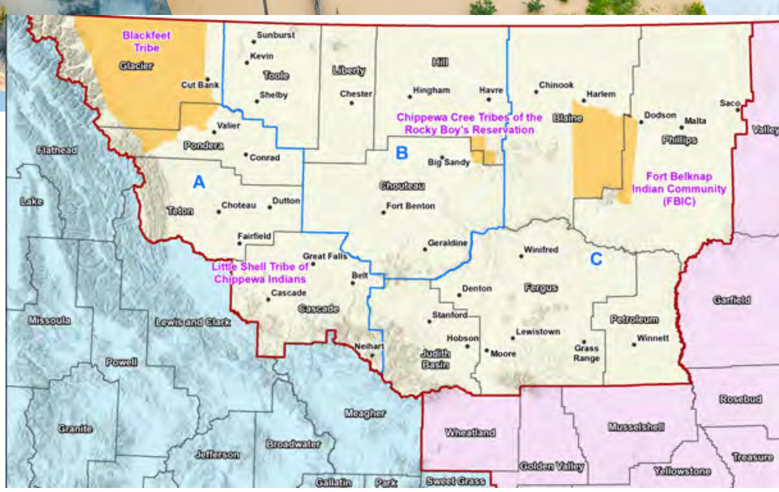
CENTRAL MONTANA

Regional Hazard Mitigation Plan

2024-2029

- Blackfeet Nation
- Blaine County
- Cascade County
- Chippewa Cree Tribe - Rocky Boys Reservation
- Chouteau County
- Fergus County
- Glacier County
- Hill County
- Judith Basin County
- Liberty County
- Petroleum County
- Phillips County
- Pondera County
- Teton County
- Toole County



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1 Introduction

1.1 Executive Summary

The Central Montana Region Hazard Mitigation Plan (HMP) is the product of a regional planning process coordinated by the Montana Disaster & Emergency Services (MTDES) in 2022-2023 to develop regional hazard mitigation plans covering the entire state of Montana. The following jurisdictions have prepared this Plan and will adopt it once it has been approved:

- Blackfeet Nation
- Blaine County
  - City of Chinook
  - City of Harlem
- Cascade County
  - City of Great Falls
  - Town of Belt
  - Town of Cascade
- Chippewa Cree Tribe - Rocky Boys
- Chouteau County
  - City of Fort Benton
  - Town of Big Sandy
- Fergus County
  - City of Lewistown
  - Town of Denton
  - Town of Grass Range
  - Town of Moore
  - Town of Winifred
- Glacier County
  - City of Cut Bank
- Hill County
  - City of Havre
  - Town of Hingham
- Judith Basin County
  - Town of Hobson
  - Town of Stanford
- Liberty County
  - Town of Chester
- Petroleum County
  - Town of Winnett
- Phillips County
  - City of Malta
  - Town of Saco
- Pondera County
  - City of Conrad
- Teton County
  - City of Choteau
  - Town of Dutton
  - Town of Fairfield
- Toole County
  - Town of Kevin
  - Town of Shelby
  - Town of Sunburst

The purpose of hazard mitigation is to reduce or eliminate long-term risk to people and property from disasters or hazard events. The impacts of hazards can often be lessened or even avoided if appropriate actions are taken before events occur. Studies have found that hazard mitigation is extremely cost-effective, with every dollar spent on mitigation saving an average of $6 in avoided future losses. By reducing exposure to known hazard risks, communities will save lives and property and minimize the social, economic, and environmental disruptions that commonly follow hazard events.

The 2023 Central Montana Region HMP (also referred to as "Plan") will serve as a blueprint for coordinating and implementing hazard mitigation policies, programs, and projects across the Region. It identifies mitigation goals and related actions to assist the participating jurisdictions in reducing risk and preventing loss from future hazard events.

The goals of the 2023 Central Montana Region HMP are:

Goal 1: Reduce impacts to people, property, the environment, and the economy from hazards.

Goal 2: Protect community lifelines and critical infrastructure to ensure the continuity of essential services.

Goal 3: Increase public awareness and participation in hazard mitigation.

Goal 4: Sustain and enhance jurisdictional capabilities to enact mitigation activities.

Goal 5: Integrate hazard mitigation into other plans, processes, and regulations.

Goal 6: Promote regional cooperation and leverage partnerships in mitigation solutions where possible.

This Plan was also developed to maintain the participating jurisdictions' eligibility for federal disaster assistance, specifically the FEMA Hazard Mitigation Assistance (HMA) grants including the Hazard Mitigation Grant Program (HMGP), Flood Mitigation Assistance (FMA), and Building Resilient Infrastructure and Communities (BRIC) grant program, as well as the Rehabilitation of High Hazard Potential Dam (HHPD) grant program.

The Central Montana Region Hazard Mitigation Plan is organized as follows:

- Chapter 1: Introduction
- Chapter 2: Region Profile
- Chapter 3: Planning Process
- Chapter 3.4: Hazard Analysis and Risk Assessment
- Chapter 5: Mitigation Strategy
- Chapter 6: Plan Adoption, Implementation, and Maintenance
- County and Tribal Annexes
- Appendices

The County and Tribal Annexes provide more detailed assessments of each jurisdiction's unique risks as well as their mitigation strategy to reduce long-term losses. Each annex contains the following:

1. Mitigation Planning and County Planning Team
2. Community Profile
3. Hazard Identification and Risk Assessment
4. Vulnerability to Specific Hazards
5. Mitigation Capabilities Assessment
6. Mitigation Strategy
7. Plan Implementation and Maintenance

It is important that local decision-makers stay involved in mitigation planning to provide new ideas and insight for future updates to the Regional HMP. As a long-term goal, the HMP and the mitigation strategies identified within will be fully integrated into daily decisions and routines of local government. This will continue to require dedication and hard work, and to this end, this Plan update continues efforts to further strengthen the resiliency of the Region.

1.2 Purpose

The participating jurisdictions of the Central Montana Region prepared this regional hazard mitigation plan to guide hazard mitigation planning and to better protect the people and property of the planning area from the effects of hazard events. This plan demonstrates the Region's commitment to reducing risks from hazards and serves as a tool to help decision-makers direct mitigation activities and resources. This plan also maintains the jurisdictions' eligibility for federal disaster assistance under the Federal Emergency Management Agency's (FEMA) Hazard Mitigation Assistance (HMA) grant programs including the Hazard Mitigation Grant Program (HMGP), Flood Mitigation Assistance (FMA) and Building Resilient Infrastructure and Communities (BRIC) program. This plan demonstrates the Region and participating jurisdictions' commitment to reducing risks from hazards and serves as a tool to help decision-makers direct mitigation activities and resources.

1.3 Background and Scope

Each year in the United States, disasters take the lives of hundreds of people and injure thousands more. Nationwide, taxpayers pay billions of dollars annually to help communities, organizations, businesses, and individuals recover from disasters. These monies only partially reflect the true cost of disasters because additional expenses to insurance companies and nongovernmental organizations are not reimbursed by tax dollars. Many disasters are predictable, and much of the damage caused by these events can be alleviated or even eliminated.

FEMA defines hazard mitigation as any sustained action taken to reduce or eliminate long-term risk to human life and property from a hazard event. The results of a three-year, congressionally mandated independent study to assess future savings from mitigation activities provides evidence that mitigation activities are highly cost-effective. On average, each dollar spent on mitigation saves society an average of $6 in avoided future losses in addition to saving lives and preventing injuries (Natural Hazard Mitigation Saves, 2019 Report).

Hazard mitigation planning is the process through which hazards that threaten communities are identified, likely impacts of those hazards are determined, mitigation goals are set, and appropriate strategies to lessen impacts are developed, prioritized, and implemented. This plan documents the planning region's hazard mitigation planning process, identifies relevant hazards and risks, and identifies the strategies that each participating jurisdiction will use to decrease vulnerability and increase resiliency and sustainability.

This plan was prepared pursuant to the requirements of the Disaster Mitigation Act of 2000 (Public Law 106-390) and the implementing regulations set forth by the Interim Final Rule published in the Federal Register on February 26, 2002 (44 CFR §201.6) and finalized on October 31, 2007 (hereafter, these requirements and regulations will be referred to collectively as the Disaster Mitigation Act (DMA)). While the act emphasized the need for mitigation plans and more coordinated mitigation planning and implementation efforts, the regulations established the requirements that local hazard mitigation plans must meet for a local jurisdiction to be eligible for certain federal disaster assistance and hazard mitigation funding under the Robert T. Stafford Disaster Relief and Emergency Act (Public Law 93-288). Because the planning area is subject to many kinds of hazards, access to these programs is vital.

Information in this plan will be used to help guide and coordinate mitigation activities and decisions for local land use policy in the future. Proactive mitigation planning will help reduce the cost of disaster response and recovery to communities and property owners by protecting critical community facilities, reducing liability exposure, and minimizing overall community impacts and disruption. The jurisdictions in the planning area have been affected by hazards in the past and are thus committed to reducing future disaster impacts and maintaining eligibility for federal funding.

1.4 Multi-Jurisdictional Planning

This plan was prepared as a regional, multi-jurisdictional plan. The Central Montana Region is comprised of thirteen counties and four tribal reservations, as established by MTDES. All tribes, counties, and incorporated municipalities in the Region were invited to participate in the planning process. The Fort Belknap Indian Community elected not to participate in the Regional plan, having just updated their own Tribal HMP in 2023; the Towns of Neihart, Geraldine, Valier, and Dodson also elected not to participate due to limited staff and resources. All other tribes, counties, and incorporated municipalities fully participated in the planning process, and have committed to adopt and implement the Regional HMP. The participating jurisdictions seeking FEMA approval of this plan are listed in Section 1.1.

2 Region Profile

This section provides a brief overview of the geography of the planning area. A base map of the planning region is illustrated in Figure 2.1 below.

2.1 Geography and Climate

The Central Montana Region is comprised of the following thirteen counties and three tribal reservations:

- Blackfeet Nation
- Blaine County
- Cascade County
- Chippewa Cree Tribe - Rocky Boys
- Chouteau County
- Fergus County
- Fort Belknap Indian Community
- Glacier County
- Hill County
- Judith Basin County
- Liberty County
- Petroleum County
- Phillips County
- Pondera County
- Teton County
- Toole County

The Central Region consists of vivid landscapes and contrasts, from prairie ranges to high mountain peaks. Mountain ranges in the Region include the Big and Little Snowy, Highwood, Judith, North and South Moccasin, Bull, Little Belt, Castle, Black Butte and the northern peaks of the Crazy Mountains. The Region can be prone to some of the state's heaviest spring snowfalls as well as severe summer thunderstorms.

The Central Montana Region is also a large tourist destination in Montana and contains a portion of Glacier National Park. Elevations range from 2,250 to 10,466 feet. Mount Cleveland in Glacier County is the highest point in the Region.

The Missouri River, the longest river in the United States, flows from west to east through the Region, passing through Cascade and Chouteau Counties, and forming the border between Blaine and Phillips Counties on the north bank, and Fergus and Petroleum Counties on the south bank. Among the major tributaries of the Missouri River are the Marias, Milk, Sun and Teton Rivers.

Major roadways include Interstate 15, Highway 2, Highway 87, Highway 89 and Highway 191. Figure 2.2 below shows the location of Federal Lands within Montana.

The climate of the Region varies depending on location and time of year. Temperature extremes range from over 100˚F in the summer, to as low as –35 ˚F in the winter. July is the hottest month in the Region, with an average monthly high of 86.5 ˚F; December is the coldest month, with average monthly lows of 4.2˚F.

The month of May has the highest average recorded rainfall in the Region. Although not enough precipitation falls in the warmer months for adequate natural growth of crops, a significant amount of precipitation is accumulated in the mountains in the form of snow. Total annual snowfall varies considerably. In the plains where elevations range from 1,800 to 12,800 feet, annual averages can be 20 to 40 inches. In the higher regions, snowfall averages often reach 100 inches. Additional geography and climate data for each jurisdiction within the Region can be found in Section C.2 of each jurisdictional annex.

Figure 2.1 Central Montana Region Base Map

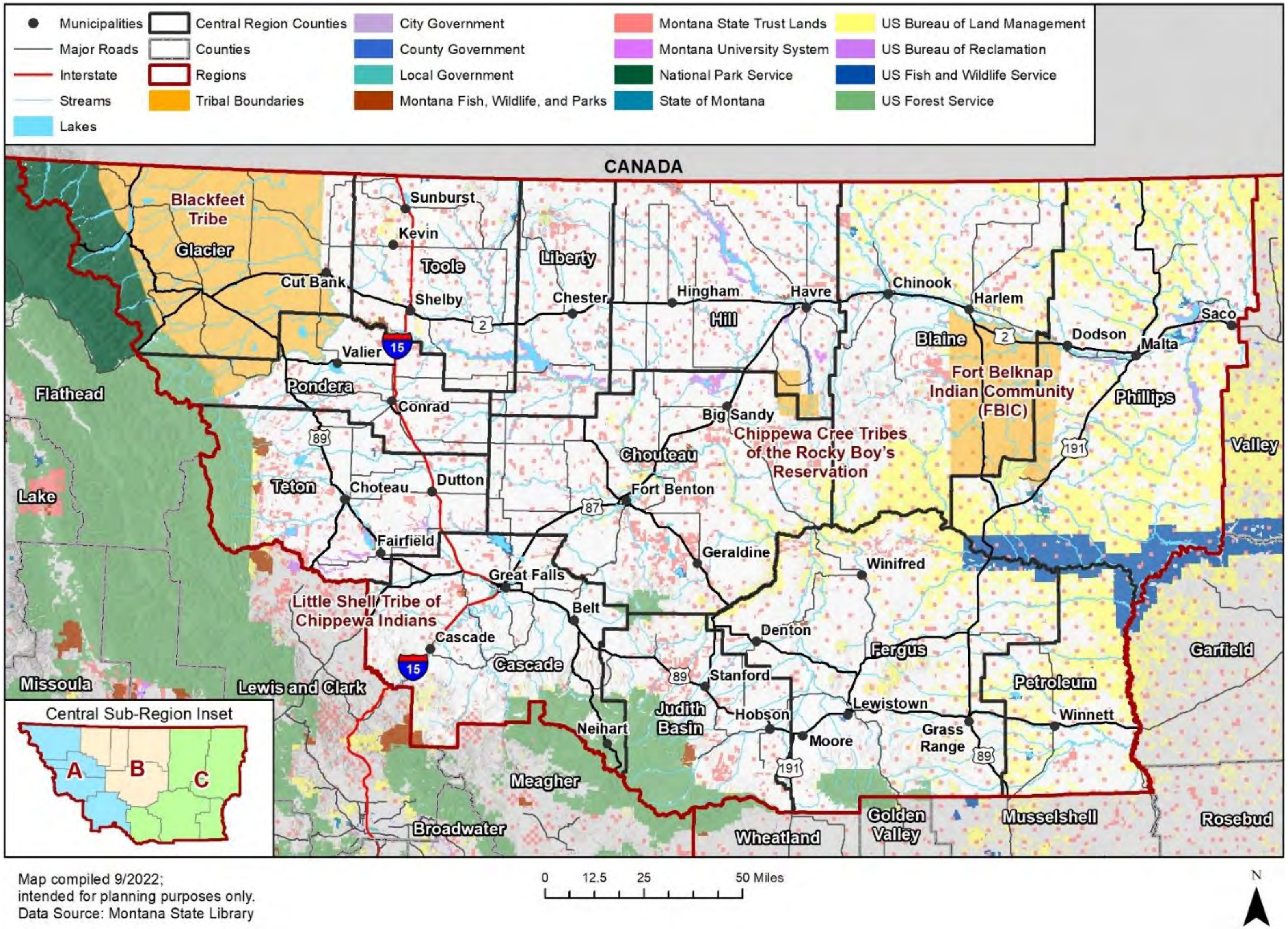
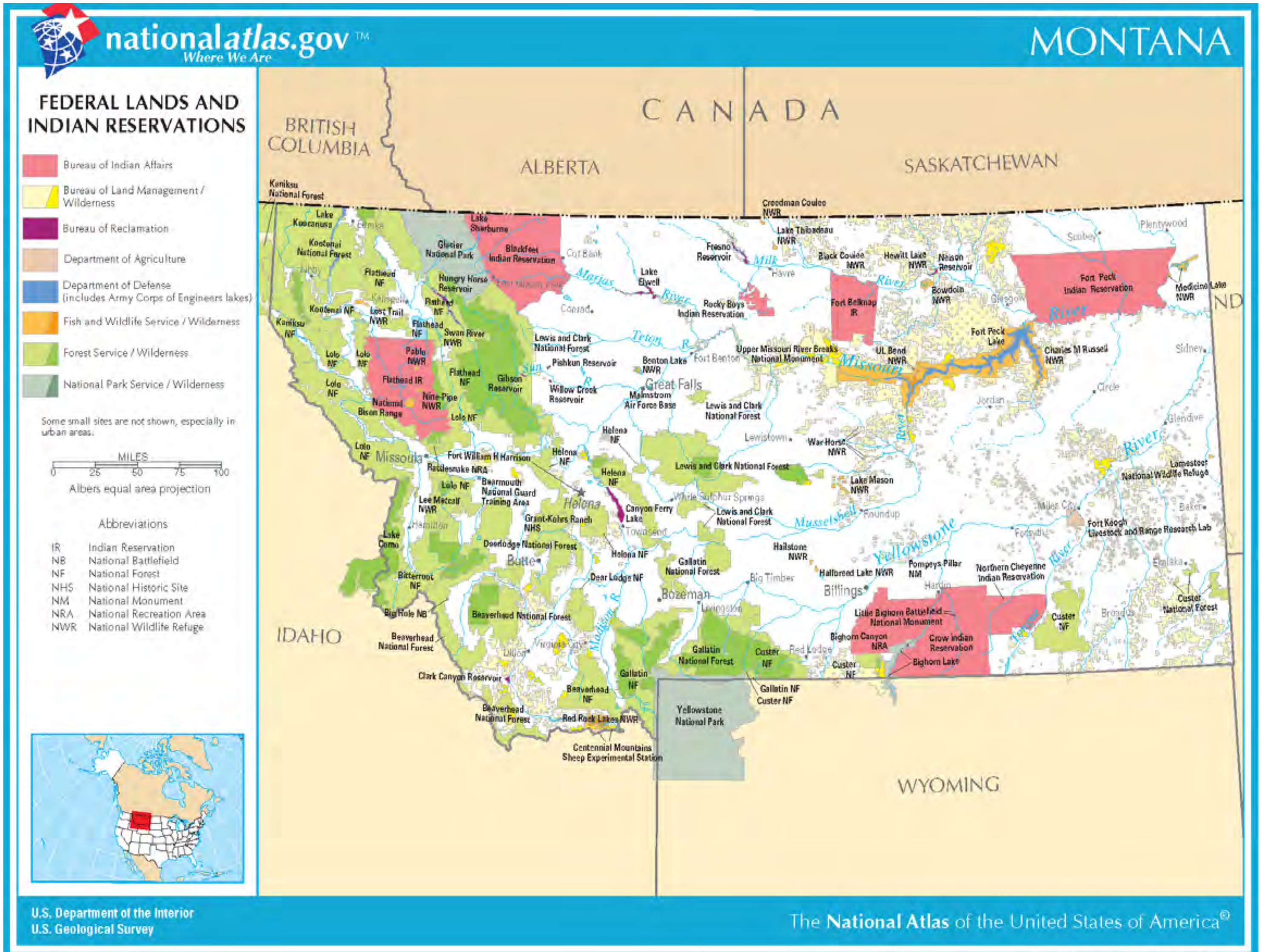


Figure 2.2 Federal Lands and Indian Reservations Montana



2.2 Population

Table 2-1 describes the population and estimated population change for the planning region as a whole and for individual counties. The tribal nations are included in the county numbers, but are also broken out separately in Table 2-2. Data in the table is based on the American Community Survey data from the US Census Bureau. Overall, the population of the Central Region has increased by 2.9% since 2010, with the largest increases in Blaine, Cascade, and Glacier Counties. In contract, Liberty and Petroleum Counties have both seen double-digit decreases. Of the region's tribal nations, the Blackfoot Reservation has seen a 2.7% increase similar to the region as a whole, but the Fort Belknap and Rocky Boy's Reservations have grown by 30% and 35% respectively.

Table 2-1 Central Region Population Change

County	2010 Census	2016 Estimate	2018 Estimate	2020 Census	2021 Estimates	% Change 2010 to 2021	2040 Projections
Blaine County	6,472	6,609	6,727	6,698	7,051	+9.0 %	5,806
Cascade County	80,562	82,049	81,746	81,576	84,178	+4.5 %	84,042
Chouteau County	5,765	5,837	5,789	5,731	5,896	+2.3 %	5,253
Fergus County	11,513	11,429	11,273	11,167	11,464	-0.4 %	11,296
Glacier County	13,251	13,695	13,699	13,706	13,827	+4.3 %	11,181
Hill County	16,007	16,529	16,439	16,422	16,297	+1.8 %	16,700
Judith Basin County	1,967	1,981	1,951	1,968	2,004	+1.9 %	1,932
Liberty County	2,261	2,292	2,280	2,455	2,026	-10.4 %	2,076
Petroleum County	598	445	432	464	434	-27.4 %	448
Phillips County	4,206	4,150	4,124	4,032	4,233	+0.6 %	3,833
Pondera County	6,145	6,166	6,044	5,911	5,974	-2.8 %	5,308
Teton County	6,105	6,067	6,040	6,127	6,173	+1.1 %	6,616
Toole County	5,143	5,114	4,976	4,812	5,013	-2.5 %	5,327
Total	**159,995**	**162,363**	**161,520**	**161,069**	**164,570**	**+2.9 %**	**159,818**

Source: US Census Bureau ACS 5-year Estimates

Table 2-2 Central Region Population Change – Tribal Nations

County	2010 Census	2016 Estimate	2018 Estimate	2020 Census	2021 Estimates	% Change 2010 to 2021
Blackfoot Reservation and Off-Reservation Trust Land	10,429	10,842	10,772	10,664	10,706	2.7%
Fort Belknap Reservation	2,798	3,020	3,187	3.302	3,627	29.6%
Rocky Boy's Reservation	1,736	2,216	2,200	2,335	2,341	34.9%
Total	**14,963**	**16,078**	**16,159**	**13,002**	**16,674**	**11.4%**

Source: US Census Bureau ACS 5-year Estimates

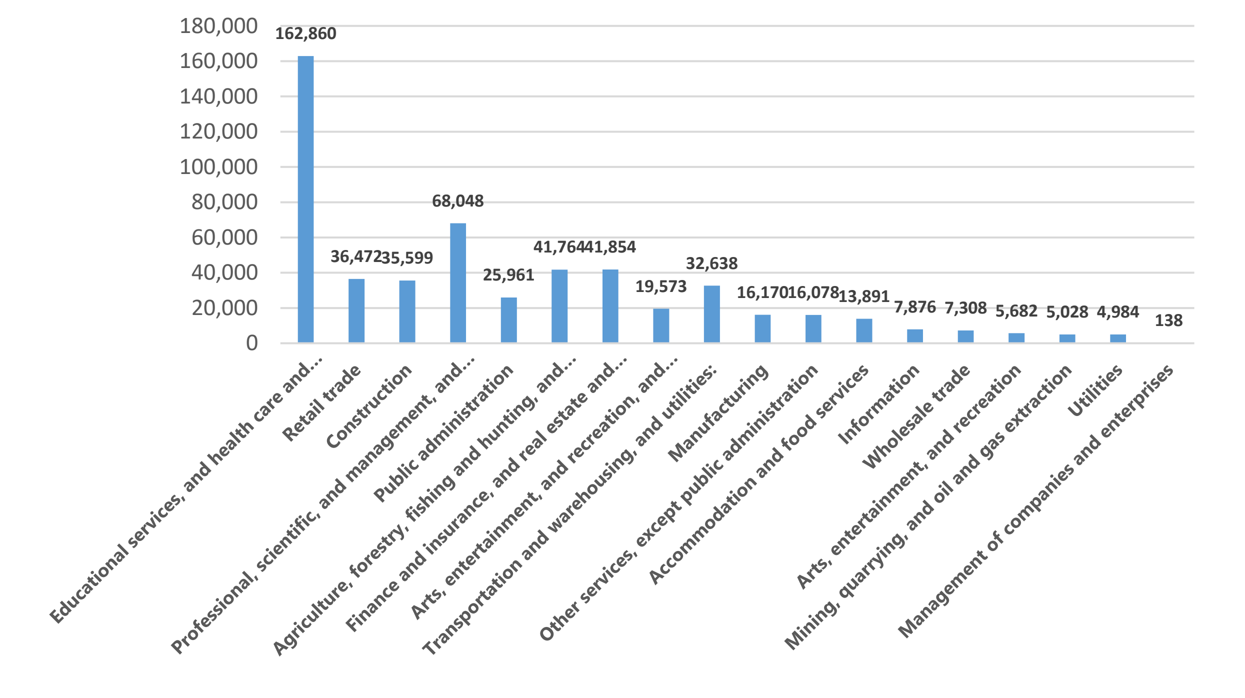
2.3 Development Trends

The population of the Central Region has been slowly declining since 2010, and the Montana Department of Commerce projects that this decline will continue through the year 2040. The projected 2040 populations of each county within the Central Region are shown in Table 2-1. (Population projections for the tribal reservations were not available.)

2.4 Economy

Figure 2.3 displays a breakdown of the total employment by industry statewide. According to the 2020 US Census, Montana's economy is largely based in the educational services, health care and social assistance industry with 162,860 people. This is followed by professional, scientific, management, administrative, technical, and waste management services with 68,048 total people. Third is finance, insurance, real estate, rental, and leasing with 41,854, followed closely by 41,764 people employed in agriculture, forestry, fishing and hunting, and mining services. These four sectors comprise 58% of employment in Montana.

Figure 2.3 Montana Industry Type by Percentage of Total Workers Employed



Data Source: US Census, 2020, Figure by WSP

2.5 Capability Assessment

Included in this Hazard Mitigation Plan is a capability assessment to review and document the planning area's current capabilities to mitigate risk and vulnerability from natural hazards. By collecting information about local/tribal existing government programs, policies, regulations, ordinances, and emergency plans, the planning team and MTDES can assess those activities and measures already in place that contribute to mitigating some of the risks and vulnerabilities identified. The capabilities assessment is divided into five sections: regulatory mitigation capabilities, administrative and technical mitigation capabilities, financial mitigation capabilities, education and outreach, and mitigation partnerships. The results of this assessment are captured in each jurisdictional annex.

3 Planning Process

Requirements §201.6(b) and §201.6(c)(1): An open public involvement process is essential to the development of an effective plan. In order to develop a more comprehensive approach to reducing the effects of natural disasters, the planning process shall include:

1) *An opportunity for the public to comment on the plan during the drafting stage and prior to plan approval;*
2) *An opportunity for neighboring communities, local and regional agencies involved in hazard mitigation activities, and agencies that have the authority to regulate development, as well as businesses, academia, and other private and non-profit interests to be involved in the planning process; and*
3) *Review and incorporation, if appropriate, of existing plans, studies, reports, and technical information.*

[The plan shall document] the planning process used to develop the plan, including how it was prepared, who was involved in the process, and how the public was involved.

i. *Tribal Requirement §201.7(c)(1): Documentation of the planning process used to develop the plan, including how it was prepared, who was involved in the process, and how the public was involved. This shall include:*
ii. *An opportunity for the public to comment on the plan during the drafting stage and prior to plan approval, including a description of how the Indian tribal government defined "public;"*

As appropriate, an opportunity for neighboring communities, tribal and regional agencies involved in hazard mitigation activities, and agencies that have the authority to regulate development, as well as businesses, academia, and other private and non-profit interests to be involved in the planning process.

3.1 Background on Mitigation Planning in Central Montana

The 2023 Central Montana Regional Hazard Mitigation Plan is the first regional hazard mitigation plan for the participating counties of Central Montana. The plan's creation over 2022-2023 will comply with the five-year update cycle required by the DMA 2000 going forward and reflects mitigation priorities for the five-year span between 2023-2028.

Prior to 2023, the counties and tribes of Central Montana had adopted jurisdictional-specific hazard mitigation plans over the years. The following table provides a summary of when each jurisdictions' hazard mitigation plan was originally developed, including the most recent adoption. Information on how the jurisdictions integrated the mitigation plan into other planning mechanisms can be found in Section 11.1 of each jurisdictional annex.

Table 3-1 Central Montana Local and Tribal HMP History, Adoption, and Integration

County/Tribe	Original Plan Approval	Most Recent Plan Adoption Prior to 2023
Blackfeet Nation	2007	2007
Blaine County	2006	2018
Cascade County	2011	2017
Chippewa Cree Tribe – Rocky Boys	2010	2020
Chouteau County	2010	2017
Fergus County	2007	2014
Fort Belknap Indian Community	2007	2022

County/Tribe	Original Plan Approval	Most Recent Plan Adoption Prior to 2023
Glacier County	2011	2018
Hill County	2006	2018
Judith Basin County	2007	2013
Liberty County	2007	2013
Petroleum County	2008	2008
Phillips County	2006	2012
Pondera County	2004	2018
Teton County	2014	2021
Toole County	2007	2013

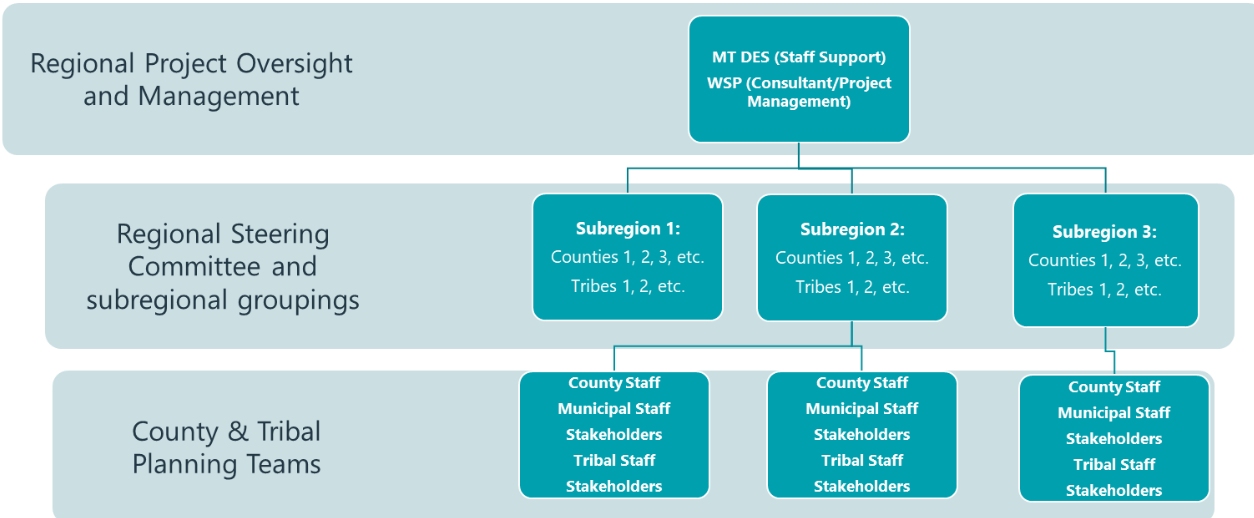
The regional planning process also provided an opportunity to reflect changes in priorities for each participating community. These are reflected in the hazard significance levels and in the mitigation strategy.

Regional Planning. While each county and tribe in Montana has an Emergency Management Coordinator, Montana DES has recognized that the process of developing and updating DMA 2000 compliant hazard mitigation plans can often be beyond local and tribal capabilities and expertise. Instead of each county and tribe hiring their own consultant, MTDES took the lead in procuring and funding a professional hazard mitigation planning consultant through a competitive bid process. In 2022, WSP USA Environment & Infrastructure Inc. (WSP) was selected by MTDES to provide assistance to the Region under a multi-year, multiple region contract. As the planning consultant, WSP's role was to:

- Provide guidance on a planning organization for the entire planning area representative of the participants;
- Ensure the plan meets all the DMA requirements as established by federal regulations, following FEMA's most recent planning guidance;
- Facilitate the entire planning process;
- Identify the data requirements that the participating counties, tribes, and municipalities could provide, and conduct the research and documentation necessary to augment that data;
- Develop and help facilitate the public input process;
- Produce the draft and final plan documents; and
- Ensure acceptance of the final Plan by MTDES and FEMA Region VIII.

Prior to initiating the development of this regional HMP in 2022, a substantial coordination effort took place to ensure the participation of the counties and tribes within Central Montana. Each jurisdiction designated the Emergency Management Coordinator as the primary point of contact. Each Coordinator was required to undertake a coordination role within their respective counties to help fulfill DMA planning requirements. The county Emergency Management Coordinators then contacted each of the incorporated communities, offering them the opportunity to participate in the development of the Regional Hazard Mitigation Plan. Most incorporated communities within the counties, as well as the tribes, chose to participate in the development of this Regional Plan. A graphic illustrating the regional planning framework is shown below.

Figure 3.1 Central Montana Regional Hazard Mitigation Planning Committee Framework



The Emergency Management Coordinator from each participating county and tribe served on the Regional Hazard Mitigation Planning Committee (HMPC), as well as convening and facilitating a County Planning Team (CPT) or Tribal Planning Team (TPT) in concert with MTDES and the consultant team.

3.2 Government Participation

The Disaster Mitigation Act (DMA) planning regulations and guidance stress that each local and tribal government seeking FEMA approval of their mitigation plan must participate in the planning effort in the following ways:

- Participate in the process as part of the Regional Hazard Mitigation Planning Committee (HMPC) through participation on a County Planning Team (CPT) or Tribal Planning Team (TPT),
- Detail areas within the planning area where the risk differs from that facing the entire area,
- Identify specific projects to be eligible for funding, and
- Have the governing board formally adopt the plan.

For the Central Montana Regional Hazard Mitigation Plan's HMPC, "participation" meant:

- Providing input by attending and participating in HMPC meetings, separate side-bar meetings, or email and phone correspondence;
- Establishing/reconvening a local steering committee;
- Providing available data requested by the HMPC coordinator and planning consultant;
- Providing/updating the hazard profile and vulnerability details specific to jurisdictions;
- Developing/updating the local mitigation strategy (action items and progress);
- Advertising and assisting with the public input process;
- Reviewing and commenting on plan drafts; and
- Coordinating the formal adoption of the plan by the governing boards.

This Regional Plan includes the participation of all counties and most of the municipalities in Central Montana as noted in Chapter 1 and detailed further in Section 3.3.1. Documentation of participation is included in Appendix B in the form of meeting sign-in sheets, meeting summaries, and more.

3.3 The 10-Step Planning Process

The HMPC established the planning process for the Central Montana plan using the DMA planning requirements and FEMA's associated guidance. This guidance is structured around a four-phase process:

1) Organize Resources
2) Assess Risks
3) Develop the Mitigation Plan
4) Implement the Plan and Monitor Progress

Into this four-phase process, WSP integrated a more detailed 10-step planning process used by FEMA's Community Rating System (CRS) and Flood Mitigation Assistance (FMA) programs. Thus, the modified 10-step process used for this plan meets the requirements of all of FEMA's Hazard Mitigation Assistance (HMA) grant programs, the CRS program, and flood control projects authorized by the US Army Corps of Engineers. Additionally, FEMA's March 2013 Local Mitigation Planning Handbook recommends a nine-task process within the four-phase process. Table 3-2 summarizes the four-phase DMA process, the detailed CRS planning steps and work plan used to develop the plan, the nine handbook planning tasks from FEMA's 2013 Local Mitigation Planning Handbook, and where the results are captured in the Plan. Tribal elements of the Regional HMP were designed to be fully compliant with the requirements of 44 CFR 201.7 as detailed in FEMA's 2019 Tribal Multi-Hazard Mitigation Planning Guidance. The sections that follow describe each planning step in more detail.

Table 3-2 Mitigation Planning Process Used to Develop the Regional Hazard Mitigation Plan

FEMA 4 Phase Guidance	CRS Planning Steps (Activity 510)	FEMA Local Mitigation Planning Handbook Tasks (44 CFR Part 201)	Location in Plan
Phase I: Organize Resources	Step 1. Organize Resources	1: Determine the Planning Area and Resources	Chapters 1, 2 and 3
		2: Build the Planning Team 44 CFR 201.6(c)(1)	Chapter 3, Section 3.3.1
	Step 2. Involve the public	3: Create an Outreach Strategy 44 CFR 201.6(b)(1)	Chapter 3, Section 3.3.1
	Step 3. Coordinate with Other Agencies	4: Review Community Capabilities 44 CFR 201.6(b)(2) & (3)	Chapter 3, Section 3.3.1 and annexes
Phase II: Assess Risks	Step 4. Assess the hazard	5: Conduct a Risk Assessment 44 CFR 201.6(c)(2)(i) 44 CFR 201.6(c)(2)(ii) & (iii)	Chapter 4 and annexes
	Step 5. Assess the problem		Chapter 4 and annexes
Phase III: Develop the Mitigation Strategy	Step 6. Set goals	6: Develop a Mitigation Strategy 44 CFR 201.6(c)(3)(i); 44 CFR 201.6(c)(3)(ii); and 44 CFR 201.6(c)(3)(iii)	Chapter 5, Section 5.2
	Step 7. Review possible activities		Chapter 5, Section 5.3
	Step 8. Draft an action plan		Chapter 5, Section 5.3.3 and annexes
Phase IV: Adopt and Implement the Plan	Step 9. Adopt the plan	8: Review and Adopt the Plan	Chapter 6
	Step 10. Implement, evaluate, revise	7: Keep the Plan Current	Chapter 6
		9: Create a Safe and Resilient Community 44 CFR 201.6(c)(4)	Chapter 6

3.3.1 Phase 1: Organize Resources

Planning Step 1: Organize the Planning Effort

With each jurisdiction's commitment to develop a Regional Plan, WSP worked with MTDES and each County and Tribal Coordinator to establish the framework and organization for the process. Organizational efforts were initiated with each county to inform and educate the plan participants of the purpose and need for the regional hazard mitigation plan. The planning consultant held an initial conference call using Microsoft Teams (Teams) to discuss the organizational aspects of the planning process with the Emergency Management Coordinators. Following FEMA planning guidance, MTDES and the consultant directed each participating county and tribe to develop their respective planning teams, comprised of representative county, tribal, and municipal staff members, prior to this meeting to ensure complete representation and active participation in the plan update process. Neighboring communities local and regional agencies involved in hazard mitigation activities, and agencies that have the authority to regulate development as well as businesses, academia, and other private and non-profit interests were also invited to participate and provide input. Additional invitations were extended as appropriate to other federal, state, tribal, and local stakeholders, as well as to members of the public, throughout the planning process. A full list of local government departments and stakeholders that participated can be found in Appendix A. More details with documentation of participation included are in Appendix B.

In the planning meetings and the online public survey outreach, community based organizations and underserved and socially vulnerable populations throughout the region were actively engaged and participated in the planning process. This allowed for a more comprehensive understanding of the diverse needs and perspectives of vulnerable populations, such as the elderly, veterans, homeless population, and low-income families, facilitating the development of more equitable and effective interventions and policies. Community-based organizations invited to participate in the planning process are shown below. Those noted with an asterisk also participated in the meetings. These groups were also asked to pass information on to the communities they serve, including encouraging participation in the public survey as a method to directly provide feedback into the planning process.

- Cascade Conservation District
- First Baptist Church Shelby*
- Harlem Ministerial Association
- Havre Family Connections*
- Laugh N Learn Childcare
- Montana Farm Service Agency
- Northfork Wellness
- Salvation Army
- Sweet Home Nursing

Local media outlets often use an innovative approach to inclusivity and thus are able to leverage their platforms to reach a wide audience, including vulnerable populations. The community-based media platforms who were invited to participate in the planning meetings are listed below:

- Fort Belknap News
- KGVA Radio Station
- Blaine County Journal

Through targeted outreach efforts, stakeholders were informed throughout the plan development process. The intent of the outreach was to facilitate partnerships and collaboration among various stakeholders, fostering a sense of shared responsibility and collective action towards mitigation goals. This can result in greater resource mobilization, improved coordination of efforts, and a better approach to risk reduction.

Throughout the plan development process, communication amongst the county and tribal planning teams occurred through a combination of face-to-face meetings, virtual meetings, conference calls, phone interviews, and email correspondence. During the kickoff meeting WSP presented information on the scope and purpose of the plan update, participation requirements of HMPC members, and the proposed project work plan and schedule. A plan for public involvement (Step 2) and coordination with other agencies and departments (Step 3) were discussed. The HMPC reviewed the hazard identification information for each jurisdiction and the Region and refined the list of identified hazards to mirror that of the Wyoming Hazard Mitigation Plan. In follow-up to the meeting, participants were provided a GIS needs worksheet to facilitate the collection of information needed to support the plan update, and a summary of the conference call.

Following the initial coordination efforts, a series of planning workshops were held during the plan's development between March 2022 and May 2023. The meeting schedule and topics are listed below. In addition, monthly conference calls were held with the Emergency Management Coordinators, MTDES and WSP to discuss the process including upcoming milestones and information needs. The sign-in sheets, meeting summaries, and agendas for each of the meetings are documented in Appendix B. HMPC planning workshops were scheduled as follows.

- Workshop #1: Kickoff meeting
  - March 31, 2022
- Workshop #2: Hazard Identification and Risk Assessment and Goals update
  - August 17, 2022
  - The purpose of this workshop was to review the results of the risk assessment and review and update/develop goals.
- Workshop #3: Mitigation Strategy update
  - Three in person workshops were held in the Region:
    - October 11, 2022 – Fairfield, Montana
    - October 12, 2022 – Lewistown, Montana
    - October 13, 2022 – Fort Benton, Montana
  - This workshop focused on the update of the mitigation strategy and brainstorming new mitigation actions to include in the HMP.

To further supplement the meetings, the consultant developed a project website to help explain the background details of the project, provide education and information on the processes of hazard mitigation planning, advertise public outreach efforts, and post meeting materials and plan documents to be available for review. Figure 3.2 shows a snapshot of the homepage of the project website, which is also available at mitigationplanmt.com.

Figure 3.2 Montana Hazard Mitigation Project Website

In some cases, HMPC meetings were supplemented with additional meetings, emails, and telephone discussions to further engage the municipalities in the process. Throughout 2022, Cascade County and MTDES engaged with elected officials in the Towns of Neihart, Geraldine, Valier, and Dodson regarding this planning effort; however, these Towns ultimately determined they did not have sufficient time or resources to fully participate and will not be adopting this version of the plan. The Fort Belknap Indian Community, having just updated their own Tribal HMP in 2023, also elected not to participate in the Regional HMP.

