CARLTON COUNTY MINNESOTA



2021

Multi-Hazard Mitigation Plan

U-SPATIAL

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CARLTON COUNTY MINNESOTA

MULTI-HAZARD MITIGATION PLAN

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Contents

Section 1 – Introduction

1.1 Introduction

Hazard mitigation is defined as any sustained action to reduce or eliminate long-term risk to human life and property from hazard events. The Federal Emergency Management Agency (FEMA) has made reducing hazards one of its primary goals, and a primary mechanism in achieving this goal is both the hazard mitigation planning process and the subsequent implementation of resulting projects, measures, and policies (FEMA, 2015).

From 1980 to 2020, damages due to natural disasters in the U.S. exceeded $1.875 trillion. 2017 was the costliest year on record with $306 billion in damage, and while the costliest disasters may occur in coastal states, in 2020, wildfires, hailstorms, drought, and tornadoes caused a record amount of billion-dollar disasters across the nation (Smith, 2020). Hazard mitigation planning is an effective process to prepare communities and lessen the impact of loss of life and property from future disasters. Although mitigation efforts will not eliminate all disasters, government at all levels should strive to be as prepared as possible for a disaster for the wellbeing of its citizens.

The Multi-Hazard Mitigation Plan (MHMP) is a requirement of the Federal Disaster Mitigation Act of 2000. The development of a local government plan is required to maintain eligibility for federal hazard mitigation grant funding programs. For communities to be eligible for future mitigation funds, they must adopt an MHMP.

Researchers at the National Institute of Building Sciences looked at the results of 23 years of federally funded mitigation grants provided by FEMA, the U.S. Economic Development Administration (EDA), and the U.S. Department of Housing and Urban Development (HUD). Their findings revealed that for every $1 spent on hazard mitigation funding in the nation, $6 is saved in future disaster costs (Multi-Hazard Mitigation Council, 2019).

Carlton County is vulnerable to a variety of natural hazards that threaten the loss of life and property in the county. Hazards such as tornadoes, flooding, wildfires, blizzards, straight-line winds, and droughts have the potential for inflicting vast economic loss and personal hardship.

This MHMP represents the efforts of Carlton County and its local governments to fulfill the responsibility of hazard mitigation planning. The intent of the plan is to limit the damages and losses caused by specific hazards.

1.1.1 SCOPE

U-Spatial, University of Minnesota, was contracted by MN Homeland Security and Emergency Management using FEMA Pre-Disaster Mitigation (PDM) grant funds to work with Carlton County Emergency Management to facilitate an update to the 2014 Carlton County MHMP. U-Spatial brings extensive geographic data analysis skills and hazard risk assessment expertise to the process. U-Spatial also employed the services of Hundrieser Consulting LLC for county and stakeholder outreach as well as mitigation action development related to this plan.

This MHMP evaluates and prioritizes the major natural hazards affecting Carlton County as determined by frequency of event, economic impact, deaths, and injuries. Mitigation recommendations are based on input from state and local agencies, the public, and national best practices.

U-Spatial performed the hazard risk assessment for 1-percent annual chance floods (also known as 100-year floods) using the FEMA Hazus GIS tool. The Minnesota Homeland Security and Emergency Management (HSEM) office, which is a division of the Minnesota Department of Public Safety, has determined that Hazus should play a critical role in Minnesota's risk assessments.

This is a multi-jurisdictional plan that covers Carlton County, including the cities of Barnum, Carlton, Cloquet, Cromwell, Kettle River, Moose Lake, Scanlon, Wrenshall, Wright, and the Fond du Lac Reservation. The Carlton County mitigation activities identified in this plan also incorporate the concerns and needs of townships, school districts, and other participating entities.

Members from each of these jurisdictions actively participated in the planning process by assisting with public outreach, attending planning team meetings, providing local information, identifying mitigation actions, and reviewing the plan document (see Appendix C). The information in these forms was used to help identify mitigation actions for local implementation (see also Section 2.2). Each jurisdiction will adopt the plan by resolution after the plan is approved by FEMA. County and local city resolutions will be added by Carlton County after final approval by FEMA (see Appendix D).

Carlton County has specified the following goals for this MHMP update:

- Include more recent data documenting the critical infrastructure and hazards faced by Carlton County.
- Reformat and reorganize the plan to reflect definitions of hazards as expressed in the 2014 State of Minnesota Multi-Hazard Identification and Risk Assessment Plan.
- Reflect current hazard mitigation priorities in Carlton County.

1.1.2 HAZARD MITIGATION DEFINITION

Hazard mitigation may be defined as any action taken to eliminate or reduce the long-term risk to human life and property from natural hazards. The benefits of hazard mitigation planning include the following:

- saving lives, protecting the health of the public, and reducing injuries
- preventing or reducing property damage
- reducing economic losses

- minimizing social dislocation and stress
- reducing agricultural losses
- maintaining critical facilities in functioning order
- protecting infrastructure from damage
- protecting mental health
- reducing legal liability of government and public officials

1.2 State Administration of Mitigation Grants

FEMA currently has three mitigation grant programs that are administered by the State of Minnesota: the Hazard Mitigation Grant Program (HMGP), the Building Resilient Infrastructure and Communities (BRIC) program, and the Flood Mitigation Assistance (FMA) program. The HMGP, BRIC, and FMA programs are administered through the state of Minnesota Department of Public Safety HSEM Division. All applicants must have or be covered under an approved Hazard Mitigation Plan. Eligible applicants include state and local governments, certain private non-profit organizations or institutions, and tribal communities.

Section 2 – Public Planning Process

2.1 Planning Team Information

The Carlton County MHMP planning team is headed by the Carlton County emergency manager, who is the primary point of contact. Members of the Carlton County MHMP planning team include representatives from the public and governmental sectors. Table 1 identifies the planning team individuals and the organizations they represent.

Table 1. Multi-Hazard Mitigation Planning (MHMP) team

Name	Agency/Organization	Participant Title
Marlyn Halvorson	Carlton County Sheriff's Office	Emergency Management Director
Ali Muller	Carlton County Public Health & Human Services	Emergency Preparedness Coordinator
Kelly Lake	Carlton County Sheriff's Office	County Sheriff
Brian Belich	Carlton County Sheriff's Office	Chief Deputy
Jared Hovi	Carlton County GIS Dept.	GIS Coordinator
Duane Buytaert	Carlton County GIS Dept.	IT Manager
Siona Roberts	Carlton County GIS Dept.	GIS Technician
Brad Matlack	Carlton County Soil & Water Conservation District	District Manager
Bernadine Reed	City of Barnum	City Administrator
Derek Wolf	City of Carlton	Public Works Director
Brent Bodie	City of Carlton	City Councilor
Lucas Goodin	Cromwell-Wright Area Fire District	Fire Chief/ Emergency Management Director
Carol Conway	City of Carlton	City Clerk/Treasurer
Kathryn Lake	City of Kettle River	City Clerk/Treasurer
Tim Peterson	City of Cloquet	City Administrator
Roger Maki	City of Cloquet	Mayor
Gwendolyn Bursey	City of Cromwell	City Clerk/Treasurer
Sharon Zelazny	City of Cromwell	Mayor
Tom Johnson	City of Cromwell	Maintenance Director
Darren Juntunen	City of Moose Lake	Chief of Police
Katie Bloom	City of Moose Lake	City Administrator
Elissa Owens	City of Moose Lake	Finance Director/Deputy Clerk
Jill Wartner	City of Scanlon	City Clerk
Hannah Jurek	City of Wrenshall	Assistant Clerk
Steve Olson	Perch Lake Township	Supervisor
Sue Chapin	Twin Lakes Township	Clerk
Mary Munn	Holyoke Township	Treasurer
Paula Siltberg	Holyoke Township	Supervisor
Steve Olson	Perch Lake Township	Supervisor

Name	Agency/Organization	Participant Title
Logan Saline	Town of Thomson	Road & Utility Supervisor
Warren LaPlante	ALLETE/Minnesota Power	Manager/ALLETE Security and Emergency Manager
Tony Guerra	American Red Cross	Disaster Program Manager
Jeff Hall	Minnesota Department of Transportation	District 1 Emergency Management
Harlan Schmeling	Moose Lake Water & Light Commission	Superintendent
John Engstrom	Carlton Public Schools	Superintendent
Patrice Erickson	Aitkin County Sheriff's Office	Deputy Emergency Manager
Michael Diver	Fond du Lac Band Police Department	Lieutenant

Jurisdictional representatives were contacted throughout the HMP process to help facilitate local participation and provide feedback on the hazards of concern to their communities. This feedback was used to develop local mitigation actions that they would seek to implement upon plan adoption (see Section 6.3 and Appendix J).

2.2 Review of Existing Plans, Capabilities & Vulnerabilities

Carlton County and its local communities utilized a variety of planning documents to direct community development. These documents included a Comprehensive/Master Plan, Emergency Operations Plan, Transportation Plan, etc. (see Appendix D for a full listing of plans and programs in place in Carlton County). The planning process also incorporated the existing natural hazard mitigation elements from previous planning efforts. In addition, the 2019 Minnesota All-Hazard Mitigation Plan was consulted.

In the development of the Carlton County MHMP, U-Spatial consultants reviewed and incorporated a variety of planning documents that direct community development and influence land use decisions for the county and its jurisdictions. In addition, U-Spatial consultants worked closely with the Carlton County Emergency Management Director and other key county staff and local city officials to collect feedback on local mitigation capabilities and vulnerabilities that either support or hinder the ability to mitigate against natural hazards at the county and local level. Following is a summary of the assessment tools used to gather information on local capabilities and vulnerabilities during the planning process:

Capabilities Assessment (*hazard-specific*): In this assessment, detailed information was collected from Carlton County on current plans and programs in place (i.e., existing programs, plans, or policies) as well as program gaps or deficiencies that currently exist to mitigate against damages caused by each natural hazard addressed in the plan. Section 5 identifies current gaps and deficiencies for mitigation and Section 6.1.3 describes the mitigation capabilities that are in place by Carlton County to support mitigation.

Local Mitigation Surveys: As part of Carlton County's 2021 MHMP update, participating jurisdictions and key county personnel were asked to fill out a Local Mitigation Survey (LMS) form. Questions in the LMS form addressed the following:

- Part A: Hazard Identification, Risk Assessment & Vulnerability Analysis
- Part B: Local Mitigation Capabilities Assessment
- Part C: Local Mitigation Projects
- Part D: Survey Participants.

The purpose of the survey was to gather jurisdictionally specific information needed to support the update of the plan and to help inform development of local-level mitigation actions for the next five-year planning cycle (for the full Carlton County LMS report, see Appendix C).

2.3 Planning Process Timeline and Steps

In order to update the 2014 Carlton County MHMP, U-Spatial consultants worked in coordination with the Carlton County Emergency Management and members of the planning team. The updated plan includes new data documenting the types of hazards faced by Carlton County residents and emergency planning officials as well as new thinking on how to address these hazards.

2.3.1 CARLTON COUNTY STAKEHOLDER COORDINATION

On May 6, 2020, U-Spatial hosted an online kickoff meeting that was attended by the Carlton County Emergency Manager. The webinar included a project overview, U-Spatial's background, the roles and responsibilities of the Emergency Manager, the contents of the MHMP, the planning process, and the projected timeline of the project (see Appendix F for webinar slides).

On June 30, 2020, Carlton County issued a news release inviting public feedback and participation for the Carlton County MHMP update (for complete documentation, see Appendix G).

A planning team meeting took place on September 9, 2020 via Zoom video conference hosted by U-Spatial. Meeting participants included representatives from Carlton County, city and township governments, neighboring jurisdictions, and other key stakeholders. The planning team was provided with an overview of the purpose, process, and timeline for the Carlton County MHMP update, as well as the roles and responsibilities of planning team members. During the meeting, participants discussed the prioritization of natural hazards facing the county and local jurisdictions, provided feedback on plans and programs in place, and identified mitigation actions that would reduce future risk. Information gathered during this meeting was used to inform the development of mitigation strategies in the updated plan. See Appendix F for a full meeting summary.

On September 23, 2020, members of the MHMP planning team convened again via Zoom video conference with U-Spatial presenters. Together, they conducted a review of and discussed the updated risk assessment for Carlton County. Draft mitigation strategies were developed for Carlton County and each city participating in the plan (see Appendix F).

In order to provide opportunity for public input, Carlton County issued a second news release on November 12, 2021, inviting public review and feedback on the draft plan. The news release provided information on where to view the plan and submit comments. U-Spatial hosted a webpage to post the full draft of the Carlton County MHMP, including excerpts of the Carlton County Master Mitigation Action Chart, each jurisdictional mitigation action chart, and an electronic feedback form.

Table 2 documents Hazard Mitigation update meetings and public outreach. Appendix G provides documentation of the public outreach for feedback on the draft plan by Carlton County and jurisdictions. The public feedback period for the draft plan was open from 11/12/21 to 11/25/21, for a total of 14 days.

Table 2. Carlton County Hazard Mitigation update meetings and public outreach

Event	Date	Appendix
Kickoff Webinar	5/6/20	Appendix F, Planning Team Meetings
News Release #1	6/30/20	Appendix G, Public Outreach & Engagement Documentation
Planning Team Meeting #1	9/9/20	Appendix F, Planning Team Meetings
Planning Team Meeting #2	2/24/2020	Appendix F, Planning Team Meetings
News Release #2	11/12/21	Appendix G, Public Outreach & Engagement Documentation

At the close of the public outreach period, the U-Spatial consultants worked with the Carlton County Emergency Manager and members of the planning team to incorporate feedback from the public into the Multi-Hazard Mitigation Plan.

For more information on the planning process, see Sections 6 and 7.

2.3.2 OVERVIEW OF JURISDICTIONAL PARTICIPATION

Throughout the planning process, Carlton County and the U-Spatial team worked to engage representatives from the county and each city in the update of the plan. Key activities for jurisdictions included assisting with public outreach, participating in planning team meetings, providing local-level information, reviewing and providing feedback to the plan update.

U-Spatial and Carlton County actively used the following methods to engage jurisdictions in the MHMP plan update process:

- **Zoom Video Conferencing**: Planning team meetings were conducted via Zoom video conferencing hosted by U-Spatial. The use of virtual meetings was used to engage stakeholders remotely during Covid-19 pandemic restrictions. Virtual meetings proved to be a beneficial addition to the planning process, resulting in a high turnout from jurisdictional representatives and other stakeholders, as well as providing the ability for presenters to collect, respond to, and document feedback from participants through Zoom functions such as surveys, chat, and Q&A.

- **Email Correspondence**: Email was a primary tool used to communicate with representatives from Carlton County, municipal governments, and other stakeholders. Emails were used to distribute news releases for public outreach, to invite participation in meetings and to share meeting summaries, as well as to request local-information and final review of the draft plan. Email proved to be an effective tool that resulted in increased jurisdictional participation and collection of locally specific information. Email was also used by the public to submit feedback to Carlton County following news releases on the MHMP.

- **Phone Calls**: Phone calls were frequently used to conduct direct outreach or follow-up to jurisdictions to ensure participation or to collect information via one-on-one interviews. Phone calls proved to be an effective tool that resulted in increased jurisdictional participation and collection of quality information. Phone calls were especially useful in engaging very small communities that had limited staff or technological capabilities.

Cities participating in Carlton County MHMP update varied by population and associated government resources to participate in the planning process (i.e., personnel, time, and technology). Rural communities with smaller populations (under 500) typically had part-time elected officials, limited to no city staff, and reduced City Hall hours in which to conduct business. Carlton County and U-Spatial were sensitive to these local challenges and worked to help these local governments to participate using the methods that worked best to accommodate them, such as phone interviews to complete local mitigation survey forms (see Appendix C).

Table 3 provides an overview of the participation of each city that took part in the Carlton County MHMP update planning process, with reference to the location of supporting documentation.

Table 3. Jurisdictional participation in planning process

Jurisdiction (Population)	News Release #1	Planning Team Mtg. #1	Local Mitigation Survey	Mitigation Action Chart	Planning Team Mtg. #2	News Release #2 & Plan Review
Carlton County	X	X	X	X	X	X
City of Barnum	X	X	X	X		X
City of Carlton	X	X	X	X	X	X
City of Cloquet	X	X	X	X		X
City of Cromwell	X	X	X	X	X	
City of Kettle River	X	X	X	X		X
City of Moose Lake	X	X	X	X	X	X
City of Scanlon	X		X	X	X	X
City of Wrenshall	X		X	X	X	
City of Wright	X	X	X	X		
Neighboring Jurisdictions:						
Fond du Lac Reservation			X	X		
Aitkin County		X			X	
Pine County						

Section 3 – Carlton County Profile

3.1 General County Description

Carlton County is located in northern Minnesota, just southwest of the Duluth area. It is bounded on the north by Saint Louis County, on the west by Aitkin County, on the south Pine County, and by Douglas County in Wisconsin to the east. The land area of the county is comprised of approximately 861 square miles and there are 77 lakes and four major watersheds.

There are 10 cities, 19 townships, and two unincorporated townships in Carlton County. Fond du Lac Reservation also falls mostly within the boundary of Carlton County. The city of Carlton is the county seat and had a population of 863 in 2010, while the largest city, Cloquet City, had 12,124 people that same year. The county had an estimated total population of 35,871 in 2019.

Carlton County is richly endowed with lakes, rivers, streams, and hills. The county has an extensive state highway system and access to the interstate system. Its location along the I-35 corridor south of Duluth makes the county a popular recreational destination and passageway to the lakes and forests of Northeast Minnesota. The county also has two general aviation airports, one in Cloquet and one in Moose Lake.

3.2 Environmental and Geologic Characteristics

Carlton County has a variety of surface landforms that are the result of glacial activity. The landscape varies from flat to hilly with a maximum relief of 750 feet in the northeastern portion of the county where the St. Louis River approaches Lake Superior. This varied topography is due to glacial deposition that formed moraines and left outwash sediments throughout the county.

The primary bedrock in the county is called the Thomson Formation and consists of slate and impure quartzite. This bedrock underlies 75% of the county starting in the northeast portion. Sandstone can also be found in the southeastern portions of the county and are known as the Hinckley and Fond du Lac Sandstones. Volcanic activity also played a role in the area's geology. The Keweenawan intrusives can be found in the southwestern portion of the county and the Keweenawan lava flows are located in the southeastern corner of the county.

Carlton County has a wide variety of soil types, all of which are acidic. Most have reddish brown subsoil and were formed by glacial drift. Approximately 48% of the county consists of nearly level soils. Organic soils make up nearly 50% of these soils, or encompass about 25% of the county. Most of the terrain in Carlton County is used for woodland recreation and wildlife habitat. Not much of the soil is used for farming due to a short, cool growing season that limits the types of crops that are suitable for the area.

3.3 Hydrography

Carlton County lies within the Lake Superior Basin, the Upper Mississippi River Basin, and the St. Croix River Basin. There are four major watersheds in Carlton County including the St. Louis River, the Mississippi River-Grand Rapids, the Kettle River, and the Nemadji River Watershed. The Kettle River

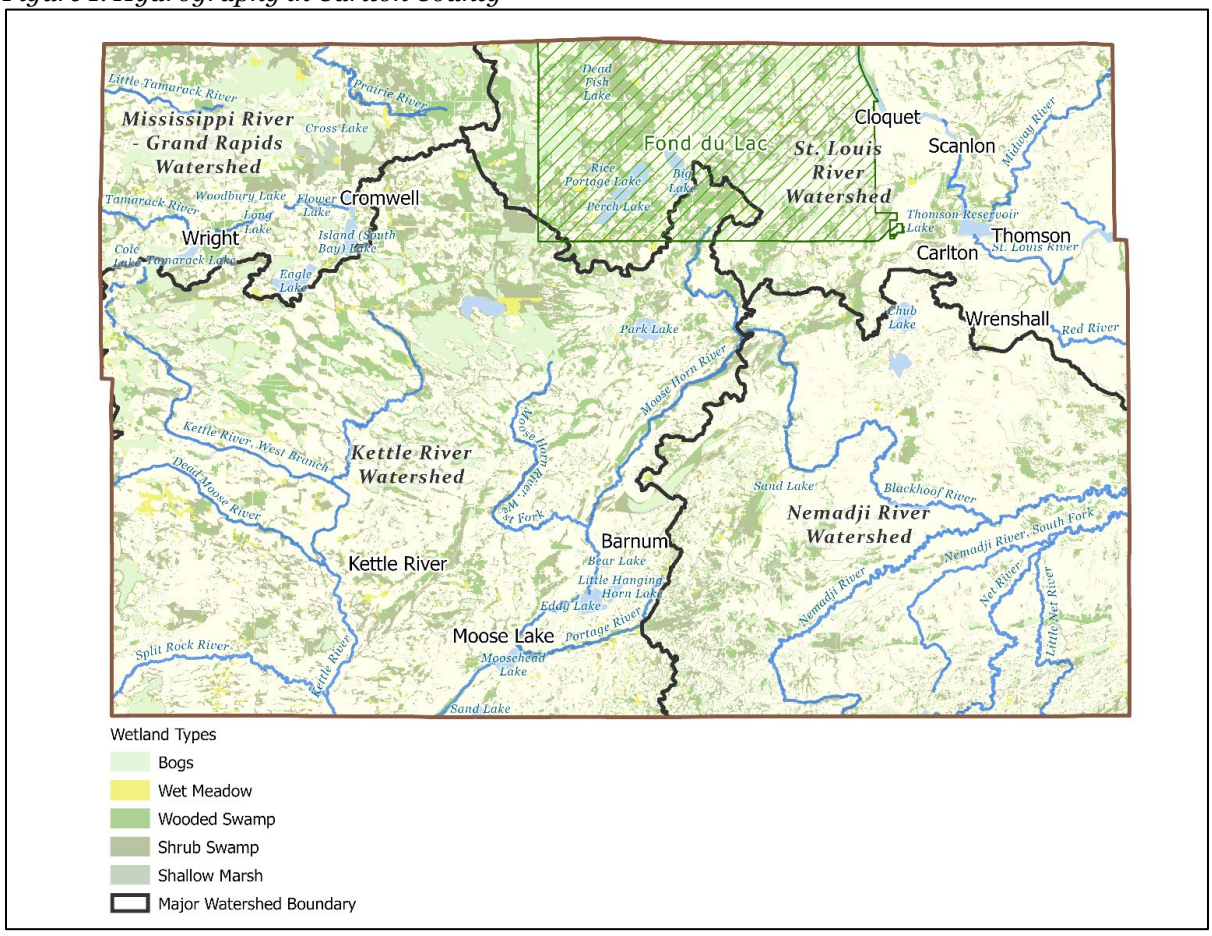
watershed is the largest spanning 360 square miles within Carlton County, or about 40% of the total county area.

Carlton County contains a number of Protected (i.e., Public) Waters, which are lakes, wetlands, and watercourses regulated by the Minnesota DNR. The inventory of the protected waters in the county includes 75 lakes, 115 watercourses (rivers and streams), and 57 wetlands (MN DNR, 2019a).

Waters across the State are continuously monitored for pollution and invasive species. The Minnesota Pollution Control Agency (MPCA) measures water pollutant levels. Waterbodies that do not meet water quality standards are designated as impaired and sent to the Environmental Protection Agency (EPA), along with pollutant-reduction goals to restore these waters (MPCA, 2017). The Minnesota Department of Natural Resources (MN DNR) is responsible for tracking and stopping the spread of aquatic invasive species. Waters with invasive species are labeled as infested.

The basic hydrography of Carlton County is mapped in Figure 1.

Figure 1. Hydrography in Carlton County



SOURCE: (MN DNR, 2013, 2019C, 2021B)

3.3.1 LAKES

There are 77 lakes in Carlton County. One of the largest lakes in this county is Big Lake, which spans 526 acres. Big Lake is located near the town of Sawyer and is often used for boating and fishing, especially for Northern Pike and Bluegill.

The MPCA classifies the following lakes as "impaired": Sand Lake, Thomson Reservoir, Eddy Lake, Hanging Horn Lake, Merwin Lake, Moosehead Lake, Twentynine Lake, Cross Lake, Lower (South) Island Lake, and Tamarack Lake (MPCA, 2020). Lakes in Carlton County have been identified as impaired due to pollutants or stressors found in these waters; examples include E. coli, mercury in fish tissue, and excess levels of nutrients. Impaired waters do not meet the State's water quality standards and they affect growth and health of communities and economies. The Clean Water Act has a mandate requiring every state to address impairments (US EPA, 2015).

Lakes that are infested with an aquatic invasive species are also of concern (MN DNR, 2020d). The MN DNR documents three lakes in Carlton County as infested with the invasive aquatic species Eurasian watermilfoil.

3.3.2 RIVERS

Two major rivers flow through Carlton County: Kettle River and a small secton of the St. Louis River. Kettle River is an 86-mile-long tributary of the St. Croix River, which is a federally classified Wild and Scenic River. The majority of it defines the upper half of the state boundary between Minnesota and Wisconsin. The St. Croix River flows 164 miles until its confluence with the Mississippi River near Prescott, WI. The fast-moving St. Louis River is the only Minnesota river with whitewater rafting opportunities. It drains a watershed of 3,650 square miles and flows into Lake Superior through the St. Louis Bay in Duluth, MN. It is the largest river within the United States to flow into this lake (MN DNR, 2020d).

The MPCA classifies a number of rivers in Carlton County as "impaired," including: the St. Louis River, Kettle River, Minnesota River, Sauk River, Rum River, and Blue Earth River.

3.3.3 WETLANDS

The term "wetland" is defined by the Minnesota Legislature as "…areas that are inundated or saturated by surface water or groundwater at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions" (Wetland Standards and Mitigation, 2016). Important benefits of wetlands include storage area for excess water during flooding; filtering of sediments and harmful nutrients before they enter lakes, rivers, and streams; and fish and wildlife habitat.

Carlton County contains many wetlands mostly in the northwestern part of the county. These wetlands total 194,825 acres and cover 35% of the county (MN DNR, 2019c). These wetlands are mostly bogs (64,813 acres), shrub swamp (61,135 acres), and wooded swamp (33,975 acres) (MN DNR, 2019d). The variety of wetland types are presented in the hydrography map in Figure 1.

Although impairment is not as prevalent as in lakes and rivers, the MPCA has identified a number of impaired wetlands throughout Minnesota; fortunately, none of these wetlands are located in Carlton County.

3.3.4 GROUNDWATER

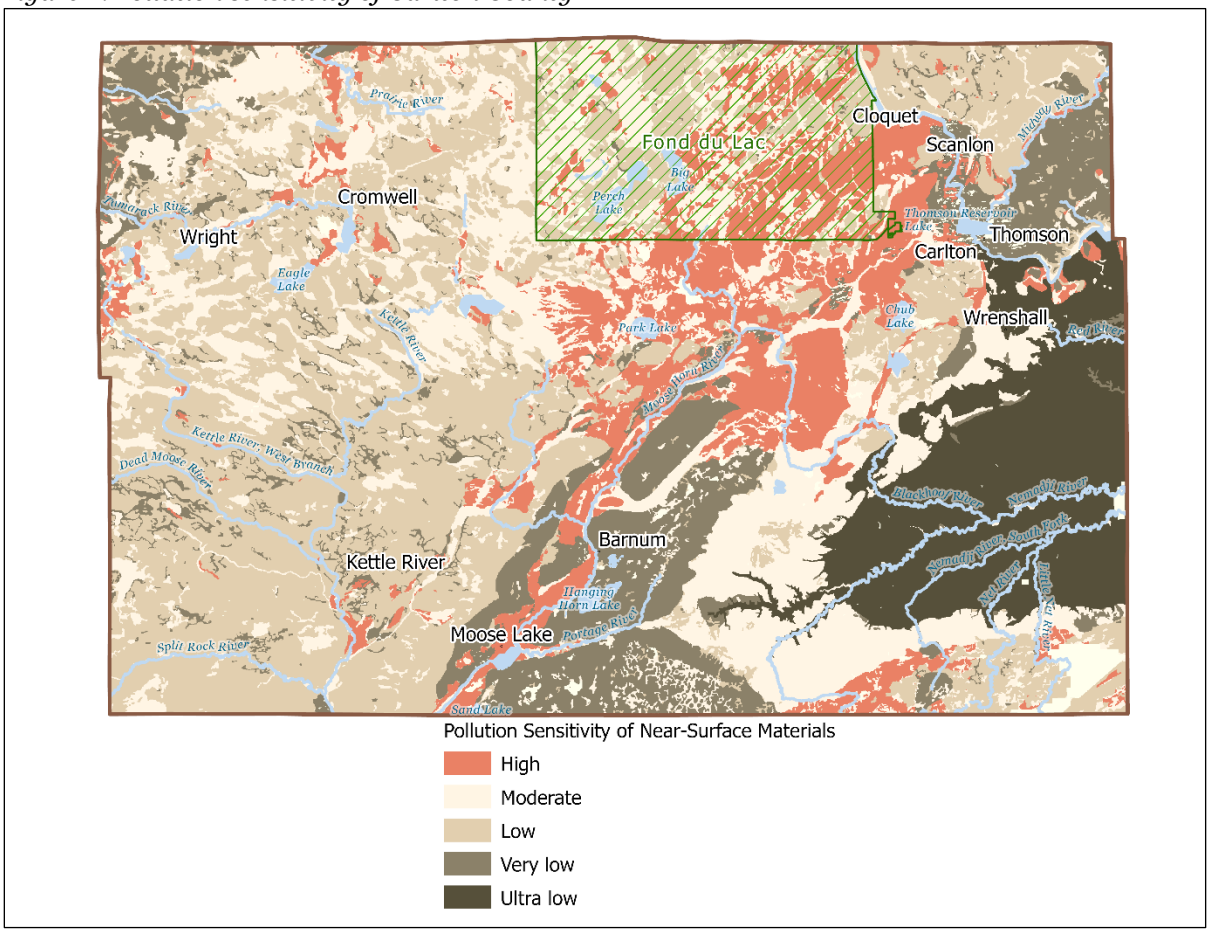
Groundwater serves a variety of vital functions in Carlton County. The Minnesota Department of Natural Resources has published a County Geologic Atlas of Carlton's Hydrogeology that provides information on the sources and uses of groundwater in Carlton County. Perhaps most significant, over 90% of the groundwater in this county used for municipal water purposes. The majority of this municipal water comes from a buried sand and gravel aquifer. Unlike many other counties in Minnesota, irrigation uses a very small percentage of water (MPCA, 2015).

The primary water sources within Carlton County are from the shallow sand plain aquifers starting in the northeast corner and continuing to the south-central area of the county. Other areas of the county have aquifers or shallower surficial layers. Approximately half of the wells in Carlton County use sand and gravel aquifers found at depths less than 100 feet and are generally situated in the sand plain area. Approximately one-quarter of the wells are in sand and gravel aquifers at depths greater than 100 feet. The remaining wells draw water from bedrock aquifers.

The location and the character of the Onanegozie's Sand Plain Aquifers have the greatest effect on water resources in the County. These include the Chub Lake and Red Clay areas. The southeast formations include two bedrock aquifers that underlie most of Carlton County. They are the Proterozoic Metasedimentary Aquifer and the Hinckley-Fond du Lac Sandstone Aquifer. Two other aquifers also underlie similar portions of the County. They include the Keweenawan Volcanics Aquifer and the Precambrian Undifferentiated Igneous and Metamorphic Aquifer. The Hinckley-Fond du Lac Sandstone Aquifer yields at least 15 gallons per minute and can yield up to several hundred gallons per minute in southern Carlton County where the bedrock is 400 feet thick (MPCA, 2015).

With such an abundance of groundwater available, it is important to examine how sensitive this natural resource is to pollution. Groundwater sensitivity to pollution is measured by flow rate and soil permeability. Figure 2 maps pollution sensitivity of near-surface materials based on the time it takes water to travel through 3 feet of soil and 7 feet of surficial geology, to a depth of 10 feet from the land surface (Adams, 2016). The total travel time is then categorized into five sensitivity classes, ranging from high (<=170 hours) to ultra-low (>8,000 hours). Areas with special geologic conditions, such as karsts, peatlands, bedrock at or near the surface, and disturbed lands (e.g., open pit mines) require individual consideration. Of these special condition areas, only karst areas have been assigned a sensitivity ranking ("very high") due to karst areas consistently showing very fast water infiltration rates. The remaining special condition areas are classified together as they cannot be assigned a sensitivity ranking using the same methodology (MN DNR, 2020c).

Figure 2. Pollution sensitivity of Carlton County



SOURCE: (MPCA, 2018A)

3.4 Climate

According to the Köppen climate classification system, Carlton County's climate is classified as "Dfb" – a humid continental climate region with large seasonal temperature contrasts with precipitation distributed throughout the year (no dry season) and at least four months of the year averaging above 50 °F but below 71.6 °F (Arnfield, 2020).

Since 1895, climate in the United States has been analyzed using the Climate Divisional Dataset. The boundaries of climate divisions have evolved significantly over the years: beginning in 1909 with 12 climatological districts that followed the principal drainage basins, to the current 344 climate divisions based largely on the USDA Bureau of Agricultural Economics Crop Reporting Districts (Guttman & Quayle, 1996). Climate division temperature, precipitation, and drought values are derived from the values reported by the weather stations in each climate division. In 2014, new methodologies to compute the climate division data were implemented, improving the data coverage and quality of the dataset (NOAA, 2020).

Table 4 displays monthly Climate Normals (three-decade averages) of temperatures as reported by the climate division in which Carlton County is located.

Table 4. Carlton County Average Monthly Temperature, 1981–2010; 1990–2020

Month	MN Climate Division 6 1981–2010	MN Climate Division 6 1990–2020	MN Statewide 1981–2010	MN Statewide 1990–2020
January	11.0°F	11.2°F	9.9 °F	10.1 °F
February	16.5°F	16.0°F	15.4 °F	14.7 °F
March	28.7°F	28.7°F	27.9 °F	27.8 °F
April	43.2°F	42.2°F	42.9 °F	41.9 °F
May	55.1°F	54.9°F	55.1 °F	54.8 °F
June	64.2°F	64.4°F	64.4 °F	64.8 °F
July	69.1°F	69.2°F	69.0 °F	69.0 °F
August	66.9°F	67.0°F	66.8 °F	66.8 °F
September	57.9°F	58.9°F	57.7 °F	58.6 °F
October	45.3°F	45.5°F	44.8 °F	45.1 °F
November	30.2°F	30.8°F	29.2 °F	29.8 °F
December	15.6°F	17.7°F	14.5 °F	16.5 °F

SOURCE: (MIDWESTERN REGIONAL CLIMATE CENTER, 2021)

3.4.1 CLIMATE CHANGE ADAPTATION

Minnesota's climate is currently changing in ways that are pushing us to adapt to weather patterns and extreme events that pose major threats to our health, homes, environment, and livelihoods. These events cost our state millions in property loss, damaged infrastructure, disrupted business, medical care, and support services, and put residents and responders at risk. Understanding how our weather is changing now and into the future will help planners and decision-makers in emergency management and supporting fields extend our progress in climate adaptation and lead to more resilient communities. (MDH, 2018)

The National Climate Assessment suggests that infrastructure planning (particularly water resources infrastructure) should "be improved by incorporating climate change as a factor in new design standards and asset management and rehabilitation of critical and aging facilities, emphasizing flexibility, redundancy, and resiliency" (Georgakakos, et al., 2014).

Federal, state, and tribal governments are increasingly integrating climate change adaptation into existing decision-making, planning, or infrastructure-improvement processes (Georgakakos, et al., 2014). Definite predictions are difficult to make, as changes may vary depending on geographical location, even within Minnesota. Intense study of these topics is ongoing.

Rural communities are particularly vulnerable to climate change, due to their dependence upon natural resources, physical isolation, limited economic diversity, higher poverty rates and aging populations. According to *Climate Change Impacts in the United States: The Third National Climate Assessment*,

> Warming trends, climate volatility, extreme weather events, and environmental change are already affecting the economies and cultures of rural areas. Many rural communities face considerable risk to their infrastructure, livelihoods, and quality of life from observed and projected climate shifts. These changes will progressively increase volatility in food commodity markets, shift the ranges of plant and animal species, and, depending on the region, increase water scarcity, exacerbate flooding

and coastal erosion, and increase the intensity and frequency of wildfires across the rural landscape (Hales et al., 2014).

The Assessment also notes that transportation systems in rural areas are more vulnerable to risks such as flooding since there are typically fewer transportation options and infrastructure redundancies. In addition, power and communication outages due to severe weather events typically take longer to repair in rural areas, which can increase the vulnerability of elderly populations. Rural area populations are also more vulnerable since they typically have limited financial resources to deal with the effects of climate change.

The composition of the region's forests is expected to change as increasing temperatures shift tree habitats northward. While forests in the Midwest are currently acting as a net absorber of carbon, this could change in the future due to projected increases in insect outbreaks, forest fires, and drought, which will result in greater tree mortality and carbon emissions (Pryor et al., 2009).

3.4.2 CLIMATE DATA TRENDS

Over 50 years of storm data on record document that Minnesota has experienced an increase in the number and strength of weather-related natural disasters, particularly those related to rising temperatures and heavy downpours.

According to the 2015 Minnesota Weather Almanac,

> During the three most recent decades, the Minnesota climate has shown some very significant trends, all of which have had many observable impacts…Among the detectable measured quantity changes are: (1) warmer temperatures, especially daily minimum temperatures, more weighted to winter than any other season; (2) increased frequency of high dew points, especially notable in mid- to late summer as they push the Heat Index values beyond 100°F; and (3) greater annual precipitation, with a profound increase in the contribution from intense thunderstorms (Seeley M. , 2015).

