability caused by “sloshing”. Diesel fuel is hard to ignite, but the volume carried aboard large trucks can cause a big problem if ignition does occur.

Rail transportation in 2002 covered some 728.9 million miles nationally. A total of 2,678 accidents resulted in 951 fatalities. On average, there were 3.67 accidents for every million miles of train travel. Derailments and track defects were determined to be the primary accident causes. Most fatalities - 94 percent - occur at highway crossings.

Two railroads - Canadian National and Escanaba and Lake Superior - serve the county.

Air transportation accidents are rare. Air traffic at Dickinson County Ford Airport includes commercial passenger and freight, as well as private and charter aviation. Ford Airport averages approximately 10,000 passenger enplanements annually. It leads all U.P. airports in airfreight tonnage by a wide margin. In 2002, 2.8 million pounds of cargo and airfreight were handled at the county airport.

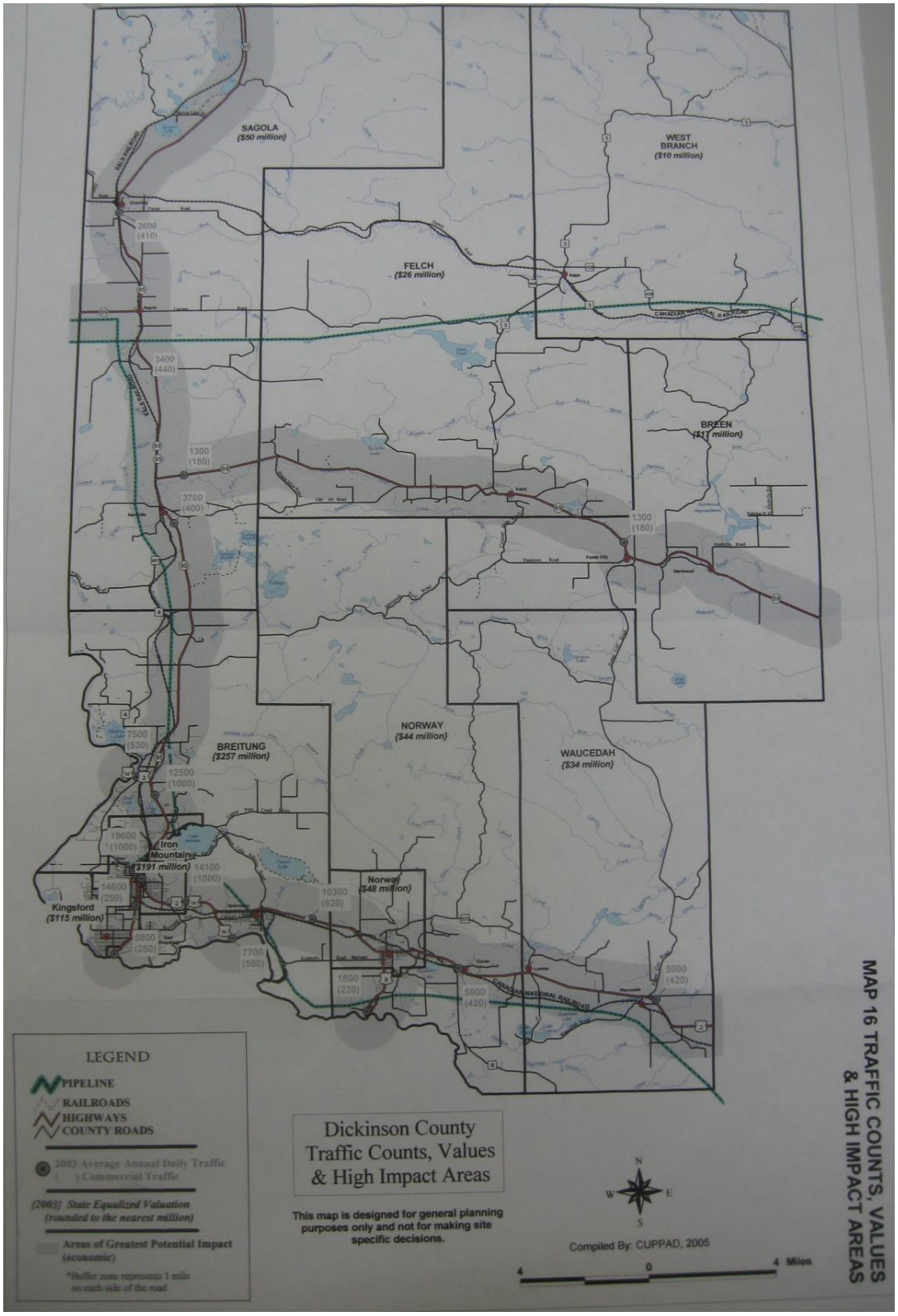
Significant Hazardous Materials Transportation Accidents Affecting Dickinson County
Following are brief synopses of some of the more significant hazardous materials transportation accidents that have affected Dickinson County in recent decades:

1994 – Dickinson County
A 1994 tanker truck accident at the junction of US-2 and US-141 in Breitung Township resulted in a gasoline spill. An estimated 100 gallons of gasoline leaked from the tankers, which was carrying 8,500 gallons.

Risk	**:**	**high**
Rating	**:**	**4th**

Vulnerability: Hazardous materials accidents can happen by air, land, or water transport. Air transportation Hazmat accidents are possible to some degree due to the large amount of freight that is handled at the airport, but air accidents are very rare. Barge/tanker transport of possible hazardous materials is not an available form of transportation in the county. The biggest hazardous materials threat is through transportation over land by truck or rail. Map-15 depicts the areas of high impact along major transportation routes in the County. Essentially, a major highway route or railroad line crosses every jurisdiction in the County. Therefore, all jurisdictions have some possibility at being affected by hazardous materials accidents.

Map 15 – Dickinson County Traffic Counts, Values, and High Impact Areas



While hazardous materials in transit could be released anywhere along the route of travel on any day of the year, it is more likely to occur at an intersection or in a high traffic area. Highways US-2 and M-95 are the most heavily traveled roadways in the county. They pass through the southern portion of Waucedah, Norway, and Breitung Townships and the Cities of Norway, Iron Mountain and Kingsford. Also, M-95 passes directly through Sagola Township. More than 800 commercial vehicles travel this route every day - many carry regulated (placarded) materials/substances. The highway corridor from Vulcan through Iron Mountain is cited as a hazardous situation for pedestrians and vehicles due to the tremendous number of access opportunities. Traffic crash data from 2003 shows four of the top five high crash intersections on US-2 through Iron Mountain. The chance of a transportation accident involving hazardous materials is increased in this high traffic area.

Railroad routes roughly follow alongside US-2 and M-95 in Dickinson County and affect the same jurisdictions. The only exception is the Canadian National Railroad running through the southern portion of West Branch Township through the middle of Felch Township to eventually meet up with the E&LS Railroad in Sagola Township. Federal Railroad Administration data for the years 1975 to 2003 totals 32 railroad accidents occurring in Dickinson County with $866,853 of reportable damage. Information was not available on whether the accidents involved railroad cars carrying hazardous materials. The percentage of rail accidents involving hazardous material nationally is .0134.

Hazardous Materials - Fixed Site (Including Industrial Accidents)

Hazard description: An uncontrolled release of hazardous materials from a fixed site capable of posing a risk to life, health, safety, property or the environment.

There is a difference between a fixed site hazardous materials incident and an industrial accident. A fixed site hazardous material incident is an uncontrolled release of hazardous materials from a fixed site capable of posing a risk to life, health, safety, property or the environment. An industrial accident is a fire, explosion, or other severe accident (especially if it involves hazardous materials) at an industrial facility that results in serious property damage, injury, or loss of life.

Over the past few decades, new technologies have developed at a stunning pace. As a result, hazardous materials are present in quantities of concern in business and industry, agriculture, universities, hospitals, utilities, and other facilities in our communities. Hazardous materials are materials or substances which, because of their chemical, physical, or biological nature, pose a potential risk to life, health, property, or the environment if they are released. Examples of hazardous materials include corrosives, explosives, flammable materials, radioactive materials, poisons, oxidizers, and dangerous gases.

Hazardous materials are highly regulated by federal and state agencies to reduce risk to the general public and the environment. Despite precautions taken to ensure careful handling during the manufacture, transport, storage, use, and disposal of these materials, accidental releases do occur. These releases can cause severe harm to people or the environment, and response actions often need to be immediately performed. Most releases are the result of human error. Occasionally, releases can be attributed to natural causes, such as a flood that washes away barrels of chemicals stored at a site. However, those situations are the exception rather than the rule.

Industrial accidents differ from hazardous material incidents in the scope and magnitude of offsite impacts. Whereas hazardous material incidents typically involve an uncontrolled release of material into the surrounding community and environment that may require evacuations or in-place sheltering of the affected population, the impacts from industrial accidents are often confined to the site or facility itself, with minimal physical outside impacts. Nonetheless, industrial accidents, such as fires, explosions, and excessive exposure to hazardous materials, may cause injury or loss of life to workers at the facility, and significant property damage. In addition, industrial accidents can cause severe economic disruption to the facility and surrounding community, as well as significant long-term impacts on the families of the workers injured or killed.

Like all industrialized communities, Dickinson County will always be concerned with the risk of accidental hazardous material releases. However, the threat of accidental hazardous material releases that can affect life, health, property or the environment can be greatly reduced by: 1) developing and maintaining adequate community hazardous material response plans and procedures; 2) adequately training hazardous material workers and off-site emergency responders; 3) educating the public about hazardous materials safety; 4) enforcing basic hazardous material safety regulations; and 5) mitigating, wherever possible, the threat of accidental hazardous material releases.

Those facilities having threshold quantities of extremely hazardous substances (EHS) on site are subject to reporting requirements set forth under federal statute (SARA Title III, Section 302). Dickinson County has a total of 9 SARA Title III Sites by LEPC. Smaller quantities of hazardous

materials are commonplace and include corrosive and incendiary products such as agricultural chemicals, cleaning agents, solvents, etc.

Accidents resulting in fires or explosions at industrial facilities can cause a release of harmful substances. Flooding and severe weather can cause an unintended release as well.

Significant Hazardous Materials Fixed Site Accidents (Including Industrial Accidents) Affecting Dickinson County

Following are brief synopses of some of the more significant hazardous materials fixed site accidents (including industrial accidents) that have affected Dickinson County in recent decades:

June 4, 1901 – Dickinson County (Iron Mountain)

Eight men were killed from an explosion in a mine shaft of the Chapin Mine near Iron Mountain. The men were killed by smoke inhalation from the fumes that followed the powder explosion. Rescuers hurried into the mine as soon as the smoke had cleared sufficiently and found the eight miners working in that particular section dead.

July 1974 – Dickinson County (Quinnesec)

An industrial accident occurred at a nitrate plant in Quinnesec where a series of four violent explosions shattered windows in an eight mile area and killed one person. Two other people were sent to the hospital with non-life threatening injuries and several other people were treated for cuts from flying glass, rocks and steel on the scene. About 50 residents were evacuated from the area and the highway was closed to traffic for several hours.

Risk	**:**	**moderate**
Rating	**:**	**8th**

Vulnerability: There are nine SARA Title III, section 302 sites in the county. Sites where threshold amounts may be stored for short periods and therefore exempt from reporting requirements are not known. A release in or nearby a populated area could interrupt essential services, the transportation network and overload emergency and medical capacities.

Structural Fires

Hazard description: The loss of life and property caused by a structural fire of any origin.

A structural fire is a fire, of any origin, that ignites one or more structures, causing loss of life and/or property. In terms of average annual loss of life and property, structural fires—often referred to as the "universal hazard" because they occur in virtually every community—are by far the most common hazard facing most communities in Michigan and across the country. Each year in the United States, fires result in approximately 5,000 deaths and 25,000 injuries requiring medical treatment. According to some sources, structural fires cause more property damage and loss of life than all types of natural disasters combined. Direct property losses due to fire exceed $9 billion per year, and much of that figure is the result of structural fires. In 2008 alone, there were 3,320 civilian deaths and 16,705 civilian injuries as a result of fire in the United States, along with 118 firefighters killed while on duty. There were an estimated 1.5 million fires in 2008, and direct property loss due to fires was estimated at $15.5 billion. There were 515,000 structure fires in the United States in 2008 that resulted in 2,900 civilian deaths, 14,960 civilian injuries, and $12.4 billion in property damage. Every 22 seconds, a fire department responds to a fire somewhere in the nation. A fire occurs in a structure at the rate of one every 61 seconds, and in particular a residential fire occurs every 78 seconds. Nationwide, there is a civilian fire injury every 31 minutes. In 2008, structure fires represented 34% of the total fires across the United States. About 85 percent of all fire fatalities happen in the home with one-fourth linked directly to smoking.

Unfortunately, although the United States has made great strides in lessening deaths and injuries caused by other types of disasters, structural fires are worse problems in this country than in many other industrialized countries. The United States Centers for Disease Control (CDC) figures indicate that fire-associated mortality rates in the United States are approximately 2-3 times greater than those in many other developed countries. According to the Federal Emergency Management Agency's National Fire Data Center, residential fires represent 78% of all structural fires and cause 80% of all fire fatalities. Approximately 83% of those fatalities occur in single-family homes and duplexes. Perhaps the most tragic statistic of all is that over 40% of residential fires and 60% of residential fatalities occur in homes with no smoke alarms. The State Fire Marshal, Department of Licensing and Regulatory Affairs / Bureau of Construction Codes and Fire Safety, and local fire departments are proactive in attempting to reduce the number, scope, magnitude, and impacts of structural fires in Dickinson County. State and local fire service efforts in the areas of training, public education, incident tracking, construction plan review, site inspection and fire analysis are all oriented toward, and contribute to, structural fire mitigation and prevention. However, like most programs, the amount of work that can be done is directly related to funding and programmatic priorities. Major impacts occur every year, beyond the ordinary single-home fires that happen in every community. Since historic areas are less well-fireproofed and tend to have greater densities, the risk of major fire impacts seems to be higher there. Fire stops were not common to home construction before the mid-1960s. Approximately half of all county housing units were constructed before 1960.

All fire departments participate in fire education programs during National Fire Prevention Week in October. There are several thermal imaging cameras available to area fire departments. Fire calls are handled through the county's 9-1-1 central dispatch system. Structural fires are a universal hazard and constitute a high hazard.

Significant Structural Fires Affecting Dickinson County
Following are brief synopses of some of the more significant structural fires that have affected Dickinson County in recent decades:

In recent history, there are no known structural fires that have affected Dickinson County.

Risk	**:**	**moderate**
Rating	**:**	**8th**

Vulnerability: Structural fires occur in Dickinson County every year. There are many potential ignition sources, but most originate as a result of human carelessness. Structural fires are most life threatening when they occur at night, as occupants are normally asleep. Where structures are close together, as in the cities of Iron Mountain, Kingsford and Norway, a flare-up is likely as the fire spreads to surrounding buildings. Over half of the county's housing units (57 percent) are found in these three cities. At a minimum, the heat from a well-advanced structure fire will affect buildings in the near proximity. The suppression capacity of individual fire departments is enhanced by mutual aid arrangements.

Response time is central to minimizing fire loss damages. Therefore, camps, cottages, homes or other structures located in remote or isolated areas are more likely to suffer extensive or total loss in a fire event. Among the 2,316 vacant units, 1,574 were identified as seasonal, recreational, or occasional use dwellings. In other word, 68 percent of the unoccupied housing units in Dickinson County are camps and cottages. A large structure fire could result in casualties, temporary loss of utilities; shelter, clothing and food needs; disruption of the transportation network; business closures; and economic hardship including job losses.

Infrastructure Failures

Hazard description: The failure of critical public or private utility infrastructure resulting in a temporary loss of essential functions and/or services.

An infrastructure failure is the failure of critical public or private utility infrastructure that results in a temporary loss of essential functions and/or services. Dickinson County's citizens are dependent on public and private utility infrastructure to provide essential life-supporting services such as electric power, heating and air conditioning, water, sewage disposal and treatment, storm drainage, communications, and transportation. When one or more of these independent, yet interrelated systems fail due to disaster or other cause – even for a short period of time – it can have devastating consequences. For example, when power is lost during periods of extreme heat or cold, people can literally die in their homes if immediate mitigation actions are not taken. When the water or wastewater treatment systems in a community are inoperable, serious public health problems can arise that must be addressed immediately to prevent outbreaks of disease. When storm drainage systems fail, due to damage or an overload of capacity, serious flooding can occur.

These are just some examples of the types of infrastructure failures that can occur, and all of these situations can lead to disastrous public health and safety consequences if immediate actions are not taken. Typically, it is the most vulnerable members of society (i.e., the elderly, children, impoverished individuals, and people in poor health) who are the most heavily impacted by an infrastructure failure. If the failure involves more than one system, or is large enough in scope and magnitude, whole communities and possibly even regions can be severely impacted.

Infrastructure failures can affect numerous individuals in Dickinson County when the conditions are "right" for a loss of critical systems. Melted transformers, ruptured pipes, crumbled bridges, and exploded transformers can cause inconvenience or havoc around the area, depending on the severity of the problem. The risk of infrastructure failure grows each year, as physical and technological infrastructure gets steadily more complex, and the interdependency between various facets of infrastructure (like pipelines, telecommunications lines, and roads) becomes more intertwined. Additionally, more vulnerable and aging infrastructure (rail lines, electrical components, bridges, roads, sewers, etc.) is in need of repair. Because of these reasons, large-scale disruptions in various components of infrastructure are likely. Major disruptions could lead to widespread economic losses, limit security, and altered ways of life.

Although Dickinson County has in place many codes and standards that govern the design, construction and operation of public and private utility infrastructure, these codes and standards are often inadequate to protect the infrastructure from disaster-related damage. In many cases, the codes and standards call for the minimum level of structural integrity and operational performance recommended in accepted engineering practice, when a higher level would result in less disaster damage. Obviously, a balance must be reached between structural integrity, operational reliability, and short- and long-term costs associated with upgrading facility codes and standards.

It is possible to design and operate facilities that are virtually "disaster-proof." However, in many cases it is not economically feasible to do so. Too extensive of increases in integrity and reliability can result in prohibitive increases in cost. It is often too expensive to upgrade infrastructure codes and standards much beyond their current levels. However, in those cases where recurring, severe damage and system down-time occur due to natural or technological

hazard events, it makes sense to explore the possibility of enhancing infrastructure design, construction, and operational codes and standards.

As Dickinson County's public and private utility infrastructure systems continue to age, infrastructure disasters will undoubtedly become more common. Because many of these systems were developed decades ago, the costs of repairing and replacing aging sections and/or components have greatly increased. As a result, many communities cannot afford to do the maintenance work necessary to keep the system in ideal operational mode. Increasing demands on the systems also lead to increased deterioration, and many components have far exceeded their useful service life. This creates a situation of increasing risk from infrastructure-related disasters, either as a primary event, or as a secondary event from floods, windstorms, snow and ice storms, or other natural or technological hazards. When those disasters do occur, they cause great inconvenience to the affected population and they can also create severe public health and safety concerns.

The Michigan Drain Code provides for the maintenance and improvement of the vast system of intra-county (county) and inter-county drainage facilities. Each drain has a corresponding special assessment district (watershed), a defined route and course, an established length, and is conferred the status of a public corporation with powers of taxation, condemnation, ability to contract, hold, manage and dispose of property, and to sue and be sued. Drainage districts and drains are established by a petition of the affected landowners and/or municipalities. County drains, with a special assessment district entirely within the county, are administered by the locally elected County Drain Commissioner. Inter-county drains, with a special assessment district in more than one county, are administered by a drainage board that consists of the drain commissioners of the affected counties, and is chaired by the Director of the Michigan Department of Agriculture and Rural Development (MDARD) or an MDARD Deputy Director.