Planning Step 2: Involve the Public

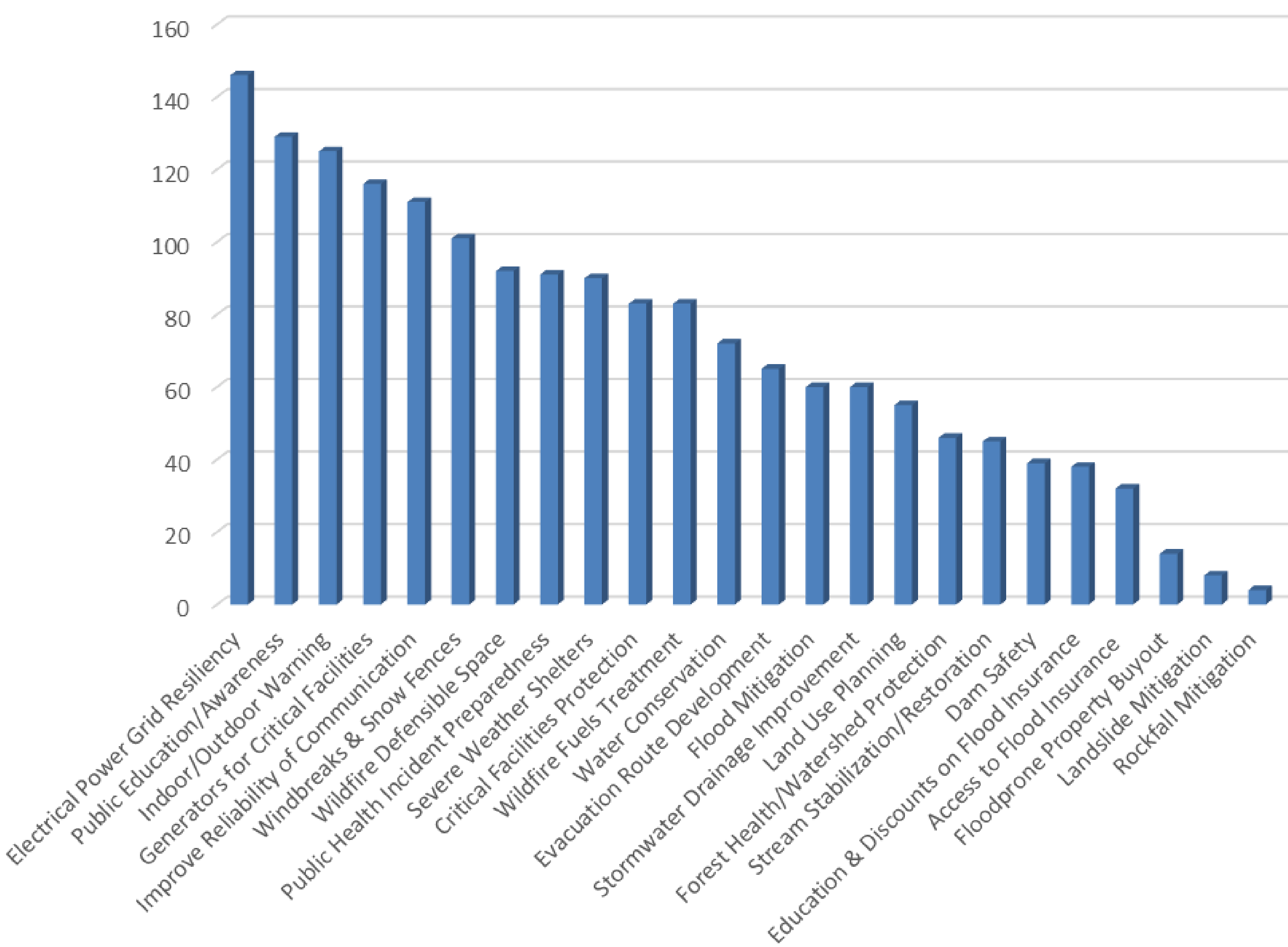
The 2022 planning process was an open one, with the public informed and involved throughout the process. In some cases, the HMPC meetings included members of the public and/or local media. Public outreach included social media notices, a public survey, and a public comment form to allow the public the opportunity to share comments on the draft plan.

2022 Public Survey

Early in the planning process, a public survey was developed as a tool to gather public input. The survey was for the public to provide feedback to the county and tribal planning teams on topics related to hazard concerns and reducing hazard impacts. The survey provided an opportunity for public input during the planning process, prior to finalization of the plan update. The survey gathered public feedback on what hazards concern them and solicited input on strategies to reduce their impacts. The survey was released as both an online tool in early May 2022 and closed on June 30, 2022. The counties and tribes provided links to the public survey by distributing it using social media, email, and posting the link on websites. In total, 267 survey responses were received and shared with the county and tribal planning committees to inform the process.

The public survey included a question on ranking hazard significance. The results generally track with the significance levels noted in Chapter 4 of this plan, with severe winter weather and wildland fires being rated the most significant, and drought and severe summer weather being rated medium significance. The following graph is a display of the results from Question 17, which asked what types of mitigation actions should have the highest priority in the Central Region Hazard Mitigation Plan. The results indicate that electrical power grid resiliency, public education and awareness programs, indoor/outdoor warning systems, and generators for critical facilities were popular mitigation topics with the public (Figure 3.3). Full results of the survey are included in Appendix D.

Figure 3.3 Central Montana Public Survey Results



Prior to finalizing, a draft of the regional plan was made available to the public for review and comment in August and September 2023. The plan and annexes were made available on the MTDES website as well via an online public engagement space, shown in Figure 3.4. The counties and tribes used social media, website posts, and email blasts to announce the public comment period. An online feedback form was provided to collect specific comments.

Three public comments were received on the draft plan. They were reviewed with the HMPC, but did not result in any meaningful changes to the HMP or its Annexes.

Figure 3.4 Regional Hazard Mitigation Plan Virtual Public Engagement Space

Planning Step 3: Coordinate with Other Departments and Agencies

Early in the planning process, the HMPC determined that data collection, mitigation strategy development, and plan approval would be greatly enhanced by inviting state and federal agencies and other organizations to participate in the process. A wide variety of stakeholders were invited by email to attend planning meetings, provide information, and review the draft plan, to include:

- Neighboring communities such as surrounding counties;
- Agencies involved in hazard mitigation activities, such as the U.S. Army Corps of Engineers and Montana Rural Water System;
- Agencies with the authority to regulate development, such as various planning boards and the Snowy Mountain Development Corporation;
- Businesses and infrastructure owners, such as Northwestern Energy, BSNF Railway, and high hazard dam owners/operators;
- Academia and schools, such as local school districts and MSU Extension Offices;
- Nonprofits and community organizations that represent socially vulnerable populations, such as the American Red Cross, Salvation Army, and the Harlem Ministerial Association.

Appendix A lists the individuals and agencies that participated in the regional planning process, as well as those that were invited but did not participate.

Coordination with certain agencies occurred on a regular basis during the planning process, including a bi-weekly (and weekly in initial months of the project) coordination call with WSP, MTDES and other stakeholders. Other federal stakeholders that regularly participated in these meetings included FEMA

Region VIII, the Environmental Protection Agency, and the US Army Corps of Engineers (USACE). Other stakeholders included private non-profit organizations (Headwaters Economics), and a consulting firm involved in the update of the Montana Hazard Mitigation Plan. USACE representatives participated in regional mitigation strategy workshops, including providing information on funding programs and suggestions for partnerships on mitigation actions. In some instances, faith-based organizations, local healthcare and local utility providers were invited to participate in HMPC meetings (e.g. Teton and Toole counties). The public survey previously described included distribution lists and social media connections with members of local businesses and schools (as well as the public) to provide input during the planning process.

Other Community Planning Efforts and Hazard Mitigation Activities

Coordination with other community planning efforts is an important aspect of mitigation planning. Hazard mitigation planning involves identifying existing policies, tools, and actions that will reduce a community's risk and vulnerability from natural hazards. Each county, the tribes, and most municipalities in the Region use a variety of comprehensive planning mechanisms, such as master plans and ordinances, to guide growth and development. Integrating existing planning efforts and mitigation policies and action strategies into this plan establishes a credible and comprehensive plan that ties into and supports other community programs. The development of this plan incorporated information from the following existing plans, studies, reports, and initiatives as well as other relevant data from neighboring communities and other jurisdictions. Examples of this include.

- County comprehensive plans
- Community Wildfire Protection Plans
- Montana State Hazard Mitigation Plan (2018)
- Existing Local and Tribal HMPs
- Montana Forest Action Plan (2020)
- Montana Climate Solutions Plan (2020)

Other documents were reviewed and cited, as appropriate, during the collection of data to support Planning Steps 4 and 5, which include the hazard identification, vulnerability assessment, and capability assessment, are noted in Appendix E References.

3.3.2 Phase 2: Assess Risks

Planning Steps 4 and 5: Identify the Hazards and Assess the Risks

WSP led the HMPC and CPT/TPTs to identify and document all the hazards that have, or could, impact the planning area. The existing county and tribal hazard mitigation plans, and the Montana State Hazard Mitigation Plan provided a knowledge basis for many of the hazard profiles. Where data permitted, Geographic Information Systems (GIS) were used to display, analyze, and quantify hazards and vulnerabilities. Sophisticated analyses for dam inundation, flood, liquefaction, and wildfire hazards were performed by WSP that included an analysis of flood risk based on the Digital Flood Insurance Rate Maps (DFIRMs), where available. A more detailed description of the risk assessment process and the results are included in Chapter 4 Hazard Analysis and Risk Assessment.

Also included in the regional plan is a capability assessment to review and document the planning area's current capabilities to mitigate risk and vulnerability from hazards. By collecting information about existing government programs, policies, regulations, ordinances, and emergency plans, the HMPC can assess those activities and measures already in place that contribute to mitigating some of the risks and vulnerabilities identified. The results of the updated capability assessment are captured in each annex.

During this phase, the tribes and participating jurisdictions reviewed hazard significance levels, as described in Chapter 4, to determine if any changes in priorities were needed. Additional feedback on priority levels were solicited during Workshop #2, using an online polling tool.

3.3.3 Phase 3: Develop the Mitigation Plan

Planning Steps 6 and 7: Set Goals and Review Possible Activities

WSP facilitated discussion sessions with the HMPC that described the purpose and the process of developing planning goals, a comprehensive range of mitigation alternatives, and a method of selecting and defending recommended mitigation actions using a series of selection criteria. This process was used to update and enhance the mitigation action plan for each jurisdiction and tribe, which is the essence of the planning process and one of the most important outcomes of this effort. The action plans are detailed in each county and reservation annex; the process used to identify and prioritize mitigation actions is described in greater detail in Chapter 5 Mitigation Strategy.

During this phase the tribes and participating jurisdictions reviewed mitigation action priority levels, as described in Chapter 5, to determine if any changes in priorities were needed using a mitigation action status tool.

Planning Step 8: Draft an Action Plan

Based on input from the HMPC regarding the draft risk assessment and the goals and activities identified in Planning Steps 6 and 7, WSP produced a complete first draft of the Regional Plan. This complete draft was shared for HMPC and CPT/LPT review and comment by email from the consultant and posted on the project website and cloud-based share drive. Comments were integrated into the second draft, which was advertised and distributed to collect public input and comments. Other agencies and neighboring county emergency managers were invited to comment on this draft as well. WSP integrated comments and issues from the public, as appropriate, along with additional internal review comments and produced a final draft for Montana DES and FEMA Region VIII to review and approve, contingent upon final adoption by the governing boards of each participating jurisdiction.

3.3.4 Phase 4: Implement the Plan and Monitor Progress

Planning Step 9: Adopt the Plan

To secure buy-in and officially implement the plan, the plan was adopted by the governing boards of each participating jurisdiction. As the adoption process follows the FEMA plan review and approval, copies of the adoption resolution will be included electronically in Appendix D.

Planning Step 10: Implement, Evaluate, and Revise the Plan

The true worth of any mitigation plan is in the effectiveness of its implementation. Each recommended action includes key descriptors, such as a lead manager and possible funding sources, to help initiate implementation. Progress on the implementation of specific actions identified in the plan is captured in a discussion and the mitigation action plan summary table in Chapter 5 Mitigation Strategy. An overall implementation strategy is described in Chapter 6 Plan Adoption, Implementation and Maintenance.

Finally, there are numerous organizations within the Central Region whose goals and interests' interface with hazard mitigation. Coordination with these other planning efforts, as addressed in Planning Step 3, is important to the ongoing success of this plan, and mitigation in Central Montana and is addressed further in Chapter 6. A plan update and maintenance schedule and a strategy for continued public involvement are also included in Chapter 6, and specifics are also in the annexes for the participating counties and tribes.

3.4 Tribal Mitigation Planning Process

The Central Montana Regional Hazard Mitigation Plan meets the requirements for Tribal Mitigation Plans described in Title 44 of the Code of Federal Regulations, Section 201.7 (44 CFR § 201.7). Under the Sandy Recovery Improvement Act of 2013, federally recognized Tribal governments could obtain their own major disaster declaration for the first time, enabling them to apply to FEMA for disaster assistance independent of the state obtaining a declaration. The Tribal Mitigation Planning Handbook outlines a 7-step planning process for the development of mitigation plans which meet the needs of tribal governments. These 7-steps are summarized in Table 3-3.

Table 3-3 Tribal Mitigation Planning 7-Step Process

Planning Step	Title	Description
1	Describe your community	Describe the planning area, Tribal assets, and any unique characteristics of your Tribe.
2	Identify your hazards	Figure out what natural hazards could occur in your planning area
3	Explain impacts that hazards can have on the community	Describe what the natural hazards could do to your people, property, and land and determine the Tribe's biggest hazard concerns
4	Review your current capability to mitigate the impacts	Inventory your Tribe's plans, policies, and programs that could be used to protect your community.
5	Develop the strategy	Keeping in mind your risks and your capabilities, identify your Tribe's mitigation goals and actions.
6	Develop an action plan	Prioritize your actions and develop the details to assist with implementation
7	Keep track of progress	Observe and record progress in implementing your mitigation program using a defined method and schedule.

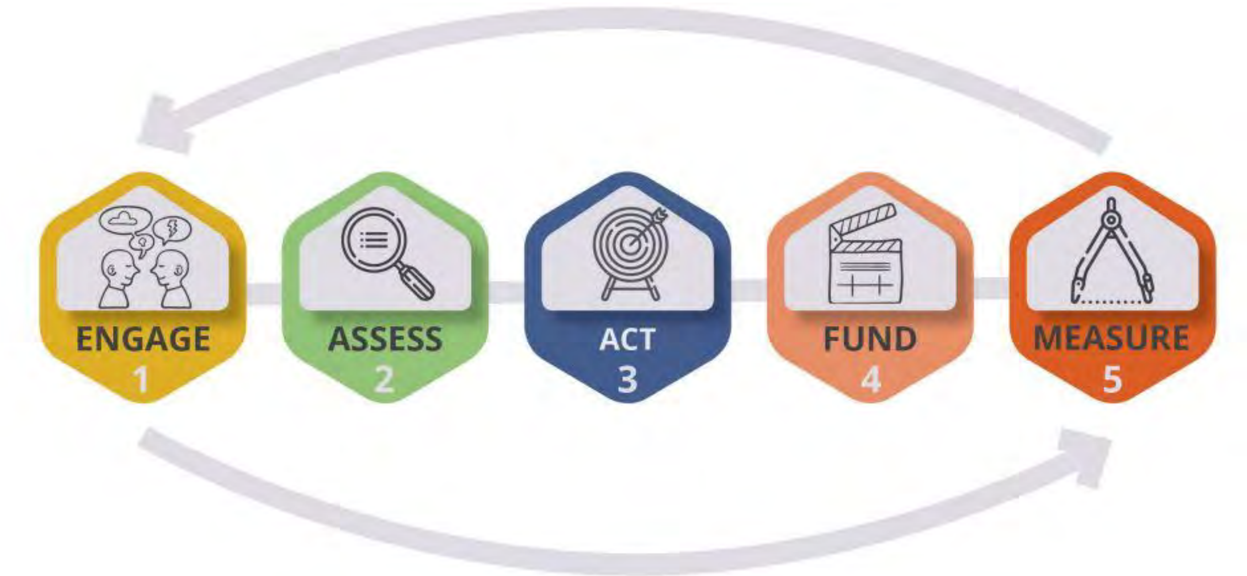
3.5 EPA Regional Resilience Toolkit

The Environmental Protection Agency (EPA), in partnership with FEMA, has developed the Regional Resilience Toolkit to focus the development of resilient communities on the regional scale at which disasters happen. As stated in the toolkit, with more and more communities facing the effects of disasters, decision-makers and community members need tools and guidance to help them take action that can both protect them from natural disasters while also creating great places to live, work, and play. This Regional Resilience Toolkit provides:

- A coordinated process for meeting many different state and federal planning requirements.
- Communication and outreach guidance and resources for engaging a broad coalition of stakeholders across a region.
- Guidance for project teams who are conducting vulnerability assessments, writing required plans, and implementing projects.
- Clear information and tools that can be used with an advisory group and to bring in decision-makers and community leaders to guide the overall action plan and ensure its successful implementation.
- Detailed appendices with worksheets to help inform and guide work, as well as additional information and resources for each step.

The toolkit includes five steps designed so that users can jump in at any point of the process depending on their progress with community resilience planning. These five steps are shown in Figure 3.5 below:

Figure 3.5 EPA Regional Resilience Toolkit Planning Steps



Source: EPA Regional Resilience Toolkit, https://www.epa.gov/smartgrowth/regional-resilience-toolkit

The toolkit also relies in part on engaging state and federal partners who have funding, policies, and programs intended to support local efforts to create sustainable and resilient communities, helping to supplement the mitigation strategy of this regional HMP. Like the FEMA mitigation planning process, the steps of the resilience toolkit are intended to ideally work in a continuous loop improving planning and community resilience over time. This is a valuable tool for the development of the Central Montana Regional HMP, due to the large scale of the planning area and the history of hazards which have had regional impacts.

4 Hazard Identification and Risk Assessment

Requirement 201.6(c)(2): [The plan shall include] A risk assessment that provides the factual basis for activities proposed in the strategy to reduce losses from identified hazards. Local risk assessments must provide sufficient information to enable the jurisdiction to identify and prioritize appropriate mitigation actions to reduce losses from identified hazards. The risk assessment shall include:

(i) A description of the type, location, and extent of all natural hazards that can affect the jurisdiction. The plan shall include information on previous occurrences of hazard events and on the probability of future hazard events.

(ii) A description of the jurisdiction's vulnerability to the hazards described in paragraph (c)(2)(i) of this section. This description shall include an overall summary of each hazard and its impact on the community. The plan should describe vulnerability in terms of:

(A) The types and numbers of existing and future buildings, infrastructure, and critical facilities located in the identified hazard areas;

(B) An estimate of the potential dollar losses to vulnerable structures identified in paragraph (c)(2)(ii)(A) of this section and a description of the methodology used to prepare the estimate;

(C) Providing a general description of land uses and development trends within the community so that mitigation options can be considered in future land use decisions.

(ii) For multi-jurisdictional plans, the risk assessment section must assess each jurisdiction's risks where they vary from the risks facing the entire planning area.

As defined by the Federal Emergency Management Agency (FEMA), risk is a combination of hazard, vulnerability, and exposure. "It is the impact that a hazard would have on people, services, facilities, and structures in a community and refers to the likelihood of a hazard event resulting in an adverse condition that causes injury or damage."

The risk assessment process identifies and profiles relevant hazards and assesses the exposure of lives, property, and infrastructure to these hazards. The process allows for a better understanding of a jurisdiction's potential risk to hazards and provides a framework for developing and prioritizing mitigation actions to reduce risk from future hazard events.

This risk assessment builds upon the methodology described in the 2013 FEMA Local Mitigation Planning Handbook, which recommends a four-step process for conducting a risk assessment:

1) Describe Hazards
2) Identify Community Assets
3) Analyze Risks
4) Summarize Vulnerability

Data collected through this process has been incorporated into the following sections of this chapter:

Section 4.1 Hazard Identification identifies the hazards that threaten the planning area and describes why some hazards have been omitted from further consideration.

Section 4.2 Hazard Profiles discusses the threat to the planning area and describes previous occurrences of hazard events, the likelihood of future occurrences, and the Region's vulnerability to particular hazard events.

Additional County Annexes include a summary of community assets including population, building stock, critical facilities, and historic, cultural, and natural resources. Additional details on vulnerability to specific hazards where they vary from those of the Region are noted in the annexes, with more detailed maps.

4.1 Hazard Identification

4.1.1 Results and Methodology

Using existing hazards data, plans from participating jurisdictions, and input gained through planning and public meetings, the County and Tribal Planning Teams agreed upon a list of hazards that could affect the Region.

Hazards data from FEMA, Montana Disaster and Emergency Services (DES), the 2018 State of Montana Multi-Hazard Mitigation Plan, approved county and tribal plans from the participating Central Region counties, and many other sources were examined to assess the significance of these hazards to the planning area. The hazards evaluated in this plan include those that have occurred historically or have the potential to cause significant human and/or monetary losses in the future.

The final list of hazards identified and investigated for the 2022/2023 Central Region Multi-Hazard Mitigation Plan includes:

- Communicable Disease
- Cyber Attack
- Dam Failure
- Drought
- Earthquake
- Flooding
- Hazardous Materials Incidents
- Landslide
- Severe Summer Weather
- Severe Winter Weather
- Human Conflict
- Tornadoes & Windstorms
- Transportation Accidents
- Volcanic Ash
- Wildland and Rangeland Fire

Members of each county's planning team used a hazards worksheet to rate the significance of hazards that could potentially affect the region. Significance was measured in general terms, focusing on key criteria such as the likelihood for future occurrences of the event, frequency of past occurrences, geographical area affected, and damage and casualty potential. Table 4-1 represents the worksheet used to identify and rate the hazards and is a composite that includes input from all the participating jurisdictions. Note that the significance of the hazard may vary from jurisdiction to jurisdiction. The County Annexes include further details on hazard significance by county and municipality.

Table 4-1 Central Region Hazard Significance Summary Table

Hazard	Geographic Area	Magnitude	Probability	Significance
Communicable Disease	Extensive	Critical	Occasional	Medium
Cyber-Attack	Significant	Critical	Likely	Medium
Dam Failure	Significant	Critical	Occasional	Medium
Drought	Extensive	Critical	Likely	Medium
Earthquake	Significant	Limited	Likely	Low
Flooding	Limited	Critical	Likely	Medium
Hazardous Material Incidents	Limited	Negligible	Likely	Low

Hazard	Geographic Area	Magnitude	Probability	Significance
Landslide	Limited	Negligible	Likely	Low
Severe Summer Weather	Extensive	Limited	Highly Likely	Medium
Severe Winter Weather	Extensive	Critical	Highly Likely	High
Human Conflict	Significant	Limited	Occasional	Low
Tornadoes & Windstorms	Extensive	Limited	Highly Likely	Medium
Transportation Accidents	Limited	Limited	Highly Likely	Medium
Volcanic Ash	Extensive	Limited	Unlikely	Low
Wildland and Rangeland Fire	Extensive	Critical	Highly Likely	High

Geographic Area	Probability of Future Occurrences
Negligible: Less than 10 percent of planning area or isolated single-point occurrences Limited: 10 to 25 percent of the planning area or limited single-point occurrences Significant: 25 to 75 percent of planning area or frequent single-point occurrences Extensive: 75 to 100 percent of planning area or consistent single-point occurrences	Unlikely: Less than 1 percent probability of occurrence in the next year or has a recurrence interval of greater than every 100 years. Occasional: Between a 1 and 10 percent probability of occurrence in the next year or has a recurrence interval of 11 to 100 years. Likely: Between 10 and 90 percent probability of occurrence in the next year, or has a recurrence interval of 1 to 10 years Highly Likely: Between 90 and 100 percent probability of occurrence in the next year or has a recurrence interval of less than 1 year.
Potential Magnitude/Severity	**Overall Significance**
Negligible: Less than 10 percent of property is severely damaged, facilities and services are unavailable for less than 24 hours, injuries and illnesses are treatable with first aid or within the response capability of the jurisdiction. Limited: 10 to 25 percent of property is severely damaged, facilities and services are unavailable between 1 and 7 days, injuries and illnesses require sophisticated medical support that does not strain the response capability of the jurisdiction, or results in very few permanent disabilities. Critical: 25 to 50 percent of property is severely damaged, facilities and services are unavailable or severely hindered for 1 to 2 weeks, injuries and illnesses overwhelm medical support for a brief period of time or result in many permanent disabilities and a few deaths. overwhelmed for an extended period of time or many deaths occur. Catastrophic: More than 50 percent of property is severely damaged, facilities and services are unavailable or hindered for more than 2 weeks, the medical response system is overwhelmed for an extended period of time or many deaths occur.	Low: Two or more of the criteria fall in the lower classifications or the event has a minimal impact on the planning area. This rating is also sometimes used for hazards with a minimal or unknown record of occurrences/impacts or for hazards with minimal mitigation potential. Medium: The criteria fall mostly in the middle ranges of classifications and the event's impacts on the planning area are noticeable but not devastating. This rating is also sometimes utilized for hazards with a high impact rating but an extremely low occurrence rating. High: The criteria consistently fall along the high ranges of the classification and the event exerts significant and frequent impacts on the planning area. This rating is also sometimes utilized for hazards with a high psychological impact or for hazards that the jurisdiction identifies as particularly relevant.

4.1.2 Other Hazards Considered But Not Profiled

As part of the hazard identification process, the Regional Steering Committee and County and Tribal Planning Teams also noted other hazards that could impact the region but are not further profiled as impacts tend to be more isolated or do not result in local, state, or federal disaster declarations. These include wildlife hazards associated with human/wildlife interaction and collisions, and avalanches. Avalanche terrain exists on the far western portion of the region but typically impacts isolated and undeveloped areas.

4.1.3 Disaster Declaration History

As part of the hazard identification process, the Regional Steering Committee and County and Tribal Planning Teams researched past events that triggered federal and/or state emergency or disaster declarations in the planning area. Federal and/or state disaster declarations may be granted when the severity and magnitude of an event surpasses the ability of the local government to respond and recover. Disaster assistance is supplemental and sequential. When the local government's capacity has been surpassed, a state disaster declaration may be issued, allowing for the provision of state assistance. Should the disaster be so severe that both the local and state governments' capacities are exceeded, a federal emergency or disaster declaration may be issued allowing for the provision of federal assistance.

The federal government may issue a disaster declaration through FEMA, the U.S. Department of Agriculture (USDA), and/or the Small Business Administration (SBA). FEMA also issues emergency declarations, which are more limited in scope and without the long-term federal recovery programs of major disaster declarations. The quantity and types of damage are the determining factors.

A USDA declaration will result in the implementation of the Emergency Loan Program through the Farm Services Agency. This program enables eligible farmers and ranchers in the affected county as well as contiguous counties to apply for low interest loans. A USDA declaration will automatically follow a major disaster declaration for counties designated major disaster areas and those that are contiguous to declared counties, including those that are across state lines. As part of an agreement with the USDA, the SBA offers low interest loans for eligible businesses that suffer economic losses in declared and contiguous counties that have been declared by the USDA. These loans are referred to as Economic Injury Disaster Loans.

Table 4-2 provides information on federal emergencies and disasters declared in the Central Region counties between 1963 and 2022. Table 4-3 provides information on state emergencies and disasters declared in the Central Region and documented in the 2023 SHMP update.

Table 4-2 Federal Disaster Declarations in the Central Region, 1953-2022

Year	Declaration Title	Disaster #	Area Impacted
1974	Severe Storms, Flooding & Landslides	DR-417-MT	Glacier
1975	Rains, Snowmelt, Storms & Flooding	DR-472-MT	Cascade, Fergus, Glacier, Judith Basin, Pondera, Teton, Toole
1977	Drought	EM-3050-MT	Glacier, Teton
1981	Severe Storms & Flooding	DR-640-MT	Cascade
1986	Heavy Rains, Landslides & Flooding	DR-761-MT	Chouteau, Fergus, Glacier, Liberty, Petroleum, Phillips, Pondera, Teton, Toole
1986	Severe Storms & Flooding	DR-777-MT	Blaine, Hill, Phillips
1996	Severe Storms, Flooding, And Ice Jams	DR-1105-MT	Chouteau
1996	Severe Storms, Flooding, Ice Jams, Soil Saturation	DR-1113-MT	Blaine, Hill, Liberty, Toole, Phillips
1997	Severe Storms, Ice Jams, Snow Melt, Flooding	DR-1183-MT	Judith Basin

Year	Declaration Title	Disaster #	Area Impacted
2000	Wildfires	DR-1340-MT	All counties in Central Region
2002	Severe Storms And Flooding	DR-1424-MT	Glacier, Liberty, Toole, Hill, Pondera
2005	Hurricane Katrina Evacuation	EM-3253-MT	Statewide
2010	Severe Storms And Flooding	DR-1922-MT	Hill, Chouteau, Rocky Boy's Reservation
2011	Severe Storms And Flooding	DR-1996-MT	All counties in Central Region
2013	Flooding	DR-4127-MT	Hill, Chouteau, Blaine, Fergus, Petroleum, Rocky Boy's Reservation, Fort Belknap
2014	Ice Jams And Flooding	DR-4172-MT	Pondera
2014	Severe Storms, Straight-Line Winds, And Flooding	DR-4198-MT	Blaine, Fort Belknap, Petroleum
2016	Severe Winter Storm And Straight-Line Winds	DR-4271-MT	Liberty, Toole, Glacier, Pondera, Teton
2017	Lodgepole Fire Complex	FM-5194-MT	Petroleum
2017	Strawberry Fire	FM-5212-MT	Blackfeet Nation, Pondera, Teton
2018	Flooding	DR-4388-MT	Pondera, Toole, Liberty, Hill, Blaine, Petroleum
2020	COVID-19	EM-3476-MT	Statewide
2020	COVID-19 PANDEMIC	DR-4508-MT	Statewide

Source: FEMA

Table 4-3 State-Declared Emergencies and Disasters

Year	Hazard	State Declaration		County (Town)
1978	Flood	E0-13-78	PA-ST-78-12	Petroleum County
1978	Flood	E0-13-78	PA-ST-78-11	Petroleum County (Winnett)
1979	Flood	PA-ST-79-10		Fergus County (Denton)
1979	Flood	PA-ST-79-11		Petroleum County
1991	Flood	EO-15-91	MT-2-91	Blaine County
1991	Flood	EO-33-91	MT-4-91	Blaine County
1991	Flood	EO-12-91	MT-1-91	Teton County
1992	Drought	EO 13-92		Statewide
1993	Drought	EO 14-92		Statewide
1994	Flood	EO-04-94	MT-1-94	Petroleum County
1998	Flood	EO-10-98	MT-2-98	Hill County
2005	Flood	EO-11-2005	MT-2-05	Chouteau County
2010	Flood	EO-21-2010	MT-4-10	Petroleum County
2018	Cold & Blizzard Conditions	EO 5-2018		Blackfeet Nation, Fort Belknap Reservation, Northern Cheyenne Reservation, Glacier County, Golden Valley County
2018	Flood	EO-20-2018		Cascade County, Lewis and Clark County, Lewis and Clark County (Great Falls)

Year	Hazard	State Declaration		County (Town)
2018	Flood	EO-11-2018		Fort Belknap Indian Reservation, Town of Chester, Counties: Pondera, Hill, Blaine, Valley, Toole, Liberty, Petroleum
2018	Flood	EO-11-2018		Liberty County (Chester)
2019	Severe Winter Weather	EO 15-2019		Statewide
2019	Flood	EO-13-2019		Teton County
2020	Wildfire	EO-8-2020		Statewide
2021	Wildfire	EO-12-2021		Statewide
2021	Drought	EO 11-2021		Statewide
2022	Harsh Winter Conditions	EO 1-2022		Statewide

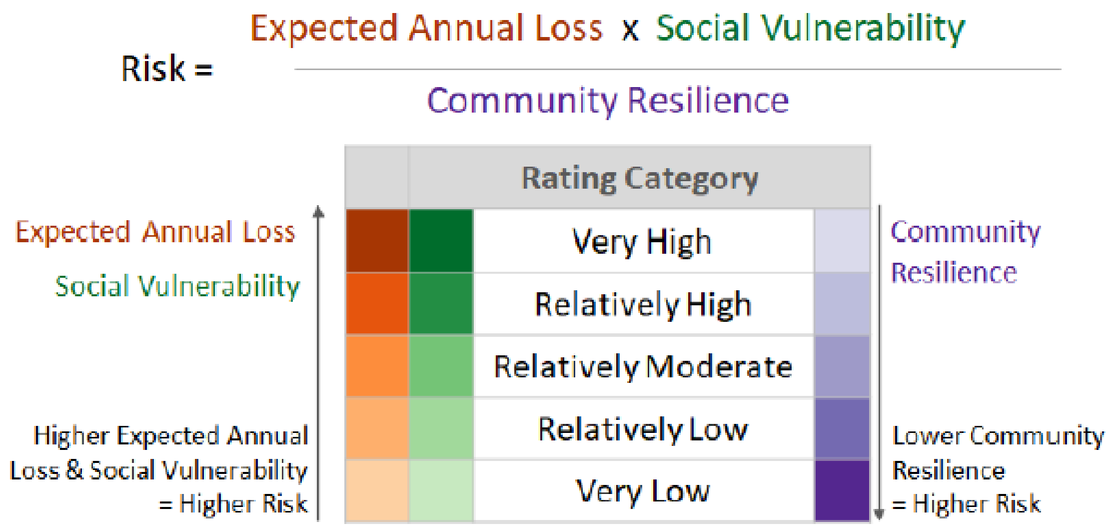
Source: State of Montana

4.1.4 National Risk Index Overview

During the 2022/2023 planning process a relatively new online risk assessment tool became available from FEMA. The National Risk Index (NRI) is a dataset and online tool to help illustrate the United States communities most at risk for 18 natural hazards. It was designed and built by FEMA in close collaboration with various stakeholders and partners in academia; local, state, and federal government; and private industry. The Risk Index leverages available source data for natural hazard and community risk factors to develop a baseline relative risk measurement for each United States county and census tract. The NRI's interactive mapping and data-based interface enables users to visually explore individual datasets to better understand what is driving a community's natural hazard risk. Users may also create reports to capture risk details on a community or conduct community-based risk comparisons, as well as export data for analysis using other software. Intended users of the NRI include planners and emergency managers at the local, regional, state, and federal levels, as well as other decision makers and interested members of the general public.

The NRI provides relative Risk Index scores and ratings based on data for Expected Annual Loss (EAL) due to natural hazards, social vulnerability, and community resilience. Separate scores and ratings are also provided for each component: Expected Annual Loss, Social Vulnerability, and Community Resilience.

Figure 4.1 Generalized National Risk Index Risk Equation and Components



Source: FEMA NRI Technical Documentation 2021

For the Risk Index and EAL, scores and ratings can be viewed as a composite score for all hazards or individually for each of the 18 hazard types.

NATIONAL RISK INDEX HAZARD TYPES

1. Avalanche	6. Hail	11. Lightning	16. Volcanic Activity
2. Coastal Flooding	7. Heat Wave	12. Riverine Flooding	17. Wildfire
3. Cold Wave	8. Hurricane	13. Strong Wind	18. Winter Weather
4. Drought	9. Ice Storm	14. Tornado	
5. Earthquake	10. Landslide	15. Tsunami	

The NRI was evaluated by the Regional Steering Committee and Montana DES's planning consultant to determine its applicability to the Central Region HIRA. An added benefit of leveraging NRI data for the regional plan included standardized methods for assessing risk on a county-by-county scale for most of the natural hazards in the HIRA. This included composite risk indicators for hazards previously lacking necessary data, including subsets of summer and winter storms including cold wave, lightning, wind, and ice storms. The other benefit is that moving forward, FEMA will be periodically updating and improving the NRI, which should provide a valuable and standardized resource for future HIRA updates.

The HIRA sections for Drought, Landslides, Flood, Severe Summer Weather, Severe Winter Weather, and Tornadoes & Windstorms contain the following aggregate risk products, mapped by WSP using NRI data:

- Annualized Frequency
- Composite Risk Index Rating
- Expected Annual Loss

Sources of hazards and exposure data includes SHELDUS, NOAA, USGS, National Weather Service (NWS), United States Department of Agriculture (USDA). Consequences of hazard occurrences are categorized into three different types: buildings, population, and agriculture. Additional details can be referenced in the FEMA NRI Technical documentation 2021, available at https://hazards.fema.gov/nri/.

4.1.5 Assets Summary

Building and Critical Facility Assets

Assets inventoried for the purpose of determining vulnerability include people, buildings, critical facilities, and natural, historic, or cultural resources. For the regional planning process two standard databases were utilized for the basis of building and critical facility data. April 2022 MSDI Cadastral Parcel layer was used for improved parcel and building inventory throughout the region. This information provided the basis for building exposure and property types. Data current as of 2022 was downloaded for all the counties within the Region, which was then analyzed using GIS to create a centroid, or point, representing the center of each parcel polygon, for vulnerability analysis using GIS. A critical facility is defined as one that is essential in providing utility or direction either during the response to an emergency or during the recovery operation. Much of this data is based on GIS databases associated with the 2022 Homeland Infrastructure Foundation-Level Data (HIFLD). Other critical facility databases were also used, such as the National Bridge Inventory (NBI) and data from Montana DES. Where applicable, this information was used in an overlay analysis for hazards such as flood and wildfire. More detail on assets potentially exposed to hazards can be found in the county annexes.

FEMA organizes critical facilities into seven lifeline categories as shown in Figure 4.2.

Figure 4.2 FEMA Lifeline Categories

These lifeline categories standardize the classification of critical facilities and infrastructure that provide indispensable service, operation, or function to a community. A lifeline is defined as providing indispensable service that enables the continuous operation of critical business and government functions, and is critical to human health and safety, or economic security. These categorizations are particularly useful as they:

- Enable effort consolidations between government and other organizations (e.g., infrastructure owners and operators).
- Enable integration of preparedness efforts among plans; easier identification of unmet critical facility needs.
- Refine sources and products to enhance awareness, capability gaps, and progress towards stabilization.
- Enhance communication amongst critical entities, while enabling complex interdependencies between government assets.
- Highlight lifeline related priority areas regarding general operations as well as response efforts.

A summary of the critical facilities inventory for the Central Region can be found in Table 4-4 below.

Table 4-4 Summary of Critical Facilities Exposure Summarized by Lifelines

County	Communications	Energy	Food, Water, Shelter	Hazardous Materials	Health and Medical	Safety and Security	Transportation	Total
Blaine	31	16	13	1	5	34	117	**217**
Cascade	165	54	52	12	13	131	191	**618**
Chouteau	39	26	8	1	3	28	52	**157**
Fergus	44	27	12	1	4	54	156	**298**
Glacier	37	28	14	4	2	37	75	**197**
Hill	45	28	16	3	1	38	53	**184**
Judith Basin	11	28	2	0	2	17	47	**107**
Liberty	10	11	3	0	1	11	13	**49**
Petroleum	2	6	2	0	1	7	28	**46**
Phillips	38	11	4	0	2	22	102	**179**
Pondera	14	16	8	0	3	26	98	**165**
Teton	21	29	10	1	4	26	88	**179**
Toole	25	17	8	2	1	19	39	**111**
Total	**482**	**297**	**152**	**25**	**42**	**450**	**1,059**	**2,507**

Source: HIFLD 2022, Montana DES, NBI

Natural Resource Assets

In addition to building and critical facility assets, natural resource assets such as wetlands, forests, animals, and protected areas, are important to include in benefit-cost analyses for future hazard mitigation projects. Natural resources are valuable to communities due to their benefits to water quality, wildlife protection, recreation, and education. Additionally, awareness of these resources may be used to leverage additional funding for projects and contribute to a community's goal in protecting sensitive resources.

To further understand natural resources that may be particularly vulnerable to a hazard event, as well as those that need consideration when implementing mitigation activities, it is important to identify at-risk species (i.e., endangered species) in the planning area. An endangered species is any species of fish, plant life, or wildlife that is in danger of extinction throughout all or most of its range. A threatened species is a species that is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range. Both endangered and threatened species are protected by law and any future hazard mitigation projects are subject to these laws. The U.S. Fish and Wildlife Service Montana Ecological Services Field Office maintains a database which documents a list of threatened and endangered species in the State of Montana. The table below summarizes these species and their status. A list of other natural resource assets by county and tribe can be found in the corresponding annexes.

Table 4-5 State of Montana Threatened and Endangered Species

Common Name	Scientific Name	Status	Range-Montana
Black-footed Ferret	*Mustela nigripes*	E/XN	Prairie dog complexes; eastern Montana
Whooping Crane	*Grus americana*	E	Wetlands; migrant eastern Montana
Pallid Sturgeon	*Scaphirhynchus albus*	E	Bottom dwelling; Missouri, Yellowstone, Marias, Milk, Poplar, Powder, Tongue Rivers
White Sturgeon (Kootenai River population)	*Acipenser transmontanus*	E	Bottom dwelling; Kootenai River
Grizzly Bear	*Ursus arctos horribilis*	T	Alpine/subalpine coniferous forest; Western Montana
Piping Plover	*Charadrius melodus*	T/CH	Missouri and Yellowstone River sandbars, alkali beaches; northeastern Montana. Alkali lakes in Sheridan County; riverine and reservoir shoreline in Garfield, McCone, Phillips, Richland, Roosevelt and Valley counties
Ute Ladies'-tresses	*Spiranthes diluvialis*	T	River meander wetlands; Jefferson, Madison, Beaverhead, Gallatin, Broadwater counties
Bull trout (Columbia River basin and St. Mary - Belly River populations)	*Salvelinus confluentus*	T/CH	Clark Fork, Flathead, Kootenai, St. Mary and Belly River basins; cold water rivers & lakes. Portions of rivers, streams, lakes and reservoirs within Deer Lodge, Flathead, Glacier, Granite, Lake, Lewis and Clark, Lincoln, Mineral, Missoula, Powell, Ravalli, Sanders counties
Canada Lynx (contiguous U.S. population)	*Lynx canadensis*	T/CH	Western Montana Resident – core lynx habitat, montane spruce/fir forests; Transient – secondary/peripheral lynx habitat. Western Montana - montane spruce/fir forest
Spalding's Catchfly	*Silene spaldingii*	T	Upper Flathead River and Fisher River drainages; Tobacco Valley - open grasslands with rough fescue
Yellow-billed cuckoo (western population)	*Coccyzus americanus*	T	Population west of the Continental Divide; riparian areas with cottonwoods and willows

Common Name	Scientific Name	Status	Range-Montana
Red Knot	*Calidris canutus rufa*	T	Migrant; eastern Montana plains along shorelines
Northern Long-eared Bat	*Myotis septentrionalis*	T	Eastern Montana; caves, abandoned mines; roosts in live trees and snags
Meltwater Lednian Stonefly	*Lednia tumana*	T	High elevation meltwater streams; Glacier, Flathead, and Lake Counties
Western Glacier Stonefly	*Zapada glacier*	T	Typically found in clean, cold running waters that have high oxygen content. Glacier and Carbon Counties
Whitebark Pine	*Pinus albicaulis*	T	Western, central, and southwestern Montana, in forests at upper subalpine elevations and near treeline
ENDANGERED (E) - Any species that is in danger of extinction throughout all or a significant portion of its range.			
THREATENED (T) - Any species that is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range.			
NON-ESSENTIAL EXPERIMENTAL POPULATION (XN) - A population of a listed species reintroduced into a specific area that receives more flexible management under the Act.			
CRITICAL HABITAT, PROPOSED CRITICAL HABITAT (CH, PCH) - The specific areas (i) within the geographic area occupied by a species, at the time it is listed, on which are found those physical or biological features (I) essential to conserve the species and (II) that may require special management considerations or protection; and (ii) specific areas outside the geographic area occupied by the species at the time it is listed upon determination that such areas are essential to conserve the species.			