Temperature and precipitation projections below are taken from the Minnesota Department of Health (MDH) Region 2 profile. Appendix H provides the full MDH profile for Region 2, which includes Carlton County. This report is one of a series of custom climate profile reports produced for each of the six HSEM regions in the state for reference to climate change projection data, impacts, and considerations for emergency management and preparedness professionals in this HSEM region. The information in this report was used to help inform the updated risk assessments in Section 4 of this plan for natural hazards and their relationship to climate change.

Temperature

The 2018 MDH report details how average temperatures have been affected by climate change:

> There has been an increase in winter and summer temperatures. Our average winter lows are rising rapidly, and our coldest days of winter are now warmer than we have ever recorded. In fact, Minnesota winters are warming nearly 13 times faster than our summers. The continued rise in winter temperatures will result in less snowpack, which will increase chances for grassland/wildfires as well

as drought. The warmer winter temperatures will also have major consequences for our ecosystems, including native and invasive species, whose growth, migration, and reproduction are tied to climate cues. The increase in Lyme disease across Minnesota is also likely influenced in part by the loss of our historical winters, due to a longer life-cycle period for ticks. Freeze-thaw cycles are likely to increase as well, damaging roads, power lines, and causing hazardous travel conditions. By mid-century our average summer highs will also see a substantial rise, coupled with an increase in more severe, prolonged heat waves that can contribute to drought and wildfires and pose a serious health threat, particularly to children and seniors. (MDH, 2018)

Changes in average temperatures are detailed in Table 5.

Increasing temperatures impact Minnesota's agricultural industry. As a result of increasing temperature, crop production areas may shift to new regions of the state where the temperature range for growth and yield of those crops is optimal. According to the National Climate Assessment, the Midwest growing season has lengthened by almost two weeks since 1950 due in large part to earlier timing of the last spring freeze. This trend is expected to continue. While a longer growing season may increase total crop production, other climate changes, such as increased crop losses and soil erosion from more frequent and intense storms and increases in pests and invasive species, could outweigh this benefit.

Table 5. Temperature trends for HSEM Region 2

Average Summer Maximum Temperature			Average Winter Minimum Temperature		
1981–2010	2050–2075	Change	1981–2010	2050–2075	Change
77.2 °F	84.6 °F	+7.4 °F	1.2 °F	11.3 °F	+10.1 °F

SOURCE: (MDH, 2018)

There may be higher livestock losses during periods of extreme heat and humidity. Losses of livestock from extreme heat led to a challenge in the disposal of animal carcasses. Currently there are only two rendering facilities in Minnesota available for livestock disposal. To minimize the detrimental effects of heat stress on animal metabolism and weight gain, Minnesota farmers have also begun redesigning and retrofitting dairy, hog, and poultry barns with better watering, feeding, and ventilation systems (Seeley, 2015).

Precipitation

Climate change has also affected precipitation, as described in detail in the 2018 MDH report:

> There has been an increase in total average as well as heavy precipitation events, with longer periods of intervening dry spells. Our historical rainfall patterns have changed substantially, giving rise to larger, more frequent heavy downpours. Minnesota's high-density rain gauge network has captured a nearly four-fold increase in "mega-rain" events just since the year 2000, compared to the previous three decades. Extreme rainfall events increase the probability of disaster-level flooding. However, there is also an increased probability that by mid-century heavy downpours will be separated in time by longer dry spells, particularly during the late growing season. Over the past century, the Midwest has not experienced a significant change in drought duration. However, the average number of days without precipitation is projected to increase in the future, leading Minnesota climate experts to state with moderate-to-high confidence that drought severity, coverage, and duration are likely to increase

in the state. Modeling future precipitation amounts and patterns is less straight-forward compared to temperature. Some climate models do a better job than others representing rainfall for the Midwest, and available data sources only provide average estimates on a monthly scale, masking the spikes in extremes that trigger flood and drought disasters. (MDH, 2018)

3.5 Demographics

Carlton County contains ten cities, nineteen townships, and two unincorporated townships. In 2020, Carlton County had a population of 36,207, averaging forty-one people per square mile of land area (U.S. Census Bureau, 2020b). The county seat, Carlton City, had a 2020 population of 948 people, while the largest city, Cloquet City, had 12,568 people that same year. Table 6 lists the communities in Carlton County along with their respective population numbers.

Population growth trends have an important influence on the needs and demands of a variety of services such as transportation, law enforcement, and emergency response. Understanding population trends and location of population concentrations is essential for making projections regarding potential impacts in the event of a disaster.

Table 6. Carlton County Population by Community, 2010 and 2020

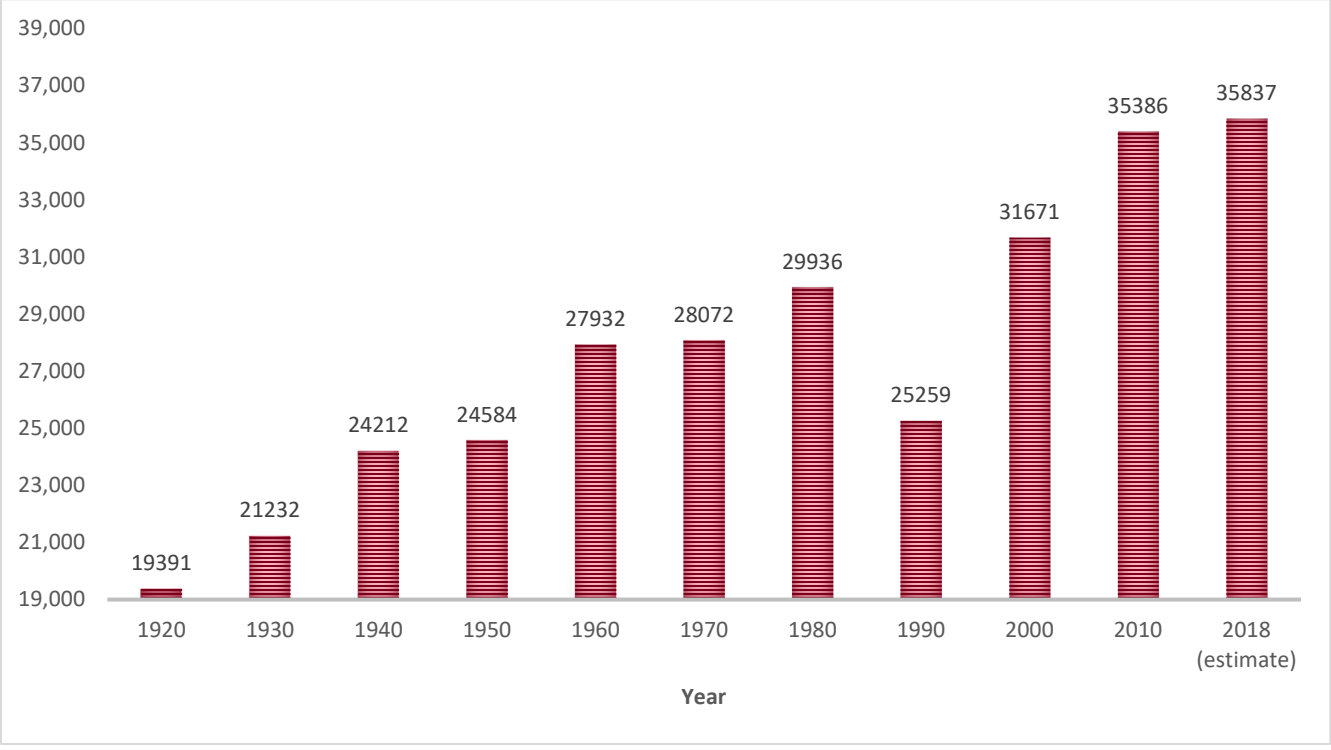
Community	2010 Population	2020 Population	% of County
Atkinson Township	406	400	1.10%
Automba Township	140	150	0.41%
Barnum City	613	620	1.71%
Barnum Township	1,061	1,098	3.03%
Beseman Township	137	138	0.38%
Blackhoof Township	893	985	2.72%
Carlton City	862	948	2.62%
Clear Creek Unincorporated Township	160	140	0.39%
Cloquet City	12,124	12,568	34.71%
Cromwell City	234	240	0.66%
Eagle Township	581	531	1.47%
Holyoke Township	182	209	0.58%
Kalevala Township	327	304	0.84%
Kettle River City	180	166	0.46%
Lakeview Township	179	207	0.57%
Mahtowa Township	613	553	1.53%
Moose Lake City	2,751	2,789	7.70%
Moose Lake Township	1,061	988	2.73%
North Carlton Unincorporated Township	982	976	2.70%
Perch Lake Township	1,046	977	2.70%
Scanlon City	991	987	2.73%
Silver Township	457	448	1.24%
Silver Brook Township	648	614	1.70%
Skelton Township	414	413	1.14%

Community	2010 Population	2020 Population	% of County
Split Rock Township	166	161	0.44%
Thomson City*	159	N/A	N/A
Thomson Township	5,003	5,465	15.09%
Twin Lakes Township	2,108	2,093	5.78%
Wrenshall City	399	428	1.18%
Wrenshall Township	382	443	1.22%
Wright City	127	168	0.46%
Total	35,386	36,207	100.00%

*Thomson City merged with Carlton in 2015.
SOURCE: (U.S. CENSUS BUREAU, 2020B)

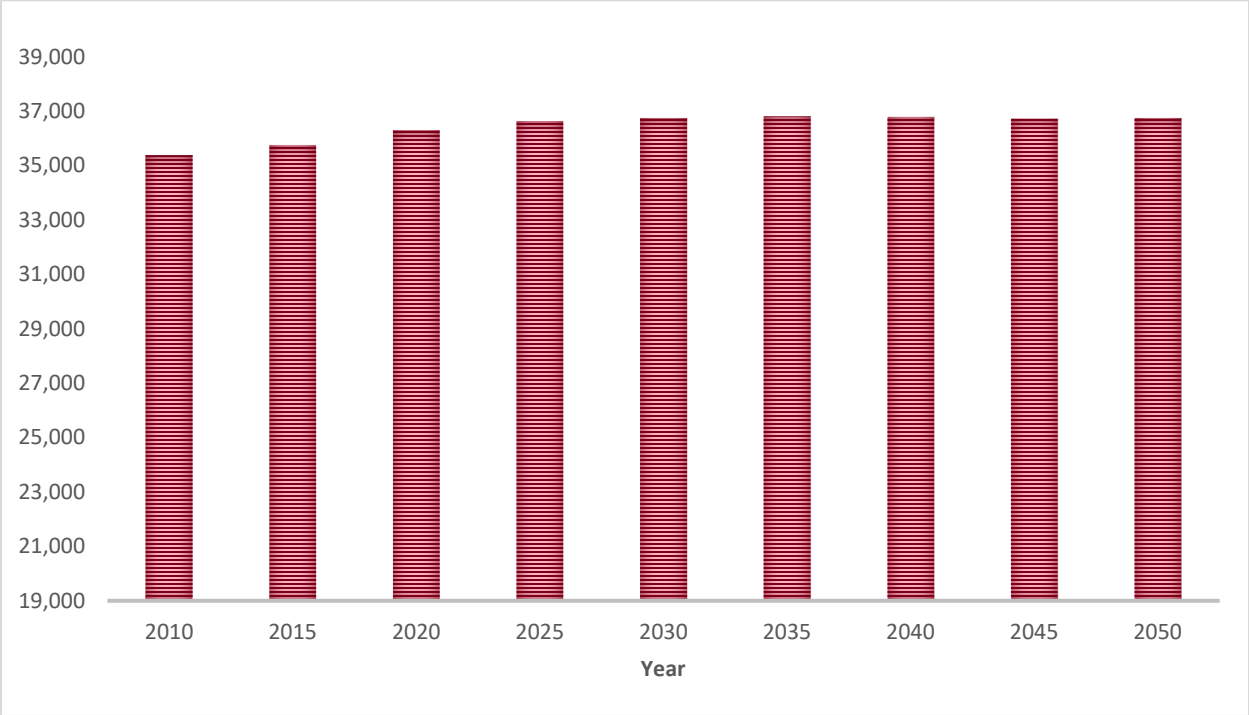
Carlton County's population saw fairly steady growth between 1920 and 1980 and doubled its population during that time, before a sudden population decrease of 15.6% occurred between 1980 and 1990. After this decrease population growth began again, and the county saw a 40% increase in population between 1990 and 2010. Carlton County's record high population occurred at the 2010 census, when the county reached 35,386 people (U.S. Census Bureau, 2020b). The Minnesota State Demographic Center projects stability in Carlton County's population through 2050 and estimates a 2.6% growth in population between 2010 and 2020. From 2020 to 2050, population fluctuations are estimated to stay within less than one percent of any increase or decrease, and the population is expected to remain around 36,700 (Minnesota State Demographic Center, 2020). Figure 3 provides an overview of the county's historic population change Projected population is detailed in Figure 4.

Figure 3. Carlton County's Population Change, 1920–2018 (estimate)



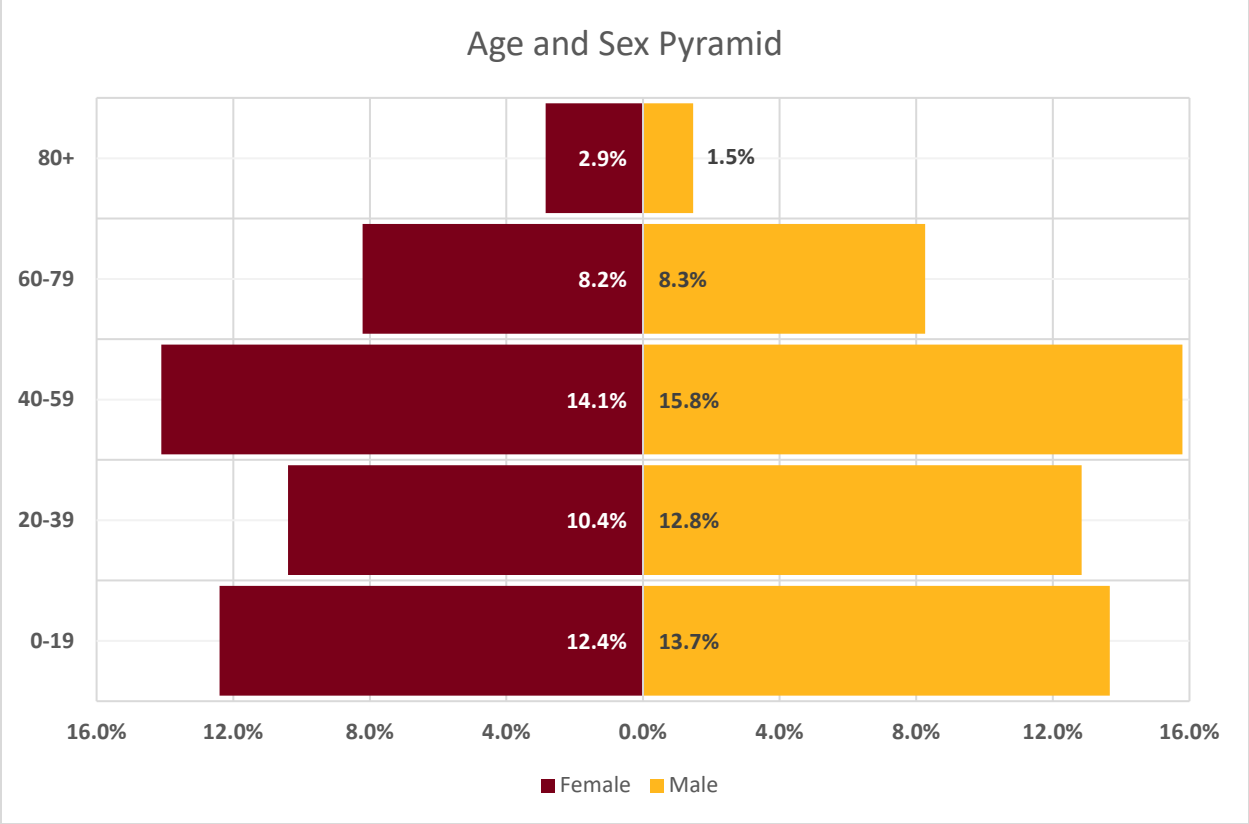
SOURCE : (U.S. CENSUS BUREAU, 2020A)

Figure 4. Carlton County's projected population change, 2010–2050



SOURCE: (MINNESOTA STATE DEMOGRAPHIC CENTER, 2020)

Figure 5. Carlton County age (years) and sex percentage of total population



SOURCE: (U.S. CENSUS BUREAU, 2020B)

Carlton County's total population consists of 48.0% females and 52.0% males. 4.3% of the total population is aged 80 and older, and 26.1% of the total population is under 20 years old. 40–59-year-olds make up the largest age category in Carlton County, at 29.9% of the total population. Figure 5 breaks down the percentage of the total population into categories of age and sex.

3.6 Economy

As of 2018, the Education and Health Services industry supersector employed (28%) of people in Carlton County, followed by Public Administration (16%), and Trade, Transportation, and Utilities (16%). The total number of jobs in the county increased by over 1.2% between 2008 and 2018. The ten-year change in the average annual employment of each industry supersector in Carlton County is in Table 7.

Table 7. Average Annual Employment by Industry Supersector, Carlton County

Industry Supersector	Average # of Employees (2008)	Average # of Employees (2018)	% Change
Natural Resources and Mining	No Data	91	NA
Construction	956	748	−21.76%
Manufacturing	1,634	1,309	−19.89%
Trade, Transportation, and Utilities	2,265	2,093	−7.59%
Information	87	65	−25.29%
Financial Activities	473	538	13.74%
Professional and Business Services	282	375	32.98%
Education and Health Services	3,530	3,809	7.90%
Leisure and Hospitality	1,781	1,903	6.85%
Other Services	290	336	15.86%
Public Administration	1,838	2,100	14.25%
Total, All Industries	**13,209**	**13,368**	**1.20%**

SOURCE: (MN DEED, 2020)

The 2017 median household income in Carlton County was $58,874 compared to a Minnesota average of $65,669. The median household income in Carlton County increased by 11.4% from 2010 to 2017.The percent of the county's population living below the poverty level in 2017 was 10.1%, compared to an 11.8% average for the state of Minnesota (U.S. Census Bureau, 2020c).

3.7 Critical Infrastructure

Critical infrastructure systems are among the most important assets of a community. While different infrastructures accomplish different goals, their continued operations are integral to the health, safety, and economic and cultural well-being of the residents of Carlton County. Critical infrastructure is identified based on FEMA guidelines (FEMA, 2013a) as well as input from Carlton County and classified into the following groups: Emergency and Shelter Facilities, Infrastructure Systems, High Potential Loss Structures, and Significant County Assets. For the complete list of critical infrastructure in Carlton County, see Appendix I.

3.7.1 ESSENTIAL FACILITIES

Emergency and shelter facilities are vital to the health and welfare of entire populations, providing services and functions essential to communities, especially during and after a disaster. Emergency and shelter facilities include healthcare facilities, emergency services, evacuation centers/shelters, and schools (often used as evacuation centers/shelters). U-Spatial provided Carlton County with an interactive online application to verify the names and locations of all emergency and shelter facilities. The verified locations were mapped, and the resulting spatial data were provided to the county. Figure 6 shows the emergency and shelter facilities in a few representative communities with concentrated facilities.

Healthcare Facilities

Carlton County is served by 73 healthcare facilities. Most are concentrated in the northwest corner of the county, in the cities of Cloquet and Scanlon. Assisted living facilities make up the vast majority of these facilities, including 35 registered adult foster care services, 24 assisted nursing facilities, three skilled nursing facilities, and one assisted living facility. Many of these are groups of establishments, including Pine Ridge Homes, which has ten adult foster care facilities in the county, REM Arrowhead, which has seven, and Safe Transitions, which has five. New Perspectives Senior Living has eight buildings.

Seven mental health and substance abuse treatment centers are also located throughout the county. The city of Carlton has the Lake Venoah board and lodging house for alcohol treatment and recovery and Community Addiction Recovery Enterprise (CARE). Moose Lake has the Minnesota Sex Offender Program (MSOP) facility, and Sawyer, located on the Fond du Lac Reservation, contains the Mash-Ka-Wisen Treatment Center. Three facilities are located in Cloquet: the Pioneer Recovery Center, Haven Chemical Health Systems LLC, and Tagwii Recovery Center (located on the Fond du Lac Reservation).

The county has two hospitals, Mercy Hospital in Moose Lake, and Community Memorial Hospital in Cloquet. Community Memorial also contains a dialysis center, the Fresenius Medical Care Center.

Five facilities, all included in the previous count, fall within the Fond du Lac Reservation. They are: the Mash-Ka-Wisen Treatment Center, an REM Arrowhead facility, the Tagwii Recovery Center, Fond du Lac Assisted Living, and Northland Adult Foster Care.

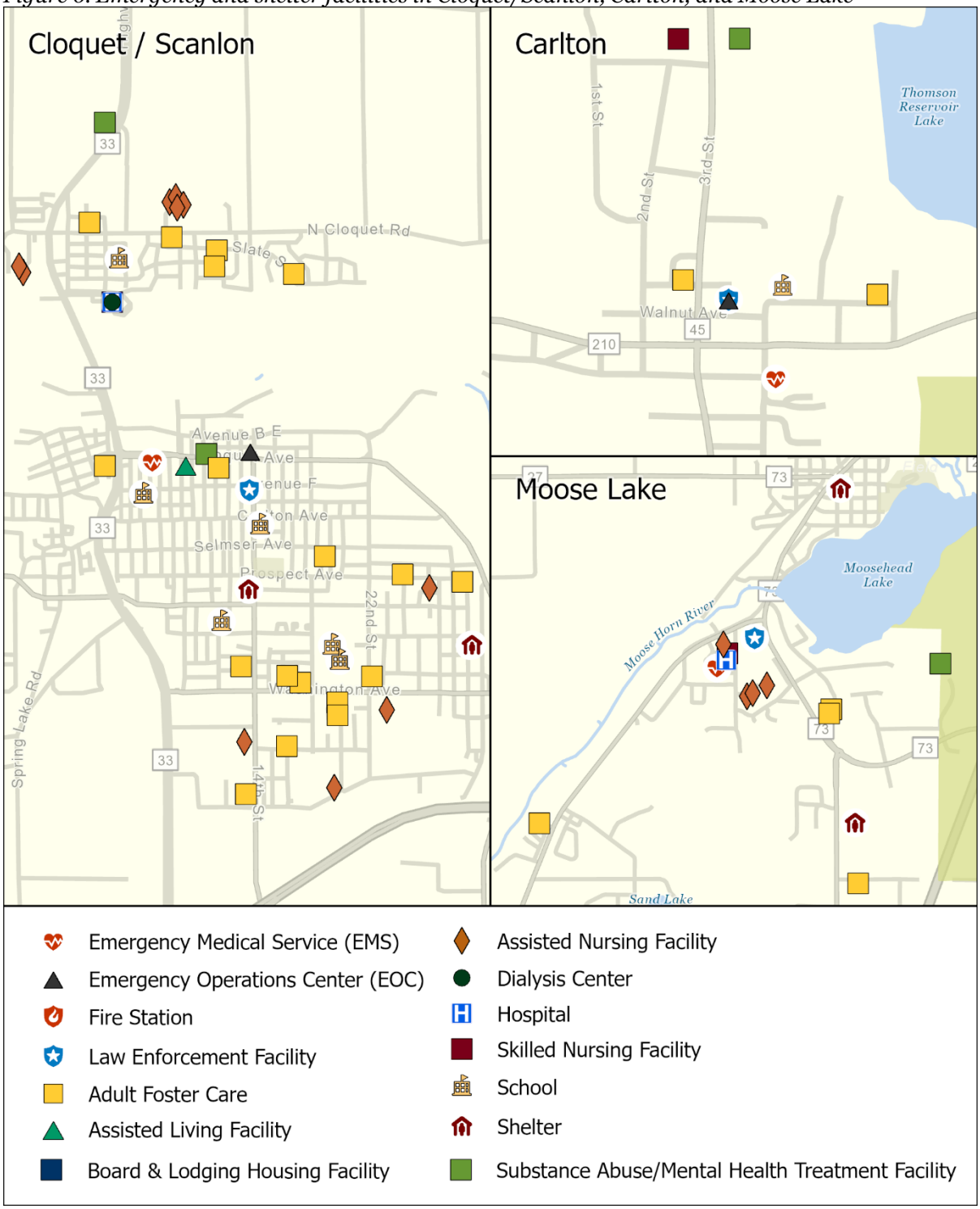
Emergency Services

Law Enforcement: Seven law enforcement facilities are located in the county, two of which are within the Fond du Lac Reservation. There is one police department in Cloquet and one in Moose Lake. The Carlton County Sheriff has two offices, in the city of Carlton, which also includes the County Jail, and in Esko. The State Patrol is in the city of Carlton. The Fond du Lac Police Department and Fond du Lac Conservation Enforcement, which consists of eight officers who enforce conservation codes, are both located on the reservation in the city of Cloquet.

Fire & Rescue Services: Seventeen fire departments service the county. Three of these are outside the county; one is in Pine County to the south, and the other two in Saint Louis County to the northeast. The Fond du Lac Reservation has one fire department, Cloquet Fire District Station 2, located on the east side of the reservation in Cloquet. The Cloquet Fire District has five stations, and Cromwell-Wright Fire and

Ambulance has three stations. Three fire departments are volunteer: Barnum Volunteer Fire Department in Barnum, Kettle River Volunteer Fire Department and First Responders in Kettle River, and Moose Lake Volunteer Fire Department in Moose Lake.

Figure 6. Emergency and shelter facilities in Cloquet/Scanlon, Carlton, and Moose Lake



SOURCE: (HIFLD, 2021; MDH, 2021A; CARLTON COUNTY)

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Law Enforcement: Seven law enforcement facilities are located in the county, two of which are within the Fond du Lac Reservation. There is one police department in Cloquet and one in Moose Lake. The Carlton County Sheriff has two offices, in the city of Carlton, which also includes the County Jail, and in Esko. The State Patrol is in the city of Carlton. The Fond du Lac Police Department and Fond du Lac Conservation Enforcement, which consists of eight officers who enforce conservation codes, are both located on the reservation in the city of Cloquet.

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All seventeen fire departments also include EMS services. There is one additional ambulance service, the Mercy Ambulance Service in Moose Lake. The one Emergency Operation Center in Carlton County is located in the sheriff's office in the city of Carlton. Two backup EOCs are also located in the city of Carlton.

Schools & Evacuation Centers/Shelters

There are 24 schools in Carlton County, as well as 29 additional shelter and evacuation sites designated by FEMA and the American Red Cross. The cities of Barnum, Esko, and Carlton both have two schools as well as a church able to act as shelters. Cloquet has 26 locations, four of which are on the Fond du Lac Reservation. Moose Lake has six locations: Moose Lake Community Schools, two churches, two government buildings, and the Willow River/Moose Lake Minnesota Correctional Facility. Cromwell has one location, the Cromwell-Wright Elementary and High School. Wrenshall also has one location, Wrenshall Elementary and Secondary. Kettle River has Kettle River City Hall and a church. Scanlon has one location, the Scanlon Community Center.

3.7.2 INFRASTRUCTURE SYSTEMS

Infrastructure systems include the transportation systems and utility systems fundamental to the functioning of communities. These systems allow for emergency facilities to operate and connect to residents; they are the lifelines for communities.

Transportation Systems

The infrastructure of transportation systems facilitates the movement of individuals, goods, and services. The primary roadways passing through the county is Interstate 35, which connects Carlton to Duluth in the north and the Twin Cities in the south.

The Minnesota Department of Transportation classifies roads into route systems according to the services a road is intended to provide. Table 8 lists the total miles of road for each route system within Carlton County.

Table 8. Road Miles by Route System

Route System Defined	Miles
County Road	192
County State Aid Highway (CSAH)	294
Interstate	63
MN Highway	117
Municipal	100
Municipal State Aid Street	23
Private Road-Public Access	4
Ramp or Connector	8
State Forest Road	37
State Park Road	2
Township Road	368
Tribal Road	14
Unorganized Territory Road	50
Total	1,272

SOURCE: (MNDOT, 2012)

The Carlton County Public Works Department is responsible for the maintenance and construction of County State Aid Highways and County Roads, which include 294 miles of roadway and 156 bridges and culverts.

The Carlton County Transportation Department is responsible for maintenance, repairs, and snow removal on 785 miles of roads in the county, in addition to assisting most townships in maintaining 368 miles of their roads.

Railways: There are three major railways running through the county. BNSF operates a railway that crosses the county east–west. In Cloquet, the Cloquet Terminal Railroad (CTRR) has six miles of track. Duluth, Winnipeg and Pacific Railway (DWP) is a subsidiary of Canadian National (CN). The DWP track is part of the railway connecting International Falls and Duluth, Minnesota.

Airports: Two airports in the county provide air service. The Cloquet–Carlton County Airport is located 3 miles southwest of Cloquet and owned by the county. Situated at an elevation of 1,279 feet, the airport has two asphalt runways: one 4,002-feet long and one 3,100-feet long. The Moose Lake Carlton County Airport lies three miles southwest of Moose Lake at an elevation of 1,076 feet. Owned by the county, the airport has one asphalt runway (3,200 feet).

Utility Systems

The infrastructure of utility system networks facilitates the process of providing essential utilities to consumers. A map of the major utilities systems in Carlton County is displayed in Figure 7.

Water & Sewer Carlton is home to four wastewater treatment plants, in Barnum, Cromwell, Moose Lake, and Kettle River.

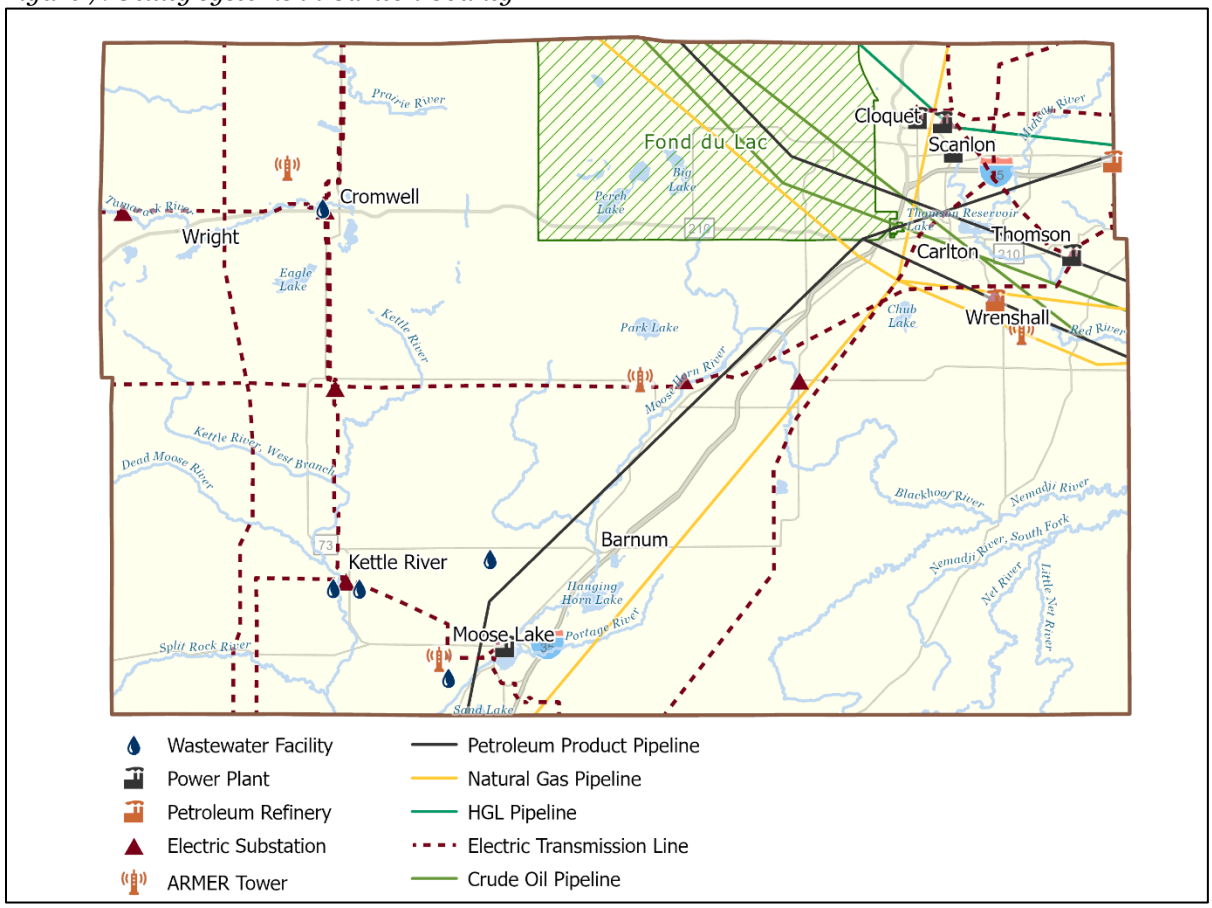
Energy: Thirteen electrical substations are located within Carlton County along with 31 major electric transmission lines. Great River Energy supplies the western half of the county, while Minnesota Power Company services the eastern half. Minnesota Power Company also runs one line through the western part of the county. There are four powerplants, three of which are operated by Allete, Inc., in Cloquet,

Scanlon, and the city of Carlton. Moose Lake Water and Light operates out of Moose Lake. Cloquet has one additional plant, Sappi Cloquet LLC.

Two natural gas companies operate in the county, the Great Lakes Gas Transmission, and the Northern Natural Gas. Enbridge's Lakehead hydraulic grade line (HGL) pipeline cuts through Cloquet in the northeast corner of the county. Additionally, the county has two crude oil pipelines, also operated by Enbridge, and three petroleum pipelines, one operated by Enbridge and the other two by Magellan Midstream Partners. These petroleum pipelines have two associated terminals, one operated by Husky Energy in Duluth, and the other by Magellan Midstream Partners in Wrenshall.

Communication: Administered in coordination with the Minnesota Statewide Radio Board, the Allied Radio Matrix for Emergency Response (ARMER) Program manages the implementation of a 700/800 megahertz (MHz) shared digital trunked radio communication system capable of servicing the radio communication needs of every public safety entity operating in Minnesota (MN DPS, 2021). There are four ARMER towers in Carlton County.

Figure 7. Utility systems in Carlton County



SOURCE: (MN GIO, 2016; MPCA, 2018B; US EIA, 2020)

3.7.3 HIGH POTENTIAL LOSS STRUCTURES

High potential loss structures are structures which would have a high loss or negative impact on the community if they were damaged or destroyed (FEMA, 2004c). These structures include dams, levees (see Section 3.4.4), and facilities storing hazardous materials.

A hazardous materials facility contains materials that would threaten the public if released. The inventory of these facilities in Carlton includes those required to register with the EPA due to the type and quantity of hazardous materials being stored or produced at the facility. Two of these facilities have been identified in Carlton. Due to the sensitive nature of these data, the locations of these facilities have not been mapped in this plan.

3.7.4 SIGNIFICANT COUNTY ASSETS

Significant county assets include larger employers which represent a primary economic sector of a community, buildings of government services deemed to be significant, and cultural or historic assets that are important to a community.

Employers: While every employer is an important asset to a community, the loss or disruption of certain employers, or the primary economic sector of a community, will have a large negative impact on the respective communities. Six employers fitting this profile were identified in Carlton County. Four are located in the city of Cloquet: Boldt Construction, Sappi Fine Paper, Upper Lakes Foods, and USG Interiors. Ideal Homes is located in Barnum, and Black Bear Resort and Casino is in the Township of Twin Lakes, on the Fond du Lac Reservation.

Government Buildings: Some government buildings deemed to be significant due to a critical service operating at the location but not previously mentioned may be considered critical infrastructure. These buildings often include government service centers, the courthouse, jails, and prisons. Forty-five buildings have been identified in Carlton. Most are town or city halls. Other significant buildings include transportation centers, airports (previously mentioned), the Cloquet Armory, the Department of Natural Resources, and the Carlton County Community Services, both also in Cloquet. The Fond du Lac Reservation contains Perch Lake Town Hall, the Fond du Lac Tribal Center, the Fond du Lac Tribal Courts, and Min No Aya Win Human Services

Cultural Resources: Cultural resources are cultural or historic assets that are unique, irreplaceable, or important to a community. Fourteen such assets have been identified in Carlton County. Eleven are buildings located in the cities of Cloquet and Carlton, including the Carlton County Courthouse and the Cloquet City Hall. The Grand Portage of the St. Louis River, a 7-mile historical portage route in Jay Cooke State Park, is another cultural asset of note.