The intra-county and inter-county drainage program, administered by county drain commissioners and the MDARD, operates, maintains, and improves water conveyance and treatment systems—ranging from small agricultural drains to large urban storm and sanitary drains. (Note: Some drains are constructed of pipes that range in size from 12 inches in diameter to over 16 feet in diameter, with massive pumping stations that carry storm and/or sanitary sewage and serve thousands of residents. Other drains are open channels or ditches that vary from several feet in width, and being dry during part of the year, to large river channels in excess of 100 feet in width. Floodwater-retarding dams, flood pumps, erosion control structures, storage basins, and wastewater treatment structures are also part of the infrastructure constructed under the Michigan Drain Code.)

As Dickinson County's communities have grown, the drains that were primarily designed to serve agricultural needs have also been used to carry storm-water from municipalities and subdivisions, as well as to serve as outlets for sanitary treatment plants and a variety of other permitted discharges. The operation, maintenance, and improvement of drains in suburban and urban areas now provides for the management of storm-water, combined sanitary overflows, and sanitary sewage collection and treatment. Increasing demands on the drainage system in many areas of the County require that continuous improvements be made to enhance drain capacity and flow characteristics, reduce sedimentation, and improve structural integrity.

The Michigan Drain Code allows for landowners and/or municipalities to petition for the maintenance or improvement of drainage systems. Drain commissioners or drainage boards, in the absence of a petition, are allowed to maintain the drainage systems but are limited by law in the amount of money they are allowed to expend. The maintenance limit is equal to $2,500 per

mile of established drain. This amount is generally sufficient for ordinary operations and maintenance, but is inadequate during times of widespread damage such as that which happens during a disaster. Because drainage districts stand on their own, money (or the maintenance limit) cannot be shared between districts. This greatly limits flexibility and can severely constrict drain reconstruction, improvement, and damage mitigation efforts in a post-disaster setting. Efforts are underway to amend the Michigan Drain Code to more adequately address current and anticipated future problems and concerns, and to make it more applicable to modern land development circumstances.

Private and public utility infrastructure is largely taken for granted except when a failure occurs. An interruption in essential utility services such as electricity, communications, transportation, storm water drainage, water, and wastewater systems can imperil life, property, economic activity, and the environment. Dependence on telecommunication (including wireless) and electric power network sources is increasing. Routine and necessary individual, business and institutional transactions rely heavily - and sometimes exclusively - on these networks. A growing number of people pay bills, bank and shop on-line. Approximately 58 percent of county residents rely on public water and wastewater systems. This approximation found by taking estimated number of customers divided by the total county population. Overhead power lines are subject to weather and other events that can disrupt service. Wind, ice, lightning, falling limbs and trees, and construction and traffic accidents are the most common hazards affecting power transmission.

Significant Infrastructure Failures Affecting Dickinson County
Following are brief synopses of some of the more significant infrastructure failures that have affected Dickinson County in recent decades:

Winter of 1993/94 Northern Michigan Water Supply and Sewer Infrastructure Failures
The underground freeze disaster in northern Michigan (including impacting Dickinson County) in 1994 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 several 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).
January 1, 2000 Statewide Y2K – Electric Power Infrastructure Failure
The most anticipated electric power failure in the history of humankind never actually occurred. The much-celebrated year 2000 (commonly known as Y2K) computer conversion crisis was considered by many to be the biggest "non-event" ever. Actually, several years of mitigation and preparedness efforts had paid off on the morning of January 1, 2000, when the electric power grid and other critical public utility systems remained operational – stemming fears that there would be widespread power outages, resource shortages, and economic and social chaos. The electrical grid in Michigan and across the country continued to operate on January 1 and beyond, without so much as a hiccup – a testament to the proactive efforts of the electric power industry.

Risk : moderate
Rating : 12th

Vulnerability: Public water and wastewater systems supply services to approximately 58 percent of County residents. Public water and wastewater connections are estimated at 8,200 customers in Iron Mountain, 6,000 in Kingsford, and 3,000 in Norway. The community of Quinnesec provides an estimated 800 people with water service only. Failure/contamination poses very serious health issues. Medical facilities, nursing homes and food service establishments in Iron Mountain, Kingsford, Norway would be most affected by public water/wastewater failures.
Roads and bridges are essential to a majority of county residents. Most transportation failures would merely be an inconvenience with traffic re-routing as the result. A major transportation system failure would affect business, commerce and services throughout the county. Failures of communication, electrical, gas and other utility infrastructure would have a similar impact. Certain populations such as the elderly or persons with specific medical needs are more vulnerable during prolonged communication and utility failures.

Dam Failures

Hazard description: Downstream flooding caused by the collapse or failure of an impoundment.

A dam failure is the collapse or failure of an impoundment that results in downstream flooding. A dam failure can result in loss of life, and in extensive property or natural resource damage for miles downstream from the dam. Dam failures occur not only during flood events, which may cause overtopping of a dam, but also as a result of poor operation, lack of maintenance and repair, and vandalism. Such failures can be catastrophic because they occur unexpectedly, with no time for evacuation. The Michigan Department of Environmental Quality (MDEQ) has documented approximately 287 dam failures in Michigan since 1888.

Information on dams with low hazard potential may be available from the National Inventory of Dams. The most recent information counted 927 dams in Michigan, with only 161 classified as "high hazard" (meaning there was at least some development downstream, in the dam's "hydraulic shadow") and 158 as "significant." There are 40 dams and impoundments in Dickinson County. All but five are rated "low hazard" by the Michigan Department of Environmental Quality with inspections required every 5 years. Two of the dams are classified as being "high hazard" and three are classified as being "significant". The Twin Falls and Kingsford dams on the Menominee River and the Hardwood Impoundment on the East Branch of the Sturgeon River all carry the rating of "significant hazard" with inspections required at 4-year intervals. Big Quinnesec Falls and Little Quinnesec Falls dams are rated in the "high hazard" category and must be inspected every 3 years. Dams receiving high hazard ratings are upstream of populated areas. Structures rated as significant or high hazards are required to have emergency action plans (which include functional exercises) coordinated with the local emergency official. Development should be discouraged in areas that would increase the risks from potential dam failures. Effects from dam failures can be more severe than those from riverine flooding, due to the possibility of the extra effects of flash flooding and wave action from a catastrophic dam failure.

Dams are important components of the county's infrastructure and provide benefits to all citizens. However, as history has demonstrated, dams can fail with disastrous consequences, causing unfortunate loss of life and property and natural resources. Many existing dams are getting older, and new dams are sometimes built in developed areas. At the same time, development continues in potential inundation zones downstream from dams. More people are at risk from dam failure than ever before, despite better engineering and construction methods. As a result, continued loss of property can be expected to occur. The challenges facing local emergency management officials are: 1) minimize loss of life and property by working closely with dam owners in the development of the EAPs to ensure consistency with the Emergency Operations Plan (EOP) for the jurisdiction; 2) developing procedures in the EOP for responding to a dam failure (including a site-specific standard operating procedure for each dam site); 3) participating in dam site exercises; and 4) increasing public awareness of dam safety procedures.

The risk of dam failures should be calculated, where possible, from past occurrences. If a community has had no history of dam failures, the community may wish to examine the histories of similar types of dams (based on size, construction, ownership, maintenance schedules) and use that information to estimate the annual chance of a failure. Remember that not all failures result in damaging floods—many failures are caught in time to prevent flood damages, but still have costs associated with emergency response and repairs. It makes sense to calculate costs from different types of events. In most years, there will be no incident. If there is an incident, it may

be relatively minor in its impact. The worst case scenario would involve catastrophic dam failure. The National Weather Service continuously monitors river levels and issues forecasts using its Advanced Hydrologic Prediction Service.

Significant Dam Failures Affecting Dickinson County
Following are brief synopses of some of the more significant dam failures that have affected Dickinson County in recent decades:

In recent history, there are no known dam failures that have affected Dickinson County.

Risk	**:**	**moderate**
Rating	**:**	**12th**

Vulnerability: There are 40 dams and impoundments in the county. All but five are assigned a "low risk" designation by the regulating agency, the Michigan Department of Environmental Quality.

Low risk dams and impoundments are found well distant from population concentrations and critical facilities. Failures would result mainly in stream bank erosion and habitat disturbance with little threat to humans. The low risk dams in the county are still a concern since funding for maintenance is lacking.

Failure of significant hazard dams (Twin Falls, Kingsford, Hardwood) and high hazard dams (Big Quinnesec and Little Quinnesec) would affect a large number of residences and structures along the Menominee River.

Nuclear Power Plant Accidents

Hazard description: An actual or potential release of radioactive material at a commercial nuclear power plant or other nuclear facility in a quantity great enough to pose a threat to the health and safety of an off-site population.

A nuclear power plant emergency is an actual or potential release of radioactive material at a commercial nuclear power plant, in sufficient quantity to constitute a threat to the health and safety of the off-site population. Though the construction and operation of nuclear power plants is closely monitored and regulated by the Nuclear Regulatory Commission (NRC), accidents at these plants are considered a possibility, and appropriate on-site and off-site emergency planning is conducted. An accident could result in the release of potentially dangerous levels of radioactive materials into the environment and could affect the health and safety of the public living near the nuclear power plant. A nuclear power plant accident might involve both a release of airborne radioactive materials and radioactive contamination of the environment around the plant. The degree and area of environmental contamination could vary greatly, depending on the type and amount of release, and the weather conditions that are present. Response to a nuclear power plant accident requires specialized personnel who have been trained to handle radioactive materials safely, who have specialized equipment to detect and monitor radiation, and who are trained in personal radiation exposure control.

After a period of decline following the 1979 Three Mile Island accident and the 1986 incident at Chernobyl, there is a recent renewed interest in nuclear energy because it could partially address problems of dwindling oil reserves and global warming, with far fewer emissions of greenhouse gases than the use of fossil fuels. However, the use of nuclear power is controversial because of the problems of storing radioactive waste for indefinite periods, the potential for radioactive contamination by accident or sabotage, and the possibility that its use could in some countries lead to the proliferation of nuclear weapons. The United States produces the most nuclear energy of any country in the world, but many other countries actually use nuclear energy as a larger percentage of their overall energy production.

Federal, state and local governments and utility personnel take extensive precautions to ensure that, should a nuclear accident occur, its impact on the safety and well being of the general public and the environment will be minimal. These precautions include the development and continual testing of emergency plans, training of response personnel, coordination of response actions, and development and dissemination of emergency public information. A regular series of large, interagency drills and exercises takes place for each nuclear plant, and each plant has two designated emergency planning zones—primary (within a 10 mile radius) and secondary (within a 50 mile radius)—to handle all possible incidents and response activities that could be anticipated, both in the short-term and the long-term.

A nuclear power plant accident would tend to pose limited threats, directly involving the environment and public over a distance typically 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 (e.g. food chain contamination) would vary with weather conditions and the extent and type of radioactive release. This hazard has been extensively studied and prepared for, allowing the likely impacts on the public to be efficiently assessed and addressed, should an event occur.

A nuclear power plant accident could result in the release of potentially dangerous levels of radioactive materials both in the air and around the plant. Contamination may occur from

radioactive gases, liquids or particles. Some possible accidents at nuclear power plants pose a risk for severe environmental contamination, and the degree and area of this contamination could vary greatly depending on the type and amount of radioactivity, and on the weather conditions.

An accidental release of large amounts of radioactive contamination could contaminate many areas of land for long periods of time, making it unusable for humans, wildlife species, and natural vegetation. The main reason is due to radioactive materials comprising unstable isotope elements that decay over a long period of time. Some isotopes can decay quickly, while others take a very long time to stabilize. Certain radioactive elements such as plutonium can remain hazardous for thousands of years, making re-use of an area difficult or hazardous. Nuclear reactors produce high level waste (an actual classification) in the reactor core that is highly reactive and thermally hot, presenting handling, transportation, and storage problems. Radioactive contamination may affect nearby water bodies, rivers, etc. and damage the environment and its aquatic life. Radioactive material has the potential to seep deep into the ground and water table.

The federal government strictly regulates nuclear power plants. Each facility must develop appropriate emergency plans. An accidental release of radioactive materials to the environment could affect public health and safety in some locations under certain weather conditions. However, the probability of a nuclear plant accident affecting Dickinson County is low since such facilities are of a distance and direction that any released material would be dispersed in relatively harmless quantities. The nearest operating commercial reactors are along the Lake Michigan shoreline southeast of the city of Green Bay (Kewaunee and Two Rivers) - a minimum direct distance of about 90 miles from Dickinson County.

Significant Nuclear Power Plant Accidents Affecting Dickinson County
Following are brief synopses of some of the more significant nuclear power plant accidents that have affected Dickinson County in recent decades:

In recent history, there are no known nuclear power plant accidents that have affected Dickinson County.

Risk	**:**	**moderate**
Rating	**:**	**12th**

Vulnerability: The County is well isolated from the potential effects of a nuclear plant accident both in terms of distance and direction.

Radiation contamination from a power facility accident would affect the health of people, plants and animals. Evacuation would be necessary and could have a long-lasting impact such as rendering the area uninhabitable.

Scrap Tire Fires

Hazard description: The accidental combustion of scrap tires at a designated storage area.

A scrap tire fire is a large fire that burns scrap tires being stored for recycling or re-use. With the disposal of an estimated 290 million vehicle tires annually in the United States, management of scrap tires has become a major economic and environmental issue. Michigan generates approximately 10 million scrap tires each year. Although responsible means of storage and disposal have become more common, tire dumps of the last forty years still present environmental and safety hazards. Inventory totals compiled for tire quantities are approximated and will vary from year to year, as new tires are brought in and others are recycled or otherwise disposed of.

Issues pertaining to the management of scrap tire disposal sites are difficult and diverse. Whole tires are difficult to landfill because they tend to float to the surface. Whole tires are banned from disposal in Michigan landfills due to their associated problems. Scrap tires are breeding grounds for mosquitoes, which can reproduce at thousands of times their natural rate in a scrap tire disposal site, and these mosquitoes can carry and transmit life-threatening diseases. Stockpiles also are home to snakes and small mammals such as rats, opossums, skunks, and raccoons. Stockpiled tires are often soiled with mud, dirt, or other foreign materials that limit potential markets and increase processing costs. From an emergency management perspective, the most serious problem that scrap tire disposal sites pose is that they can be a tremendous fire hazard if not properly designed and managed.

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

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

Much work still needs to be done to mitigate the impacts of scrap tire fires. Incident management planning, recognition of the hazardous material potential of fires at scrap tire sites, and improving and enhancing disposal site selection and design processes are all critical pre-incident preparedness factors that must be addressed by government and the private sector. In light of the potential consequences of scrap tire fires, prevention must become a primary goal in the treatment of scrap tire disposal sites. The Rubber Manufacturers Association has put together a document on the Prevention and Management of Scrap Tire Fires that can be printed and used by local fire officials.

The Dickinson County Solid Waste Processing Center accepts scrap tires. Storage is limited to no more than 500 scrap tires at a site. Tires are shipped to Wisconsin where they are melted or shredded for reuse. At least some scrap tires are shredded and used for fuel in paper mills.

Significant Scrap Tire Fires Affecting Dickinson County
Following are brief synopses of some of the more significant scrap tire fires that have affected Dickinson County in recent decades:

In recent history, there are no known scrap tire fires that have affected Dickinson County.

Risk	**:**	**low**
Rating	**:**	**23rd**

Vulnerability: A record of scrap tire fires is not found in the county. Limited storage of tires is available at the Dickinson County Solid Waste Processing Facility outside of Quinnesec. If a fire did occur it would be isolated to this specific site and would produce lots of heat and acrid smoke. Adjacent property would be endangered and evacuation of people would be required. Fires could also occur at smaller sites such as automobile service centers or salvage-yards.

Petroleum Pipeline Failures

Hazard description: An uncontrolled release of petroleum product(s) from pressurized pipelines lying above or below the ground.

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

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

While it is true that the petroleum and natural gas industries have historically had a fine safety record, and that pipelines are by far the safest form of transportation for these products, the threat of fires, explosions, ruptures, and spills nevertheless exists. Petroleum and natural gas pipeline accidents are on the rise, due to the aging of the underground infrastructure (much of which was laid over 50 years ago) and an increase in construction excavation. In addition to these hazards, there is the danger of hydrogen sulfide (H_2S) release. These dangers can be found around oil and gas wells, pipeline terminals, storage facilities, and transportation facilities where the gas or oil has a high sulfur content. Hydrogen sulfide is not only an extremely poisonous gas, but is also explosive when mixed with air at temperatures of 500 degrees Fahrenheit or above.

Natural gas is piped into the storage facilities from Michigan wells, and from large transmission pipelines that originate in Canada, the southwestern United States, and the Gulf of Mexico area. Because petroleum and natural gas pipeline accidents will occur eventually, affected local communities must be prepared to respond to the accident, institute necessary protective actions, and coordinate with federal and state officials and the pipeline company emergency crews to effectively manage and recover from the accident. That can best be accomplished through the collaborative planning, training, and exercising of emergency procedures with all potentially involved parties.

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 and other energy needs being used to maintain their homes and health. Transportation and fuel costs may become too expensive to allow business profits to be maintained, when such businesses rely on fuel-driven transportation or functions. Those in the vicinity of the pipeline break itself may suffer from health problems, unpleasant odors,

evacuations, and damage/contamination of their property. Some pipeline accidents result in explosions that cause extensive damage, injury and even loss of life. Gas leaks in particular can cause surprising amounts of damage from sudden explosions, without any advance warning to those nearby.

Michigan's first line of defense against pipeline (and other utility line) breaks from construction excavations is the "MISS DIG" Program established with the passage of 1974 PA 53 – The Protection of Underground Facilities. MISS DIG System, Inc., is a 24-hour utility communications system that helps contractors comply with the 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 or boring procedures, or explosive discharges for a project. When properly administered and followed, the MISS DIG safety system does an excellent job of minimizing pipeline and utility line accidents.

Pipeline accidents are largely the result of excavation not related to operation and maintenance of the pipeline itself. Major gas and petroleum (natural gas liquids or NGL) pipelines traverse the northern part of the county in an east-west direction. A branch of the natural gas pipeline runs southeasterly from the Sagola area into Menominee County.

Significant Petroleum Pipeline Failures Affecting Dickinson County
Following are brief synopses of some of the more significant petroleum pipeline failures that have affected Dickinson County in recent decades:

March 15, 2002 – Crystal Falls (in nearby Iron County)
On March 15, 2002, a pipeline break occurred in Crystal Falls in Iron County, a neighboring county of Dickinson County, resulting in a half hour of rerouted traffic and two months of pipeline shut-down. The cost of repair was around 4 million dollars.
July 7, 2003 – Dickinson County
During reconstruction of US-2 through Iron Mountain on July 7, 2003, an 8-inch natural gas line was struck. Several businesses and homes were evacuated for two days. More than 69 million cubic feet of natural gas was lost before repairs were completed. Total property damage was $123,818.

Risk : low
Rating : 27th

Vulnerability: Major pipelines cross the county roughly following highway trunk-lines. They run through every county jurisdiction. The pipeline routes are buffered somewhat from populated and developed areas. An explosion or rupture could result in casualties, infrastructure damage, transportation interruptions (rail and trunk-line), local road closures and select area evacuations.

Human Related

The hazards associated with human behavior cannot be predicted with scientific certainty. However, past events document that unruly human actions happen in many forms and under a variety of circumstances. The potential for loss of life and property is not less serious with hazards of this type.

Public Health Emergencies

Hazard description: Incidents of contamination or epidemic that present a clear danger to the general health and well being of the public.