Source: Montana Ecological Services Field Office, https://www.fws.gov/office/montana-ecological-services/species

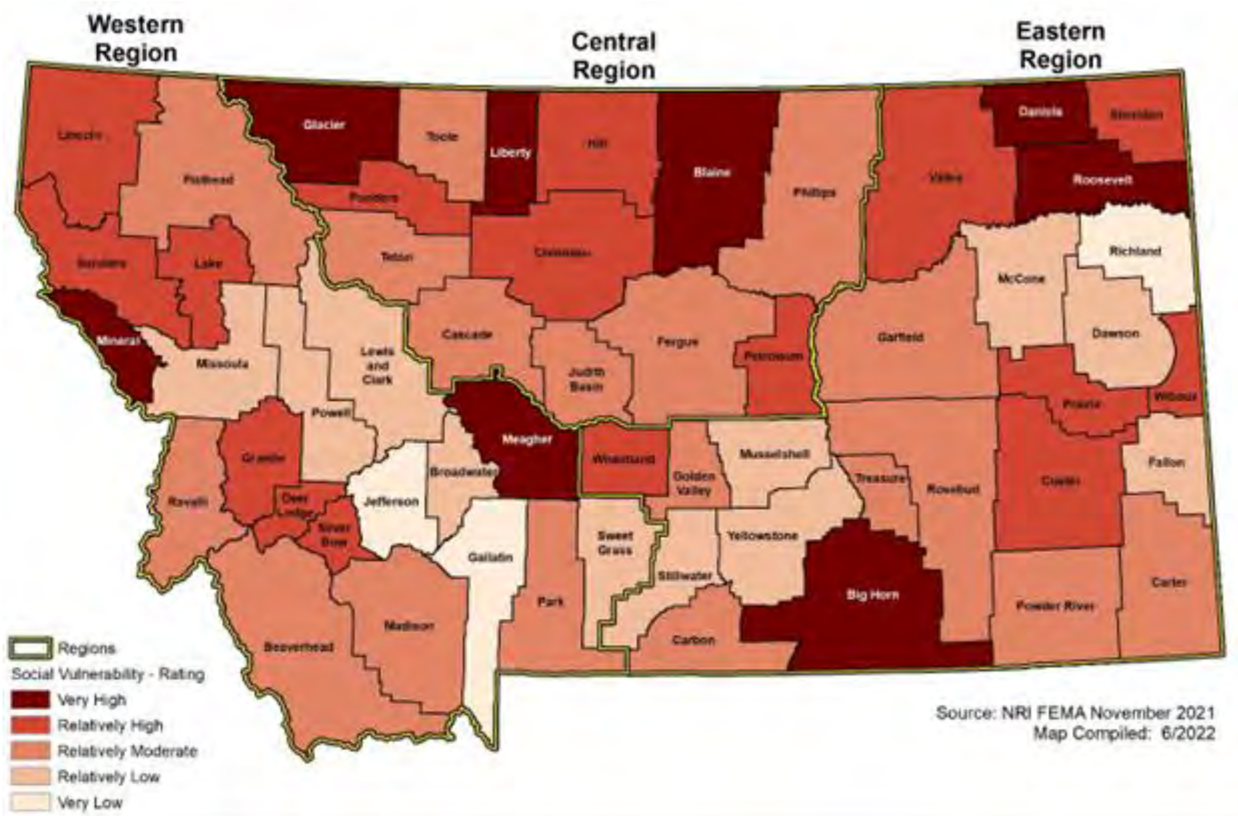
4.1.6 Social Vulnerability

Social vulnerability is broadly defined as the susceptibility of social groups to the adverse impacts of natural hazards, including disproportionate death, injury, loss, or disruption of livelihood. Social vulnerability considers the social, economic, demographic, and housing characteristics of a community that influence its ability to prepare for, respond to, cope with, recover from, and adapt to environmental hazards.

The NRI has incorporated a social vulnerability index (SoVI) rating[1] as a "consequence enhancing risk component" using the SoVI compiled by the Hazards and Vulnerability Research Institute in the Department of Geography at the University of South Carolina. This SoVI is a location-specific assessment and measures the social vulnerability of U.S. counties to environmental hazards utilizing 29 socioeconomic variables which have been deemed to influence a community's vulnerability. The comparison of SoVI values between counties within the State allows for a more detailed depiction of variances in risk and vulnerability. Figure 4.3 shows this social vulnerability rating by county in Montana, with those counties shaded in darker red having the highest levels of social vulnerability.

[1] As of 2024 the NRI has switched to use a different social vulnerability index (SVI) produced by the CDC. The analysis here was done using the SoVI model described here. Both indices produce similar results.

Figure 4.3 Social Vulnerability Rating by County in Montana

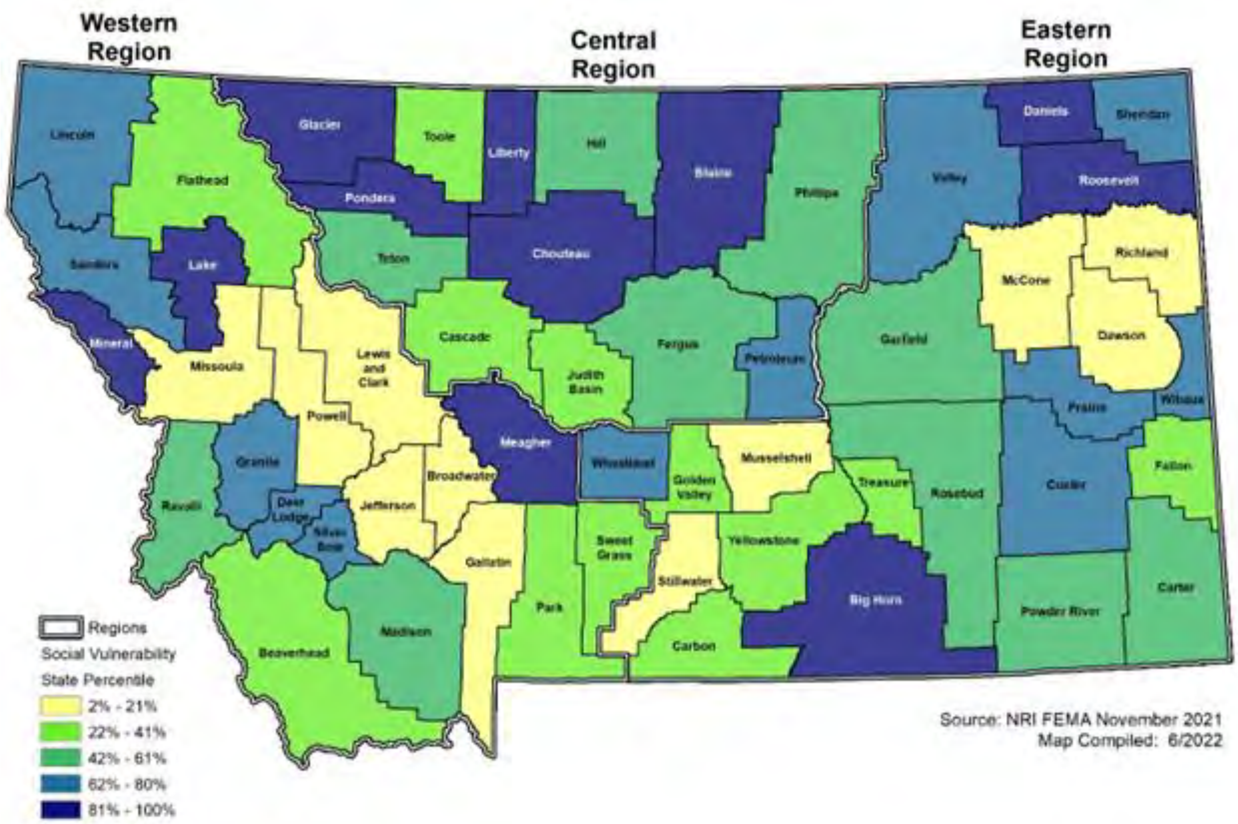


The index can be used by the State to help determine where social vulnerability and exposure to hazards overlaps and how and where mitigation resources might best be used. The SoVI provides a score between 0.01 and 100, with higher scores indicative of higher levels of social vulnerability. According to the index, the following, listed in order, are Montana's ten most socially vulnerable counties:

1. Glacier County (Score 75.72)
2. Roosevelt County (Score 70.60)
3. Big Horn County (Score 70.32)
4. Liberty County (Score 63.07)
5. Meagher County (Score 62.99)
6. Blaine County (Score 61.14)
7. Mineral County (Score 59.05)
8. Lake County (Score 55.77)
9. Chouteau County (Score 54.59)
10. Pondera County (Score 54.24)

Each of the above counties are also in the top 20 percent in the nation in terms of social vulnerability. The average national social vulnerability score is 38.35 and the average for Montana is 43.46. Glacier County for instance has a higher social vulnerability score than 99.2% of U.S. counties. In addition to the ten counties listed above, Wheatland, Valley, Sanders, Granite, Sheridan, and Lincoln also rank in the top 20% most socially vulnerable counties nationwide. Figure 4.4 below shows the percentile of each county's social vulnerability ranking on a national scale.

Figure 4.4 Social Vulnerability State Percentile

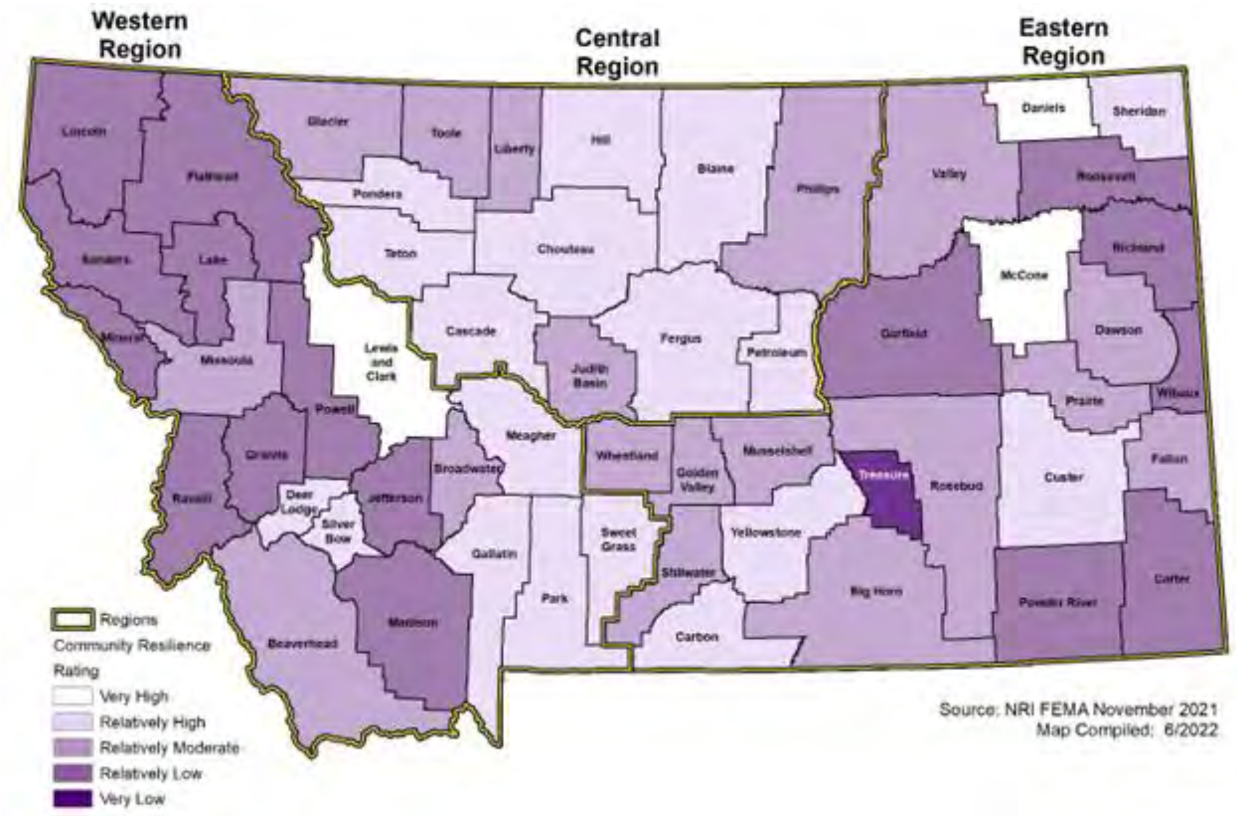


Community Resilience

Related to social vulnerability, the NRI utilizes community resilience as a "consequence reduction component". Community Resilience can essentially be thought of as an inverse to social vulnerability. The NRI defines community resilience as the ability of a community to prepare for anticipated natural hazards, adapt to changing conditions, and withstand and recover rapidly from disruptions. There are multiple, well-established ways to define community resilience at the local level, and key drivers of resilience vary between locations. Because there are no nationally available, bottom-up community resilience indices available, the Social Vulnerability and Community Resilience Working Group chose to utilize a top-down approach. The NRI relies on using broad factors to define resilience at a national level and create a comparative metric to use as a risk factor.

The Community Resilience score is a consequence reduction risk factor and represents the relative level of community resilience in comparison to all other communities at the same level. A higher Community Resilience score results in a lower Risk Index score. Because Community Resilience is unique to a geographic location—specifically, a county—it is a geographic risk factor. Community resilience data are supported by the University of South Carolina's Hazards and Vulnerability Research Institute (HVRI) Baseline Resilience Indicators for Communities (BRIC). HVRI BRIC provides a sound methodology for quantifying community resilience by identifying the ability of a community to prepare and plan for, absorb, recover from, and more successfully adapt to the impacts of natural hazards. The HVRI BRIC dataset includes a set of 49 indicators that represent six types of resilience: social, economic, community capital, institutional capacity, housing/infrastructure, and environmental. It uses a local scale within a nationwide scope, and the national dataset serves as a baseline for measuring relative resilience. The data can be used to compare one place to another and determine specific drivers of resilience, and a higher HVRI BRIC score indicates a stronger and more resilient community. Figure 4.5 below shows the community resilience rating for each county in Montana.

Figure 4.5 Community Resilience Rating by County in Montana

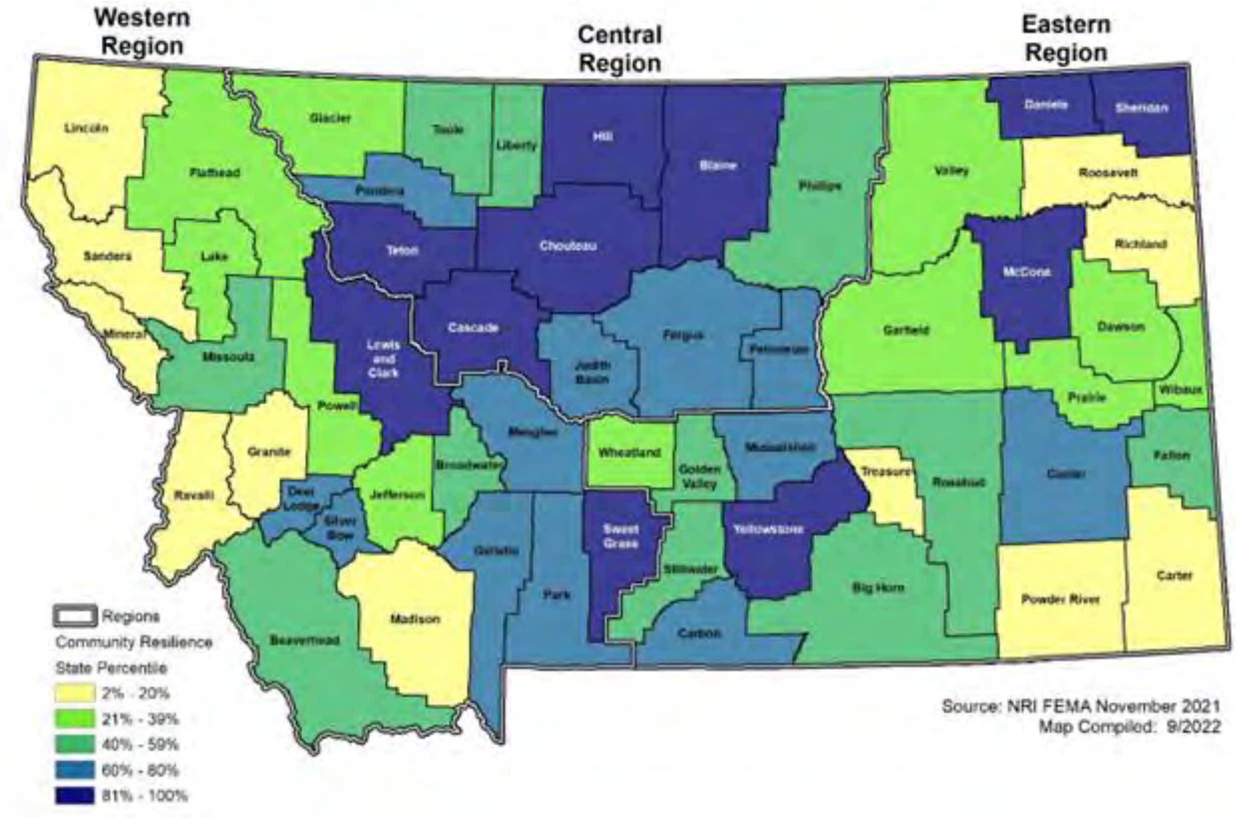


The community resilience rating can be useful in determining counties which have higher levels of ability to cope with hazards and identify success stories for building resilience. According to the index, the following, listed in order, are Montana's ten most resilient counties:

1. Daniels County (58.16)
2. Lewis and Clark County (57.80)
3. Cascade County (57.72)
4. Sheridan County (57.49)
5. Yellowstone County (56.92)
6. Hill County (56.90)
7. Chouteau County (56.79)
8. Teton County (56.71)
9. Sweet Grass County (56.63)
10. Blaine County (56.17)

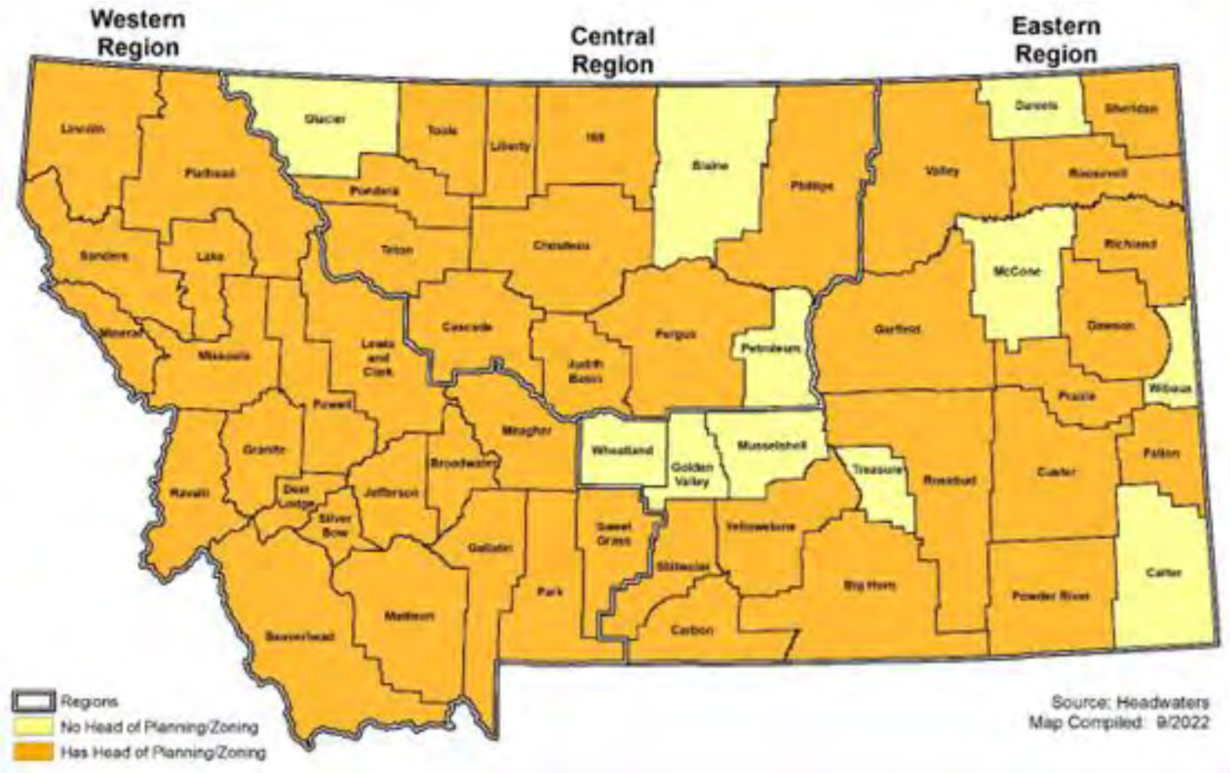
Only a select few of the above counties are in the top 20 percent in the nation in terms of community resilience with those being limited to Daniels, Lewis and Clark, and McCone counties. The average community resilience score for the State of Montana is 54.43, which is slightly lower than the national average score of 54.59. Only 11.1% of counties in the country have a higher level of community resilience than Montana's highest rated county, Daniel County. In addition to the ten counties listed above, Petroleum, Silver Bow, Custer, Pondera, Carbon, Meagher, Gallatin, and Fergus counties each are identified as having relatively high levels of community resilience. Figure 4.6 below shows the percentile of each county's community resilience ranking on a national scale.

Figure 4.6 Community Resilience State Percentile



Adaptive capacity is the potential for a system to adjust to change and to potential damage and take advantage of opportunities, and cope with consequences. As such, other indicators of community resilience include whether local municipalities have planning departments and administrative and technical staff capabilities to address community needs during hazard events through effective planning processes, community engagement, and planning projects related to resiliency. Data from Headwater Economics was reviewed to map those counties that lack a Planning Department and/or a Zoning Ordinance. Figure 4.7 shows the counties in Montana that do not have a Planning Department. In other words, these are the counties in the State that lack formal planning resources and have less capability for land use and hazard mitigation planning. These include the counties of Glacier, Blaine, Wheatland, Golden Valley, Musselshell, Treasure, Carter, McCone, and Daniels.

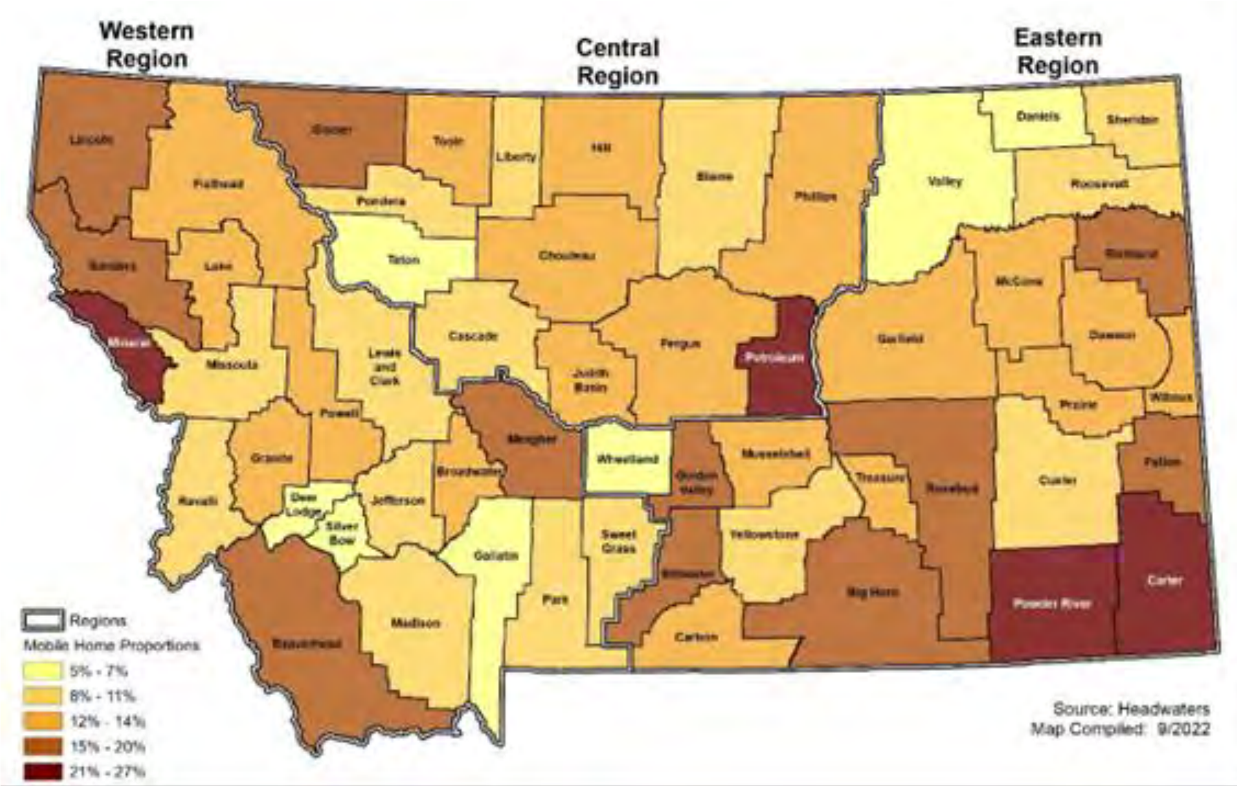
Figure 4.7 Counties in Montana that Lack a Planning Department



Mobile Homes

Mobile and manufactured homes are the most common unsubsidized, affordable housing in the United States. Research shows that these structures face a disproportionately higher risk of flooding and also damage from wind events. Approximately 9.2% of the housing types in Montana are mobile homes compared to approximately 5.6% mobile homes in the United States (U.S. Census 2020). Compared to those who live in other types of housing, mobile home residents have higher exposure to natural hazards such as wind, tornadoes, hurricanes, extreme heat, wildfire, and particularly flooding. For example, according to analysis by Headwater Economics, one in seven mobile homes is located in an area with high flood risk, compared to one in 10 for all other housing types (Headwater Economics 2022). Figure 4.8 shows the number of mobile homes as a proportion to the number of households within the County.

Figure 4.8 Mobile Homes in Montana



As shown above, Mineral, Petroleum, Powder River, and Carter counties have the highest number of mobile homes as a proportion to the number of households in that County. Other counties with 15% to 20% mobile home proportions include Lincoln, Sanders, Beaverhead, Glacier, Meagher, Stillwater, Golden Valley, Big Horn, Rosebud, Richland, and Fallon counties.

4.2 Hazard Profiles

The hazards identified in Section 4.1 are profiled individually in this section. Much of the profile information came from the same sources used to initially identify the hazards.

4.2.1 Profile Methodology

Each hazard is profiled in the following format:

Hazard/Problem Description

This subsection gives a description of the hazard and associated problems, followed by details on the hazard specific to the Region.

Geographical Area Affected

This subsection discusses which areas of the Region are most likely to be affected by a hazard event.

- **Negligible:** Less than 10 percent of planning area or isolated single-point occurrences
- **Limited:** 10 to 25 percent of the planning area or limited single-point occurrences
- **Significant:** 25 to 75 percent of planning area or frequent single-point occurrences
- **Extensive:** 75 to 100 percent of planning area or consistent single-point occurrences

Past Occurrences

This subsection contains information on historic incidents, including impacts where known. Information provided by the Regional Steering Committee is included here along with information from other data sources, including NOAA's National Centers for Environmental Information (NCEI) Storm Events Database and other data sources. When available, tables showing county-specific data from the NCEI database may be found in each hazard profile.

Frequency/Likelihood of Occurrence

The frequency of past events is used in this section to gauge the likelihood of future occurrences. Based on historical data, the likelihood of future occurrences is categorized into one of the following classifications:

- **Highly Likely:** 90 to 100 percent chance of occurrence in next year or happens every year.
- **Likely:** Between 10 and 90 percent chance of occurrence in next year or has a recurrence interval of 10 years or less.
- **Occasional:** Between 1 and 10 percent chance of occurrence in the next year or has a recurrence interval of 11 to 100 years.
- **Unlikely:** Less than 1 percent chance of occurrence in next 100 years or has a recurrence interval of greater than every 100 years.

The frequency, or chance of occurrence, was calculated where possible based on existing data. Frequency was determined by dividing the number of events observed by the number of years and multiplying by 100. Stated mathematically, the methodology for calculating the probability of future occurrences is:

$$\frac{\text{\# of known events}}{\text{years of historic record}} \times 100$$

This gives the percent chance of the event happening in any given year. An example would be three droughts occurring over a 30-year period which equates to 10 percent chance of that hazard occurring any given year.

Climate Change Considerations

This describes the potential for climate change to affect the frequency and intensity of the hazard in the future.

Potential Magnitude and Severity

This subsection discusses the potential magnitude of impacts, or extent, from a hazard event. Magnitude classifications are as follows:

- **Negligible:** Less than 10 percent of property is severely damaged, facilities and services are unavailable for less than 24 hours, injuries and illnesses are treatable with first aid or within the response capability of the jurisdiction.
- **Limited:** 10 to 25 percent of property is severely damaged, facilities and services are unavailable between 1 and 7 days, injuries and illnesses require sophisticated medical support that does not strain the response capability of the jurisdiction, or results in very few permanent disabilities.
- **Critical:** 25 to 50 percent of property is severely damaged, facilities and services are unavailable or severely hindered for 1 to 2 weeks, injuries and illnesses overwhelm medical support for a brief period of time or result in many permanent disabilities and a few deaths. overwhelmed for an extended period of time or many deaths occur.
- **Catastrophic:** More than 50 percent of property is severely damaged, facilities and services are unavailable or hindered for more than 2 weeks, the medical response system is overwhelmed for an extended period of time, or many deaths occur.

Vulnerability Assessment

The primary function of the *Vulnerability Assessment* section for each hazard is to identify which *assets* are both *likely to be exposed* to a hazard and *susceptible* to damage from that exposure. In this context, *assets* are (1) people, (2) property, (3) critical facilities and lifelines, (4) the economy, (5) historic and cultural resources, and (6) natural resources. *Exposure* is defined here as interacting with a hazard, and *likely to be exposed* indicates a presence in areas deemed to be especially likely to experience a hazard. *Susceptible* is meant to indicate assets that are easily damaged from exposure to a hazard. Finally, vulnerability under future conditions is considered as it relates to both climate change and development.

Susceptible is a peculiar term in the context of hazard mitigation plans. FEMA avoids defining the term and apparently yields to the common definition of “easily harmed by something” (Cambridge Dictionary). In practice, estimating susceptibility of assets or lifelines to each hazard is a remarkably complex task. Even defining which assets are, or are not, susceptible is subject to an implicit judgment of *how easily harmed is easily enough to be deemed susceptible?* FEMA also avoids the issue of how easily harmed qualifies for susceptible in its guidance documents for developing hazard mitigation plans. However, FEMA’s Local Mitigation Planning Policy Guide provides a statement that plan participants may identify which specific assets are most susceptible to damage or loss from hazards (Local Mitigation Policy Guide, p. 23). In this plan, an attempt is made to at least describe which assets are susceptible to a given hazard. When this fails, input from plan participants serves as a guide to defining what is susceptible and what is not.

Another limitation of the vulnerability assessment is the inconsistent ability to define which specific assets are vulnerable. The reasons for this are many, but the most common problem is that GIS datasets may not contain consistent information about the characteristics of specific assets. Information about the characteristics of each asset could allow a judgment of which assets are susceptible to damage. For example, if a dataset only contains the location of houses, it is easy to identify which houses exist within a high-hazard area. However, not all houses are equally susceptible to damage. Some were built with older housing codes, some may not be well maintained, some may be oriented in ways or located on sites that cause subtle differences in exposure to a hazard such as wind. In the absence of reliable data on key characteristics, judging which assets are susceptible to harm becomes a 'best estimate' rather than a determination. Another example is if one dataset has the location of assets in a different format than is used to define a hazard area. In this case it is not possible to determine which assets are within a hazard area without additional analysis.

Development Trends Related to Hazards and Risk

This section describes how future development and growth could impact vulnerability to each hazard. Specific trends can be found in each County or tribal annex.

Risk Summary

The primary function of the *Risk Summary* section for each hazard is to describe the potential severity of loss to vulnerable assets and the impact that loss on jurisdictions. In the context of hazard mitigating planning, vulnerability can be viewed as *what* is likely to be damaged, while risk can be viewed as *how severe* the damage will be to those assets and to the community. Risk is sometimes described as the *consequence* or *effect* a hazard has on assets.

This section summarizes risk by county according to the area affected, likelihood, and magnitude of impacts. Overall hazard significance is summarized for the region and by county and tribe. If the hazard has impacts on specific towns or cities in the region that differ from the county, they are noted here, where applicable.

4.2.2 Communicable Disease

Hazard/Problem Description

A communicable disease spreads from one person to another through a variety of ways that include: contact with blood and bodily fluids; breathing in an airborne virus; or being bitten by an insect. ("Communicable Disease" 2022).

The scale of a communicable disease outbreak or biological incident is described by the extent of the spread of disease in the community. An outbreak can be classified as an endemic, an epidemic, or a pandemic depending on the prevalence of the disease locally and around the world.

- An endemic is defined as something natural to or characteristic of a particular place, population, or climate. For example, threadworm infections are endemic in the tropics.
- An epidemic is also defined as a disease that spreads rapidly through a demographic segment of the human population, such as everyone in a given geographic area, a similar population unit, or everyone of a certain age or sex, such as the children or women of a region.
- A pandemic is defined as a widespread epidemic with effects felt worldwide.

Many potentially devastating diseases are spread through physical contact, ingestion, insects, and inhalation. Airborne diseases and those spread through physical contact pose higher risks to the community because they are difficult to control. Diseases such as influenza, Pertussis, Tuberculosis, and meningitis are all spread through these methods and pose a threat to all communities. Health agencies closely monitor for diseases with the potential to cause an epidemic and seek to develop and promote immunizations.

A pandemic is a global disease outbreak. Pandemic flu is a human flu that causes a global outbreak, or pandemic, of serious illness. A flu pandemic occurs when a new influenza virus emerges for which people have little or no immunity, and for which there is no vaccine. This disease could easily spread person-to-person, causing serious illness, and can sweep across the country and around the world in a very short time. The Centers for Disease Control and Prevention (CDC) has been working closely with other countries and the World Health Organization to strengthen systems to detect outbreaks of influenza that might cause a pandemic and to assist with pandemic planning and preparation.

An especially severe influenza pandemic could lead to high levels of illness, death, social disruption, and economic loss. Impacts could range from school and business closings to the interruption of basic services such as public transportation, health care, and the delivery of food and essential medicines.

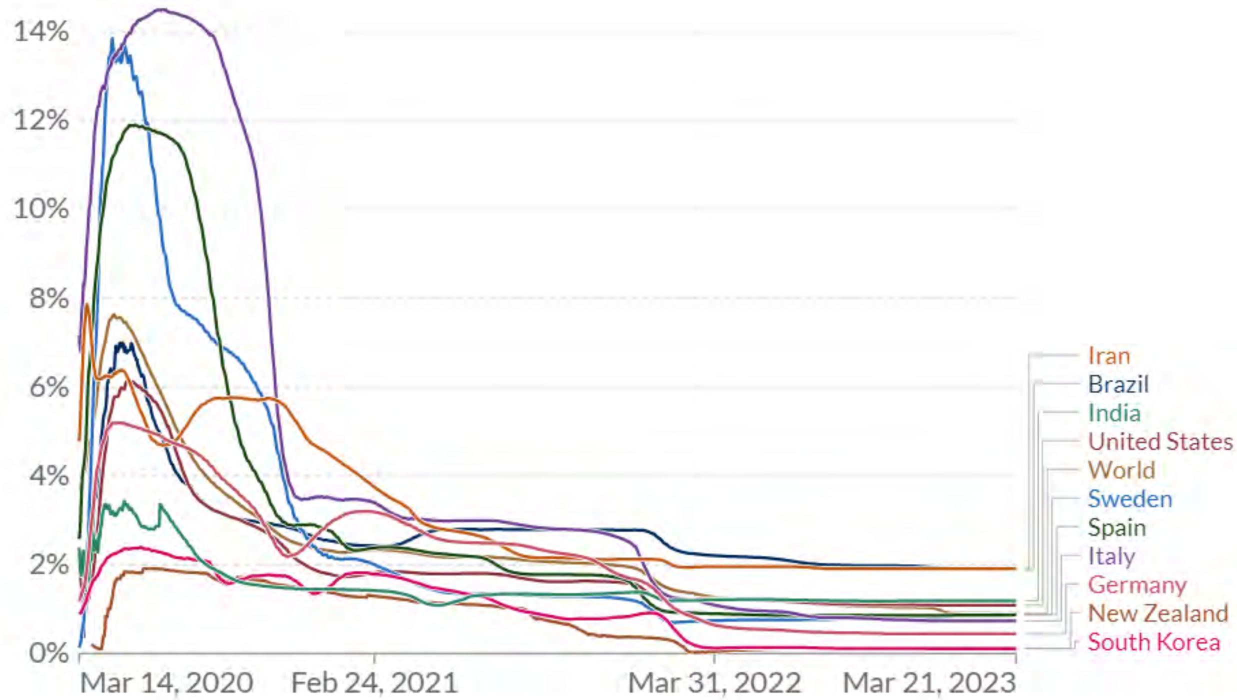
Pandemics are generally thought to be the result of novel strains of viruses. Because of the process utilized to prepare vaccines, it is impossible to have vaccines pre-prepared to combat pandemics. Additionally, for novel viruses, identification of symptoms, mode of transmission, and testing/identification may require development, causing significant delays in response actions. A portion of the human and financial cost of a pandemic is related to the lag time to prepare a vaccine to prevent the future spread of the novel virus. In some cases, current vaccines may have limited activity against novel strains. Even when there is a strong healthcare system in place, disease outbreaks can strain and overwhelm community resources if there is significant outbreak. The Central Region's vulnerable populations, young children, the elderly, under-resourced households, and those with underlying health conditions, will be the hardest hit during any disease outbreak.

Ongoing COVID-19 Pandemic

Since March 2020 and during the update of this plan, the State of Montana, the nation, and the world were dealing with the COVID-19 pandemic, confirming that the pandemic is a key public health hazard in the State. The COVID-19 virus has a much higher rate of transmission than the seasonal flu, primarily by airborne transmission of droplets/bodily fluids. Common symptoms include fever, cough, fatigue, shortness of breath or breathing difficulties, and loss of smell and taste.

Figure 4.9 shows the case fatality rate of COVID-19 from March 14, 2020 to March 21, 2023. The case fatality rate (CFR) is the ratio between confirmed deaths and confirmed cases. As shown in the figure, the CFR was relatively much higher in 2020 and started dropping towards the end of 2020 and early 2021. The highest CFR that the US experienced was a bit higher than 6%. On the other hand, since early 2022, the US' CFR has been lower than 2%. However, as also mentioned by the figure's source – Our World In Data, CFR does not reflect the risk of dying from COVID-19 because the CFR relies on the number of confirmed cases, and many cases are not confirmed.

Figure 4.9 Case Fatality Rate of COVID-19 March 2020 through March 2023



Source: Our World In Data – Global Change Data Lab

Moreover, as mentioned in CDC's most up-to-date summary on January 27, 2023, there is a rapid reduction in the overall US COVID-19-related mortality rate in March 2022. From April through September 2022, COVID-19–related mortality rates remained relatively stable. On the other hand, although overall COVID-19-related mortality rates declined, adults aged ≥65 years continued to have the highest mortality rates. During April–September 2022, the proportion of COVID-19-related deaths accounted for by adults aged ≥85 years increased to ~40% despite accounting for <2% of the U.S. population. COVID-19–related deaths among children remained rare (Covid-19 Data Review: Update on COVID-19–related mortality 2023).

2022 US Mpox Outbreak

As discussed by CDC in February 2023, Mpox is a rare disease caused by infection with the mpox virus. Mpox virus is part of the same family of viruses as variola virus, the virus that causes smallpox. Mpox symptoms are similar to smallpox symptoms but milder, and mpox is rarely fatal. Mpox is not related to chickenpox.

Mpox was discovered in 1958 when two outbreaks of a pox-like disease occurred in colonies of monkeys kept for research. Despite being named "monkeypox," the source of the disease remains unknown. However, African rodents and non-human primates (like monkeys) might harbor the virus and infect people.

The first human case of mpox was recorded in 1970. Prior to the 2022 outbreak, mpox had been reported in people in several central and western African countries. Previously, almost all mpox cases in people outside of Africa were linked to international travel to countries where the disease commonly occurs or through imported animals. These cases occurred on multiple continents.

People with mpox often get a rash that may be located on hands, feet, chest, face, or mouth or near the genitals, including penis, testicles, labia, and vagina, and anus. The incubation period is 3-17 days. During this time, a person does not have symptoms and may feel fine. The rash will go through several stages, including scabs, before healing. The rash can initially look like pimples or blisters and may be painful or itchy. Other symptoms of mpox can include fever, chills, swollen lymph nodes, exhaustion, muscle aches and backache, headache, and respiratory symptoms (e.g., sore throat, nasal congestion, or cough). Mpox can spread to anyone through close, personal, often skin-to-skin contact. The risk is considered low for getting mpox by touching objects, fabrics, and surfaces that have been used by someone with mpox and not disinfected.