3.8 Land Use and Ownership

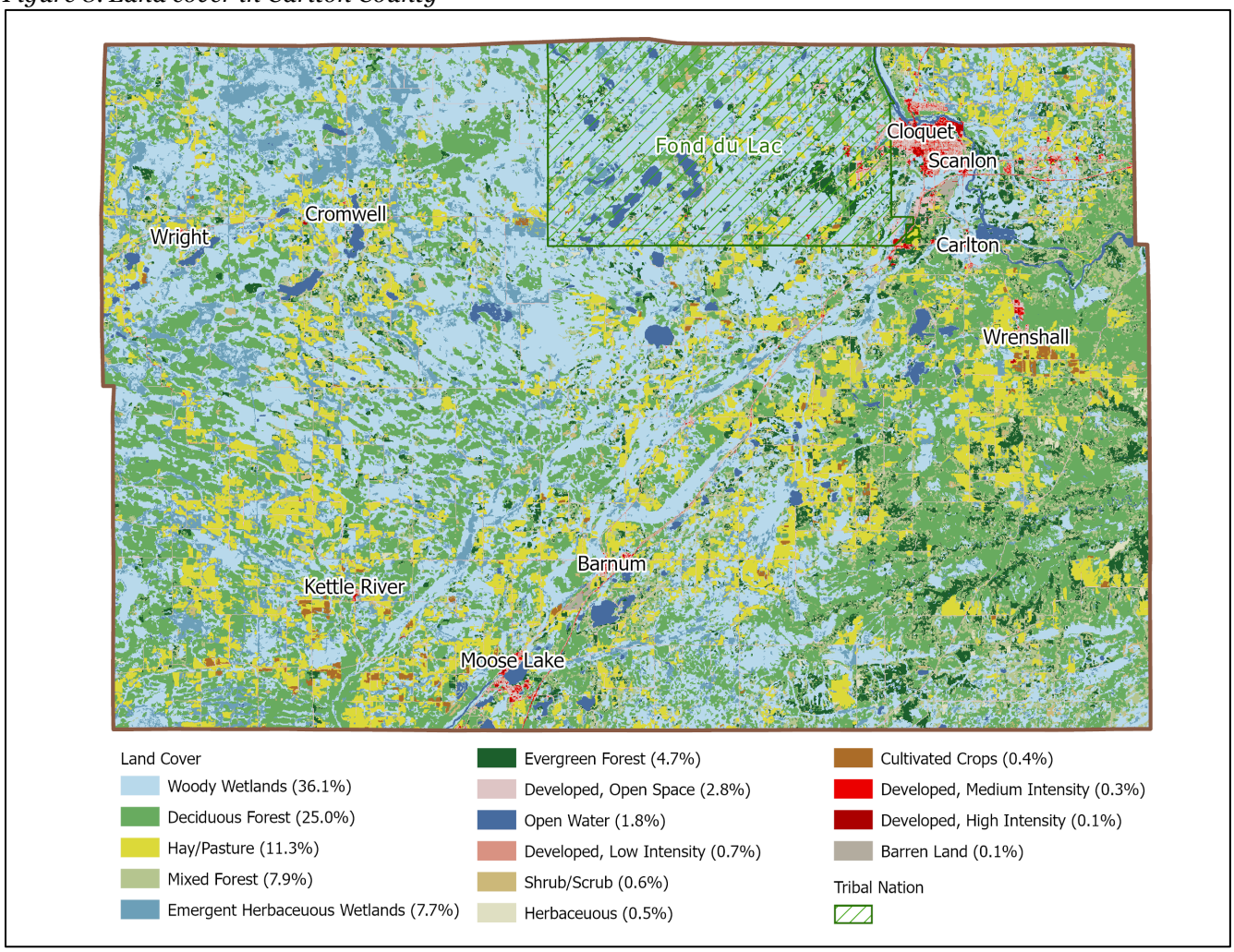
Carlton County is a wet and forested county. The county is 861 square miles, 36% of which is covered by woody wetlands, followed by deciduous forest (25%), and hay/pasture (11%) (USGS, 2016). A map of Carlton County's land cover is displayed in Figure 8.

Nearly 12% of the land in Carlton County is cropland. The term "cropland" encompasses five components: harvested cropland, crop failure, cultivated summer fallow, cropland used only for pasture, and idle cropland (USDA ERS, 2019). Between 2012-2017 the area of total cropland in the county decreased by nearly 2.6%, from 42,431 acres in 2012 to 41,339 acres in 2017 (USDA, 2012, 2017). "Harvested cropland" are the acres of cropland that are planted and successfully harvested. Table 9 shows a breakdown of Carlton County's harvested cropland in 2017.

In addition to growing crops, Carlton County is also home to numerous feedlots. A 2016 inventory counted 69 active feedlots in the county. Nearly 96% of the feedlots raise cattle as the primary stock and 4% raise horses. An average of 88 animals are on each feedlot (MPCA, 2016).

Ownership of the county is divided between 18 different agencies; the majority being privately owned (65%). Following private ownership, MN State Division of Forestry owns just over 11% of the land. Jay Cooke State Park and Fond du Lac State Forest are both primarily located in Carlton County. Fond du Lac Reservation also falls mostly within the boundary of Carlton County. Land ownership is displayed in Figure 9.

Figure 8. Land cover in Carlton County



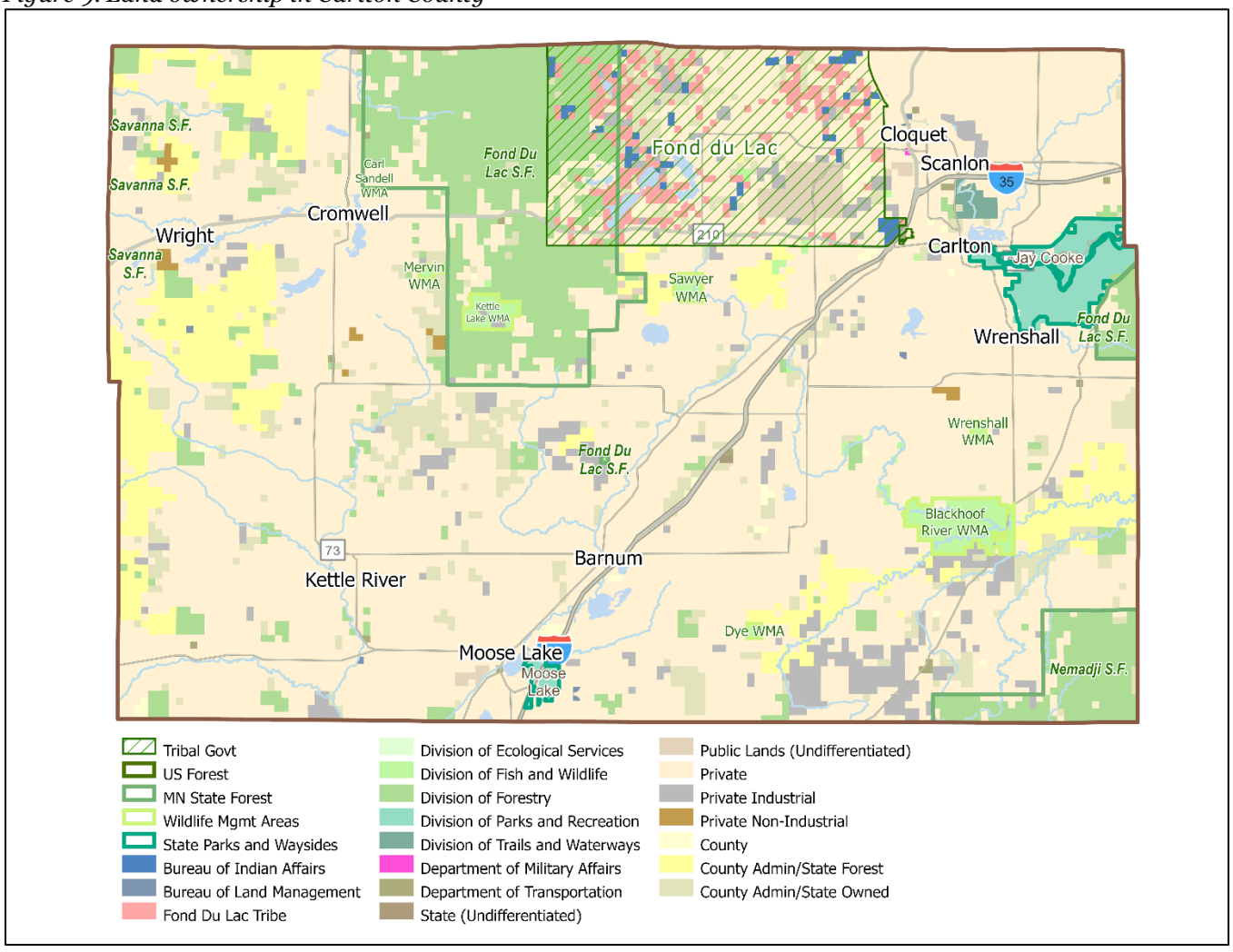
SOURCE:(USGS, 2016)

Table 9. Carlton County's harvested cropland, 2017

Crop	Acres	% of Harvested Cropland
Hay & Haylage	155,596	93.79%
Corn (grain and silage)	134,274	1.94%
Oats	11,535	1.19%
Barley	6,800	0.13%
Potatoes	996	0.02%
Other	641	2.93%
Total	**37,057**	**100.00%**

SOURCE: (USDA NASS, 2017)

Figure 9. Land ownership in Carlton County



SOURCE: (MN DNR, 2008)

Section 4 – Risk Assessment and Vulnerability Analysis

The goal of mitigation is to reduce or eliminate the future impacts of a hazard, including loss of life, property damage, disruption to local and regional economies, and the expenditure of public and private funds for recovery. Sound mitigation practices must be based on sound risk assessment. A risk assessment involves quantifying the potential loss resulting from a disaster by assessing the vulnerability of buildings, infrastructure, and people.

The risk assessments in this plan are based on widely accepted tools and databases as well as consultation with hazard mitigation planning expertise at FEMA and HSEM as well as technical guidance from the MN DNR State Climatology Office. Geographic Information System (GIS) tools are used throughout to demonstrate geographically based risk and vulnerabilities.

This assessment identifies the characteristics of natural hazard events, the severity of the risk, the likelihood of these events occurring, and the vulnerability of each jurisdiction's population and assets.

4.1 Hazard Identification and Prioritization

The cornerstone of the risk assessment is identification of the hazards that affect jurisdictions. To facilitate the planning process, several sources were employed to ensure that the natural hazards are identified prior to assessment. Listed below are the natural hazards addressed in the 2019 Minnesota State Hazard Mitigation Plan:

- Flooding
- Dam/Levee Failure
- Wildfires
- Windstorms
- Tornadoes
- Hail
- Lightning
- Winter Storms
- Landslides (Erosion and Mudslides)
- Land Subsidence (Sinkholes and Karst)
- Drought
- Extreme Heat
- Extreme Cold
- Earthquakes
- Coastal Erosion & Flooding

4.1.1 HAZARD PRIORITIZATION

As part of the plan update process, the planning team reviewed, updated, and prioritized the hazards faced by residents of Carlton County, updated the existing mitigation actions published in the 2014 Multi-Hazard Mitigation Plan, and proposed new mitigation actions.

To engage in this process, the planning team drew on a number of data sources. First, the team examined the hazards identified in the 2014 Multi Hazard Mitigation Plan. The natural hazards that pose risk to Carlton County were discussed and adjusted to reflect the definitions of natural hazards used in the 2019 Minnesota State Hazard Mitigation Plan.

While the focus of this MHMP is on natural hazards, planning took place with the understanding that many non-natural hazards could occur as a result of natural disasters (i.e., disruption in electrical service due to downed powerlines from heavy snow, ice storms, or high wind events).

The prioritization of hazards for the Carlton County MHMP Update (Table 10) was based upon group review and discussion of the natural hazards that pose risk to the county during the MHMP Planning Team Meeting #1 on September 9, 2020. In the review of each hazard, the group was asked to consider if the risk to severe natural hazards had increased or decreased since the last plan, and if this affected their priority level to mitigate against that hazard. The group agreed that since the last plan the prioritization of flooding should be moved from moderate to high due to an increase in high rain and flooding events. The prioritization for drought decreased from moderate to low based on historical data of low drought events. The prioritization of all other natural hazards was unchanged since the last plan. Appendix F provides the discussion notes from the September 9, 2020 meeting.

Table 10. Prioritization of hazards for 2014 and in this Update

Natural Hazards	Hazard Priority
Blizzards	High
Heavy Snow	High
Ice Storms	High
Windstorms	Moderate
Lightning	Low
Hailstorms	Moderate
Tornadoes	Moderate
Flooding	High
Landslides	Moderate
Extreme Cold	Moderate
Extreme Heat	Low
Drought	Low
Dam Failure	Low
Wildfire	High

4.1.2 NATIONAL CENTERS FOR ENVIRONMENTAL INFORMATION (NCEI) STORM EVENTS DATABASE

Much of the storm data used in this plan is from the NOAA National Centers for Environmental Information's (NCEI) Storm Events Database. The NCEI receives storm data from the National Weather Service (NWS), which receives the information from various local, state, and federal sources. The Storm Events Database contains records documenting:

- the occurrence of storms and other significant weather phenomena having sufficient intensity to cause loss of life, injuries, significant property damage, and/or disruption to commerce;
- rare, unusual weather phenomena that generate media attention, such as snow flurries in South Florida or the San Diego coastal area; and

- other significant meteorological events, such as record maximum or minimum temperatures or precipitation that occur in connection with another event (NCEI, 2021).

Records in the Storm Events Database go back as far as January 1950; however, only tornado events were being reported from the beginning. Revisions to the type of storm events reported to the database are ongoing. As of July 16, 2018, 55 different types of storm events were being reported to the Storm Events Database (NCEI, 2021). Storm Events Database hazard categories used in this plan are listed in Table 11 below. For some hazards, other sources are used in the hazard histories to create a more comprehensive record.

A summary table of events related to each hazard type is included in the hazard profile sections that follow in Section 5. Please note, frequency statements in hazard profile sections are based on the hazards reported for the entire period of record. In some cases, events may be underreported.

The Storm Events Database is updated regularly. NCEI receives data from the NWS approximately 75 days after the end of a data month therefore, during the timeframe of compiling this plan, data more current than what is used in this report will become available (NCEI, 2021).

The economic and property loss estimates in the Storm Events Database are often preliminary in nature and may not match the final assessment of losses related to given weather events.

Table 11. National Centers for Environmental Information Event Types

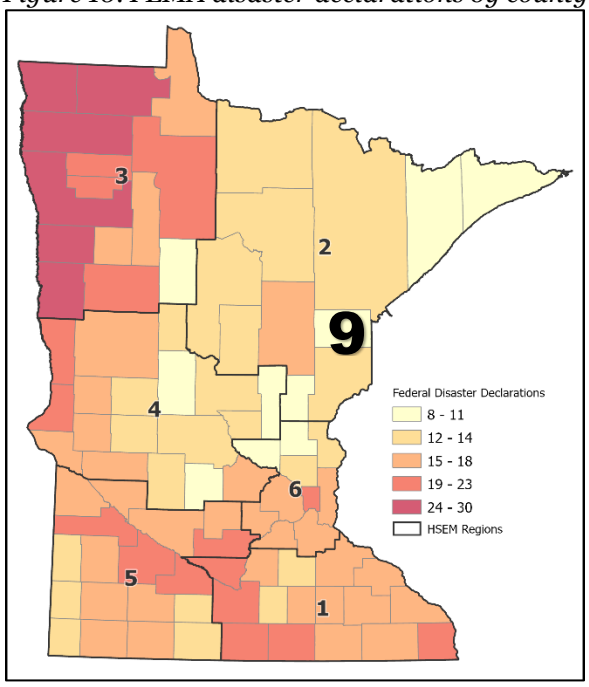
Hazard	NCEI Event Types	Period of Record
Flooding	Flood, Flash Flood, Heavy Rain	1996–present
Windstorms	Thunderstorm Wind, High Wind, Strong Wind	1955–present
Tornadoes	Tornado	1950–present
Wildfire*	Wildfire	1996–present
Hail	Hail	1955–present
Lightning	Lightning	1996–present
Winter Storms	Winter Weather, Winter Storm, Blizzard, Heavy Snow, Ice Storms, Lake Effect Snow, Sleet	1996–present
Extreme Cold	Cold, Wind Chill	1996–present
Extreme Heat	Excessive Heat, Heat	1996–present

SOURCE (NCEI, 2021)

4.1.3 FEMA- AND MINNESOTA-DECLARED DISASTERS AND ASSISTANCE

Another historical perspective is derived from FEMA-declared disasters. Six major disaster and three emergency declarations in Carlton County have been made between 1957 and January 2021, for a total of nine (Figure 10). These are listed in Table 12.

Figure 10. FEMA disaster declarations by county



SOURCE: (FEMA, 2021A)

Minnesota Statutes Chapter 12A established a framework for state agencies to help communities recover from disaster. In 2014, Governor Mark Dayton signed legislation establishing the state's Disaster Assistance Contingency Account to assist local communities after a natural disaster when federal aid is not available. Damage required to declare a disaster is half the threshold of the federal/FEMA public assistance (only) program threshold (MN HSEM, 2019). Carlton County was included in two State Disaster Declarations (Table 13)

The Hazard Mitigation Grant Program (HMGP), Building Resilient Infrastructure and Communities (BRIC), and Flood Mitigation Assistance (FMA) Program are FEMA-administered hazard mitigation assistance programs which provide funding for eligible mitigation planning and projects which reduce disaster losses and protect life and property from future disaster damages (FEMA, 2021b). Table 14 lists the projects in the county funded by a hazard mitigation assistance program.

Table 12. FEMA-declared major disasters and emergency declarations in Carlton County (1957–April 2021)

Declaration Number	Declaration Year	Incident	Incident Period
DR-4531-MN	2020	Covid-19 Pandemic	01/20/2020–current
EM-3453-MN	2020	Covid-19	01/20/2020–current
DR-4390-MN	2018	Severe Storms, Tornadoes, Straight-Line Winds, and Flooding	06/15/2018–07/12/2018
DR-4069-MN	2012	Severe Storms and Flooding	06/14/2012–06/21/2012
EM-3242-MN	2005	Hurricane Katrina Evacuation	08/29/2005–10/01/2005
DR-1370-MN	2001	Severe Winter Storms, Flooding, and Tornadoes	03/23/2001–07/03/2001
EM-3013-MN	1976	Drought	06/17/1976–06/17/1976

Declaration Number	Declaration Year	Incident	Incident Period
DR-347-MN	1972	Severe Storms & Flooding	08/01/1972–08/01/1972
DR-350-MN	1972	Severe Storms & Flooding	08/25/1972–08/25/1972

SOURCE: (FEMA, 2021A)

Table 13. State disaster declarations in Carlton County, 2014–2021

DR	Date Declared	Incident Period	Incident Type	Eligible Counties & Tribes
SD-040 (open)	1/6/2020	9/20–10/17/2019	Heavy rains and flooding	Carlton, Kittson, Lake of the Woods, Marshall, Roseau
SD-008 (open)	8/30/2016	7/9 –7/11/2016	Severe storms, tornadoes, heavy rains, flooding	Aitkin, Benton, Carlton, Crow Wing, Kanabec, Meeker, Mille Lacs, Morrison, Pine, Traverse

SOURCE: (MN HSEM, 2021)

Table 14. Historical hazard mitigation funding awarded in Carlton County

DR/project #	Sub-Grantee	Project Type	Federal Share (%75)
4069.03	Carlton County	Plan Update	$24,929.00
4069.18	City of Barnum	Acquisitions, 2 (flood)	$151,875.00

SOURCE: (MN HSEM, 2021)

4.2 Jurisdictional Change in Risk or Vulnerability Assessment

Jurisdictions in Carlton County have varying vulnerabilities to and concerns about impacts to their communities. Interviews with jurisdictional representatives in addition to the Local Mitigation Survey resulted in some specific concerns (see Appendix C: Local Mitigation Surveys). Participants were asked to provide feedback on how their community's vulnerability to natural hazards had either increased (due to changes such as development) or decreased (due to local mitigation efforts) over the past five years.

At the local jurisdictional level, several communities did note an increase in development over the last five years as a factor for an increase in vulnerability to severe weather or disaster events.

4.2.1 JURISDICTIONAL RESPONSES

As part of the Local Mitigation Survey form, Carlton County Emergency Management and each city jurisdiction were asked to provide a vulnerability assessment that described what structures, systems, populations, or other community assets were susceptible to damage and loss from specific hazard events. Following are examples of common responses related to noted local vulnerabilities (as preserved in Appendix C: Part A, Question 3) for each jurisdiction. This information was used to help tie local vulnerability back to the exposure of people, buildings, infrastructure, and the environment to the natural hazards listed in Table 10 and to assist local governments in development of related local mitigation actions to reduce risk.

Carlton County

Tornadoes, Windstorms: Summer storms, including thunderstorms, hailstorms, and windstorms affect Carlton County on an annual basis. Thunderstorms are the most common summer storm in the county, occurring primarily during the months of May through August, with the most severe storms most likely to occur from mid-May through mid-July. We have power lines, transmission lines and high voltage lines running through several areas of our county that could be impacted by severe windstorms or tornadoes.

Flooding: Thunderstorms with heavy amounts of rainfall can cause localized flooding, which can affect property and infrastructure such as roads. With several small cities, most having their own utility system, flooding could pose a problem with city sewer and well service. Carlton County also has a pipeline that runs through several sections of land. A significant flood could potentially cause damage to this utility. The forest road and recreational trail systems are susceptible to damage caused by flooding and heavy rain events. Flooding may also cause erosion problems on county roads.

Winter Storms, Ice Storms: Winter storms affect Carlton County each year, so there is a 100% probability that the county and its jurisdictions will experience them. We have power lines, transmission lines and high voltage lines running through several areas of our county that could be impacted by winter storms.

City of Barnum

Flooding: Due to the proximity of our lift station to the Moosehorn River, it is vulnerable to being overtaken by the river in an extensive rain event.

Windstorms, Tornadoes: We have 2 mobile home parks (Heaton's Trailer Park and Sherwood Forest Park) and a municipal campground (Bear Lake Campground) that currently do not have a siren available to warn residents and visitors of high wind events.

City of Carlton

Blizzards: The city could have a power outage to lift stations, the water tower, and the water treatment plant. Residents could also be without power for extended periods of time.

Ice Storms, Windstorms: The city has many large growth white pine areas which could take down power lines/power poles and cause major damage to buildings.

Flooding: If Otter Creek were to overflow its banks, residential homes would have flooded basements. Lift stations could also be flooded.

Extreme Cold: The City has a nursing home, assisted living facility, and a 55+ housing complex. If power were to go out the residents could be exposed to extreme cold conditions.

Windstorms, Tornadoes: The Thomson neighborhood of Carlton does not have a warning siren and residents may not hear the nearest siren in the city.

City of Cloquet

Blizzards: The 2019 blizzard left portions of the local transportation network unpassable for up to 3 days. The emergency response was slowed due to impassable roads. Limited snow removal equipment was available capable of opening some routes.

Ice Storms: Ice storms resulting in extended power outages may lead to service issues with critical infrastructure. Currently, the potable water network has no backup generators, so water production is not possible during an outage. Only 2 of 9 sewer lift stations are equipped with generators, which could result in sewer backups. The City Hall/police department building does not have a backup generator, so access to computer systems and critical data would be limited during emergency response.

Windstorms: Extended power outages may lead to service issues with critical infrastructure. The potable water network has no backup generators, so water production is not possible during an outage. Only 2 of 9 sewer lift stations are equipped with generators, which could result in sewer back-ups. The City Hall/police dept. building has no backup generator, so access to computer systems and critical data would be limited during emergency response.

Flooding: Portions of the sanitary sewer system, including the city's highest flow lift station, have been flooded during extreme events. Localized street and private property flooding have also occurred.

City of Cromwell

Flooding: The city has an outdated storm sewer system. We have not had a major flood event since 2012, but during that event homes along the lake flooded in rising waters.
Windstorms, Tornado: The city has many trees that could come down and take the power out during strong windstorms or a tornado.

Ice Storms, Blizzards: We have overhead power lines which are susceptible to heavy ice and trees over power lines that could come down and take out power.

City of Kettle River

Flooding: Our city sewer lift station is vulnerable to failure during flood events if the power goes down or the lift station is flooded.

Ice Storms, Blizzards: Power poles and power lines may have damage to them due to heavy snow or ice.

Windstorms: Windstorms can cause downed trees and branches and do damage to structures.

Extreme Cold: There are several elderly and young children that are vulnerable to extreme cold and more so if it is due to power outage during a storm. Our Senior Apartments has no backup generator.

City of Moose Lake

Flooding: Our city sewer lift station is vulnerable to failure during flood events if the power goes down or the lift station is flooded. We also have basements in homes that continue to be flooded during high rain events. We also have a city campground (Moose Lake Park & Campground) that is located on Moosehead Lake that is very susceptible to flood damage.

Windstorms: The Moose Lake Park & Campground has experienced falling trees during severe windstorms and thunderstorms which is a danger to tent and RV campers. We have annual windstorms that affect the power supply.

Ice Storms, Blizzards: We have power lines and power poles that have failed or may fail due to heavy snow and ice storms. In addition to power, our police department, fire department, and ambulance have a difficult time navigating around the city during ice storms and blizzards due to unsafe road conditions.

Extreme Cold: We have seniors & children are vulnerable to extreme cold, especially if the power goes down during storm events.

City of Scanlon

Ice Storms, Blizzards: We have power lines and power poles that have failed or may fail due to heavy snow and ice storms.
Windstorms: Damage to parks, trees down, and residential damage could occur.

Extreme Cold/Heat: We have seniors & children are vulnerable to extreme cold/heat, especially if the power goes down during storm events. Most seniors do not have air conditioners.

City of Wrenshall

Flooding/Power Outage: Our city sewer lift station is vulnerable to failure during heavy rain events if the power goes down or the lift station is flooded. If this should happen, we would have sewer backup into homes.

Tornadoes: We have a mobile home park without a storm shelter and several residents without basements that would be vulnerable.

Windstorms, Tornadoes, and Ice storms: We have power lines and power poles running through our city park and along our main street that could break / fail due to heavy winds, ice, and snow.

City of Wright

Extreme Cold: There is an assisted living facility in Wright (Vista Villas) that has an elderly population that would be vulnerable if there were a period of extreme cold coupled with an extended power outage. The facility does have its own generator.

Fond du Lac Reservation

Blizzard: We have two elder housing complexes with vulnerable populations. We have assisted living and veterans housing that also house vulnerable populations.

Tornadoes, Straight-line Winds: We have a large rural population base that could be affected by loss of power due to power line damage.

Flooding: A number of roads on the FDL Reservation have flood potential.

Wildfire: Many residents in our large rural population live close to forest areas. Some homes do not have adequate defensible zones with trees close to the dwelling

4.2.2 FUTURE DEVELOPMENT

Because Carlton County is vulnerable to a variety of natural hazards, the county government—in partnership with the state government—must make a commitment to prepare for the management of these events. Carlton County is committed to ensuring that county elected and appointed officials become informed leaders regarding community hazards so that they are better prepared to set and direct policies for emergency management and county response.

As part of the vulnerability assessment conducted for the Carlton County MHMP update, jurisdictions were asked to describe if there were any factors related to population growth, zoning, or development they felt have increased their community's vulnerability to future severe weather or disaster events (see Section 4.1.2). Below is a compilation of common responses as noted in Appendix C: Part A, Question 5.

Carlton County

Carlton County does experience annual growth, demographics show the average age of the population trending upwards, indicating a population that is more susceptible to environmental risk due to decreased mobility, increased susceptibility to disease, decreased routine maintenance of personal infrastructure, decreased willingness to vacate premises.

City of Carlton

In 2020, a 55+ apartment building was built which increases the vulnerability of residents if the power were to go out during a period of extreme cold.

Fond du Lac Reservation

The addition of assisted living, veterans housing and other multi-unit housing has increased the density of population in a few areas.

In the development of local mitigation actions, all jurisdictions were encouraged to consider hazard mitigation strategies that would reduce risk in relation to future development, such as the update of local comprehensive plans, enforcement of ordinances, and incorporation of infrastructure improvements to reduce local vulnerabilities (see Appendix J).

The Carlton County emergency management director will work to keep the jurisdictions covered by the MHMP engaged and informed during the plan's cycle. By keeping jurisdictional leaders involved in the monitoring, evaluation, and update of the MHMP, they will keep their local governments aware of the hazards that face their communities and how to mitigate those hazards through planning and project implementation.

Section 6 of this plan further outlines the process by which Carlton County will address the maintenance of this plan, including monitoring, evaluation, and update of the plan, as well as implementation and continued public involvement.

4.3 Shared Vulnerabilities for all Hazards

Vulnerability is the susceptibility to physical injury, harm, damage, or economic loss (FEMA, 2006). While a community's vulnerability may vary by hazard, certain population groups and structures are vulnerable to multiple hazard types. This section highlights the population groups and structures which may not be as resilient to natural hazards or deserve special attention.

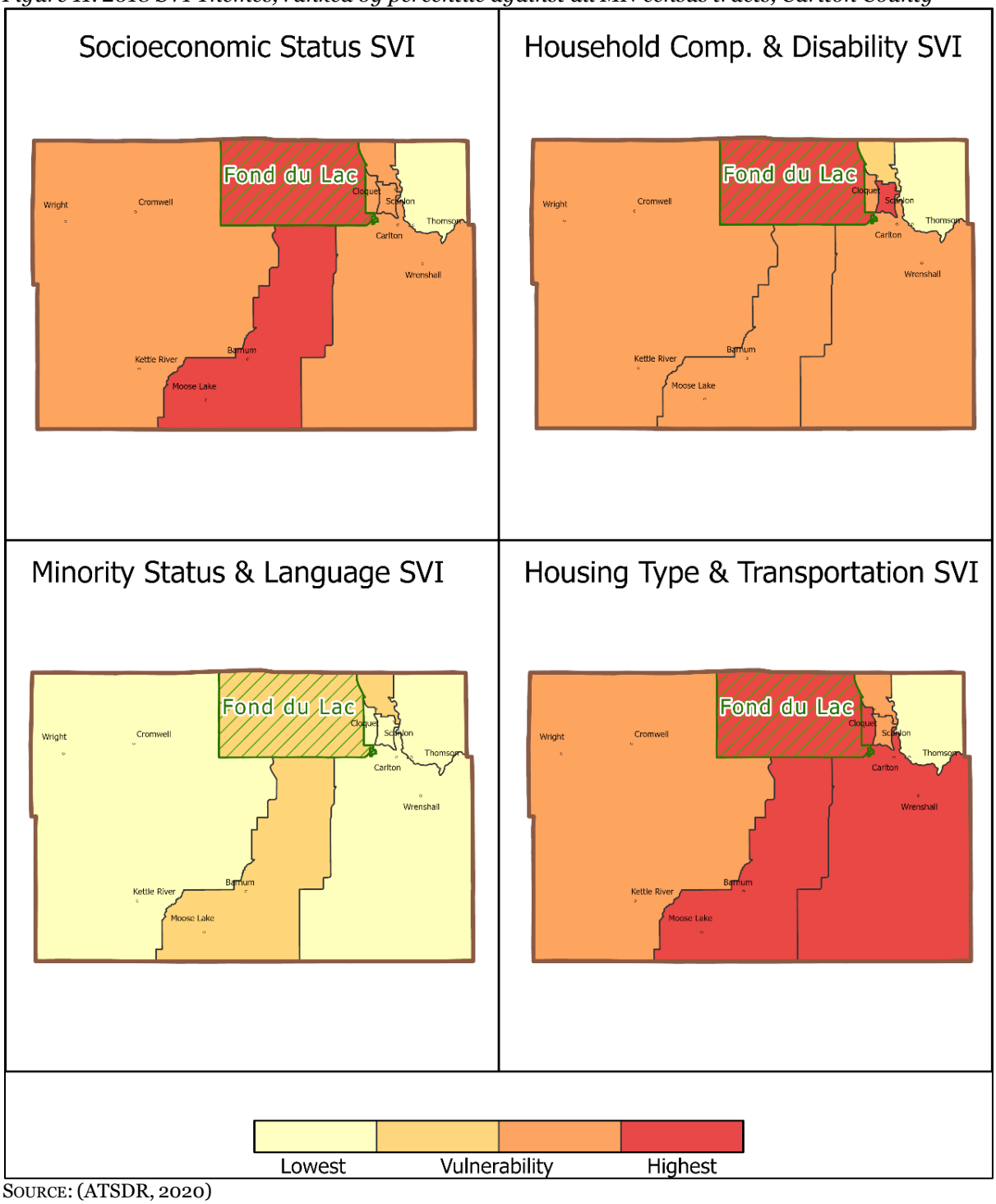
4.3.1 POPULATION VULNERABILITY

The degree to which a person is vulnerable to the impacts of a hazard depends on how well they can react before, during, and after a hazardous event. The Centers for Disease Control and Prevention (CDC) Agency for Toxic Substances & Disease Registry (ATSDR) defines social vulnerability as "…the resilience of communities when confronted by external stresses on human health, stresses such as natural or human-caused disasters, or disease outbreaks" (ATSDR, 2020). Exacerbating these stressors are the increasing number of extreme weather events attributed to Minnesota's changing climate (MPCA, 2018c).

The ATSDR created the CDC Social Vulnerability Index (SVI) to help identify vulnerable communities who may need support in preparing for hazardous or recovering from disaster. The CDC SVI is created at the census tract level using American Community Survey (ACS) 5-year data. Table 15 displays how the ACS data is organized into 15 social variables, which are further grouped into four themes (ATSDR, 2020).

Census tracts within Minnesota were ranked and given a percentile value from 0 to 1, with higher values indicating greater vulnerability compared to other census tracts in the state. Theme-specific percentile rankings were generated by summing the percentiles of the variables comprising each theme and ordering the summed percentiles. For more information about the SVI methodology, visit https://svi.cdc.gov. A map of each SVI theme for Carlton County is displayed in Figure 11.

Figure 11. 2018 SVI Themes, ranked by percentile against all MN census tracts, Carlton County



SOURCE: (ATSDR, 2020)

Table 15. Social Vulnerability Index (SVI) Variables

Overall vulnerability	Socioeconomic status	Below poverty
		Unemployed
		Income
		No high school diploma
	Household composition & disability	Aged 65 or older
		Aged 17 or younger
		Older than age 5 with a disability
		Single-parent households
	Minority status & language	Minority
		Speaks English "less than well"
	Housing type & transportation	Multi-unit structures
		Mobile homes
		Crowding
		No vehicle
		Group quarters

SOURCE: (ATSDR, 2020)

4.3.2 STRUCTURE VULNERABILITY

Carlton County-specific building data was sourced from the county tax databases and parcel polygon data. The total estimated building exposure for the county is shown in Table 16.

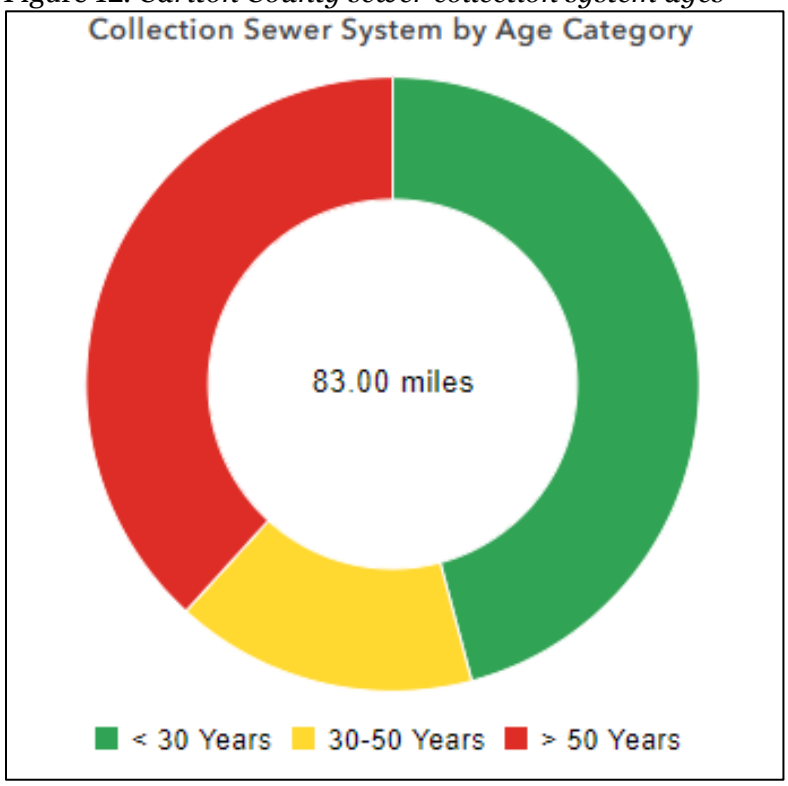
Carlton County's infrastructure systems are outlined in Section 3.7. Estimates of county infrastructure economic exposure were not available. Because infrastructure protects public health and provides vital services to residents and Minnesota's infrastructure is aging, the State Auditor's office hosts an online infrastructure stress visualization tool to assist with planning and to provide transparency about the condition of water and wastewater infrastructure systems in the state. This tool indicates that 38% of the 83 miles of sewer collection system in the county are over 50 years old. 46% of the collection system is less than 30 years old (OSA, 2020). A chart of this age distribution is located in Figure 12.

Table 16. Carlton County total building exposure

General Occupancy	County Total Buildings	County Building and Contents Value
Residential	24,783	$2,380,300,064
Commercial	850	$699,270,478
Other	5,017	$1,722,908,218
Totals	30,650	$4,802,478,760

SOURCE: CARLTON COUNTY

Figure 12. *Carlton County sewer collection system ages*



SOURCE: (OSA, 2020)

Table 17. Mobile home park locations

Name	Address	City
Barnum Mobile Home Park, LLC	Old Hwy 61	Barnum
Sherwood Forest	3958 County Rd 138	Barnum
Sunnyside Estates	33 Sunnyside Estates	Cloquet
Coffee Lake Park	4754 Coffee Lake Road	Moose Lake
Hillside Terraces MHP LLC	1 Hillside Terrace	Moose Lake
Bandle's MHP	Bandle Court Road	Wrenshall
Pioneer Manufactured Home Community	*No Address Found*	Wrenshall

SOURCE: MINNESOTA DEPARTMENT OF HEALTH

Water and wastewater utilities provide critical services to the community that need to remain in operation for as long as possible and return to operation quickly following a severe storm situation. Undersized sewer systems can experience capacity issues following heavy rain events, resulting in overflows containing stormwater as well as untreated human and industrial waste, toxic substances, debris, and other pollutants.