A public health emergency is a widespread and/or severe epidemic, incident of contamination, or other situation that presents a danger to or otherwise negatively impacts the general health and well-being of the public. Public health emergencies can take many forms—disease epidemics, large-scale incidents of food or water contamination, extended periods without adequate water and sewer services, harmful exposure to chemical, radiological or biological agents, and large-scale infestations of disease-carrying insects or rodents, to name just a few. Public health emergencies can occur as primary events by themselves, or they may be secondary events to another disaster or emergency such as a flood, tornado, or hazardous material incident. The common characteristic of most public health emergencies is that they adversely impact, or have the potential to adversely impact, a large number of people.

Perhaps the greatest emerging public health threat would be the intentional release of a radiological, chemical, or biological agent with the potential to adversely impact a large number of people. Such a release would most likely be an act of sabotage aimed at the government or at a specific organization or segment of the population. Fortunately, Dickinson County has not yet experienced such a release aimed at mass destruction. If it does, the public health implications—under the right set of circumstances—could be staggering. Although no area in Dickinson County is immune to public health emergencies, areas with high population concentrations will always be more vulnerable to the threat. In addition, the more vulnerable members of society—the elderly, children, impoverished individuals, and persons in poor health—are also more at risk than the general population.

The primary types of public health impacts involve the threat or presence of either disease, contamination, or sanitation problems. Disease epidemics or pandemics have the potential to cause widespread debilitation or loss of life, associated medical expenditures, and decreases in productivity and quality of life. Contamination can at least temporarily lower property values, as well. Sanitation problems require effort and expense to resolve. Contamination and sanitation issues increase the probability and variety of diseases that may affect the population. Facilities may be shut down, as a means of preventing disease transmission or of containing contamination, and thus cause a loss of the services being provided to the public (by schools, for example). Medical resources may become overwhelmed and unable to deal with any additional needs. As traditional medical services become increasingly difficult to access (or if their quality declines due to overwork or understaffing) then increasing numbers may turn to less responsible and effective alternative means of treatment (or may forego treatment entirely).

There have been several communicable disease outbreaks or epidemics, or the potential for such threats, which can be classified as public health emergencies. One of the principal dangers of communicable disease outbreaks is that they can rapidly overwhelm the local health care system. Influenza is an example of a potential public health emergency of very large proportions. No one

knows when the influenza virus might "shift" its structure to produce a virus to which no one will be immune. Influenza can exact a terrible toll on communities. As hard as the world public health community is trying to conduct influenza surveillance in order to provide the most advance notice possible, if pandemic influenza were to strike it would likely do so very early in the season and spread so rapidly that preparation would need to be done on an emergency basis. In the northern hemisphere, the normal flu season starts in November and ends in May. Flu viruses are amenable to chilly weather, and therefore predominate around the winter season in temperate climates. Enough potential threats exist that some type of public health emergency tends to affect the county every couple of years (although some threats, such as influenza, occur annually) throughout the whole area. Medical impacts upon the county's population are usually significant, but in a serious pandemic event, could become catastrophic.

The World Health Organization (WHO) has established six levels of pandemic "phases," based upon observable phenomena, and allowing the easy incorporation of new recommendations and approaches into existing national preparedness and response plans. Phases 1 to 3 concern preparedness activities, including capacity development and response planning, while Phases 4 to 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.

Inter-Pandemic Period (phases 1 and 2):
Phase 1: No new influenza virus subtypes have been detected in humans. An influenza virus subtype that has caused human infection may be present in animals. Although present in animals, the risk of human disease is considered to be low.
Phase 2: No new influenza virus subtypes have been detected in humans. However, a circulating animal influenza virus subtype poses a substantial risk of human disease.
Pandemic Alert Period (phase 3, 4, and 5):
Phase 3: Human infection(s) with a new subtype has caused sporadic cases or small clusters of disease in people, but has not resulted in human-to-human transmission sufficient to sustain community-level outbreaks. Limited human-to-human transmission may occur under some circumstances, or may affect close contacts.
Phase 4: Small clusters include limited human-to-human transmission, but the spread is highly localized, suggesting that the virus is not well adapted to humans. The ability to cause sustained disease outbreaks in a community marks a significant upward shift in the risk for a pandemic. Phase 4 indicates a significant increase in the risk of a pandemic but does not necessarily mean that a pandemic is a forgone conclusion.
Phase 5: Large outbreak clusters occur, but human-to-human spread is still localized, suggesting that the virus is becoming better adapted to humans, but may not yet be fully transmissible.
Pandemic Period (phase 6):
Phase 6: Pandemic phase, with increased and sustained transmission in the general population.

During the post-peak period, pandemic disease levels in most countries with adequate surveillance will have dropped below peak observed levels. The post-peak period signifies that pandemic activity appears to be decreasing. However, it is uncertain whether additional waves will occur, and countries therefore need to be prepared for a second wave. Previous pandemics have been characterized by waves of activity spread over months. Once the level of disease activity drops, a critical communications task will be to balance this information with the possibility of another wave. Pandemic waves can be separated by months, and an immediate "at-ease" signal may be premature. In the post-pandemic period, influenza disease activity will have returned to levels normally seen for seasonal influenza. It is expected that the pandemic virus will behave as a seasonal influenza A virus. At this stage, it is important to maintain surveillance, and

to update pandemic preparedness and response plans accordingly. An intensive phase of recovery and evaluation may be required.

Some diseases, such as influenza, are contagious or infectious, and can be transmitted by any of a variety of mechanisms, including droplets from coughs and sneezes, insect bites, contaminated water or food, or other vectors. Epidemiology is the study of the distribution and determinants of disease in human populations and the application of this study to control health problems. The following table explains a few epidemiology terms that may be helpful in understanding the spread of disease.

Epidemiology Terms	
Epidemic	The occurrence of more cases of a disease than would be expected in a community or region during a given time period.
Pandemic	An epidemic that becomes very widespread and affects a whole region, a continent, or the world.
Endemic	Present in a community at all times but in relatively low frequency. Something that is endemic is typically restricted to, or peculiar to, a locality or region.
Zoonosis	An infectious disease that may be transmitted from (wild and domestic) animals to humans.

At the national level, the U.S. Centers for Disease Control and Prevention (CDC), a branch of the Department of Health and Human Services, has the responsibility and authority to investigate public health emergencies to determine their cause, probable extent of impact, and appropriate mitigation measures. 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 general public. The CDC announced dedicated funding for bioterrorism response, and Michigan has been strengthening its surveillance and intervention infrastructures with these funds.

The U.S. Food and Drug Administration (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. The Food Code provides practical, science-based advice and manageable provisions for mitigating risk factors known to contribute to foodborne illnesses. Michigan initially adopted the 1999 FDA Food Code with the Michigan Unified Food Law of 2000 (2000 PA 92). The FDA Food Code is revised every two years.

Significant Public Health Emergencies Affecting Dickinson County
Following are brief synopses of some of the more significant public health emergencies that have affected Dickinson County in recent decades:

1918-1919 The "Spanish flu"
The world's worst influenza pandemic—the "Spanish flu" of 1918-19—resulted in 500,000 to 675,000 deaths in the United States and 20 to 40 million worldwide. More than 25 million Americans—nearly one quarter of the population at the time—fell ill. Scientists speculate that the virus that caused that pandemic may have percolated for several years within humans, or possibly pigs, until it grew strong enough to kill millions worldwide. The virus spread rapidly—moving around the world in a matter of a few months—in a time period in which there was much less

movement of people than there is today. The virus reached Michigan in the fall of 1918. Over 8,000 of the 2.8 million state residents fell ill and half of those eventually succumbed to the disease. In retrospect, the spread of the illness was felt to be exacerbated by behavior of important officials who had misguided concerns that the effects of "panic" might be more harmful than the disease itself—a notion that proved disastrous. The pandemic had an unusual aspect, however, in that many of those who died were persons who had been young and healthy, whereas the normal pattern for influenza deaths is to take a higher toll among those who are elderly or have compromised immune systems.

(Note: As a sheer numerical comparison, the 1918-19 influenza pandemic worldwide death tolls came close to equaling the death tolls of the medieval Black [Bubonic] Plague that struck in the 6th, 14th, and 17th centuries. The number of U.S. deaths from the pandemic exceeded the number of U.S. soldiers killed on the battlefield in World Wars I and II, the Korean War, and the Vietnam War combined.)

1973 Chemical Contamination (Polybrominated Biphenyl Contamination)

One of Michigan's most serious statewide public health emergencies occurred in 1973 when a chemical company inadvertently sent bags of a fire retardant containing polybrominated biphenyl (PBB), a highly toxic chemical, along with a shipment of livestock feed supplement to Michigan Farm Bureau Services. After being mixed with the livestock feed, the contaminated mixture was distributed statewide for use by farmers in feeding livestock herds. The result was an environmental and public health disaster of unprecedented magnitude in Michigan. Thousands of cattle and other animals died from the poisoning and serious questions were raised regarding the long-term effects of this contamination on all Michigan residents.

Spring 1994 Northern Michigan Loss of Water and Sewer Service

A breakdown of critical water and sewer infrastructure can (if not immediately abated) result in a public health emergency for the affected area. That is exactly what happened in the early spring of 1994 in northern Michigan, when over 3,200 water and sewer lines broke or became frozen due to unusually deep subterranean frost depths. The emergency conditions were present in some locations for up to 5 months. As a result, many communities had to provide shelter for those residents without water and/or sewer service for an extended period of time. In addition, boil-water advisories were issued in many communities, due to the potential for water contamination from lack of adequate system pressure. Fire safety hazards were also prevalent, due to the lack of adequate system pressure, as well as the fact that many homeowners were using improper equipment to thaw out frozen water and sewer lines (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 physical damage caused to this vital infrastructure, Michigan was granted a Presidential Disaster Declaration in May, 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, thus bringing to a close one of Michigan's (and the nation's) most unusual public health emergencies.

1999-present Statewide West Nile Virus

The West Nile virus is a mosquito-borne virus 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 have occurred in Egypt, Asia, Israel, South Africa, and some parts of Europe and Australia. The virus was first seen in the U.S. in the fall of 1999 in New York City, and has since spread across the U.S. to the Pacific Ocean, into several Canadian Provinces, and possibly into Mexico. The virus was first detected in Michigan in 2001 and has been detected in Michigan each year since then. The virus peaked in Michigan in 2002, when 644 human cases were reported, including 51 deaths. In 2003, human cases in the state dropped to 19, with no fatalities. In 2004, 16 human cases, none fatal, were reported in Michigan. 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 most vulnerable to West Nile

and most likely to become seriously ill from it. Experts urge residents to monitor the birds in their yards, especially when one dies.

Risk : high
Rating : 2nd

Vulnerability: Dickinson County has experienced one food borne illness outbreak in recent years. Virtually the entire county population is susceptible to a public health emergency. However, the risk and likelihood increases where the largest population concentrations are found: City of Iron Mountain, Kingsford and Breitung Township. This southwestern area of the county has over seventy percent of the total population and development.

A greater concern exists for elderly and very young children. Approximately 24 percent of the county population is in this category (65+ and 4 and under) according to the 2000 Census. Those undergoing continued medical treatment are also vulnerable public health emergencies. There are two hospitals (Dickinson County Memorial and Veterans Affairs Medical Center) and three nursing facilities located in Iron Mountain and Kingsford.

Sabotage of the critical water and storage facilities would roughly affect the populations where they are located: Iron Mountain, Kingsford, and Norway. A major outbreak or event would stress existing medical capacities. The concern about property would be with contamination that might result in special decontamination measures or destruction.

One food borne illness outbreak has occurred within the county in approximately the last 2.5 years.

The northern Michigan water and sewer infrastructure disaster of 1994 is unprecedented in scope, magnitude, and public health and safety implications for the affected communities. These events, though unusual, have heightened awareness of the broad nature of threats that can result in a public health emergency. Such emergencies no longer simply involve the spread of disease, but rather can arise out of a variety of situations and circumstances.

Currently, public health and medical staff are working on preparedness for all types of public health emergencies.

Transportation Accidents

Hazard description: Unintended events associated with any mode of transportation that brings harm to people and property.

A transportation accident is a crash or accident involving an air, land, or water-based commercial passenger carrier. There are four circumstances that can result in an air transportation accident: 1) an airliner colliding with another aircraft in the air; 2) an airliner crashing while in the cruise phase of a flight due to mechanical problems, sabotage, or other cause; 3) an airliner crashing while in the takeoff or landing phases of a flight; or 4) two or more airliners colliding with one another on the ground during staging or taxi operations. When responding to any of these types of air transportation accidents, emergency personnel may be confronted with a number of problems, including: 1) suppressing fires; 2) rescuing and providing emergency first aid for survivors; 3) establishing mortuary facilities for victims; 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.

A major land transportation accident in Dickinson County has the potential to create a local emergency event, or to seriously strain or overwhelm local response and medical services. It could involve a commercial intercity passenger bus, a local public transit bus, a school bus, or an intercity passenger train. Although these modes of land transportation have a good safety record, accidents do occur. Typically, bus accidents are caused by the bus slipping off a roadway in inclement weather or colliding with another vehicle. Intercity passenger train accidents usually involve a collision with a vehicle attempting to cross the railroad tracks before the train arrives at the crossing. Unless the train accident results in a major derailment, serious injuries are usually kept to a minimum. Bus accidents, on the other hand, can be quite serious—especially if the bus has tipped over. Numerous injuries are a very real possibility in those types of situations. Sometimes, "ordinary" highway crashes can be of unusual significance, when they either involve a large number of vehicles or in some manner cause the entire shut-down of a major highway for a significant period of time.

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

Statistics from the NTSB and the airline industry show that the majority (over 75%) of airplane crashes and accidents occur during the takeoff or landing phases of a flight. As a result, developed areas that are adjacent to major airports, and along airport flight paths, are particularly vulnerable to this hazard. Accordingly, the greater the number of landings and takeoffs, the greater the probability of a crash or accident. The challenge for jurisdictions with a passenger air carrier airport is to develop adequate procedures to handle a mass casualty incident that could result from an airplane crash or accident.

Although automobile crashes can tragically kill many Dickinson County residents each year, this analysis necessarily focuses on the types of accidents that are large enough in scale to potentially cause an emergency or disaster-level situation. Routine "fender benders" or personal vehicle accidents are usually handled by law enforcement officers and are not considered to be community-level emergency events (although they may cause traffic jams and delays that impede

emergency response). Only when large numbers of vehicles or persons are involved would motor vehicle accidents be considered large-scale events with the need to engage community-wide response efforts. Transportation accidents that constitute a community-level emergency are fairly rare, estimated to occur about every couple of decades, usually with the loss of multiple lives.

Airplane crashes and train derailments pose the largest problems, with the potential to cause mass casualties and significant local property destruction – especially since these modes of transportation pass through densely populated urban areas. On a smaller scale, but still potentially devastating to smaller or rural areas, would be major highway accidents involving passenger buses that result in heavy casualties, with the potential to overwhelm smaller emergency medical systems throughout the county. In certain cases, power equipment or other infrastructure may be damaged by such accidents, causing additional impacts.

Most vehicular accidents occur between 6:00 a.m. and 6:00 p.m. Accidents increase during busy traffic times such as those associated with start and dismissal of schools, industries and businesses.

Recreational transportation by means such as boats (power and sail), snowmobile, off-road-vehicle, and road and mountain bikes results in injuries and deaths each year. Most serious injuries and fatalities are connected with snowmobiling. Generally, the consequences of such accidents are limited to the user(s) and their recreational apparatus.

Much of the US-2 corridor is intensively developed because of its heavy traffic volume. Growing commercial development along the corridor creates more points of vehicular access and traffic flow disruptions. Michigan statistics indicate that the highest incidence of vehicle crashes and fatal vehicle crashes occurs between noon and 6:00 p.m. Further, the crash, injury and death rate is highest along county and city roads. A 5-year ranking of Michigan's 83 counties by the number of injuries casing death or incapacitation puts Dickinson at 68th overall.

A manifestation of anger on the nation's roadways in recent years has been widely reported. Incidents of "road rage" have resulted in injuries and fatalities. Behavior of this sort reflects a lack of consideration for the safety of others, as well as an unwillingness or inability to control personal emotions. Anecdotal information indicates that this behavior is less common with older drivers. Statistically, drivers between the ages of 25-34 are involved in the most fatal accidents.

Significant Transportation Accidents Affecting Dickinson County
Following are brief synopses of some of the more significant transportation accidents that have affected Dickinson County in recent decades:

In recent history, there are no known transportation accidents that have affected Dickinson County.

Risk : high
Rating : 6th

Vulnerability: Single and multiple-vehicle accidents are numerous - in Dickinson County. Traffic crash accidents are still potentially dangerous and expensive. Property damage along with injury and response costs of these accidents are unknown but would be a substantial dollar amount.

Commercial and residential development in the county is mainly concentrated along the US-2 corridor. Traffic crash data shows four of the top five high crash intersections occurring along US-2 through Iron Mountain. Average daily traffic volumes have increased in the county. As speeds, traffic volume, access points (development), and driver impatience all increase, so does the probability of serious accidents.

Railroad routes in the county roughly follow US-2 and M-95. They pass through every jurisdiction in the County except Breen Township. The Federal Railroad Administration data states there were 32 rail accidents from 1975 to 2003. Most of the accidents were derailments caused by track defects. Reportable damage totaled $866,853.

Accidents involving air and commercial and pleasure water craft present an extremely low probability. Accidents involving personal watercraft, snowmobiles, and all-terrain vehicles are numerous and typically involve only the operator with little collateral impact.

Terrorism/WMD

Hazard description: Intentional, unlawful and subversive action(s) against persons and property to further political, social or religious objectives through intimidation and coercion.

Terrorism is defined as 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.

Terrorism is the use of violence by individuals or groups to achieve political goals by creating fear. The political motives of terrorism distinguish it from ordinary crime. Terrorism is carried out for a cause; not for financial gain, personal revenge, or a desire for fame.

Terrorism is a long-established strategy that is practiced by many groups in many nations. The United States is threatened not only by international terrorists such as Al Qaeda, but also by home-grown domestic terrorist groups including racist, ecological, anti-abortion, and anti-government terrorists.

A wide range of techniques can be used by terrorists, including bombings, shootings, arson, and hijacking. Regardless of the specific tactics used, terrorists seek the greatest possible media exposure. The goal of terrorists is to frighten as many people as possible, not necessarily to cause the greatest damage possible. Media coverage allows terrorists to affect a much larger population than those who are directly attacked.

Non-terrorist criminal activity may resemble terrorism, but lacks a political objective. Emergency management is typically not concerned with routine, individual crimes, but does need to prepare for crimes that impact large portions of the population. Such attacks may require resources not available to local law enforcement agencies. Crimes of this sort include mass shootings, random sniper attacks, sabotage of infrastructure, and cyber-attacks. The types of criminal attacks considered in this section are those that resemble terrorism or that may cause widespread immediate disruption to society.

<u>Terrorism in the United States</u>

Terrorists intend to use fear as a weapon to achieve their goals. This approach allows a small, weak group to potentially influence the actions of an entire nation or government. Terrorists lack the power to achieve their ultimate aims through the direct use of force, but by staging relatively small attacks in a spectacular fashion, they hope to have a major political impact. Their goals are effectively summarized by the proverb "Kill one, frighten 10,000." Terrorism can be an effective strategy for a weak group to use when fighting a strong opponent.

Terrorism has been used for thousands of years, but modern terrorism developed in the 19th Century. The United States has suffered from terrorist attacks for more than a century: U.S. President William McKinley was assassinated by an anarchist terrorist in 1901, the Los Angeles Times building was destroyed in 1910, and Wall Street was bombed in 1920. Racial and religiously-motivated terrorism continued throughout the 20th century. A new wave of terrorism was instigated in the 1960s by left-wing radicals. This was followed by right-wing extremist terrorism in the 1980s and 1990s. All of these attacks were conducted by American domestic terrorists against other Americans.