As of March 15, 2023, there are 86,500 global cases, while 30,262 of them are in the US. The World Health Organization (WHO) declared Monkeypox Spread a Global Health Emergency on July 23, 2022. Since the number of new cases remained low, the Biden Administration ended the mpox public health emergency declaration on January 31, 2023.

Hantavirus Pulmonary Syndrome (HPS)

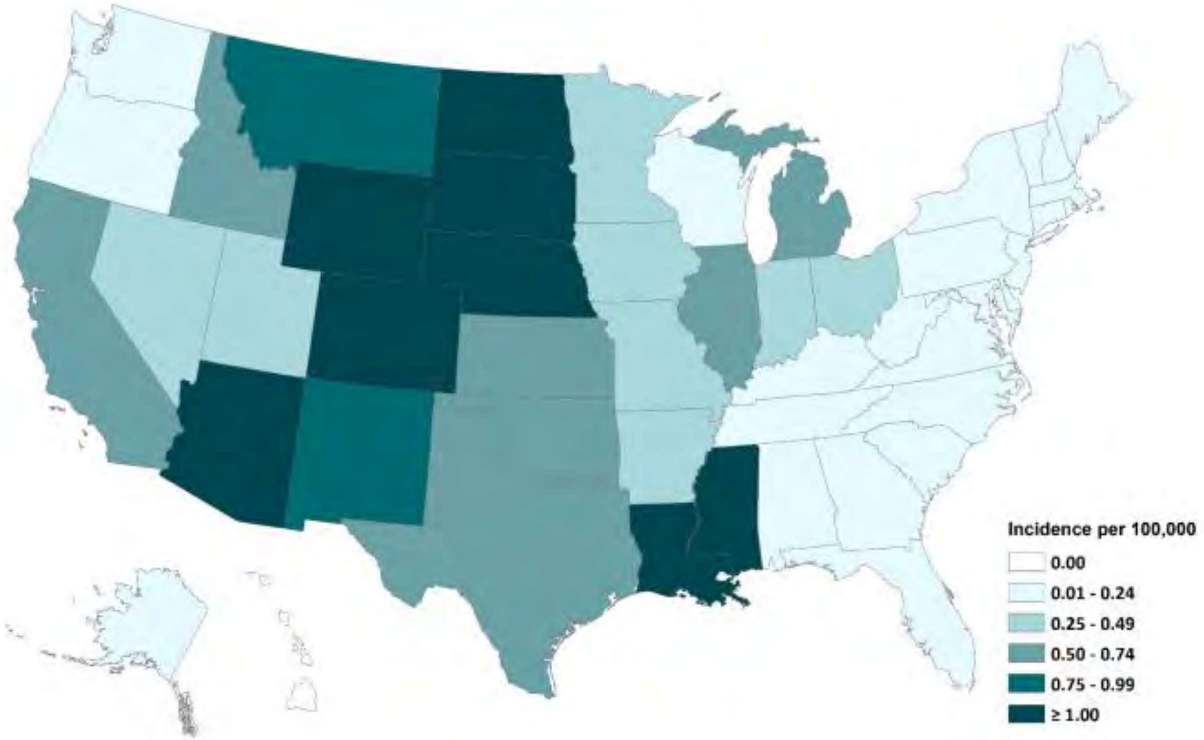
Another communicable disease of concern to the State of Montana is Hantavirus Pulmonary Syndrome (HPS), an illness caused by a family of viruses called hantaviruses. According to the State of Montana's Department of Public Health and Human Services (DPHHS), HPS is a rare but often serious illness of the lungs. In Montana, the deer mouse is the reservoir for the hantavirus. The virus is found in the droppings, urine, and saliva of infected mice. The most common way that a person can get HPS is by breathing in the virus when it is aerosolized (stirred up into the air). People can also become infected after touching mouse droppings or nesting materials that contain the virus and then touching their eyes, nose, or mouth.

West Nile Virus

West Nile virus (WNV) is the leading cause of mosquito-borne disease in the continental United States. It is most commonly spread to people by the bite of an infected mosquito. Cases of WNV occur during mosquito season, which starts in the summer and continues through fall. There are no vaccines to prevent or medications to treat WNV in people. Fortunately, most people infected with WNV do not feel sick. About 1 in 5 people who are infected develop a fever and other symptoms. About 1 out of 150 infected people develop a serious, sometimes fatal, illness.

The following map from CDC shows the average annual incidence of West Nile virus neuroinvasive disease reported to CDC by state from 1999 to 2021. The state of Montana has a relatively higher average annual incidence when compared to other states in the US.

Figure 4.10 Average Annual Incidence of West Nile Virus by State 1999-2021



Source: ArboNET, Arboviral Diseases Branch, Centers for Disease Control and Prevention

Geographical Area Affected

The entire geographic area of the Montana Central Region is susceptible to the spread of infectious diseases. Disease spread usually occurs in areas where vulnerable populations are, and also in areas where people live and work in close quarters. Depending on the specifics of the illness and its spread, these areas include shelters, senior homes, schools, and places of business.

The Montana DPHHS has reported 294,340 cases of COVID-19 and 3,467 deaths as of July 22, 2022. The current COVID-19 pandemic has affected all the counties in the Central Region. Table 4-6 below shows the total cases and deaths specific to the Central Region. Data specific to tribes are included in the nearest Counties. Central Region comprises approximately 16% of the statewide total of cases and 20% of the statewide total of deaths. In general, it is likely that the more-populated areas municipal areas may be affected sooner and may experience higher infection rates. Some indirect consequences may be the diversion of health and medical resources that may be otherwise available.

Table 4-6 COVID-19 Cases and Deaths by County (as of July 22, 2022)

County	Cases	Cases Per Total Pop*.	Deaths	Deaths Per Total Pop.
Blaine	2,207	33%	33	0.5%
Cascade	26,791	33%	351	0.4%
Choteau	1,074	19%	15	0.3%
Fergus	2,613	23%	57	0.5%

County	Cases	Cases Per Total Pop*.	Deaths	Deaths Per Total Pop.
Glacier	4,210	31%	75	0.5%
Hill	4,779	29%	73	0.4%
Judith Basin	244	12%	1	0.1%
Liberty	438	18%	4	0.2%
Petroleum	35	8%	1	0.2%
Phillips	1,089	27%	29	0.7%
Pondera	1,291	22%	9	0.2%
Teton	1,388	23%	25	0.4%
Toole	1,304	27%	25	0.5%
Total	**47,463**	**29%**	**698**	**0.4%**

Source: The New York Times *Population total is based on U.S. Census Bureau ACS 5-Year Estimates 2016-2020.

Past Occurrences

Since the early 1900s, five lethal pandemics have swept the globe:

- 1918-1919 Spanish Flu: The Spanish Flu was the most severe pandemic in recent history. The number of deaths was estimated to be 50-100 million worldwide and 675,000 in the United States. Its primary victims were mostly young, healthy adults. At one point, more than 10% of the American workforce was bedridden.

- 1957-1958 Asian Flu: The 1957 Asian Flu pandemic killed 1.1 million people worldwide, including about 70,000 people in the United States, mostly the elderly and chronically ill. Fortunately, the virus was quickly identified, and vaccine production began in May 1957.

- 1968-1969 H3N2 Hong Kong Flu: The 1968 Hong Kong Flu pandemic killed one million people worldwide and approximately 100,000 people in the United States. Again, the elderly population was more severely affected. This pandemic peaked during school holidays in December, limiting student-related infections, which may have kept the number of infections down. Also, people infected by the Asian Flu ten years earlier may have gained some resistance to the new virus.

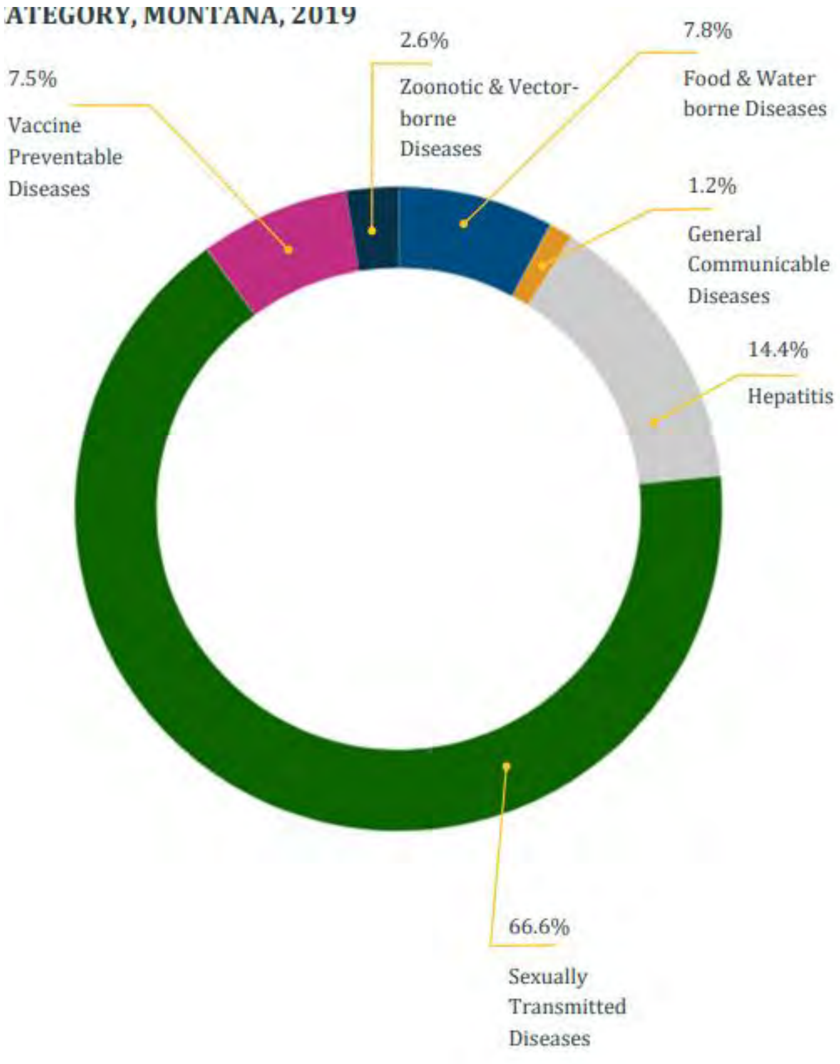
- 2009-2010 H1N1 Swine Flu: This influenza pandemic emerged from Mexico in early 2009 and was declared a public health emergency in the US on April 26. By June, approximately 18,000 cases had been reported in the US and the virus had spread to 74 countries. Most cases were fairly mild, with symptoms similar to the seasonal flu, but there were cases of severe disease requiring hospitalization and some deaths. On May 11, 2009, the Montana DPHHS reported the state's first confirmed case of swine flu. As of July 26, 2009, there were 122 reported cases. As of January 21, 2010, there were 801 confirmed cases of A/H1N1, and 18 confirmed deaths due to H1N1 flu.

- 2020-Ongoing COVID-19: The COVID-19 or novel coronavirus was detected in December 2019 and was declared a pandemic in March 2020. As of July 22, 2022, 568 million cases have been reported around the world with 6.38 million deaths, including approximately 90.2 million cases and 1.02 million deaths in the US. Worldwide there have been 12.3 billion vaccine doses administered. The Montana DPHHS has reported 294,340 cases of COVID-19 and 3,467 deaths as of July 22, 2022. The response to the COVID-19 Pandemic included numerous public health orders, including stay-home orders; massive testing and vaccination efforts; the establishment of alternate care sites to support the hospital system; and an unprecedented community-wide vaccination push. A report released by the State's Department of Public Health and Human

Services points out that COVID-19 was responsible for 251 of the 1,022 total deaths among Montana's Native Americans in 2020. While Native Americans only make up around 7 percent of the state's population, they accounted for 32 percent of the deaths and 19 percent of cases in the state from March to October of 2020 (Schubert 2021).

Additionally, as shown in the 2019 Montana DPHHS Communicable Disease in Montana Annual Report, sexually transmitted diseases rank the highest among all the reported communicable diseases, followed by Hepatitis, Food & Water Borne Diseases and Vaccine-Preventable Diseases, as shown in Figure 4.11 below.

Figure 4.11 2019 Montana DPHHS Communicable Disease Rates



The 2019 Montana DPHHS Communicable Disease in Montana Annual Report also noted a sudden increase in the incidence of hepatitis A, which has been linked to person-to-person outbreaks reported in more than 30 states, predominantly due to injection drug use and outbreaks among people experiencing homelessness. Moreover, the report also mentioned a continued increase in the incidence of gonorrhea. The report noted that it is thought to be potentially due to that the increase in reported cases is partially due to an increase in screening tests being performed across the state, which suggests that gonorrhea has been underreported for many years.

In addition, the 2019 Montana DPHHS Communicable Disease in Montana Annual Report shows that in the year 2019, the top five communicable diseases that have the highest case numbers are: Chlamydia (4,752), Gonorrhea (1,571), Hepatitis C, chronic (1,335), Pertussis (494), Campylobacteriosis (374). Influenza was not included in the stats.

Frequency/Likelihood of Occurrence

Although it is impossible to predict the next disease outbreak, there is recent history that shows these outbreaks are not uncommon and are likely to reoccur. Based on the five pandemics that have affected the United States in roughly the last 100 years, a pandemic occurs on average roughly every 20 years. In other words, there is a 5% probability that a pandemic that affects the entire United States will occur in any given year.

For the current COVID-19 pandemic, due to the virus's ability to mutate and rapidly infect, the pandemic may extend for several years, and booster vaccines may be necessary to prevent future outbreaks. In just the last couple of decades, the world has drastically increased points of transmissions through global travel and trade to levels unseen in human history – this may have a drastic impact on the frequency of pandemics and the speed with which they spread in coming years.

Climate Change Considerations

As the Earth’s climate continues to warm, researchers predict wild animals will be forced to relocate their habitats — likely to regions with large human populations — dramatically increasing the risk of a viral jump to humans that could lead to the next pandemic. This link between climate change and viral transmission is described by an international research team led by scientists at Georgetown University and is published on April 28, 2022, in *Nature*. The scholars noted that the geographic range shifts due to climate change could cause species that carry viruses to encounter other mammals to share thousands of viruses. The viruses can then further be spread to humans. In addition, rising temperatures caused by climate change could impact bats, which account for the majority of novel viral sharing. Bats’ ability to fly will allow them to travel long distances and share the most viruses. Altogether, the study suggests that climate change could become the biggest upstream risk factor for disease emergence — exceeding higher-profile issues like deforestation, wildlife trade and industrial agriculture. The authors suggest the solution is to pair wildlife disease surveillance with real-time studies of environmental change. ("New Study Finds Climate Change Could Spark The Next Pandemic - Georgetown University Medical Center" 2022)

Potential Magnitude and Severity

The magnitude of a disease outbreak or public health emergency can range significantly depending on the aggressiveness of the virus in question and the ease of transmission. Today, a much larger percentage of the world’s population is clustered in cities, making them ideal breeding grounds for epidemics. Additionally, the explosive growth in air travel means a virus could spread around the globe within hours, quickly creating a pandemic. Under such conditions, there may be very little warning time. Disease outbreaks are expected to occur simultaneously throughout much of the nation, preventing shifts in human and material resources that normally occur with other natural disasters. These aspects make influenza pandemic unlike most other public health emergencies or community disasters.

As seen with the ongoing COVID-19 pandemic, the rapid spread of the virus combined with the need for increased hospital and coroner resources, testing centers, first responders, and vaccination administration sites caused significant strain on the medical system and public health departments. Additionally, other public health-related triggers or commingled public health hazards (such as an outbreak of another pathogen) or even other contagious strains of COVID such as the recent Omicron, BA.5 and Delta B.1.617.2 variant can lead to more outbreaks.

The Pandemic Intervals Framework (PIF) developed by WHO is a six-phased approach to defining the progression of an influenza pandemic. This framework is used to guide influenza pandemic planning and provides recommendations for risk assessment, decision-making, and action. These intervals provide a common method to describe pandemic activities that can help guide public health actions. The duration of each pandemic interval might vary depending on the characteristics of the virus and the public health response.

The six-phase approach was designed for the easy incorporation of recommendations into existing national and local preparedness and response plans. Phases 1 through 3 correlates with preparedness in the pre-pandemic interval, including capacity development and response planning activities, while Phases 4 through 6 signal the need for response and mitigation efforts during the pandemic interval.

Pre-Pandemic Interval

Phase 1 is the natural state in which influenza viruses circulate continuously among animals (primarily birds) but do not affect humans.

In **Phase 2** an animal influenza virus circulating among domesticated or wild animals is known to have caused infection in humans and is thus considered a potential pandemic threat. Phase 2 involves cases of animal influenza that have circulated among domesticated or wild animals and have caused specific cases of infection among humans.

In **Phase 3** an animal or human-animal influenza virus has caused sporadic cases or small clusters of disease in people but has not resulted in human-to-human transmission sufficient to sustain community-level outbreaks. Limited human-to-human transmission may occur under some circumstances, for example, when there is close contact between an infected person and an unprotected caregiver. Limited transmission under these circumstances does not indicate that the virus has gained the level of transmissibility among humans necessary to cause a pandemic. Phase 3 represents the mutation of the animal influenza virus in humans so that it can be transmitted to other humans under certain circumstances (usually very close contact between individuals). At this point, small clusters of infection have occurred.

Phase 4 is characterized by verified human-to-human transmission of the virus able to cause "community-level outbreaks." The ability to cause sustained disease outbreaks in a community marks a significant upward shift in the risk for a pandemic. Phase 4 involves community-wide outbreaks as the virus continues to mutate and become more easily transmitted between people (for example, transmission through the air)

Phase 5 is characterized by verified human-to-human spread of the virus into at least two countries in one World Health Organization (WHO) region. While most countries will not be affected at this stage, the declaration of Phase 5 is a strong signal that a pandemic is imminent and that the time to finalize the organization, communication, and implementation of the planned mitigation measures is short. Phase 5 represents human-to-human transmission of the virus in at least two countries.

Phase 6, the pandemic phase, is characterized by community-level outbreaks in at least one other country in a different WHO region in addition to the criteria defined in Phase 5. The designation of this phase will indicate that a global pandemic is underway. Phase 6 is the pandemic phase, characterized by community-level influenza outbreaks.

Vulnerability Assessment

People

Pandemics can affect large segments of the population for long periods. Risk groups cannot be predicted with certainty; the elderly, people with underlying medical conditions, and young children are usually at higher risk. People without health coverage or access to good medical care are also likely to be more adversely affected. According to data collected from the American Community Survey (ACS) five-year estimates for 2016-2020, in the Central Region, the elderly (those over 65 years of age) make up 17.7% of the population; the young (those under five years of age) make up 7% of the population, and 16.3% of the Central Region's population had income in the past 12 months below poverty level. On the other hand, within the State of Montana, the elderly (those over 65 years of age) make up 18.7% of the population; the young (those under five years of age) make up 5.8% of the population, and 12.8% of the State's population had income in the past 12 months below poverty level. There is no significant difference in these vulnerable populations between the Central Region and the State. These populations may be the most vulnerable to communicable diseases. Nevertheless, impacts, mortality rates, speed and type of spread are disease-specific, though certain illnesses could cause high infectivity and mortality rates.

As seen with the current COVID-19 pandemic statewide, according to the State's DPHHS data as of March 8, 2023, the majority of positive cases occurred in the 20-39 age group (32% of the total number of cases). Deaths, however, happened more within the 60+ age groups (85% of the total deaths).

Property

Communicable diseases would not have specific impacts on infrastructure or the built environment. Should infrastructure require human intervention to fulfill vital functions, these functions could be impaired by absenteeism, sick days and isolation, quarantine, and disease prophylaxis measures. As concerns about contamination increase, property may be quarantined or destroyed as a precaution against spreading illness. Additionally, traditional sheltering facilities including shelters for persons experiencing homelessness or facilities stood up to support displaced persons due to an evacuation or other reasons due to a simultaneous disaster occurring cannot be done in a congregate setting. This requires additional planning considerations or the use of facilities that allow for non-congregate shelter settings which may require an approval of request to FEMA for non-congregate sheltering and may have an increased cost (such as the use of individual hotel rooms) as opposed to traditional congregate sheltering facilities.

Critical Facilities and Lifelines

The impacts of a communicable disease on critical infrastructure and lifelines would center on service disruption due to staff missing work; shortages in essential resources and supplies to perform services as seen with personal protective equipment (PPE) during the COVID-19 pandemic within Health and Medical Sector. While automated systems and services that allow for the physical distancing of staff from other persons may fare better through a communicable disease incident, due to the globalization of supply chains, services, and interdependency of most communities on robust staffing, all critical infrastructure sectors and lifelines could be affected in various ways.

Economy

A widespread communicable disease outbreak could have devastating impacts on Central Region's economy. The economic impacts fall under two categories – economic losses as a result of the disease, and economic losses to fight the disease. Economic impacts as a result of a disease include those costs associated with lost work and business interruption. Depending on the disease and the type and rate of spread, businesses could see a loss of consumer base as people self-isolate or avoid travel to the State. This could last for a protracted amount of time, compounding economic loss. Economic costs are also associated with incident response.

In a normal year, lost productivity due to illness costs US employers an estimated $530 billion, as noted by Integrated Benefits Institute – a nonprofit health and productivity research organization. During a pandemic, that figure could be considerably high and could be a significant trigger possibly leading to a recession or depression. According to The Journal of American Medical Association (JAMA) Network in October 2020, the estimated cumulative financial costs of the COVID-19 pandemic related to the COVID-19 economic recession and compromised health (premature death, mental health, long-term health impairment) in the

US population was almost $16 trillion. As of July 29, 2021, the Montana Coronavirus Relief Fund has awarded over $819 million to businesses and nonprofits across the State to support economic recovery efforts.

Historic and Cultural Resources

As mentioned previously, communicable diseases would not have specific impacts on the built environment, which then include historic and cultural resources. However, historic, and cultural resources oftentimes are related to the tourism industry, while reduced tourism could lead to additional economic impacts.

Natural Resources

Impacts on natural resources are typically minimal. However, zoonotic diseases can spread from animals to humans, wreaking havoc on both populations. Examples of zoonotic diseases include avian flu, swine flu, tuberculosis, plague, and rabies.

Development Trends Related to Hazards and Risk

Population growth and development contribute to pandemic exposure. Future development in the Central Region has the potential to change how infectious diseases spread through the community and impact human health in both the short and long term. New development may increase the number of people and facilities exposed to public health hazards and greater population concentrations (often found in special needs facilities and businesses) put more people at risk. During a disease outbreak, those in the immediate isolation area could have little to no warning, whereas the population further away in the dispersion path may have some added time to prepare and mitigate against disease depending on the hazard, its transmission, and public notification.

Risk Summary

In summary, the Communicable Disease hazard is considered to be overall **Medium** significance for the Region. Variations in risk by jurisdiction are summarized in the table below, along with key issues from the vulnerability assessment.

- Pandemics affecting the U.S. occur roughly once every 20 years but cannot be reliably predicted.
- Effects on people will vary, while the elderly, people with underlying medical conditions, and young children may be at higher risk;
- Effects on property are typically minimal, although quarantines could result in business closures.
- Effects on economy: lost productivity due to illness and potential business closures could potentially have severe economic impacts. Social distancing requirements, and/or other governmental restrictions, and fear of public gatherings could significantly reduce in-person commerce.
- Effects on critical facilities and infrastructure: community lifelines, such as healthcare facilities, like hospitals could be impacted and may be overwhelmed and have difficulty maintaining operations due to bed availability, medical staffing shortages, and lack of PPE and other supplies.
- Unique jurisdictional vulnerability: As mentioned above, COVID-19 was the leading cause of death in Montana's Native American tribes.
- Ongoing mitigation activities for the current COVID-19 pandemic or other disease outbreaks should focus on disease prevention and ways to improve health. This includes, but is not limited to, pre-season community outreach campaigns to educate the public about risks and available support; establishing convenient vaccination centers; reaching out to vulnerable populations and caregivers; and issuing advisories and warnings.
- Related Hazards: Human Conflict.

Table 4-7 Risk Summary Table: Communicable Disease

Jurisdiction	Overall Significance	Additional Jurisdictions	Jurisdictional Differences?
Central Region	Medium	NA	NA
Blackfeet Tribe	Medium	NA	None
Blaine County	Medium	Chinook and Harlem	None
Cascade County	Medium	Great Falls, Belt, Cascade, and Neihart	None
Chippewa Cree Tribes Rocky Boy's Reservation	Medium	NA	None
Chouteau County	Medium	Fort Benton, Big Sandy	None
Fergus County	Medium	Lewistown, Denton, Grass Range, Moore, Winifred	None
Fort Belknap Indian Community	Medium	NA	None
Glacier County	Medium	Cut Bank	None
Hill County	Medium	Havre, Hingham	None
Judith Basin County	Medium	Stanford, Hobson	None
Liberty County	Medium	Chester	None
Petroleum County	Medium	Winnett	None
Phillips County	Medium	Malta, Saco	None
Pondera County	Medium	Conrad	None
Teton County	Medium	Choteau, Dutton, Fairfield	None
Toole County	Medium	Shelby, Kevin, and Sunburst	None

4.2.3 Cyber-Attack

Hazard/Problem Description

The Merriam-Webster dictionary defines cyber-attacks as "an attempt to gain illegal access to a computer or computer system to cause damage or harm." Cyber-attacks use malicious code to alter computer operations or data. The vulnerability of computer systems to attacks is a growing concern as people and institutions become more dependent upon networked technologies. The Federal Bureau of Investigation (FBI) reports that "cyber intrusions are becoming more commonplace, more dangerous, and more sophisticated," with implications for private- and public-sector networks. Cyber threats can take many forms, including:

- **Phishing attacks:** Phishing attacks are fraudulent communications that appear to come from legitimate sources. Phishing attacks typically come through email but may come through text messages as well. Phishing may also be considered a type of social engineering meant to exploit employees into paying fake invoices, providing passwords, or sending sensitive information.
- **Malware attacks:** Malware is malicious code that may infect a computer system. Malware typically gains a foothold when a user visits an unsafe site, downloads untrusted software, or may be downloaded in conjunction with a phishing attack. Malware can remain undetected for years and spread across an entire network.
- **Ransomware:** Ransomware typically blocks access to a jurisdiction's/agency's/ business' data by encrypting it. Perpetrators will ask for a ransom to provide the security key and decrypt the data, although many ransomware victims never get their data back even after paying the ransom.
- **Distributed Denial of Service (DDoS) attack**: Perhaps the most common type of cyber-attack, a DDoS attack seeks to overwhelm a network and causes it to either be inaccessible or shut down. A DDoS typically uses other infected systems and internet-connected devices to "request" information from a specific network or server that is not configured or powerful enough to handle the traffic.
- **Data breach**: Hackers gaining access to large amounts of personal, sensitive, or confidential information has become increasingly common in recent years. In addition to networked systems, data breaches can occur due to the mishandling of external drives.
- **Critical Infrastructure/SCADA System attack:** There have been recent critical infrastructure Supervisory Control and Data Acquisition (SCADA) system attacks aimed at taking down lifelines such as power plants and wastewater facilities. These attacks typically combine a form of phishing, malware, or other social engineering mechanisms to gain access to the system.

The FBI Internet Crime Report 2021 reported that cyber-attacks have rapidly increased in the United States over the past decade. The FBI Internet Crime Complaint Center (IC3) was developed to provide the public with a direct way to report cyber-crimes to the FBI. The Crime Complain Center (IC3) recorded a record number of cyber-attacks in 2021, a 7% increase from 2020. The events reported to the FBI are used to track the trends and threats from cyber criminals to combat cyber threats and protect U.S. citizens, businesses, and government from future attacks.

Geographical Area Affected

Cyber-attacks can and have occurred in every location regardless of geography, demographics, and security posture. Anyone with information online is vulnerable to a cyber-attack. Incidents may involve a single location or multiple geographic areas. A disruption can have far-reaching effects beyond the location of the targeted system; disruptions that occur far outside the state can still impact people, businesses, and institutions within the County. All servers in the Central Region are potentially vulnerable to cyber-attacks. Businesses, industry, and even individuals are also susceptible to cyber-attacks. Therefore, the geographic extent of cyber-attack is **significant**.

Past Occurrences

According to the FBI's 2021 Internet Crime Report, the FBI received 2.76 million complaints with $18.7 billion in losses over the last five years due to cyber-attacks. The Crime Report also noted a trend of increasing cybercrime complaints and losses each year. Nationwide losses in 2021 alone exceeded $6.9 billion, a 392% increase since 2017. According to the 2021 Report, Montana ranked 48/57 among U.S. territories in the total number of victims, with 1,188 victims of cyber-crime, and 49th in total victim losses, with $10,107,283 in total losses,

Data on past cyber-attacks impacting Montana was gathered from the 2021 Montana Cybersecurity Report conducted by Pine Cove Consulting. Montana law (MCA 30-14-1704(8)) (effective October 1, 2015) requires any business that experiences a data breach to send a copy of the consumer notification to the Office of Consumer Protection (OCP) to be documented by the Montana Department of Justice. Pine Cove Consulting took the data that is publicly available on the Montana Department of Justice website and summarized the information for public consumption. The 2021 Montana Cybersecurity Report found that in 2021, 134,900 Montanans were affected by a data breaches, up from 82,531 in 2020, a 63.5% increase. The largest recorded data breach in the state of Montana in 2021 affected 14,722 residents of Montana.

The Privacy Rights Clearinghouse, a non-profit organization based in San Diego, maintains a timeline of 9,741 data breaches resulting from computer hacking incidents in the United States from 2005-2021. In total, the Privacy Rights Clearinghouse has reported 35 attacks in Montana since 2005 with a total of 1,471,889 records. Of these records lost in Montana, a majority were from healthcare organizations. It is difficult to know how many of these incidents affected residents in the Montana Central Region. Attacks happening outside of the state can also impact local businesses, personal identifiable information, and credit card information. Table 4-8 displays the most significant cyber-attacks (based on 10,000+ records) in Montana in recent years. The data aims to provide a general understanding of the impacts of cyber-attacks by compiling an up-to-date list of incidents but is limited by the availability of data: "This is an incomplete look at the true scope of the problem due in part to varying state laws" (The Privacy Rights Clearinghouse, 2021).

Table 4-8 Major Cyber Attacks Impacting Montana, 2005-2021

Date Reported	Target	City	Organization Type	Total Records	Type of Attack
7/7/2014	Montana Department of Public Health & Human Services	-	Healthcare	1,062,509	Hacked by an Outside Party or Infected by Malware
1/30/2008	Davidson Companies	Great Falls	Business	226,000	Hacked by an Outside Party or Infected by Malware
3/11/2011	OrthoMontana	Billings	Healthcare	37,000	Portable Device (lost, discarded or stolen laptop, PDA, smartphone, memory stick, CDs, hard drive, data tape, etc.)
1/15/2016	New West Health Services dba New West Medicare	Kalispell	Healthcare	28,209	Portable Device (lost, discarded or stolen laptop, PDA, smartphone,

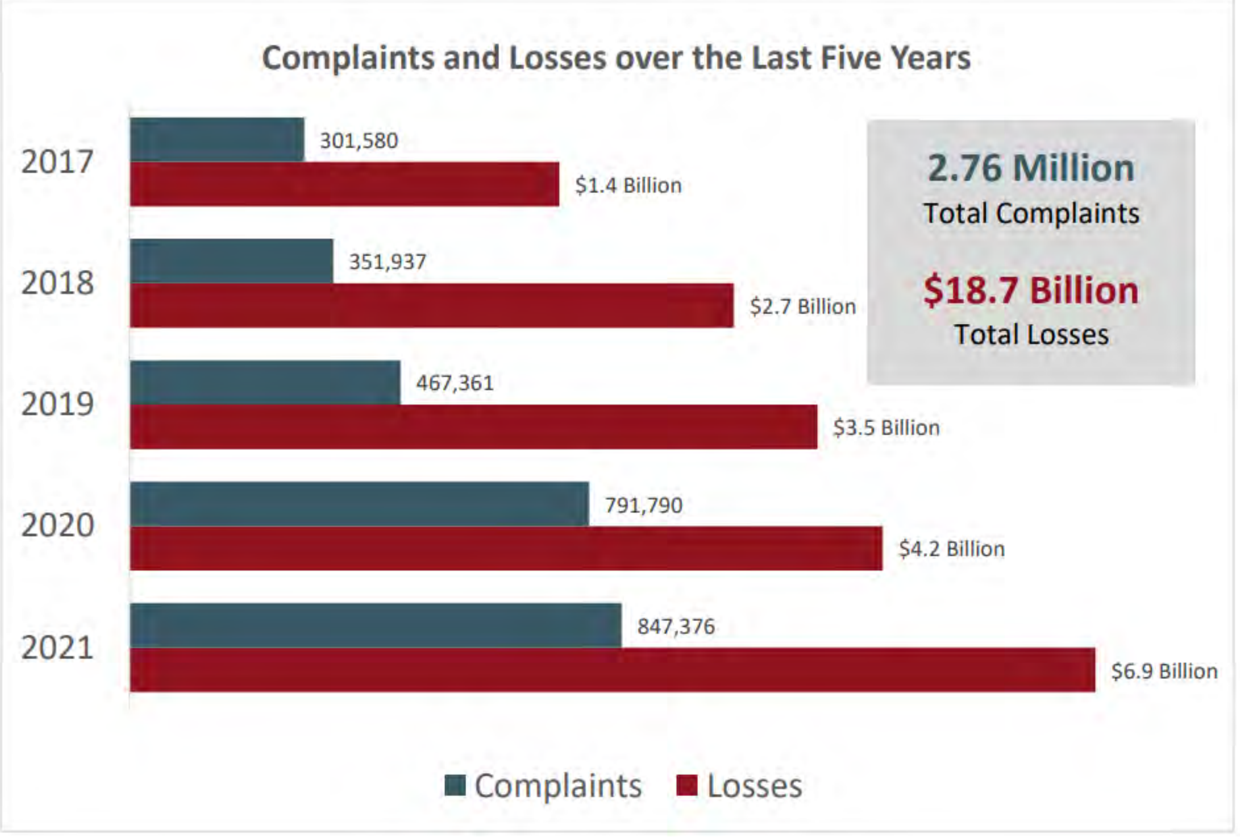
Date Reported	Target	City	Organization Type	Total Records	Type of Attack
					memory stick, CDs, hard drive, data tape, etc.)
4/14/2017	Western Health Screening	-	Healthcare	15,326	PHYS

Source: The Privacy Rights Clearinghouse, https://privacyrights.org/data-breaches

Frequency/Likelihood of Occurrence

The FBI Internet Crime Report 2021 reported that small-scale cyber-attacks such as DDoS attacks occur daily, but most have negligible impacts at the local or regional level. Data breaches are also common, but again most have only minor impacts on government services. However, as reported by the Montana Department of Justice, it is possible for one breach to impact over 100,000 individuals, seen in breaches reported in 2018. The FBI Internet Crime Report found that there is a trend of increasing cyber-attacks over the past 5 years at a national level. These trends are shown in Figure 4.12 below.

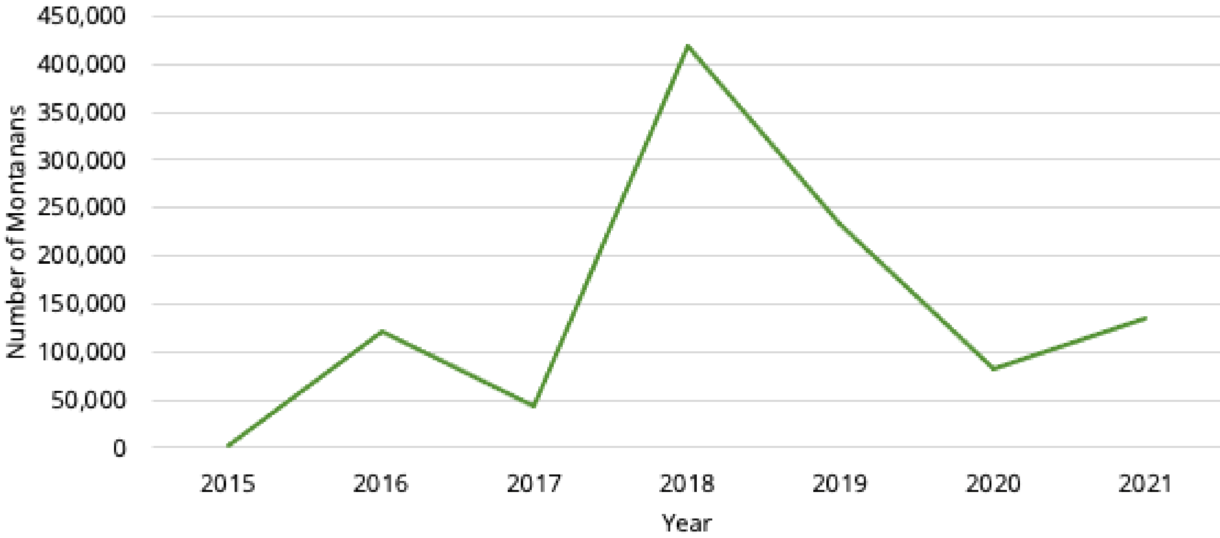
Figure 4.12 Trends of the Frequency of Cyber-attacks, 2017-2021



Source: The FBI Internet Crime Report 2021, https://www.ic3.gov/Media/PDF/AnnualReport/2021_IC3Report.pdf

Despite general trends of increasing cyber-attack cases in the United States (FBI Internet Crime Report 2021), the Montana Department Justice Office of Consumer Protection (OCP) reported variable number of Montanans affected by breaches in data over the past 7 years. The greatest number of residents were impacted in the year 2018, which Pine Cove Consulting explains in their 2021 Report is most likely due to several large data breaches that impacted 100,000+ people. Figure 4.13 below displays temporal trends of cyber breaches by year in Montana from the 2021 Montana Cybersecurity Report.

Figure 4.13 Montanans Affected by Cyber Breaches by Year



Source: 2021 Montana Cybersecurity Repot, https://www.pinecc.com/montana-cyber-security-report

The possibility of a larger disruption affecting systems within each county is a constant threat, but it is difficult to quantify the exact probability due to such highly variable factors as the type of attack and intent of the attacker. Major attacks specifically targeting systems or infrastructure in the Central Region cannot be ruled out. Therefore, the probability of future cyber-attack somewhere in the Region is **likely**.

Climate Change Considerations

Changes in development have no impact on the threat, vulnerability, and consequences of a cyber-attack.

Potential Magnitude and Severity

There is no universally accepted scale to explain the severity of cyber-attacks. The strength of a DDoS attack is often explained in terms of a data transmission rate. One of the largest DDoS disruptions ever, known as the Dyn Attack which occurred on October 21, 2016, peaked at 1.2 terabytes per second and impacted some of the internet's most popular sites to include Amazon, Netflix, PayPal, Twitter, and several news organizations (The Guardian, 2016).

Data breaches are often described in terms of the number of records or identities exposed. The largest data breach ever reported occurred in August 2013, when hackers gained access to all three billion Yahoo accounts. The hacking incidents associated with Montana in the Privacy Rights Clearinghouse database (2005-2021) are of a smaller scale, ranging from 201 record to approximately 1.06 million, along with several cases in which an indeterminate number of records may have been stolen.

Ransomware attacks are typically described in terms of the amount of ransom requested, or by the amount of time and money spent to recover from the attack. One report from cybersecurity firm Emsisoft estimates the average successful ransomware attack costs $81 million and can take 287 days to recover from. Therefore, the potential magnitude and severity of cyber-attack is **critical**.

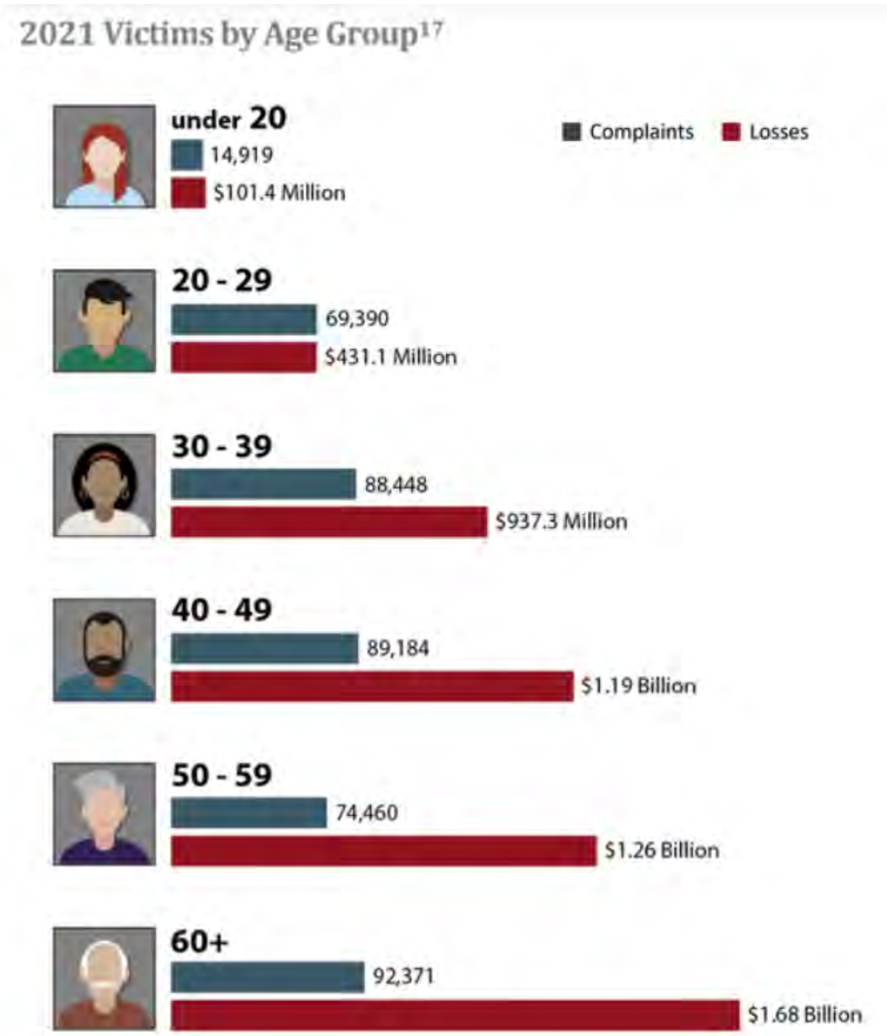
Vulnerability Assessment

People

Injuries or fatalities from cyber-attacks would generally only be possible from a major cyber terrorist attack against critical infrastructure. More likely impacts to the public are financial losses and an inability to access systems such as public websites and permitting sites. Indirect impacts could include interruptions to traffic control systems, water distribution systems, or the energy grid.