Mobile homes, and therefore the people living in mobile homes, are particularly vulnerable to natural hazards. Evidence show that mobile home parks are disproportionately located in more hazard-prone regions, often undesirable or marginal lands like floodplains, and that mobile homes are particularly

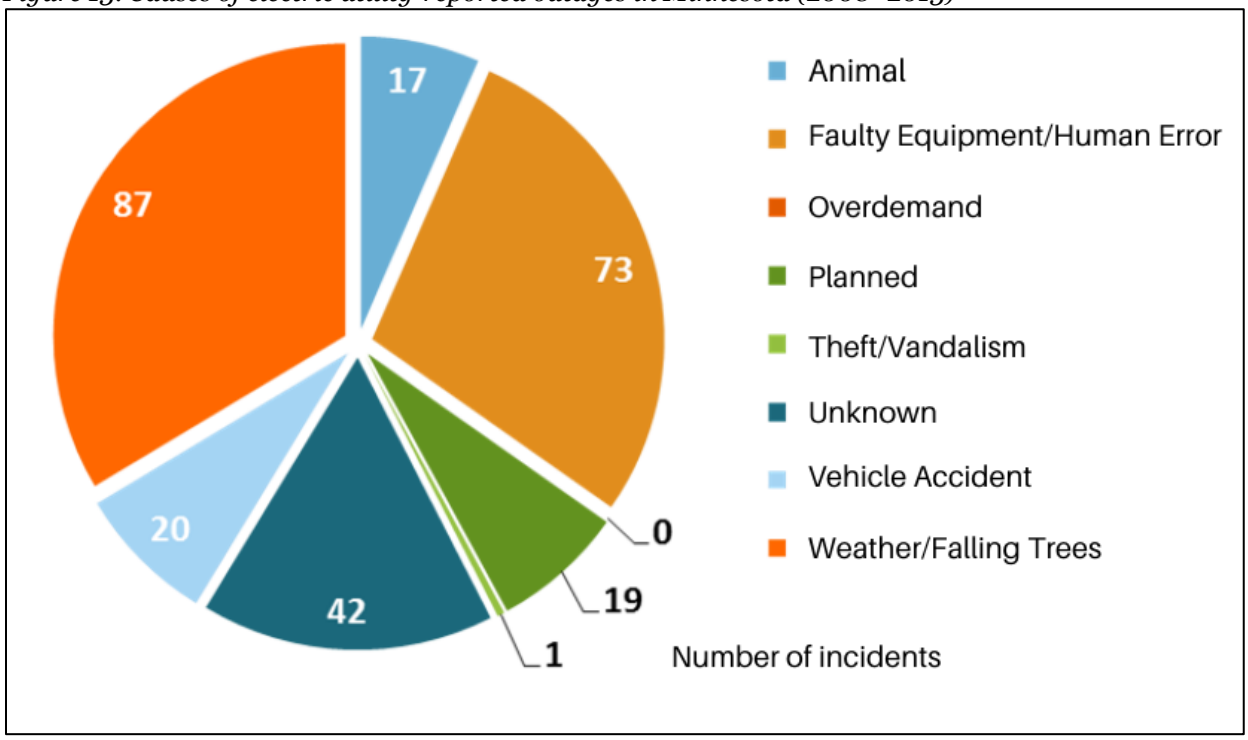
vulnerable to high-wind events (Rumbach et al., 2020). While Minnesota law requires most mobile home parks to have storm shelters, many do not (Sepic, 2017). Given the vulnerability of mobile home residents it is important to have a general understanding of where mobile homes are located. Licensed mobile home park locations in Carlton County are identified in Table 17.

4.3.3 ELECTRIC UTILITIES AND OUTAGES

Loss of power is often the result of a natural hazard. According to the U.S. Department of Energy (2016), the leading cause of electric outages in Minnesota from 2008 through 2013 was severe weather/falling trees (see Figure 13), affecting nearly half a million Minnesotans annually. While the power grid is vulnerable to weather-induced power outages, certain communities are more vulnerable to prolonged outages, which are dependent on a few factors, including the type of severe weather event (the grid being the most vulnerable to high wind events); the transmission and distribution infrastructure (overhead infrastructure being the most exposed and therefore susceptible to failure); and the density of the community (a greater number of customers affected by power outage in rural areas than in urban areas) (Mukherjee et al., 2018).

Because of the significance of physical and economic disruption power outages can cause, HSEM prepared a Rural Electric Annex to the MN State All Hazard Mitigation Plan to make rural electric cooperatives eligible for FEMA's Hazard Mitigation Assistance (HMA) Program. Thirty-five percent of Minnesota's population, and 85% of Minnesota's territory, is covered by electrical distribution cooperatives. Flooding, windstorms, tornado, and winter storms are the greatest risks to electric utilities.

Figure 13. Causes of electric utility-reported outages in Minnesota (2008–2013)



SOURCE: (US DOE, 2016)

The damage to rural electric cooperative infrastructure has often been how Minnesota reaches economic damage thresholds for federal disaster declaration (MN HSEM, 2014). Rural electric cooperatives are vulnerable and could very well be becoming more vulnerable without mitigation against future damages.

In a survey to Minnesota electric cooperatives, 59% of respondents indicated that flooding has adversely affected or damaged critical infrastructure in their service area. Debris may damage the infrastructure immediately or decrease the life of the utility poles, which may be more easily damage in a subsequent event. Eighty-three percent of respondents indicated that windstorms have a high potential to impact electrical infrastructure, and nearly all (94%) cooperatives surveyed indicated that they have been affected or damaged by a tornado in the past. The most vulnerable electrical structures to wind events are overhead utility lines and the poles (MN HSEM, 2014).

Winter storms are another very common risk to electric utilities and pose additional challenges that put crews and equipment in danger. Difficult winter driving conditions put crews on icy or wind-drifted and snowy roads. And in the case of ice storms and extreme cold winter temps, crews are subject to harsh conditions when repairing utility lines.

Power outages can also make vulnerable populations more vulnerable. Outages may force the closure of businesses, schools, and government offices. State and local governments may experience economic challenges related to large-scale power outages when they must open shelter facilities and to care for people displaced from their homes. Public agencies are frequently responsible for debris removal and clean-up in the event of a storm or tornado. Police and fire personnel may be responsible for securing downed power lines if they are dangerous to nearby residents.

People recovering from illnesses, the elderly, children, and low-income populations may be more vulnerable to the impacts of power outages than others. Those who are dependent on power for their health care needs become immediately at risk. Homeowners may see food spoiled, move to a temporary shelter, experience flooding inside of their homes, or have their pipes burst all due to the lack of power (MN HSEM, 2014).

Section 5 – Hazard Profiles

As part of the risk assessment, each natural hazard that poses risk to the county was independently reviewed for its past hazard history, relationship to future trends, and jurisdictional vulnerability to future events. A capabilities assessment was also conducted by the county to review the plans and programs that are in place or that are lacking (program gaps or deficiencies) for the implementation of mitigation efforts, as related to each natural hazard. An assessment was also conducted for local jurisdictions to identify the plans, policies, programs, staff, and funding they have in place in order to incorporate mitigation into other planning mechanisms (see Section 7.1 and Appendix C).

Hazards that were deemed by Carlton County to be of moderate to high risk are addressed in the following hazard profiles. Hazards that were determined to be of low risk or without substantive mitigation actions to address them are not required to be included (see Section 4.1.1).

5.1 Flooding

Flooding is the most significant and costly natural hazard in Minnesota. The type, magnitude, and severity of flooding are functions of the amount and distribution of precipitation over a given area, the rate at which precipitation infiltrates the ground, the geometry and hydrology of the catchment, and flow dynamics and conditions in and along the river channel.

Flash floods generally occur in the upper parts of drainage basins and are typically characterized by periods of intense rainfall over a short duration. These floods arise with very little warning and often result in locally intense damage, and sometimes loss of life, due to the high energy of the flowing water. Flood waters can snap trees, topple buildings, and easily move large boulders or other structures. Six inches of rushing water can upend a person; another 18 inches might carry off a car. Generally, flash floods cause damage over relatively localized areas, but they can be quite severe. Flash floods in urban areas involve the overflow of storm drain systems and can be the result of inadequate drainage combined with heavy rainfall or rapid snowmelt. Flash floods can occur at any time of the year in Minnesota, but they are most common in the spring and summer.

Riverine floods refer to floods on large rivers at locations with large upstream catchments. Riverine floods are typically associated with precipitation events that are of relatively long duration and occur over large areas. Flooding on small tributary streams may be limited, but the contribution of increased runoff may result in a large flood downstream. The lag time between precipitation and the flood peak is much longer for riverine floods than for flash floods, generally providing ample warning for people to move to safe locations and, to some extent, secure some property against damage.

During the past several decades, agencies have used the “100-year floodplain” as the design standard for projects funded by the federal government. However, today floods of that magnitude are occurring far more often than once per century (Natural Resources Defence Council, 2015). In recognition of increasing risks, in January of 2015 the President issued an executive order that updates flood protection standards that guide federally funded projects in or near floodplains or along coastlines. These new standards require federally-funded projects to either build two feet above the 100-year flood elevation for standard

projects and three feet above for critical buildings like hospitals and evacuation centers; or build to the 500-year flood elevation (The White House, 2015).

Please note, the term "100-year floodplain" has largely been discontinued in favor of "1-percent annual chance floodplain."

5.1.1 HISTORY OF FLOODING

Minnesota experienced the wettest year on record in 2019. Heavy precipitation between February and May contributing to flooding throughout the state. Carlton County has experienced four federal disaster declarations for flooding; one of those occurred since 2010. The county was included in DR-4069 for flooding in June 2012 (FEMA, 2021a). In September 2019, over half the state received at least two times the normal amount of precipitation. The average precipitation for the year statewide was 35.51 inches, with many stations of over 50 years of observations breaking their own precipitation records (MN DNR, 2019e). Carlton County had 35.6 inches of rain in 2019. The record precipitation in Carlton County was 39.89 inches in 1986 (MN DNR, 2020a).

In September 2019, over half the state received at least two times the normal amount of precipitation. The average precipitation for the year statewide was 35.51 inches, with many stations of over 50 years of observations breaking their own precipitation records (MN DNR, 2019e). Carlton County had 35.6 inches of rain in 2019. The record precipitation in Carlton County was 39.89 inches in 1986 (MN DNR, 2020a).

Carlton County has experienced many floods and flash floods, some resulting in severe property damage. Table 18 lists all Carlton County's historical flood events from 2014-2021 as recorded by the NCEI. No deaths or injuries were reported as a result of flooding. The cumulative property damage estimate is greater than $52 million dollars (CEMHS, 2019).

The USGS provides information from gauge locations at points along various rivers across the United States. There are three active USGS gauging stations located in Carlton County according to the National Water Information System.

Table 19 below shows data on its highest-recorded annual peaks (gauge heights). Eight discontinued gauge stations across the county are not included. If the two highest peaks for the last five years are not in the top five peaks on record, they are included with their overall risk indicated in parentheses (USGS, 2021b).

Table 18. Flood events in Carlton County, January 2014–August 2021

Date	Event Type	Description
6/4/2019	Flash Flood	The southbound lanes of MN Highway 33, 1.5 miles north of Cloquet, began to flood and traffic slowed to navigate water on the road.
9/15/2018	Flash Flood	Storm sewer manhole covers flipped over and standing water was reported in town.
6/18/2018	Flash Flood	Floodwaters washed out a stone culvert on the BNSF Railway railroad tracks, opening up a 300 foot long and 60-foot-deep hole in the railroad roadbed. The tracks were suspended over the washout.
6/17/2018	Flash Flood	Minnesota State Highway 23 washed out at the Nemadji River Crossing at mile marker 322.

Date	Event Type	Description
10/3/2017	Flood	Portions of County Road 8 closed due to high water east of Moose Lake.
7/11/2016	Flash Flood	Five flash flood events were registered in the NCEI database on this day. In Frogner, floodwaters washed out parts of Sheetz Road, and water entered a residence on the road. In Moose Lake, flooding occurred at the intersection of Elm Avenue and Arrowhead Lane, as well as in front of the Moose Lake Implement and Sport and the nearby areas of Fifth Street and Industrial Road. Floodwaters also washed out a Stretch of County Road 61. In Automba, floodwaters near the intersection of County Roads 129 and 73 made the road impassable.

SOURCE: (NCEI, 2021)

Table 19. Historical Peak Streamflow data (in feet) for USGS gauging stations

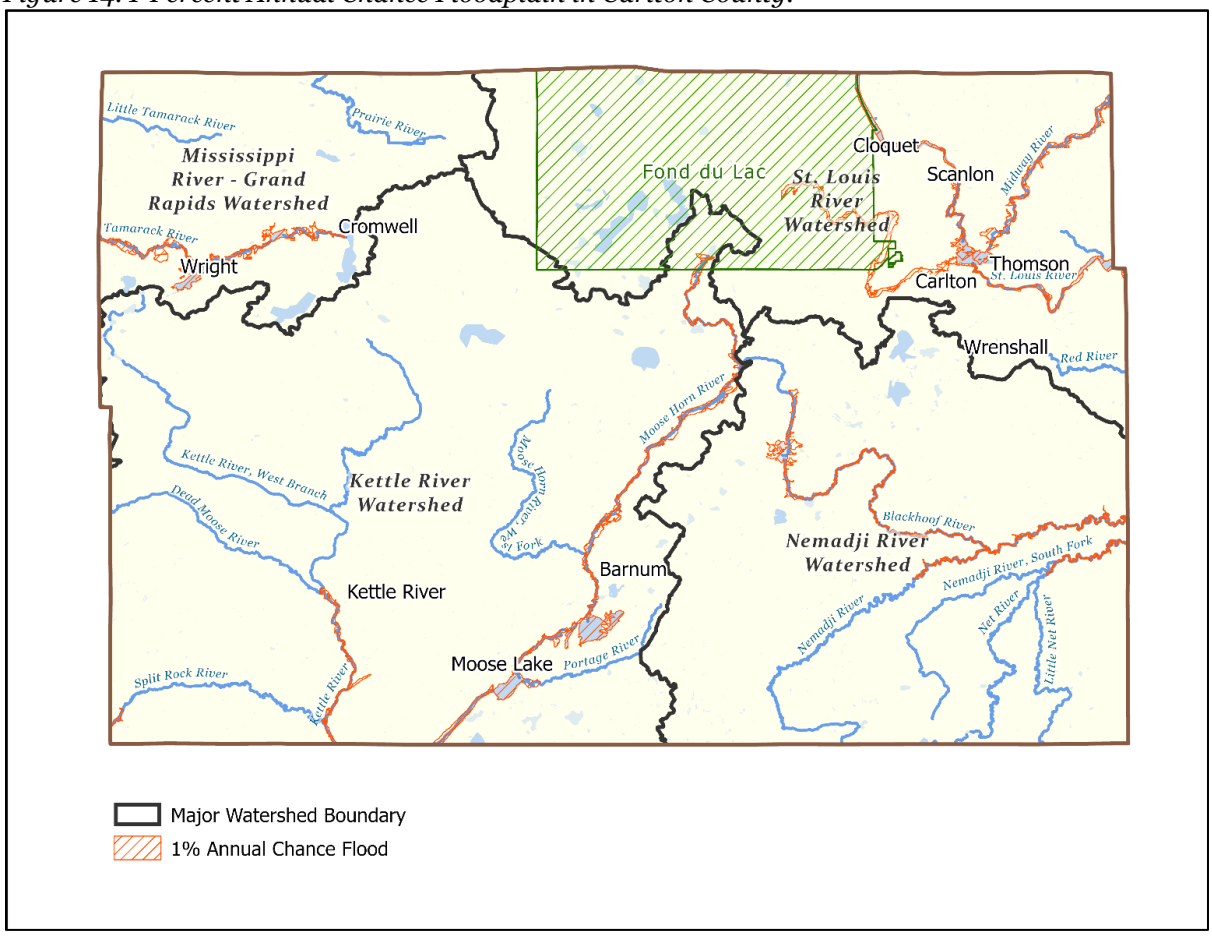
USGS 04024000 St. Louis River near Scanlon Carlton, MN 1908-2020			USGS 04024095 Nemadji River near Holyoke Carlton, MN 1972-2020			USGS 05336200 Glaisby Brook near Kettle River Carlton, MN 1960-2020		
(1)	Jun. 21, 2012	16.62	(1)	Jun. 20, 2012	21.05	(1)	Jun. 20, 2012	12.26
(2)	Apr. 23, 1979	13.93	(2)	Jun. 17, 2018	20.31	(2)	Jul. 22, 1972	10.18
(3)	Oct. 13, 1973	12.76	(3)	Aug. 3, 2011	18.60	(3)	Jul. 12, 2016	9.22
(4)	Apr. 15, 1969	12.60	(4)	Jul. 11, 2016	18.57	(4)	May 10, 1979	9.02
(5)	Jul. 10, 1999	12.45	(5)	Sep. 3, 1985	17.38	(5)	Apr. 16, 1982	8.85
(23)	Mar. 18, 2016	10.53				(19)	Aug. 8, 2020	6.64
(39)	Oct. 4, 2017	9.30						

SOURCE: (USGS, 2021B)

5.1.2 PROBABILITY OF OCCURRENCE

A potential risk and economic loss analysis for a 1-percent annual chance flood was performed using a FEMA tool, Hazus for ArcGIS. Existing 1-percent annual chance depth grids were used for regions of the county where available. The remainder of the 1-percent annual chance depth grids were developed from the Digital Flood Insurance Rate Map (DFIRM) flood boundary and cross section or base flood elevation data. Where no boundary data were available, the hydraulics and hydrology model in Hazus was used to generate a 1-percent annual chance flood boundary with a 10-meter horizontal resolution Digital Elevation Model (DEM). The resulting Hazus 1-percent annual chance floodplain output is shown in Figure 14.

Figure 14. 1-Percent Annual Chance Floodplain in Carlton County.



SOURCE: (MN DNR, 2021A)

5.1.3 CLIMATE CHANGE PROJECTIONS

As Minnesota's climate changes, the quantity and character of precipitation is changing. Average precipitation has increased in the Midwest since 1900, with more increases in recent years. According to the Minnesota DNR State Climatology Office "Since 2000, Minnesota has seen a significant uptick in devastating, large-area extreme rainstorms as well. Rains that historically would have been in the 98th percentile annually (the largest 2%) have become more common. Climate projections indicate these big rains will continue increasing into the future."

The Midwest has seen a 45% increase in very heavy precipitation (defined as the heaviest 1-percent of all daily events) from 1958 to 2011 (*National Climate Assessment Development Advisory Committee*, 2013). This precipitation change has led to amplified magnitudes of flooding. Increased precipitation may also show seasonal changes, trending toward wetter springs and drier summers and falls. An example of a recent year with this character was 2012, when many MN counties were eligible for federal disaster assistance for drought, while others were eligible for flooding, and 7 were eligible for both in the same year (Seeley, 2015). In 2007, 24 Minnesota counties received drought designation, while 7 counties were declared flood disasters. In 2012, 55 Minnesota counties received federal drought designation at the same time 11 counties declared flood emergencies. In addition, the yearly frequency of the largest storms –

those with 3 inches or more of rainfall in a single day – has more than doubled in just over 50 years. In the past decade, such dramatic rains have increased by more than 7% (MN EQB, 2014).

Southeastern Minnesota has experienced three 1000-year floods in the past decade: in September 2004, August 2007, and September 2010 (Meador, 2013). The 2004 flood occurred when parts of south- central Minnesota received over 8 inches of precipitation. Faribault and Freeborn counties received over 10 inches in 36 hours. The deluge led to numerous reports of stream flooding, urban flooding, mudslides, and road closures (MN DNR, 2004). During the 2007 event, 15.10 inches fell in 24 hours in Houston County, the largest 24-hour rainfall total ever recorded by an official National Weather Service reporting location. The previous Minnesota record was 10.84 inches in 1972. The resulting flooding from the 2007 rainfall caused 7 fatalities (MN DNR, 2007a). In September 2010, a storm on the 22-23rd resulted in more than 6 inches of rain falling over 5,000 square miles in southern Minnesota. Rainfall totals of more than 8 inches were reported in portions of 10 counties. The heavy rain, falling on soils already sodden from a wet summer, led to numerous reports of major rural and urban flooding. For many monitoring locations in southern Minnesota, stream discharge resulting from the deluge was the highest ever seen during an autumn flood (Minnesota Climatology Working Group, 2010). None of the five wettest years for total precipitation in Carlton County occurred in the last two decades (MN DNR, 2020a).

5.1.4 VULNERABILITY

Potential economic loss estimates were based on county-specific building data. Carlton County provided parcel tax and spatial databases that included building valuations, occupancy class, square footage, year built, and number of stories. The quality of the inventory is the limiting factor to a Hazus flood model loss estimation. Best practices were used to use local data and assumptions were made to populate missing (but required) values.

Hazus reports the percent damage of each building in the floodplain, defined by the centroid of each building footprint. After formatting the tax and spatial data, 30,650 points were input to Hazus to represent buildings with a total estimated building plus contents value of $4.8 billion. Approximately 81% of the buildings (and 50% of the building value) are associated with residential housing. The estimated loss by occupancy class for the entire county is shown in Table 20.

Table 20. Summary of 1-percent annual chance flood loss estimation by occupancy class

General Occupancy	County Total Buildings	County Building and Contents Value	Floodplain Total Buildings	Floodplain Building + Contents Value	Buildings with damage	Building + Contents Loss
Residential	24,783	$2,380,300,064	184	$19,415,250	113	$2,233,158
Commercial	850	$699,270,478	18	$412,010,400	0	$0
Other	5,017	$1,722,908,218	32	$124,198,200	17	$3,763,225
Totals	30,650	$4,802,478,760	234	$555,623,850	130	$5,996,383

SOURCE: (FEMA, 2021C)

The distinction between building attributes within a parcel was not known, so the maximum percent damage to a building in that parcel was used to calculate loss estimates for the entire parcel. The sum of all the losses in each census block were aggregated for the purposes of visualizing the loss. An overview of these results with the percent damage of buildings is shown in Figure 15. Please note: It is possible for a building location to report no loss even if it is in the flood boundary. For example, if the water depth is minimal relative to 1st-floor height, there may be 0% damage.

Hazus Critical Infrastructure Loss Analysis

Critical facilities and infrastructure are vital to the public and their incapacitation or destruction would have a significant negative impact on the community. These facilities and infrastructure were identified in Section 3.7 and verified by Carlton County.

Buildings identified as essential facilities for the Hazus flood analysis include hospitals, police and fire stations, and schools (often used as shelters). Loss of essential facilities are vulnerable to structural failure, extensive water damage, and loss of facility functionality during a flood, thereby negatively impacting the communities relying on these facilities' services. Fortunately, none of Carlton County's essential facilities included in the Hazus flood analysis are located within the 1-percent annual chance floodplain.

Extreme precipitation resulting in flooding may overwhelm water infrastructure, disrupt transportation and cause other damage. Particularly where stormwater, sewage and water treatment infrastructure is aging or undersized for more intense rainstorms, extreme rain events may pose both health and ecological risks in addition to costly damage (USGCRP, 2018).

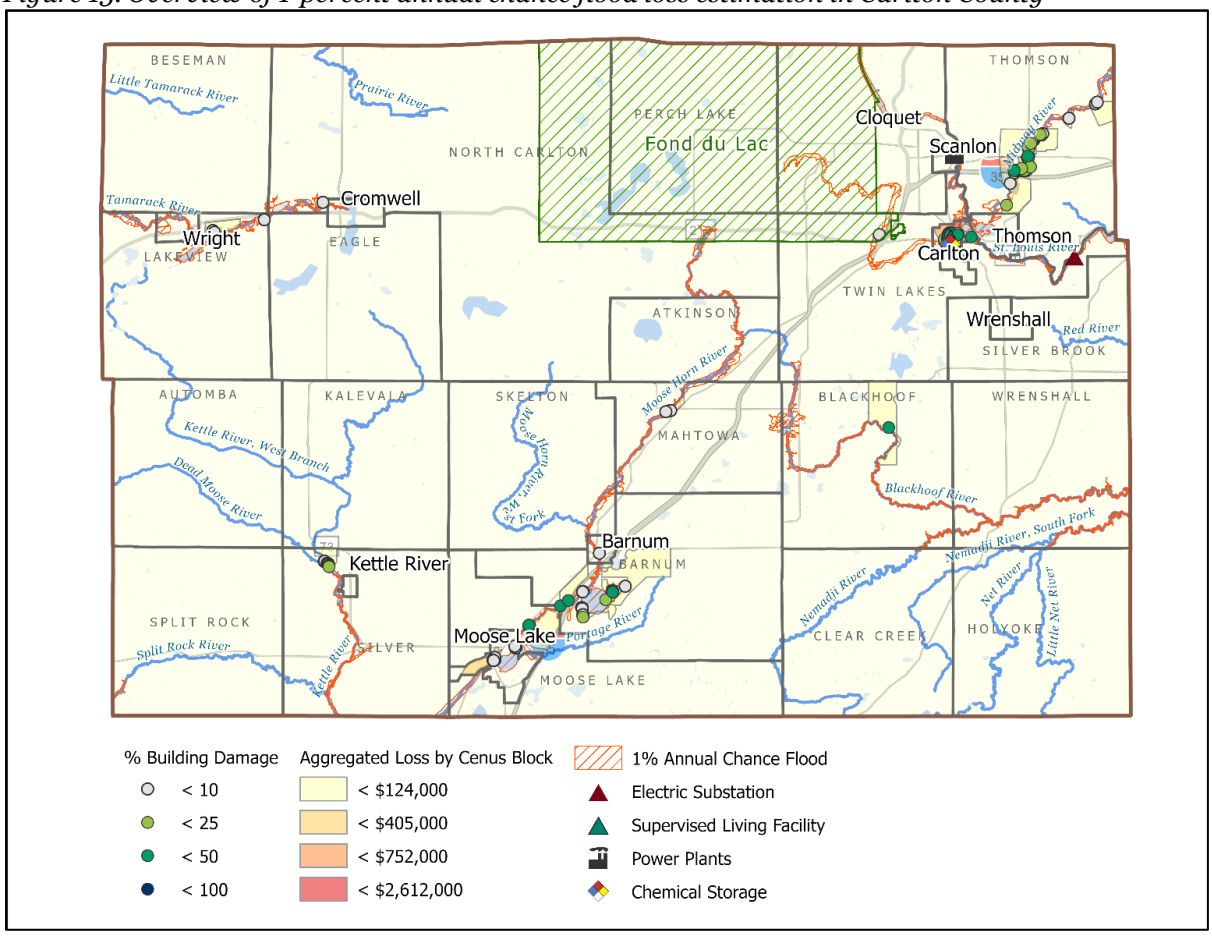
It is important to identify if any critical infrastructure within the 1-percent annual chance floodplain, given the higher risk of the facility or infrastructure being incapacitated or destroyed during a flood. In Carlton County, four critical infrastructure locations were found to be at risk in the 1-percent annual chance flood (Table 21). No other information is available about these facilities. Critical infrastructure in the floodplain is mapped in Figure 16.

Table 21. Critical infrastructure identified in 1-percent annual chance flood boundary

Facility Name	Location
Thomson Hydro-Electric Substation	Thomson Township
Chemstar Products Company	City of Carlton
Austin Homes (Supervised Living Facility)	City of Carlton
Allete, Inc. Hydro-Electric Power Plant	City of Scanlon

SOURCE: (FEMA, 2021c)

Figure 15. Overview of 1-percent annual chance flood loss estimation in Carlton County



SOURCE: (FEMA, 2021c)

Community Vulnerability

Potential economic losses were estimated by Census County Subdivision. The City of Carlton as well as Thomson Township would suffer significant estimated losses in the one-percent annual chance flood. All jurisdictions with buildings identified in the 1-percent annual chance flood zone are listed in Table 22.

Figure 16 highlights four communities with the highest economic loss, including the City of Carlton where two critical infrastructure locations were within the 1% annual chance flood boundary. Mobile home parks were also reviewed, and none were within the flood zone. In addition to the aggregate economic loss by census block, the point locations used to represent flooded buildings are symbolized by percent damage to the building.

The status of jurisdictional participation in the National Flood Insurance Program and any repetitive loss properties are detailed in Section 6.1.1. National Flood Insurance Program (NFIP).

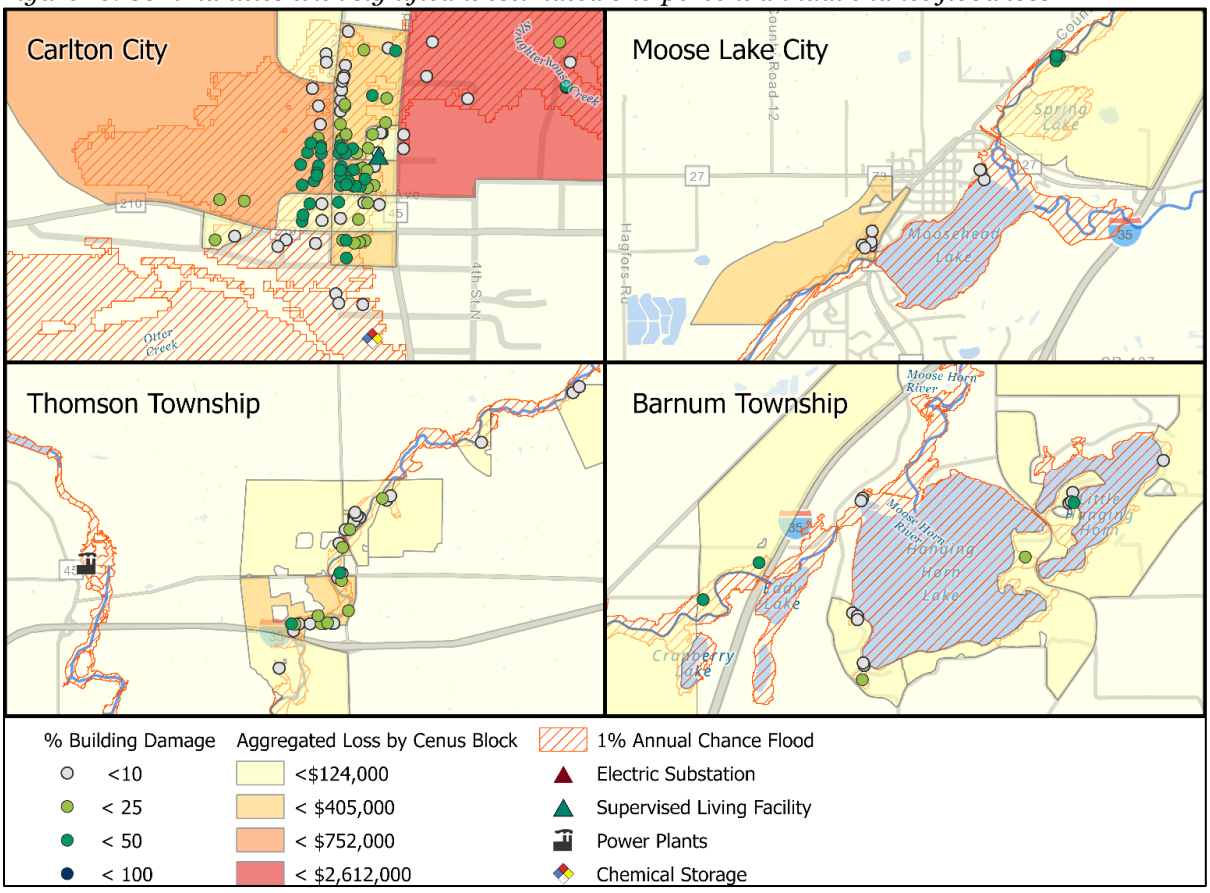
Table 22. 1-percent annual chance flood building-related loss estimates by jurisdiction

Jurisdiction (county subdivision)	Count of Buildings in Floodplain	Estimated Building and Contents Loss*
Barnum City	1	$3,913
Barnum Township	9	$172,332
Blackhoof Township	1	$544
Carlton City	76	$4,558,964
Lakeview Township	1	$914
Mahtowa Township	2	$9,751
Moose Lake City	3	$168,662
Moose Lake Township	5	$26,764
North Carlton Unorganized Territory	0	$0
Silver Township	6	$7,387
Thomson Township	25	$932,989
Twin Lakes Township	1	$114,164
Total	130	$ 5,996,383

SOURCE: (FEMA, 2021C)

*It is possible for a building to register no loss even if it is in the flood boundary. For example, if the water depth is minimal relative to 1st-floor height, there may be 0% damage

Figure 16. Communities with significant estimated one-percent annual chance flood loss



SOURCE: (FEMA, 2021C)

5.1.5 PROGRAM GAPS AND DEFICIENCIES

Carlton County Emergency Management identified several program gaps and deficiencies that make its citizens more vulnerable to flooding. The following gaps and deficiencies should be addressed with new mitigation efforts to reduce that vulnerability:

Increasing Culverts and Raising Roads: Some roads, bridges, and culverts within Carlton County continue to need improvements as they are impacted by high rain events. The Carlton County Transportation Department works to identify and address issues on an ongoing basis.

Road Infrastructure: Continued culvert replacement to prevent road flooding is a strain on our smaller townships that have limited funding for road infrastructure.

Funding for Culvert Replacements: More funding is needed to maintain the effort of replacing culverts across the county before flooding occurs to mitigate road gravel erosion, which also impacts the trout streams of the watershed and improving trout spawning habitat. This is a goal in the Nemadji 1W1P.

5.2 Wildfires

A wildfire is an uncontrolled fire spreading through vegetative fuels, posing danger and destruction to property. Minnesota experienced an average of 1,400 wildfires each year between 1985 and June 2021 (MN DNR, 2021d). Wildfires occur throughout the spring, summer and fall; however, most wildfires in Minnesota take place in March, April and May. During this period, much of the existing vegetation has been killed due to winter temperatures and is dead, brown, and combustible. Also, there is little green vegetation to serve as a barrier for a moving wildfire.

Wildfires can occur in undeveloped areas and spread to urban areas where structures and other human developments are more concentrated. While some wildfires start by natural causes, humans cause over 80% of wildfires in the United States (Balch et al., 2017). In Minnesota, 98% of wildfires are caused by humans, with most fires starting from burning debris (38%), miscellaneous (25%), arson and incendiary devices (14%), and equipment (12%). A smaller number of wildfires start from campfires (5%), railroads (3%), and smoking (2%). As a natural hazard, a wildfire is often the direct result of a lightning strike; however, lightning strikes account for less than 2% of Minnesota's wildfires (MN DNR, 2021c). The dangers from wildfire include the destruction of timber, property, wildlife, and injury or loss of life to people in the affected area or using the area for recreational facilities.

The frequency and behavior of wildfires varies within the state. Vegetation (fuel), topography, and weather contribute significantly to these variations. Vegetative material is the main source of fuel for a wildfire. Fuel is classified by its size, moisture content, and volume. Fuel with low moisture content ignites easier than wet fuel. Areas with a greater volume of fuel will produce more intense fires with larger flames that are difficult to extinguish. Topography affects the movement of air and fire over the ground surface. The slope and shape of terrain can change the rate of speed at which the fire travels. Weather variables such as temperature, humidity, wind, and lightning affects the probability, severity, and duration of wildfires. Extreme weather, such as high temperatures and low humidity, can lead to extreme wildfire activity. In contrast, cooling and higher humidity often signals reduced wildfire occurrence and easier containment (ENR-ITI-Lands Resource Centre, 2021).

Fire severity refers to the effects of a fire on the environment, typically focusing on the loss of vegetation both above ground and below ground but also including soil impacts. A fire classified as "low severity" has limited effect on overstory trees (< 30% mortality), understory vegetation, and soils. A fire producing variable, moderate effects on trees and vegetation (<80% killed) and/or moderate soil exposure would be classified as "moderate severity." High-severity fires have great losses to vegetation and result in extensive mineral soil exposure (Northwest Fire Science Consortium, 2018).

The most severe fires result in greatly reduced soil productivity, slow vegetative recovery (5–10 years) and great potential for soil erosion. Severe burning wildfires typically occur in areas with steep north or east slopes and dense timber.

Homes threatened by wildfire are primarily those located in the "wildland–urban interface." This is the zone where homes and subdivisions have been located in wildland areas where natural wildfires can have an impact. As people settled in the country and began clearing natural lands for development, new, artificially caused wildfires emerged, and their frequency and level of destruction increased. While wildfires are necessary for healthy ecosystems, they burn whatever fuel is in their path, whether vegetation or buildings.

The topographic features of the building site, defensible space around the structures, and fire-resistant materials in the building envelope (siding and roofing) are the major factors that contribute to whether or not a home will survive a wildfire. One of the most common causes of a home being damaged or destroyed is due to radiant heat. In a wildfire, radiant heat is the heat given off by burning vegetation. The high temperatures of some wildfires can cause the deck, siding or roof of a home to ignite, because the fire was too near the home (FEMA, 2004a).

5.2.1 HISTORY OF WILDFIRES

The Minnesota DNR responded to 1,871 wildfires in Carlton County between 1985 and June 2021. These include fires not only on state lands, but also rural private lands for which there is not another agency with primary responsibility. Wildfires that are not included in this data are those that occur on federal lands and those that are responded to by local fire departments. The overwhelming majority of these fires were started by humans and burned a total area of 5,132 acres. The largest wildfire occurred in the southeast corner of Clear Creek Township on April 26, 1988. The railroad was blamed as the cause of the fire which scorched 150 acres of land. (MN DNR, 2021d). Wildfire damage to property and crops have cost the county more than $42,000 since 1960 (CEMHS, 2019).