The United States has also been the target of terrorists from other countries. Conflict in the Middle East led to many attacks on American targets overseas, primarily by Palestinian nationalist terrorists, as well as groups supported by Libya and Iran. Hijackings, kidnappings, and bombings of Americans occurred throughout the 1970s and 1980s, and into the 1990s. By the mid-Nineties the danger had shifted toward attacks by violent Islamic extremist groups such as al-Qaeda. Al-Qaeda successfully moved their terrorist campaign inside of the United States homeland with the World Trade Center bombing in 1993 and the devastating 9/11 attacks in 2001.

Types of Terrorists

Terrorists fall into five major categories, based upon the political cause that motivates their actions. These categories are: nationalist, religious extremists, left wing terrorists, right wing terrorists, and single-issue terrorists.

Nationalist terrorists act in support of a cultural or ethnic group. Typically they are fighting on behalf of national populations that wish to have an independent government, but are currently ruled by another country. Nationalist terrorists tend to direct their attacks against the "occupying power" that they wish to drive away, but may also attack other nations that support their enemies. Nationalist terrorists claim to speak for their entire national group, but usually only represent a small minority of extremists. Examples of nationalist terror groups include the Provisional Irish Republican Army (Northern Ireland), the Popular Front for the Liberation of Palestine (Palestine), and the Armed Forces of National Liberation (Puerto Rico).

Religious extremist terrorists are violent adherents of a specific religion. They may be violent 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 supported by their deity and because they may expect to be rewarded after death. Religious terrorists see themselves as fighting in a battle of ultimate good against pure evil, in which any action is justified. Examples of religious extremist terrorists include al Qaeda (International), Hezbollah (Lebanon), and the Aum Shinrikyo cult (Japan).

Left wing terrorists attempt to force society to change to match their goals and values. They tend to target the government, powerful institutions, and symbols of authority. Socialist and Communist terrorists of this type were a threat in the late 1960s and 1970s, but have weakened in recent decades. Examples of left-wing terrorist groups include the Weathermen (United States), the Red Army Faction (Western Europe), and Shining Path (Peru).

Right wing terrorists see themselves as fighting for traditional values against an invading group and/or against a tyrannical government. In the United States these terrorists are associated with anti-immigration, white supremacy, anti-government, and Christian Identity movements. Only the most extreme elements of these movements have become terrorists, but they have carried out a substantial portion of the recent attacks in the United States. Right wing groups tend to target members of hated ethnic or religious minorities, or government employees. In recent years, right wing terrorists have usually operated as violent individuals termed "lone wolves" and not in organized groups. Examples of right wing terrorist groups in the United States include "The Covenant, The Sword, and the Arm of the Lord" and "The Order." Examples of right-wing "lone wolf" terrorists include Timothy McVeigh (of the 1995 Oklahoma City bombing) and James von Brunn (of the 2009 National Holocaust Museum shooting in Washington, D.C.).

Single-issue terrorists are not committed to an all-encompassing belief system, but rather are intensely concerned with one particular cause. Frequently these issues are of interest to many members of society, but only small numbers of individuals convert this interest into terrorist action. Common causes for single issue terrorists in the United States include animal-rights, environmentalism, and opposition to abortion. These terrorists carry out the majority of terrorist attacks within the United States, but tend to target property or individuals rather than attempting to cause massive casualties. Examples of American single issue terrorist groups include the Animal Liberation Front and the Earth Liberation Front, but many single issue terrorists operate as independent lone wolves or in small informal groups.

Terrorists and terrorist groups tend to fall into one of these five categories, but there are examples of terrorists who fit more than one of these categories. For example, nationalist terror groups have often promoted radical left-wing political views while religious extremist terrorists frequently have extreme right-wing views.

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 each. This structure, combined with the intense personal commitment of many terrorists, makes these groups difficult to discover, infiltrate, and disrupt.

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 cyber-attacks. Such major criminal events may resemble terrorist attacks, but there are important differences between terrorists and other criminals.

The principal difference between terrorism and other types of crime is motivation. Terrorists are motivated by a political cause, not by personal gain. Terrorism is not only defined by what an attacker does, but why he or she does it. This is an important distinction because it explains other characteristic differences between terrorism and non-terrorist crimes.

Non-terrorist criminals may be driven by a wide variety of purposes. These motivations are highly idiosyncratic and difficult to categorize or predict. Most criminals avoid major crimes with widespread impact because the chance of monetary gain is low and the risk of punishment is high. Occasionally a criminal will be willing to take that risk. Major criminal events have been conducted for reasons of personal revenge, monetary gain, desire for fame, and due to mental illness.

There are other important differences between terrorists and criminals, although these are generalizations that do not hold true in all cases. Terrorists tend to prioritize their mission over their personal safety and will often risk capture or death to achieve their goals. Criminals usually seek freedom to enjoy the rewards of their crimes and so plan to escape undetected after their attacks. American criminals, especially those who conduct large-scale attacks, tend to operate as individuals or small groups. The most effective terrorists belong to organizations or networks that coordinate multiple members and share extensive resources.

Criminal and Terrorist Weapons and Techniques

There are a wide variety of harmful weapons and tactics available to terrorists and criminals. The specific effects of a terrorist or criminal attack, as well as the emergency response required, are determined largely by the tools used.

Explosives are by far the most common terrorist tool 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 that terrorists seek out.

A wide variety of explosive materials are available. Military explosives are the most powerful, but are difficult for most terrorists and criminals to get. Commercial explosives are widely available for legitimate use by mines, farms, and businesses. With over 2.5 million tons used each year in the United States, commercial explosives are powerful and easy to acquire. Alternatively, terrorists and criminals may choose to make their own explosives. Effective bombs can be built from commonly available materials such as farm fertilizer, diesel fuel, and hydrogen peroxide.

Explosives are also relatively easy to use. This allows even untrained bombers to launch damaging 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 the secondary device. This tactic uses a pair of bombs, the first of which draws rescuers and bystanders to the scene and a second, hidden bomb is targeted to then kill these emergency responders.

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 important 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. If a bomb or potential bomb is detected, specially trained law enforcement bomb squads should be contacted to dispose of it.

Incendiaries are similar to explosives and share many characteristics. Incendiaries are used to start fires rather than to destroy through explosion. Generally they are targeted at structures and property rather than directly against people. This makes incendiaries appealing to groups such as animal rights 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 can be considered a massive application of improvised incendiary devices.

Countermeasures against incendiary attacks 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.

Shooting attacks are a popular tactic for both terrorists and criminals. Firearms 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 large capacity magazines. 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 has to 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 such as schools. Rapid response by well-trained law enforcement officers and emergency medical personnel is also very important.

Chemical weapons attacks involve the use of poisonous materials, usually toxic gases. This is a potentially dangerous type of weapon, but is difficult to use effectively. Poison gas tends to disperse quickly and unpredictably, which reduces casualties even when used on an unsuspecting target. Chemical weapons attacks are very similar in effect to the accidental release of hazardous materials.

As with explosives, there are many possible types of chemical weapons. Military gases such as nerve gases can be deadly, but are difficult to acquire or manufacture. Commercial gases such as chlorine and hydrogen cyanide are produced in massive quantities and easier to find, but they are less effective. One possible terrorist tactic is to attack chemical storage facilities in order to harm the surrounding communities. Chemical attacks have been rare in practice. Despite their theoretical effectiveness, few terrorists or criminals have attempted to use chemical weapons and most of their attacks have failed.

Biological weapons use disease organisms to cause illness and death. This type of attack is sometimes referred to as "germ warfare." Some biological weapon organisms, such as anthrax, will sicken victims that come in contact with weapon materials, but the victims cannot easily spread their disease to others. This type of attack resembles the use of a chemical weapon. Other germ warfare organisms, such as smallpox and plague, can pass from one victim to another, allowing an initially small attack to eventually infect a large number of victims.

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 causes significant economic damage instead of human casualties.

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 most deadly germ warfare agents, such as smallpox and breathable anthrax, are quite difficult to manufacture. In addition, standard infectious disease control techniques, such as patient isolation, antiseptics, hand washing, and antibiotics, can be

very effective countermeasures against biological attacks, just as they are against natural disease outbreaks.

One major consideration for potential biological attacks is that germ warfare is often not recognized as an attack. Victims often do not show symptoms for several days and unlike a bomb explosion or mass-shooting, biological attacks are often mistaken for naturally occurring diseases. This may be an advantage for certain criminals who want their attacks to go unrecognized, but may be a major drawback for a terrorist who wants to use a biological attack to achieve political goals.

Bioterrorism can be overt or covert and involves the dispersion of disease pathogens. Germ warfare is very difficult to defend against and places new and demanding responsibilities on the public health system and primary healthcare providers. Anthrax (bacillus anthracis), botulism (Clostridium botulinum toxin), plague (Yersinia pestis), smallpox (variola major), tularemia (Francisella tularensis), and viral hemorrhagic fevers (ebola and others) are the highest priority agents (Category A).

Category A diseases/agents have the following characteristics:

- Easily transmitted from person to person
- High mortality rates and potential for major impact
- Potential to incite public panic
- Require special preparedness measures

Category B diseases/agents are less easily spread and less likely to cause illness or death. These include the poison ricin, bacterial food and water safety threats, and many others.

Third highest priority diseases/agents (Category C) include emerging infectious threats from pathogens such as hantavirus. Category C agents are considered easy to produce and introduce, as well as highly effective in terms of causing illness and death.

Radiological weapons, sometimes called Radiological Dispersal Devices (RDDs) or "dirty bombs," are weapons designed to spread hazardous radiological materials. These devices do <u>not</u> create a nuclear explosion. The most standard design for a radiological bomb surrounds 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 and in addition would spread radioactive materials around the area near the explosion.

No radiological weapon has even 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. In addition, radioactive threats tend to cause a great deal of fear in the general public. This makes radiological weapons potentially very useful for terrorists: they create little actual destruction, but considerable terror and disruption.

Radiological weapons are considered a serious threat because the components for a dirty bomb have legitimate civilian uses and can easily be stolen by terrorists or criminals. Hospitals, food

processing plants, and research centers all possess radioactive materials that would be of use in making a weapon. 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.

Nuclear weapons are potentially the deadliest terrorist tools. Unlike the radiological "dirty bombs" described above, nuclear weapons create very large explosions capable of creating widespread damage and many casualties over a large area. The great destructive potential of these devices make them very desirable for terrorist groups that wish to cause massive and indiscriminate casualties. Fortunately, nuclear weapons are difficult to build, especially because they require 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 likely, but that it is possible, and that the damage caused by such an attack would be immense. Nuclear weapons cause damage by releasing enormous amounts of heat, by creating powerful explosive shock waves, by releasing damaging radiation, by disrupting electronic devices, and in some cases, by creating radioactive dust, called fallout, that drifts downwind from nuclear explosions. Nuclear weapons vary greatly in their power and effects: the weapons most likely to be used by terrorists are very dangerous, but are still far less powerful than the strategic nuclear weapons possessed by nations such as the United States, Russia, and China.

Sabotage is the destruction of property or the disruption of operations in an attempt to harm a business, government, or other entity. Attackers who use sabotage are called saboteurs. 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. The principal identifying characteristic of sabotage is that the attack is unusually not intended to harm large numbers of people, but rather to cause economic harm or embarrassment to the target. Where deaths or injuries do occur, they are usually incidental, rather than the purpose of the attack. Past sabotage tactics have included the toppling of electrical power pylons, the burning of vehicles, destruction of railroads and bridges, and contamination of food and medicine.

Many single-issue terrorists, including ecological extremists and anti-abortion radicals, have used sabotage widely. These groups have usually preferred to destroy property rather than to kill people. Most other terrorists tend to avoid sabotage as they seek the media coverage that results from numerous 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.

Cyber-attack is a new category of terrorist and criminal threat. Cyber-attacks involve the use of computers, electronic devices, and/or the Internet to attack computer systems. Examples of some types of cyber-attacks include computer viruses, which damage many infected computers, denial-of-service attacks, which shut down a targeted website, and hacking attacks, which damage sensitive information. These attacks may be used as part of extortion schemes, to undermine public confidence in the target's security, as a form of technological vandalism, or as military sabotage.

Early cyber-attacks were primarily conducted by amateur computer "hackers" operating individually or in small teams. More recently, well organized groups of profit-driven professional

cyber-attackers have developed. These teams of cyber-saboteurs can operate globally, attacking targets anywhere in the world through the Internet. Their customers include organized crime, national governments, and possibly terrorist organizations. These professional cyber-attackers can be very effective because they control large networks of "zombie" computers called "botnets." These are computers taken over without their owners' knowledge and controlled remotely, often for criminal purposes.

Another possible source of cyber-attacks are "hacktivists," computer criminals motivated by a political cause rather than by a profit motive. 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. There are also a number of nationalist hacktivist organizations, some of which may be sponsored by national intelligence services. Hacktivists groups are difficult to disrupt, both because of the challenge in determining the real identity of group members, and because they may be located in countries which refuse to cooperate with international law enforcement. Hacktivists have generally confined their cyber attacks to vandalism of websites, denial of service attacks, and theft of personal information. There is however, the potential for extremist members of these politically-motivated groups to shift their activities to more destructive cyber-terrorism.

National governments are also developing sophisticated cyber-attack capabilities, both to support espionage programs and to damage the computer networks of enemies. Cyber-attacks backed by extensive national military and intelligence resources could be especially destructive and difficult to counter. One new cyber-attack capability which appears to have been deployed by government-sponsored programmers is the ability to cripple or destroy industrial machinery by taking over the software that controls the machines. Cyber-attacks on these "industrial control systems" could be used to damage critical infrastructure such as electrical grids, water treatment systems, and fuel pipelines as well as to attack industrial targets. National cyber-attack capabilities are also expected to include efforts to disrupt secure national networks such as those used for banking and by law enforcement. A cyber war between nations with sophisticated cyber-attack capabilities could be very damaging, even to innocent bystanders in the conflict.

Possible Terrorist/Criminal Targets

Terrorists typically select targets that will generate the maximum possible media coverage, but the specific types of targets selected by terrorists and criminals depend entirely on the goals of the attackers. For nationalist, left-wing, and right-wing terrorists, the preferred targets are usually buildings or people with strong symbolic meaning for their enemies. These terrorists may attack government buildings, strike public monuments, or assassinate well-known leaders. Single-issue terrorists tend to target facilities or individuals directly associated with their specific cause. For example, anti-abortion terrorists might target abortion clinics, anti-Jewish terrorists might target synagogues, and animal rights terrorists may target animal research centers. Finally, religious extremist terrorists tend to emphasize killing or injuring large numbers of victims in a spectacular manner. These terrorists might be expected to target schools, airports, mass-transportation systems, sporting events, places of worship, or entire cities.

Most terrorists will usually seek out 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, and well-protected targets can make that difficult to achieve. Terrorists rarely feel the need to strike only one specific target, so they will examine multiple targets until they find one that is vulnerable.

Targets for non-terrorist criminals are difficult to identify because criminals may have a wide range of motivations, including financial gain, personal revenge, a desire for fame, or mental illness. 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.

Significant Terrorism Incidents Affecting Dickinson County
There are no known major terrorist incidents that have affected Dickinson County; however the following are brief synopses of some of the more significant terrorism incident examples that could occur in Dickinson County in the future:

Bath School Disaster (1927)
On May 18, 1927, the Bath Consolidated School in Bath, Michigan, was the target of an attack with explosives. The bomber was probably motivated by personal revenge against the local school district (stemming from a taxation issue), and so this event is classified as criminal, rather than as a terrorist attack. Although many of the explosives failed to detonate, the bombs in the school killed dozens of students and teachers. The bomber also destroyed his home and farm with explosives. Immediately after the school attack, the bomber approached the rescue operations scene and detonated an explosive device carried in his vehicle, killing himself, local officials, and several bystanders. The final death toll was 45, with 58 additional persons injured. The Bath Disaster remains the second most deadly U.S. bombing attack, after the Oklahoma City Bombing, as well as the most lethal attack on an American school. This case also provides early examples of such tactics now in common use by terrorists, including a secondary device, suicide bombing, and car bomb.

Pontiac School Bus Bombings (1971)
On August 30, 1971, ten Pontiac school buses were bombed and destroyed in response to a controversial, court ordered busing plan to integrate Pontiac schools. Authorities believe that several individuals slipped through a hole cut in the wire fence that surrounded the Pontiac bus depot, and placed dynamite under the buses. The explosion and fire destroyed the buses and focused national attention on Pontiac and the school busing issue. Subsequent attempts to overturn the Pontiac busing plan failed, and eventually 70 other school districts across the country were ordered to implement similar busing plans to achieve racial integration in schools. The Pontiac bombers, later apprehended and convicted of the attack, were identified as members of the Ku Klux Klan.

Unabomber Bombings (1978- 1995)
Beginning in May 1978 and continuing through April 1995, a man dubbed the "Unabomber" by law enforcement and the media pulled off a series of pre-meditated bombing attacks against business and academic targets across the country (including the University of Michigan at Ann Arbor in November 1985) – all involved in one way or another with technology or technological pursuits. By the time he was captured in April 1996, the Unabomber had carried out 16 bombing attacks, killing 3 persons and injuring 23 others. The Unabomber was finally caught after he issued his famous "manifesto" against industrialization, which was published in the Washington Post and New York Times. The bomber's brother recognized the writing style as that of his brother and contacted the FBI. The bomber was arrested at his remote cabin in Montana, tried and convicted in 1998, and sentenced to four consecutive life sentences.

World Trade Center Bombing (1993)
One of the highest profile incidents – and certainly the one that awoke the United States to the emerging threat of domestic sabotage / terrorism – was the World Trade Center bombing in New

York City on February 26, 1993. That attack resulted in six deaths and 1,000 injuries. Fortunately, the intended plan of total structural collapse did not occur, saving thousands from certain death. Several members of Middle East extremist organizations have been convicted for their role in this bombing.

Oklahoma City Federal Building Bombing (1995)
On April 19, 1995, the Alfred P. Murrah Federal Building in Oklahoma City, Oklahoma, was attacked by a large truck bomb. The attack killed 168, injured more than 680, destroyed the building, and caused widespread destruction over a sixteen-block area. Although initially suspected of being carried out by international terrorists, the attackers were in fact anti-government domestic terrorists, one of whom had extensive Michigan connections. This attack is an example of right wing anti-government terrorism. It also demonstrates the extensive destruction that can be caused to large buildings which lack adequate target hardening and security measures.

Summer Olympic Games Bombing (1996)
On July 27, 1996 a bomb exploded at a concert at the Summer Olympic Games in Atlanta, Georgia, killing one person and injuring 118 others. One suspect at the scene was initially detained by law enforcement officials, but was later cleared of any wrongdoing. It was later determined that Eric Rudolph was the actual suspect and was captured.

U.S. Embassy Bombings (1998)
On August 7, 1998 simultaneous bombings of U.S. Embassies in Nairobi, Kenya and Dar Es Salaam, Tanzania killed 224 persons (including 12 Americans) and injured another 5,486. Eighteen persons – including Saudi exile Osama bin Laden – have been indicted in the two bombings. Four of the 18 have been convicted for their part in the attacks.

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 of 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 close proximity. It also illustrates the short duration of most mass shooting attacks and the need for a very rapid law enforcement response.

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

9/11 Airliner Attacks (2001)

On the morning of September 11, 2001, terrorists hijacked four commercial airliners originating from Boston Logan Airport, Newark International Airport, and Washington Dulles International Airport and then deliberately crashed the aircraft into the World Trade Center in New York City, and the Pentagon in Arlington, Virginia (with a fourth crashing in rural Pennsylvania), killing approximately 3,000 persons and causing billions of dollars in property damage. This coordinated attack was the deadliest act of terrorism in history. The attack would have been even worse had the fourth aircraft hit its intended target, which was presumed to be the White House in Washington, D.C. Instead, passengers attacked the hijackers, probably causing them to crash the aircraft into the open field in Pennsylvania.