The FBI Internet Crime Reports on the victims of cyber-attack by age group. While the number of cyber-attack complaints is comparable across age groups, the losses increase significantly as age group increases, with individuals 60 years and older experiencing greatest losses. This is likely due to seniors being less aware of cyberthreats and lacking the tools to identify cyberthreats. "Grandparent Scams," where criminals impersonate a loved one in need, such as a grandchild, and ask for money are also prevalent. Figure 4.14 displays the breakdown of victims by age group in 2021 from the FBI Internet Crime Report 2021.

Figure 4.14 Victims by Age Group in 2021



Source: The FBI Internet Crime Report 2021, https://www.ic3.gov/Media/PDF/AnnualReport/2021_IC3Report.pdf

Property

Most cyber-attacks affect only data and computer systems and have minimal impact on general property. However, sophisticated attacks have occurred against the supervisory control and data acquisition (SCADA) systems of critical infrastructure, which could potentially result in system failures on a scale equal to natural disasters. Facilities and infrastructure such as the electrical grid could become unusable. According to the report *Analysis of the Cyber Attack on the Ukrainian Power Grid,* a cyber-attack took down the power grid in Ukraine in 2015, leaving over 230,000 people without power. A ransomware attack on the Colonia Pipeline in 2021 caused temporary gas shortages on the East Coast (Tsvetanov, Slaria, 2021).

Critical Facilities and Lifelines

The delivery of services can be impacted since governments rely to a great extent on the electronic delivery of services. Most agencies rely on server backups, electronic backups, and remote options for Continuity of Operations/Continuity of Government. Access to documents on the network, OneDrive access, and other operations that require collaboration across the County will be significantly impacted.

Cyber-attacks can interfere with emergency response communications, access to mobile data terminals, and access to critical pre-plans and response documents. According to the Cyber & Infrastructure Security Agency (CISA), cyber risks to 9-1-1 systems can have "severe impacts, including loss of life or property; job disruption for affected network users; and financial costs for the misuse of data and subsequent resolution." CISA also compiled a recent list of attacks on 9-1-1 systems including a DDoS in Arizona, unauthorized access with stolen credentials in Canada, a network outage in New York, and a ransomware attack in Baltimore.

Public confidence in the government could suffer if systems such as permitting, DMV, voting, or public websites are down for a prolonged amount of time. An attack could raise questions regarding the security of using electronic systems for government services.

Economy

Data breaches and subsequent identity thefts can have huge impacts on the public. The FBI Internet Crime Report 2021 reported losses in Montana due to cyber-attacks totaled $10,107,283 in 2021 alone.

Economic impacts from a cyber-attack can be debilitating. The cyber-attack in 2018 that took down the City of Atlanta cost at least $2.5 million in contractor costs and an estimated $9.5 million additional funds to bring everything back online. The attack in Atlanta took more than a third of the 424 software programs offline and recovery lasted more than 6 months (Reuters, 2018). The 2018 cyber-attack on the CDOT cost an estimated $1.5 million. None of these statistics consider the economic losses to businesses and ongoing IT configuration to mitigate from a future cyber-attack.

Additionally, a 2016 study by Kaspersky Lab found that roughly one in five ransomware victims who pay their attackers never recover their data. A 2017 study found ransomware payments over a two-year period totaled more than $16 million. Even if a victim is perfectly prepared with full offline data backups, recovery from a sophisticated ransomware attack typically costs far more than the demanded ransom.

Historic and Cultural Resources

Most cyber incidents have little to no impact on historic, cultural, or natural resources. A major cyber terrorism attack could potentially impact the environment by triggering a release of hazardous materials, or by causing an accident involving hazardous materials by disrupting traffic control devices.

Natural Resources

Most cyber-attacks would have a limited impact on natural resources. There are cases, such as a cyber-attack on a hydroelectric dam, that could result in catastrophic consequences to natural and human-built environments in the case of a flood (Lewis, 2002). If a cyber-attack occurred on several upstream dams and released significant amounts of water downstream, the additional pressure put on downstream dams could fail, resulting in massive flood events. This would not only jeopardize the energy system that relies on these dams but also cause significant damage to the natural environment.

Development Trends Related to Hazards and Risk

Changes in development have no impact on the threat, vulnerability, and consequences of a cyber-attack. Cyber-attacks can and have targeted small and large jurisdictions, multi-billion-dollar companies, small mom-and-pop shops, and individual citizens. The decentralized nature of the internet and data centers means that the cyber threat is shared by all, regardless of new construction and changes in development.

Risk Summary

In summary, the Cyber-attack hazard is overall medium significance for the Region. Variations in risk by jurisdiction are summarized in the table below, as well as key issues from the vulnerability assessment.

- Overall, cyber-attacks are rated as a **medium** significance in the planning area
- Cyber-attacks can occur anywhere and on any computer network, therefore, this hazard is rated as **significant** location
- There is an increasing trend in the number of cyber-attacks in the U.S. each year, therefore, the frequency of cyber-attack is rated as **likely**
- Cyber-attacks can result in significant economic losses, interruptions of critical facilities and services, and confidential data leaks; therefore, magnitude is ranked as **critical**
- People ages 60+ are the most likely age group to experience the greatest monetary losses, although anyone of any age can be a victim to a cyber-attack (FBI Internet Crime Report 2021)
- Small businesses worth less than $10 million and local governments are increasingly becoming targets for cyber-attack, with criminals assuming these smaller organizations could lack the resources to prevent an attack (FBI Internet Crime Report 2021)
- Critical infrastructure, such as the energy grid and first responder communication, is vulnerable to cyber-attack and disruption
- Significant economic losses can result from cyber-attacks if the attackers ask for ransom
- Jurisdictions with a significantly large population and advanced infrastructure, such as Great Falls, are most likely to experience cyber-attacks

Table 4-9 Risk Summary Table: Cyber-Attack

Jurisdiction	Overall Significance	Additional Jurisdictions	Jurisdictional Differences?
Central Region	Medium	NA	NA
Blackfeet Tribe	Medium	NA	NA
Blaine County	Medium	Chinook and Harlem	None
Cascade County	Medium	Great Falls, Belt, Cascade, and Neihart	Great Falls is more likely to experience cyber-attack due to larger population
Chippewa Cree Tribes Rocky Boy's Reservation	Medium	NA	NA

Jurisdiction	Overall Significance	Additional Jurisdictions	Jurisdictional Differences?
Chouteau County	Medium	Fort Benton, Big Sandy	None
Fergus County	Medium	Lewistown, Denton, Grass Range, Moore, Winifred	None
Fort Belknap Indian Community	Medium	NA	NA
Glacier County	Medium	Cut Bank	NA
Hill County	Low	Havre, Hingham	None
Judith Basin County	Medium	Stanford, Hobson	None
Liberty County	Medium	Chester	NA
Petroleum County	Medium	Winnett	NA
Phillips County	Medium	Malta, Saco	None
Pondera County	High	Conrad	NA
Teton County	Medium	Choteau, Dutton, Fairfield	None
Toole County	Medium	Shelby, Kevin, and Sunburst	None

4.2.4 Dam Failure

Hazard/Problem Description

A dam is a barrier constructed across a watercourse that stores, controls, or diverts water. Dams are constructed for a variety of uses, including flood protection, power, agriculture/irrigation, water supply, and recreation. The water impounded behind a dam is referred to as the reservoir and is usually measured in acre-feet, with one acre-foot being the volume of water that covers one acre of land to a depth of one foot. Depending on local topography, even a small dam may have a reservoir containing many acre-feet of water. Dams serve many purposes, including irrigation control, providing recreation areas, electrical power generation, maintaining water levels, and flood control.

Dam failures and releases from dams during heavy rain events can result in downstream flooding. Water released by a failed dam generates tremendous energy and can cause a flood that is catastrophic to life and property. Two factors that influence the potential severity of a full or partial dam failure are the amount of water impounded and the density, type, and value of downstream development and infrastructure. The speed of onset depends on the type of failure. If the dam is inspected regularly then small leaks allow for adequate warning time. Once a dam is breached, however, failure and resulting flooding occurs rapidly. Dams can fail at any time of year, but the results are most catastrophic when the dams fill or overtop during winter or spring rain/snowmelt events.

A catastrophic dam failure could challenge local response capabilities and require evacuations to save lives. Impacts to life safety would depend on the warning time and the resources available to notify and evacuate the public and could include major loss of life and potentially catastrophic damage to roads, bridges, and homes. Associated water quality and health concerns could also be an issue.

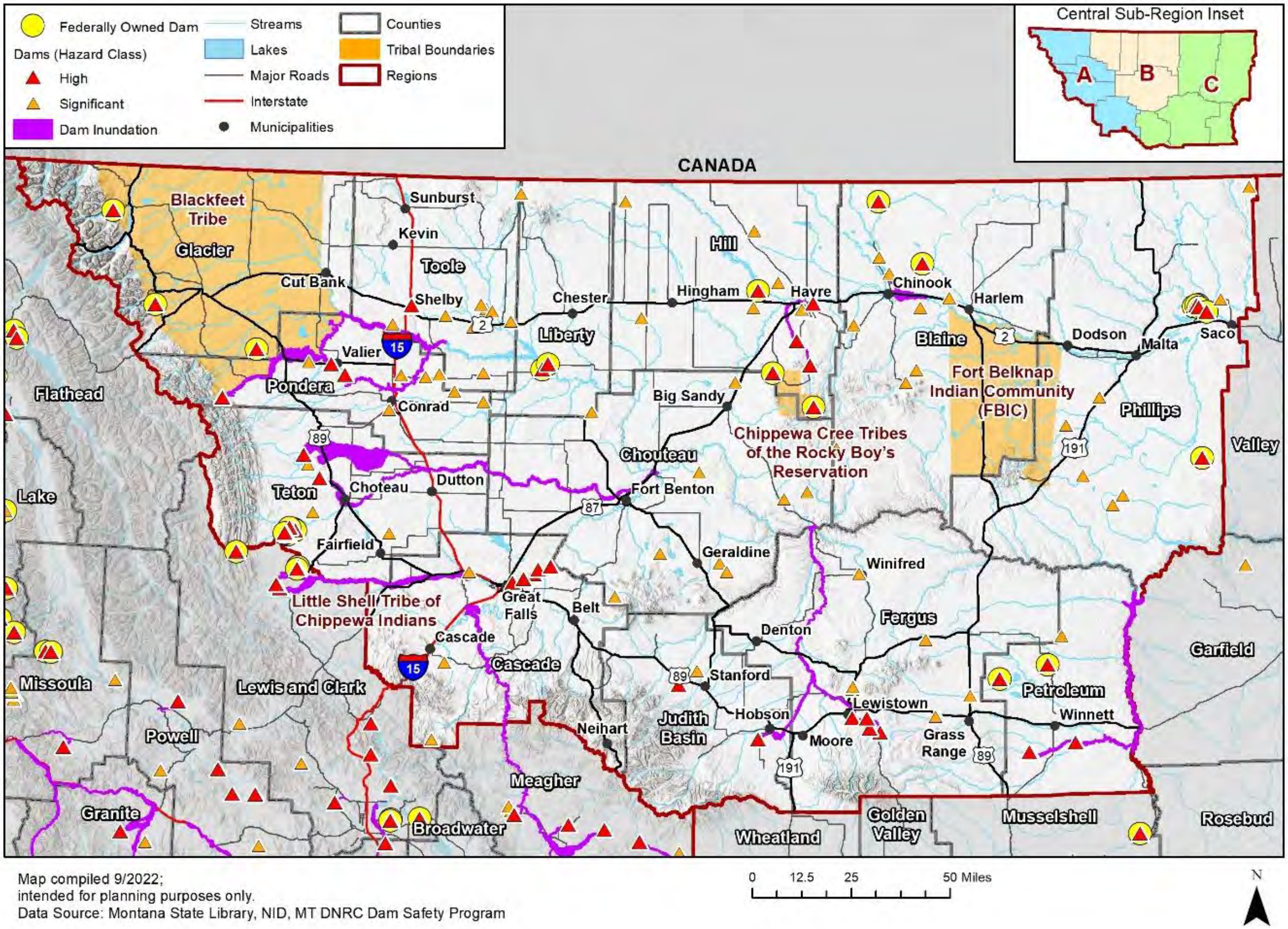
Dam failures are often the result of prolonged rainfall and overtopping, but can happen in any conditions due to erosion, piping, structural deficiencies, lack of maintenance and repair, or the gradual weakening of the dam over time. Other factors that can lead to dam failure include earthquakes, landslides, improper operation, rodent activity, vandalism, or terrorism.

According to FEMA, dams are classified in three categories that identify the potential hazard to life and property:

- **High hazard** - Dams where failure/mis-operation will probably cause loss of human life.
- **Significant hazard** - Dams where failure or mis-operation results in no probable loss of human life but can cause economic loss, environmental damage, disruption of lifeline facilities, or impact other concerns. Significant hazard potential classification dams are often located in predominantly rural or agricultural areas but could be located in areas with population and significant infrastructure.
- **Low hazard** - Dams where failure or mis-operation results in no probable loss of human life and low economic and/or environmental losses. Losses are principally limited to the owner's property.

Dam inundation can also occur from non-failure events or incidents such as when outlet releases increase during periods of heavy rains or high inflows. Controlled releases to allow water to escape when a reservoir is overfilling can help prevent future overtopping or failure. When outlet releases are not enough, spillways are designed to allow excess water to exit the reservoir and prevent overtopping. This can protect the dam but result in flooding downstream. Dam safety incidents are defined as situations at dams that require an immediate response by dam safety engineers.

Figure 4.15 Central Region Dams



Geographical Area Affected

The geographical area affected by dam failure is potentially **significant**. According to the National Inventory of Dams, there are a total of 962 dams throughout the counties of the Central Region. 55 of these dams are high hazard, and 65 are significant hazard dams, with the remainder being low hazard dams. These dams are mapped in Figure 4.15 and described in detail in the jurisdictional annexes.

All high hazard dams in the Central Region have up-to-date Emergency Action Plans (EAP) on file. Inundation data is frequently only available for high hazard dams which are not federally owned, based on data from the MT DNRC. It is important to note that a lack of mapped inundation areas does not necessarily indicate a lack of risk. Additionally, inundation zones for dams owned by the Bureau of Indian Affairs are used with permission.

Dam inundation maps are frequently treated as sensitive documents due to concerns about causing public alarm, particularly in regions prone to flooding. There is also potential that these maps may be misused by individuals representing realty or insurance interests. Potential exists for maps to be exploited for malicious purposes, such as terror attacks. Therefore, the availability of these maps to the public remains limited due to a combination of security concerns, legal considerations, and the potential for misuse or misinterpretation.

Past Occurrences

Dam failure floods in Montana have primarily been associated with riverine and flash flooding. According to the 2023 Montana State Hazard Mitigation Plan and the Montana Department of Natural Resources and Conservation, aging infrastructure is largely to blame for a number of failed dams in Montana. There have been numerous small failures primarily related to deterioration of corrugated metal pipe outlet works, which causes slow release of reservoir contents along the outside of the outlet pipe, with minimal downstream property damage but serious damage to the structure. Dams with potential for loss of life downstream are subject to stringent permitting, inspection, operation, and maintenance requirements. Deficiencies and problems are identified in advance and actions taken to mitigate the chance that the deficiency leads to failure. If a deficiency cannot be immediately addressed due to lack of data or lack of dam owner resources, risk reduction measures are put in place.

According to the Association of State Dam Safety Officials, Dam Incident Database, there have been two instances of dam failure flooding in the Central Region, both triggered during the same flood event in June of 1964. Approximately 12 to 16 inches of precipitation fell in a 72 hour period, which quickly melted much of the remaining snowpack and caused flooding. The storm event was later estimated to have a 5,000 to 10,000 year or more period of return, both the Swift Reservoir Dam and the Two Medicine Dam failed and contributed to massive downstream flooding. The Swift Dam was located in Pondera County and the Two Medicine Dam in Glacier County, and both dams were located on the Blackfeet Indian Reservation. The flooding and subsequent dam failures, especially combined with an initial lack of warning when the Swift Dam failed, led to 30 deaths on the Reservation, the loss of 265 homes and 20,000 acres of hay land, and an estimated $626 million dollars (in 2022 dollars) in property damage.

Frequency/Likelihood of Occurrence

Dam failures in the United States typically occur in one of four ways:

- Dam overtopping occurs when the water level behind the dam exceeds the top of the dam. Overtopping accounts for 34% of all dam failures, can occur due to inadequate spillway design, settlement of the dam crest, blockage of spillways, and other factors.
- Foundation defects due to differential settlement, slides, slope instability, uplift pressures, and foundation seepage can also cause dam failure. These account for 30% of all dam failures.

- Internal erosion or piping of an earth dam takes place when water that seeps through the dam carries soil particles away from the embankment, filters, drains, foundation or abutments of the dam. Failure due to piping and seepage accounts for 20% of all failures. These are caused by internal erosion due to piping and seepage, erosion along hydraulic structures such as spillways, erosion due to animal burrows, and cracks in the dam structure.
- Failure due to problems with conduits and valves, typically caused by the piping of embankment material into conduits through joints or cracks, constitutes 10% of all failures.

The remaining 6% of U.S. dam failures are due to miscellaneous causes. Many dam failures in the United States have been secondary results of other disasters. The prominent causes are earthquakes, landslides, extreme storms, massive snowmelt, equipment malfunction, structural damage, foundation failures, and sabotage.

Poor construction, lack of maintenance and repair, and deficient operational procedures are preventable or correctable by a program of regular inspections. According to the 2023 State of Montana Multi-Hazard Mitigation Plan and the 2023 National Inventory of Dams, there is only one high hazard potential dam in the Central Region that is currently rated as being in poor condition: the Eureka Reservoir Dam located 11 miles upstream of the City of Choteau; see Addendum AA Teton County for more details on this dam. MTDES and the participating jurisdictions will continue to monitor dam conditions and may amend this plan if additional high hazard potential dams are assessed as being in poor condition.

Terrorism and vandalism are also serious concerns that all operators of public facilities must plan for; these threats are under continuous review by public safety agencies.

All of these factors considered, and taking into consideration the record of past events, the likelihood of a catastrophic dam failure is unlikely, but still possible, with a record of past occurrences in the region. This gives a probability rating for dam failure of **occasional**. All counties and tribes in the Central Region have at least some risk of dam failure from the high hazard dams located throughout the Region. In addition, the other low hazard dams could potentially fail and cause issues downstream, though not enough data is available to determine the magnitude or detail how impactful a low hazard dam could be on their surrounding communities. Given the density of population and property, and the age and condition of the high hazard dams, the potential exists for catastrophic dam failure in the Region.

Climate Change Considerations

As of this HMP update it is not clear if climate change will affect dam hazards negatively, but a healthy dose of caution is warranted. Dam safety is a high priority in Montana, the state has made a considerable investment developing laws and rules for the design, construction, and maintenance of dams to ensure dam safety. The state has a staffed dam safety program that conducts a sophisticated inspection program. However, dam failures have happened when events occurred that were unforeseen when the structures were designed and built.

For example, the Swift Dam in Pondera County and the Two Medicine Dam in Glacier County, both located on the Blackfeet Indian Reservation and within the planning area, failed in 1964 due to freak rain-on-snow event later estimated to have a 5,000-to-10,000-year return interval. Flood waters filled both reservoirs and evidently exceeded spillway capacities, leading to overtopping the dams and the eventual failures. The Swift Dam failure caused 19 deaths[2] and tremendous property damage (see the above subsection titled *Past Occurrences*).

[2] Case Study: Swift and Two Medicine Dams (Montana, 1964), Association of State Dam Safety Officials contribution by Lee Mauney, P.E., CFM

With regard to climate change, a fundamental concern is that future conditions will be different from past conditions used to develop design parameters for existing dams. Extreme weather events have occurred throughout history, a pattern that seems to be accelerating as climate change progresses. Further complicating matters, many climate change impacts are indirect and difficult or impossible to predict. The 2021 Montana Climate Change and Human Health report considers climate "surprises" to be the third greatest concern with climate change impacts to human health.

Cascading effects of wildfire are one potential source of climate change "surprise" that is especially relevant to dam safety. Wildfire scars can alter watershed hydrology, causing extreme, unprecedented runoff that causes flash flooding and often causes debris flows. The concern in this case is that a future wildfire regime could leave unprecedented fire scars. If an extreme precipitation event occurred on such a fire scar, unprecedented runoff could result that exceeds the design parameters of a dam and is sufficient to cause a dam failure. In a worst case, a failure would cause a reservoir to burst and release floodwaters, but debris flows are also capable of filling reservoirs with sediment and necessitate costly dredging to restore reservoir function. Predicting these scenarios is difficult.

To be clear, none of the climate reports reviewed for this HMP update specified climate change as a particular concern for dam safety. The issue is not mentioned in 2021 Climate Change and Human Health report, the Fifth National Climate Assessment chapter 25 on the Northern Great Plains region, or NOAA Climate Summaries for Montana. Nor is the issue explicitly addressed on the Montana Dam Safety Program landing page (https://dnrc.mt.gov/Water-Resources/Dam-Safety/). There does not appear to be recent, or perhaps any, academic studies that have addressed the issue in Montana, let alone in the planning area.

Despite the lack of study to document specific impacts of climate change on dam safety, it is prudent to approach the issue with humility and monitor changing knowledge in future HMP updates.

Potential Magnitude and Severity

As noted above, dams are classified as High Hazard Potential (HHPD) if failure is likely to result in loss of life, or Significant Hazard Potential if failure is likely to cause property damage, economic loss, environmental damage, or disruption of lifeline facilities.

According to the 2023 State of Montana Multi-Hazard Mitigation Plan and the 2023 National Inventory of Dams, there is only one high hazard potential dam in the Central Region that is currently rated as being in poor condition: the Eureka Reservoir Dam located 11 miles upstream of the City of Choteau. In the event of a failure at the Eureka Reservoir Dam, the ensuing inundation would trigger significant consequences along its path. The total building exposure from the Eureka Reservoir Dam failure exceeds $190 million, with over $152 million of this exposure stemming from parcels within the City of Choteau. Inundation from the Eureka Reservoir Dam would also impact 27 critical facilities in the County, including 12 transportation facilities in the unincorporated County and six safety and security facilities in the City of Choteau. The known inundation zone ends just east of the Teton County border without running into any additional major developments. See the Teton Addendum for more information on the potential impacts of a failure of the Eureka Reservoir Dam.

Information from the event of record is used to calculate a magnitude and severity rating for comparison with other hazards, and to assist in assessing the overall impact of the hazard on the planning area. In some cases, the event of record represents an anticipated worst-case scenario, and in others, it is a reflection of common occurrence. The event of record for the Central Region could be considered to be the 1964 failures of the Swift and Two Medicine dams, which resulted in 30 deaths and an estimated $626 million dollars in damage in 2022 dollars. Overall, dam failure impacts could be critical in the Central Region. Roads closed due to dam failure floods could result in serious transportation disruptions due to the limited number of roads in the region.

The potential magnitude of a dam failure in the planning area could change in the future; the hazard significance of certain dams could increase if development occurs in inundation areas.

Vulnerability Assessment

The dam failure *Vulnerability Assessment* identifies *assets* are both *likely to be exposed* in the event of a dam failure and *susceptible* to damage from that exposure. In this context, *assets* are (1) people, (2) property, (3) critical facilities and lifelines, (4) the economy, (5) historic and cultural resources, and (6) natural resources.

Exposure is defined here as interacting with dam failure hazards, and *likely to be exposed* indicates a presence in areas deemed to be especially likely to experience dam failure hazards. *Susceptible* indicates a strong likelihood of damage from exposure to dam failure hazards. Finally, vulnerability under future conditions is considered below as it relates to development in the section titled *Development Trends Related to Hazards and Risk*. The effects of climate change on future conditions are considered above in the subsection titled *Climate Change Considerations*.

Dam failures are often associated with other natural hazard events such as earthquakes, landslides, or severe weather, which makes dam failures difficult to predict far in advance. When they occur, dam failures can cause massive and catastrophic flash flooding downstream, often occurring with little or no warning. Flooding caused by dam failure can extend well outside of the normal floodplain to what is known as the dam inundation area or dam inundation zone and are discussed above in the section titled, *Geographical Area Affected*. When dams fail, damage to assets often causes great disruption to communities.

The analysis of dam failure vulnerability is simplified somewhat by the assumption that any person or physical object that comes into contact with flooding from a dam failure is susceptible to damage. This assumption is based on some key characteristics of dam failure hazards. Dam failure flooding can be among the most violent hazards in existence. The flooding hazard also has definite boundaries. Finally, dam failure flooding can occur with little or no warning and possibly at night when warning and evacuation are difficult. For hazard mitigation planning purposes, it is assumed that anything in the designated flood inundation zone is vulnerable. Susceptibility is discussed further in the asset-specific subsections, below.

A key limitation of hazard mitigation planning is that flood inundation areas for federally-owned dams are typically not available. This prevents identification of many assets that are vulnerable to dam-failure hazards. A solution to this limitation is to reference the hard-copy maps that are available within Emergency Action Plans associated with these dams and on file with the local emergency management offices.

People

Flooding caused by dam failure is among the most violent and destructive hazard events. People are certainly susceptible to injury or death when exposed to dam inundation hazards. From a planning perspective, all populations exposed to dam failure hazards are considered vulnerable.

Fortunately, the population exposed to dam failure hazards is variable. The presence of people within dam inundation areas can be reduced in many ways, such as limiting development in high hazard areas. Also, providing advance warning of approaching dam failure hazards can be effective when the warning is received and successfully acted upon to evacuate the area. However, even if advance warning exists, any population that does not receive and act on that warning is also remains vulnerable. Even when warnings are received and acted upon, the time to successfully evacuate may be brief and insufficient for some people. People prevented from evacuating by blocked or otherwise inaccessible evacuation paths also remain vulnerable. Improving any of the above-mentioned factors will reduce the vulnerability of people to dam failure hazards. Aiding the evacuation of certain populations deserves special consideration, most notably the elderly, people with disabilities, and young children. These issues are considered more thoroughly in Section 5, *Mitigation Strategy*.

According to Geographic Information System (GIS) analysis conducted for this vulnerability assessment by WSP, there are an estimated 10,594 people residing in identified dam inundation zones throughout the Central Region. This number does not include people downstream of federally-owned dams that do not release information on dam inundation zones. This estimate was derived by taking the number of residential parcels within the inundation zone and multiplying them by the average household size for each county per the U.S. Census Bureau American Community Survey estimates. The breakdown of these exposed populations per county and jurisdiction are shown in Table 4-10 below.

Property

The potentially violent and destructive nature of dam failure hazards makes property that exists within the dam inundation area susceptible to damage and therefore potentially vulnerable. Low-lying areas where dam waters would collect are subject to additional flood hazards.

Table 4-10 summarizes the estimated number of improved parcels, building values, and people within inundation zones (private dams only) for each county in the Central Region. Counties with the highest exposure of people and property include Hill, Fergus, Teton, and Cascade.

Table 4-10 Central Region Parcels at Risk to Overall Dam Inundation by Jurisdiction

County	Jurisdiction	Improved Parcels	Improved Value	Content Value	Total Value	Population
Blaine	Blaine County	57	$5,213,584	$4,313,242	$9,526,826	80
Cascade	Cascade County	317	$44,286,131	$28,098,298	$72,384,429	552
Chouteau	Chouteau County	94	$6,786,247	$4,865,289	$11,651,536	175
Fergus	Lewistown	901	$111,713,022	$58,153,686	$169,866,708	1,879
	Fergus County	136	$23,029,164	$13,893,812	$36,922,976	239
Glacier	Glacier County	3	$312,030	$312,030	$624,060	0
Hill	Havre	1,639	$273,783,203	$151,512,429	$425,295,632	3,912
	Hill County	250	$26,929,804	$16,860,889	$43,790,693	585
Judith Basin	Judith Basin County	4	$914,070	$765,110	$1,679,180	4
Liberty	-	-	-	-	-	-
Petroleum*	Petroleum County	11	$2,862,110	$2,776,045	$5,638,155	7
Phillips	-	-	-	-	-	-
Pondera	Blackfeet Tribe	10	$803,440	$649,390	$1,452,830	6
	Pondera County	31	$3,781,722	$3,114,141	$6,895,863	41
Teton	Choteau	768	$96,270,139	$56,007,137	$152,277,276	1,749
	Teton County	251	$36,780,641	$24,490,510	$61,271,151	372
Shelby	Shelby	446	$56,644,984	$37,934,206	$94,579,190	973
	Toole County	18	$4,345,340	$3,528,365	$7,873,705	21
	Total	**4,936**	**$694,455,631**	**$407,274,577**	**$1,101,730,208**	**10,594**

Source: County Assessor data, NID, MT DNRC, WSP GIS Analysis, 2022

Critical Facilities and Lifelines

A total dam failure can cause catastrophic impacts to areas downstream of the water body. It is assumed that any infrastructure or asset in an inundation area is susceptible to damage or destruction from a dam failure and is therefore vulnerable. Transportation routes are vulnerable to dam inundation and have the potential to be wiped out, creating isolation issues. Roads closed due to floods caused by dam failure or incident could result in serious transportation disruptions due to the limited number of roads in the County. Those that are most vulnerable are those that are already in poor condition and would not be able to withstand a large water surge. Utilities such as overhead power lines, cable and phone lines could also be vulnerable. Loss of these utilities could create additional isolation issues for the inundation areas.

Based on the critical facility inventory considered in the updating of this plan there are 189 critical facilities throughout the Central Region which lie within mapped dam inundation areas (Table 4-11). These at-risk facilities are listed in the table below by critical facility classification as based on the Lifeline categories (FEMA Community Lifelines, 2019).

Table 4-11 Central Region Critical Facilities at Risk to Dam Inundation

County	Jurisdiction	Communications	Energy	Food, Water, Shelter	Hazardous Materials	Health and Medical	Safety and Security	Transportation	Total
Blaine	Blaine County	-	-	1	-	-	-	14	**15**
	Total	**0**	**0**	**1**	**0**	**0**	**0**	**14**	**15**
Cascade	Cascade County	-	-	1	1	-	1	13	**16**
	Total	**0**	**0**	**1**	**1**	**0**	**1**	**13**	**16**
Chouteau	Chouteau County	-	1	-	-	-	1	6	**8**
	Total	**0**	**1**	**0**	**0**	**0**	**1**	**6**	**8**
Fergus	Lewistown	4	1	1	-	1	5	11	**23**
	Fergus County	-	-	1	-	-	1	16	**18**
	Total	**4**	**1**	**2**	**0**	**1**	**6**	**27**	**41**
Glacier	Glacier County	-	-	-	-	-	-	1	**1**
	Total	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**1**
Hill	Havre	5	1	4	-	1	11	-	**22**
	Hill County	2	-	1	-	-	-	8	**11**
	Total	**7**	**1**	**5**	**0**	**1**	**11**	**8**	**33**
Judith Basin	Judith Basin County	-	-	-	-	-	-	1	**1**
	Total	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**1**
Petroleum	Petroleum County	-	-	-	-	-	-	2	**2**
	Total	**0**	**0**	**0**	**0**	**0**	**0**	**2**	**2**
Pondera	Pondera County	-	1	-	-	-	-	17	**18**
	Total	**0**	**1**	**0**	**0**	**0**	**0**	**17**	**18**
Teton	Chouteau	2	-	1	-	1	6	-	**10**
	Teton County	2	1	2	1	-	1	21	**28**
	Total	**4**	**1**	**3**	**1**	**1**	**7**	**21**	**38**
Toole	Shelby	2	-	2	-	1	6	-	**11**
	Toole County	-	-	-	-	-	1	4	**5**
	Total	**2**	**0**	**2**	**0**	**1**	**7**	**4**	**16**
	Grand Total	**17**	**5**	**14**	**2**	**4**	**33**	**114**	**189**

Source: Montana DNRC Dam Safety Program, Montana State Library, NID, HIFLD 2022, Montana DES, NBI

Economy

The economy in the Central Region is both exposed and susceptible to dam failure. For example, a dam failure would likely cause the long-term loss of a reservoir. Reservoirs are often critical water sources for potable or irrigation water needs, support tourism, and provide wildlife habitat. The loss of potable water could directly cause businesses to close, at least temporarily, and the loss of a reservoir could indirectly disrupt tourism. Downstream flooding would cause additional layers of economic disruption.

Historic and Cultural Resources

Reservoirs themselves are often significant cultural and economic resources for tourism and recreation. A dam failure and subsequent loss of a reservoir would be potentially catastrophic to these resources. In addition, downstream flooding is also capable of damaging or destroying historic and cultural resources such as historic buildings, aquatic habitat, or additional dams downstream. Specific historic resources have not been identified, but historic buildings in the towns of Choteau, Havre, and Shelby may have more exposure than other jurisdictions in the Region based on the overall numbers of developed parcels within inundation areas and concentration of historic buildings in downtown areas.

Natural Resources

Reservoirs held behind dams affect many ecological aspects of a river. Rivers often experience wide fluctuations in key aspects of aquatic habitat such as flow rate, temperature, and suspended sediment. But below dams, rivers often experience relatively stable conditions with very little suspended sediment. These conditions can provide ideal habitat for desirable species such as trout. A dam failure can completely alter this arrangement.

Dam failure also can cause severe downstream flash flooding, depending on the magnitude of the failure. Loss of the water resource from dam failure could impair the supply of water for potable or irrigation water needs.

Development Trends Related to Hazards and Risk

Specific areas experiencing growth and development below dams in Montana has not been assessed, but it's possible there has been development within inundation zones, which are not regulated like other flood hazard areas. Development below dams can cause vulnerability to increase and have significant financial impact on dam owners. When new development occurs in the inundation area below an existing dam that previously lacked downstream hazards, the dam could be reclassified as "high hazard". High hazard dams are required to meet stringent requirements for design, construction, inspection, and maintenance. Bringing a dam up to high hazard design standards can be costly for a dam owner. Even for dams already classified as high hazard, additional downstream development can still have a financial impact. Spillway design standards are based on potential for loss of life downstream. As the population at risk increases, the spillway design standard increases. A dam that is currently in compliance with state design standards can suddenly be out of compliance after a subdivision is built downstream.

Risk Summary

Dam failure is a hazard that presents an unlikely chance of occurrence, but a very significant negative impact should a dam failure occur. Major impacts to downstream populations, property, infrastructure, and natural and cultural resources could occur.

- While dam failures are relatively rare events, the high risk associated with a dam failure in the Central Region makes the overall significance rating **Medium**.
- Dam failures, especially those of high hazard dams, could potentially result in people downstream caught in inundation area flooding with little to no warning;

- Property and buildings located within the inundation area are vulnerable to damage or destruction in the event of a dam failure; Counties with the highest exposure of people and property include Hill, Fergus, Teton, and Cascade.
- Direct economic losses in terms of property damage, as well as indirect losses in terms of impeded tourism and loss of cultural or recreational resources like reservoirs, could result from dam failures. There is an estimated $1,101,730,208 in total property value located within inundation areas in the Central Region exclusive to privately owned high hazard dams;
- Critical facilities and infrastructure, most notably roads and bridges, located in the inundation zones are also vulnerable to damage or complete loss in the event of a dam failure;
- Related hazards: flooding, earthquake, landslide

Table 4-12 Risk Summary Table: Dam Failure

Jurisdiction	Overall Significance	Additional Jurisdictions	Jurisdictional Differences?
Central Region	Medium	NA	55 HHPDs exist in the Central Region, affecting most, but not all, jurisdictions. Many cities and variable land uses exist downstream of high hazard dams. Many dam inundation area delineations are unavailable and extent of risk is unquantified. 65 significant hazard dams and over 800 low hazard dams also exist within the Central Region.
Blackfeet Nation	Medium	NA	The Blackfeet tribe has experienced two high-hazard dam failures in the past, causing loss of life. The reservation has three HHPDs and is affected by two other HHPDs in neighboring Pondera County. The cities of East Glacier Park and Babb are each within 5 and 6 miles of HHPDs, respectively.
Blaine County	Medium	Chinook and Harlem	Blaine County has two high hazard dams, upstream of the cities of Fort Belknap Agency, Savoy, and Zurich. Dam inundation area is unavailable for these dams and risk is unquantified.
Cascade County	Medium	Great Falls, Belt, Cascade,	Cascade County has five high hazard potential dams, all on the Missouri River, upstream of Fort Benton in Chouteau County. Three significant hazard dams affect the county.
Chippewa Cree Tribes Rocky Boy's Reservation	Medium	NA	Two HHPDs exist on the reservation and are upstream of the towns of Box Elder and Havre in Hill County.
Chouteau County	Medium	Fort Benton, Big Sandy	One HHPD exists in Chouteau County and many HHPDs exist upstream of the county. Populated areas downstream from HHPDs include Box Elder, Loma, and Fort Benton. Only the inundation zones on the Teton River and Box Elder Creek are delineated.
Fergus County	Medium	Lewistown, Denton, Grass Range, Moore, Winifred	Four HHPDs exist within Fergus County, all are upstream of Lewistown. One high hazard dam exists on the Judith River in Judith Basin County, which flows through remote areas before emptying into the Missouri River and flowing east.
Fort Belknap Indian Community	Medium	NA	One HHPD exists upstream of the reservation, in Blaine County. Outflow from this HHPD eventually flows past the town of Fort Belknap Agency. The inundation area has not been delineated.
Glacier County	High	Cut Bank	Three HHPDs exist within the county, all on the Blackfeet Tribe Reservation. Communities downstream from these

Jurisdiction	Overall Significance	Additional Jurisdictions	Jurisdictional Differences?
			dams includes East Glacier Park and Babb. No inundation delineation is available for the Lake Sherburne Dam.
Hill County	Medium	Havre, Hingham	Seven HHPDs exist within Hill County, in addition the HHPD Bonneau Dam (Chouteau County) and the Tiber Dam and the Tiber Dike HHPDs (both in Liberty County) exist upstream of Hill County. The city of Havre is downstream of nearly all of these HHPDs. Other communities downstream from HHPDs include Beaver Creek, Box Elder (Chouteau County) and Herron.
Judith Basin County	Medium	Stanford, Hobson	Two HHPDs exist in Judith Basin County but do not affect communities. The inundation area for one of the HHPDs is mapped.
Liberty County	Low	Chester	Liberty County is affected by two HHPDs that together create Lake Elwell. Dam inundation areas are not available for these structures. Many HHPDs exist upstream of Lake Elwell. The Town of Loma (Chouteau County) is downstream from HHPDs.
Petroleum County	Medium	Winnett	There are five HHPDs in Petroleum County, four of which are upstream from the town of Mosby. Inundation delineations are not available for the Duck Creek Retention Dam or the Dry Blood Creek Detention Dam.
Phillips County	Low	Malta, Saco	Six HHPDs exist in Phillips County that form two reservoirs. The city of Saco is downstream of both reservoirs. No inundation delineations are available for any of HHPDs.
Pondera County	Medium	Conrad	There are 4 HHPD's within Pondera County. Three additional HHPDs exist upstream of Pondera County. One of these HHPDs is in Teton County and has a mapped inundation area that very slightly extends into southern Pondera County. Two other HHPDs exist in Glacier County and affect the north-central part of the county. Communities downstream form HHPDs include Ledger and Cut Bank (Toole County).
Teton County	Low	Choteau	Within Teton County there are 12 HHPD's. Additional HHPDs exist upstream in Lewis and Clark County and affect the Sun River. Inundation areas are not available for Gibson Dam or the Pishkun Dikes/Reservoir. Cities downstream of HHPDs include Choteau, Bynum, Agawam, and Collins. Note: The Eureka Reservoir HHPD is rated as being in poor condition and exists 11 miles upstream of the city of Choteau. Nearly all of Choteau exists within the mapped inundation zone for this dam.
Toole County	Low	Shelby, Kevin, and Sunburst	Toole County has two HHPD's owned by, and immediately upstream of, the City of Shelby. Dam inundation areas are not available for these dams. Toole County is also affected by HHPDs upstream in Glacier and Pondera Counties, with inundation areas mapped to the mouth of Lake Elwell.

4.2.5 Drought

Hazard/Problem Description

Drought is a condition of climatic dryness that is severe enough to reduce soil moisture and water below the minimum necessary for sustaining plant, animal, and human life systems. Influencing factors include temperature patterns, precipitation patterns, agricultural and domestic water supply needs, and growth. Lack of annual precipitation and poor water conservation practices can result in drought conditions.

Drought is a gradual phenomenon. Although droughts are sometimes characterized as emergencies, they differ from typical emergency events. Most natural disasters, such as floods or wildland fires, occur relatively rapidly and afford little time for preparing for disaster response. Droughts occur slowly, over a multi-year period, and can take years before the consequences are realized. It is often not obvious or easy to quantify when a drought begins and ends. Droughts can be a short-term event over several months or a long-term event that lasts for years or even decades.

Drought is a complex issue involving many factors—it occurs when a normal amount of moisture is not available to satisfy an area's usual water-consuming activities. Drought can often be defined regionally based on its effects:

- **Meteorological drought** is usually defined by a period of below average water supply.
- **Agricultural drought** occurs when there is an inadequate water supply to meet the needs of the state's crops and other agricultural operations such as livestock.
- **Hydrological drought** is defined as deficiencies in surface and subsurface water supplies. It is generally measured as streamflow, snowpack, and as lake, reservoir, and groundwater levels.
- **Socioeconomic drought** occurs when a drought impacts health, well-being, and quality of life or when a drought starts to have an adverse economic impact on a region.

Drought impacts are wide-reaching and may be economic, environmental, and/or societal. The most significant impacts associated with drought in Montana are those related to water intensive activities such as agriculture, wildland fire protection, municipal usage, commerce, tourism, recreation, and wildlife preservation. An ongoing drought may leave an area more prone to beetle kill and associated wildland fires. Previous drought events in Montana have led to grasshopper infestations. Drought conditions can also cause soil to compact, increasing an area's susceptibility to flooding, and reduce vegetation cover, which exposes soil to wind and erosion. A reduction of electric power generation and water quality deterioration are also potential problems. Drought impacts increase with the length of a drought, as carry-over supplies in reservoirs are depleted and water levels in groundwater basins decline.

The onset of drought in the Central Region is usually signaled by a lack of significant winter snowfall. Montana receives most of its precipitation as snow in the higher elevations between November and April. Hot and dry conditions that persist into spring, summer, and fall can aggravate drought conditions, making the effects of drought more pronounced as water demands increase during the growing season and summer months.