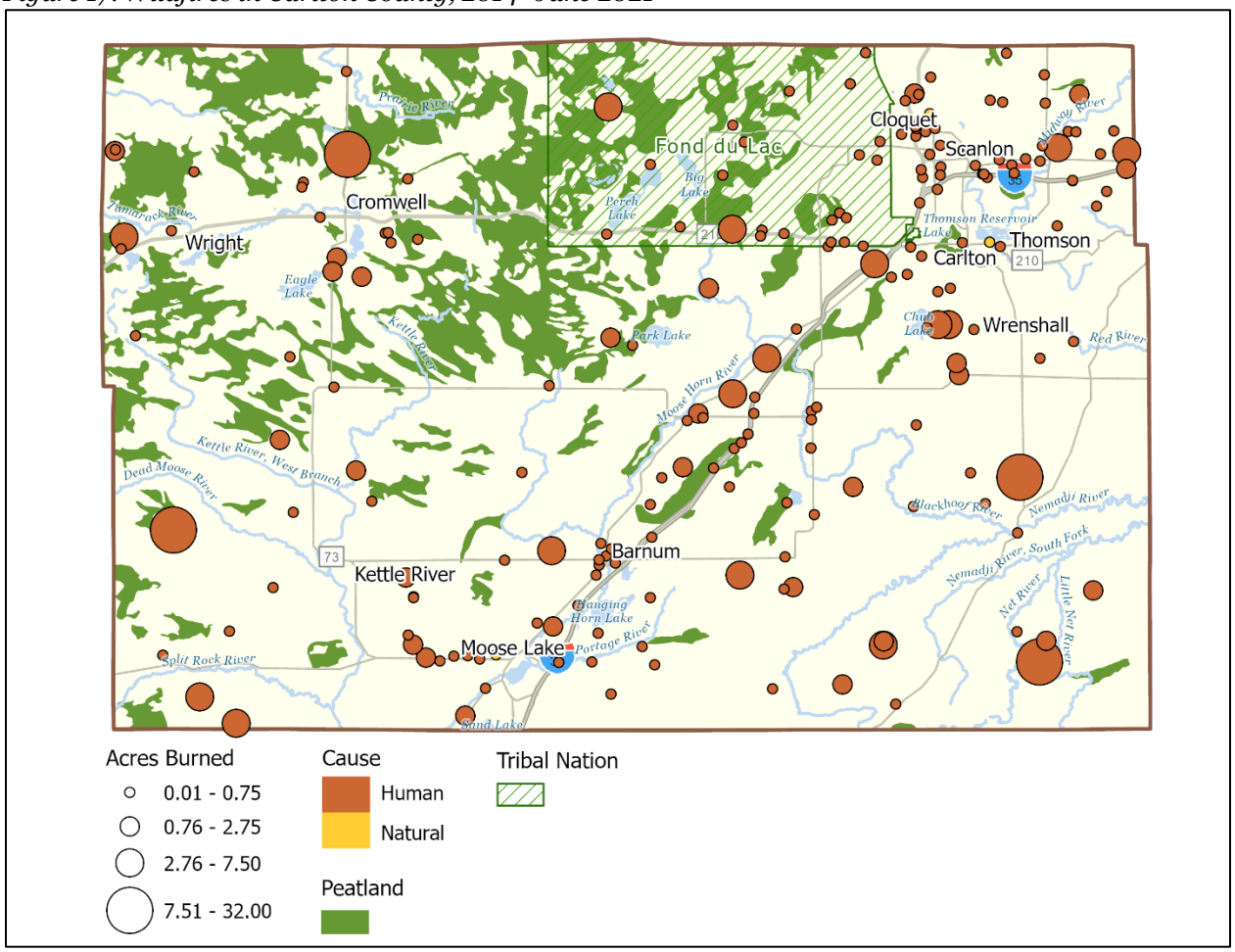
Carlton County experienced 204 wildfires since the beginning of 2014, the year the county's Hazard Mitigation Plan was last updated. A map of these fires is shown in Figure 17. Although the wildfires occurred throughout the county, the highest concentration of wildfires occurred in the areas in and around the towns of Scanlon, and Barnum.

When examining wildfires, it is important to consider the locations of peatlands as peat fires can burn for days, weeks, months, or even years—smoldering underground and re-emerging in another location, making them very difficult to extinguish (MPR, 2012). Peat is partially decayed plant matter found in ancient bogs and swamps. Minnesota has approximately 6 million acres of peatland, the highest total acreage in the contiguous United States (MN DNR, 2007b). Peat fires can smolder during winter months

beneath the snow, surfacing again in the spring to burn above ground. Peat ignites when its moisture content is low, and then it supports combustion rather than flame. Once started, combustion is persistent because peat contains oxygen and needs little or no outside oxygen to continue burning. Peat's insulating qualities mean the fire loses little heat. As the peat dries it becomes water repellent. These factors result in long-lasting fires that require extensive operations to extinguish.

According to the MN DNR, about 16% of the county's surface areas contains peat (87,398 acres) (2007b).

Figure 17. Wildfires in Carlton County, 2014–June 2021



SOURCE: (MN DNR, 2021e)

5.2.2 PROBABILITY OF OCCURRENCE

To determine the probability of future wildfires in Carlton County, records of previous wildfire events in were summed and divided by the dataset's period of record, resulting in the annual relative frequency of wildfires during the period of record. Based on Minnesota DNR records, from January 1985 to June 10, 2021, the relative frequency of wildfire events in the county is 51 per year (MN DNR, 2021e). This relative frequency can be used to infer the probability of these events occurring in the future.

5.2.3 CLIMATE CHANGE PROJECTIONS

Temperatures are predicted to rise in the state, which could lead to more extreme heat events and associated wildfire risks. As Minnesota's climate changes, weather fluctuations between drought and extreme rain events and increasing temperatures will result in changes to forest composition and/or distribution. These fluctuations can lead to dry conditions that may cause increased fire risk in both grassland and forest environments.

5.2.4 VULNERABILITY

Wildfires jeopardize the built environment, health, and wellbeing of individuals living near its fuel source. Some residents are more vulnerable to air quality conditions of wildfire, including children, older adults, and those with respiratory issues (AirNow, 2021). The Household Composition & Disability SVI map is made up of these population groups and should be reviewed to better understand the vulnerability of each jurisdiction.

Structures located in areas near undeveloped wildland are vulnerable to wildfires. The SILVIS Lab at University of Wisconsin–Madison created a dataset documenting the changes of the wildland–urban interface (WUI) in the United States from 1990 to 2010. Radeloff et al. (2018) define WUI as the area where structures and other human development meet or intermingle with wildland vegetation. With the increase of development in metropolitan fringes and rural areas, the WUI is growing. The expansion of the WUI in recent decades has significant implications for wildfire management and impact as it creates an environment in which fire can readily move between structural and vegetation fuels. Its expansion has increased the likelihood that wildfires will threaten structures and people (Radeloff et al., 2018).

There are two main types of WUI: intermix and interface. Intermix WUI are areas where housing and wildland vegetation intermingle; interface WUI are areas where housing are adjacent to wildland vegetation (Radeloff et al., 2018). Table 23 shows the change of total WUI (intermix and interface) in the county from 1990 to 2010, and the percent of the county's land, housing, and population located in the WUI area. Figure 18 displays the WUI areas in Carlton County.

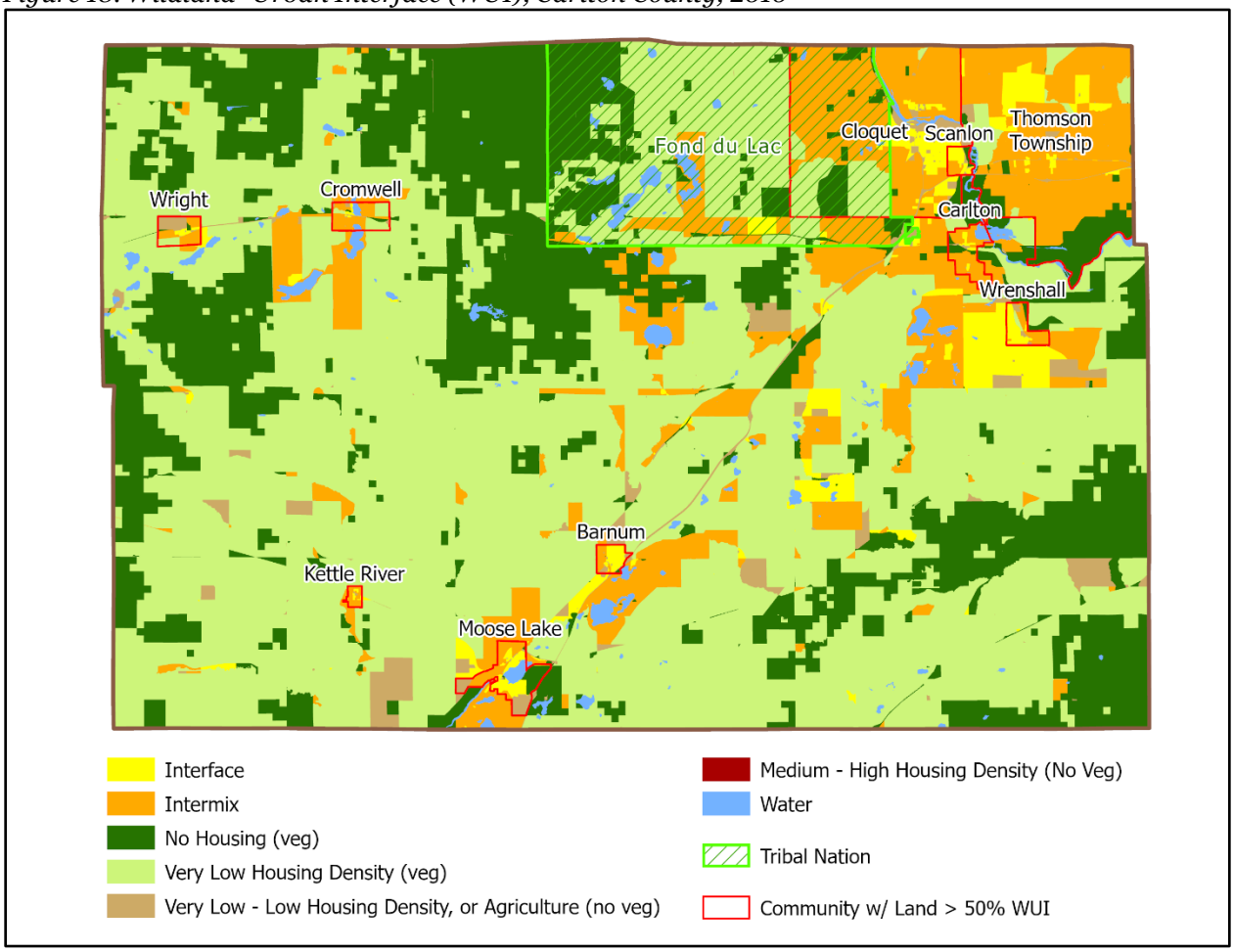
Communities within the county with more than 50% of land classified as WUI include the towns of Barnum, Carlton, Cloquet, Cromwell, Kettle River, Moose Lake, Scanlon, Wrenshall, and Wright, as well as Thomson Township. These communities along with others in WUI areas are more vulnerable to wildfires.

Table 23. Wildland–Urban Interface (WUI), Carlton County, 1990–2010

	Total WUI 1990	Total WUI 2000	Total WUI 2010	% Change (1990–2010)
Land Area	10.3%	12.8%	16.1%	+56.3%
Housing	76.4%	77.5%	78.9%	+3.3%
Population	76%	78%	80.7%	+6.2%

SOURCE: (RADELOFF ET AL., 2019)

Figure 18. Wildland–Urban Interface (WUI), Carlton County, 2010



SOURCE: (Radeloff et al., 2017)

5.2.5 PROGRAM GAPS AND DEFICIENCIES

Carlton County Management identified existing program gaps and deficiencies that make its citizens more vulnerable to wildfire. These gaps should be addressed with new mitigation efforts to reduce vulnerability, outlined as follows:

Community Wildfire Protection Plan/Firewise Program: The MN DNR Firewise Program notes there is a CWPP equivalent that was developed for Carlton County, but a copy cannot be located. Carlton County should review how wildfire is addressed in the EOP and if a full CWPP should be developed with help from the MN DNR. The CWPP would help to define high-risk wildfire areas and wildfire mitigation activities which may be eligible for Firewise grant funding. Funding for a Firewise program has always been a barrier to implementing wildfire mitigation with private and public landowners in Carlton County.

Rural Water Access for Wildland Firefighting: There may be areas within Carlton County where improved water access is needed for fighting wildfire. These areas are rural and not supported by a municipal water source. Local fire departments should be encouraged to evaluate if dry hydrant/well

access projects are needed. The county should seek to provide support in conducting a mapped inventory of where existing dry hydrants are located and their condition.

Public Awareness: Raising public awareness of wildfire safety and dangerous conditions is an ongoing effort of Carlton County Emergency Management, local fire departments, Carlton County SWCD and the MN DNR.

5.3 Windstorms

A windstorm is a wind strong enough to cause damage to trees and buildings and typically exceeding 34 mph (Pielke, 2012). Windstorm events encompass a variety of types of damaging wind, including:

- *straight-line wind*: a thunderstorm wind not associated with rotation,
- *downdraft*: a small-scale column of air that rapidly sinks toward the ground,
- *downburst*: a strong downdraft with an outrush of damaging winds at or near the earth's surface,
- *macroburst* and *microburst*: outward bursts of strong winds at or near the earth's surface, differentiated by the diameter of the burst,
- *gustnado*: a small whirlwind originating from the ground and not connected to any cloud-based rotation), and
- *derecho*: a widespread, long-lived windstorm associated with a band of rapidly moving showers or thunderstorms (NSSL, 2020).

Tornadoes are categorized as separate hazards from windstorms. The National Weather Service (2018) classifies windstorm events using the following criteria.

- *Strong wind events* are non-convective winds gusting less than 50 knots (58 mph), or sustained winds less than 35 knots (40 mph), resulting in a fatality, injury, or damage.
- *High wind events* are sustained non-convective winds of 35 knots (40 mph) or greater lasting for one hour or longer or gusts of 50 knots (58 mph) or greater for any duration.
- *Thunderstorm wind events* are winds arising from convection (occurring within 30 minutes of lightning being observed or detected), with speeds of at least 50 knots (58 mph), or lower wind speeds producing a fatality, injury, or damage. Downbursts and gustnadoes are classified as thunderstorm windstorm events.

When wind speeds are not able to be measured, they are estimated. Part of the process to determine wind speed is observing the damage. Table 24 lists the expected effects of increasing wind speeds.

Table 24. Effects of wind speed

Wind Speed	Effects
26–38 knots (30–44 mph)	Trees are in motion. Lightweight loose objects (e.g., lawn furniture) may be tossed or toppled.
39–49 knots (45–57 mph)	Large trees bend; twigs, small limbs, and a few larger dead or weak branches may break. Old/weak structures may sustain minor damage. Buildings under construction may be damaged. A few loose shingles may be removed from houses. Carports may be uplifted and minor cosmetic damage may occur to mobile homes.

Wind Speed	Effects
50–64 knots (58–74 mph)	Large limbs break; shallow rooted trees may be pushed over. Semi-trucks may be overturned. Significant damage to old/weak structures may occur. Shingles and awnings may be removed from houses, damage may occur to chimneys and antennas, mobile homes and carports may incur minor structural damage, and large billboard signs may be toppled.
65–77 knots (75–89 mph)	Trees experience widespread damage, including breaking and uprooting. Mobile homes may incur significant structural damage, including being pushed off foundations or overturned. Roofs may be partially peeled off industrial/commercial/warehouse buildings. Some minor roof damage may occur to homes. Weak structures (e.g., farm buildings, airplane hangars) may be severely damaged.
78+ knots (90+ mph)	Many large trees may be broken and uprooted. Mobile homes may be severely damaged; moderate roof damage to homes may occur, roofs may be partially peeled off homes and buildings. Moving automobiles may be pushed off dry roads. Barns and sheds may be demolished.

SOURCE: (NWS, 2018)

5.3.1 HISTORY

Carlton County experienced 7 high wind, 4 strong wind, and 93 thunderstorm wind events between 1955 and August 2021, with wind speeds up to 70 knots (81 mph) (NWS, 2020c). The majority of these windstorms occurred in June (21%) and July (37%). Wind damage to property and crops have cost the county more than $2.5 million since 1960 (CEMHS, 2019). Table 25 lists the wind-related events that have occurred in Carlton County since 2014. Thunderstorm Wind events, from 1955–2018, in Carlton County, are shown in Figure 19.

Table 25. Wind Events in Carlton County, January 2014–August 2021

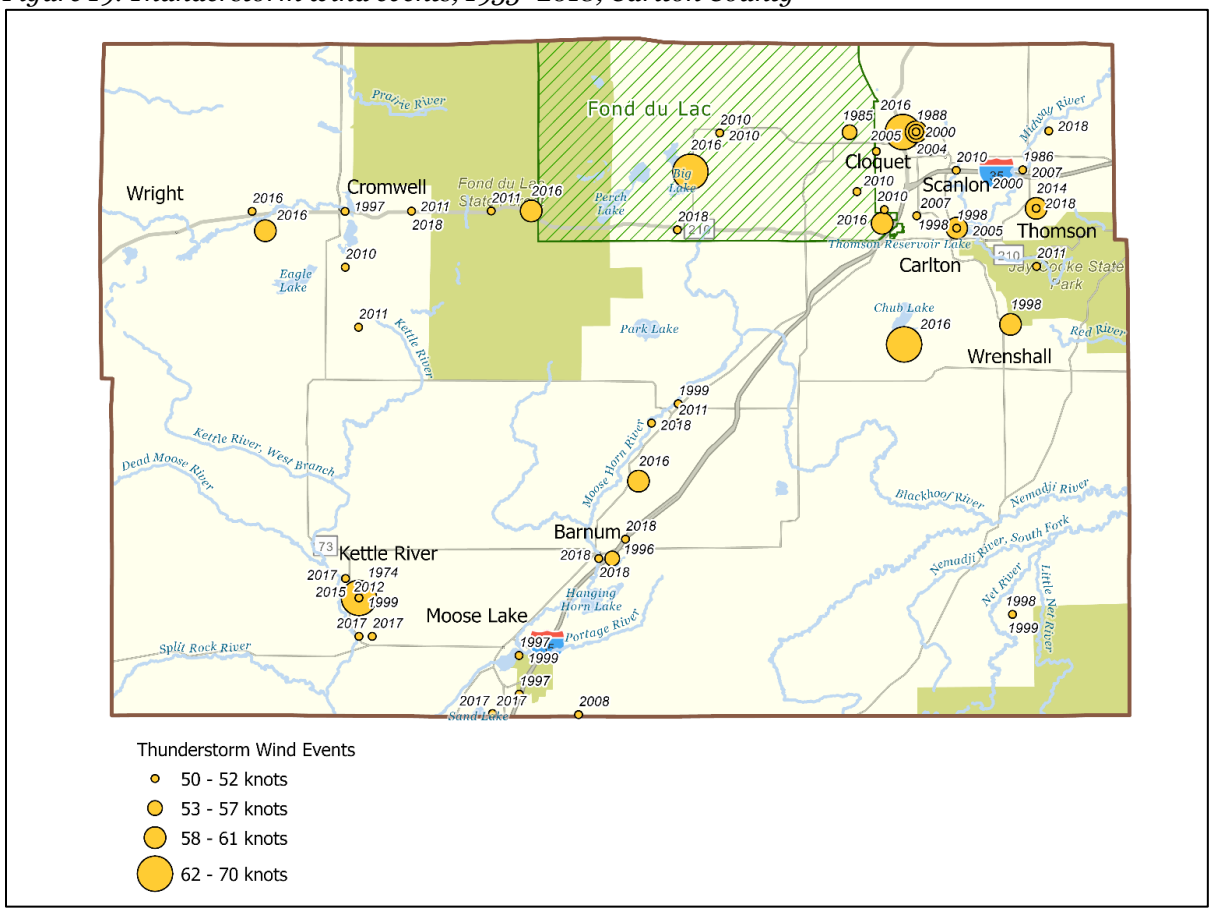
Date	Event Type	Description
8/14/2020 (8 events)	Thunderstorm wind	A strong cold front pushed across Minnesota the evening of the 14th and led to the development of a line of storms ahead of the front. As the storms pushed across northeastern Minnesota, they produced all modes of severe weather.
8/8/2020	Thunderstorm wind	A complex of storms moved across north central and northeastern Minnesota during the afternoon and evening hours of the 7th. A few of the storms were marginally severe and produced small hail and gusty winds that brought down a few tree limbs. Heavy rainfall combined with the slow movement of the storms lead to some minor flooding in spots.
7/9/2020	Thunderstorm wind	Storms begin firing during the afternoon hours ahead of a cold front bringing all modes of severe weather during the late afternoon and evening hours before transitioning to more of a low-end hail and damaging wind threat through the overnight hours and into the morning of the 9th.
10/21/2019 (2 events)	High / strong wind	An intense area of low pressure produced increasingly strong east to northeast winds. The winds downed trees and power lines down leading to power outages. Winds gusted 40–50 mph in the Twin Ports area. $10,000 worth of property damage was reported.

Date	Event Type	Description
6/4/2019	Thunderstorm wind	Thunderstorms developed over northeastern Minnesota. Storms became stronger through the afternoon as they moved southeast. There were a few hail and wind damage reports, and one instance of flash flooding was noted along a Minnesota State Highway. Multiple trees were downed in Cloquet.
9/15/2018 (2 events)	Thunderstorm wind	Storms developed along a stationary boundary. One supercell storm produced large hail before a line of storms formed and brought damaging winds and heavy rain. Downed trees partially blocked Palkie Road and Harney Road.
8/31/2018 (2 events)	Thunderstorm wind	Large hail and strong winds were seen with storms as they moved through the region. Additional storms formed later in the evening as a cold front moved in. A few trees were knocked down along State Highway 210 between Cromwell and Cloquet.
6/30/2018	Thunderstorm wind	Storms developed in eastern North Dakota and moved east across northern Minnesota. The line of storms featured a bow echo leading to numerous wind damage reports. Many trees were blown down in Barnum. One of the larger trees was estimated to be 16 inches in diameter.
6/28/2018 (4 events)	Thunderstorm wind	Two supercells developed along a warm front and traveled east-southeast. Large hail and numerous downed trees were reported, including quite a few trees in the Barnum, Minnesota. A thunderstorm microburst blew down 30–40-foot trees along Interstate 35 both north and south of the Barnum exit.
10/24/2017	Strong wind	Strong winds across the Northland caused damage to power lines, which resulted in outages. $5,000 worth of property damage was reported.
9/22/2017 (2 events)	Thunderstorm wind	Severe thunderstorms developed across portions of northeast Minnesota. Several large trees were knocked down along with nearby powerlines. A cupola was blown off of a bar and hail as large as an inch fell. Trees blocked Minnesota Highway 27.
9/20/2017 (2 events)	Thunderstorm wind	A series of severe thunderstorms moved across portions of northeast Minnesota. The storms caused very gusty winds that led to numerous reports of downed trees blocking roads and bringing down nearby power lines. A few buildings were also damaged by downed trees.
7/17/2017	Thunderstorm wind	Severe thunderstorms moved across portions of northeast Minnesota. The storm brought winds which blew down many trees.
3/7/2017	High wind	Widespread strong and gusty winds occurred across northeast Minnesota. The winds were 40–55 mph across northeast Minnesota, but parts of the Minnesota Northshore had wind gusts in excess of 58 mph. The winds brought down trees and branches and fell on power lines.
8/4/2016	Thunderstorm wind	A cluster of storms in eastern North Dakota moved into northeast Minnesota. Bow echoes within the cluster of storms caused damaging winds. Many trees and power lines were blown down. A Minnesota icon, a 3-ton statue of Babe the Blue Ox at Paul Bunyan Land east of Brainerd, was toppled over by the winds. There was tree and tent damage at the Crow Wing County Fairgrounds in Brainerd. The damage suggested widespread sustained wind speeds of 70–90 mph.
7/21/2016 (3 events)	Thunderstorm wind	A cluster of thunderstorms merged into a couple of main bow echoes that quickly sped across northeast and central Minnesota. The multi-bow storm caused extensive damage across the region from widespread straight-line winds of 60–80 mph. Power was out to 75,000 customers across the region.

Date	Event Type	Description
6/25/2016 (4 events)	Thunderstorm wind	Thunderstorms brought strong winds to parts of northeast Minnesota on June 25th, first in the morning, and then again in the afternoon. Numerous trees of up to 12 inches in diameter were snapped.
8/8/2015	Thunderstorm wind	An eastward moving cold front interacted with an east west oriented outflow boundary to trigger storms in north central Minnesota. The storms tracked slowly east and produced large hail and heavy rain. Winds from the storm downed trees.
4/2/2015	High wind	There were strong winds over northeast Minnesota, with widespread maximum wind gusts of 40–55 mph. There were scattered reports of downed trees down across northeast Minnesota. The trees may have been in poor condition and more susceptible to the wind.
7/22/2014	Thunderstorm wind	Thunderstorms developed during the late afternoon and early evening and moved into northern Minnesota. Widespread wind damage occurred from 50–70 mph winds over much of northeast Minnesota, blowing and/or snapping trees and knocking out power. There were more focused areas of structural damage that suggested there were winds in excess of 70 mph.

SOURCE: (NCEI, 2021)

Figure 19. Thunderstorm wind events, 1955–2018, Carlton County



SOURCE: (NCEI, 2021)

5.3.2 PROBABILITY OF OCCURRENCE

To determine the probability of future wind-related events in Carlton County, records of previous wind-related events (strong wind, high wind, and thunderstorm wind) in the county were examined for the period of record. Because the datasets have two different periods of record, separate relative frequencies were calculated. Thunderstorm wind events, which date back to January of 1955, have a relative frequency of 1.3 per year. The relative frequency of all wind-related events since January of 1996 is 3.0 per year. These relative frequencies can be used to infer the probability of these events occurring in the future.

5.3.3 CLIMATE CHANGE PROJECTIONS

Lack of high-quality long-term data sets make assessment of changes in wind speeds very difficult (Kunkel et al., 2013). One analysis generally found no evidence of significant changes in wind speed distribution (Pryor et al., 2009), while other models suggest an increase in the frequency and intensity of severe thunderstorms as the climate changes (USGCRP, 2018). The lack of confidence in the projections of future changes in thunderstorms, tornadoes, hail, and windstorms, is in part due to the difficulty in monitoring and modeling these small-scale and short-lived events (USGCRP, 2018). Since the impact of more frequent or intense storms can be significant, climate scientists are actively researching the connections between climate change and severe weather.

5.3.4 VULNERABILITY

The likelihood of a windstorm event does not vary geographically within the county, but the vulnerability of its citizens is not constant. Vulnerability to injury from all kinds of windstorms decreases with adequate warnings, warning time, and sheltering in a reinforced structure. Therefore, residents living in rural areas, living alone or with limited mobility, or living in a manufactured home may be more vulnerable. Also at a higher risk to windstorms are those who work outdoors or do not have permanent housing.

Structural vulnerability depends in part upon the construction of a building and its infrastructure. Residents of mobile homes are more vulnerable to fatality or injury from windstorms because mobile homes are not able to withstand high winds as well as other structural dwellings, with 50 mph (43.4 knots) being the lower limit of wind speeds capable of damaging mobile homes (AMS, 2004). Steps to mitigate these vulnerabilities have been taken by the state, requiring all mobile home parks to provide an evacuation plan, and parks with at least 10 homes licensed after March 1, 1988 to provide a storm shelter (MDH, 2020). However, mobile home parks often do not provide the required storm shelters (Sepic, 2017). Building codes have also changed to improve the strength of new mobile home construction but there are still many older mobile homes in use that do not meet these new standards.

The Housing Type & Transportation and Household Composition & Disability themes of the Social Vulnerability Index (Table 15) include variables that can be helpful in identifying where these vulnerable citizens are concentrated within the county.

5.3.5 PROGRAM GAPS AND DEFICIENCIES

Carlton County Emergency Management identified several program gaps and deficiencies that make its citizens more vulnerable to summer storms, including windstorms, that should be addressed with new mitigation efforts to reduce vulnerability. These include:

Above-Ground Power Lines: A majority of the power lines in the county are above ground and subject to damage from high winds and falling tree limbs from severe summer storms. Power lines that are above ground are susceptible to coming down during severe storm events, resulting in power outages.

Public Education: Continued public education needs to be conducted during tornado season to inform the public on what is a tornado watch/warning and what to do when warning sirens are activated. Carlton County Emergency Management and local cities need to continue to encourage all residents to be ready for long-term power outages resulting from severe spring & summer storm events such as thunderstorms or straight-line winds.

Storm Shelters/Tornado Safe Rooms: Additional storm shelter areas in the county would enhance public safety. Local municipalities should evaluate where storm shelters or tornado safe rooms should be constructed to protect those who are vulnerable to dangerous wind events, such as at campgrounds, mobile home parks, and schools.

5.4 Tornadoes

Tornadoes are violently rotating columns of air formed in a thunderstorm when the rotating air of an updraft meets the spinning air of a downdraft, which has turned upward (UCAR, 2021). With wind speeds reaching up to 300 mph, they are one of nature's most violent storms (Hogeback, 2020).

Since 2007, tornado strength in the United States has been measured using the Enhanced Fujita Scale (EF Scale), which replaced the original Fujita Scale (F Scale). The EF Scale is a set of estimated wind speeds based on damage (Table 26). The EF Scale incorporates the use of 28 damage indicators to derive estimated wind speeds and assign an associated EF rating (NWS, 2020b; SPC, 2007). The EF Scale is used extensively by the NWS to investigate tornadoes, and by engineers in correlating damage to buildings and building techniques.

Table 26. Enhanced Fujita Scale (EF Scale)

EF Rating	3-second gust (mph)
0	65–85
1	86–110
2	111–135
3	136–165
4	166–200
5	Over 200

SOURCE: (NWS, 2020B)

5.4.1 HISTORY

From 1950 through 2018, 1,940 tornadoes occurred throughout Minnesota, resulting in 99 deaths and nearly 2,000 injuries (MN DNR, 2019b). While the majority of tornadoes in Minnesota are minor (F0/EF0) and occur without injury, a number of the tornadic events will forever be remembered due to the sheer death and destruction they left behind. Examples include the St. Cloud/Sauk Rapids tornado of 1886, which claimed 72 lives, injured 213, and remains the deadliest tornado in the State's history. May 6, 1965 is another day often remembered for tragedy when six tornadoes ravaged the Twin Cities, killing 13, injuring 683, and causing $51 million in damages (without inflation adjustment) (MN DNR, 2019b).

The peak months of tornadic activity in Minnesota are June and July respectively (MN DNR, 2019b). According to the NCEI Storm Events Database, 8 tornadoes have occurred in Carlton County between 1950 and February 2020, resulting in two injuries (NCEI, 2021), and an estimated $330,000 - $440,000 in property and crop damage (CEMHS, 2019). The strength of these tornadoes ranged from F0/EF0 to F2. The costliest of these tornadoes occurred on July 7, 1970, when an F2 tornado occurred in the southeast corner of Carlton County. This tornado caused two injuries and an estimated quarter million dollars in damages (NCEI, 2021). Two tornadoes have occurred in Carlton County since 2014 (Table 27).

Table 27. Tornadoes in Carlton County, January 2014–August 2021

Date	Start Location	End Location	Magnitude	Description
8/14/2020	Moose Lake Municipal Airport	Kettle River	EF1	A tornado tracked north-northwest west of Moose Lake, MN, embedded within a line of thunderstorms. This tornado produced the most significant damage of this severe weather event, damaging multiple properties including lifting the roof off of a two-car garage and destroying at least one metal shed building. There were also pockets of tree damage along the path of the tornado, with numerous trees snapped 10-20 feet above the ground. Damage was strewn across fields, with several two-by-fours driven into the Earth.
8/14/2020	Automba	Automba	EF0	A brief radar-confirmed tornado produced a two-mile swath of tree damage across mainly forested areas near Automba. No property damage reports were received.

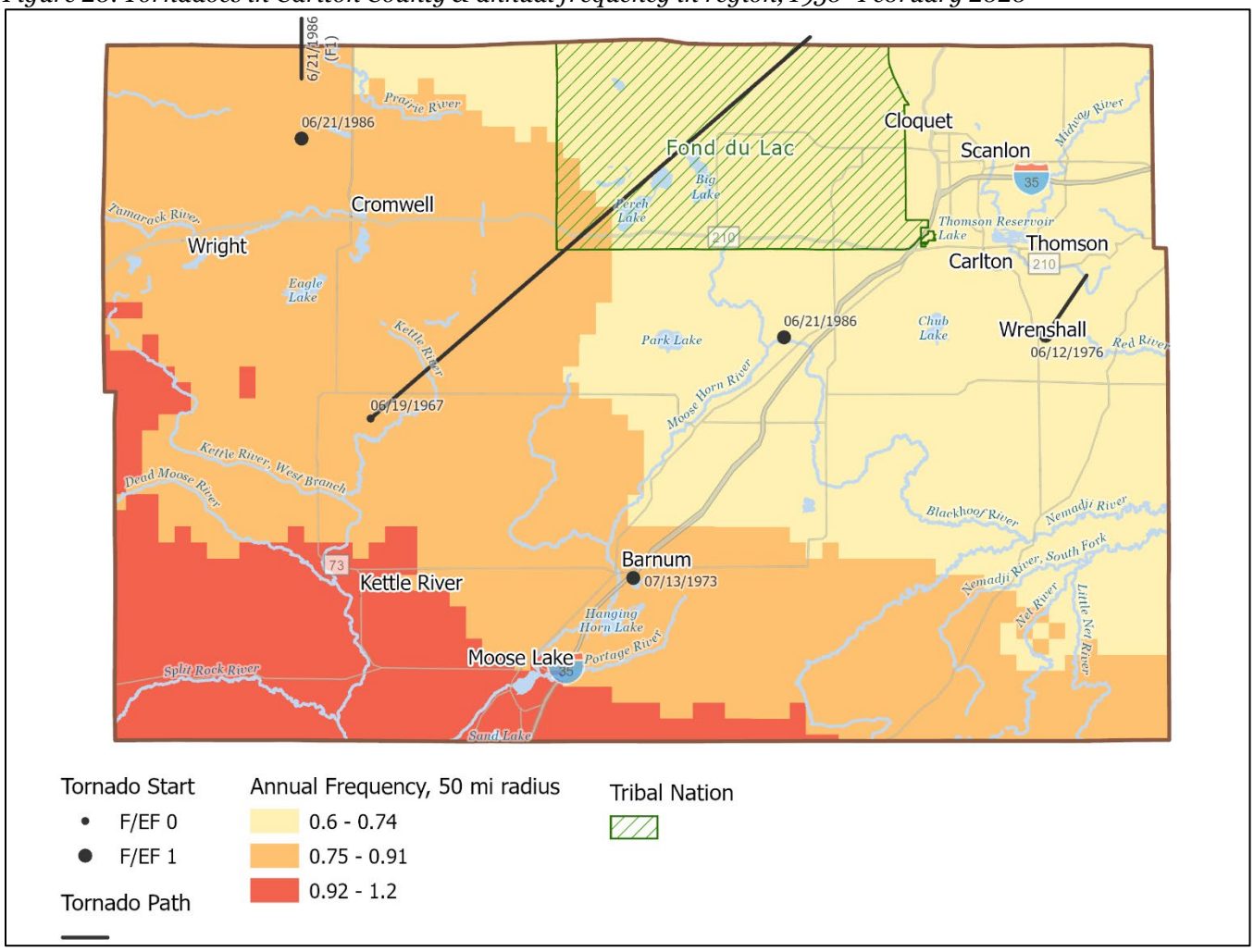
SOURCE: (NCEI, 2021)

5.4.2 PROBABILITY OF OCCURRENCE

Estimating the probability of future tornadoes in Carlton County was done using two methods. The first method summed the total number of tornadoes which either touched down in or traveled through the county. This sum was divided by the number of years tornado data was recorded, resulting in the annual relative frequency of tornado occurrences in the county. Based on records in the NCEI Storm Events Database through February 2020, the relative frequency of tornados in Carlton County is 0.1 per year. (These 8 tornadic events occurred in 6 of the 70 years on record.)

Because tornadoes often cross county lines and tornadic frequency may be better understood using events from a larger area, a second method was used to describe the frequency of tornadic events within a 50-mile radius of any location within the county. A grid of 900 square-meter cells was used to cover Minnesota and 50 miles beyond its border. From the center of each cell, the number of tornadoes that intersected a 50-mile radius was counted. Each cell was assigned a total tornado line count, which was then divided by the tornado dataset's period of record, resulting in the annual relative frequency of tornadoes occurring within 50 miles of the respective cell.

Figure 20. Tornadoes in Carlton County & annual frequency in region, 1950–February 2020



(MN DNR, 2019b; NCEI, 2021)

For any location in Carlton County, there was an annual frequency of 0.6–1.2 tornadoes within a 50-mile radius. The historical frequency was only slightly higher in the southeast than the northwest. These relative frequencies can be used to infer the probability of these events occurring in the future.