Although these attacks began as hijackings, they may be classified as 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.

These attacks caused major disruption to airline travel, including a temporary ban on all civilian flights in the United States. Significant and expensive changes were made to improve security at airports and aboard aircraft. Substantial damage was caused to the overall U.S. economy, due to the direct and indirect costs of the attacks. With the 9/11 attacks as justification, the United States and its allies launched major military campaigns in Afghanistan, Iraq, and Pakistan that have cost tens of thousands of lives and trillions of dollars. This one terrorist operation, conducted by 19 men armed with knives, continues to have global repercussions years after the event.

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 terrorist tactics were unexpected, and terrorists will continue to attempt to surprise their targets with new weapons and techniques. These attacks also illustrate that a major terrorist attack can have repercussions that extend well beyond the immediate scene of the attack.

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 content of the contaminated letters had initially suggested that Islamic terrorists were responsible for the attack. Following shortly after the 9/11 terrorist disaster, the Amerithrax attack was the subject of considerable media coverage and caused great national concern. Public fear was heightened by a large number of "copycat" incidents which 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. The likely motive was personal and professional gain, as the attacks increased funding for the researcher's anthrax vaccine project.

This incident is an example of a criminal use of biological weapons. It demonstrates that it can sometimes be difficult to determine whether an attack is criminal or terrorist in nature. It also shows that attackers are not all foreigners or members of the radical political fringe; in this case the criminal was a highly trusted government employee.

Washington D.C. Sniper Attacks (2002)
The Beltway sniper attacks took place during three weeks of October 2002 in the eastern United States. Ten people were killed and three others critically injured by spree killers in and around Washington D.C., in various locations throughout the Baltimore-Washington Metropolitan Area, and along Interstate 95 in Virginia. The shootings occurred at gas stations and in parking lots outside supermarkets, restaurants, and schools in a rough circular pattern around Washington. The victims were apparently selected at random, crossing racial, gender, and socioeconomic categories. The locations of the attacks always had close freeway access. It was later learned that the rampage apparently began the month before with murders and robbery in other states which had resulted in 3 deaths. The sniper attacks finally ended on October 24, when police arrested John Allen Muhammad and Lee Boyd Malvo at a highway rest area in Maryland after receiving two telephone tips from alert citizens. It was later learned that the three-week-long rampage was motivated, at least in part, by a plot to extort $10 million from government agencies. In 2004, Muhammad was sentenced to death and Malvo to several sentences of life imprisonment without parole in Virginia for several of the attacks.

Byron Center Meat Tampering (2003)
In January 2003, a disgruntled employee intentionally contaminated 250 pounds of ground beef sold at a local supermarket in Byron Center (Kent County), Michigan. 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.

July 2009 Cyber-Attacks (2009)
On the 4th of July, 2009, a series of cyber-attacks were directed against computer systems in the United States and in South Korea. Targets included the websites of the U.S. State Department, the U.S. Department of Defense, the White House, numerous South Korea government agencies, a large bank, and a major South Korean media company. The attacks were designed to shut down the targeted websites by overloading them with traffic. 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. The cyber-attack software was also designed to damage the computers in the botnet several days after the start of the attack. Some experts believe that the attack was sponsored by the government of North Korea, perhaps with the help of criminal networks operating outside of that country. As with many cyber-attacks, it has been impossible to definitively prove who was responsible for the attacks. This case demonstrates the significant economic and governmental disruption which can be caused by even primitive cyber-attacks. It also demonstrates that the geographic locations of the cyber attackers and of their targets are largely irrelevant. Attacks can be launched from anywhere, to anywhere, through the use of the Internet.

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. Maj. 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, Maj. Hasan does not fit the expected terrorist profile, which may have enabled him to avoid detection as a deadly threat.

Northwest Airlines Flight 253 Bombing Attempt (2009)

On Christmas Day 2009, Umar Farouk Abdulmutallab attempted to destroy Northwest Airlines Flight 253, approaching Detroit Metropolitan Airport. The weapon used was an explosive device provided by the "al-Qaeda in the Arabian Peninsula" terrorist group and hidden in his underwear. The device was small and easy to conceal, but was capable of damaging or destroying the airliner. The explosive failed to detonate properly and instead ignited and burned Mr. Abdulmutallab, who was then subdued by the plane's passengers and crew. This attack demonstrates the potential effectiveness of even small bombs when used against vulnerable targets such as aircraft. It also demonstrates that international terrorism may be directed at targets in Michigan.

Highway Shootings (2012)

During October 2012, a man shot at cars as they drove along and near a Michigan highway corridor in Oakland, Ingham, Shiawassee, and Livingston counties, over the span of several days. The first car was shot in Commerce Township on October 16th. On that same day, four more shootings occurred in Wixom. On the next day, another Commerce Township shooting took place near the same location as the first day. The northernmost shooting occurred in Perry on October 18th. On that same day, there were eight shootings near the I-96 exit in Webberville. There was also an October 18th shooting in Howell, and six shootings in Wixom. About a week later, on October 27th, two shootings occurred along Grand River and I-96 in the area of Fowlerville, and a driver on I-96 reported being injured by a bullet (the only such instance reported). During his trial, the shooter claimed that shooting at vehicles was connected to a condition of mental illness. Investigators connected him with 24 shooting incidents in the area. In 2014, a Livingston County jury convicted him of terrorism and he was sentenced to 16 to 40 years. This was in addition to a sentence of at least 6 years received in Oakland County. It is possible that additional charges may be sought in Ingham and Shiawassee County. NOTE: Media headlines often simplified these incidents by referring to them as involving "The I-96 Shooter," even though most incidents did not involve Interstate traffic.

Sandy Hook School Shooting (2012)

On December 14, 2012, 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 twenty 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.

Boston Marathon Bombings (2013)
On April 15, 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 faced numerous federal terrorism charges, resulting in him receiving the death penalty. 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.

Risk : moderate
Rating : 10th

Vulnerability: Aside from prank bomb threats at local schools, there is no record of terrorist acts in the county.

Although the means and location of a terrorist action could impact any area of the county, places where large numbers of people congregate or are housed such as schools, churches, nursing homes and the hospital would be most affected by an act of terrorism. Therefore, urban areas of the county (City of Iron Mountain, Kingsford, Norway and Breitung Township) would be most vulnerable. While acts of terrorism do not seem likely in Dickinson County, they are possible and carry a large potential for harm to humans and property.

A major terrorist action in an urbanized area could trigger and influx of people into the county in search of safety and quiet. A large and rapid population convergence on the county could strain local resources, possibly to a dangerous level.

While no acts of bioterrorism types of events have occurred in the county, a large percentage of the population could be affected if an agent was introduced where large numbers of people congregate or through public water supplies. The extreme southwestern area of the County (Iron Mountain, Kingsford and Breitung Township) has over 70 percent of the total population and would be the most vulnerable.

Sabotage of public water supplies would nearly affect populations where water and storage facilities are located: Iron Mountain, Kingsford, Norway and Quinnesec. A major event would stress existing medical capacities. High casualties and elevated community anxiety would be likely. Currently, public health and medical staff are working on preparedness activities.

Workplace Violence

Hazard description: Rowdy, threatening, unlawful, or otherwise aberrant behavior within places of employment.

Workplace violence is a serious and deadly hazard. Incidents of assaults or threats to employees or supervisory personnel by discharged, disgruntled, or otherwise emotionally unbalanced employees seem to be on the rise. Tragic incidents of workplace violence have spawned a variety of resources aimed at early interdiction to underlying causes. Recordable incidents are absent from the public record.

Significant Workplace Violence Incidents Affecting Dickinson County
Following are brief synopses of some of the more significant workplace violence incidents that have affected Dickinson County in recent decades:

In recent history, there are no known workplace violence incidents that have affected Dickinson County.

Risk : moderate
Rating : 21st

Vulnerability: Incidents of workplace violence are absent from the public record. Citizens, for the most part, interact with one another and know their co-workers and neighbors. An incident would affect the victim(s) and have little impact on property.

School Violence

Hazard description: Rowdy, threatening, unlawful, or otherwise aberrant behavior within educational facilities.

The reported incidents of serious school violence over the past decade have increased. Multiple shooting incidents at various school locations around the nation have resulted in the implementation of new security and preventative measures.

Schools are required to report incidents of crime annually. A categorical listing of crimes is intended to assist schools and communities to develop appropriate prevention programs.

Significant School Violence Incidents Affecting Dickinson County
Following are brief synopses of some of the more significant school violence incidents that have affected Dickinson County in recent decades:

In recent history, there are no known school violence incidents that have affected Dickinson County.

Risk : low
Rating : 28th

Vulnerability: There is no record of serious violence occurring in area schools as defined by PA 102. While an elevated concern exists in view of tragic national events and cultural changes, violence constituting criminal action has not been experienced.

School violence events could affect one or several persons. Property damage would be limited to school structures and equipment.

Public Assembly Events

Hazard description: Publicized congregations of people, admitted with or without fee, and held for entertainment, enrichment, socialization or education purposes.

Public gatherings are important for all sorts of reasons. The movement of people to, from and within such events can temporarily overload ingress, egress and control capacities and create a hazardous situation.

Large assembly events occur year-round and include:

•Dickinson County Fair (Norway township), September
•Pine Mountain Ski Jumping (Breitung township), February, 10,000
•School sporting, musical, theatrical, graduation and extra-curricular events
•Leif Ericsson Parade (Norway), October
•Lake Antoine Fishing Derby, February
•Tip-Up Town (Sawyer Lake), February

Significant Public Assembly Event Incidents Affecting Dickinson County
Following are brief synopses of some of the more significant public assembly event incidents that have affected Dickinson County in recent decades:

In recent history, there are no known public assembly event incidents that have affected Dickinson County.

Risk : low
Rating : 29th

Vulnerability: Numerous large public gatherings are held throughout the year. Most are family-type events that attract people of all ages and take place in the more urbanized southern-portion of Dickinson County such as the Cities of Iron Mountain and Norway and Breitung and Norway Township. Law enforcement activity is at a level ordinarily expected with such events. Vulnerability is present in any such situation with large crowds and heavy traffic. Attendees, assembly site and adjoining properties could be harmed. Effective crowd and traffic control capacity is limited.

Civil Disturbance

Hazard description: Collective behavior that results in a significant level of law breaking, perceived threat to public order, or disruption of essential functions and quality of life.

Civil disturbances can be classified within the following four types: (1) acts or demonstrations of protest, (2) hooliganism, (3) riots, or (4) insurrection. Since most of these types of disturbance share similarities with each other, and the classifications presented here are not absolute and mutually exclusive, **it is recommended that this entire section be studied as a whole**. The descriptions that follow, while roughly organized by type of disturbance, provide information of interest in evaluating and understanding all types of civil disturbance, and therefore should not be treated as independent subsections or read in isolation from each other.

The first type, protest, usually contains 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 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 disturbance events. 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.

The second category of civil disturbance, 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. The majority of 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 are added only by a small minority of participants after the disturbances have already begun, but in other circumstances, 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.

The third type, riots, may stem from motivations of protest, but lacks 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 community that is sufficiently cohesive may quickly take on a set of shared leaders and clear organization, such as a march or chant that is clearly in the form of a protest or demonstration, but in an area that doesn't have the same cohesiveness and shared norms and values, a relatively chaotic form of expression may take place instead, involving assaults, intimidation, and unlawfully destructive expressions of discontent, possibly including the victimization of innocent citizens or businesses who have been selected by part of the crowd to function as scapegoats during their expression of discontent. In addition to the sentiments of discontent that may have sparked the initial activities, however, 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.

The fourth type of civil disturbance, 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 reemerge 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, q.v.)

Hazard Analysis

Violent protests, disturbances, and riots have occurred throughout our nation's history. The Stamp Act Riots in the American Colonies in the 1760s, the "Boston Tea Party," and the Revolution itself involved riots and insurrection, as discontent escalated into organized international conflict. Though these events have occurred in the past, they are not considered an acceptable part of ordinary modern life.

Although destructive civil disturbances are rare, the potential is always there for an incident to occur. It is possible that risks for future disturbances may be exacerbated today by the ability of modern mass media (television, radio, the Internet, and various wireless communication devices) to instantly relay information (factual or not), in real time, to large numbers of people. That coverage may help to spread awareness of protests, discontent, riots, disorderly "parties," or other incidents to other areas or interested groups and persons, potentially exacerbating an already difficult situation. For example, media coverage of certain events has, in the past, spurred uprisings inside prisons. Communications technologies were also important in swelling the numbers of "Cedar Fest" revelers in recent East Lansing disturbances. Real-time media coverage of unfolding events is a fact of modern life that is inescapable. As a result, law enforcement officials must be skilled in monitoring all forms of media coverage to anticipate public and perpetrator actions and event progression.

Civil disturbances might be separated into several sub-categories of disturbance that could affect a community.

1. Disturbances that center around a particular facility: the facility could be a prison, a courthouse or other center of government, a stadium or other public meeting place, where large numbers of people may at some point gather in a disruptive fashion that is threatening to the community, its businesses, residents, or quality of life. Typically, a risk assessment would examine the history of the facility, and similar facilities in other communities. Such historical information might identify particular conditions that may cause collective behavior to get out of hand. The degree to which a community contains facilities and conditions that have been associated with civil disturbances will indicate the amount of risk that it faces from civil disturbances.

2. Disturbances that arise in general areas experiencing conflict and hardship: This refers to neighborhoods or regions that have experienced one or more economic, social, or political stresses such as poverty, ethnic intimidation, corruption, and/or the notable presence of illegal activities. These ongoing conflicts and challenges may sometimes flare up into more widespread and blatant conflicts and unrest. The important thing to recall about these sorts of civil disturbances is that it is the presence of these conflicts and problems (rather than a particular ethnic or demographic composition) that eventually generates broader disturbances. Care must be taken not to inappropriately "profile" areas based on the characteristics of their residents.

3. Disturbances that interfere with normal business functions: Sometimes, protests are organized in a way that is deliberately designed to disrupt the normal operations of one or more businesses, and may also happen to disrupt surrounding business operations or traffic flows nearby. Many such incidents are political, and eventually addressed through court actions or legislative proceedings. Labor negotiations may have associated employee unrest, including strikes. Protesters may object to the existence of specific facilities or businesses, or their location in a specific area, and while seeking to make such a business or its associated activities illegal, may attempt to take more direct action against its employees or patrons. Typically, the perceived harm from such businesses are either from environmental impacts or injury to persons, or social impacts concerning the image or moral standards associated with an area. In other cases, a political demonstration may not have anything to do with the sorts of facilities or businesses in an area, but merely seeks the most crowded and inconvenient location so as to maximize the attention that it receives.

There is no specific "formula" recommended here for analyzing civil disturbance hazards, but it is probably helpful to include a historical approach that specifically addresses the social conflicts and political controversies affecting disturbance-prone areas of a community. The various costs of past events (crowd control, vandalism, arson, business disruption and closures, injuries, diverted traffic, negative economic impacts) can be estimated along with their past frequency (e.g. three times in the past hundred years) so as to produce an estimated annual cost. The history of cities with similar conditions can also be analyzed in this way, because the risk of a disturbance may be present even though there have not yet been any historic local events. This is particularly true for communities with newly-developed facilities, in rapidly growing areas, or experiencing significant social and economic changes. Their risk of civil disturbance may be increasing but there is not yet a local history of incidents that can be generalized from.

Michigan operates 44 prisons and 13 prison camps. Prisons security levels range from VI (highest) to Level I (easily managed prisoners). The 68-bed Dickinson County Correctional Facility houses both male and female prisoners. Sentences for less serious crimes or first time offenders may be served in halfway houses or through home confinement monitored electronically.

Public meetings or proceedings dealing with controversial issues carry an elevated risk of unruly behavior. This includes meetings at every level of government and places where decisions affecting individuals are rendered such as courtrooms and regulatory/compliance agencies. Demonstrations for or against something are usually peaceful but can transform to unruly quickly under certain circumstances. Celebrations are generally associated with some special accomplishment that joins people together. Normally celebrations are peaceful and fun for the participants, but can get out of hand - particularly if the partying involves alcohol consumption.

Significant Civil Disturbance Incidents Affecting Dickinson County
Following are brief synopses of some of the more significant civil disturbance incidents that have affected Dickinson County in recent decades:

Early 1800s Statewide
Native-American resistance to pressures that were compelling land cessions (the first of which took place in 1795), and widespread activity organized by Tecumseh (a Shawnee chief) led to direct military conflict. The famous Battle of Tippecanoe took place in Indiana on the morning of November 7, 1811, killing dozens and wounding several hundred of the forces on both sides. American suspicion that the British may have encouraged various Native American hostilities was one of the major reasons leading to the War of 1812, and during that conflict, certain tribes fought and killed numerous American citizens in Michigan. Overall harm to the Native American tribes was far greater in the long run. Various Native American migrations took place, often compulsory to a greater or lesser extent. A large part of the Potawatomi moved west in the 1830s. The final land cession in Michigan took place in 1842.
July 1913 to 1914 Upper Peninsula (including Dickinson County)
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 down in the area, and nearly 15,000 miners stopped work. Rioting and violence was 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 started, to try 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. By early 1914, the union announced that it was giving up the strike.

Risk : low
Rating : 30th

Vulnerability: While minimal incidents are found in the historical record, a single highly emotional issue can quickly trigger a disturbance. In the unlikely event that such a disturbance was to occur, crowd control capacities would be challenged. Casualties and property damage would be limited to a specific area of the county and a small percentage of the population.

Economic Adversity

Hazard description: A situation characterized by business downturns and closings and severe labor force reductions.

Employment base losses due to closure or relocation and serious business downturns - especially if prolonged - can bring about tremendous hardship and pressure on a community and its people. Desperation can lead to uncharacteristic and destructive behavior. An area is likely to experience population losses during hard times as people relocate to areas with better employment prospects. As disposable personal income dwindles, local businesses will find it more difficult to remain in operation. Moreover, as private and public investment wane, the physical condition of structures and infrastructure will likely degrade.

The last severe and prolonged economic period was the Great Depression. With lifestyle changes, technology and a plethora of assistance programs, it is unlikely that those extreme difficulties will be repeated. In addition to the 9.1 percent of the county residents whose incomes fall within government poverty standards, there are many individuals and families that are perilously close to those levels.

Significant Economic Adversity Incidents Affecting Dickinson County
Following are brief synopses of some of the more significant economic adversity incidents that have affected Dickinson County in recent decades:

1874 to 1879, 1883 to 1885, 1893 to 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 over-supply 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.
March 6, 1930 – National Protests
As the full effects of the Great Depression were being felt, discontent became organized into a nationwide series of gatherings, which included the involvement of communist groups. In Detroit, many tens of thousands participated, and violence resulted when protesters resisted police efforts to disperse them.

Risk : low
Rating : 30th

Vulnerability: Dickinson County has strong employment in the service, manufacturing and retail trade industries. Unemployment rates in the County, while higher than the State average, are typically among the lowest in the Upper Peninsula. Strong economic ties also exist with neighboring Wisconsin, making this hazard a lower possibility.

However, a prolonged economic slump, closure of a major employer, or a collapse of the financial market would impact nearly all persons living in the county. A decrease in property values, business, employment and investment would occur commensurate with the severity of the economic situation. A corresponding increase for services could be expected that would exceed local capacities.

Identified Hazards with Affected/Vulnerable Facilities

Throughout Dickinson County, there are a number of critical services/facilities that are potentially vulnerable, or at risk to be affected by identified hazards. Data presented below identifies both the number of such facilities and the names of the facilities. Table 13 shows which facilities/services are potentially at risk or would be affected by each identified hazard for the county. It should be noted that no new facilities are planned within the five-year planning period.