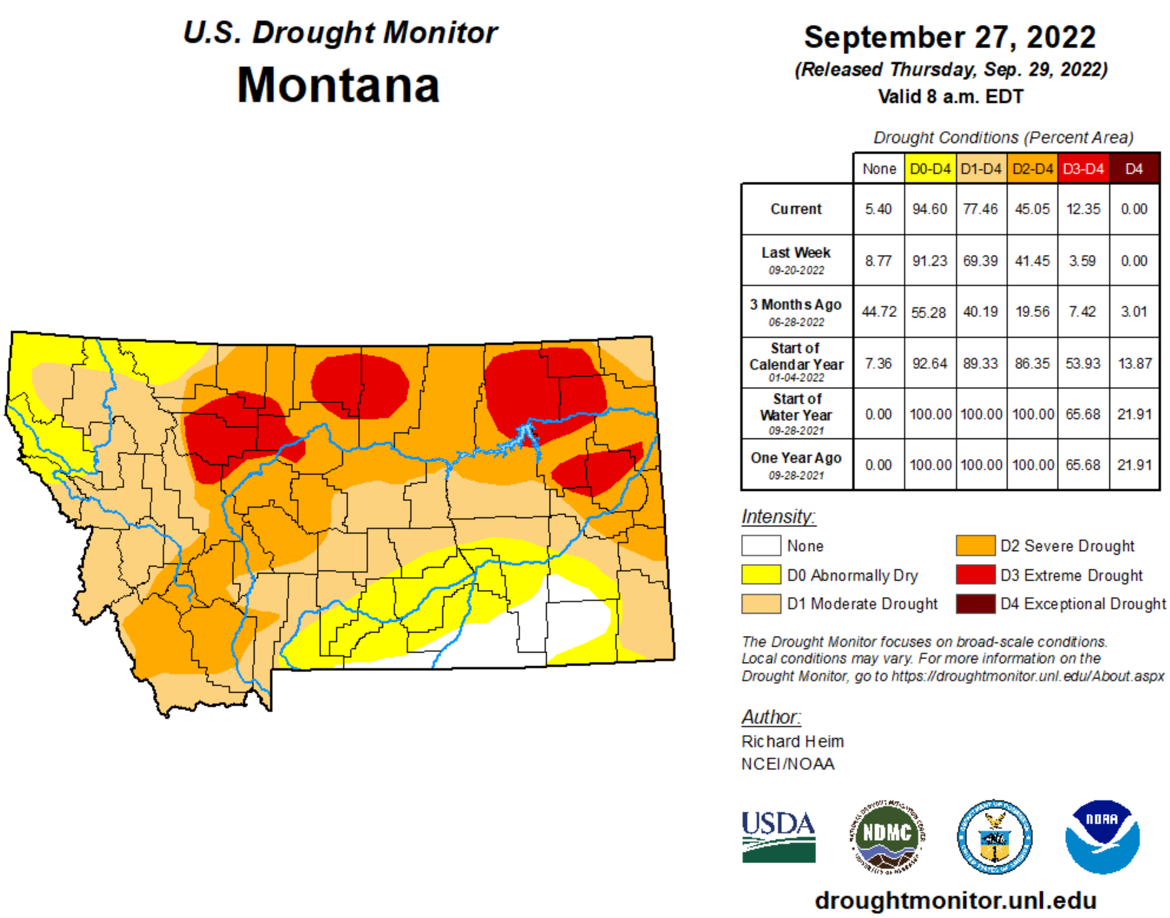
As mentioned in the Teton County Hazard Mitigation Plan 2021, historically, much of the State of Montana, had been in drought during much of the late 1980's. In response to this, and to assist with increasing awareness of and planning for drought in the future, the Governor's Drought Advisory Committee was formed in 1991. This committee, comprised of state and federal water supply and moisture condition experts, meets monthly to evaluate conditions for each county in the state and supports watershed groups and county drought committees by providing planning support and information. Water supply and moisture status maps are produced monthly from February to October by the Committee unless above average moisture conditions are prevalent.

Geographical Area Affected

Droughts are often regional events, impacting multiple counties and states simultaneously. Therefore, as the climate of the planning area is contiguous, it is reasonable to assume that a drought will impact the entire planning region. Based on this information, the geographic extent rating for drought is **extensive.**

As explained in the Teton County HMP 2021, Drought in the United States is monitored by the National Integrated Drought Information System (NIDIS). A major component of this portal is the U.S. Drought Monitor. The Drought Monitor concept was developed jointly by the NOAA's Climate Prediction Center, the National Drought Mitigation Center, and the USDA's Joint Agricultural Weather Facility in the late 1990s as a process that synthesizes multiple indices, outlooks, and local impacts into an assessment that best represents current drought conditions. The outcome of each Drought Monitor is a consensus of federal, state, and academic scientists who are intimately familiar with the conditions in their respective regions. A snapshot of the most current drought conditions in Montana can be found in Figure 4.16.

Figure 4.16 Drought Status September 2022 in the State of Montana



Source: U.S. Drought Monitor *Montana* | *U.S. Drought Monitor (unl.edu)*

Past Occurrences

Between 2012 and 2021, there were 30 USDA disaster declarations due to drought that affected counties in the Central Region. Table 4-13 provides a list of these events with details on impacted counties.

Table 4-13 USDA Drought Disaster Declarations (2012-2021)

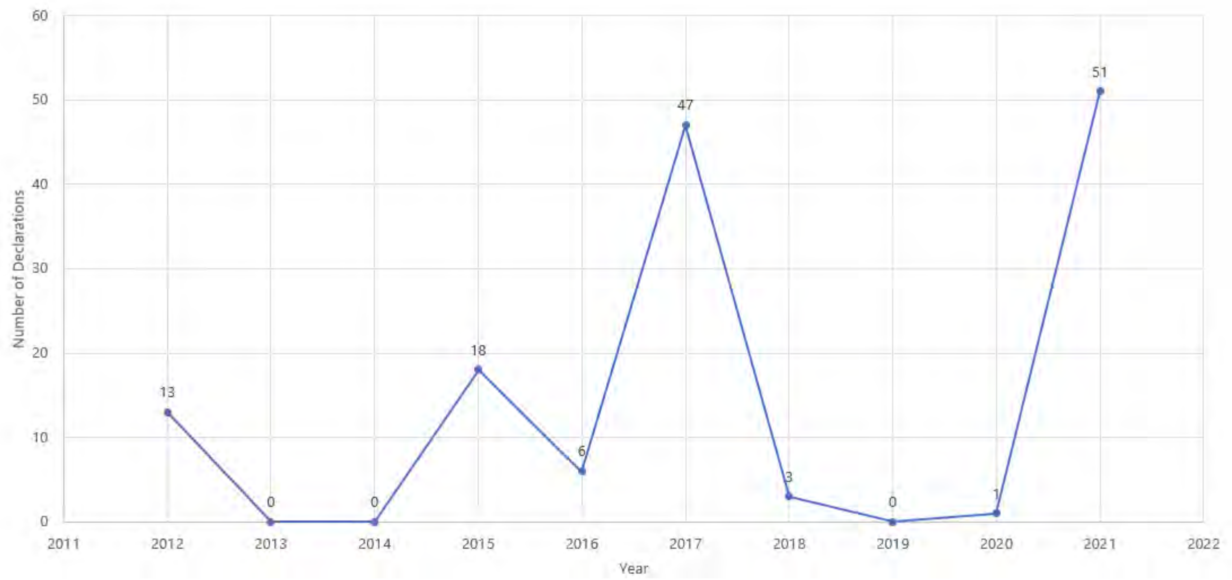
Year	Declaration	Counties Included
2012	S3432	Blaine, Chouteau, Fergus, Judith Basin, Petroleum, Phillips
	S3365	Petroleum
	S3391	Cascade, Chouteau, Fergus, Judith Basin, Petroleum, Teton
2015	S3849	Cascade, Chouteau, Glacier, Liberty, Pondera, Teton, Toole
	S3877	Cascade, Chouteau, Glacier, Liberty, Pondera, Teton, Toole
	S3941	Blaine, Chouteau, Hill, Liberty
2016	S4061	Fergus, Judith Basin
	S4066	Cascade, Chouteau, Glacier, Teton
2017	S4185	Petroleum, Phillips
	S4193	Blaine, Chouteau, Fergus, Judith Basin, Petroleum, Phillips
	S4195	Blaine, Chouteau, Fergus, Hill, Phillips
	S4210	Fergus, Petroleum
	S4214	Blaine, Cascade, Chouteau, Fergus, Hill, Judith Basin, Liberty, Pondera, Teton
	S4217	Cascade, Chouteau, Fergus, Hill, Judith Basin, Liberty, Pondera, Teton, Toole
	S4221	Cascade, Chouteau, Judith Basin, Pondera, Teton
	S4226	Chouteau, Glacier, Liberty, Pondera, Teton, Toole
	S4232	Glacier, Pondera, Teton
2018	S4411	Glacier, Pondera, Teton
2020	S4889	Petroleum
2021	S4960	Blaine, Fergus, Petroleum, Phillips
	S4970	Petroleum, Phillips
	S4993	Blaine, Chouteau, Fergus, Hill, Judith Basin, Petroleum, Phillips
	S5001	Blaine, Chouteau, Fergus, Hill, Judith Basin
	S5016	Cascade, Chouteau, Fergus, Judith Basin, Teton
	S5022	Cascade, Glacier, Pondera, Teton
	S5029	Chouteau, Hill, Pondera, Toole
	S5047	Blaine, Cascade, Chouteau, Fergus, Hill, Judith Basin, Pondera, Teton
	S5057	Glacier, Pondera, Toole
	S5076	Glacier, Pondera, Toole
	S5085	Cascade, Chouteau, Glacier, Pondera, Teton, Toole

Source: USDA

Figure 4.17 displays the temporal trend in USDA disaster declarations from drought by year in the Central Region. While there is evident variability in the number of declarations from year to year, there has been a general increase in the number of declarations due to drought in the Central Region, with the greatest number of declarations in 2021. Figure 4.18 displays the breakdown of declarations by county. In the Central

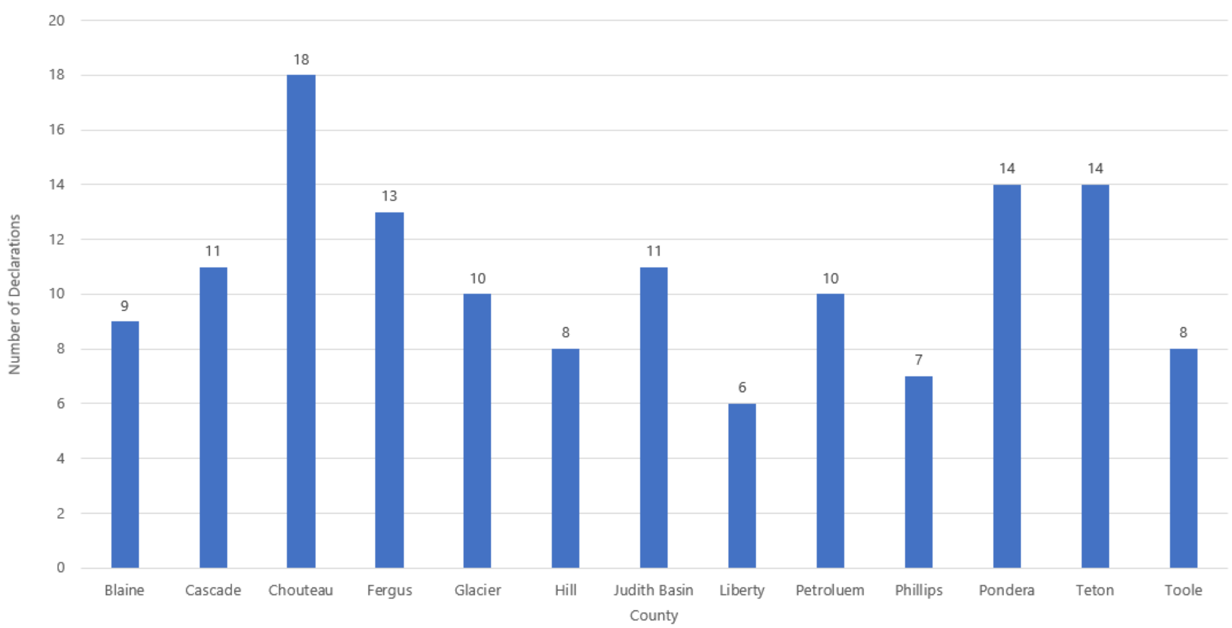
Region, Chouteau County has experienced the greatest number of USDA disaster declarations, followed by Pondera and Teton Counites.

Figure 4.17 USDA Drought Disaster Declarations by Year (2012-2021)



Source: USDA

Figure 4.18 USDA Drought Disaster Declarations by County (2012-2021)



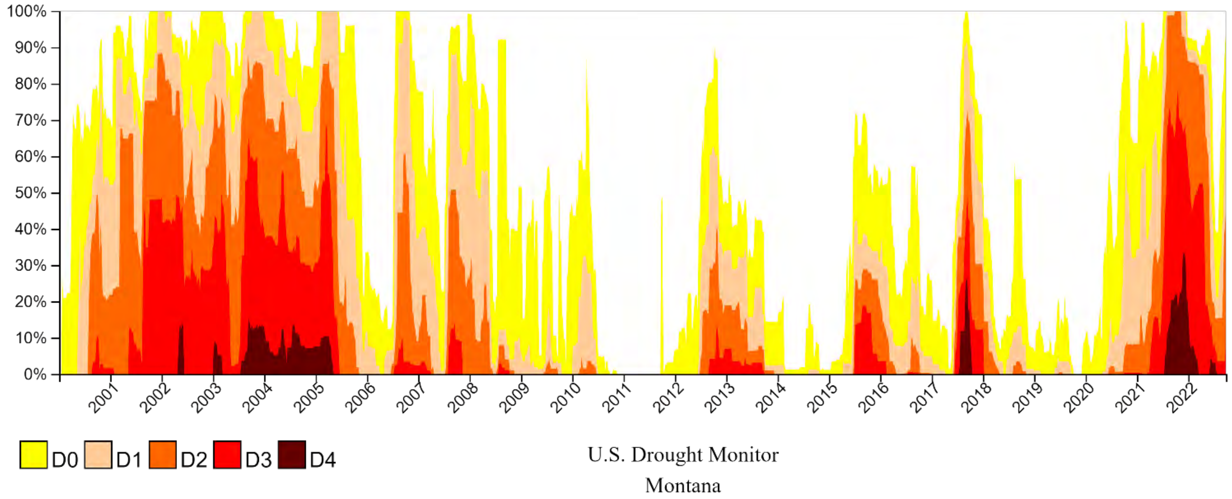
Source: USDA

The Teton County Hazard Mitigation Plan 2021 and State of Montana Hazard Mitigation Plan 2018 provide details of drought history in the State of Montana:

- **1917-1923:** Rising wheat prices encouraged farmers to transform grasslands into farmland for wheat, corn, and row crops. Significant loss of soil and overconsumption of water for crops.
- **1928-1939:** Driest period in the historic record, the Palmer Hydrologic Drought Index (PHDI) showed the entire state was in a hydrologic deficit for over 10 years. Dust Bowl years. Better conservation practices such as strip cropping were helping to lessen the impacts of the worst water shortages since the 1930's.
- **Mid-1950's**: Montana faced a period of reduced rainfall in eastern and central portions of the state. By November of 1956, a total of 20 Montana counties had applied for federal drought assistance.
- **1961:** Montana's State Crop and Livestock Reporting Service called it the worst drought since the 1930's. By August of 1961, 24 counties had applied for federal drought disaster aid.
- **1966:** The entire state was experiencing yet another episode of drought. Although water shortages were not as great as in 1961, a study of ten weather recording stations across Montana showed all had recorded below normal precipitation amounts for a ten-month period.
- **1977:** In June, officials from Montana were working with others from Idaho, Washington, and Oregon on the Northwest Utility Coordination Committee to moderate potential hydroelectricity shortages. On June 23, Governor Judge issued an energy supply alert and ordered a mandatory ten percent reduction in electricity use by state and local governments.
- **1979-1981:** By October of 1980, estimates of 1980 federal disaster payments were five times those paid in 1979. Total drought related economic losses from Montana in 1980 were estimated to be $380 million (equivalent to $1.26 billion dollars in 2021). Large May storms in 1981 brought flooding to formerly parched areas.
- **1984:** By July, Montana was again experiencing water shortages and rationing schedules were put into effect. Crop losses were estimated at $12 to $15 million. Numerous forest and range fires burned out of control across the state in August.
- **1985:** All 56 counties received disaster declarations for drought. Cattle herds were reduced by approximately one-third. The state's agriculture industry lost nearly $3 billion in equity.
- **1999-2008:** This period of dryness and hydrologic deficits mimicked the Dust Bowl years in every measurable factor besides duration. Severe water losses to the area aquifers as well as municipal water supplies.
- **2017:** Northeastern Montana had record dry conditions for much of 2017, especially through August
- **2021-2022:** By December of 2021, every county in Montana was identified as experiencing some level of drought. A third of the state was classified as "D4" or "exceptional" drought, a designation the U.S. Department of Agriculture expects to occur in any one location just once every 50 to 100 years.

Figure 4.19 displays data from the U.S. Drought Monitor for the State of Montana from 2000-2022. D0 represents least severe drought conditions and D4 is most severe. The chart shows peak drought conditions in the years 2002-2005, 2017, and 2021-2022 across the State.

Figure 4.19 US Drought Monitor: State of Montana Drought Conditions (2000-2022)



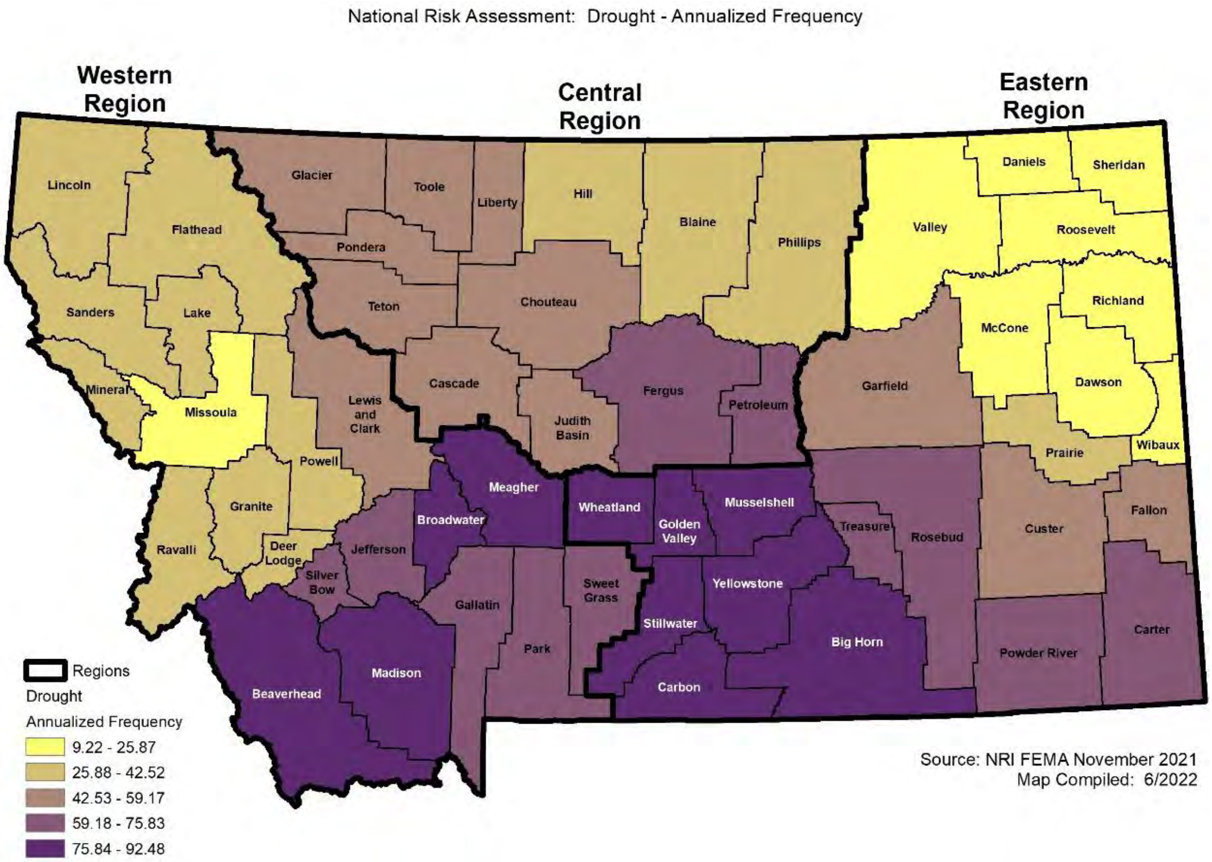
Source: U.S. Drought Monitor, https://droughtmonitor.unl.edu/CurrentMap.aspx

Frequency/Likelihood of Occurrence

The likelihood of drought in the Central Region is ranked as **Highly Likely**. Based on historic USDA Drought Disaster Declarations, there is continued probability that drought will occur in the future in the Central Region. Although there may be periods of higher-than-average precipitation, the PDSI long-term trend data indicate that Montana is one of the highest risk states in the United States for severe drought. The State of Montana Hazard Mitigation Plan 2018 also reported that, despite variation in severity of droughts each year, drought losses are sustained every year in Montana.

Figure 4.20 depicts annualized frequency of drought at a county level based on the NRI. The mapping shows a trend towards increased likelihood in the western and southern region, particularly Fergus and Petroleum counties.

Figure 4.20 Annualized Frequency of Drought Events by County



Map by WSP, Data Source: FEMA National Risk Index, https://hazards.fema.gov/nri/determining-risk

Climate Change Considerations

Montana's future drought hazard is largely a story of how climate change will impact precipitation, compared to how it will impact evapotranspiration. Evapotranspiration is sensitive to temperature and climate-change associated increases in temperature are fairly certain to occur and to increase transpiration for the foreseeable future. The more dynamic part of the drought story is how climate change will affect precipitation.

Changes in the seasonal distribution of precipitation in Montana are becoming evident. The 2021 Montana Climate Change and Human Health Study documents summer precipitation has decreased slightly and is roughly offset by slightly increased spring and fall precipitation. This observation is consistent with observations of increasing drought in recent years and the early stages of anticipated changes due to climate change.

Looking farther into the future, Figure 4.21 shows the projected change in monthly average precipitation for 2040-2069 relative to 1971-2000. During the spring, precipitation is expected to increase in coming decades. The springtime increase in precipitation is likely to continue and offset increases in evapotranspiration driven by increasing temperature. However, during summer months, precipitation is expected to remain relatively stable or continue to decline slightly. This stable or slightly decreasing precipitation, combined with higher evapotranspiration rates due to increasing temperatures, can reasonably be anticipated to increase the drought hazard during summer months. Fall and winter months are less certain but are more likely to resemble the springtime pattern described above.

The magnitude of climate change impact on drought, especially during the summer, is significant and worthy of attention, but not necessarily catastrophic. The Fifth National Climate Assessment, Chapter 25, confirms that drought is increasing in Montana, and is projected under moderate climate change scenarios to be 10% more frequent by 2050, and 20% by 2100.

Figure 4.21 Projected Change in Montana Monthly Precipitation

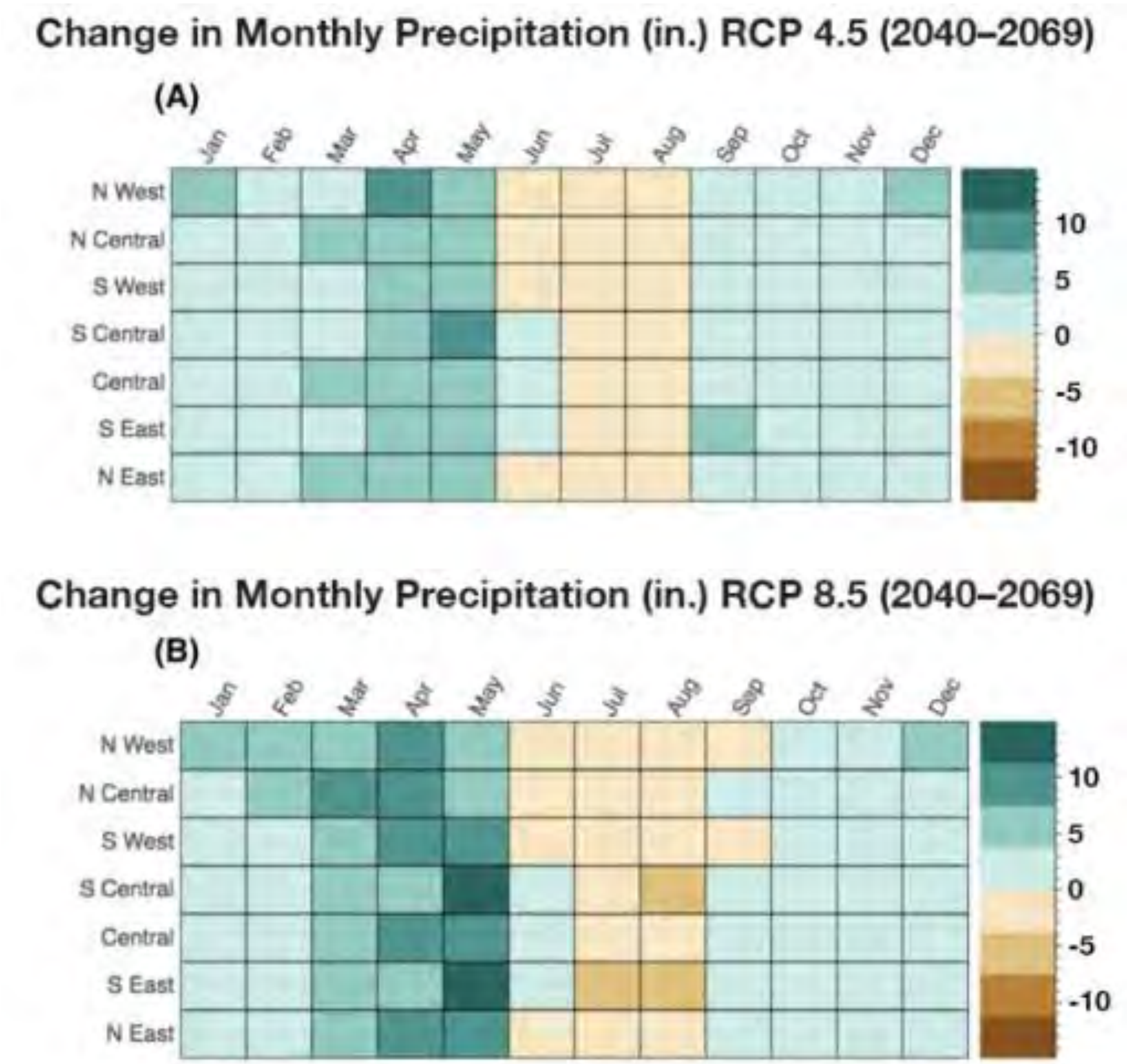


Figure source: Montana Climate Change and Human Health report, 2021. RCP 4.5 (figure A) is described as the "stabilization scenario" and RCP 8.5 (figure B) is described as the upper-bound emission scenario.

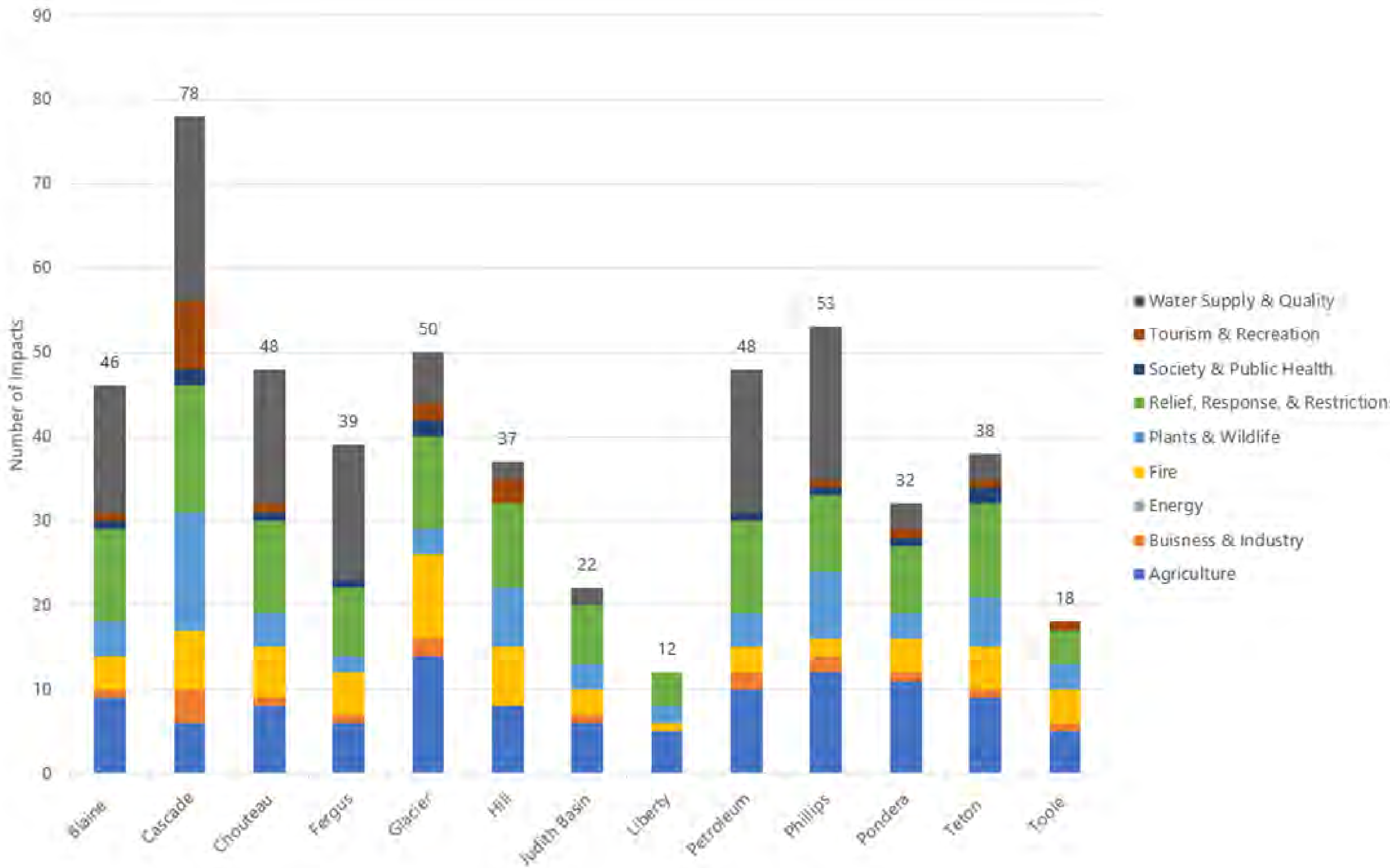
Climate science has advanced far in recent years but limitations in our understanding of climate change remain, especially at projecting changes at small spatial scales. Scientifically defensible projections do not yet exist to differentiate the effects of climate change on the drought hazard in each jurisdiction within the Central Region. For example, current scientific information indicates exposure to summertime drought is likely to get worse throughout the region. However, there is virtually no scientific information regarding if or how drought will get worse in one part of the Central Region relative to another part.

Susceptibility to drought may also shift from jurisdiction to jurisdiction in ways that are difficult to predict and may or may not be related to climate change. For example, consider a scenario where deteriorating infrastructure degrades the reliability of irrigation water supply in a specific jurisdiction. Susceptibility to drought would increase in the affected jurisdiction more than in others. Whatever the cause of the increase of susceptibility to drought, climate change will amplify the consequence of the change. Future updates to this plan should revisit the topic of future drought conditions and susceptibility as scientific knowledge progresses, and note any trends that emerge over time.

Potential Magnitude and Severity

Drought impacts are far-reaching and may be economic, environmental and/or societal; therefore, the potential magnitude and severity is ranked as **critical**. The most significant impacts associated with drought in the Central Region are those related to water intensive activities such as agriculture, wildfire protection, municipal usage, commerce, tourism, recreation, and wildlife preservation. A reduction of electric power generation and water quality deterioration are also potential problems, as seen in the history of droughts in Montana. Drought conditions can also cause soil to compact and not absorb water well, potentially making an area more susceptible to flooding. Indirect effects include those impacts that ripple out from the direct effect and include reduced business and income for local retailers, increased credit risk for financial institutions, capital shortfalls, loss of tax revenues and reduction in government services, unemployment, and outmigration. Figure 4.22 displays number of impacts from drought in the Central Region by impact type and county based on the Drought Impact Reporter.

Figure 4.22 Drought Impacts by County and Impact Type (2000-2021)



Source: The Drought Impact Reporter (2000-2021), Chart by WSP

Vulnerability Assessment

The drought *Vulnerability Assessment* identifies, or at least discusses, *assets* that are both *likely to be exposed* to drought and are *susceptible* to damage from that exposure. In this context, *assets* are (1) people, (2) property, (3) critical facilities and lifelines, (4) the economy, (5) historic and cultural resources, and (6) natural resources. *Exposure* indicates interacting with drought hazards, and *likely to be exposed* indicates a presence in areas deemed to be especially likely to experience drought hazards. *Susceptible* indicates a strong likelihood of damage from exposure to drought hazards and is described in greater detail in Section 4.2.1, subsection titled *Vulnerability Assessment*. Finally, vulnerability under future conditions is considered as it relates to both climate change and development.

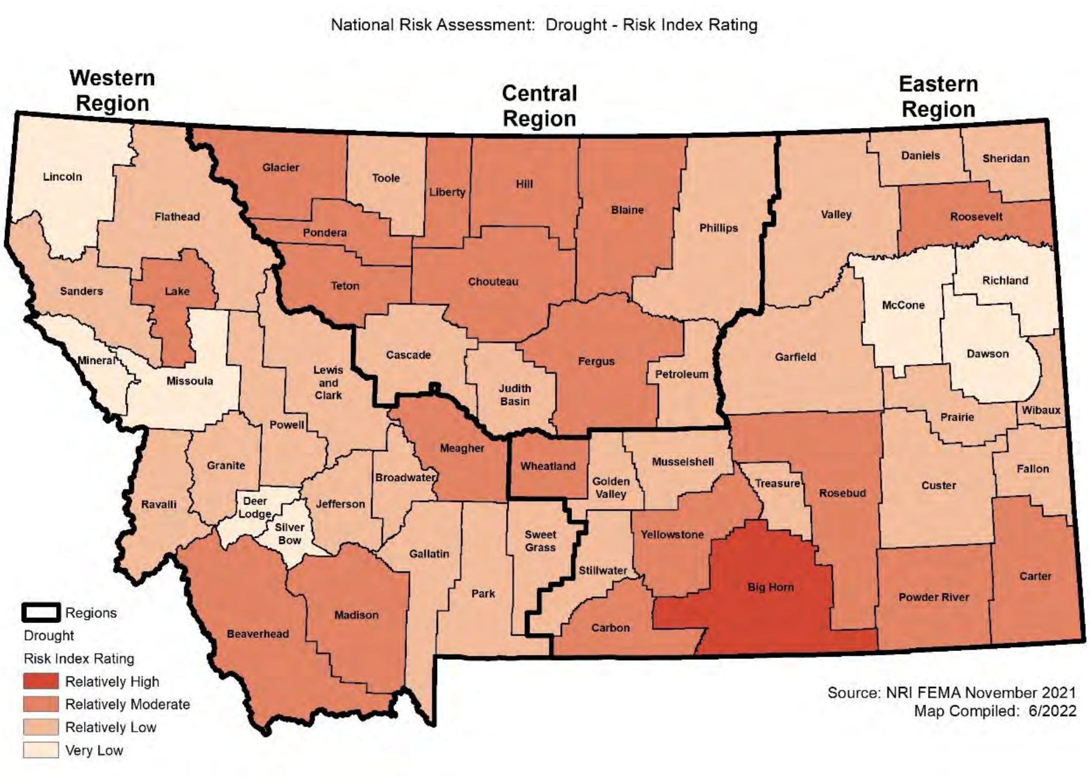
The high-hazard zone for drought extends throughout the Central Region of Montana. Variability in the hazard severity exists from drought to drought, but over time all parts of the Central Region are exposed to severe drought conditions. Susceptibility to drought is variable throughout the Central Region and is discussed further in the asset-specific subsections, below.

The role of climate change in future vulnerability to drought is discussed above in the section titled, *Climate Change Considerations*, while the effect of future development is considered below in the section titled *Development Trends Related to Hazards and Risk.*

A key limitation of hazard mitigation planning is that most drought impacts other than to the agricultural sector are indirect. This complicates the evaluation of assets that are vulnerable to drought hazards.

The figure below illustrates the NRI risk index rating to drought for Montana counties. The risk index calculation considers the expected annual losses from drought, social vulnerability, and community resilience in each county. Most counties in the region have a *relatively low* to *moderate* rating; none have a *high* or *very high* rating.

Figure 4.23 NRI Risk Index Rating for Drought



Map by WSP, Data Source: FEMA National Risk Index, 2020 https://hazards.fema.gov/nri/determining-risk

People

The historical and potential impacts of drought on populations include agricultural sector job loss, secondary economic losses to local businesses and public recreational resources, increased cost to local and state government for large-scale water acquisition and delivery, and water rationing and water wells running dry for individuals and families. As drought is often accompanied by prolonged periods of extreme heat, negative health impacts such as dehydration can also occur, where children and elderly are most susceptible. The CDC reports that other public health issues can include impaired drinking water quality, increased incidence of mosquito-borne illness, an increase in wildlife-human confrontations and respiratory complications because of declined air quality in times of drought.

Farmers are likely to experience economic losses due to drought. The Montana Governor's Drought Report of May 2004 referenced the economic and societal effects of drought: "The state's biggest drought story remains the deepening socio-economic drought. The drought threatens to change the very fabric of Montana's rural communities and landscape. It is the final straw that can bankrupt 4th and 5th generation farmers and ranchers, placing the birthright of descendants of pioneer families on the auction block. And like the changing vistas, many of the well-established County agri-businesses are disappearing forever, along with other main street institutions."

Exposure to drought occurs similarly across the Central Region. The vulnerability of people to that exposure is variable and is what drives the variability in drought impacts described in the opening paragraph of this subsection. Relationships between drought exposure, susceptibility, and impact to people are generally consistent throughout the planning area. For example, rain-fed agriculture is susceptible to the effects of drought wherever it occurs in the Central Region and when crops fail jobs are lost in a similar fashion across the Central Region. Individual annexes discuss drought vulnerabilities that are particularly important at the jurisdiction-level.

Property

Structures are generally not susceptible to the effects of drought but direct structural damage from drought can happen. When drought exposure is sufficient, it can affect soil shrinking and swelling cycles and can cause cracked foundations and infrastructure damage. Droughts can also have significant impacts on vegetation in landscapes, which could cause a financial burden to property owners and municipalities that own public parks.

Property is typically more susceptible to the many secondary effects of drought. For example, drought increases the risk of wildfire and may create water shortages that inhibit adequate fire response. The dust bowl years are notorious for drought-caused loss of vegetation on agricultural landscapes that led to serious wind erosion of topsoil. Additionally, heavy rains after prolonged drought conditions can result in significant flooding, which can damage property.

Exposure to drought occurs similarly across the Central Region. Relationships between drought exposure, susceptibility, and impact to property are consistent within each participating jurisdiction. Individual annexes discuss drought vulnerabilities that are particularly important at the jurisdiction-level.

Critical Facilities and Lifelines

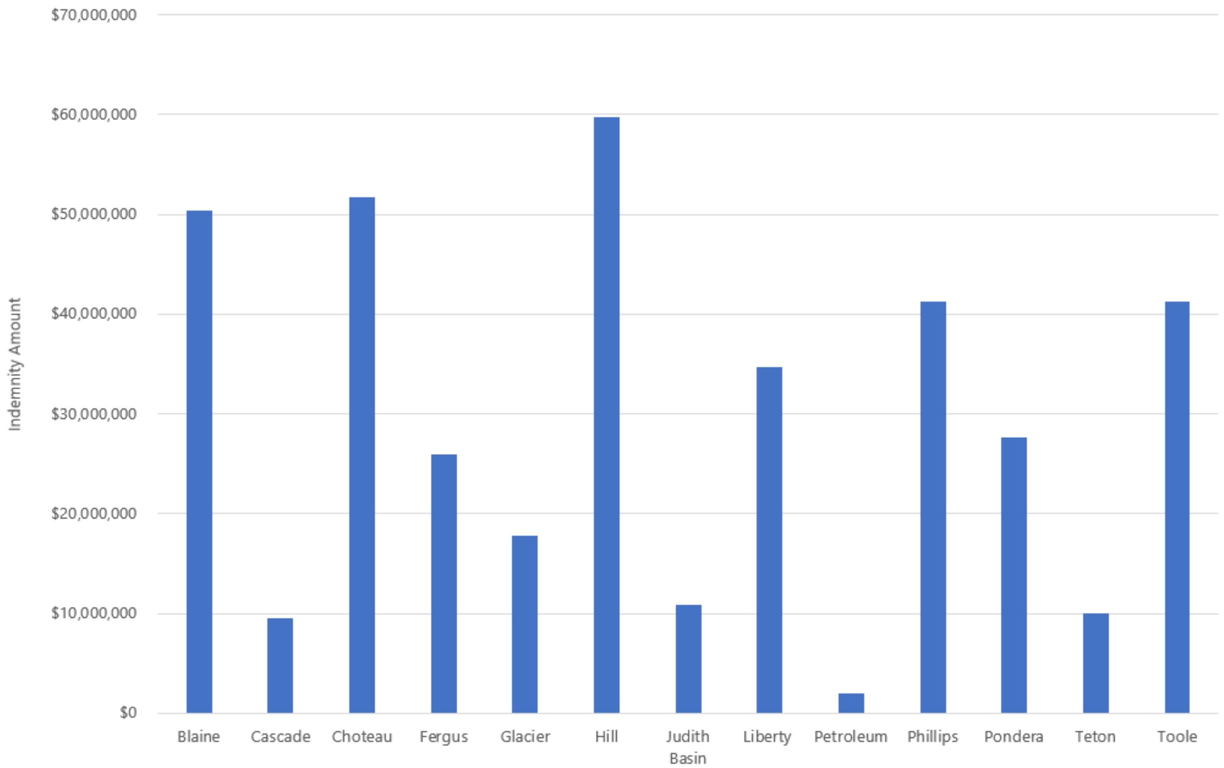
Water systems are the critical infrastructure most susceptible to drought. As shown in Figure 4.22 above, nearly every county in the Central Region, besides Liberty and Toole County, have experienced impacts to water supply and quality due to drought. Additionally, hydroelectric power is susceptible to being reduced during periods of drought. Drought-caused reduction of biofuel seedstock can reduce energy production and cause conservation mandates. Most critical facility infrastructure is more susceptible to secondary hazards caused by drought, such as wildfire and flooding.