Figure 20 shows the tornadoes that have occurred in Carlton County from 1950 through February 2020 (data were not available for the two 2020 tornadoes), as well as the annual frequency of tornado occurrences within 50 miles of any location within the county.

5.4.3 CLIMATE CHANGE PROJECTIONS

Tornadoes and other severe convective storms are the largest annual aggregated risk peril to the insurance industry, costing the U.S. $11.23 billion (in 2016 USD) each year (Gunturi & Tippett, 2017). Although recent research has yielded insights into the connections between global warming and the factors that cause tornados and severe thunderstorms, such as atmospheric instability and increases in wind speed with altitude (Del Genio et al., 2007), these relationships remain mostly unexplored, largely

because of the challenges in observing thunderstorms and tornadoes and simulating them with computer models (USGCRP, 2018).

According to Brooks et al., while the mean annual number of tornadoes in the U.S. has remained relatively consistent the variability of tornado occurrences has increased since the 1970s. According to the data, tornadoes have been occurring in larger clusters since the 1970's, with an overall decrease in the number of tornado days but an increase in the number of tornadoes that occur on tornado days (2014).

An increase in the variability of tornado occurrences affects the timing of the start of the tornado season (Brooks et al., 2014). The earliest reported tornado in Minnesota occurred on March 6, 2017, when two tornadoes touched down in southern Minnesota. These tornadoes occurred 12 days earlier and 115 miles further north than the previous record from 1968. According to State Meteorologist Paul Huttner, "Those records fit seasonally and geographically with longer term climate trends pushing weather events earlier in the season and further northward" (Huttner, 2017).

5.4.4 VULNERABILITY

The likelihood of a tornado does not vary significantly across geography within Carlton County; however, certain populations may be more vulnerable and less resilient to the impacts of a tornado. In general, tornado casualties decrease when people receive adequate warnings with sufficient time to seek shelter in a reinforced structure. Because communication is critical before a tornadic event, certain citizens may be more negatively impacted by a tornado, including those living in rural areas, individuals with limited mobility, people who do not live near an outdoor warning siren, or those who do not use social media.

As discussed in section 4.4.3, people living in mobile homes are particularly vulnerable to tornadoes due to them not being able to withstand the strong winds produced by a tornado. According to NOAA's Storm Prediction Center, from 1985–2002, 49% of tornado fatalities in the United States were people who remained within or attempted to flee from mobile homes (AMS, 2004). While Minnesota law requires most mobile home parks to have storm shelters, many do not (Sepic, 2017). Section 4.3 lists the mobile home parks in Carlton County.

Some of the vulnerability factors mentioned above are included as social factors in the Housing Type & Transportation and Household Composition & Disability themed SVI map (Table 15*)* and may provide general insight on where in the county these vulnerable communities are located.

5.4.5 PROGRAM GAPS AND DEFICIENCIES

Carlton County Emergency Management identified that there are several program gaps and deficiencies that make its citizens more vulnerable to summer storms, including tornadoes, that should be addressed with new mitigation efforts to reduce vulnerability. These include:

Above-Ground Power Lines: A majority of the power lines in the county are above ground and subject to damage from high winds and falling tree limbs from severe summer storms. Power lines that are above ground are susceptible to coming down during severe storm events, resulting in power outages.

Public Education: Continued public education needs to be conducted during tornado season to inform the public on what is a tornado watch and what is a warning and what to do when warning sirens are activated. Carlton Emergency Management and local cities need to continue to encourage all residents to

be ready for long-term power outages resulting from severe spring and summer storm events such as thunderstorms or straight-line winds.

Storm Shelters/Tornado Safe Rooms: Additional storm shelter areas in the county would enhance public safety. Local municipalities should evaluate where storm shelters or tornado safe rooms should be constructed to protect those who are vulnerable to dangerous wind events, such as at campgrounds, mobile home parks, and schools.

5.5 Hail

A hailstorm is a storm producing spherical balls of ice. Hailstones form in a thunderstorm's unstable air mass when warm moist air rises rapidly into the upper atmosphere and subsequently cools, leading to the formation of ice crystals. The ice crystals grow into hailstones through the storm's updraft and downdraft cycle, each time being coated with a layer of ice until the hailstone becomes too heavy to be carried by the updraft and falls to the ground.

A number of factors determine the damage potential from hail including hailstone size, texture, numbers, fall speed, speed of storm translation, and strength of the accompanying wind (TORRO, 2021). The maximum hailstone size is the most important parameter relating to structural damage. Studies have determined that most property damage begins when hailstone diameters are ≥ .75 in., while crop damage can occur from hailstones as small as .25 in (Changnon et al., 2009) depending on the crop and growth stage. Table 28 shows the TORnado and storm Research Organization's (TORRO) Hailstorm Intensity Scale, which describes the typical damage from different sized hailstones.

Hailstorms occur throughout the year though are most frequent between May and August (NWS, 2020c). Although hailstorms rarely cause injury or loss of life, they do cost Minnesota nearly $16 million in property and crop damage each year (CEMHS, 2019). In 2017, 44% of properties in Minnesota were affected by damaging hail events (Samanta & Wu, 2017).

Table 28. TORRO hailstorm intensity scale

	Intensity Category	Typical Hail Diameter (in.)	Typical Damage Impacts
H0	Hard Hail	.2	No damage
H1	Potentially Damaging	.2–.6	Slight general damage to plants, crops
H2	Significant	.4–.8	Significant damage to fruit, crops, vegetation
H3	Severe	.8–1.2	Severe damage to fruit and crops, damage to glass and plastic structures, paint and wood scored
H4	Severe	1–1.6	Widespread glass damage, vehicle bodywork damage
H5	Destructive	1.2–2	Wholesale destruction of glass, damage to tiled roofs, significant risk of injuries
H6	Destructive	1.6–2.4	Bodywork of grounded aircraft dented, brick walls pitted
H7	Destructive	2–3	Severe roof damage, risk of serious injuries
H8	Destructive	2.4–3.5	Severe damage to aircraft bodywork
H9	Super Hailstorms	3–4	Extensive structural damage. Risk of severe or even fatal injuries to persons caught in the open
H10	Super Hailstorms	> 4	Extensive structural damage. Risk of severe or even fatal injuries to persons caught in the open

SOURCE: (TORRO, 2021)

5.5.1 HISTORY

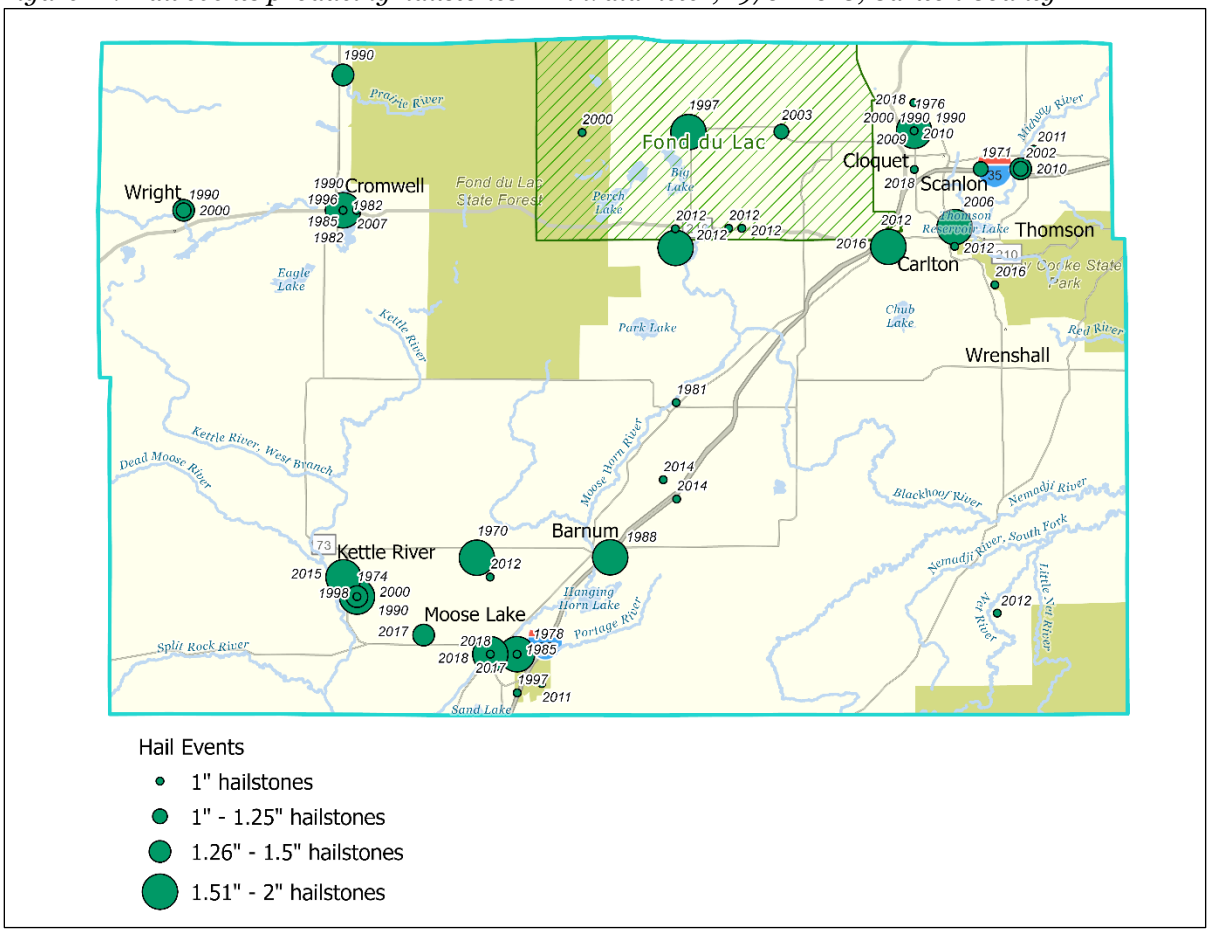
Carlton County experienced 87 hail events from 1955 through February 2020; 62% of these hailstorms produced hailstones ≥ 1 in. diameter. The largest hailstone recorded in Carlton County was 2 in., which occurred in an unrecorded location on September 5, 1990 as well as in Cloquet on August 14, 2000 (NWS, 2020c). Hail damage to property and crops have cost the county more than 12.2 million dollars since 1960, ranking the county 21st for hail damage incurred by Minnesota counties (CEMHS, 2019). Table 29 lists hail events in Carlton County that produced hailstones ≥ 1 in. diameter since January 2014. Figure 21 shows the hail events in Carlton County from that produced hailstones ≥ 1 in. in diameter.

Table 29. Storms producing hail ≥ 1 in. diameter, Carlton County, January 2014–February 2020

Date	Location	Hailstone Diameter (in.)	Damage
8/31/2018	Cloquet	1	Warm advection ahead of a cold front lead to the development of storms by late afternoon that brought large hail and strong winds. Additional storms formed later in the evening as the cold front moved in.
6/30/2018	Cloquet	1	Low pressure along with warm and cold fronts led to the development of fast-moving storms that contained heavy winds and lead to numerous wind damage reports.
6/15/2018 (3 events)	Multiple	1–1.75	Storms occurred throughout much of the day, a few of which were severe with damaging winds and hail. The storms also contained heavy rainfall which primed parts of the area for major flash flooding the following night. The hail events were recorded in Moose Lake and Holyoke.
7/6/2017 (2 events)	Multiple	1–1.5	Severe thunderstorms produced damaging winds and hail across multiple counties. Several trees were blown down, damaging power lines and in one case, a home. The storms also contained hail, with the largest the size of golf balls. The hail events were recorded in Moose Lake and Kettle River.
6/19/2016 (2 events)	Multiple	1–1.75	Tornadic thunderstorms formed in a very unstable airmass ahead of a cold front that moved through the area during the evening. Tornadoes, large hail, and damaging winds occurred across parts of the area. Carlton County saw half dollar sized and golf ball sized hail stones. The locations that received hail include Carlton and Wrenshall.
8/8/2015	Kettle River	1.75	An eastward moving cold front interacted with an east west oriented outflow boundary to trigger storms in north central Minnesota. The storms tracked slowly east and produced large hail and heavy rain.
8/1/2014 (3 events)	Multiple	1	Thunderstorms dropped hail over parts of northeast Minnesota. The locations the received hail include Mahtowa and Barnum.

SOURCE: (NWS, 2020C)

Figure 21. Hail events producing hailstones ≥ 1 in. diameter, 1970–2018, Carlton County



SOURCE: (NWS, 2020c)

5.5.2 PROBABILITY OF OCCURRENCE

To determine the probability of future hailstorms in Carlton County, records of previous hail events in the county were examined for the period of record. From January 1970 through February 2020, the relative frequency of hail events was 1.3 per year. This relative frequency can be used to infer the probability of hail events occurring in the future.

5.5.3 CLIMATE CHANGE PROJECTIONS

Numerous models suggest an increase in the frequency and intensity of severe thunderstorms as the climate changes (USGCRP, 2018) but scientists are less confident of how it will specifically affect hail. Some studies indicate climate changes will result in fewer overall hail days but an increase in the mean hail size, the frequency of large hail events, and the overall damage potential of hail (Brimelow et al., 2017). The lack of confidence in the projections of future changes in thunderstorms, tornadoes, hail, and windstorms is in part due to the difficulty in monitoring and modeling these small-scale and short-lived events (USGCRP, 2018). Since the impact of more frequent or intense storms can be significant, climate scientists are actively researching the connections between climate change and severe weather.

5.5.4 VULNERABILITY

Carlton County's agricultural lands and structures are vulnerable to hail damage and its citizens to injury and possibly death. Data from the Spatial Hazard Events and Losses Database for the United States (SHELDUS) was examined to identify the county's monetary losses due to hail damage to crops, property, injury, and death. From 1960 through 2018 Carlton County reported over $12 million in hail damages, ranking 21st among Minnesota counties in total hail damages. The losses are primarily due to property damages reported at $11,292,368, followed by $901,505 in crop damages.

Within Carlton County, the vulnerability of jurisdictions to hailstorms does not vary geographically. As with all summer storms, those who work outdoors or do not have permanent housing are at greater risk during hailstorms.

5.5.5 PROGRAM GAPS AND DEFICIENCIES

Carlton County Emergency Management identified that there are several program gaps and deficiencies that make its citizens more vulnerable to summer storms, including hail. The following gaps and deficiencies should be addressed with new mitigation efforts to reduce that vulnerability:

Above-Ground Power Lines: A majority of the power lines in the county are above ground and subject to damage from high winds and falling tree limbs from severe summer storms. Power lines that are above ground are susceptible to coming down during severe storm events, resulting in power outages.

Storm Shelters/Tornado Safe Rooms: Additional storm shelter areas in the County would enhance public safety. Local municipalities should evaluate where storm shelters or tornado safe rooms should be constructed to protect those who are vulnerable to dangerous wind events, such as at campgrounds, mobile home parks, and schools.

Public Education: Continued public education needs to be conducted during tornado season to inform the public on what is a tornado watch and what is a warning and what to do when warning sirens are activated. Carlton County Emergency Management and local cities need to continue to encourage all residents to be ready for long-term power outages resulting from severe spring & summer storm events such as thunderstorms or straight-line winds.

5.6 Winter Storms

Winter storms encompass a number of winter-related weather events that the National Weather Service (NWS) organizes into the following categories: blizzard, heavy snow, ice storm, winter storm, and winter weather. Winter weather events are common in Minnesota and can be costly. According to the Spatial Hazard Events and Losses Database (SHELDUS), winter weather events in Minnesota have cost more than $957 million dollars in damages since 1960 (CEMHS, 2019).

The definitions below are used to record winter storm events in the NWS Storm Events Database (NCEI, 2021).

Blizzard: A blizzard (Figure 22) is a winter storm that has the following conditions for at least three consecutive hours: (1) sustained winds or frequent gusts of 35 mph or greater, and (2) falling and/or

blowing snow which reduces visibility to less than ¼ mile. Blizzards are the most dramatic and destructive of all winter storms generally characterized as bearing large amounts of snow accompanied by strong winds. They have the ability to completely immobilize travel in large areas and can be life threatening to humans and animals in their path. Blizzards in Minnesota have claimed the lives of 10 people since 1996: (NCEI, 2021).

According to the NWS, there is no fixed temperature requirement for blizzard conditions, but the life-threatening nature of low temperatures in combination with blowing snow and poor visibility increases dramatically when temperatures fall below 20° F. In Minnesota, blizzards typically occur between October and April, with the majority occurring the months of January, March, and November, respectively.

Figure 22. Thanksgiving Weekend Blizzard, 2019

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Damages from blizzards can range from human and livestock deaths to significant snow removal costs. Stranded drivers can make uninformed decisions, such as leaving the car to walk in conditions that put them at risk. Because of the blinding potential of heavy snowstorms, drivers are also at risk of collisions with snowplows or other road traffic. Drivers and homeowners without emergency plans and kits are vulnerable to the life-threatening effects of heavy snowstorms such as power outages, cold weather, and inability to travel, communicate, obtain goods, or reach their destinations. Heavy snow loads can cause structural damage, particularly in areas where there are no building codes or where residents live in manufactured home parks. The frequency of structural fires tends to increase during heavy snow events, primarily due to utility disruptions and the use of alternative heating methods by residents.

Heavy Snow: A heavy snow event is characterized as snow accumulation meeting or exceeding the local/regional defined 12 and/or 24-hour warning criteria. Depending on the area, this could mean 4–8 inches or more of snow in 12 hours or less, or 6–10 inches or more of snow in 24 hours or less. Heavy snow events may cause structural damage due to the weight of snow accumulation.

Ice Storm: An ice storm is characterized by a buildup of ice (typically ¼–½ inch or more) due to freezing rain or other type of precipitation; however, even small accumulations of ice on sidewalks, streets, and highways may create extremely hazards conditions to motorists and pedestrians. The terms “freezing rain” and “freezing drizzle” warn the public that a coating of ice is expected on the ground and other exposed surfaces.

Heavy accumulations of ice can bring down electrical wires, telephone lines, and even trees, telephone poles, and communication towers. The NWS notes that over 85% of ice storm-related deaths are the result of traffic accidents.

Winter Storm & Winter Weather: A winter storm is an event that has more than one winter hazard (i.e., heavy snow and blowing snow; snow and ice; snow and sleet; sleet and ice; or snow, sleet, and ice) and

meets or exceeds locally/regionally defined 12- and/or 24-hour warning criteria for at least one of the precipitation elements. Winter weather is a winter precipitation event that causes a death, injury, or a significant impact to commerce or transportation, but does not meet locally/regionally defined warning criteria. The winter weather classification is also used to document out-of-season occurrences of winter precipitation.

5.6.1 HISTORY

Carlton County has an active history of winter-related weather events. Since 1996, the county experienced 116 events, including blizzards, heavy snows, ice storms, winter storms, and winter weather (NCEI, 2021). Winter weather events in the county have cost over $10.8 million dollars in property and crop damages since 1960 (CEMHS, 2019). Table 30 Provides descriptions from the NCEI Storm Events Database of the events that have occurred since 2014, the year the county's MHMP was last updated.

Table 30. Winter-related weather events in Carlton County, January 2014–August 2021

Date	Type	Description
3/10/2021	Heavy Snow	Snowfall totals were highest across the Arrowhead, ranging from 6 to 11 inches.
12/29/2020	Heavy Snow	An upper-level trough deepened as it pivoted across Minnesota late on the 29th into the 30th and its associated surface low brought widespread snowfall to the region as it passed. Overall, snow totals yielded 2-6 inches with locally higher amount upwards of 8 inches along the North Shore.
12/23/2020	Heavy Snow and Blizzard	The eastern half of northeast Minnesota received 6 to 10 inches of snowfall with lesser amounts further west in addition to the widespread blizzard conditions.
11/14/2020	Heavy Snow	A narrow band of heavy snowfall near the Twin Ports, with reports of 6 to 10 inches in the area. A site near Esko reported 11 inches of snow for the event.
11/10/2020	Heavy Snow	Snowfall reports of 6 to 10 inches were recorded from the Brainerd Lakes area into the Twin Ports and Minnesota Arrowhead with a total of 11 inches recorded near Motley. Some of the Brainerd area received just over 6 inches of snow in as little as 3 hours during this event.
10/20/2020	Heavy Snow	Stronger than anticipated storm developed across the southern CWA leading to enhanced snowfall of 4 to 7 inches in that area. The highest snowfall report was 7 inches near Baxter.
3/28/2020	Heavy Snow	While areas immediately adjacent to Lake Superior along the North Shore and Twin Ports area did not receive heavy snowfall, areas inland above the terrain ridge saw between 6 and 13 inches of accumulation.
1/17/2020	Heavy Snow	Snowfall totaled from six to ten inches across the area. Winds of 30 to 40 mph on January 18 lead to blowing and drifting snow and reduced visibility.
12/28/2019	Heavy Snow	Snowfall totaled six to eight inches. A layer of ice covered the snowy roads leading to dangerous driving conditions.
12/8/2019	Heavy Snow	Snowfall totals of six to eight inches were common across much of northeastern Minnesota.

Date	Type	Description
11/30/2019	Blizzard	This storm saw an almost twelve-hour period of heavy snow along and 40 to 50 mph winds. This led to reduced visibilities of a quarter mile or less leading to whiteout conditions. Snowfall of almost two feet accumulated and created impassable roads and stranded motorists. Plows were pulled off the roads until the next morning due to dangerous conditions.
11/26/2019	Heavy Snow	Six to ten inches of snow fell across this area.
5/8/2019	Heavy Snow	Snowfall accumulated eight to twelve inches.
4/11/2019	Heavy Snow	A long snowfall event mixed with occasional periods of freezing rain. Strong winds of over 40 mph led to numerous reports of downed trees and power lines with multiple vehicle crashes due to the snow and freezing rain. Snowfall amounts ranged from three to nine inches, with up to thirteen inches in some areas.
2/20/2019	Heavy Snow	Heavy snowfall fell at rates of one to two inches per hour and caused whiteout conditions. Totals of three to eight inches were seen across northeastern Minnesota.
2/6/2019	Heavy Snow	Multiple waves of heavy snowfall occurred along with areas of freezing drizzle in between waves. Most locations saw between eight and twelve inches of snow.
2/5/2019	Heavy Snow	The area received eight to nine inches of snow.
1/21/2019	Heavy Snow	Snowfall totals across this county ranged from eight to ten inches.
12/26/2018	Heavy Snow	A prolonged three-day snowfall created snowfall amounts of eight to sixteen inches, with some areas reaching up to twenty-two inches.
4/15/2018	Winter Storm	This was an unusually strong mid-April snowstorm. The storm brought heavy winds and a little over twelve inches of snow in some areas.
3/5/2018	Heavy Snow	An extremely slow-moving storm system with multiple periods of snow affected portions of east-central Minnesota. Winds were also very strong with gusts well into the 40-mph range. The winds caused sporadic power outages. Snowfall ranged from seven to thirteen inches.
2/24/2018	Heavy Snow	Heavy snow fell overnight, and the area accumulated six to eight inches of snow. Snowfall and strong winds made travel conditions difficult.
2/22/2018	Heavy Snow	The highest snowfall amounts ranged from six to eleven inches.
2/19/2018	Heavy Snow	Snowfall ranged from nine to eleven inches. A car crash during the snowstorm just north of Carlton County claimed the life of a woman driver and injured two others. Roads were snow-covered and slippery at the time.
2/3/2018	Winter Weather	A winter weather advisory was in effect due to a few inches of snowfall and slick roadways. Two separate car accidents occurred in Carlton County on I-35 near Cloquet. These resulted in one serious injury of a 12-year-old girl and two deaths of both a 15-year-old girl and a 19-year-old man.
10/27/2017	Winter Storm	Some areas received up to a foot of snow and the heavy snow took down trees, branches, and power lines. Roads were slick and one death occurred in Carlton County when a semi-truck driver lost control of his vehicle on I-35 near Scanlon and slid into the St. Louis River.

Date	Type	Description
12/25/2016	Winter Storm	The storm brought a surge of precipitation and caused a mixture of freezing rain, sleet, and snow. There were up to a few inches of freezing rain and sleet, as well as strong winds and some snow accumulation across northern Minnesota. An ice storm and the strong winds felled numerous trees, which contributed to power outages.
12/11/2016	Heavy Snow	Heavy snows caused total snowfall amounts ranging from six to ten inches.
11/18/2016	Heavy Snow	The snowfall was reported at 8.1 inches three miles northeast of the city of Wright in Carlton County.
12/26/2015	Heavy Snow	Snowfall ranged from six to eight inches throughout the area.
12/15/2015	Heavy Snow	Snow across the northland was preceded by freezing rain. The heaviest snow ranged from nine to fourteen inches.
11/10/2014	Heavy Snow	Widespread snowfall ranged from six to nine inches across northeast Minnesota.
4/16/2014	Heavy Snow	A winter storm system brought heavy snow to parts of northeast Minnesota. The heaviest snow amounts were generally between six and eight inches.
4/3/2014	Heavy Snow	Snowfall amounts generally ranged from six to eight inches.
3/27/2014	Heavy Snow	Heavy snow of six to twelve inches fell in a band from the east side of Mille Lacs Lake to the Twin Ports of Duluth/Superior.
3/17/2014	Heavy Snow	Heavy snow fell across a small part of the extreme southern part of Carlton County. Snowfall amounts ranged from eight to eleven inches.
2/20/2014	Heavy Snow	Snowfall ranged from about ten to fifteen inches across the county. Strong winds developed in the wake of the storm, with gusts of about 30 to 50 mph. This caused major blowing and drifting snow, and low visibility.
2/17/2014	Heavy Snow	Snowfall ranged from six to eight inches.

SOURCE: (NCEI, 2021)

5.6.2 PROBABILITY OF OCCURRENCE

To determine the probability of future winter-related storm events in Carlton County, records of previous events (blizzards, heavy snows, ice storms, winter storms, and winter weather) were summed and divided by the dataset's period of record, resulting in the annual relative frequency of winter-related storms. Based on records in the NCEI Storm Events Database through February 2020, the relative frequency of winter-related storm events in Carlton County is 4.5 per year. This relative frequency can be used to infer the probability of these events occurring in the future.

5.6.3 CLIMATE CHANGE PROJECTIONS

Historically, winter storms have had a large impact on public safety in Minnesota. This will continue, with a possible increase in annual total snowfall (MPCA, 2018c). Winter weather is often the cause of power outages. Pressures on energy use, reduced reliability of services, potential outages, and the potential rise in household costs for energy are major climate change risks to public health.

According to the 2015 Minnesota Weather Almanac, seasonal snowfall records across the state from 1890–2000 showed that 41 of 46 climate stations recorded an increase in average annual snowfall, by as much as 10 inches. Climate change is causing the atmosphere to hold more moisture, that drives heavier than normal precipitation. Higher snowfall levels can result in greater runoff potential during spring snowmelt, and many watersheds in Minnesota have shown more consistent measures of high-volume flows during spring, often at or above flood stage (Seeley, 2015).

5.6.4 VULNERABILITY

Transportation systems, electrical distribution systems, and structures are vulnerable to winter storms throughout the county. These events do not vary geographically within the county; all jurisdictions are equally vulnerable. While it is highly likely these events will continue occurring annually, the amount of snow and ice and number of winter-related storm events to occur each year are unpredictable. Citizens living in climates such as these must always be prepared for situations that put their lives or property at risk. It is important that extra consideration be given to the vulnerable populations and energy infrastructure discussed in section 4.3.

5.6.5 PROGRAM GAPS AND DEFICIENCIES

Carlton County Emergency Management identified several program gaps and deficiencies that make its citizens more vulnerable to severe winter storms. The following gaps and deficiencies should be addressed with new mitigation efforts to reduce that vulnerability:

Above-Ground Power Lines: A majority of the power lines in Carlton County are above ground and subject to damage from ice storms, wind, and falling tree limbs. Power lines that are above ground are susceptible to coming down during severe winter storm events, resulting in power outages.

Public Education: Carlton County Emergency Management and local cities need to continue to encourage all residents to be ready for long-term power outages or to be snowed in during dangerous winter events such as ice storms and blizzards.

Backup Power: Not all designated shelter facilities have generator back-up power to provide the ability to care for residents if displaced during a severe winter event coupled with an extended power outage.

Mapping of Snow Drifting Sites and New Living Snow Fences: The Carlton SWCD offers technical and financial assistance to private and public landowners of Carlton County to implement conservation practices. One conservation practice offered in this program is planting a living snow fence. The practice involves planting trees strategically in places of historic snow drifting. The SWCD has an old map of road drifting sites in the county. This map could be updated with information from snowplow drivers and more outreach to landowners at those sites conducted to implement the living snow fence conservation practice in priority areas.

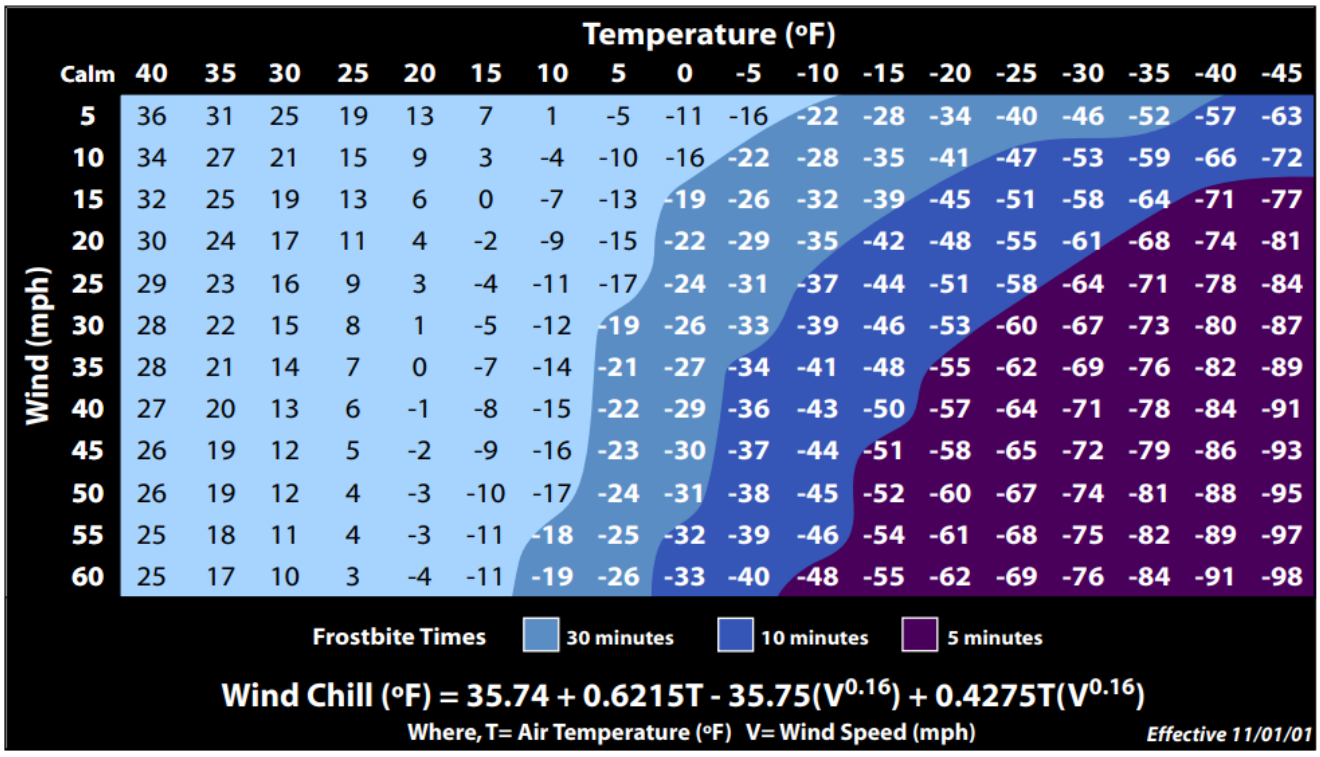
5.7 Extreme Cold

Due to Minnesota's position in the middle of the continent and subsequent climate, the state may experience extremely frigid temperatures in winter. Winter in Carlton County can be especially dangerous when low temperatures and wind create arctic-like wind chills.

Wind chill, defined as how cold people and animals feel when outside, is based on the rate of heat loss from exposed skin caused by wind and cold. As wind increases it draws heat from the body, driving down skin temperature and eventually the internal body temperature.

The National Weather Service (NWS) issues a wind chill warning when life-threatening wind chill values are expected or occurring. The criteria for issuing official wind chill warnings and advisories are set by the local weather forecasting office (WFO). The Duluth WFO (DLH) uses a wind chill warning criteria of −40 °F or colder to issue a wind chill warning and −25 °F and colder for a wind chill advisory in Carlton County (NWS, 2010). Figure 23 shows the relationship between temperature and wind speed to measure wind chill.

Figure 23. NWS wind chill temperature index



SOURCE: (NWS, 2010)

5.7.1 HISTORY

Extreme cold temperatures affect Carlton County nearly every year. January is the coldest month in the East Central Minnesota climate division, with an average monthly minimum temperature of 2.1 °F (Vose et al., 2021). Extreme cold data was compiled from the Midwestern Regional Climate Center (MRCC) using daily minimum temperature data from weather stations in Carlton County which have complete datasets (< 10% missing data), as well as cold-related events reported in the NCEI Storm Events Database. Extreme cold days in Carlton County were counted each day a station's daily minimum temperature reached −18 °F, a standard used by the National Weather Service to report cold weather events (2018).

There are two weather stations in the county currently reporting daily temperature. From January 1, 2014 through June 11, 2020, daily low temperatures ≤ −18 °F were recorded 86 times at the Cloquet station and 135 times at the Wright 3 E station (GHCN, 2020; NWS, 2020a; NWS COOP, 2020). Carlton County experiences an average of 13–21 extreme cold days each year. The lowest daily low temperature reported since January 2014 was −41 °F recorded by the Wright 3 E station on January 31, 2019. This date corresponds with the "Polar Vortex" of late January 2019 that affected most of the state. Strong winds and arctic air on the heels of a snowstorm brought bitter cold to Minnesota. Schools closed and postal mail service stopped statewide. The extreme cold also brought some natural gas shortages, power outages, and broken water mains.

The lowest temperature ever reported in Carlton County occurred on January 15, 1972 when temperatures plummeted to −53 °F at the Moose Lake 1 SSE station (GHCN, 2020; NWS, 2020a; NWS COOP, 2020).

Daily minimum temperatures mentioned above do not factor in wind chill. The NCEI Storm Events Database includes 13 cold/wind chill and 32 extreme cold/wind chill events affecting Carlton County since 1996 (NCEI, 2021). At least four people have died and at least one person was injured in Carlton County from these events.

Table 31 shows cold-related events in Carlton County as reported to the NCEI Storm Events Database since January 2014.

Table 31. Cold events in Carlton County, January 2014–August 2021

Date	Event Type	Description
2/15/2021	extreme cold / wind chill	The last night of the arctic outbreak was once again widespread, affecting almost all of the Northland. High pressure led to optimized radiational cooling conditions and the slight wind sent wind chills into dangerous criteria. Air temperatures dropped into the negative 30s and 40s with wind chills as low as −50 °F. This was the ninth and final night of an arctic outbreak across the region that lasted over a week.
2/14/2021	extreme cold / wind chill	The entirety of the Northland saw extreme wind chills and air temperatures in the negative 30s and 40s. This was the eighth night of an arctic outbreak across the region that lasted over a week.
2/12/2021	extreme cold / wind chill	An upper-level low pulled reinforcing arctic air into the Northland. Air temperatures dropped into the negative 20s and 30s once again wind chills as low as −44 °F. This was the sixth night of an arctic outbreak across the region that lasted over a week.
2/6/2021	extreme cold / wind chill	An arctic air mass brought air temperatures in the negative 20s to 30s. They were observed with light winds that led to wind chills as low as −50 °F. This was the first night of an extended cold outbreak across the region that lasted over a week.
2/13/2020	extreme cold / wind chill	An influx of very cold air and building high pressure led to a very cold morning. Light winds overnight resulted in wind chills of −40 °F to −50 °F.