Dickinson County Critical Facilities

2 hospitals;	Dickinson County Memorial Hospital, Veterans Affairs Medical Center
1 health department;	Dickinson-Iron District Health Department
13 police/fire departments;	Dickinson County Sheriff Dep., Iron Mountain Police Dep., Kingsford Public Safety Dep., Norway Police Dep., Michigan State Police Post (Iron Mountain), Breen Twp. VFD, Breitung Twp. VFD, Felch Twp. VFD, Sagola Twp. VFD, West Branch Twp. VFD, Iron Mountain FD, Kingsford DPS, Norway VFD
4 emergency medical services;	Beacon Ambulance Service, Nordic Ambulance Service, North Alert Ambulance Service, Ambulance Star Ambulance Service
1 solid waste facility;	Dickinson County Solid Waste Management Authority
1 jail facility;	Dickinson County Sheriff Dept.

Dickinson County Public Infrastructure

4 municipal water systems;	Iron Mountain, Kingsford, Norway, Quinnesec
4 municipal wastewater systems;	Iron Mountain-Kingsford, Norway, Channing, Sagola
2 electrical service providers;	City of Norway, Wisconsin Electric Power Company
2 telephone service providers;	Ameritech, U.P. Telephone Company

Dickinson County Education Facilities

7 public school buildings;	Breitung Twp., Iron Mountain, Norway-Vulcan, North Dickinson
3 private school buildings;	Dickinson Area Catholic Schools, Holy Spirit Catholic School, Pine Mountain Christian Academy (SDA)
3 Headstart centers;	Kingsford, Norway, Felch

Table 13	
Identified Hazard	**Affected/Vulnerable Facilities & Infrastructures**
Tornadoes	All facilities and infrastructures
Public Health Emergencies	Water systems, hospitals, police/fire departments, emergency medical services
Bioterrorism	Water systems
Hazardous Materials Accidents – Transportation	Hospitals
Earthquakes	All facilities and infrastructures located in southern Dickinson County
Snowstorms	Hospitals, police/fire departments, emergency medical services, educational facilities
Structural Fires	Hospitals, health department, police/fire departments, educational facilities
Hazardous Materials Accidents - Fixed Site	Hospitals, emergency medical services, police/fire departments
Terrorism, Sabotage, WMD	Educational facilities, hospitals
Lightning & Thunderstorms	Electrical service providers, telephone service providers
Infrastructure Failures	Water systems, wastewater systems, electrical service providers, telephone service providers
Dam Failures	Facilities located along Menominee River
Severe Wind	Electrical service providers, telephone service providers
Ice & Sleet Storms	Hospitals, health department, police/fire departments, emergency medical services, electrical service providers, telephone service providers, educational facilities
Temperature Extremes	Water systems, wastewater systems
Drought	Water systems
Workplace Violence	Hospitals, educational facilities
Urban Flooding	Water systems, wastewater systems
School Violence	Educational facilities
Public Assembly Events	Educational facilities
Scrap Tire Fire	Solid waste facility

Identify and Prioritize Strategies

The Hazard Analysis results outlined in the previous section helped guide the goals and strategies in this section. However, the issues, goals and strategies below are the culmination of many meetings and discussions with various hazard mitigation participants in Dickinson County: the Emergency Management Coordinator, Local Emergency Planning Committee, Fire Training Association, Township and City Officials, etc.

Issues, Goals, and Strategies

Issue(s): There is a need for more communication with the public and local officials on emergency preparedness and availablity for emergency preparedness grant funding.

Goal: Provide aqdequate coordination, support and funding for emergency management and first responder services in Dickinson County.

Strategies:

- Research grant opportunities related to emergency management and provide this information to communties.
- Strengthen the County LEPC through recruitment of diversified municipal representation and public education of the LEPC functions and progress.

Issue(s): Severe winter weather (snowstorms, ice and sleet, extreme cold) and weather associated with thunderstorms (high winds, hail, lightning) are seasonal hazards in Dickinson County. NOAA weather radio coverage is poor in the county. The recent tornado that struck southern Dickinson pointed to weaknesses in facilities during a power failure.

Goal: Improve the capacity of Dickinson County to respond to and prepare for severe weather-related incidents.

Strategies:

- Increased coverage and use of NOAA Weather Radio.
- Maintain and improve/expand emergency warning systems in communities across the county.
- Educate the public about emergency warning systems available in Dickinson County.
- Indentify existing shelter locations, strengths and weaknesses.
- Correct shelter weaknesses by updating equipment, providing adequate generators, and educate the public on the availability of shelters in an emergency.
- Insure critical facilities in the County have adequate emergency power generators to better address emergencies across the area.
- Construct storm shelters in public buildings and areas where vulnerable populations are located (ex. Mobile home parks).

Issue(s): About eighty percent of the County population lives along trunklines (US-8, US-141, US-2, and M-95) and railroad lines which are routes for hazardous materials. The US-2 corridor is intensely developed and commercial development continues to grow contributing to traffic accidents.

Goal: Minimize the possibility of hazardous materials and general transportation accidents in the County and increase the County's ability to deal with such incidents.
Strategies:

- Insure firefighters countywide have the appropriate training and equipment to respond to a variety of transportation accidents and those involving hazardous materials.
- Continued hazardous materials transportation preparedness activities for first responders.
- Support access management planning and implement access management techniques along the County's highway corridors.
- Improved design, routing, and traffic control at problem roadway areas.

Issue(s): A public health or bioterrorism event in Dickinson County would affect large portions of the population and cause high casualties. Medical, public health, and other agencies are not fully prepared for this type of event.

Goal: Increase the County's capability to prepare and respond to public health emergencies and bioterrorism events.

Strategies:

- Countywide training and equipment to respond to a public health and bioterrorism event.
- Develop plans to cover situations.
- Education of emergency preparedness.

Issue(s): Extensive underground mining activity has taken place in Dickinson County for over a hundred years and cave-ins have been experienced in the southern portion of the County. Local governments do not know where all mineshafts and tunnels are lcoated therefore cannot accurately assess the risk of cave-ins.

Goal: Reduce the risk of property damages and loss of life from subsidence of old mining areas and earthquakes in the County.

Strategies:

- Identification and mapping of old mining areas to determine the extent of risk.
- Limit or plan for new development in high-risk areas.
- Filling or buttressing abandoned mines to discourage their collapse.

Issue(s): The City of Kingsford has a Repetitive Loss Property that has not been permanetly mitigated. Flooding due to returning water levels in old mine shafts has presented problems in several communities.

Goal: Reduce flood damage to buildings and infrastructure in the County.

Strategies:

- Research and evaluate feasible strategies to mitigate the Repetitive Loss Property (RLP) in the City of Kingsford in coordination with the current property owner.
- Insurance of a back-up power source for pumping water from mine shafts that pose a flood threat due to elevated water levels.

Evaluation Criteria

The Dickinson County Local Emergency Planning Committee (LEPC) and Emergency Management Coordinator devised criteria to evaluate the proposed strategies. The criteria introduces a system fo points for strategies that affect large or small groups of people, recurring hazards, property damage, cost effectiveness, and natural resources.

With agreement of the LEPC as a whole, a subcommittee used the evaluation criteria to "weight" mitigation strategies for the issues listed earlier in this chapter. Larger point values were given to strategies that: affect large groups of people, mitigate recurring hazards, attempt to reduce property damage countywide, are cost effective to implemetn and use local resources. The results of this process are described in the Mitigation Strategies section.

Table - 14

	Evaluation Criteria	Points
A	•The project/alternative protects the health, safety, and general welfare of the greatest number of residents (countywide, at least ½ the population, less than ½ the population).	25 - 15 - 5
B	•The project/alternative mitigates a recurring problem.	20
C	•The project/alternative is intended to reduce property damage to structures community-wide.	15
D	•The project/alternative is intended to reduce property damage to selected areas of a community.	10
E	•The project/alternative is cost effective for the community.	20
F	•The project/alternative can be implemented using only local resources (100% local resources, less than 100%)	10 - 5
G	•The cost of the project/alternative does not exceed the anticipated cost of probable damage (if an event occurs).	5
H	•The project/alternative is intended to protect the area's natural resources. (forests, surface water, etc.)	5

Mitigation Strategies

Below are the results of using the evaluation criteria to “weight” the hazard mitigation strategies discussed in the Issues, Goals, and Strategies section.

Table - 15

Strategies	Points
Increased coverage and use of NOAA Weather Radio.	70
Continued hazmat transportation preparedness activities for first responders.	65
Educate the public about emergency warning systems available in Dickinson County.	63
Education of emergency preparedness.	62
Insure firefighters and other first responders countywide have the appropriate training and equipment to respond to a variety of transportation accidents and those involving hazardous materials.	60
Develop/update plans to cover situations (public health and bioterrorism events).	60
Maintain and improve/expand emergency warning systems in communities across the County.	48
Strengthen the County LEPC through recruitment of diversified municipal representation and public education of the LEPC functions and progress.	47
Research grant opportunities related to emergency management and provide this information to communities.	43
Identify existing shelter locations, strengths and weaknesses.	43
Insure critical facilities in the County have adequate emergency power generators to better address emergencies across the area.	43

Table - 15

Strategies	Points
Filling or buttressing abandoned mines to discourage their collapse.	43
Improved design, routing, and traffic control at problem roadway areas.	42
Correct shelter weaknesses by updating equipment, providing adequate generators, establishing shelters for vulnerable populations (ex. mobile home parks) and educate the public on the availability of shelters in an emergency.	40
Research and evaluate feasible strategies to acquire, elevate or demolish the RLP in the City of Kingsford in coordination with the current landowner.	40
Construct storm shelters in public buildings and areas where vulnerable populations are located (ex. mobile home parks)	40
Support access management planning and implement access management techniques along the County's highway corridors.	40
Limit or plan for new development in high-risk areas.	38
Identification and mapping of old mining areas to determine the extent of risk.	30

Action Plan

The overall purpose of this plan is to identify strategies to mitigate the hazards identified to reduce threats to public safety and property. These strategies strive to mitigate the higher risk hazards of severe weather, public health emergencies, bioterrorism, hazardous materials-transportation accidents, subsidence/earthquakes, transportation accidents, and specific issues regarding flooding.

Mitigation Actions

This section describes the action to be taken, the agency responsible, and available funding source if known. The three main federal funding sources for hazard mitigation are:

HMGP= Hazard Mitigation Grant Program
PDMP= Pre-Disaster Mitigation Program
FMAP= Flood Mitigation Assistance Program

If applicable, these funding sources were listed under each action. Other funding sources were listed if known. In many instances staff time was the only needed resource. Additional information on available hazard mitigation funding can be found in EMHSD/MSP Pub. 207a – Funding Sources for Hazard Mitigation. Pub. 207a is a comprehensive document listing Federal, State, and private hazard mitigation funding sources.

The following "Hazard Related Actions" are listed in order of priority as explained in Table-15 Strategies. At the end of this section, Table-16 summarizes the actions and agencies/personnel responsible. Of note the responsible local government agency to carry out an action is stated generally as Local Units of Government.

The deadline for completion of the following actions has been purposely omitted. Local government budget concerns dictate that project implementation would depend largely on securing grant funding. Therefore, the agencies and organizations are responsible for the following strategies permitted adequate funding and availability of resources.

<u>Hazard Related Actions</u>

•*Action*: Increased coverage and use of NOAA Weather Radio.
Responsible Agency: County Emergency Services
Funding Source: PDMP, HMGP

•*Action*: Continued hazardous materials transportation preparedness activities for first responders.
Responsible Agency: County Emergency Services, Fire Departments, Law Enforcement, Emergency Medical Services, and Public Health.
Funding Source: N/A

•*Action*: Educate the public about emergency warning systems available in Dickinson County.
Responsible Agency: County Emergency Services
Funding Source: Staff time

•*Action*: Education of emergency preparedness.
Responsible Agency: County Emergency Services, Emergency Medical Services, and Public Health
Funding Source: Staff time

•*Action*: Insure firefighters and other first responders countywide have the appropriate training and equipment to respond to a variety of transportation accidents and those involving hazardous materials.
Responsible Agency: County Emergency Services, Fire Departments
Funding Source: Assistance to Firefighters Grant Program

•*Action*: Develop/update plans to cover situations (public health and bioterrorism events).
Responsible Agency: Emergency Medical Services and Public Health
Funding Source: Staff time

•*Action*: Maintain and improve/expand emergency warning systems in communities across the County. (ex. sirens)
Responsible Agency: County Emergency Services, Local Units of Government
Funding Source: PDMP, HMGP

•*Action*: Strengthen the County LEPC through recruitment of diversified municipal representation and public education of the LEPC functions and progress.
Responsible Agency: LEPC, County Emergency Services
Funding Source: Staff time

•*Action*: Research grant opportunities related to emergency management and provide this information to communities.
Responsible Agency: County Emergency Services
Funding Source: Staff time

•*Action*: Identify existing shelter locations, strengths and weaknesses.
Responsible Agency: Red Cross, County Emergency Services
Funding Source: Staff time

•*Action*: Insure critical facilities in the County have adequate emergency power generators to better address emergencies across the area.
Responsible Agency: County Emergency Services, Local Units of Government
Funding Source: HMGP

•*Action*: Filling or buttressing abandoned mines to discourage their collapse.
Responsible Agency: County Emergency Services, Local Units of Government
Funding Source: HMGP, PDMP

•*Action*: Improved design, routing, and traffic control at problem roadway areas.
Responsible Agency: MDOT
Funding Source: MDOT

•*Action*: Correct shelter weaknesses by updating equipment, providing adequate generators, and educate the public on the availability of shelters in an emergency.
Responsible Agency: County Emergency Services, Red Cross
Funding Source: Staff time

•*Action*: Research and evaluate feasible strategies to acquire, elevate or demolish the RLP in the City of Kingsford in coordination with the current landowner.
Responsible Agency: Local Unit of Government, County Emergency Services

Funding Source: HMGP, PDMP

•*Action*: Construct storm shelters in public buildings and areas where vulnerable populations are located. (Ex. mobile home parks)
Responsible Agency: Local Units of Government, County Emergency Services
Funding Source: HMGP

•*Action*: Support access management planning and implement access management techniques along the County's highway corridors.
Responsible Agency: Local Units of Government
Funding Source: Staff time

•*Action*: Limit or plan for new development in high-risk subsidence areas.
Responsible Agency: Local Units of Government
Funding Source: Staff time

•*Action*: Identification and mapping of old mining areas to determine the extent of risk.
Responsible Agency: Local Units of Government
Funding Source: HMGP, PDMP

Administration Actions Related to Hazard Mitigation

•*Action*: Adopt the Dickinson County Hazard Mitigation Plan.
Responsible Agency: Dickinson County Board, Local Units of Government
Funding Source: Staff time

Table – 16
Summary of Actions and Responsible Agencies

	*Improve/Expand Warning Systems	*Emergency Generators	*Increased NOAA weather coverage	Public Education	Plans, Studies, and/or Mapping	Training and Education	*Construct storm shelters	*Equipment for First Responders	*Filling or buttressing abandoned mines	*Acquire, elevate, & demolish RLP properties	Adopt Plan
County Board											X
County Emergency Services	X	X	X	X		X	X	X	X	X	
Local Emergency Planning Committee				X							
Law Enforcement						X					
Fire Service						X		X			

Emergency Medical Services				X	X	X		X			
Public Health				X	X	X		X			
Human Services		X			X						
MDOT					X						
Township/City											
Breen	X	X	X		X			X	X		X
Breitung	X	X	X		X		X	X	X		X
Felch	X	X	X		X			X	X		X
Norway	X	X	X		X		X	X	X		X
Sagola	X	X	X		X			X	X		X
Waucedah	X	X	X		X			X	X		X
West Branch	X	X	X		X			X	X		X
City of Iron Mountain	X	X	X		X		X	X	X		X
City of Kingsford	X	X	X		X		X	X	X	X	X
City of Norway	X	X	X		X		X	X	X		X

*****FEMA fundable grant project

Plan Maintenance

Maintenance of the plan consists of the responsible agencies performing the following:
• Reviewing and evaluating the original plan for changes due to new circumstances, information, or projects.
•Updating the plan on an annual or 5-year basis.
•Continued public participation in the hazard mitigation plan.

Reviewing, Evaluating, and Updating

The Dickinson County Emergency Services Department will be responsible for reviewing and updating the plan. Review of the plan is recommended annually. If the community is unable to examine the plan annually, the plan must be reviewed every five years and updated if necessary. The 5-year mandatory review and update of the hazard mitigation plan is needed due to ever changing circumstances in communities. The next mandatory update of this hazard mitigation plan will be scheduled in five years from the date of FEMA plan approval.

Reviewing and evaluating the hazard mitigation plan is crucial since changes in the type, extent, and number of hazards are likely to occur over time. For instance, the plans identified risks and hazards may increase or decrease, new hazards may be brought forward due to new development patterns, or strategies may be implemented and new ones proposed.

The County Emergency Services staff will be responsible for meeting with the Local Emergency Planning Committee (LEPC) on February of each year to evaluate the plans performance in the past calendar year. The LEPC meetings are open to the public but notice through a letter will be sent to local units of government inviting them to attend.

Suggested measures for evaluating the plan are: changes in the number, type and/or extent of risk in the county or local jurisdiction; number of mitigation strategies accomplished; implementation problems; and recommendations on new projects or revision of current action items. The plan evaluation results will be summarized into a report. The need for plan amendments or updates will be determined at this time.

The County Board of Commissioners will approve recommendations for any appropriate changes. Local governments that have adopted the County Hazard Mitigation Plan would then adopt the new amendments or new updated plan. It is recommended that the findings of the County Hazard Mitigation Plan be incorporated into other county and local comprehensive plans through procedures outlined in the County, Township and Municipal Planning Acts.

Public Participation

The County Emergency Services or other appointed agency will achieve on-going public participation. The Emergency Management Director or other appointed staff member will attend meetings at least annually to update local officials and residents on hazard mitigation and inquire on potential projects. The Emergency Management Director will meet with organizations such as: the Local Emergency Planning Committee, Township Association, Infrastructure Committee, Fire Training Association, and the County Board.

The County Emergency Services may arrange to have hazard mitigation information displayed on the County, CUPPAD Regional Commission or other organization's website. Local officials and residents alike could easily access this type of media. An appropriate agency could also utilize a newsletter in notifying local governments.

APPENDIX A

GENERAL STATISTICS, INFORMATION FOR:

Dickinson County

Breen Township

Breitung Township

Felch Township

City of Iron Mountain

City of Kingsford

City of Norway

Norway Township

Sagola Township

Waucedah Township

West Branch Township

Dickinson County

Office location	Courthouse 705 South Stephenson Avenue Iron Mountain, MI 49801
Total area*	777.12 square miles (766.34 land) 497,356.8 acres (490,457.6 land)
2010 population	26,168
Housing units	13,702
Total households	13,995
Average household size	1.86 persons
2013 state equalized valuation	$1,112,906,916

*Census 2010

Breen Township: T41N & 42N - R27W &28W

Office location	Township Hall Highway M-69 Hardwood, MI 49807
Mailing address	P.O. Box 68 Foster City, MI 49834
Phone	906.246.3555
Fax	-
E-mail	-
Total area*	88.27 square miles (87.86 land) 56,492.8 acres (56,230.4 land)
2010 population	454
Housing units	441
Primary fire department	Breen Township Volunteer Fire Department
Primary police department	Dickinson County Sheriff
School district(s)	North Dickinson County School District

*Census 2010

Breen Township is "T" shaped extending for 12 miles at its widest and longest points. It borders Menominee and Marquette counties on the south and east. More than 20 percent of the land area is managed state forest and more than 10 percent is in corporate ownership. A few commercial establishments are found along highway M-69 in the area of Foster City. The township building is in the community of Hardwood, also along highway M-69. CR569 extends north-south and connects M-69 at Foster City with and US-2 at Waucedah. Residential development is scattered, and nearly half of all housing units are camps or cottages. Some land is in agricultural crops.