Exposure to drought occurs similarly across the Central Region. Relationships between drought exposure, susceptibility, and impact to critical facilities and lifelines are consistent within each participating jurisdiction. Individual annexes discuss drought vulnerabilities that are particularly important at the jurisdiction-level.

Economy

Vulnerability of the economy to drought is undeniable, but complex. In particular, industries that use water or depend on water for their business are susceptible to economic impacts when drought occurs. Such industries include agriculture, hydro-power generation, water-based recreation, and water supply. The economy is susceptible to both direct and indirect effects of drought. For example, agriculture is impacted when water usage is restricted for irrigation. The Risk Management Agency (RMA) reported that from 2007-2021, $319,751,544 was lost as indemnity payments to farmers due to lost crops from drought in the Central Region. Figure 4.24 displays indemnity payments by county from 2007-2021. These direct payouts for drought damages are only part of the picture. The economy is susceptible to additional impacts that result from water-dependent industries generating less revenue and eventually reducing the flow of capital through the economy.

Figure 4.24 Losses by Agricultural Commodity 2007-2021

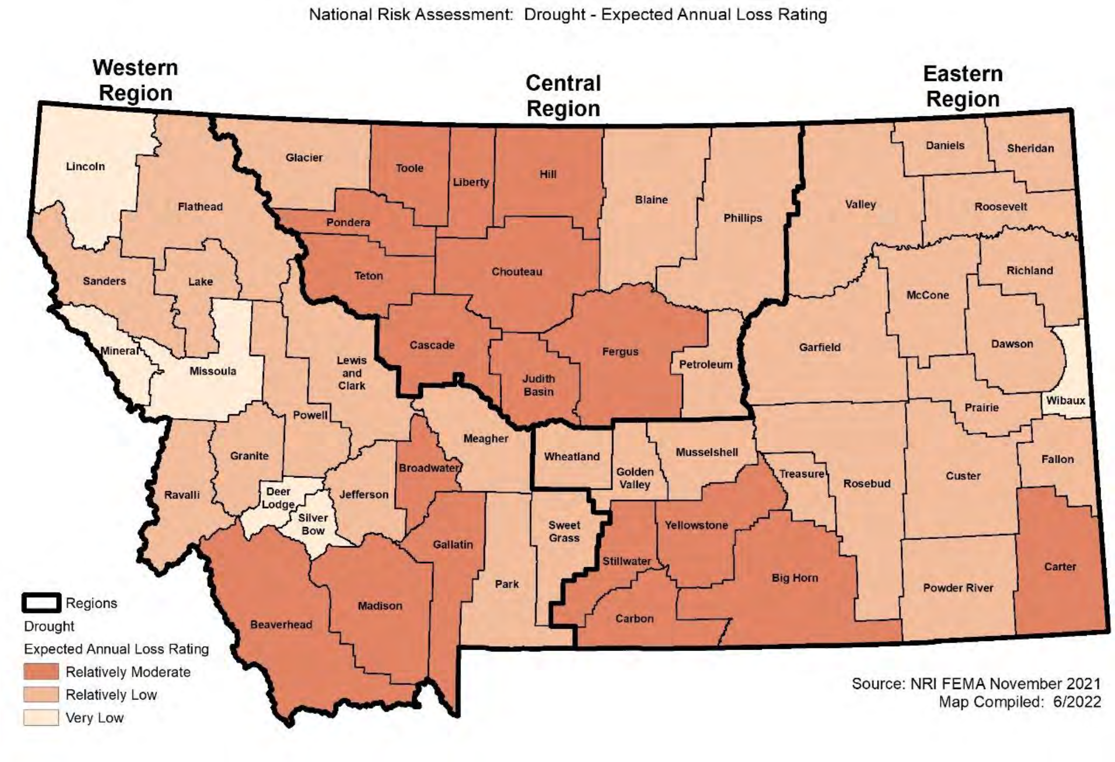


Source: Risk Management Agency (RMA), https://www.rma.usda.gov/SummaryOfBusiness Chart by WSP

Exposure to drought occurs similarly across the Central Region. The patterns of vulnerability of the economy to damage from that exposure are consistent within each participating jurisdiction, unless specified otherwise in the jurisdiction-specific annexes. For example, throughout the planning area, jurisdictions that are more dependent on rain-fed agriculture have economies that are more vulnerable to damage from drought.

Figure 4.25 provides NRI ratings for Expected Annual Loss (EAL) due to drought for Montana counties. Most counties in the region have a relatively moderate rating; none have a *high* or *very high* EAL rating. The EAL calculation provides an account of direct impacts to agriculture using agricultural value exposed to drought, annualized frequency for drought, and direct historical loss to agriculture for drought. The EAL rating is thus heavily biased to direct agricultural impacts.

Figure 4.25 NRI Drought Expected Annual Loss Rating



Map by WSP, Data Source: FEMA National Risk Index, https://hazards.fema.gov/nri/determining-risk

Historic and Cultural Resources

The biggest susceptibility of historic and cultural resources to drought are the long-standing, multi-generational farms existing in the Central Region. Past droughts have threatened to bankrupt farmers and ranchers and alter the farming tradition in the State.

Natural Resources

Susceptibility of natural resources to drought is most commonly associated with habitat for plants, animals, and wildlife; air and water quality; forest and range fires; degradation of landscape quality; loss of biodiversity; and soil erosion. Some of the effects are short-term and conditions quickly return to normal following the end of the drought. Other environmental effects linger for some time or may even become permanent. Wildlife habitat, for example, may be degraded through the loss of wetlands, lakes, and vegetation. However, many species will eventually recover from this temporary aberration, and may even depend on it. The degradation of landscape quality, including increased soil erosion, may lead to a more permanent loss of biological productivity, soil loss during the dust bowl years is a notable example. Although environmental losses are difficult to quantify, growing public awareness and concern for environmental quality has forced public officials to focus greater attention and resources on these effects.

Exposure to drought occurs similarly across the Central Region. Vulnerability exists where natural resources are susceptible to drought hazards. The patterns of vulnerability of natural resources to damage from that exposure are consistent within each participating jurisdiction.

Development Trends Related to Hazards and Risk

The effect of development on vulnerability to drought is a result of either changing the assets that are exposed to drought or could by changing the susceptibility of assets to drought. Neither of these factors were cause for concern among plan participants. In addition, the Montana Department of Environmental Quality (DEQ) is responsible for monitoring and regulating public water systems and they consider the impact of future development with respect to drought to be low.

While development is generally not a significant concern, variability inevitably exists throughout the planning area. The jurisdiction-specific annexes address these relatively isolated concerns regarding development and vulnerability to drought hazards.

Risk Summary

Overall, drought is considered to be high significance for the Region. Variations in risk by jurisdiction are summarized in the table below, as well as key issues from the vulnerability assessment.

- Frequency of drought is rated as **highly likely** because the Central Region experiences agricultural losses from drought every year and the US Drought Monitor indicates a high frequency of drought conditions.
- Due to historic economic losses from drought in the Central Region, magnitude of drought is ranked as **critical.**
- Drought, like other climate hazards, occurs on a regional scale and can impact every county in the Central Region; therefore, geographic extent is rated as **extensive.**
- Drought impacts to people include public health issues such as impaired drinking water quality, increased incidence of mosquito-borne illness, an increase in wildlife-human confrontations and respiratory complications because of declined air quality in times of drought (CDC, NOAA 2022).
- Most common impacts to property from drought are damage from secondary hazards caused by drought such as flooding and wildfire, however, a direct impact from drought is structural damage resulting from lack of moisture in the soil.
- Significant economic impacts are likely to result from drought from direct damages to crops and livestock, as well as indirect economic losses from business disruptions.
- Water systems are at significant risk to drought, as well as energy systems that depend on hydropower.
- Climate change has the potential to amplify the physical hazards associated with drought on the planning area.
- Related Hazards: Wildfire, Flooding, Severe Summer Weather

Table 4-14 Risk Summary Table: Drought

Jurisdiction	Overall Significance	Additional Jurisdictions	Jurisdictional Differences?	Notes
Central Region	High	NA	NA	
Blackfeet Tribe	High	NA	NA	
Blaine County	Medium	Chinook and Harlem	None	City of Harlem noted several droughts in the last 3 years, with multiple farmers losing crops due to drought and then pests. County also noted that drought has impacted water use. Repairs

Jurisdiction	Overall Significance	Additional Jurisdictions	Jurisdictional Differences?	Notes
				and management of St. May's system has become more apparent during drought season.
Cascade County	High	Great Falls, Belt, Cascade, and Neihart	Great Falls is less vulnerable to drought losses due to more access to water resources	
Chippewa Cree Tribes Rocky Boy's Reservation	High	NA	NA	
Chouteau County	High	Fort Benton, Big Sandy	None	County noted that 2021-2022 droughts have had a significant impact on agricultural community
Fergus County	High	Lewistown, Denton, Grass Range, Moore, Winifred	Large agriculture producers in rural Lewistown and Denton (Snow Mountain Honey Ranch and Hilltop Angus Ranch)	County noted that wells are stressed, fire restrictions are in place, trees and crop landscape are showing signs of stress, and producers are hauling water, buying supplemental feed, and selling cattle early
Fort Belknap Indian Community	Medium	NA	NA	
Glacier County	Medium	Cut Bank	NA	
Hill County	High	Havre, Hingham	None	Town of Hingham reported trees in parks have suffered and needed to be removed
Judith Basin County	High	Stanford, Hobson	None	Hobson noted it does not have a well and concerns with limited water supply for fire suppression
Liberty County	High	Chester	NA	
Petroleum County	High	Winnett	NA	County reported that most farmers have significantly reduced stock numbers
Phillips County	High	Malta, Saco	None	
Pondera County	Medium	Conrad	NA	
Teton County	Medium	Choteau, Dutton, Fairfield	None	
Toole County	High	Shelby, Kevin, and Sunburst	None	Town of Sunburst noted limited grass available to feed livestock

4.2.6 Earthquake

Hazard/Problem Description

An earthquake is the vibration of the earth's surface following a release of energy in the earth's crust. This energy can be generated by a volcanic eruption or by the sudden dislocation of the crust, which is the cause of most destructive earthquakes. The crust may first bend and then, when the stress exceeds the strength of the rocks, break and snap to a new position. In the process of breaking, vibrations called "seismic waves" are generated. These waves travel outward from the source of the earthquake at varying speeds.

Earthquakes can last from a few seconds to over five minutes; they may also occur as a series of tremors over several days. The actual movement of the ground in an earthquake is seldom the direct cause of injury or death. Casualties generally result from falling objects and debris. Disruption of communications, electrical power supplies and gas, sewer, and water lines should be expected. Earthquakes may trigger fires, dam failures, landslides, or releases of hazardous material, compounding their disastrous effects.

Earthquakes east of the Rocky Mountains are generally less frequent than in the western United States and are typically felt over a much broader region. Most of North America east of the Rocky Mountains has infrequent earthquakes, and the region from the Rockies to the Atlantic Ocean can go years without an earthquake large enough to be felt. The earthquakes that do occur in this region are typically small and occur at irregular intervals.

Earthquakes tend to reoccur along faults, which are zones of weakness in the crust. Even if a fault zone has recently experienced an earthquake, there is no guarantee that all the stress has been relieved. Another earthquake could still occur. Thousands of faults have been mapped in Montana, but according to the U.S. Geological Survey seismological records indicate that only about 95 of these faults have been active in the Quaternary Period, which is the past 1.6 million years of the geological record. Although it has been over six decades since the last destructive earthquake in Montana, small earthquakes are common in the region, occurring at an average rate of 4-5 earthquakes per day. Scientists continue to study faults in Montana to determine future earthquake potential.

A "great" earthquake is defined as any earthquake classified as a magnitude 8 or larger on the Richter Scale. Montana has not experienced a great earthquake in recorded history. A great earthquake is not likely in Montana, but a major earthquake (magnitude 7.0-7.9) occurred near Hebgen Lake in 1959 and dozens of active faults have generated magnitude 6.5-7.5 earthquakes during recent geologic time.

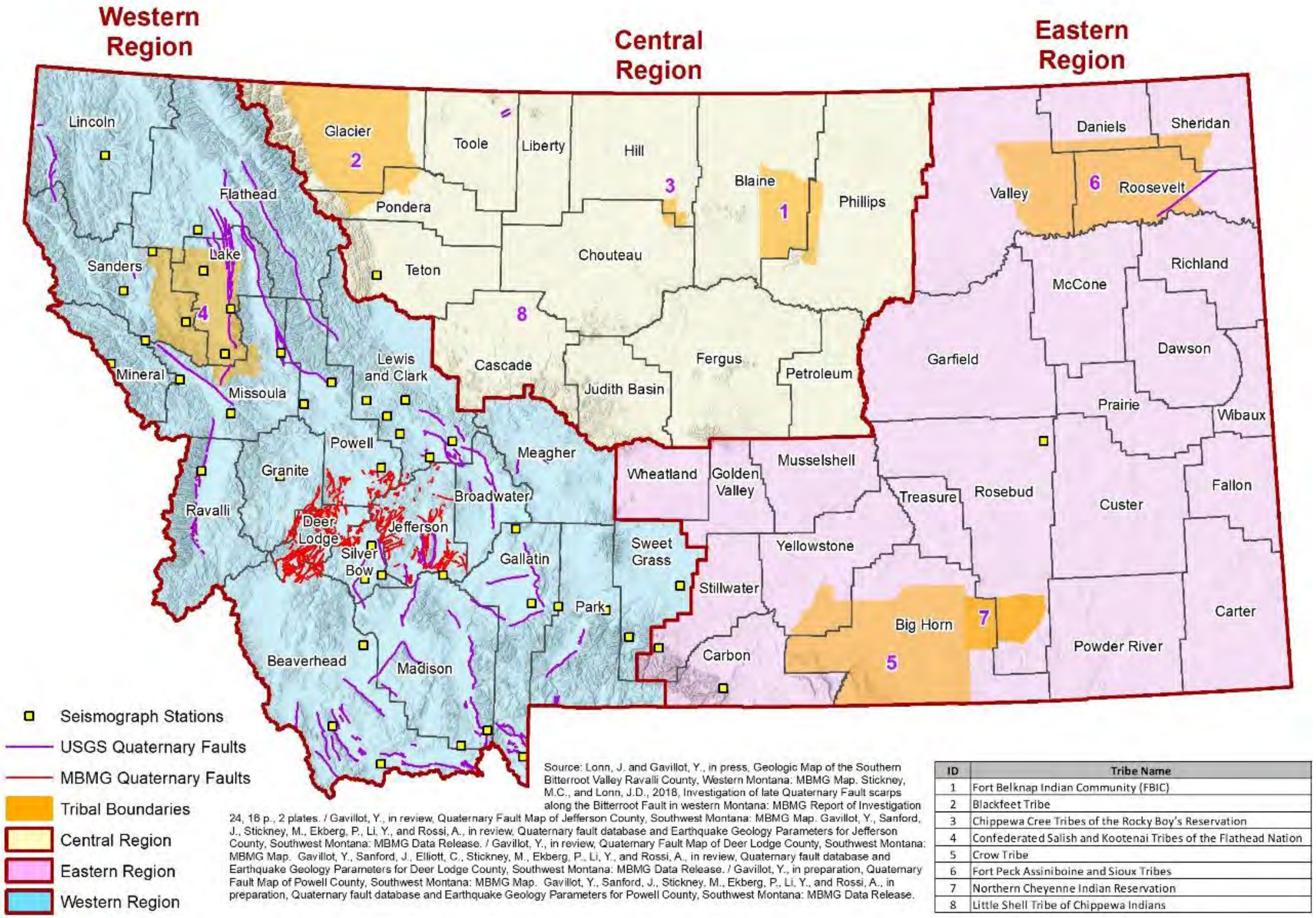
Liquefaction is the process by which water-saturated sediment temporarily loses strength due to strong ground shaking and acts as a fluid. Buildings and road foundations may lose load-bearing strength and cause major damage if liquefaction occurs beneath them. The increased water pressure that accompanies liquefaction can also cause landslides and dam failure. See Figure 4.27.

Seismic events may lead to landslides, uneven ground settling, flooding, and damage to homes, dams, levees, buildings, power and telephone lines, roads, tunnels, and railways. Broken natural gas lines may also ignite fires as a cascading hazard.

Geographical Area Affected

The geographic extent of earthquakes in the planning area is **significant**. All of the Central Region could be impacted by earthquakes, but the probability of a damaging earthquake is greater in the counties on the western portion along the Rocky Mountain Front.

Figure 4.26 Fault Map of Montana



Source: Lonn, J. and Gavillot, Y., in press, Geologic Map of the Southern Bitterroot Valley Ravalli County, Western Montana: MBMG Map. Stickney, M.C., and Lonn, J.D., 2018, Investigation of late Quaternary Fault scarps along the Bitterroot Fault in western Montana: MBMG Report of Investigation 24, 16 p., 2 plates. / Gavillot, Y., in review, Quaternary Fault Map of Jefferson County, Southwest Montana: MBMG Map. Gavillot, Y., Sanford, J., Stickney, M., Ekberg, P., Li, Y., and Rossi, A., in review, Quaternary fault database and Earthquake Geology Parameters for Jefferson County, Southwest Montana: MBMG Data Release. / Gavillot, Y., in review, Quaternary Fault Map of Deer Lodge County, Southwest Montana: MBMG Map. Gavillot, Y., Sanford, J., Elliott, C., Stickney, M., Ekberg, P., Li, Y., and Rossi, A., in review, Quaternary fault database and Earthquake Geology Parameters for Deer Lodge County, Southwest Montana: MBMG Data Release. / Gavillot, Y., in preparation, Quaternary Fault Map of Powell County, Southwest Montana: MBMG Map. Gavillot, Y., Sanford, J., Stickney, M., Ekberg, P., Li, Y., and Rossi, A., in preparation, Quaternary fault database and Earthquake Geology Parameters for Powell County, Southwest Montana: MBMG Data Release.

ID	Tribe Name
1	Fort Belknap Indian Community (FBIC)
2	Blackfeet Tribe
3	Chippewa Cree Tribes of the Rocky Boy's Reservation
4	Confederated Salish and Kootenai Tribes of the Flathead Nation
5	Crow Tribe
6	Fort Peck Assiniboine and Sioux Tribes
7	Northern Cheyenne Indian Reservation
8	Little Shell Tribe of Chippewa Indians

Figure 4.27 Liquefaction Map of the Central Region

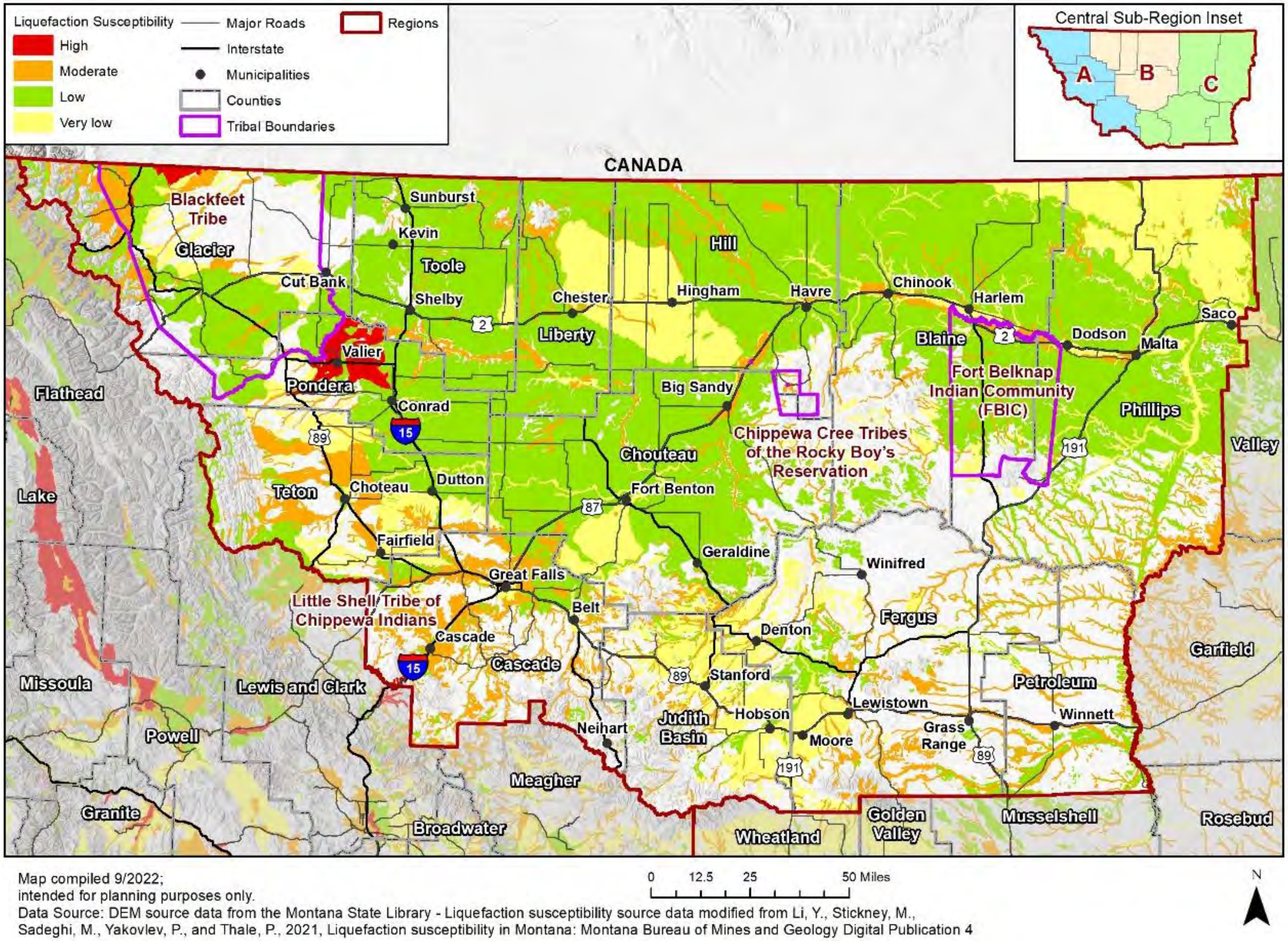
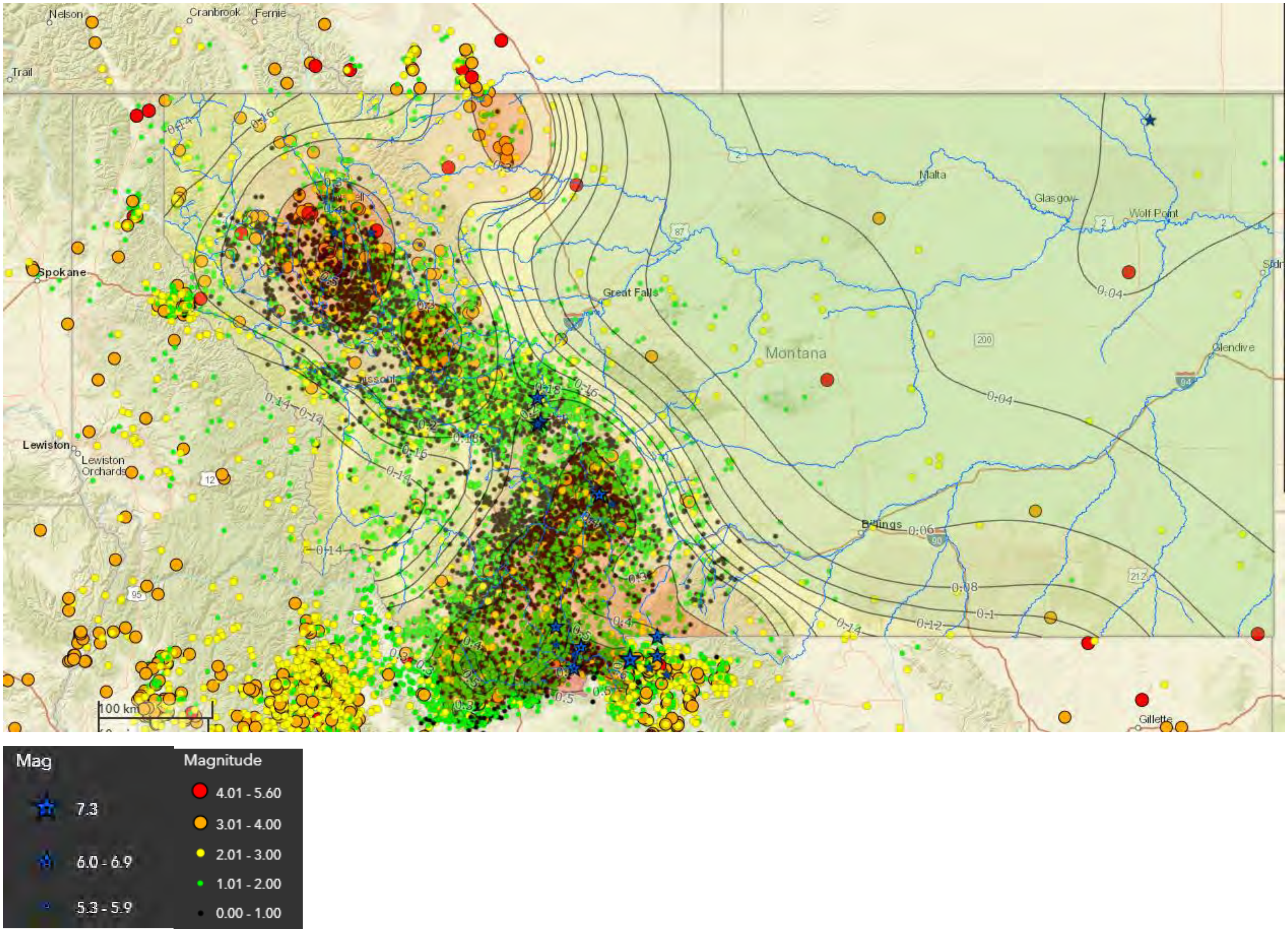


Figure 4.28 Statewide Map of Earthquake Epicenters, 1982-2022



Source: Montana Bureau of Mines and Geology(https://mbmg.mtech.edu/mapper/mapper.asp?view=Quakes&).

According to the USGS, Montana is one of the most seismically active states in the United States. There is a belt of seismicity known as the Intermountain Seismic Belt which extends through western Montana. This Intermountain Seismic Belt ranges from the Flathead Lake region in the northwest corner of the state to the Yellowstone National Park region. Since 1925, the state has experienced five shocks that reached intensity VIII or greater (Modified Mercalli Scale). During the same interval, hundreds of less severe tremors were felt within the state.

Montana's earthquake activity is concentrated mostly in the mountainous western third of the state, which lies within the Intermountain Seismic Belt, largely skirting the western edge of the Central Region. Generally speaking, the most likely counties for seismic activity in the Central Region would be Glacier, Toole, Pondera, and Teton counties. Large seismic events centered in other parts of the state may cause impacts in the Central Region.

Past Occurrences

According to the U.S. Geological Survey, Montana is one of the most seismically active states in the country. However, Montana's earthquake activity occurs primarily in the western third of the state. In the Central Region the majority of recorded earthquakes are smaller, in the magnitude 2.5 to 4.5 range. These types of earthquakes very rarely cause any structural damage or injuries. There have been relatively few larger earthquakes of magnitude 4.5 or higher which have been centered in the Central Region. However, numerous earthquakes in the western part of the state have been felt in the Central Region. A map of recorded earthquakes is presented above based an online mapping tool developed by the Montana Bureau of Mines and Geology (https://mbmg.mtech.edu/mapper/mapper.asp?view=Quakes&).

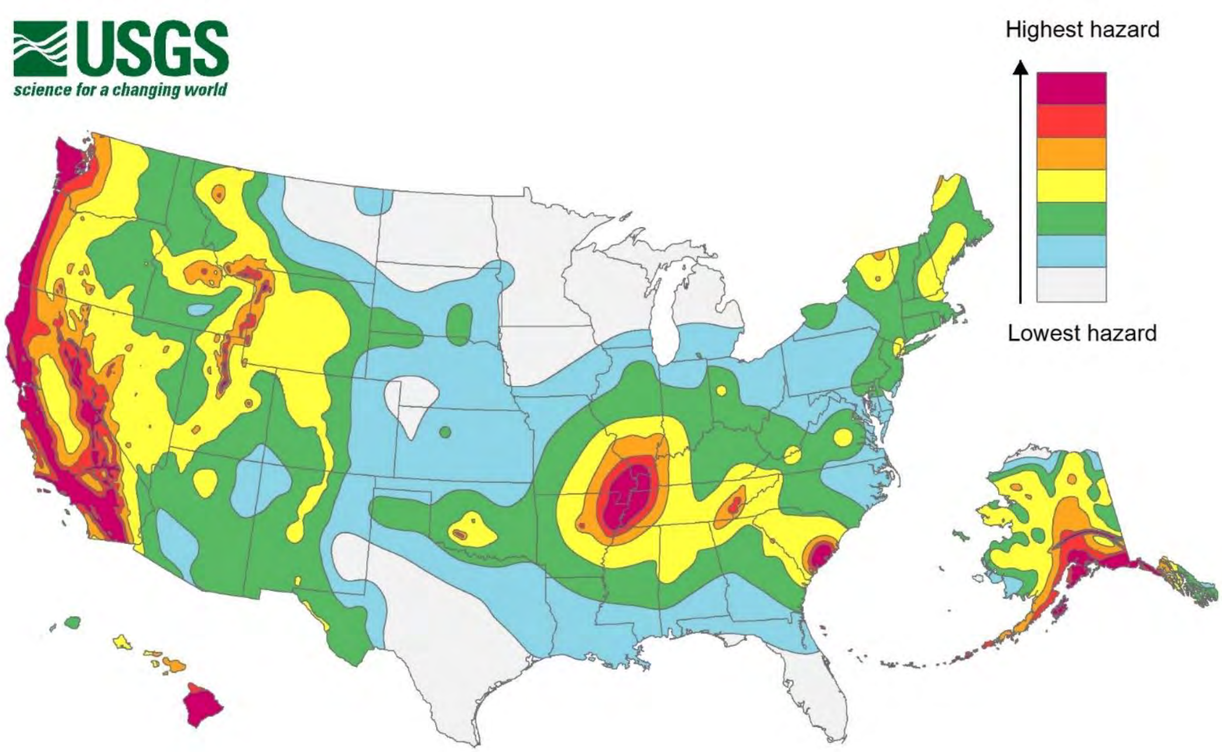
The majority of recorded past earthquakes in the Central Region have occurred in Glacier County. However, the largest magnitude event recorded in the Central Region since 1900 was a magnitude 4.1 centered in Fergus County in 2007. The event was felt as far away as Billings but did not result in any damages or injuries. As mentioned previously, earthquakes of this magnitude or smaller very rarely result in damage. According to the USGS, only 27 earthquakes of magnitude 2.5 or larger have been recorded in the Central Region since 1900. None of these events have resulted in measurable damages, injuries, or deaths. Despite this lack of activity specifically centered within the region, the Western Region of Montana is significantly more seismically active than the Central Region. Many more, and larger, earthquakes have occurred in the Western Region and these have the potential to cause impacts within the Central Region, specifically in counties along the Rocky Mountains.

Frequency/Likelihood of Occurrence

The frequency of earthquakes in the Central Region is ranked as **likely**, although damaging events are more Occasional (between 1 and 10 percent chance of occurrence in the next year or has a recurrence interval of 11 to 100 years). Earthquakes will continue to occur in Montana; however, the precise time, location, and magnitude of future events cannot be predicted. As discussed above, earthquake hazard areas in Montana are concentrated in the western portion of the state, which is part of the Intermountain Seismic Belt.

The U.S. Geological Survey (USGS) issues National Seismic Hazard Maps with updates approximately every five years. These maps provide various acceleration and probabilities for time periods. Figure 4.29 below is from the most recent USGS models for the contiguous U.S., showing peak ground accelerations having a 2 percent probability of being exceeded in 50 years, for a firm rock site. The models are based on seismicity and fault-slip rates and take into account the frequency of earthquakes of various magnitudes. Until recently, the 500-year map was often used for planning purposes for average structures and was the basis of the most current Uniform Building Code. The new International Building Code, however, uses a 2,500-year map as the basis for building design.

Figure 4.29 USGS Long-Term National Seismic Hazard Map



Source: USGS March 2022, National Seismic Hazard Model

Climate Change Considerations

Impacts of global climate change on earthquake hazards are not anticipated to occur.

Potential Magnitude and Severity

The expected magnitude of earthquakes in the Central Region is **limited**. Earthquakes can cause structural damage, injury, and loss of life, as well as damage to infrastructure networks, such as water, power, communication, and transportation lines. Damage and loss of life can be particularly devastating in communities where buildings were not designed to withstand seismic forces (e.g., historic structures). Other damage-causing effects of earthquakes include surface rupture, fissuring, settlement, and permanent horizontal and vertical shifting of the ground. Secondary impacts can include landslides, rock falls, liquefaction, fires, dam failure, and hazardous materials (HAZMAT) incidents.

In simplistic terms, the severity of an earthquake event can be measured in the following terms:

- How hard did the ground shake?
- How did the ground move (horizontally or vertically)?
- How stable was the soil?
- What is the fragility of the built environment in the area of impact?

Earthquakes are typically classified in one of two ways: By the amount of energy released, measured as magnitude; or by the impact on people and structures, measured as intensity. A comparison of magnitude and intensity is shown in the table below.

Table 4-15 Magnitude and Modified Mercalli Scales for Measuring Earthquakes

Magnitude	Modified Mercalli Intensity
1.0 – 3.0	I
3.0 – 3.9	II, III
4.0 – 4.9	IV – V
5.0 – 5.9	VI – VII
6.0 – 6.0	VII – IX
7.0 and higher	VIII or higher

Source: USGS Earthquake Hazards Program

Magnitude

Magnitude measures the energy released at the source of the earthquake and is measured by a seismograph. Currently the most used magnitude scale is the moment magnitude (Mw) scale, with the follow classifications of magnitude:

- Great—Mw > 8.
- Major—Mw = 7.0 – 7.9.
- Strong—Mw = 6.0 – 6.9.
- Moderate—Mw = 5.0 – 5.9.
- Light—Mw = 4.0 – 4.9.
- Minor—Mw = 3.0 – 3.9.
- Micro—Mw < 3.

The USGS explains that estimates of Mw scale roughly match the local magnitude scale (ML), commonly called the Richter scale. One advantage of the Mw scale is that, unlike other magnitude scales, it does not saturate at the upper end. That is, there is no value beyond which all large earthquakes have about the same magnitude. For this reason, Mw scale is now the most often used estimate of large magnitude earthquakes.

Intensity

Intensity is a measure of the shaking produced by an earthquake at a certain location and is based on felt affects. Currently the most used intensity scale is the modified Mercalli intensity scale, with ratings defined as follows (US Geological Survey [USGS] 1989):

Table 4-16 Modified Mercalli Intensity (MMI) Scale

Magnitude	Mercalli Intensity	Effects	Frequency
Less than 2.0	I	Micro-earthquakes, not felt or rarely felt; recorded by seismographs.	Continual
2.0-2.9	I to II	Felt slightly by some people; damages to buildings.	Over 1M per year
3.0-3.9	II to IV	Often felt by people; rarely causes damage; shaking of indoor objects noticeable.	Over 100,000 per year
4.0-4.9	IV to VI	Noticeable shaking of indoor objects and rattling noises; felt by most people in the affected area; slightly felt outside; generally, no to minimal damage.	10K to 15K per year
5.0-5.9	VI to VIII	Can cause damage of varying severity to poorly constructed buildings; at most, none to slight damage to all other buildings. Felt by everyone.	1K to 1,500 per year

Magnitude	Mercalli Intensity	Effects	Frequency
6.0-6.9	VII to X	Damage to a moderate number of well-built structures in populated areas; earthquake-resistant structures survive with slight to moderate damage; poorly designed structures receive moderate to severe damage; felt in wider areas; up to hundreds of miles/kilometers from the epicenter; strong to violent shaking in epicenter area.	100 to 150 per year
7.0-7.9	VIII<	Causes damage to most buildings, some to partially or completely collapse or receive severe damage; well-designed structures are likely to receive damage; felt across great distances with major damage mostly limited to 250 km from epicenter.	10 to 20 per year
8.0-8.9	VIII<	Major damage to buildings, structures likely to be destroyed; will cause moderate to heavy damage to sturdy or earthquake-resistant buildings; damaging in large areas; felt in extremely large regions.	One per year
9.0 and Greater	VIII<	At or near total destruction - severe damage or collapse to all buildings; heavy damage and shaking extends to distant locations; permanent changes in ground topography.	One per 10-50 years

Source: USGS Earthquake Hazards Program

Vulnerability Assessment

The earthquake *Vulnerability Assessment* identifies, or at least discusses, *assets* that are both *likely to be exposed* to earthquake and are *susceptible* to damage from that exposure. In this context, *assets* are (1) people, (2) property, (3) critical facilities and lifelines, (4) the economy, (5) historic and cultural resources, and (6) natural resources. *Exposure* indicates interacting with earthquake hazards, and *likely to be exposed* indicates a presence in areas deemed to be especially likely to experience earthquake hazards. *Susceptible* indicates a strong likelihood of damage from exposure to earthquake hazards and is described in greater detail in Section 4.2.1 *Profile Methodology*, subsection titled *Vulnerability Assessment*. Finally, vulnerability under future conditions is considered as it relates to both climate change and development.

Numerous factors contribute to determining areas of vulnerability such as historical earthquake occurrence, proximity to faults, soil characteristics, building construction, and population density. Earthquake vulnerability data was generated during the 2022 planning process using a Level 1 Hazus-MH analysis for the Central Region. Hazus-MH estimates the intensity of the ground shaking, the number of buildings damaged, the number of casualties, the damage to transportation systems and utilities, the number of people displaced from their homes, and the estimated cost of repair and clean up. Details specific to the HAZUS analysis for each county are provided in each county's respective annex.

The HAZUS analysis also incorporates information on what assets are susceptible to earthquake damage and provides information on earthquake vulnerability. The results of the HAZUS analysis are discussed further in the asset-specific subsections, below.

The role of climate change in future vulnerability to earthquake is discussed above in the section titled, *Climate Change Considerations*, while the effect of future development is considered below in the section titled *Development Trends Related to Hazards and Risk*.

People

The entire population of the Central Region is within an earthquake hazard area and are potentially exposed to direct and indirect impacts from earthquakes. The degree of exposure is dependent on many factors, the soil type their homes are constructed on, their proximity to fault location and earthquake epicenter, etc. The degree of susceptibility to earthquake hazards is also dependent on various factors, such as including the age and construction type of the structures people live in.

Whether impacted directly or indirectly, the entire population could have to deal with the consequences of an earthquake to some degree. Business interruption could keep people from working, road closures could isolate populations, and loss of functions of utilities could impact populations that suffered no direct damage from an event itself.

Impacts on persons and households in the planning area were estimated for the entire region for a 2,500-Year probabilistic earthquake scenario (2% chance of occurrence in 50 years). Table 4-17 summarizes the results of displaced households. It is estimated in a 2 p.m. time of occurrence scenario that there would be an estimated 2 fatalities and 65 injuries across the region, 9 of which would require hospitalization. Additionally, there could be increased risk of damage or injury from rock fall or landslides to travelers, hikers, and others recreating outdoors at the time of the earthquake. More detailed descriptions of the numbers of estimated casualties in the region under the various time of occurrence scenarios are available in the county annexes.

Table 4-17 Estimated Earthquake Impacts on Persons and Households

	Number of Displaced Households	Number of Persons Requiring Short-Term Shelter
2,500-Year Earthquake	81	59

Source: HAZUS-MH Global Summary Report, WSP Analysis

Property

The HAZUS analysis, which uses data from the 2010 U.S. Census, estimates that there are 71,000 buildings in the planning area, with a total replacement value of $16.95 billion. Because all structures in the planning area are exposed to earthquake hazards and are susceptible to earthquake impacts to varying degrees, this total represents the regionwide property vulnerability to seismic events. Most of the buildings and most of the associated building value are residential.

Risk to earthquake hazards considers the consequence of exposure. According to the model, about 2,609 buildings will be at least moderately damaged, with 18 buildings completely destroyed, as shown in Table 4-18.

Table 4-18 Estimated Building Damage by Occupancy

	None		Slight		Moderate		Extensive		Complete	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Agriculture	705.43	1.12	82.41	1.40	52.30	2.31	12.96	4.01	0.89	4.91
Commercial	3356.44	5.32	402.84	6.84	251.21	11.08	60.14	18.60	4.38	24.16
Education	196.22	0.31	21.64	0.37	14.36	0.63	3.50	1.08	0.29	1.59
Government	218.38	0.35	24.50	0.42	16.20	0.71	3.62	1.12	0.29	1.61
Industrial	764.29	1.21	91.10	1.55	59.84	2.64	13.96	4.32	0.81	4.45
Other Residential	8382.21	13.30	1459.95	24.77	1044.16	46.04	149.07	46.10	9.61	53.07
Religion	351.79	0.56	34.59	0.59	20.20	0.89	4.11	1.27	0.31	1.69
Single Family	49062.56	77.83	3776.42	64.08	809.48	35.70	75.99	23.50	1.54	8.53
Total	**63,037**		**5,893**		**2,268**		**323**		**18**	

Source: HAZUS-MH Global Summary Report, WSP Analysis

The HAZUS model provides estimates of building related losses in the earthquake scenario, broken out into two categories: direct building losses and business interruption losses. The direct building losses are the estimated costs to repair or replace the damage caused to the building and its contents. The business interruption losses are the losses associated with inability to operate a business because of the damage sustained during the earthquake. Business interruption losses also include the temporary living expenses for those people displaced from their homes because of the earthquake.