Date	Event Type	Description
1/29/2019	extreme cold / wind chill	Heading into the last few days of January, a historically cold air mass settled over the region. This led to a prolonged period of sub-zero temperatures and dangerously cold wind chills. The coldest temperatures were seen January 30th into the 31st and record lows were reached during that time. Wind chills during this stretch remained in the −30s and −40s with numerous locations reaching −50 °F.
1/27/2019	extreme cold / wind chill	This was day three of a prolonged cold period. Temperatures were in the −20s and −30s. Winds were able to remain light through the night leading to wind chills of −40 °F to −50 °F in many areas.
2/4/2018	extreme cold / wind chill	Cold arctic air descended overnight with wind chills in the −40 °F range. A wind chill value of −40 °F was measured at Duluth International Airport.
1/12/2018	extreme cold / wind chill	Overnight wind chills were near or below −40 °F across northern Minnesota. Wind chill measured −41 °F at Duluth International Airport.
1/5/2018	extreme cold / wind chill	Overnight temperatures dropped into the −20s and −30s with wind chills of −30 °F to −40 °F. Daytime highs barely made it above zero for many areas. The coldest mornings were on the 4th and 5th. The Duluth International Airport measured a peak wind chill of −42 °F.
12/25/2017	extreme cold / wind chill	Cold arctic air descended upon the region leading to dangerously cold wind chills. Wind chills on Christmas morning were in the −40s. The morning of the 27th was the coldest with wind chills nearing −50 °F.
12/16/2017	cold / wind chill	A man and his dog were found deceased in a cabin in the Saginaw area. Authorities determined that the cause of death was carbon monoxide poisoning from a generator running inside the cabin.
10/28/2017	extreme cold / wind chill	To the north of Carlton County, police responded to a report of an unresponsive male near downtown Duluth with preliminary autopsy results having exposure as cause of death. Temperatures were in the 20s that day.
1/16/2016	extreme cold / wind chill	The Northland was subjected to its first Arctic cold outbreak during the middle of January. The coldest period occurred late Saturday, January 16th, into the morning of January 17th when wind chills ranged from −40 °F to −50 °F.
2/23/2015	extreme cold / wind chill	Wind chills of around −40 °F developed over northern Minnesota late February 22nd into the morning of February 23rd.
2/22/2015	extreme cold / wind chill	Wind chills of −40 °F to −50 °F developed over northeast Minnesota late February 21st into the morning of February 22nd.
1/6/2015	extreme cold / wind chill	Northwest winds of 10 to 15 mph and temperatures of −15 °F to −30 °F resulted in widespread wind chills of −35 °F to −45 °F.
1/5/2015	extreme cold / wind chill	Temperatures plummeted to about −15 °F to −30 °F. The combination of 5 to 15 mph winds resulted in widespread wind chills of −35 °F to −50 °F.
3/1/2014	extreme cold / wind chill	Winds Chills fell to dangerous levels of −40 °F to −50 °F. The lowest wind chill at the Duluth International Airport was −47 °F.
2/27/2014	extreme cold / wind chill	Dangerous wind chills of −35 °F to −50 °F developed across northeast Minnesota early February 27th.
1/27/2014	extreme cold / wind chill	The combination of Arctic air and winds up to 15 mph (higher in some areas) resulted in a prolonged period of dangerously cold wind chill temperatures of −40 °F to −60 °F across northeast Minnesota.

Date	Event Type	Description
1/22/2014	extreme cold / wind chill	The combination of wind and cold temperatures resulted in a period of widespread dangerously cold wind chills around −40 °F to −45 °F across much of northeast Minnesota.
1/8/2014	extreme cold / wind chill	Arctic air resulted in dangerously cold wind chills of about −35 °F to −45 °F across parts of northeast Minnesota.
1/4/2014	extreme cold / wind chill	Bitterly cold Arctic air resulted in a prolonged period of very dangerous wind chills of −40 °F to −60 °F across northeast Minnesota.
1/2/2014	cold / wind chill	Dangerously cold wind chills of −40 °F to −50 °F developed across parts of northeast Minnesota.
1/1/2014	extreme cold / wind chill	Dangerously cold wind chills of −35 °F to −45 °F developed over parts of northeast Minnesota early on January 1st.

SOURCE: (NCEI, 2021)

5.7.2 PROBABILITY OF OCCURRENCE

To determine the probability of future cold-related events in Carlton County, records of previous cold/wind chill and extreme cold/wind chill events were summed and divided by the dataset's period of record, resulting in the annual relative frequency. Based on records in the NCEI Storm Events Database from January 2014 to August 2021, the relative frequency of cold-related events in Carlton County is 3.3 per year. This relative frequency can be used to infer the probability of these events occurring in the future.

5.7.3 CLIMATE CHANGE PROJECTIONS

Although climate research indicates that Minnesota's average winter lows are rising rapidly and our coldest days of winter are now warmer than we have ever recorded (MN DNR, 2020a) cold temperatures have always been a part of Minnesota's climate and extreme cold events will continue. An increase in extreme precipitation or storm events such as ice storms as the climate changes could lead to a higher risk of residents being exposed to cold temperatures during power outages or other storm-related hazards during extreme cold.

5.7.4 VULNERABILITY

The risk of extreme cold does not vary geographically within the county. Citizens living in climates such as these must always be prepared for situations that put their lives or property at risk. The youngest and more elderly citizens, homeless persons, individuals with chronic medical conditions, and those who are working or recreating outdoors are most at risk for frostbite and hypothermia (MDH, 2021b)

It is not always the depth of the cold that poses a threat but rather unpreparedness for the cold, such as an individual with a vehicle breakdown who lacks a personal winter safety kit in the vehicle. The cost of propane can make rural citizens more vulnerable to issues with extreme cold. A propane shortage and resulting crisis, such as that which occurred in 2014, may increase the cost of heating homes and farms to a prohibitive amount (Eaton, 2014). The Minnesota Department of Commerce presents options and suggestions for homeowners who use propane on their website: https://mn.gov/commerce/consumers/tips-tools/propane/

The CDC publication "Extreme Cold: A Prevention Guide to Promote Your Personal Health and Safety" outlines preparation measures that individuals can take to reduce their vulnerability to extreme cold. Highlights in this document include advice about travel preparations, securing your home water supply, and safety during recreation (CDC, 2021).

5.7.5 PROGRAM GAPS AND DEFICIENCIES

Carlton County Emergency Management identified several program gaps and deficiencies that make its citizens more vulnerable to extreme cold. The following gaps and deficiencies should be addressed with new mitigation efforts to reduce that vulnerability:

Public Education: Continued outreach should occur to encourage residents and long-term care facilities to be ready with generator backup power *in the event of a power outage from a severe winter storm coupled with extreme temperatures*.

Generators for Backup Power to Shelter Facilities: Not all designated shelter facilities have generator back-up power to provide heat if there is a loss of power during an extreme cold event.

5.8 Landslides

Erosion is the wearing away of land, such as the loss of a riverbank, beach, shoreline, or dune material. It is measured as the rate of change in the position or displacement of a riverbank or shoreline over a period of time. Short-term erosion typically results from periodic natural events, such as flooding, hurricanes, storm surges and windstorms, but may be intensified by human activities. Long-term erosion is a result of multi-year impacts such as repetitive flooding, wave action, sea level rise, sediment loss, subsidence, and climate change. Death and injury are not typically associated with erosion; however, major incidents of erosion, such as landslides, can destroy buildings and infrastructure (FEMA, 2013b).

The movement of a mass of rock, debris, or earth down a slope by the force of gravity is considered a landslide. They occur when the slope or soil stability changes from stable to unstable, which may be caused by earthquakes, storms, erosion, fire, or additional human-induced activities. Slopes greater than 10 degrees are more likely to slide, as are slopes where the height from the top of the slope to its toe is greater than 40 feet. Slopes are also more likely to fail if vegetative cover is low and/or soil water content is high. Potential impacts of a landslide include environmental disturbance, property and infrastructure damage, and injuries or fatalities (USGS, 2021a).

Slope materials that become saturated with water may develop a debris flow or mud flow. The resulting slurry of rock and mud may pick up trees, houses, and cars, thus blocking bridges and tributaries causing flooding along its path (USGS, 2021a).

Landslides and mudslides often occur together with other major natural disasters, thereby exacerbating relief and reconstruction efforts. Wildfires may remove vegetation from hillsides, significantly increasing runoff and landslide potential. Floods and landslides are closely related, and both involve precipitation, runoff, and ground saturation that may be the result of severe thunderstorms; however, landslides also take place over time and often take place when no natural disaster is evident.

5.8.1 HISTORY

The most significant reports of landslides impacting Carlton County occurred in June of 2014 when heavy rains caused flooding and landslides, resulting in multiple road closures and the destruction of a house near Henderson, MN (Linehan, 2014).

Other than this incident, there are no other reported issues resulting in slope failure or landslides occurring in the county since its last Hazard Mitigation Plan in 2014.

Given the lack of data on landslide incidents in Minnesota, the locations of Best Management Practices (BMPs) reported to the MN Board of Soil and Water Resources (BWSR) were used to identify areas in the State which may be more susceptible to landslides. BMPs are ways to manage land and activities to protect water quality and promote soil conservation, they can be a structural "thing" or part of a process. The BWSR identifies five BMPs which may be implemented to mitigate against erosion and slope failure issues that may result in landslide. Descriptions of these BMPs and the number of them installed in Carlton County are in Table 32.

While BMPs are spread throughout Carlton County, a greater concentration of BMPs is in the region around Volney Lake.

The lack of landslide data in Minnesota has prompted researchers from eight colleges and universities across Minnesota to examine the prevalence of landslides across the state and compile an inventory of geological activity. By summer 2021, this research will produce tools and data for mitigation and restoration including a landslide inventory and landslide susceptibility map (Gran, 2016).

Table 32. Best Management Practices (BMP) affiliated with erosion, slope failure, and landslides

Practice Name	Code	Description	Count in County
Grade Stabilization Structure	410	A structure used to control the grade and head cutting in natural or artificial channels. Includes side-inlet controls for existing drainage ditches and/or streams.	8
Streambank and Shoreline Protection	580	Treatment(s) used to stabilize and protect banks of streams or constructed channels, and shorelines of lakes, reservoirs, or estuaries.	9
Stream Channel Stabilization	584	Measures used to stabilize the bed or bottom of a channel.	1
Water and Sediment Control Basin	638	An earth embankment, or combination ridge and channel, generally constructed across the slope and minor watercourses to form a sediment trap and water detention basin.	73

SOURCE: (MN BWSR, 2021)

5.8.2 PROBABILITY OF OCCURRENCE

In January 2018, a study was conducted in Carlton and Sibley County to determine areas susceptible to slope failure. Using physics-based concepts and state-wide data, researchers created a GIS-based model

and produced maps where slopes were identified and ranked one of five levels based on slope-failure susceptibility.

The lack of landslide data makes it is difficult to determine the probability of future landslides in Carlton County by reviewing historic incidents. The USGS conducted an analysis for potential landslide of the conterminous US, and while highly generalized and not intended to be used for local planning, still provides a general overview of landslide potential. The delineation process of this research is based on geologic formations of the US which were classified as having high, medium, or low landslide incidence; and being of high, medium, or low susceptibility to landslides (Radbruch-Hall et al., 1982). The research found that the area in Carlton County most susceptible to landslides is along the Minnesota River Valley, being moderately susceptible to landslides and having a low count of incidents.

In addition to reviewing the USGS study the locations of installed BMPs affiliated with erosion and slope failure can be an indicator as to where these issues have happened in the past and may continue being an issue in the future. We can infer from available data that the probability of destructive landslides occurring in susceptible areas in the county is low to moderate.

5.8.3 CLIMATE CHANGE PROJECTIONS

The increased magnitude and frequency of flooding events and storm activity that may result from climate change may in turn increase the risk of soil erosion and landslides. According to University of Washington geologist Dave Montgomery, “If the climate changes in a way that we get a lot more rainfall you would expect to see a lot more landslides” (Phillips, 2014).

In Minnesota, the wettest days are getting wetter. This can contribute to increased erosion in many locations due to flooding and saturation of soils. Reduced ice cover on lakes and shorelines (due to warmer temperatures) could potentially expose shorelines to increased erosion or damage during weather events when they previously may have been covered with ice (Pryor et al., 2014).

According to the 2014 National Climate Assessment, “Increased precipitation intensity also increases erosion, damaging ecosystems and increasing delivery of sediment and subsequent loss of reservoir storage capacity” (Pryor et al., 2014).

5.8.4 VULNERABILITY

Properties, structures, and individuals located in areas susceptible to slope failure are vulnerable to landslides. Radbruch-Hall’s study determined the area along the Minnesota River is at a higher risk of landslide than other areas (1982), so special attention should be given to townships and cities along the Minnesota River, as well as the northwestern portion of Sharon and Cleveland Townships.

The locations of BMPs installed to counter erosion and slope failure issues can also be considered when trying to identify areas of the county more vulnerable to landslides. Nearly half of the BMPs in the county have been implemented in Blackhoof Township and another 17% in Eagle Township, clustered around Eagle and Island Lake.

The parcels in the county on which BMPs were installed are classified as various types of residential land; vacant rural land; managed forest lands; church property; state forest, park and wildlife refuges; and

agricultural. Structures on these parcels may be more vulnerable to issues of erosion and landslides given the nature of the BMPs installed on the properties.

5.8.5 PROGRAM GAPS AND DEFICIENCIES

Carlton County Emergency Management identified several program gaps and deficiencies that make its citizens more vulnerable to landslides. The following gaps and deficiencies should be addressed with new mitigation efforts to reduce that vulnerability:

Landowner Impacts: Due to the clay soils and steep slopes prevalent throughout the lower St. Louis and Nemadji River watersheds, land slumping and slides are a natural issue exacerbated by human impacts (i.e., individual septic systems, storm water runoff management, land use activities). The Carlton County SWCD has programs for landowners to access technical and financial assistance to address these issues. Same funding limitations apply.

5.9 Dam & Levee Failure

A dam is a structure built across a stream or river to retain water for the purpose of storage or control. The difference in elevation between the water at the top and bottom of a dam creates large amounts of potential energy, allowing the chance for failure. Dam failures are typically not caused by storm events. In the U.S., 36% of dam failures are due to mechanical reasons (malfunctioning gates, conduits, or values); 34% are from hydraulic failures (overtopping due to inadequate spillway design, debris blockage, or the settlement of the dam crest), and 30% are caused by structural failures (foundation defects from settlement and slope instability) (FEMA, 2013c).

A levee is a structure, typically made from embankments of dirt, built along the edges of rivers and streams to contain, control, or divert the flow of water to prevent flooding of the adjacent land (Lotha et al., 2019). Common causes for levees failing include foundation failure, surface erosion, or overtopping (USACE, 2010). Both dam and levee failures can be devastating, resulting in loss of human life, downstream property damage, lifeline disruption (transportation routes and utility lines required to maintain or protect life), and environmental damage. Dams and levees require constant monitoring and regular maintenance to ensure their integrity.

Dam & Levee Regulation: There are over 1,150 dams in Minnesota (MN DNR, 2020b). Dam regulatory authorities vary between state and federal agencies based mainly on the ownership of the dam.

The MN DNR Dam Safety Program has the mission of protecting the life and safety of people by ensuring that dams are safe. Minnesota's Dam Safety Program sets minimum standards for dams and regulates the design, construction, operation, repair, and removal of both privately and publicly (non-federal) owned dams (MN DNR, 2020b). The federal government is responsible for regulating and maintaining dam safety of federally owned dams. No single agency regulates all federally owned dams. 42% of federal dams are owned and managed by the U.S. Army Corp of Engineers (USACE) and the Bureau of Reclamation. The remaining federal dams are owned and managed by other federal agencies, including the Fish and Wildlife Service, Forest Service, the Department of Defense, and the Bureau of Indiana Affairs, among others (Normand, 2019).The Federal Energy Regulatory Commission (FERC) Dam Safety Program is the largest dam safety program in the U.S. The Commission works with federal and state

agencies to ensure and promote dam safety of over 3,000 dams across the U.S. The Commission inspects projects on an unscheduled basis to investigate potential dam safety problems; complaints about constructing and operating a project; safety concerns related to natural disasters; and issues concerning compliance with the term and conditions of a license (FERC, 2020).

Similar to dams, levees in Minnesota are regulated by various federal, state, and local entities that own the levee. While the USACE has designed and built many of the levees in the U.S., the USACE is only responsible for the maintenance of federally owned levees in the USACE system.

Dam & Levee Inventory: There are 21 dams and no levees in Carlton County. Table 33 provides the properties of each dam.

Table 33. Dams in Carlton County

Dam Name	Owner	Waterway	Type	Height (ft)	Length (ft)	Purpose	Rating	Condition
Langhorst Pond	Langhorst, Alvin	Portage River-TR	Earth	8’	No Data	Other	Class III	Satisfactory
Ninefeldt Pool	Ninefeldt, Ernest	Moose Horn River W Branch	Earth	9’	261’	Other	Class III	Satisfactory
Elim Creek	SWCD of Carlton County	Elim Creek	Earth	7’	430’	Flood Control	Class III	Fair
Sawyer Pool	MNDNR-Wildlife	Bob Lake - TR	Earth	43’	250’	Other	Class III	Satisfactory
Cloquet	Sappi Fine Paper	St. Louis River	Concrete, Gravity	10’	No Data	Hydroelectric	Class III	Not Rated
Thomson	Allete, Inc.	St. Louis River	No Data	47’	369’	Hydroelectric	Class I	Not Rated
Scanlon	Allete, Inc.	St. Louis River	No Data	No Data	No Data	Hydroelectric	Class III	Not Rated
Knife Falls	Allete, Inc.	St. Louis River	No Data	No Data	No Data	Hydroelectric	Class III	Not Rated
Park Lake	County of Carlton	Park Lake Creek	Earth	No Data	No Data	Other	Class III	Poor
Moehrke SCS	Moehrke, Douglas	Deer Creek - TR	Earth	7’	40’	Fire Protection, Stock, or Small Fish Pond	Class III	Poor
Rice Portage Lake	Fond du Lac Band of Lake Superior Chippewa	Stoney Brook	No Data	21’	350’	Other	Class III	Satisfactory
Hanson	Schneider, James	Skunk Creek	Earth	8’	No Data	Flood Control	Class III	Satisfactory
Mader Pond	Mader, Hermon	Net River-TR	Earth	19’	830’	Other	Class III	Fair
Moose Lake State Park	MNDNR-Parks	Moose Horn River-OS	Earth	22’	392’	Fish and Wildlife Pond	Class III	Poor
Coffee Lake	County of Carlton Hwy Dept	Moose River	Concrete, Gravity	10’	400’	Recreation	Class III	Satisfactory
Perch Lake	Fond du Lac Reservation(BIA)	Stoney Brook-TR	No Data	10’	4’	Fish and Wildlife Pond	Class III	Satisfactory
Blackhoof 34	Lund, Dale	Blackhoof River	No Data	7’	No Data	No Data	No Data	Fair
Sterle Pool	MNDNR-Wildlife	Moose Horn River-TR	Concrete, Earth	No Data	No Data	Fish and Wildlife Pond	No Data	Satisfactory
Holyoke 5	Scavina, Michael & Glenda	Skunk Creek	No Data	7’	No Data	Flood Control	No Data	Not Rated

Dam Name	Owner	Waterway	Type	Height (ft)	Length (ft)	Purpose	Rating	Condition
Upper Deadfish Impoundment	Fond du Lac Band of Lake Superior Chippewa	No Data	No Data	No Data	No Data	No Data	No Data	Not Rated
Deadfish Lake	Fond du Lac Band of Lake Superior Chippewa	No Data	No Data	10’	No Data	No Data	No Data	Not Rated
Fond du Lac	Allete, Inc.	St. Louis River	Gravity, Earth, Arch	80’	1475’	Hydroelectric	Class I	Not Rated

SOURCES: (MN DNR, 2014; USACE, 2021)

5.9.1 HISTORY

According to the State Dam Safety Engineer at the MN DNR, dam failures have only occurred at one dam in the county, the Elim Creek Dam.

The Elim Creek Dam had massive slope failures in July of 1977. Failures in both the upstream and downstream embankments occurred immediately after the dam was constructed. It was later found that the earth fill had been placed much too wet to be stable. The dam has since been rebuilt.

Thomson Dam is the largest dam in Carlton County and is very near the City of Carlton. Overtopping of this dam did occur in the summer 2012 floods, but the dam did not fail. The intensity of the 2012 rain event caused a failure of the Forebay canal wall, which caused significant damage (Boyle, Jason (MN Dam Safety Engineer), personal communication, October 22, 2019).

5.9.2 PROBABILITY OF OCCURRENCE

To determine the probability of future dam failures in Carlton County, records of previous failures and the period in which they occurred were examined. There MN DNR has one record of dam failure occurring in the county; therefore, the relative frequency of these events is 0 per year. This relative frequency can be used to infer that the probability of dam failures occurring in the future is very low.

5.9.3 CLIMATE CHANGE PROJECTIONS

Dams are designed based on assumptions about a river’s annual flow behavior that will determine the volume of water behind the dam and flowing through the dam at any one time. Changes in weather patterns due to climate change may change the expected flow pattern, and indirectly increase the likelihood of dam failures. It is conceivable that bigger rainfalls at earlier times in the year could threaten a dam’s designed margin of safety, causing dam operators to release greater volumes of water earlier in a storm cycle in order to maintain the required margins of safety. Such early releases of increased volumes can increase flood potential downstream.

Minnesota had a dam failure due to a large storm event in June 2012. The Forebay Canal in Carlton County had operated as designed for nearly 100 years. The intensity of the 2012 rain event caused a failure of the canal wall, which caused significant damage. Climate change is adding a new level of uncertainty that needs to be considered with respect to assumptions made during dam construction.

5.9.4 VULNERABILITY

Although dam regulatory authorities differ between various federal and state agencies, all authorities attempt to classify dams according to the potential impacts from a dam failure or mis-operation. In response to the numerous classification systems, FEMA's Interagency Committee on Dam Safety created a downstream hazard potential classification system that is adaptable to any agency's current system. Table 34 provides an overview of the main criteria agencies consider when determining a dam's downstream hazard potential. This classification system does not imply that the dam is unsafe, but rather categorizes dams based on the probable loss of human life and the impacts on economic, environmental, and lifeline interests (FEMA, 2004b).

Table 34. Downstream Hazard Potential Classification Criteria

Hazard Potential Classification	Loss of Human Life	Economic, Environmental, Lifeline Losses
Class III (Low)	None expected	Low and generally limited to owner
Class II (Significant)	None expected	Yes
Class I (High)	Probable - one or more expected	Yes (but not necessary for this classification)

SOURCE: (USACE, 2008)

Dams for which a hazard potential has not been designated, or is not provided, are classified as "Undetermined."

An Emergency Action Plan (EAP) is a document which identifies potential emergency conditions at a dam and specifies preplanned actions to be followed during a dam failure to minimize property damage or loss of life. An EAP is required for Class I dams and strongly recommended for Class II dams (MN DNR, 2020b).

Thirteen of the dams in Carlton County are a Class III (low hazard potential), four are Class II (significant hazard potential), and no hazard information is available for the other five dams. The two Class I dams have an Emergency Action Plan (EAP). The descriptions of the vulnerable structures and populations for the Class II Thomson Dam and Fond du Lac dam is described below. These descriptions are taken directly from the dam's EAPs (David L. Aspie, Principal Engineer/Dam Safety Engineer, Minnesota Power, personal communication, October 20, 2020).

Thomson Dam (sections 1, 2A, 2B, 3, 5½, 6, 9, 11, 12 and Canal):

> *A series of dams are used to form the Thomson Reservoir, several of which are classified as having a high hazard potential. The reservoir supplies the Thomson Canal as it conveys water to the powerhouse for hydroelectric generation.*
> *The potential inundation areas for the high hazard structures includes one residence on Almar Drive and the WLSSD Carlton pump station downstream of Dam 1; the Thomson neighborhood (City of Carlton), particularly along Vermilion Street, Falls Avenue and Dalles Avenue, along with the WLSSD Thomson pump station downstream of Dams 5½, 6, 9 and 11; and one or two recreation trails within Jay Cooke State Park downstream of the Canal dam.*
> *Water released from Dams 2A and 2B would flow into Slaughterhouse Creek, which then flows into the St. Louis River, and no structures are affected. Dam 3 is along the natural course of the*

St. Louis River and water is released directly back into the river channel. The State Highway 210 bridge just downstream of Dam 3 might be affected in an extreme flood (note that the road was heavily damaged in the 2012 flood, but subsequently was rebuilt with increased capacity for safely passing flood waters). Water released from Dam 12 flows directly into the Canal and no structures are affected.

Fond du Lac Dam:

The Fond du Lac dam straddles the boundary between Carlton and St. Louis Counties. The potential inundation area includes neighborhoods within the City of Duluth (St. Louis County, Minnesota) and the Town of Superior (Douglas County, Wisconsin). The State Highway 23 bridge might be affected in an extreme flood (note that it was not damaged in the 2012 flood). There are no structures in Carlton County that might be affected.

In addition to dams being classified by their hazard potential, the physical condition of dams is inspected and given a condition ranking. The condition of a dam is categorized into one of the following classifications:

Satisfactory: No existing or potential dam safety deficiencies are recognized. Acceptable performance is expected under all loading conditions (static, hydrologic, seismic) in accordance with the applicable regulatory criteria or tolerable risk guidelines.

Fair: No existing dam safety deficiencies are recognized for normal loading conditions. Rare or extreme hydrologic and/or seismic events may result in a dam safety deficiency. Risk may be in the range to take further action.

Poor: A dam safety deficiency is recognized for loading conditions which may realistically occur. Remedial action is necessary. "Poor" may also be used when uncertainties exist as to critical analysis parameters which identify a potential dam safety deficiency. Further investigations and studies are necessary.

Unsatisfactory: A dam safety deficiency is recognized that requires immediate or emergency remedial action for problem resolution.

Not Rated: The dam has not been inspected, is not under state jurisdiction, or has been inspected but, for whatever reason, has not been rated. (USACE, 2008)

Dams in "Poor" or "Unsatisfactory" conditions may be more vulnerable to failure and pose a greater threat to the surrounding community and infrastructure. Three of the dams of those who were rated in Carlton County have been rated as "Poor." See Figure 24 for a map of dams in the county and their condition.

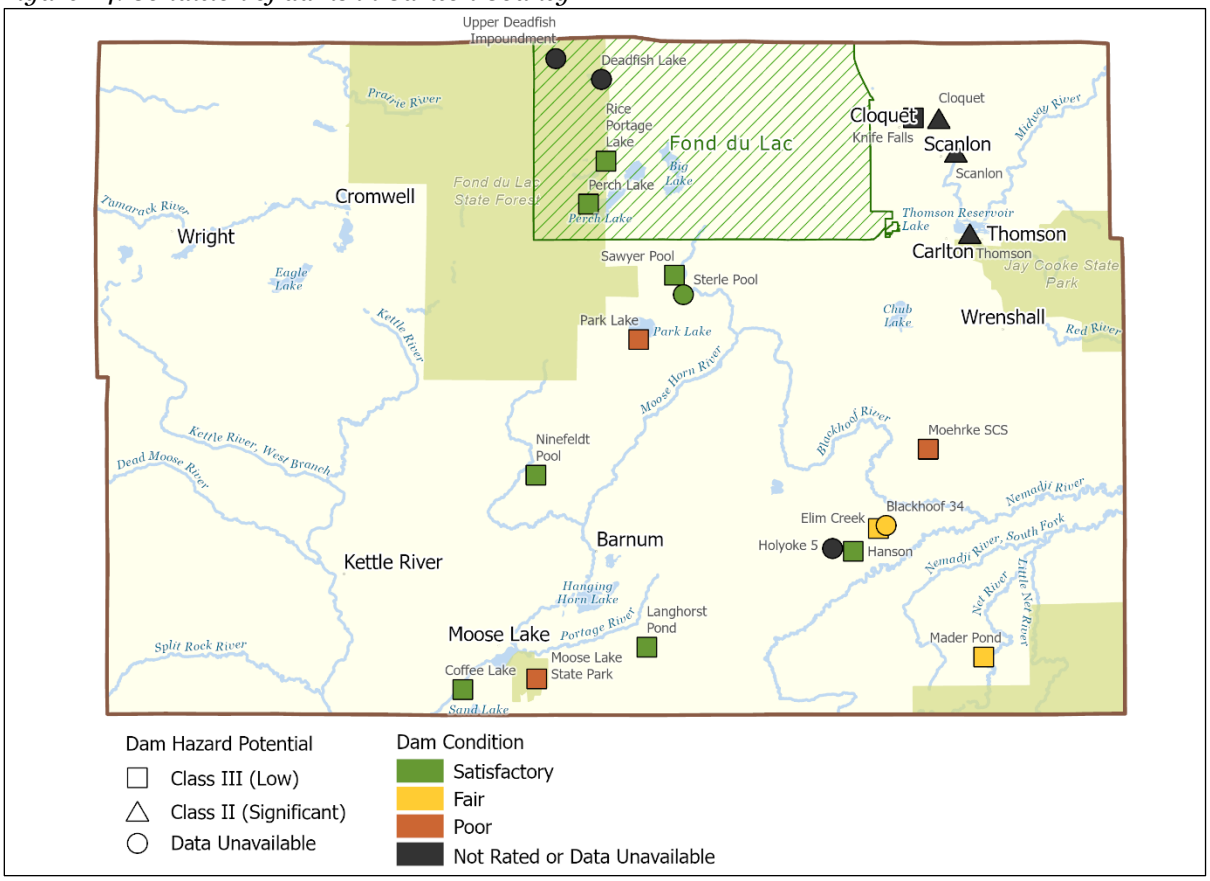
Minnesota Power has maintenance responsibilities for the Thomson, Fond du Lac, Scanlon, and Knife Falls dams. There are no current concerns for mitigation as all are deemed to be in fair condition. Annual maintenance is conducted by MN Power at each site to ensure the dams are in good working order.

5.9.5 PROGRAM GAPS AND DEFICIENCIES

Carlton County Emergency Management identified several program gaps and deficiencies that make its citizens more vulnerable to more vulnerable to dam failure. The following gaps and deficiencies should be addressed with new mitigation efforts to reduce that vulnerability:

Dam Maintenance: The Carlton SWCD has maintenance responsibilities for two Class III, low hazard dams (Elim Creek Dam and Hanson Dam), both located on private property in the Skunk Creek sub-watershed of the Nemadji River watershed. Both dams were put in in the 1970s and have exceeded their design life expectancy. Although both low head dams are on private land, the SWCD is responsible for maintaining them according to the maintenance agreements that were signed in the 1970s. The land is still owned by private citizens, and to do any work on the property, they have to agree. The SWCD continues an annual maintenance review at these two sites at the invitation of the landowners. Both structures have been requested to be added to the MN DNR dam removal program list.

Figure 24. Condition of dams in Carlton County



SOURCE: (USACE, 2021)

Section 6 – Mitigation Strategy

The goal of mitigation is to protect lives and reduce the impacts of future hazard events including property damage, disruption to local and regional economies, the amount of public and private funds spent to assist with recovery, and to build disaster-resistant communities. Mitigation actions and projects should be based on a well-constructed risk assessment, provided in Section 5 of this plan. Mitigation should be an ongoing process adapting over time to accommodate a community's needs.

6.1 Community Capability Assessments

The capability assessment identifies current activities and existing planning tools used to mitigate hazards. The capability assessment identifies the policies, regulations, procedures, programs and projects that contribute to the lessening of disaster damages. The assessment also provides an evaluation of these capabilities to determine whether the activities can be improved in order to more effectively reduce the impact of future hazard events. The following sections identify existing plans and mitigation capabilities within all of the communities:

- Appendix D: Lists the plans and programs in place in Carlton County as related to hazard mitigation.
- Appendix C: As part of the Carlton County MHMP update, the county and city governments were asked to participate in filling out a "Local Mitigation Survey" (LMS) form to report on their current mitigation capabilities and program gaps. Appendix C provides the LMS reports gathered for Carlton County.

Information from the capability assessments was used to support development of local mitigation actions for implementation over the next five years (see column *Comments on Implementation & Integration).*

6.1.1 NATIONAL FLOOD INSURANCE PROGRAM (NFIP)

The NFIP is a federal program created by Congress to mitigate future flood losses nationwide through sound, community-enforced building and zoning ordinances and to provide access to affordable, federally backed flood insurance protection for property owners. The NFIP is designed to provide an insurance alternative to disaster assistance to meet the escalating costs of repairing damage to buildings and their contents caused by floods. Participation in the NFIP is based on an agreement between local communities and the federal government that states that if a community will adopt and enforce a floodplain management ordinance to reduce future flood risks to new construction in Special Flood Hazard Areas (SFHAs), the federal government will make flood insurance available within the community as a financial protection against flood losses.

Table 35 below lists and describes jurisdictional participation in the National Flood Insurance Program (NFIP).

Table 35. NFIP participation in Carlton County

Community Name	Participation in the NFIP	FEMA Map	Description of Participation
Carlton County	Participating	FEMA-mapped high-risk areas	Carlton County Zoning & Environmental Services Department maintains floodplain maps and the floodplain management ordinance for the rural areas of Carlton County (includes all areas of Carlton County except the following cities and townships: City of Barnum, City of Carlton, City of Cloquet, City of Cromwell, City of Kettle River, City of Moose Lake, City of Scanlon, Thomson Township, City of Wrenshall and City of Wright. Carlton County also has zoning authority in shoreland areas (property within 1,000 feet of a lake or 300 feet of a river or stream) in the City of Cromwell and Thomson Township). Carlton County Zoning Ordinance No. 27 includes Subd. G, Floodplain Management District which establishes restrictions and requirements for any development within Special Flood Hazard Areas.
Barnum	Participating	FEMA-mapped high-risk areas	The City of Barnum adopted a Floodplain Ordinance on 5/14/1990 and continues to enforce it in order to restrict development in high-risk flood areas.
Carlton	Participating	NO FEMA-mapped high-risk areas	The City of Carlton is working with FEMA to update our flood map. City Code Chapter 10 Flood Ordinances addresses development in Special Flood Hazard Areas.
Cloquet	Participating	FEMA-mapped high-risk areas	The City of Cloquet's Planning and Zoning Department maintains the floodplain maps and floodplain management ordinance for the city. Chapter 17.5.18 of the city Code, Floodplain Regulations establishes restrictions and requirements for any development within Special Flood Hazard Areas.
Cromwell	Participating	NO FEMA-mapped high-risk areas	The City of Cromwell has No Special Flood Hazard Area mapped and does not have a specific floodplain ordinance. With regard to all permits and regulation of buildings, improvements and structures to be located within one thousand feet (1000') of a lake or waterway, such applications will be handled first by Carlton County Planning and Zoning consistent with the Carlton County Zoning Code. Upon approval by the Carlton County Planning and Zoning office such matters will then be reviewed for final action by the City.
Kettle River	Not participating	NO FEMA-mapped high-risk areas	The city does not have a FEMA map and is not participating.
Moose Lake	Participating	FEMA-mapped high-risk areas	The City of Moose Lake enforces Floodplain provisions in article 15 of Ordinance 104, which was passed on May 11, 2011.
Scanlon	Participating	FEMA-mapped	The City of Scanlon has established a Floodplain Ordinance 160 interpreting the boundaries of the floodplain as indicated by

Community Name	Participation in the NFIP	FEMA Map	Description of Participation
		high-risk areas	the Flood Hazard Boundary Map developed by the Federal Emergency Management Agency.
Wrenshall	Not participating	NO FEMA-mapped high-risk areas	The city does not have a FEMA map and is not participating.
Wright	Not participating	FEMA-mapped high-risk areas	The city has a FEMA map and is not participating (considered "sanctioned" by FEMA) According to flood analysis, using FEMA mapped flood areas, there are no structures in the 1% annual chance flood plain to insure (verified with air photos). The mapping was done in 1974 and has not been updated.
Fond du Lac Reservation	Not participating		

SOURCE: (CEIL STRAUSS, MN FLOODPLAIN MANAGER, PERSONAL COMMUNICATION, APRIL 6, 2020)

Repetitive loss properties are defined as properties that have had two or more flood insurance claims of $1,000 or more in any rolling 10-year period. Property owners are asked to consider mitigation activities such as acquisition, relocation, or elevation, among other options. FEMA's Repetitive Loss (RL) properties strategy is to eliminate or reduce the damage to property and the disruption to life caused by repeated flooding of the same properties. Property owners are notified of their status by FEMA.

Carlton County has one RL property and a total of two losses. The property is a single-family residence in Moose Lake. Payments have totaled $41,651 as of February 2022. There are no severe repetitive loss properties (SRL) in Carlton County.

For more on the areas that flood repeatedly in Carlton County, see Section 5.1.

6.1.2 PLANS AND ORDINANCES

Carlton County and its incorporated communities have a number of plans and ordinances in place to ensure the safety of residents and the effective operation of communities including a Zoning Ordinance, Floodplain Ordinance, Emergency Operations Plan, and Wellhead Protection Plan.

6.1.3 PLANS AND PROGRAMS IN PLACE TO ADDRESS NATURAL HAZARDS

Carlton County has numerous plans and programs in place to address natural hazards. Some of these programs are specific to a hazard and others address impacts and human safety for many types of events ("All Hazards"). For the purpose of grouping related natural hazards, "Summer Storms" encompasses Tornadoes, Windstorms, Lightning and Hail. Following is a description of the plans and programs in place by Carlton County to support mitigation for the hazards addressed in this plan.

All Hazards

All-Hazards Emergency Operations Plan: Carlton County Emergency Management maintains an all-hazards Emergency Operations Plan which details key emergency management functions (i.e., Public Information and Warning, Evacuation, Mass Care Sheltering, etc.) that may be necessary in advance of, during and following hazard events that pose risk to life safety. This includes events such as severe summer and winter storms, tornadoes, extreme temperatures, flooding, and wildfire.

Public Warning and Emergency Notification: In the event of emergencies or hazardous conditions that require timely and targeted communication to the public, Carlton County utilizes the Everbridge emergency notification system which users must sign up for ("opt-in service"). Carlton County also has IPAWS (Integrated Public Alert Warning System) which allows for both targeted and county-wide emergency notifications to both residents and visitors (not an "opt-in" service). Severe spring and summer storm warnings are initiated by the National Weather Service or by local trained SkyWarn spotters. Extreme cold temperature warnings and extreme heat warnings, and winter weather warnings are issued by the National Weather Service. Residents receive warnings by NOAA weather radio, local media, Everbridge, cell phone apps and the outdoor warning siren system.

Preparedness Outreach: Carlton County Emergency Management utilizes the Carlton County Sheriff's Office Facebook page and local news media to communicate with residents and visitors on emergency preparedness. A link for the Everbridge emergency notification system is located on the Carlton County website.

Shelter Facilities: There are 25 designated shelter facilities within Carlton County that have an MOU with the American Red Cross. A severe storm or a period of extreme heat/cold coupled with a major power outage may require emergency sheltering for those in need. Carlton County Emergency Management and Public Health Department maintain a list of shelters within the county and have trained staff for shelter operations. Carlton County has sheltering and pet sheltering plans in place.