Breitung Township: T39N, 40N & 41N - R30W & 31W

Office location	Township Building 3851 Menominee Quinnesec, MI 49876
Mailing address	same as above
Phone	906.779.2065
Fax	906.779.2077
E-mail	-
Total area*	68.27 square miles (65.06 land) 43,692.8 acres (41,638.4 land)
2010 population	5,853
Housing units	2,779
Primary fire department	Breitung Township Volunteer Fire Department
Primary police department	Dickinson County Sheriff
School district(s)	Breitung Township School District

*Census 2010

Breitung Township surrounds the cities of Iron Mountain and Kingsford in the southwest corner of the county. The Menominee River forms the remainder of the western and southern boundaries. It is the county's most populous township and has the highest valuation of all county civil divisions. A significant part of the valuation is due to the International Paper mill in Quinnesec, one of the area's largest employers. Highways US-2, US-141 and M-95 are the major roadways in the township. The Iron Mountain-Kingsford Wastewater Treatment Plant is within the township. Sewer and water service has been extended to parts of the township. A considerable amount of commercial development has collected along US-2. The Fumee Lake Natural Area, Lake Antoine and Pine Mountain are within the township. Residential growth in the township outpaces all other county jurisdictions. Breitung is the fastest growing residential area in the county.

Felch Township: T42N, 43N & 44N - R28W & 29W

Office location	Felch Community Center W4084 Highway M-69 Felch, MI 49831
Mailing address	P.O. Box 187 Felch, MI 49831
Phone	906.246.3573
Fax	-
E-mail	-
Total area*	143.75 square miles (143.08 land) 92,000 acres (91,571.2 land)
2010 population	752
Housing units	617
Primary fire department	Felch Township Volunteer Fire Department
Primary police department	Dickinson County Sheriff
School district(s)	North Dickinson County School District

*Census 2010

Felch Township is centered in the northern half of the county. Approximately 60 percent of the land area is managed state forest. Corporate holdings account for less than 5 percent of the total land area. Highway M-69 and county roads 577, 426 and 422 are the main transportation routes. Commercial development and a collection of residences are found in and near the community of Felch. More than 40 percent of the residential dwellings are camps or cottages. The North Dickinson School is found along the north side of M-69 about 5 miles west of the community of Felch. The Dickinson County Road Commission maintains a garage in the community of Felch.

City of Iron Mountain: T39N & 40N - R30W & 31W

Office location	City Hall 501 Stephenson Avenue Iron Mountain, MI 49801
Mailing address	same as above
Phone	906.774.8530
Fax	906.774.3774
E-mail	-
Total area*	7.8 square miles (7.2 land) 4,992 acres (4,608 land)
2010 population	7,624
Housing units	3,784
Primary fire department	Iron Mountain Fire Department
Primary police department	Iron Mountain Police Department
School district(s)	Iron Mountain Public Schools Breitung Township School District (annex of Moon Lake only)

*Census 2010

Iron Mountain (city) is the county seat and most populated jurisdiction in the county. It was at the center of iron mining activity that was the dominating economic activity from the 1880s to early 1990s. The largest mining site in the city, the Chapin, operated from 1880 to 1934. Steep terrain that yielded millions of tons of ore dominates the city landscape. Highways US-2, US-141, and M-95 move a high volume of traffic through the city. Dickinson County Memorial Hospital and the Veterans Administration Hospital are within the corporate limits. A municipal water system serves most of the city with several interconnecting locations with the Kingsford system. Wastewater is collected and treated at the Iron Mountain-Kingsford plant along the Menominee River in Breitung Township.

City of Kingsford: T39N & 40N - R31W

Office location	City Hall 305 South Carpenter Avenue Kingsford, MI 49802
Mailing address	same as above
Phone	906.774.3526
Fax	906.774.7093
E-mail	(by employee, no general address)
Total area*	4.53 square miles (4.31 land) 2,899.2 acres (2,758.4 land)
2010 population	5,133
Housing units	2,414
Primary fire department	Kingsford Public Safety Department
Primary police department	Kingsford Public Safety Department
School district(s)	Breitung Township School District

*Census 2010

Kingsford (city) is a creation of the Ford Motor Company, which operated from 1920 to 1951. Until separated by a vote of the people in 1923, Kingsford was a part of Breitung Township. The western boundary of the city is formed by approximately 4 miles of Menominee River frontage. The former Ford industrial area is largely filled with numerous manufacturing, transportation, and service entities. Environmental contamination from earlier industrial operations is an ongoing issue. Kingsford is the third most populated unit of government in the county (Iron Mountain and Breitung township have larger populations). Carpenter (US-141), Woodward, Breitung and Westwood avenues are the busiest roadways. Dickinson County Ford Airport is within the city. A municipal water system serves nearly the entire city and a part of Breitung Township. Several interconnection locations make it possible to tap into the Iron Mountain system if necessary. The municipal wastewater system is treated at the plant jointly owned with Iron Mountain.

City of Norway: T39N & 40N - R 29W

Office location	City Hall 915 Main Street Norway, MI 49870
Mailing address	P.O. Box 99 Norway, MI 49870
Phone	906.563.9961
Fax	906.563.7502
E-mail	citymanager@norwaymi.com
Total area*	8.87 square miles (8.82 land) 5,676.8 acres (5,644.8 land)
2010 population	2,845
Housing units	1,402
Primary fire department	Norway Volunteer Fire Department
Primary police department	Norway Police Department
School district(s)	Norway-Vulcan Area Schools

*Census 2010

Norway (city) is a very large geographic city (about 9 square miles). The south-central part of the city contains a distinct downtown, street grid and a concentration of residences. The remainder of the city area is suburban looking and farmland. Municipal water, wastewater, power, television cable services, and a golf course are provided in the developed areas and portions of Norway Township. The dam, wastewater treatment plant, well field and golf course are all in Norway Township.

Norway Township: T39N, 40N, & 41N - R29W

Office location	Township Hall N1732 Mission Street Vulcan, MI 49892
Mailing address	P.O. Box 495 Vulcan, MI 49892
Phone	906.563.9100
Fax	906.563.9154
E-mail	-
Total area*	90.9 square miles (89.29 land) 58,176 acres (57,145.6 land)
2010 population	1,489
Housing units	796
Primary fire department	Norway Volunteer Fire Department
Primary police department	Dickinson County Sheriff
School district(s)	Norway-Vulcan

*Census 2010

Norway Township extends from the Menominee River northward 16 miles at its longest point and is 6 miles across at its widest. It occupies the south central part of the county. More than 50 percent of its land area is state-owned, mostly as state managed forestland. The community of Vulcan contains most of the commercial development and a concentration of residences. Seasonal dwellings make up 15 percent of the housing stock. Several major tourist attractions are found in the township included Norway Mountain (skiing) and a former underground mine where tours are conducted. Highways US-2, US-8 and county roads 577 and 573 are the most important transportation routes. A mostly undeveloped industrial park is along the south side Highway US-2 east of Vulcan. The city of Norway's wastewater treatment facility, public water supply well field, and hydro project all are within the township. Services through these systems are available in the greater Vulcan area.

Sagola Township: T41N, 42N, 43N & 44N - R29W & 30W

Office location	Township Hall 306 1st Street Sagola, MI 49881
Mailing address	P.O. Box 195 Channing, MI 49815
Phone	906.542.6966
Fax	-
E-mail	-
Total area*	162.84 square miles (160.31 land) 104,217.6 acres (102,598.4 land)
2010 population	1,106
Housing units	962
Primary fire department	Sagola Township Volunteer Fire Department
Primary police department	Dickinson County Sheriff
School district(s)	North Dickinson County School District

*Census 2010

Sagola Township is the largest township in the county. It borders Iron County on the west, Marquette County on the north. Highway M-95 extends throughout the center of the township for its entire north-south length. Commercial development is concentrated in and around the communities of Channing and Sagola. Wastewater collection systems serve both communities. About one-third of the township land area is in state ownership. Corporate ownership is considerable with much of it listed under CFA. Close to half the residential dwellings are used seasonally or recreationally. Louisiana Pacific Corporation manufactures wafer board at their large, modern facility near Sagola.

Waucedah Township: T39N, 40N & 41N - R28W

Office location	Township Hall W3930 Morgan Street Loretto, MI 49852
Mailing address	P.O. Box 130 Loretto, MI 49852
Phone	906.563.9080
Fax	-
E-mail	-
Total area*	90.04 square miles (88.94 land) 57,625.6 acres (56,921.6 land)
2010 population	804
Housing units	650
Primary fire department	Norway Volunteer Fire Department
Primary police department	Dickinson County Sheriff
School district(s)	Norway-Vulcan Area Schools

*Census 2000 Summary File 1 (SF 1)

Waucedah Township occupies the southeastern corner of the county bordering Menominee County. About one-fourth of its land area is state-owned. A collection of residential development and some commercial development is found in the community of Loretto. Significant collections of homes are found along the lake areas south of US-2 and Loretto. More than 40 percent of the housing units are used seasonally. Besides US-2, the most significant roadways are county roads 573, 577 and 569.

West Branch Township: T43N & 44N - R 27W & 28W

Office location	Township Hall N10604 CR581 Ralph, MI 49877
Mailing address	P.O. Box 30 Ralph, MI 49877
Phone	906.246.3610
Fax	-
E-mail	-
Total area*	111.85 square miles (111.46 land) 71,584 acres (71,334.4 land)
2010 population	63
Housing units	145
Primary fire department	West Branch Volunteer Fire Department
Primary police department	Dickinson County Sheriff
School district(s)	North Dickinson County School District

*Census 2010

West Branch Township is the least populated of all county jurisdictions. About 90 percent of the land area is state-owned. Principal roadways, county roads 425 and 581, intersect at the community of Ralph in the southwest part of the township. The township hall, fire hall and a collection of dwellings are found in Ralph. About 80 percent of the residential housing units are used seasonally or recreationally.

APPENDIX B

HAZARD RISK ANALYSIS:

HAZARD RISK ANALYSIS

Hazards of all types were evaluated based primarily on the probability of an occurrence and severity of impact. Local residents from business and industry, police and fire agencies, emergency services, education, public health, medical services, transportation, planning and zoning, and local elected officials participated in a series of reviews and discussions. Hazards were ranked according to aspects and values determined by local evaluators. In all, some two-dozen residents participated directly in the process.

Six measures, each with a weighted value, were used in the hazard risk assessment rating and are as follows:

A.	Casualty Potential	-	30%
B.	Percent of Population Affected	-	20%
C.	Likelihood of Occurrence	-	20%
D.	Capacity to Cause Physical Damage	-	15%
E.	Size of Affected Area	-	10%
F.	Corollary Effects	-	5%

Injury and death potential was considered based on available county information and also state and national sources.

The impacted population was rated based known and potential incident locations in relation to current census data. Direct and indirect impacts were considered.

The likelihood of a particular hazard occurring is based on Dickinson County incidents to the extent that such information is available. Regional, state, and national data were used throughout.

Consideration for capacities to cause physical damage was based on hazard characteristics and historic behavior. The potential area of impact was assessed similarly. Corollary effects were determined by known and anticipated future conditions.

The sum of rating points from each of the six hazard aspects reflects an order of importance as a threat within the county. While this ranking is useful for planning purposes and is based on the most current information available and many hours of deliberation, it should not be assumed that lower ranked hazards will not occur. Most hazard events are extremely difficult to predict.

RATING TABLE - COUNTY: DICKINSON **Indicate likelihood from 1-10 with 10 representing the greatest potential**

Hazard	Casualty Potential (30%)	% Population Affected	Likelihood of Occurrence (20%)	Capacity to Cause Physical Damages (15%)	Size of Affected Area (10%)	Corollary Effects (5%)	Total Rating Score	**Rank**
1 - Wildfires	1	1	7	5	8	5	3.70	**12***
2 - Riverine Flooding	1	2	2	2	1	2	1.60	**24***
3 - Tornadoes	9	6	1	10	10	10	6.50	**1**
4 - Severe Wind	2	3	4	5	5	5	3.40	**16**
5 - Lightning & Thunderstorms	1	3	10	7	3	3	4.30	**11**
6 - Hail	1	1	2	3	3	3	1.60	**24***
7 - Snowstorms	1	8	8	2	6	6	5.00	**7**
8- Ice & Sleet Storms	3	5	3	3	3	2	3.35	**17**
9 - Temperature Extremes	3	2	2	2	10	2	3.10	**18**
10 - Drought	1	2	3	3	10	5	3.00	**19**
11- Earthquakes	7	5	1	8	5	10	5.50	**5**
12- Other Environmental (invasive, exotics, diseases, etc.)	1	1	6	3	3	7	2.80	**20**
13- Infrastructure Failures	1	9	3	2	4	6	3.70	**12***
14- Structural Fires	4	2	10	8	1	1	4.95	**8***
15- Dam Failures	2	2	4	8	2	10	3.70	**12***
16- Nuclear Power Plant Accidents	3	7	1	1	10	1	3.70	**12***
17- Subsidence	1	1	3	2	1	1	1.55	**26**
18- Scrap Tire Fires	2	2	1	1	1	4	1.65	**23**
19- Hazardous Materials Accident - Fixed Site	7	5	2	6	4	3	4.95	**8***
20- Hazardous Materials Accident - Transportation	8	5	5	3	5	6	5.65	**4**

RATING TABLE - COUNTY: DICKINSON Indicate likelihood from 1-10 with 10 representing the greatest potential								
21- Petroleum Pipeline Failures	1	1	3	1	1	3	1.50	**27**
22- Civil Disturbance	1	1	1	1	1	1	1.00	**30***
23- Terrorism, Sabotage, WMD	8	4	4	2	2	6	4.80	**10**
24- Public Assembly Events	1	1	1	1	1	2	1.05	**29**
25- School Violence	1	1	1	1	1	4	1.15	**28**
26- Workplace Violence	5	1	3	1	1	1	2.60	**21**
27- Public Health Emergencies	8	9	2	1	10	7	6.10	**2**
28- Economic Recession	1	1	1	1	1	1	1.00	**30***
29- Transportation Accidents	9	1	10	2	1	2	5.40	**6**

APPENDIX C

NATIONAL CLIMATIC DATA CENTER – WEATHER EVENTS

Table - 1 11 Tornado Events in Dickinson County 1950 - 2015 (NCDC)							
	Location or County	**Date**	**Magnitude**	**Death**	**Injury**	**Property Damage**	**Crop Damage**
1	Dickinson	4/21/74	F1	0	0	0.25K	0
2	Dickinson	6/14/81	F2	0	0	2.5K	0
3	Dickinson	7/11/87	F3	0	0	25K	0
4	Norway	7/14/95	Funnel Cloud	0	0	0	0
5	Ralph	6/10/00	F1	0	0	0	120K
6	Norway	5/30/02	Funnel Cloud	0	0	0	0
7	Kingsford	9/30/02	F1	0	0	7.0M	0
8	Quinnesec	9/30/02	F0	0	0	0	0
9	Norway	9/30/02	F0	0	0	0	0
10	Vulcan	7/27/10	EF0	0	0	10K	0
11	Vulcan	7/27/10	EF0	0	0	3K	0
			TOTALS:	**0**	**0**	**7.041M**	**120K**

Table - 2 101 Snow, Blizzard & Ice Events, Dickinson County 1950 – 2015 (NCDC)							
	Location or County	Date	Type	Death	Injury	Property Damage	Crop Damage
1	Southwest Lower	2/16/93	Heavy Snow	0	0	0	0
2	Southern	3/10/93	Heavy Snow	0	0	0	0
3	Dickinson & other counties	4/1/93	Heavy Snow	0	0	50K	0
4	Dickinson & other counties	10/29/93	Heavy Snow	0	0	0	
5	Upper Michigan	11/4/93	Heavy Snow	0	0	0	0
6	Upper Michigan & West Lower	12/20/93	Heavy Snow	0	0	0	0
7	Part of Upper & all of	1/27/94	Heavy Snow/freezing rain	0	0	5.0M	0
8	Central Upper; North	2/22/94	Heavy Snow	0	0	0	0
9	Dickinson & other counties	3/4/95	Heavy Snow	0	0	0	0
10	Dickinson & other counties	3/6/95	Heavy Snow	0	0	0	0
11	West & Central Upper	12/13/95	Heavy Snow	0	0	0	0
12	Dickinson & other counties	1/18/96	Winter Storm	0	0	0	0
13	Dickinson & other counties	1/26/96	Heavy Snow	0	0	0	0
14	Dickinson County	1/29/96	Blizzard	0	0	0	0
15	Dickinson & other counties	4/12/96	Winter Storm	0	0	0	0
16	Dickinson & other counties	4/29/96	Winter Storm	0	0	0	0
17	Dickinson County	1/15/97	Blizzard	0	0	0	0
18	Dickinson & other counties	3/13/97	Winter Storm	0	0	0	0
19	Dickinson & other counties	1/8/98	Heavy Snow	0	0	0	0
20	Dickinson & other counties	1/2/00	Heavy Snow	0	0	0	0
21	Dickinson & other counties	2/15/00	Winter Storm	0	0	0	0
22	Dickinson & other counties	11/26/01	Heavy Snow	0	0	0	0
23	Dickinson & other counties	3/8/02	Winter Storm	0	0	0	0
24	Dickinson & other counties	3/9/02	Ice Storm	0	0	0	0
25	Dickinson & other	3/15/02	Winter Storm	0	0	0	0

Table - 2 101 Snow, Blizzard & Ice Events, Dickinson County 1950 – 2015 (NCDC)							
	Location or County	Date	Type	Death	Injury	Property Damage	Crop Damage
	counties						
26	Dickinson & other counties	4/28/02	Heavy Snow	0	0	0	0
27	Dickinson & other counties	12/18/02	Ice Storm	0	0	0	0
28	Dickinson & other counties	2/3/03	Heavy Snow	0	0	0	0
29	Dickinson & other counties	2/4/03	Heavy Snow	0	0	0	0
30	Dickinson & other counties	3/28/03	Heavy Snow	0	0	0	0
31	Dickinson & other counties	4/5/03	Heavy Snow	0	0	0	0
32	Dickinson & other counties	1/7/04	Winter Storm	0	0	0	0
33	Dickinson & other counties	3/5/04	Heavy Snow	0	0	0	0
34	Dickinson & other counties	3/13/04	Heavy Snow	0	0	0	0
35	Dickinson & other counties	12/30/04	Ice Storm	0	0	0	0
36	Dickinson County	1/1/05	Sleet	0	0	0	0
37	Dickinson & other counties	11/14/05	Heavy Snow	0	0	0	0
38	Dickinson & other counties	11/15/05	Winter Storm	0	0	0	0
39	Dickinson & other counties	2/24/06	Heavy Snow	0	0	0	0
40	Dickinson County	3/13/06	Sleet	0	0	0	0
41	Dickinson & other counties	11/10/06	Heavy Snow	0	0	0	0
42	Dickinson & other counties	12/14/06	Winter Weather	0	0	0	0
43	Dickinson & other counties	12/21/06	Winter Weather	0	0	0	0
44	Dickinson & other counties	2/25/07	Winter Storm	0	0	0	0
45	Dickinson & other counties	3/1/07	Winter Storm	0	0	0	0
46	Dickinson & other counties	12/1/07	Winter Storm	0	0	0	0
47	Dickinson & other counties	1/17/08	Heavy Snow	0	0	0	0
48	Dickinson & other	2/17/08	Winter Storm	0	0	0	0

Table - 2 101 Snow, Blizzard & Ice Events, Dickinson County 1950 – 2015 (NCDC)							
	Location or County	Date	Type	Death	Injury	Property Damage	Crop Damage
	counties						
49	Dickinson & other counties	3/12/08	Winter Weather	0	0	0	0
50	Dickinson & other counties	3/31/08	Winter Storm	0	0	0	0
51	Dickinson & other counties	4/1/08	Winter Storm	0	0	0	0
52	Dickinson & other counties	4/8/08	Heavy Snow	0	0	0	0
53	Dickinson & other counties	4/11/08	Winter Weather	0	0	0	0
54	Dickinson & other counties	1/3/09	Winter Weather	0	0	0	0
55	Dickinson & other counties	1/18/09	Winter Weather	0	0	0	0
56	Dickinson & other counties	2/09/09	Winter Weather	0	0	0	0
57	Dickinson & other counties	2/14/09	Heavy Snow	0	0	0	0
58	Dickinson & other counties	2/17/09	Winter Weather	0	0	0	0
59	Dickinson & other counties	2/26/09	Winter Storm	0	0	0	0
60	Dickinson & other counties	10/12/09	Winter Weather	0	0	0	0
61	Dickinson & other counties	11/18/09	Winter Weather	0	0	0	0
62	Dickinson & other counties	12/8/09	Winter Storm	0	0	0	0
63	Dickinson & other counties	4/7/10	Winter Weather	0	0	0	0
64	Dickinson & other counties	12/11/10	Winter Storm	0	0	0	0
65	Dickinson & other counties	12/21/10	Winter Weather	0	0	0	0
66	Dickinson & other counties	1/17/11	Winter Weather	0	0	0	0
67	Dickinson & other counties	1/28/11	Winter Weather	0	0	0	0
68	Dickinson & other counties	3/9/11	Winter Weather	0	0	0	0
69	Dickinson & other counties	3/23/11	Winter Weather	0	0	0	0
70	Dickinson & other counties	11/9/11	Winter Storm	0	0	0	0

Table - 2 101 Snow, Blizzard & Ice Events, Dickinson County 1950 – 2015 (NCDC)							
	Location or County	Date	Type	Death	Injury	Property Damage	Crop Damage
71	Dickinson & other counties	1/23/12	Winter Weather	0	0	0	0
72	Dickinson & other counties	1/30/12	Winter Weather	0	0	20k	0
73	Dickinson & other counties	2/28/12	Winter Storm	0	0	0	0
74	Dickinson & other counties	12/20/12	Winter Storm	0	0	0	0
75	Dickinson & other counties	1/10/13	Winter Weather	0	0	0	0
76	Dickinson & other counties	1/18/13	Winter Weather	0	0	0	0
77	Dickinson & other counties	1/24/13	Winter Weather	0	0	0	0
78	Dickinson & other counties	1/27/13	Winter Weather	0	0	0	0
79	Dickinson & other counties	1/29/13	Winter Weather	0	0	0	0
80	Dickinson & other counties	1/30/13	Winter Weather	0	0	0	0
81	Dickinson & other counties	2/6/13	Winter Weather	0	0	0	0
82	Dickinson & other counties	2/22/13	Winter Weather	0	0	0	0
83	Dickinson & other counties	3/10/13	Winter Weather	0	0	0	0
84	Dickinson & other counties	3/18/13	Winter Weather	0	0	0	0
85	Dickinson & other counties	3/30/13	Winter Weather	0	0	0	0
86	Dickinson & other counties	4/11/13	Winter Weather	0	0	0	0
87	Dickinson & other counties	12/3/13	Winter Storm	0	0	0	0
88	Dickinson & other counties	1/10/14	Winter Weather	0	0	0	0
89	Dickinson & other counties	1/30/14	Winter Storm	0	0	0	0
90	Dickinson & other counties	2/17/14	Winter Weather	0	0	0	0
91	Dickinson & other counties	2/20/14	Winter Weather	0	0	0	0
92	Dickinson & other counties	3/27/14	Winter Weather	0	0	0	0

Table - 2 101 Snow, Blizzard & Ice Events, Dickinson County 1950 – 2015 (NCDC)							
	Location or County	Date	Type	Death	Injury	Property Damage	Crop Damage
93	Dickinson & other counties	4/4/14	Winter Storm	0	0	0	0
94	Dickinson & other counties	4/13/14	Winter Weather	0	0	0	0
95	Dickinson & other counties	4/16/14	Winter Storm	0	0	0	0
96	Dickinson & other counties	12/26/14	Winter Storm	0	0	0	0
97	Dickinson & other counties	1/8/15	Winter Weather	0	0	0	0
98	Dickinson & other counties	3/3/15	Winter Weather	0	0	0	0
99	Dickinson & other counties	3/25/15	Winter Weather	0	0	0	0
100	Dickinson & other counties	4/6/15	Winter Weather	0	0	0	0
101	Dickinson & other counties	4/9/15	Winter Weather	0	0	0	0
			TOTALS:	**0**	**0**	**5.070M**	**0k**

Table - 3
77 Thunderstorm & High Wind Events, Dickinson County 1950-2015 (NCDC)

	Location or County	Date	Magnitude	Death	Injury	Property Damage	Crop Damage
1	Dickinson	7/29/61	0 knots	0	0	0	0
2	Dickinson	9/21/70	0 knots	0	0	0	0
3	Dickinson	6/22/75	0 knots	0	0	0	0
4	Dickinson	8/15/78	0 knots	0	0	0	0
5	Dickinson	6/20/79	0 knots	0	0	0	0
6	Dickinson	8/4/79	54 knots	0	0	0	0
7	Dickinson	7/10/80	62 knots	0	0	0	0
8	Dickinson	7/17/81	0 knots	0	0	0	0
9	Dickinson	6/26/83	0 knots	0	0	0	0
10	Dickinson	7/3/83	0 knots	0	0	0	0
11	Dickinson	7/20/87	0 knots	0	0	0	0
12	Dickinson	7/19/92	65 knots	0	0	0	0
13	Ralph	7/14/95	N/A	0	0	0	0
14	Along US-2	7/14/95	N/A	0	0	0	0
15	Waucedah	7/14/95	N/A	0	0	0	0
16	Foster City	7/14/95	N/A	0	0	0	0
17	Kingsford	6/24/97	60 knots	0	0	0	0
18	Iron Mountain	6/24/97	60 knots	0	0	0	0
19	Felch	10/5/97	60 knots	0	0	0	0
20	Foster City	3/29/98	50 knots	0	0	0	0
21	Iron Mountain	6/25/98	70 knots	0	0	100K	0
22	Iron Mountain	7/14/98	55 knots	0	0	0	0
23	Dickinson & other counties	11/10/98	76 knots	0	0	450K	10.0M
24	Hardwood	6/11/99	55 knots	0	0	0	0
25	Channing	7/16/99	55 knots	0	0	0	0
26	Randville	7/16/99	55 knots	0	0	0	0
27	Norway	7/29/99	58 knots	0	0	0	0
28	Countywide	7/30/99	52 knots	0	0	500K	0
29	Iron Mountain	8/31/00	55 knots	0	0	0	0
30	Norway	8/31/00	55 knots	0	0	0	0
31	Quinnesec	9/11/00	65 knots	0	0	0	0
32	Ralph	5/30/02	55 knots	0	0	0	0
33	Channing	5/30/02	60 knots	0	0	0	0
34	Sagola	6/13/02	60 knots	0	0	0	0
35	Felch	6/25/02	55 knots	0	0	0	0
36	Iron Mountain	7/21/02	65 knots	0	0	0	0
37	Norway	7/27/02	55 knots	0	0	0	0
38	Iron Mountain	7/31/02	65 knots	0	0	0	0
39	Foster City	7/31/02	60 knots	0	0	0	0
40	Hardwood	7/31/02	65 knots	0	0	0	0
41	Kingsford	9/30/02	60 knots	0	0	0	0
42	Iron Mountain	9/30/02	70 knots	0	0	0	0
43	Quinnesec	9/30/02	70 knots	0	0	0	0
44	Randville	8/26/03	65 knots	0	0	0	0

	Location or County	Date	Magnitude	Death	Injury	Property Damage	Crop Damage
45	Foster City	8/26/03	65 knots	0	0	0	0
46	Channing	4/18/04	65 knots	0	0	0	0
47	Norway	7/13/04	60 knots	0	0	0	0
48	Randville	5/9/05	55 knots	0	0	0	0
49	Iron Mountain	6/11/05	55 knots	0	0	0	0
50	Norway	6/11/05	55 knots	0	0	0	0
51	Channing	8/9/05	70 knots	0	0	0	0
52	Ralph	7/25/06	50 knots	0	0	0	0
53	Dickinson County	4/3/07	45 knots	0	0	2k	0
54	Norway	5/14/07	52 knots	0	0	0	0
55	Norway	6/18/07	50 knots	0	0	0	0
56	Sagola	7/8/07	60 knots	0	0	2k	0
57	Iron Mountain	7/8/07	60 knots	0	0	2k	0
58	Iron Mountain	7/8/07	60 knots	0	0	3k	0
59	Felch	7/10/07	50 knots	0	0	0	0
60	Iron Mountain	8/28/07	50 knots	0	0	0	0
61	Kingsford	8/28/07	50 knots	0	0	12k	0
62	Hardwood	8/28/07	50 knots	0	0	0	0
63	Dickinson County	6/6/08	45 knots	0	0	1k	0
64	Dickinson County	10/26/10	55 knots	0	0	15k	0
65	Iron Mountain Airport	7/20/10	65 knots	0	0	75k	0
66	Norway	7/27/10	60 knots	0	0	5k	0
67	Norway	7/27/10	55 knots	0	0	2k	0
68	Dickinson County	5/31/11	50 knots	0	0	0	0
69	Iron Mountain Airport	7/30/11	57 knots	0	0	30k	0
70	Antoine	7/30/11	57 knots	0	0	0	0
71	Antoine	7/30/11	57 knots	0	0	5k	0
72	Iron Mountain	7/30/11	55 knots	0	0	1k	0
73	Dickinson County	9/29/11	50 knots	0	0	1k	0
74	Floodwood	5/20/12	52 knots	0	0	1k	0
75	Floodwood	7/4/12	78 knots	0	0	70k	0
76	Felch Mountain	7/25/13	50 knots	0	0	1k	0
77	Dickinson County	6/17/14	42 knots	0	0	1k	0
			TOTALS	**0**	**0**	**1.279M**	**10.0M**

Table - 4 62 Hail Events, Dickinson County 1950 –2015 (NCDC)							
	Location or County	Date	Magnitude	Death	Injury	Property Damage	Crop Damage
1	Dickinson	5/8/63	2.00 in.	0	0	0	0
2	Dickinson	5/7/65	.75 in.	0	0	0	0
3	Dickinson	5/20/75	1.00 in.	0	0	0	0
4	Dickinson	7/17/81	1.50 in.	0	0	0	0
5	Dickinson	9/6/85	1.00 in.	0	0	0	0
6	Iron Mountain	7/14/95	.75 in.	0	0	0	0
7	Watersmeet	7/14/95	.75 in.	0	0	0	0
8	Foster City	7/31/95	1.00 in.	0	0	0	0
9	Iron Mountain	7/15/96	1.00 in.	0	0	0	0
10	Iron Mountain	7/15/96	1.00 in.	0	0	0	0
11	Norway	3/29/98	.75 in.	0	0	0	0
12	Quinnesec	3/29/98	.75 in.	0	0	0	0
13	Hardwood	6/11/99	1.75 in.	0	0	0	0
14	Foster City	6/11/99	1.25 in.	0	0	0	0
15	Granite Bluff	7/14/99	.75 in.	0	0	0	0
16	Norway	7/29/99	.75 in.	0	0	0	0
17	Iron Mountain	6/9/00	2.75 in.	0	0	225K	0
18	Iron Mountain	6/9/00	1.00 in.	0	0	0	0
19	Sagola	8/31/00	1.00 in.	0	0	0	0
20	Iron Mountain	8/31/00	1.25 in.	0	0	0	0
21	Ralph	6/11/01	.75 in.	0	0	0	0
22	Iron Mountain	6/16/01	.88 in.	0	0	0	0
23	Iron Mountain	6/16/01	.88 in.	0	0	0	0
24	Iron Mountain	12/5/01	.75 in.	0	0	0	0
25	Granite Bluff	12/5/01	.88 in.	0	0	0	0
26	Felch	12/5/01	.75 in.	0	0	0	0
27	Foster City	5/6/02	.75 in.	0	0	0	0
28	Channing	5/30/02	.75 in.	0	0	0	0
29	Channing	5/30/02	1.50 in.	0	0	0	0
30	Sagola	5/30/02	1.75 in.	0	0	0	0
31	Randville	5/30/02	2.00 in.	0	0	0	0
32	Hardwood	5/30/02	1.75 in.	0	0	0	0
33	Foster City	5/30/02	.75 in.	0	0	0	0
34	Iron Mountain	7/31/02	.75 in.	0	0	0	0
35	Granite Bluff	8/1/02	.75 in.	0	0	0	0
36	Iron Mountain	9/30/02	.75 in.	0	0	0	0
37	Randville	7/20/03	.75 in.	0	0	0	0
38	Randville	8/25/03	.75 in.	0	0	0	0
39	Randville	4/18/04	.75 in.	0	0	0	0
40	Sagola	7/13/04	1.00 in.	0	0	0	0
41	Ralph	7/19/04	1.00 in.	0	0	0	0
42	Felch	5/27/05	.75 in.	0	0	0	0
43	Iron Mountain	7/25/06	1.00 in.	0	0	0	0
44	Sagola	7/28/06	1.50 in.	0	0	0	0

Table - 4 62 Hail Events, Dickinson County 1950 –2015 (NCDC)							
45	Norway	7/28/06	1.00 in.	0	0	0	0
46	Channing	7/28/06	1.00 in.	0	0	0	0
47	Sagola	9/16/06	1.25 in.	0	0	0	0
48	Felch	6/20/07	.75 in.	0	0	0	0
49	Kingsford	5/25/08	1.00 in.	0	0	0	0
50	Iron Mountain	5/25/08	1.50 in.	0	0	0	0
51	Randville	4/24/09	.75 in.	0	0	0	0
52	Iron Mtn Arpt	7/20/10	.88 in.	0	0	0	0
53	Quinn	7/20/10	.88 in.	0	0	0	0
54	Quinn	4/10/11	.88 in.	0	0	0	0
55	Felch Mtn	6/6/11	1.75 in.	0	0	0	0
56	Hardwood	6/6/11	1.00 in.	0	0	0	0
57	Granite Bluff	6/7/11	.75 in.	0	0	0	0
58	Sagola	7/5/11	.75 in.	0	0	0	0
59	Iron Mtn Arpt	5/20/12	.75 in.	0	0	0	0
60	Granite Bluff	5/20/12	.75 in.	0	0	0	0
61	Turner	7/4/12	1.75 in.	0	0	0	0
62	Antoine	8/21/13	.75 in.	0	0	0	0
Total				0	0	**225K**	0

Table - 5 3 Lightning Events, Dickinson County 1950 – 2015 (NCDC)							
	Location or County	Date	Magnitude	Death	Injury	Property Damage	Crop Damage
1	Iron Mountain	10/5/05	N/A	0	0	140k	0
2	Iron Mtn Arpt	8/14/09	N/A	0	0	1k	0
3	Iron Mountain	5/20/12	N/A	0	0	30k	0
Total				0	0	171k	0

Table - 6 27 Temperature Extreme Events in Dickinson County 1950 - 2015 (NCDC)							
	Location or County	**Date**	**Local Temp**	**Death**	**Injury**	**Property Damage**	**Crop Damage**
1	Dickinson/other UP counties	1/31/96	-33 Iron Mtn.	0	0	0	0
2	Dickinson/other UP counties	2/1/96	-33 Iron Mtn.	0	0	0	0
3	Dickinson/other UP counties	2/2/96	-30 Iron Mtn.	0	0	0	0
4	Dickinson/other UP counties	2/3/96	N/A	0	0	0	0
5	Dickinson/other UP counties	2/4/96	-39 Iron Mtn.	0	0	0	0
6	Dickinson/other UP counties	1/14/05	N/A	0	0	0	0
7	Dickinson/other UP counties	2/18/06	N/A	0	0	0	0
8	Dickinson/other UP counties	2/4/07	N/A	0	0	0	0
9	Dickinson/other UP counties	3/6/07	N/A	0	0	0	0
10	Dickinson/other UP counties	1/19/08	N/A	0	0	0	0
11	Dickinson/other UP counties	1/30/08	N/A	0	0	0	0
12	Dickinson/other UP counties	2/10/08	N/A	0	0	0	0
13	Dickinson/other UP counties	12/16/08	N/A	0	0	0	0
14	Dickinson/other UP counties	1/14/09	N/A	0	0	0	0
15	Dickinson/other UP counties	1/26/09	N/A	0	0	0	0
16	Dickinson/other UP counties	1/19/12	N/A	0	0	0	0
17	Dickinson/other UP counties	1/21/13	N/A	0	0	0	0
18	Dickinson/other UP counties	1/5/14	N/A	0	0	0	0
19	Dickinson/other UP counties	1/27/14	N/A	0	0	0	0
20	Dickinson/other UP counties	2/27/14	N/A	0	0	0	0
21	Dickinson/other UP counties	12/31/14	N/A	0	0	0	0
22	Dickinson/other UP counties	1/4/15	N/A	0	0	0	0
23	Dickinson/other UP counties	1/7/15	N/A	0	0	0	0
24	Dickinson/other UP counties	2/14/15	N/A	0	0	0	0
25	Dickinson/other UP counties	2/18/15	N/A	0	0	0	0
26	Dickinson/other UP counties	2/22/15	N/A	0	0	0	0
27	Dickinson/other UP counties	2/26/15	N/A	0	0	0	0
			TOTALS:	0	0	0	0

Table - 7 21 Flood and Heavy Rain Events in Dickinson County 1950 - 2015 (NCDC)							
	Location or County	**Date**	**Type**	**Death**	**Injury**	**Property Damage**	**Crop Damage**
1	Dickinson/Southern Lower MI	1/3/93	Flooding	0	0	5K	0
2	Dickinson/other Counties	3/23/93	Flood	0	0	0	0
3	Dickinson/other Counties	4/19/93	Flood	0	0	5.0M	0
4	Dickinson	8/16/93	Flood/flash Flood	0	0	0	0
5	Iron Mountain	7/14/99	Flash Flood	0	0	20K	0
6	Iron Mountain	8/31/00	Flood	0	0	0	0
7	Norway	8/31/00	Flood	0	0	0	0
8	Quinnesec	8/31/00	Flood	0	0	0	0
9	Dickinson/ other UP Counties	4/12/02	Flood	0	0	18.5M	0
10	Iron Mountain	9/30/02	Flash Flood	0	0	0	0
11	Quinnesec	9/30/02	Flash Flood	0	0	0	0
12	Randville	5/28/06	Heavy Rain	0	0	0	0
13	Antoine	9/23/10	Flash Flood	0	0	1k	0
14	Randville	7/4/12	Heavy Rain	0	0	0	0
15	Foster City	7/25/13	Flash Flood	0	0	10k	0
16	Floodwood	8/23/14	Heavy Rain	0	0	0	0
17	Norway	8/29/14	Heavy Rain	0	0	0	0
18	Quinn	9/4/14	Heavy Rain	0	0	0	0
19	Norway	9/4/14	Flash Flood	0	0	20k	0
20	Antoine	9/4/14	Flash Flood	0	0	30k	0
21	Channing	9/10/14	Heavy Rain	0	0	0	0
			TOTALS:	0	0	**23.586M**	0

Sources Cited:

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http://primis.phmsa.dot.gov/comm/reports/safety/IncDetSt_st_MI_flt_sig.html?nocache=9362 (pipeline failure)

http://www.linkpendium.com/genealogy/USA/MI/Dickinson/hist/

Appendix A