NOAA Weather Radios: Carlton County Emergency Management promotes the use of NOAA weather radios by schools, long-term care facilities, county buildings, local residents, and visitors to receive information broadcast from the National Weather Service. We promote use of these radios in advance of and during our severe weather months using our Sheriff's Office social media and also during the NWS severe weather awareness weeks.

Backup Power: Generator back-up power is in place for the Carlton County EOC, Courthouse, Public Works Building, Jail, Sheriff's Office, and Dispatch.

School Closings: All school districts within Carlton County have a school closing policy and communications plan in place if inclement weather or other event creates a hazardous situation for students or staff.

Severe Winter Storms

Winter Hazard Awareness Week: Carlton County Emergency Management helps promote and participates in the National Weather Service's "Winter Hazard Awareness Week" held in November each year. The event provides education to residents on the dangers of winter weather and how to properly deal with it. We utilize our Carlton County Sheriff's Office Facebook page and local news media to share information with the public.

Snow Removal: The Carlton County Transportation Department is responsible for the removal of snow and ice from county roads, as well as some township roads and city streets based on interagency agreements. The department completes its snow removal process in accordance with the Carlton County Transportation Department Snow & Ice Removal Policy. MNDOT removes snow from State Highways as well as disperses salt/sand as needed.

Severe Summer Storms

Outdoor Warning Sirens: There are 10 outdoor warning sirens located in Carlton County. Sirens are activated when the National Weather Service notifies Dispatch of high winds or tornado conditions that pose a risk to the public. Warning sirens are owned by the cities, townships or tribal government where they are located and maintained by those jurisdictions. All sirens are remotely activated by the Carlton County Sheriff's Office.

SKYWARN Program: Carlton County Emergency Management works with the National Weather Service to offer training on an annual basis to local fire and law enforcement departments and local residents that wish to be trained as volunteers. SKYWARN Spotters help to keep their local communities safe by providing timely and accurate reports of severe weather to their local National Weather Service office.

Severe Weather Awareness Week: Carlton County Emergency Management helps promote and participates in the National Weather Service's "Severe Weather Awareness Week" held in April each year. The week-long event seeks to educate residents on the dangers of severe storms and highlights the importance of preparing for severe weather before it strikes. We utilize the Carlton County Sheriff's Office Facebook page and local news media to share information with the public.

Vegetation Management: The Carlton County Highway Department oversees maintenance operations on all county roadways including tree, brush and weed control. Managing vegetation in the right-of-way of county-owned roads helps to reduce the danger of trees falling on roads during severe storm events such as thunderstorms, severe wind events, or ice storms. Local road authorizes are encouraged to do the same.

MDH Requirements for Manufactured Home Parks: The Carlton County Department of Public Health and Human Services works with the owners of manufactured home parks (MHP's) within the County to ensure that they are meeting Minnesota Department of Health (MDH) requirements for storm shelters and evacuation plans. Shelter and evacuation plans must be approved by the city or township in which they are located and submitted to the Minnesota Department of Health. Mobile Home Parks share their shelter and evacuation plans with the city or township and then are submitted to MDH.

Flooding

National Flood Insurance Program (*NFIP*): Carlton County and nearly all cities participate in the NFIP (either with or without FEMA-mapped high-risk areas). Only the City of Wright is noted by the MN DNR to have FEMA Mapped High Risk Areas but does not participate in the NFIP.

Floodplain Mapping & Ordinance: Carlton County's Zoning & Environmental Services Department maintains the floodplain maps and floodplain management ordinance for the county. Carlton County Zoning Ordinance No. 27 includes Subd. G, Floodplain Management District which establishes restrictions and requirements for any development within Special Flood Hazard Areas.

Buffer Ordinance: Carlton County enforces Ordinance #34 Buffer Ordinance. The purpose of the ordinance is to help 1) Protect state water resources from erosion and runoff pollution, 2) Stabilize soils, shores, and banks; and 3) Protect or provide riparian corridors. Enforcement of the ordinance helps mitigation damages of erosion as a result of high rain events.

Road & Bridge Maintenance and Repair: The Carlton County Transportation Department maintains an inventory of the condition of county roads, bridges, and culverts and slates improvement projects as needed on an annual basis. Following high-rain events or flood disasters the Transportation Dept. assesses damages due to erosion and flood damage and implements mitigation for those areas such as road re-surfacing, culvert replacement, and ditch/bank stabilization.

Comprehensive Local Water Management Planning: The Carlton County Local Water Management Plan (2010–2020) addresses existing and/or potential water resource related issues and concerns, including water quality, development impacts and land use, and public education about the county's water resources. In 2016, the Carlton County Soil and Water Conservation District (SWCD) was delegated responsibility for Water Planning in Carlton County by the Carlton County Board.

1 Watershed 1 Plan (*1W1P*): In Carlton County, Comprehensive Local Water Management Planning has shifted from a county boundary to planning by major watersheds. There are 4 watersheds within the county that will each undertake a planning process known as 1 Watershed 1 Plan (1W1P) in a phased in approach resulting in approved plans for all of Carlton County by 2025. These plans will be developed with all SWCDs and counties within the watershed, and will prioritize where to work, what issues to work on, and how much funding will be needed to address the priority restoration and protection issues outlined in the plans.

Wildfire

Database of dry hydrants/well access: Each local fire department maintains their dry hydrants. Carlton County GIS has a location of them.

Extreme Cold

Extreme Cold Safety Awareness: Carlton County Emergency Management and Carlton County Department of Public Health promote public awareness of personal safety measure to take during periods of extreme cold, such as minimizing exposure and being prepared with survival kits in vehicles during winter.

Landslides

Highway 210 Mitigation: The Minnesota Department of Transportation (MnDOT) has addressed the issue of washouts and landslides on Highway 210 near Jay Cooke State Park following past major rain events. Following the flood event of 2012 MnDOT did outreach to the public to warn of imminent slope failure and to obey road closures until repairs were made.

Setback Ordinance—Zoning Bluff Impact Zone: Carlton County Zoning Ordinance #27 establishes the definition of a bluff and setback requirements. We have a reduced slope qualifying as a bluff in red clay areas of the St. Louis River and Nemadji River basins. The ordinance requires a setback of 30 feet from the top of the bluff and also establishes restrictions for enhanced vegetation removal and grading & filling in bluff areas.

Dam Failure

High Hazard Potential Dam EAPs: Carlton County has ten "high hazard potential" dams in the National Dams Inventory (Fond du Lac, Thomson Dam, Thomson Dam Nos. 2A&2B, 3, 5 1/2, 6, 9, 11, 12, and Thompson Canal Dam) which are all part of the St Louis River dam system owned by Allete, Inc. Allete is responsible for the development of Emergency Action Plans (EAPs) for these dams which identify the vulnerable areas downstream in the event of dam failure and emergency procedures.

6.2 Mitigation Goals

The goals and strategies for natural hazards in the 2019 Minnesota State Hazard Mitigation Plan were adopted for use in the Carlton County Plan. This framework, as outlined below, will allow for integration of the mitigation actions that are listed by Carlton County and its jurisdictions into the state plan. The state will then be able to develop a statewide strategy that will benefit all of Minnesota.

Flooding Goal: Reduce deaths, injuries, property loss and economic disruption due to all types of flooding (riverine, flash, coastal, dam/levee failure).

Wildfire Goal: Reduce deaths, injuries, property loss, natural resource and economic disruption due to wildfires (forest, prairie, grass, and peat bogs).

Windstorms Goal: Reduce deaths, injuries, property loss, and economic disruption due to windstorms.

Hail Goal: Reduce deaths, injuries, property damage, and economic disruption due to hailstorms.

Winter Storms Goal: Reduce deaths, injuries, property loss, and economic disruption due to winter storms (blizzard, ice, and ice storm).

Lightning Goal: Reduce deaths, injuries, property losses, loss of services, and economic disruption due to lightning.

Tornado Goal: Reduce deaths, injuries, property loss, and economic disruption due to tornadoes.

Drought Goal: Reduce economic loss and environmental impacts due to drought.

Extreme Heat Goal: Reduce deaths, injuries, and economic disruption due to extreme heat.

Extreme Cold Goal: Reduce deaths, injuries, and economic disruption due to extreme cold.

Dam/Levee Failure Goal: Reduce deaths, injuries, property loss, natural resource and economic disruption due to dam/levee failure.

Erosion/Landslide/Mudslide Goal: Reduce deaths, injuries, property loss, and economic disruption due to hillside, coastal, bluff: caused primarily by oversaturation of soil.

6.3 Mitigation Action and Project Strategies

The mitigation actions in this plan are summarized into four main strategy types, as described in the FEMA publications *Local Mitigation Planning Handbook* (2013) and *Mitigation Ideas: A Resource for Reducing Risk to Natural Hazards* (2013). A fifth strategy type was determined by Minnesota HSEM for use within the state: Mitigation Preparedness and Response. The strategies and example actions are listed in Table 36.

Table 36. Mitigation strategies and action types

Mitigation Strategy	Description	Example Mitigation Actions
Local Plans and Regulations	These actions include government authorities, policies, or codes, that influence the way land and buildings are developed and built.	• Comprehensive plans • Land use ordinances • Planning and zoning • Building codes and enforcement • Floodplain ordinances • NFIP Community Rating System • Capital improvement programs • Open space preservation • Shoreline codes • Stormwater management regulations and master plans

Mitigation Strategy	Description	Example Mitigation Actions
Structure and Infrastructure Projects	These actions involve modifying existing structures and infrastructure to protect them from a hazard or remove them from a hazard area. This could apply to public or private structures as well as critical facilities and infrastructure. This type of action also involves projects to construct manmade structures to reduce the impact of hazards. Many of these types of actions are projects eligible for funding through the FEMA Hazard Mitigation Assistance program.	• Acquisitions and elevations of structures in flood prone areas • Utility undergrounding • Structural retrofits • Floodwalls and retaining walls • Detention and retention structures • Culverts • Safe rooms
Natural Systems Protection	These are actions that minimize damage and losses and also preserve or restore the functions of natural systems.	• Sediment and erosion control • Stream corridor restoration • Forest management • Conservation easements • Wetland restoration and preservation
Education and Awareness Programs	These are actions to inform and educate citizens, elected officials, and property owners about hazards and potential ways to mitigate them. These actions may also include participation in national programs, such as StormReady or Firewise Communities. Although this type of mitigation reduces risk less directly than structural projects or regulation, it is an important foundation. A greater understanding and awareness of hazards and risk among local officials, stakeholders, and the public is more likely to lead to direct actions.	• Radio or television spots • Websites with maps and information • Real estate disclosure • Presentations to school groups or neighborhood organizations • Mailings to residents in hazard-prone areas. • StormReady Certification • Firewise Communities
Mitigation Preparedness and Response	This is a State of Minnesota mitigation strategy with the intent of covering preparation and actions that protect life and property during a natural disaster.	• Emergency operations plan • Flood fight plans and preparedness • Dam emergency action plans • Warning • Backup power • Emergency capabilities

Local leaders work together with the Carlton County emergency management director to assure that the hazards and mitigation actions included in this plan are accurate and addressed in their jurisdictions. Development of mitigation actions for the county and each city was informed by a community's hazard and risk assessment; identification of local vulnerabilities, and review of capabilities in place to address mitigation. Planning team members, local elected officials and staff from Carlton County and each city actively participated in the development and review of mitigation action charts for implementation through participation in planning team meetings (see Appendix F) and development of Local Mitigation Surveys (see Appendix C). Additional jurisdictional and public feedback was incorporated following news releases inviting public input to the planning process (see Appendix G).

The Carlton County risks and mitigation activities identified also incorporate the concerns and needs of townships, school districts, and other entities participating in this plan. Appendix J contains the jurisdictional mitigation action charts for the cities of Barnum, Carlton, Cloquet, Cromwell, Kettle River, Moose Lake, Scanlon, Wrenshall, Wright, and the Fond du Lac Reservation.

Following is an overview the mitigation action charts and description of each element of the chart.

Number (#)
Each mitigation action is identified by a number.

Hazard
Each mitigation action is identified by the natural hazard that it relates to. Actions that fall under "All-Hazards" relate to both natural and non-natural hazards.

Mitigation Strategy
Each mitigation action is identified by one of the following five mitigation strategies.

- Local Planning and Regulations
- Structure and Infrastructure Projects
- Natural Systems Protection
- Education and Awareness Programs
- Mitigation Preparedness and Response Support

See Table 36 for a description of each mitigation strategy and related types of actions.

Mitigation Action
Each mitigation action provides a concise, action-oriented description of the action or project to be undertaken. If a mitigation reduces risk to new or existing buildings/infrastructure it is noted.

Status
The status of each mitigation action is indicated by one of the following categories:

- New – New actions that have been identified since the last plan.
- Existing – Actions that are carried over from the last plan or have been updated.
- In Progress – Actions from the last plan that are currently being acted upon.

Mitigation actions that have been completed or deleted from the 2014 Carlton County Multi-Hazard Mitigation Plan are identified and reported on in Appendix H. Completed and deleted mitigation actions are not carried over into the updated mitigation action chart.

Priority

In the review and discussion of selected mitigation strategies and actions, the planning team ranked of mitigation actions by priority for implementation. Table 37 provides criteria that were taken into consideration in the process.

Table 37. Criteria for Mitigation Action Priority Ranking

Ranking	Criteria
High Priority	• Methods for reducing risk from the hazard are technically reliable. • The County has experience in implementing mitigation measures. • Mitigation measures are eligible under federal grant programs. • There are multiple mitigation measures for the hazard. • The mitigation measure(s) are known to be cost effective. • The mitigation measures protect lives and property for a long period of time, or are permanent risk reduction solutions.
Moderate Priority	• Mitigation methods are established. • The County has limited experience with the kinds of measures that may be appropriate to mitigate the hazard. • Some mitigation measures are eligible for federal grants. • There is a limited range of effective mitigation measures for the hazard. • Mitigation measures are cost-effective only in limited circumstances. • Mitigation measures are effective for a reasonable period of time.
Low Priority	• Methods for reducing risk from the hazard are not well-established, are not proven reliable, or are experimental. • The State or Counties have little or no experience in implementing mitigation measures, and/or no technical knowledge of them. • Mitigation measures are ineligible under federal grant programs. • There is a very limited range of mitigation measures for the hazard, usually only one feasible alternative. • The mitigation measure(s) have not been proven cost effective and are likely to be very expensive compared to the magnitude of the hazard. • The long-term effectiveness of the measure is not known or is known to be relatively poor.

Time frame

Each mitigation action identifies the anticipated timeframe for implementation of the action within the next five-year planning cycle.

- Ongoing – Implementation of the action will require continued application.

- Defined (year) – Implementation of the action will occur within a defined time frame that is noted.
- TBD – The anticipated time frame for implementation of an action is to be determined.

Responsibility
Each mitigation action identifies what personnel, department or agency will be lead for the administration or implementation of the action.

Comments on Implementation & Integration
Each mitigation action provides a description of how the jurisdiction will work to implement the mitigation action and incorporate the activity into other existing planning mechanisms.

Possible Funding
Each mitigation action identifies where potential funding may come from to support implementation of the mitigation activity, such as existing county or city funding, state or federal funding. Projects that may be eligible for future FEMA Hazard Mitigation Assistance grant funding are noted.

The Carlton County Mitigation Action Chart is provided in Table 38. Appendix J provides the mitigation action charts developed for each city participating in the MHMP update.

Table 38. Carlton County Mitigation Action Chart (2021–2026)

#	Hazard	Mitigation Strategy	Mitigation Action	Status Priority Timeframe	Responsibility	Comments on Implementation & Integration	Possible Funding
1	All-Hazards	Education & Awareness Programs	Encourage all county residents to sign-up for the county's Everbridge emergency notification alert system.	Existing High Ongoing	Carlton County Emergency Management (CCEM)	A link for the Everbridge emergency notification system is located on the Carlton County website and reminders are put out on the Carlton County Sheriff's Office Facebook page as well as during the NWS's Severe Weather Awareness Week.	County
2	All-Hazards	Mitigation Preparedness & Response Support	Ensure the Carlton County Emergency Operations Plan (EOP) is updated and addresses policies & procedures needed to support EM functions prior to, during, and following a disaster.	Existing Moderate Ongoing	CCEM	CCEM has an EOP that is updated on a regular basis which helps the county be ready to respond to disasters across a range of EM functions. This includes plans in place for sheltering of displaced residents and pet sheltering.	County
3	All-Hazards	Mitigation Preparedness & Response Support	Ensure designated facilities are in place and prepared for providing mass care sheltering and county staff are trained in sheltering operations.	Existing Moderate Ongoing	CCEM, CC Public Health & Human Services (CC PH&HS)	CCEM and CC PH&HS maintain a list of shelters within the county and have trained staff for shelter operations. We partner with the American Red Cross to establish MOU's with facilities in the county to serve as official shelter locations that meet ARC shelter requirements for space and accessibility. We will continue to work to ensure that portable generators are available for use at shelters if needed.	County
4	All-Hazards	Mitigation Preparedness & Response Support	Work with the National Weather Service (NWS) for Carlton County to become a designated "StormReady" community.	Existing Moderate 2022	CCEM in coord with NWS	CCEM will work with the Duluth, MN NWS on verifying we have all StormReady requirements in place and apply for designation.	County, NWS
5	All-Hazards	Mitigation Preparedness & Response Support	Collaborate with Carlton County Public Health & Human Services to engage key stakeholders in related mitigation planning.	Existing Moderate Ongoing	CCEM in coord with CC PH&HS	CC PH&HS oversees the Carlton County Emergency Preparedness Advisory Committee (CC EPAC) which meets quarterly. The CC EMD participates on this committee and hazard mitigation planning is incorporated into the stakeholder engagement process.	County

#	Hazard	Mitigation Strategy	Mitigation Action	Status Priority Timeframe	Responsibility	Comments on Implementation & Integration	Possible Funding
6	Severe Winter & Summer Storms	Education & Awareness Programs	Provide education and outreach to residents on personal preparedness for severe weather events and extended power outages. Coordinate with local jurisdictions to share information locally.	Existing High Ongoing	CCEM in coord with Local Gov't	CCEM participates in and promotes the NWS Severe Weather Awareness Weeks in spring and fall each year. We also promote residents to be prepared for emergencies, to have NOAA weather radios, and to sign up for the county's Everbridge system and Sheriff's Office Facebook page to receive emergency notifications and other information. CCEM shares information with local governments and encourages them to use their communication platforms to keep residents informed.	County
7	Severe Winter & Summer Storms	Structure & Infrastructure Systems	Work with municipal & rural electric coops to encourage them to address burying powerlines or strengthening power poles to avoid power outages from high wind events and storms.	Existing High Ongoing	CCEM in coord with Local Gov't and Rural & Municipal Utility Coops	Lake Country Power, Minnesota Power, and Moose Lake Power & Light continue to address where power lines can be strengthened or buried underground. CCEM will assist as needed with applications to FEMA for eligible project measures that help to eliminate or reduce risk of power outages by these coops.	Electric Coops, FEMA HMA grant
8	Severe Winter & Summer Storms	Mitigation Preparedness & Response Support	Work with local jurisdictions to acquire generator backup power to support critical infrastructure and delivery of essential services during an extended power outage due to storms.	Existing Moderate Ongoing	CCEM in coord with Local Gov't	CCEM continues to provide assistance to local jurisdictions that need to acquire portable generators to power infrastructure such as lift stations and other key facilities such as City Hall /community shelters in the event of a power outage. In some cases, this may include helping to identify where used portable generators may be obtained or helping to prepare a funding application.	County, Local Gov't
9	Severe Winter & Summer Storms	Natural Systems Protection	Conduct vegetation management along county-owned roads to reduce the risk of downed trees and branches resulting from severe storms.	Existing Moderate Ongoing	CC Transportation Dept.	The Carlton County Transportation Dept. and local utility providers address removal of trees near powerlines. Townships & cities are encouraged to do the same for roads under their authority.	County
10	Severe Winter & Summer Storms	Mitigation Preparedness & Response Support	Encourage schools and long-term facilities that house senior citizens or other vulnerable populations to have emergency plans and generators in place to deal with severe weather, extreme temperatures, and power outages.	Existing High Ongoing	CCEM in coord with CC PH&HS Schools & Other Facilities, and Local Govt's	CCEM and CC PH&HS continue to work with schools and other long-term care facilities across the county and will encourage them to have plans in place for when the need arises. CCEM encourages local jurisdictions to work directly with facilities in their community to be prepared.	County, Local Facilities

#	Hazard	Mitigation Strategy	Mitigation Action	Status Priority Timeframe	Responsibility	Comments on Implementation & Integration	Possible Funding
11	Severe Winter Storms	Natural Systems Protection	Work with MnDOT and the Carlton County SWCD on the planting of living snow fences along high-drift road corridors.	New Moderate TBD	CCEM, CC Transportation Dept, in coord with MnDOT and CC SWCD	CCEM and CC Transportation Dept. will seek to work with MnDOT, Carlton SWCD, and willing landowners to plant living snow fences on high-drift snow corridors to help improve safety for motorists during winter storms. SWCD has some old maps that could be updated and some practice funding that could be applied to do more here.	County, State, SWCD
12	Severe Summer Storms	Education & Awareness Programs	Encourage campground operators to post information regarding storm shelters and safety during strong summer storms.	Existing Moderate Ongoing	CCEM in coord with local Govt's	Campground operators will be encouraged to take action on this locally.	County, State/Local
13	Severe Summer Storms	Local Planning & Regulations	Work with owners of mobile home parks (MHP's) to ensure they are in compliance with the Minnesota Department of Health (MDH) requirements for evacuation plans and storm shelters.	Existing High Ongoing	CC PH&HS in coord with Local Gov't & MHP's	CC PH&HS works with the owners of manufactured home parks and the municipalities where they are located to help to ensure that they are meeting MDH requirements for storm shelters and evacuation plans.	CCPH, MHP Owners
14	Severe Summer Storms	Mitigation Preparedness & Response Support	Ensure there is a network of trained Storm Spotters throughout the county.	Existing Moderate Ongoing	CCEM in coord with NWS & Local Gov't	CCEM works with the NWS to provide SKYWARN storm spotter training on an annual basis to local law enforcement, fire departments, and local residents who wish to participate. Storm Spotters help to support situational awareness of and public notification for dangerous storms such as severe thunderstorms and tornadoes.	County, NWS
15	Severe Summer Storms	Local Planning & Regulations / Structure & Infrastructure Projects	Provide assistance to local jurisdictions that require purchase & installation of new outdoor warning sirens and ensure they are connected to the county's remote activation system.	Existing High Ongoing	CCEM in coord with Local Gov't	Warning siren upgrades or new installations are needed for the cities of Barnum, Carlton, and Scanlon. CCEM will assist these communities as needed with applying for funding to the USDA Community Facilities Grant Program which is a source for funding outdoor warning sirens. All new sirens will be connected to the county's remote activation system.	County, Local Gov't, USDA CF Grant Program

#	Hazard	Mitigation Strategy	Mitigation Action	Status Priority Timeframe	Responsibility	Comments on Implementation & Integration	Possible Funding
16	Severe Summer Storms	Structure & Infrastructure Projects	Address the need for the construction of storm shelters or tornado safe rooms in communities, parks, or other locations in the county where people are vulnerable to high wind or tornadic events.	Existing Moderate Ongoing	CCEM in coord with Local Gov't	The cities of Carlton, Moose Lake, and Wrenshall have all identified a need for either a storm shelter or tornado safe room to help protect residents/visitors that are vulnerable to high wind events (i.e., mobile home parks, campgrounds). CCEM will provide assistance as requested to help assess need, possible construction options, and development of grant applications as needed (i.e., FEMA HMA safe room grant).	County, FEMA HMA, Other (TBD)
17	Wildfire	Local Planning & Regulations	Work with the MN DNR Firewise Program and Carlton SWCD to address update of the Carlton County Community Wildfire Protection Plan (CWPP).	New Moderate TBD	CCEM in coord with MN DNR Firewise and Carlton SWCD	The MN DNR Firewise Program has noted that Carlton County has a CWPP equivalent on file (which is addressed in the county's EOP), but cannot locate a copy. CCEM will work with the MN DNR FW Coordinator for NE MN to evaluate if a CWPP equivalent or full CWPP is best for Carlton County and proceed with that planning for wildfire mitigation with local communities. The Carlton County SWCD will also be engaged in this effort as they are working actively on wildfire mitigation measures within the county.	County, MN DNR Firewise Grant
18	Wildfire	Education & Awareness Programs	Promote Firewise outreach & education on wildfire safety & mitigation and encourage local actions to reduce wildfire risk.	New Moderate TBD	CCEM in coord with CC SWCD & Local Gov't	CCEM and the CC SWCD promote wildfire safety and awareness in coordination with the MN DNR and local communities through measures such as posting wildfire safety information on the Sheriff's Office Facebook page during times of high risk for wildfire. The SWCD also received a grant to help develop more capacity to promote the Firewise program and do some mitigation demos. Homeowners are encouraged to create & maintain defensible space around structures.	County, SWCD, MN DNR
19	Wildfire	Local Planning & Regulations	Create an inventory of where dry hydrants are located and identify where they are needed.	New Moderate TBD	Carlton County GIS in coord with SWCD and local FD's	Currently a comprehensive inventory of where dry hydrants are located and where they are needed does not exist. This is something that the Carlton SWCD, Carlton County GIS and local fire departments can work on together.	County, SWCD

#	Hazard	Mitigation Strategy	Mitigation Action	Status Priority Timeframe	Responsibility	Comments on Implementation & Integration	Possible Funding
20	Flooding	Local Planning & Regulations	Participate in the National Flood Insurance Program and enforce policies that address development in high-risk flood areas.	Existing High Ongoing	CC Zoning & Envir. Services Dept.	Carlton County participates in the National Flood Insurance Program (NFIP). The CC Zoning & Environmental Services Department maintains the floodplain maps and floodplain management ordinance for the county. Carlton County Zoning Ordinance No. 27 includes Subd. G, Floodplain Management District which establishes restrictions and requirements for any development within Special Flood Hazard Areas areas.	County
21	Flooding	Local Planning & Regulations / Structure & Infrastructure Projects	Work with township and city governments to plan for and implement measures to address minor localized flood reduction projects for roads, bridges, and culverts throughout the county.	In-Progress High 2019-2023	CC Transportation Dept. in coord with Local Gov'ts	The CC Transportation Dept continues to evaluate needed projects on an annual basis and following flood events, and works closely with townships to provide engineering on issues such as washouts of gravel roads, damage to road surfaces, and water diversion. CC Transportation Dept. maintains a 5-year construction plan that identifies and schedules road improvement projects that include culvert and drainage improvements.	County, State, Federal
22	Flooding	Local Planning & Regulations / Structure & Infrastructure Projects	Work in partnership with the Carlton County SWCD and local municipalities to address mitigation projects that address erosion and localized flooding.	Existing Moderate Ongoing	CC Transportation Dept. in coord with SWCD and Local Gov'ts	CC Transportation Dept. continues to partner together with the SWCD and local governments to address flood and erosion projects such as ditch drainage, culvert & rural road repair, and bank stabilization projects. Both technical and financial assistance are provided through the county and SWCD.	County, Local Gov't, SWCD Cost Share Grant Funding
23	Flooding	Local Planning & Regulations / Structure & Infrastructure Projects	Conduct property buyouts to acquire homes affected by repetitive flooding and physically relocate or remove those homes to eliminate future flood damages.	Existing Low Ongoing	CCEM, CC Zoning & Envir. Services Dept. in coord with Local Gov'ts	There are currently no projects slated for conducting property buyouts by the county or local jurisdictions; however, Carlton County will continue to evaluate and assist municipalities with any future property acquisition projects and application to FEMA or MN DNR for grant funding to conduct buyouts.	County, MN DNR, FEMA HMA, Local Gov't

#	Hazard	Mitigation Strategy	Mitigation Action	Status Priority Timeframe	Responsibility	Comments on Implementation & Integration	Possible Funding
24	Flooding	Local Planning & Regulations	Enforce county policies that regulate zoning for new development, setbacks in shoreline areas, and stormwater management.	Existing Moderate Ongoing	CC Zoning & Envir. Services Dept.	The CC Environmental Services Department administers land use and zoning ordinances for rural and unincorporated portions of Carlton County, including for floodplains and shoreland. The 'County-Wide' Zoning Ordinance addresses Shoreland Management Regulations including building regulations to mitigate against flooding during high-water elevation (for structures along lakes, ponds, flowages, rivers, and streams). Carlton County Zoning Ordinance Section 5.5 of the Shore Land Management Ordinance addresses stormwater management. Carlton County Environmental Services Dept. also enforces Ordinance #34 Buffer Ordinance. Enforcement of the ordinance helps mitigation damages of erosion as a result of high rain events.	County
25	Flooding / Landslides	Local Planning & Regulations	Work in partnership with the Carlton County SWCD and area watershed groups to coordinate planning efforts that address flooding and erosion concerns.	Existing Moderate Ongoing	CC Zoning & Envir. Services Dept., CC SWCD, in coord with Watershed Districts	CC Environmental Services Dept. continues to work with the Carlton County SWCD, Big Sandy Area Lakes Watershed Group and the Mille Lacs Watershed Management Group on projects that affect water quality, erosion control, and shoreland stabilization. Carlton County and Carlton SWCD participate in the Nemadji 1W1P (1 Watershed, 1 Plan).	County, SWCD Cost Share Grant Program, & Watershed Districts,
26	Flooding / Landslides	Structure & Infrastructure Projects / Natural Systems Protection	Implement identified high-priority measures to mitigate areas of flooding and high-erosion concern (i.e., culvert replacements, slope stabilization for slumps & slides, and water storage projects that effect runoff volumes and thus flooding).	Existing High Ongoing	CC Zoning & Envir. Services Dept., CC SWCD, in coord with Watershed Districts	Carlton County, in partnership with the SWCD and watershed groups continue to seek significant funding to implement priority projects we have identified through our planning efforts. FEMA Hazard Mitigation Grant Program funding and other funding streams will be explored for eligible projects as we move forward.	County, SWCD, FEMA HMA, Other (TBD)

#	Hazard	Mitigation Strategy	Mitigation Action	Status Priority Timeframe	Responsibility	Comments on Implementation & Integration	Possible Funding
27	Landslides	Local Planning & Regulations	Enforce county ordinance that address setbacks from bluffs for new development to reduce risk of erosion and landslides.	Existing Moderate Ongoing	CC Zoning & Envir. Services Dept.	Carlton County Zoning Ordinance #27 establishes the definition of a bluff and setback requirements. We have a reduced slope qualifying as a bluff in red clay areas of the St. Louis River and Nemadji River basins. The ordinance requires a setback of 30 feet from the top of the bluff and also establishes restrictions for enhanced vegetation removal and grading & filling in bluff areas.	County
28	Dam Failure	Local Planning & Regulations / Structure & Infrastructure Projects	Work with private landowners to conduct annual maintenance reviews of the Elim Creek Dam and Hanson Dam and identify/implement maintenance measures as deemed necessary.	Existing Moderate Ongoing	Carlton SWCD in coord with private landowners	The Carlton SWCD has maintenance responsibilities for the Elim Creek and Hanson Dams, however inspections or work on the dams can only occur with approval of the private landowners where the dams are located. SWCD continue to provide outreach to these landowners to conduct these efforts. Future funding for dam improvement measures may come from the Great Lakes Restoration Initiative as well as Carlton SWCD.	Carlton SWCD, GLRI

Section 7 – Plan Maintenance

7.1 Monitoring, Evaluation, and Updating the Plan

The Carlton County Multi-Hazard Mitigation Plan should be considered a living document. The plan should be updated and approved by FEMA at a minimum of every five years. The guidance in this section will function as the primary tool when reviewing progress on the implementation of the Carlton County MHMP.

The Carlton County Emergency Management Director is the individual responsible for leading all efforts to monitor, evaluate, and update the hazard mitigation plan within the 5-year window. Throughout the 5-year planning cycle, the Carlton County Emergency Management Director will work with the local Carlton County Emergency Preparedness Advisory Committee (CC EPAC) to serve as the committee to help monitor, review, evaluate, and update the Multi-Hazard Mitigation Plan. The CC EPAC meets quarterly and is coordinated by Carlton County Public Health and Human Services in partnership with Emergency Management. There is a wide variety of membership on the committee. Including, Carlton County Emergency Management, Carlton County Public Health and Human Services, other county departments, Fond du Lac Emergency Management, Fond du Lac Human Services, Schools, Healthcare Facilities, related regional partners, Minnesota Department of Health, Long Term Care facilities, Fire/EMS/Law Enforcement, Institutes of Higher Education, and elected officials including County Commissioners and other City/Township representatives. If there is a need for a special meeting due to new developments or a declared disaster occurring in the county, the committee will meet to update pertinent mitigation strategies. Depending on Carlton County opportunities and fiscal resources, mitigation projects may be implemented independently by individual communities or through local partnerships.

The committee will continue to review the MHMP goals and objectives to determine their relevance to changing situations in Carlton County. In addition, state and federal policies will be reviewed to ensure they are addressing current and expected conditions. The committee will also review the risk assessment portion of the plan to determine if this information should be updated or modified. The parties responsible for the various implementation actions will report on the status of their projects, and will include which implementation processes worked well, any difficulties encountered, how coordination efforts are proceeding, and which strategies should be revised.

Updates or modifications to the MHMP during the five-year planning process will require a public notice and a meeting prior to submitting revisions to the individual jurisdictions for approval. The plan will be updated via written changes, submissions as the committee deems appropriate and necessary, and as approved by county commissioners.

Throughout the five-year window of the plan, Carlton County Emergency Management Director will request updates from county departments and jurisdictions on that status of mitigation efforts so that progress notes may be maintained for the next plan update.

7.2 Implementation

Carlton County and its included municipalities share a common Multi-Hazard Mitigation Plan and work together closely to develop, revise, and implement it. This MHMP provides a comprehensive chart of mitigation actions for Carlton County and its jurisdictions. The cities of Barnum, Carlton, Cloquet, Cromwell, Kettle River, Moose Lake, Scanlon, Wrenshall, Wright, and the Fond du Lac Reservation participated in the MHMP planning process and identified the specific mitigation strategies that they would seek to implement in their communities during the five-year planning cycle. These mitigation actions are provided in Section 6.3 Appendix J.

A number of implementation tools are available to address hazards. Many of these tools are below, however, in some cases additional discussion is needed in order to identify what strategies are most appropriate to use. This will be part of an ongoing discussion as Carlton County looks for opportunities for plan implementation. The following tools will be considered:

Education: In many cases, education of residents has been identified as one of the most effective mitigation strategies.

Capital Investments: Capital investments such as fire and ambulance equipment, sprinkler systems, and dry hydrants are tools that can limit risks and impacts of natural and man-made hazards.

Data Collection and Needs Assessments: Data collection and needs assessments can aid in gaining a better understanding of threats and allow planning for mitigation strategies accordingly. As resources are limited for this part of the planning process, additional data collection is likely to be an ongoing activity as resources become available.

Coordination: Responsibilities for mitigation strategies run across various county departments, local fire and ambulance departments, city and township governments, and a host of state and federal agencies. Ongoing coordination is an important tool to ensure resources are used efficiently. Coordination can also avoid duplication of efforts or prevent gaps that are created because of unclear roles and responsibilities. The mitigation plan review process can function as a tool to have an ongoing discussion of roles, responsibilities, and opportunities for coordination.

Regional Cooperation: Counties and public safety services providers throughout the region often share similar challenges and concerns. In some cases, a regional approach may be warranted as a mitigation strategy in order to save resources. Mutual aid agreements are a tool already in use for a number of services. Needs assessments for fire and ambulance services and development of assistance for volunteer recruiting, training, and retention could benefit from a regional approach. Cooperation among counties could also help in lobbying for certain funding priorities that address concerns relating to challenges in service delivery in rural areas. Organizations such as FEMA Region V and the MN Department of HSEM through the Regional Program Coordinator can offer tools and resources to assist in these cooperative efforts.

Regulation: Regulation is an important mitigation tool for Carlton County. Regulation plays a particularly important role for land use, access to structures and the protection of water resources and public health.

7.3 Continued Public Involvement

Continued public involvement is critical to the successful implementation of the Multi-Hazard Mitigation Plan. The Carlton County Emergency Management Director and the MHMP planning team members will continue to engage new public stakeholders in planning discussions and project implementation during the five-year cycle of this plan.

In order to seek continued public participation after the plan has been approved and during the five-year window of implementation for this plan, Carlton County will take the following measures:

- The plan will be posted on the Carlton County Emergency Management website for the public to read and provide feedback. Collected feedback will be reviewed and the plan will be amended as necessary.
- Following any major storms or natural disasters, Carlton County Emergency Management will seek to gather concerns and new ideas for mitigation from local residents to include in the next update of the plan. This may be done through public meetings, outreach via social media (e.g., Sheriff's Office Facebook page), or news releases via local media.
- Each community participating in the plan will be responsible to keep their local government, schools and community members updated and engaged in the implementation of their respective mitigation action charts (see Appendix J. Each respective jurisdiction will be required to report on the status of mitigation actions in their charts to the Carlton County Emergency Management Director.
- Jurisdictions will use numerous means of public outreach to engage new public stakeholders in providing input on mitigation efforts or concerns on hazards by sharing information at city council/township board meetings, sharing information at special events, working with local schools and partner organizations, and posting information on relevant local or social media that their communities use to inform and engage the public. As mitigation projects are implemented, jurisdictions will work to keep the public updated and engaged in those local efforts.