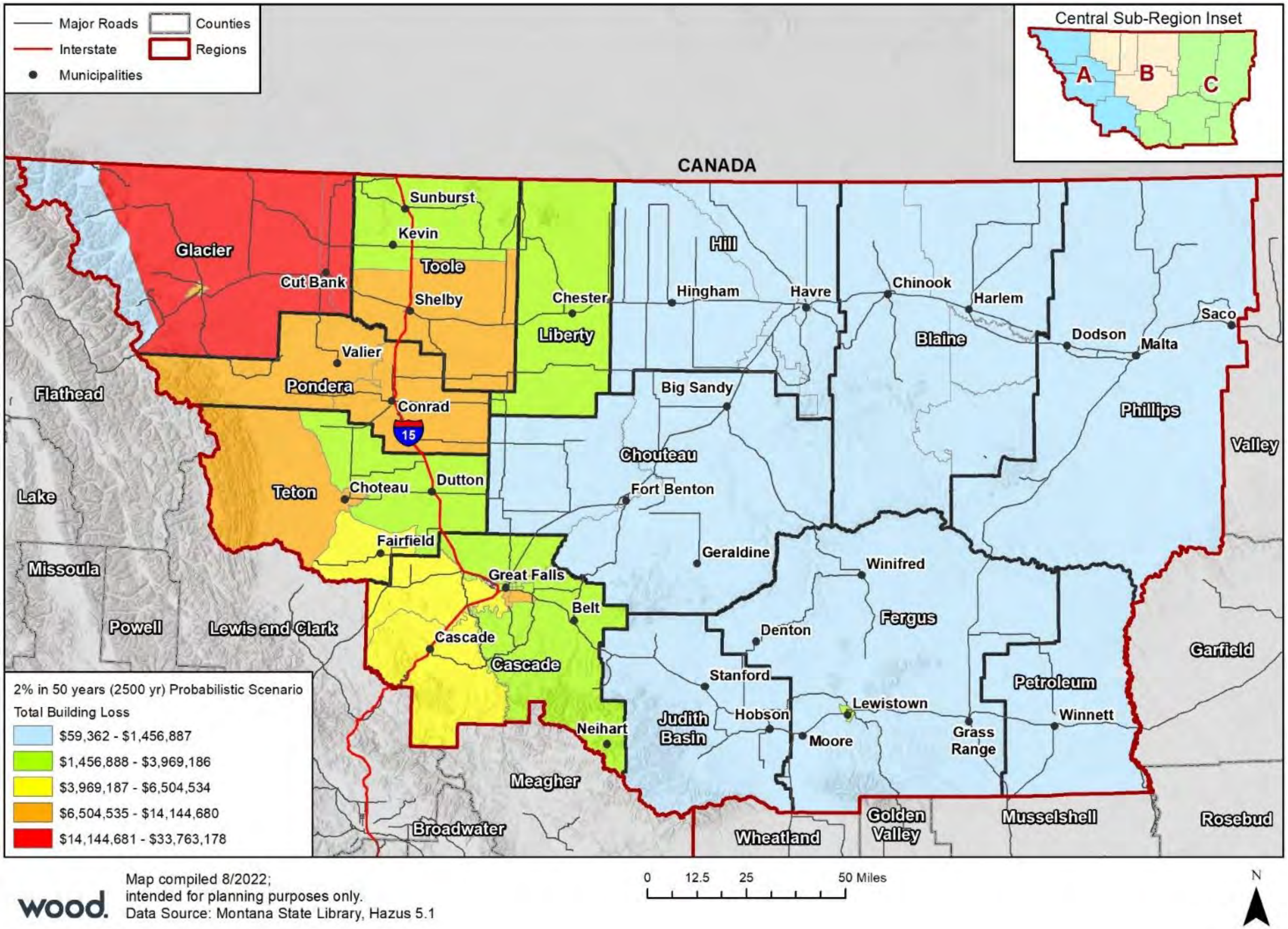
For the 2,500-year probabilistic earthquake scenario, the total building related losses for the entire planning area is an estimated $233.2 million. Of this total, direct building losses are estimated at $185.8 million and $47.4 million in income related losses. A map of these losses per county is shown in Figure 4.30 below.

Table 4-19 HAZUS Building Related Economic Loss Estimates for 2,500-Year Scenario (Millions of Dollars)

Category	Area	Single Family	Other Residential	Commercial	Industrial	Others	Total
Income Losses							
	Wage	0.0000	1.5182	8.1524	0.1902	1.1373	10.9981
	Capital-Related	0.0000	0.6468	7.0079	0.1189	0.1897	7.9633
	Rental	1.5467	3.4743	4.3278	0.0819	0.3784	9.8091
	Relocation	5.2818	2.9623	6.8463	0.5360	3.0050	18.6314
	Subtotal	**6.8285**	**8.6016**	**26.3344**	**0.9270**	**4.7104**	**47.4019**
Capital Stock Losses							
	Structural	8.0802	7.0858	8.3962	1.3078	4.4762	29.3462
	Non_Structural	47.0499	26.5558	20.8403	4.0715	9.3889	107.9064
	Content	18.8967	7.0359	12.4511	2.7882	6.2257	47.3976
	Inventory	0.0000	0.0000	0.3556	0.5369	0.2414	1.1339
	Subtotal	**74.0268**	**40.6775**	**42.0432**	**8.7044**	**20.3322**	**185.7841**
	Total	**80.86**	**49.28**	**68.38**	**9.63**	**25.04**	**233.19**

Source: HAZUS-MH Global Summary Report, WSP Analysis

Figure 4.30 Central Region HAZUS 2,500-Year Probabilistic Scenario Direct Economic Loss



The HAZUS analysis also estimated the amount of earthquake-caused debris in the planning area for the 2,500-Year probabilistic earthquake scenario event, which is estimated to be 201,000 tons.

Critical Facilities and Lifelines

Many critical facilities and infrastructure in the planning area are exposed to earthquakes. HAZMAT releases can occur during an earthquake from fixed facilities or transportation-related incidents. Transportation corridors can be disrupted during an earthquake, leading to the release of materials to the surrounding environment. Facilities holding HAZMAT are of particular concern because of possible isolation of neighborhoods surrounding them. During an earthquake, structures storing these materials could rupture and leak into the surrounding area or an adjacent waterway, having a disastrous effect on the environment.

HAZUS-MH classifies the vulnerability of essential facilities to earthquake damage in two categories: at least moderate damage or complete damage. The analysis did not indicate any damages in these categories to specific facilities. The model also anticipates pipeline breaks and leaks in the county's potable water, wastewater, and natural gas lines. Across these linear networks, the earthquake is expected to cause 1,067 pipeline leaks and 267 complete fractures in the potable and wastewater systems. This is expected to leave 751 households without potable water service on the first day of the earthquake. The model also estimates lifeline damages to linear networks such as transportation and utilities. Damage to the transportation system is estimated at $20.7 million and utility lifelines at $1.17 billion. The steep terrain in the western counties of the region would likely experience multiple rockslides that could damage roadways and disrupt traffic along the rail, highway, and road corridors.

Economy

Economic impacts of an earthquake could be staggering in the impacted areas. Not only the costs of direct damages to property, infrastructure, and inventory, but the losses incurred from businesses forced to close temporarily or permanently. As mentioned above, the total income-related economic losses are estimated by the model to be $47.4 million in the 2,500-year scenario. HAZUS-MH models many other estimated impacts, which are summarized in the table below. Cascade and Glacier counties have the highest potential losses; Pondera, Toole and Teton counties also have potential for losses and higher loss ratios.

Table 4-20 HAZUS-MH Earthquake Loss Estimation 2,500-Year Scenario Results

Type of Impact	Impacts to Region
Total Buildings Damaged	Slight: 5,893 Moderate: 2,268 Extensive: 323 Complete: 18
Building and Income Related Losses	$233.2 million 56% of damage related to residential structures 20% of loss due to business interruption
Total Economic Losses (includes building, income, and lifeline losses)	$1,419.7 Million - Total Building: $185.8 Million Income: $47.4 Million Transportation/Utility: $1,186.6 Million
Casualties (based on 2 a.m. time of occurrence)	Without requiring hospitalization: 28 Requiring hospitalization: 3 Life threatening: 0 Fatalities: 0
Casualties	Without requiring hospitalization: 56 Requiring hospitalization: 8

Type of Impact	Impacts to Region
(based on 2 p.m. time of occurrence)	Life threatening: 1 Fatalities: 2
Casualties (based on 5 p.m. time of occurrence)	Without requiring hospitalization: 39 Requiring hospitalization: 6 Life threatening: 1 Fatalities: 1
Fire Following Earthquake	0 Ignitions
Debris Generation	52,000 tons of debris generated 2,080 estimated truckloads to remove
Displaced Households	81
Shelter Requirements	59

Source: HAZUS-MH Global Summary Report, WSP Analysis

Table 4-21 Direct Economic Losses by County (In thousands of Dollars)

	Capital Stock Losses					Income Losses				
	Cost Structural Damage	Cost Non-struct. Damage	Cost Contents Damage	Inventory Loss	Loss Ratio %	Relocation Loss	Capital Related Loss	Wages Losses	Rental Income Loss	Total Loss
Montana										
Fergus	490	1,329	454	14	0.14	284	151	201	164	3,088
Teton	3,208	10,118	4,186	133	1.93	1,828	569	941	929	21,911
Toole	2,030	8,453	4,369	105	1.60	1,267	660	934	749	18,566
Blaine	132	308	95	2	0.08	76	25	42	34	714
Phillips	98	217	64	2	0.06	52	22	33	29	518
Hill	472	1,218	430	12	0.10	317	152	230	168	2,998
Pondera	2,948	10,109	4,570	163	1.92	1,567	536	809	877	21,578
Chouteau	359	1,059	409	10	0.23	200	85	112	96	2,329
Petroleum	15	38	12	0	0.10	8	0	2	2	77
Liberty	290	940	411	9	0.44	161	55	77	73	2,016
Glacier	7,910	34,854	17,164	323	3.69	5,402	1,980	2,862	2,619	73,115
Judith Basin	132	395	143	3	0.22	76	25	45	26	845
Cascade	11,263	38,869	15,093	359	0.59	7,394	3,702	4,711	4,043	85,434
Total	29,346	107,907	47,398	1,134	0.85	18,632	7,963	10,998	9,809	233,188
Region Total	29,346	107,907	47,398	1,134	0.85	18,632	7,963	10,998	9,809	233,188

Source: HAZUS-MH Global Summary Report, WSP Analysis

Historic and Cultural Resources

Older and historic buildings, which are often significant cultural resources for a region, are especially vulnerable to earthquake hazards. Older and historic buildings were constructed before the adoption of modern building and seismic codes and are commonly made of unreinforced masonry. This construction is more susceptible to damage from earthquakes and results in higher vulnerability. The historic downtown areas of the municipalities in the Region are considered to be slightly more at risk, though the overall risk is lower than western Montana. A complete inventory of historic and unreinforced masonry buildings was not available to be able to refine vulnerability further.

Natural Resources

Natural resources of all kinds are exposed to earthquake hazards, but impacts are considered relatively minor. Very few, if any, natural resources are susceptible to direct damage from earthquakes. However, natural resources are susceptible to damage from secondary hazards associated with earthquakes. For example, earthquake-induced landslides can potentially impact surrounding habitat. Dam failure is also associated with earthquake and can result in the loss of entire reservoirs, permeant alteration of unique downstream habitat, and damage caused by catastrophic flash flooding. Where relevant, secondary impacts on natural resources from earthquake are discussed in sections for other hazards.

Development Trends Related to Hazards and Risk

Development generally increases the exposure of assets to earthquake hazards. However, susceptibility of assets to earthquake may increase or decrease as demographics change and old buildings fall into disuse and new buildings are constructed. For example, development may lead to the abandonment or replacement of old structures built to old building codes, especially those in poor condition. In this case the development would lead to a decrease in susceptibility of building assets. The overall effect of development on vulnerability is the product of changes in asset exposure and the change in asset susceptibility to earthquake hazards.

In the case of Central Montana, development concerns with regard to earthquake were generally not raised by plan participants and development in general is slight. However, jurisdiction-specific concerns are discussed further in jurisdiction annexes, where relevant.

Risk Summary

Overall, earthquake is considered a low significance hazard due the unlikely nature of a severe earthquake in the Central Region, and the lack of history of damaging events in the planning area.

- Effects on people: People can be injured or killed in earthquakes due to falling items or structures, as well as from cascading events triggered by the earthquake. Regionwide, 65 injuries and 2 fatalities are estimated by the HAZUS scenario, as well as 81 displaced households.
- Effects on property: Impacts on property include direct damage to structures from the shaking. Regionwide, 2,609 buildings are estimated to be at least moderately damaged, with 18 of them completely destroyed, resulting in $185.8 million in building damage.
- Cascade and Glacier counties have the highest potential losses; Pondera and Teton counties also have potential for losses and higher loss ratios.
- Effects on the economy: economic impacts can be from direct damages to structures as well as lost wages and income. The total economic loss is projected to be $1,419.7 million.
- Effects on critical facilities and infrastructure: Linear facilities, such as pipelines, railroads, and roadways, are largely at much greater risk than other facility types. $1,186.6 million in damages to linear facility networks are projected.

- Unique jurisdictional vulnerability: the vulnerability is generally low throughout the region, but the potential for damage is greater in the western part of the region.
- Related hazards: landslide, dam incidents

Table 4-22 Risk Summary Table: Earthquake

Jurisdiction	Overall Significance	Additional Jurisdictions	Jurisdictional Differences?
Central Region	Low	NA	In general, counties in the eastern half of the region have much lower vulnerability than the west
Blackfeet Tribe	Low	NA	
Blaine County	Low	Chinook and Harlem	None
Cascade County	Medium	Great Falls, Belt, Cascade, and Neihart	Greater losses expected in Great Falls area
Chippewa Cree Tribes Rocky Boy's Reservation	Low	NA	none
Chouteau County	Low	Fort Benton, Big Sandy	Medium in Fort Benton
Fergus County	Low	Lewistown, Denton, Grass Range, Moore, Winifred	Greater losses expected in Lewistown area
Fort Belknap Indian Community	Low	NA	None
Glacier County	Medium	Cut Bank	Glacier County has the highest expected losses of the Central Region as estimated by HAZUS
Hill County	Low	Havre, Hingham	None
Judith Basin County	Low	Stanford, Hobson	None
Liberty County	Low	Chester	None
Petroleum County	Low	Winnett	None
Phillips County	Low	Malta, Saco	None
Pondera County	Medium	Conrad	Pondera County has some of the highest expected losses of the Central Region as estimated by HAZUS
Teton County	Medium	Choteau, Dutton, Fairfield	Teton County has some of the highest expected losses of the Central Region as estimated by HAZUS
Toole County	Medium	Shelby, Kevin, and Sunburst	Toole County has some of the highest expected losses of the Central Region as estimated by HAZUS

4.2.7 Flooding

Hazard/Problem Description

Riverine flooding is defined as when a watercourse exceeds its "bank-full" capacity and is usually the most common type of flood event. Riverine flooding generally occurs because of prolonged rainfall, or rainfall that is combined with soils already saturated from previous rain events. The area adjacent to a river channel is its floodplain. In its common usage, "floodplain" most often refers to that area that is inundated by the 100-year flood, the flood that has a 1 percent chance in any given year of being equaled or exceeded. Other types of floods include general rain floods, thunderstorm generated flash floods, alluvial fan floods, snowmelt, rain on snow floods, dam failure and dam release floods, and local drainage floods. The 100-year flood is the national standard to which communities regulate their floodplains through the National Flood Insurance Program.

The potential for flooding can change and increase through various land use changes and changes to land surface. A change in environment can create localized flooding problems inside and outside of natural floodplains by altering or confining watersheds or natural drainage channels. These changes are commonly created by human activities. These changes can also be created by other events such as wildland fires. Wildland fires create hydrophobic soils, a hardening or "glazing" of the earth's surface that prevents rainfall from being absorbed into the ground, thereby increasing runoff; erosion, and downstream sedimentation of channels.

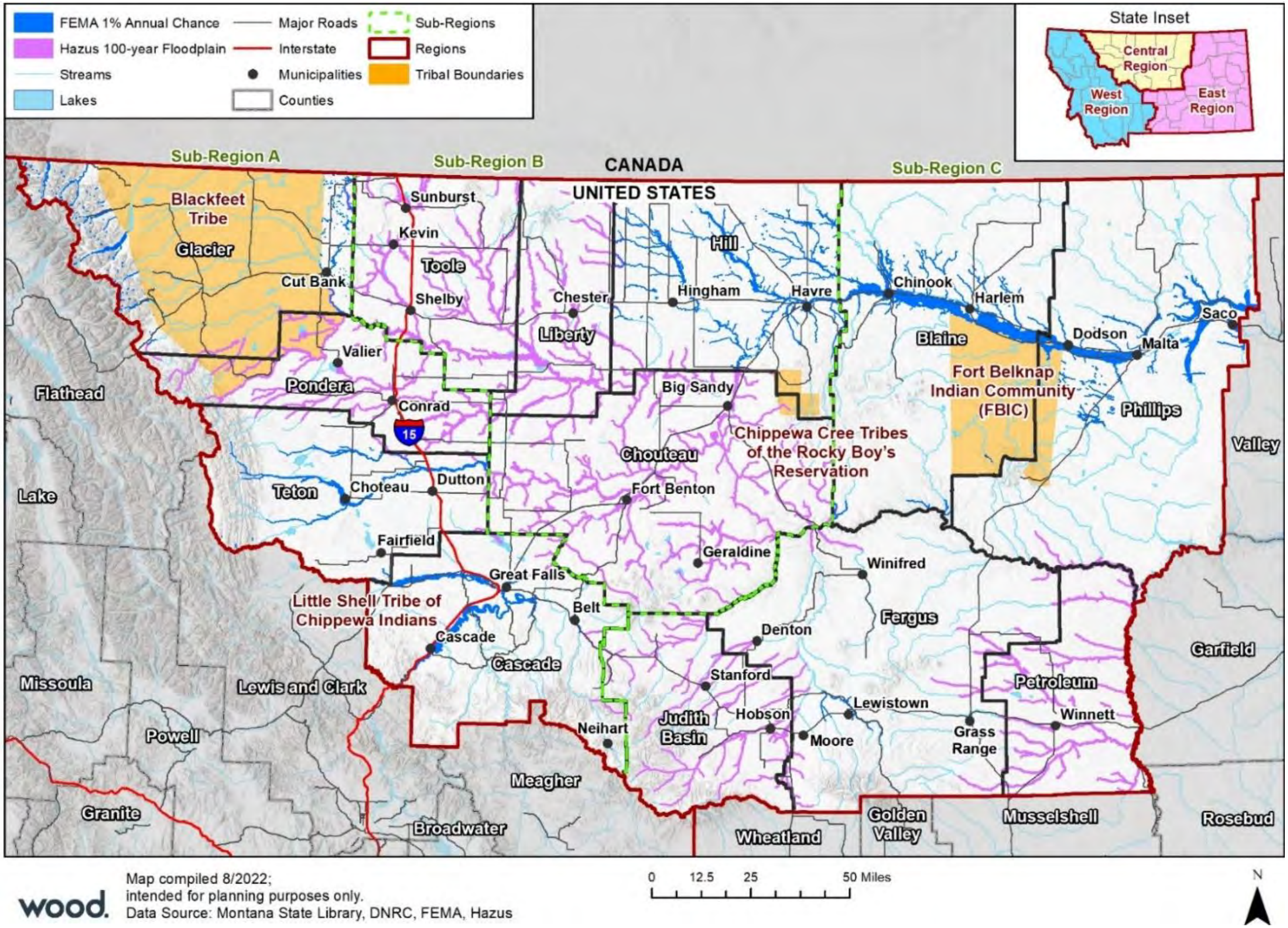
Montana is susceptible to the following types of flooding:

- Rain in a general storm system
- Rain in a localized intense thunderstorm
- Melting snow
- Rain on melting snow
- Ice Jams
- Dam or levee failure
- Urban stormwater drainage
- Rain on fire damaged watersheds

Slow rise floods associated with snowmelt and sustained precipitation usually are preceded with adequate warning, though the event can last several days. Flash floods, by their nature, occur very suddenly but usually dissipate within hours. Even flash floods are usually preceded with warning from the National Weather Service in terms of flash flood advisories, watches, and warnings.

The average total annual precipitation in Montana is roughly 15.37 inches. The average total annual snowfall is 49 inches. Generally, the flood season extends from late spring and early summer, when snowmelt runoff swells rivers and creeks, to fall. Much of the rainfall occurs with thunderstorms during April to August. Within the Central Region, Glacier County, where the Glacier National Park is located, has the highest annual average of precipitation with 40.85 inches.

Figure 4.31 Central Region Flood Hazards (NFHL and Hazus)



Geographical Area Affected

The Missouri River, along with its watersheds and tributaries are Central Montana's primary flood hazards. Among the tributaries located within the different watersheds are the Marias, Milk, Sun, and Teton Rivers. The Missouri River is the longest river in the United States, rising in the Rocky Mountains of the Eastern Centennial Mountains of Southwestern Montana and flows east and south. Flowing from east to west through Phillips County and forming a border through Blaine and Fergus County, proceeding westward. Flooding along the Missouri typically occurs during the spring and is caused by long rainstorms. Flooding may also occur during the spring due to snowmelt runoff. Localized thunderstorms during the summer monsoons can also result in flash flooding throughout the planning area. Flood hazards for the central region are pictured in Figure 4.31 above.

Past Occurrences

Flooding is a natural event and rivers and tributaries in the study area have experienced periodic flooding with associated floods and flash floods. There has been 15 federally declared disasters within the 13 counties and three Indian Reservations located in the Central Region from 1974 to 2022. While there have been federally declared flooding events in Montana since 2018, none have occurred since 2018 within the Central Regional study area. The federal declarations since 2010 to present are summarized in Table 4-23 below.

- **July 10, 2010:** Hill, Chouteau, Rocky Boy's Reservation received a presidential disaster declaration due to severe storms and flooding that swept through the area.
- **June 17, 2011:** All counties in Central Region sustained flood damage resulting from heavy rains (4-10 inches in 24 hours) and runoff from snowmelt of record snows occurred. Damages were over $60 million statewide.
- **July 07, 2013**: Blaine, Chouteau, Fergus, Fort Belknap Indian Reservation, Hill, Petroleum, Pondera, and the Rocky Boy's Indian Reservation all experienced heavy rains (record or near record amounts) which caused infrastructure damages totaling $3 million overall. (DR-4127-MT)
- **April 17, 2014**: Pondera County received a presidential disaster declaration due to ice jams and flooding earlier in March. Nearly $2 million in FEMA public assistance grant dollars were allocated.
- **October 9, 2014**: Blaine, Fort Belknap, Petroleum received a disaster declaration due to severe storms, straight-line winds, and flooding.
- **September 21, 2018**: Pondera, Toole, Liberty, Hill, Blaine, Petroleum counties received a major disaster declaration due to flooding. Nearly $2 million in FEMA public assistance and $82,375,50 in Hazard Mitigation assistance was also allocated.

Table 4-23 Federally Declared Flooding Events Montana Central Region 1974-2022

Year	Declaration Title	Disaster Number	County/Reservation Impacted
1974	Severe Storms, Flooding & Landslides	DR-417-MT	Glacier
1975	Rains, Snowmelt, Storms & Flooding	DR-472-MT	Cascade, Fergus, Glacier, Judith Basin, Pondera, Teton, Toole
1981	Severe Storms & Flooding	DR-640-MT	Cascade
1986	Heavy Rains, Landslides & Flooding	DR-761-MT	Chouteau, Fergus, Glacier, Liberty, Petroleum, Phillips, Pondera, Teton, Toole
1986	Severe Storms & Flooding	DR-777-MT	Blaine, Hill, Phillips
1996	Severe Storms, Flooding, And Ice Jams	DR-1105-MT	Chouteau
1996	Severe Storms, Flooding, Ice Jams, Soil Saturation	DR-1113-MT	Blaine, Hill, Liberty, Toole, Phillips

Year	Declaration Title	Disaster Number	County/Reservation Impacted
1997	Severe Storms, Ice Jams, Snow Melt, Flooding	DR-1183-MT	Judith Basin
2002	Severe Storms and Flooding	DR-1424-MT	Glacier, Liberty, Toole, Hill, Pondera
2010	Severe Storms and Flooding	DR-1922-MT	Hill, Chouteau, Rocky Boy's Reservation
2011	Severe Storms and Flooding	DR-1996-MT	All counties in Central Region
2013	Flooding	DR-4127-MT	Hill, Chouteau, Blaine, Fergus, Petroleum, Rocky Boy's Reservation, Fort Belknap
2014	Ice Jams and Flooding	DR-4172-MT	Pondera
2014	Severe Storms, Straight-Line Winds, And Flooding	DR-4198-MT	Blaine, Fort Belknap, Petroleum
2018	Flooding	DR-4388-MT	Pondera, Toole, Liberty, Hill, Blaine, Petroleum[3]

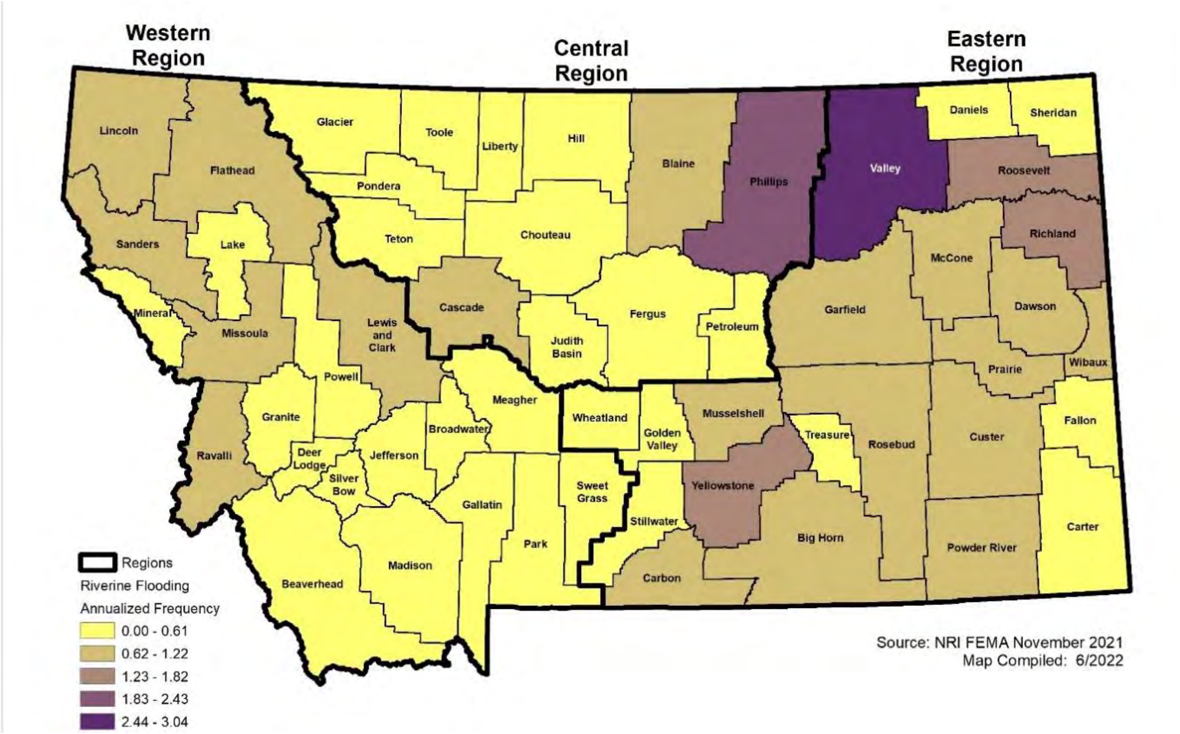
Source: FEMA.gov

Frequency/Likelihood of Occurrence

The Central Region has experienced multiple catastrophic flood events resulting in large-scale property damages. Snowmelt runoffs present a threat of serious flooding along rivers and creeks in the study area each year. Flash floods that produce debris flows and mudflows occur regularly and have caused significant damages in the past to homes, roads, bridges, and culverts. Based on the historical record of the 15 federally declared events in the past 48 years from 1974 to present within the Central Region, the Region has a major flood disaster every 3 years on average. Using past occurrences as an indicator of future probability, flooding has the probability of future occurrence rating of **likely** throughout the Central Region.

Figure 4.32 depicts the annualized frequency of riverine flooding at a county level based on the NRI. The mapping shows a trend toward increased likelihood in the northeastern part of the Region in Blaine and Philips counties, as well as in Cascade County.

Figure 4.32 Annualized Frequency of Riverine Flooding by County



Climate Change Considerations

As documented elsewhere in Section 4.2.7 *Flooding*, precipitation is one factor of several that determine flooding. Other factors include existing soil moisture conditions, frozen soils, rainfall *rate*, and special conditions such as rain-on-snow. In urban areas, stormwater infrastructure is perhaps the single greatest determinant of flooding. Other infrastructure, in the form of large dams that are abundant across the planning area, provides a large degree of protection from flooding in rural and urban areas. Perhaps the biggest concern of climate change impacts on flooding involves complex cascading effects that start with increased drought, which drives increased wildfire, which leaves more and larger fire scars, which can dramatically increase runoff and create flooding or debris flows on a scale that did not previously exist. These factors complicate the impact of climate change on flooding. Nevertheless, much can be said about the current and future effects of climate change on flooding in the planning area.

The Climate Change and Human Health report documents that a shift in the seasonality of precipitation amount is occurring. Spring precipitation has slightly increased, which has been offset by decreases during other times of the year (see Section 4.2.5 Drought, subsection titled Climate Change Considerations, and especially Figure 4.21).

The Montana Climate Change and Human Health report (2021) projects the seasonal shift from snow to rain will occur earlier, as will peak runoff on streams. Peak runoff already occurs 10-20 days earlier than in 1948. The Climate Change and Human Health report also documents research indicating peak runoff at the end of the century is projected to occur 5-35 days earlier than it did from 1951-1980.

This early-and-rapid snowmelt scenario can cause spring flooding or even ice-jam flooding and appears to already be playing out. In recent years these have been problems on many rivers in Montana, leading to great damage and loss of life, as documented in the 2021 Montana Climate Change and Human Health report. It is unclear if increasing late winter snow and early spring rain will increase the probability of rain-on-snow events, but this issue is potentially serious and worthy of monitoring in future HMPs.

Ice jams are responsible for much of the worst flooding in Montana's history. Ice-jam flooding typically occurs along mountain streams, when heavy rainfall or upstream melting raises stream flows to the point of breaking up the ice cover, which can pile up on bridge piers or other channel obstructions and cause flooding behind the jam. Once the ice jam breaks up, downstream areas are vulnerable to flash floods. The increasing possibility of midwinter thaws and heavy early spring rainfall events could increase the risk of sudden ice break up. The situation is further exacerbated if the ground is still frozen and unable to soak up rainwater.

Potential impacts are discussed in the Vulnerability subsection of this hazard profile, as well as the impacts of population changes and development trends. Current variability in vulnerability by jurisdiction, based on existing conditions, is discussed in these sections and jurisdictional annexes. Due to the uncertainty with climate change on floods, it is not possible to define with further specificity the impacts related to climate change on each jurisdiction within the Region. Future updates to this plan should revisit this topic as scientific knowledge progresses, and certain trends could emerge over time.

Potential Magnitude and Severity

Magnitude and severity can be described by several factors that contribute to the relative vulnerabilities of certain areas in the floodplain. Development, or the presence of people and property in the hazardous areas, is a critical factor in determining vulnerability to flooding. Additional factors that contribute to flood vulnerability range from specific characteristics of the floodplain to characteristics of the structures located within the floodplain. The following is a brief discussion of some of these flood factors which pose risk.

- **Elevation:** The lowest possible point where floodwaters may enter a structure is the most significant factor contributing to its vulnerability to damage, due to the higher likelihood that it will come into contact with water for a prolonged amount of time.
- **Flood depth:** The greater the depth of flooding, the higher the potential for significant damages due to larger availability of flooding waters.
- **Flood duration:** The longer duration of time that floodwaters are in contact with building components, such as structural members, interior finishes, and mechanical equipment, the greater the potential for damage.
- **Velocity:** Flowing water exerts forces on the structural members of a building, increasing the likelihood of significant damage (such as scouring).
- **Construction type:** Certain types of construction and materials are more resistant to the effects of floodwaters than others. Typically, masonry buildings, constructed of brick or concrete blocks, are the most resistant to damages simply because masonry materials can be in contact with limited depths of flooding without sustaining significant damage. Wood frame structures are more susceptible to damage because the construction materials used are easily damaged when inundated with water.

Major flood events present a risk to life and property, including buildings, contents, and their use. Floods can also affect lifeline utilities (e.g., water, sewage, and power), transportation, the environment, jobs, and the local economy.

Past flood events in Montana's Central Region have damaged roads, bridges, private property, businesses, and critical lifeline facilities. Future events may result in greater damages depending on patterns of growth, land use development and climate change.

National Flood Insurance Program Policy Analysis

The National Flood Insurance Program (NFIP) aims to reduce the impact of flooding on private and public structures by providing affordable insurance to property owners and by encouraging communities to adopt and enforce floodplain management regulations. These efforts help mitigate the effects of flooding on new and improved structures. The State has analyzed NFIP flood-loss data to determine areas of Montana's Central Region with the greatest flood risk. Montana's Central Region flood-loss information was obtained from FEMA's "Montana's Coverage Claims" for Montana's Central Region, which documents losses from 1978. This section was updated based on information obtained from FEMA through Montana Department. of Natural Resources and Conservation dated August 10th, 2022.

There are several limitations to analyzing flood risk entirely on this data, including:

- Only losses to participating NFIP communities are represented, Petroleum County is not a participant in the NFIP
- Communities joined the NFIP at various times since 1978,
- The number of flood insurance policies in effect may not include all structures at risk to flooding, and
- Some of the historical loss areas have been mitigated with property buyouts.

Montana's Central Region has a total of $143,511,600 in NFIP coverage. With 910 total flood claims, 651 current polices and $4,758,879 dollars paid out total due to flood damage and losses. NFIP data and statistics for the Central Region are summarized in Table 4-24 below. Judith Basin County has the highest amount of dollars paid out due to flood claims with $3,283,855, followed by Cascade County with $860,925 in claims.

Table 4-24 Montana Central Region NFIP Statistics

County	Date Joined	Effective Firm Date	Dollars Paid ($ Historical)	Flood Claims	Current Policies	Coverage ($)
Blaine	02/07/78	09/20/06	$71,266	53	20	$2,745,200
Cascade	04/15/80	03/19/13	$860,925	260	343	$78,188,200
Chouteau	-	-	-	0	5	$1,470,000
Fergus	04/18/78	07/22/10	$243,625	26	31	$8,808,000
Glacier	12/22/77	01/01/90	$32,243	8	5	$925,400
Hill	02/21/78	06/03/88	$55,508	17	13	$3,031,300
Judith Basin	-	-	$3,283,855	486	187	$41,978,700
Liberty	-	08/02/97	$7,075	4	7	$751,000
Petroleum	-	11/15/19	-	-	-	-
Phillips	02/07/78	05/19/87	$173,304	50	13	$1,182,900
Pondera	-	-	-	-	6	$4,430,900
Teton	11/22/77	07/18/83	$30,662.44	5	21	
Toole	-	05/21/09	$415.66	1	-	-
Totals			**$4,758,879**	**910**	**651**	**$143,511,600**

Source: FEMA Pivot NFIP Data as of August 10th, 2022; FEMA Community Status Book Report

Repetitive Loss

Repetitive losses are NFIP-insured structures that have had at least two paid flood losses of more than $1,000 each in any 10-year period since 1978. Severe Repetitive Loss (SRL) properties are defined as those that have had four or more separate claims payments. The Central Region has a total of 11 repetitive loss properties, which have had 21 flood losses resulting in $338,329.68 total payments. There are currently no SRL properties in the Central Region.

Table 4-25 shows repetitive losses in Montana's Central Region by community as of November 1, 2023. All of these structure types of are residential properties. Cascade County has the highest amount of repetitive losses with four properties and eight flood loss claims resulting in $141,703.93 in payments; this constitutes

42% of all RL payments in the Central Region. Fergus County only has two RL properties (including one in the City of Lewistown) but has had $135,777.54 in RL payments. Jurisdictions that were previously defined in this document, but not listed below do not have RL/SRL claims.

Table 4-25 Central Region Repetitive Loss Properties by Community

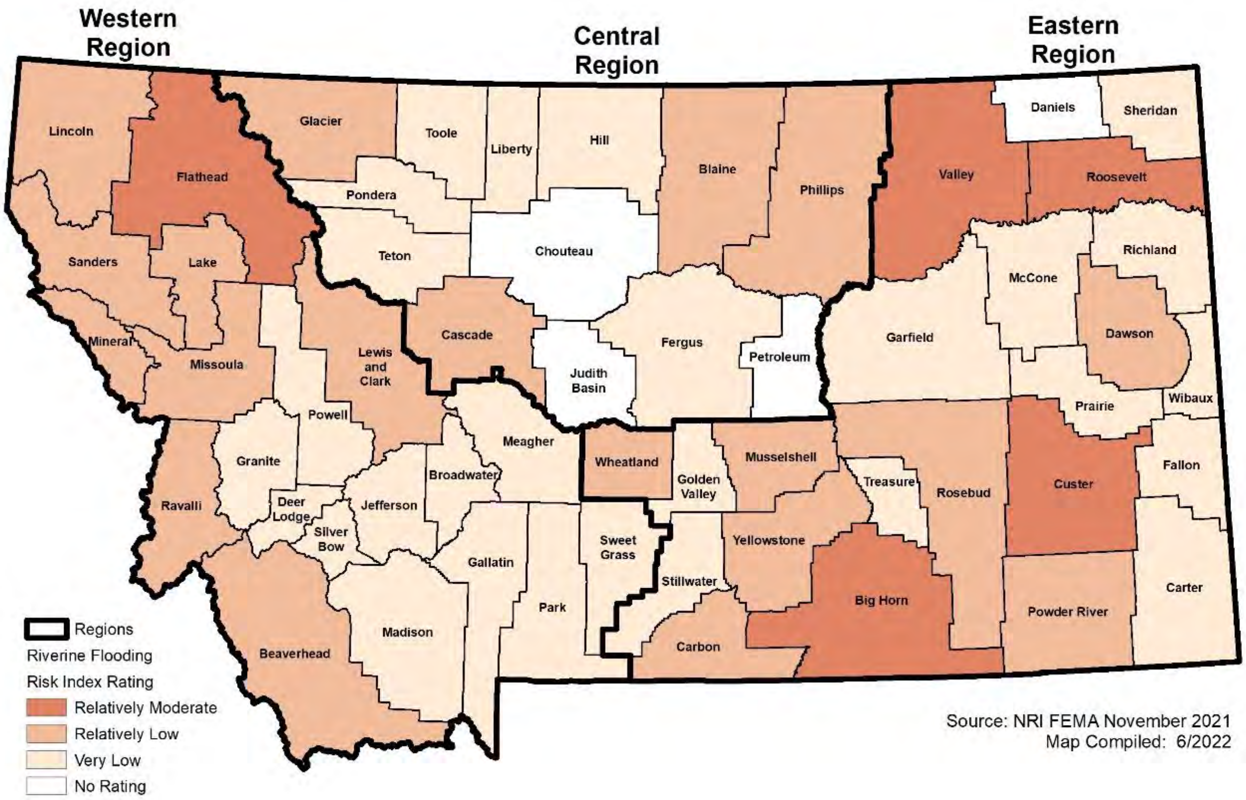
Community	County	Repetitive Loss Properties	Repetitive Loss Claims	Total Paid Out
Blaine County	Blaine	1*	1	$9,947.34
Cascade County	Cascade	4*	8	$151,181.93
Fergus County	Fergus	1*	3	$129,157.61
Hill County	Hill	1*	2	$23,227.41
Lewistown, City of	Fergus	1*	2	$6,619.93
Phillips County	Phillips	2*	4	$23,227.41
Saco, Town of	Phillips	1*	1	$12,068.57
Total		**11**	**21**	**$355,430.20**

Source: FEMA Region VIII as of 11/1/2023. Totals include SRL properties. *=Residential

Vulnerability Assessment

Figure 4.33 depicts the risk index rating for riverine flooding based on the National Risk Index (NRI). The NRI defines risk as the potential for negative impacts as a result of a natural hazard and determines a community's risk relative to other communities by examining the expected annual loss and social vulnerability in a given community in relation to that community's resilience. The Central Region trends toward relatively low to very low ratings, with the highest ratings being in Blaine, Cascade, Glacier, and Philips counties.

Figure 4.33 Risk Index Rating for Riverine Flooding by County



Preservation and restoration of floodplains could reduce losses from flooding events. If floodplain areas were left in their natural state, flooding would not cause major damage. Urban, industrial and other surface development in natural floodplain areas of Montana has increased the vulnerability to flooding. In urbanized areas, the extent of artificial surface area created by development prevents rainfall from soaking into the ground and increases the rate of runoff.

Vulnerability to flooding is also dependent on local weather conditions and site-specific flood water constraints. Some areas can be completely immune to flooding because the steeply incised river banks have physically impeded development near the river, limiting flood damage when floodwaters arrive. Other areas experience flooding annually where meandering rivers have created broad floodplains and development have encroached and impeded floodwaters. Because local conditions have a significant impact on the vulnerability to flooding, historic data on occurrence and loss is the best means to assess flooding vulnerability statewide.

There is increased risk of flash flooding and debris flows in Montana as a result of recent active fire seasons. Most burn areas will be prone to flash flooding and debris flows for at least 2 years after the fire. Locations downhill and downstream from burned areas are most susceptible, especially near steep terrain. Rainfall that would normally be absorbed will run off extremely quickly after a wildfire, as burned soil can be as water repellant as pavement. As a result, much less rainfall is required to produce a flash flood. As water runs downhill through burned areas it can create major erosion and pick up large amounts of ash, sand, silt, rocks and burned vegetation.

People

Vulnerable populations in Montana's Central Region include those that live within known floodplains or near areas vulnerable to flash floods, as well as people traveling through or in areas used for recreational purposes prone to flash flooding. Within the central region Cascade County has the highest amount of people located in the floodplain with 2,960. This is followed by Fergus County with 1,112. Third is Glacier County with 578. Of these totals, this can include the elderly and very young, those living in long-term care facilities, mobile homes, hospitals, low-income housing areas, or temporary shelters, people who do not speak English well, tourists and visitors, and those with developmental, physical, or sensory disabilities.

The impacts of flooding on vulnerable populations can be more severe Health impacts of floods - PubMed (nih.gov). Families may have fewer financial resources to prepare for or recover from a flood, and they may be more likely to be uninsured or underinsured. Individuals with disabilities may need more time to evacuate, so evacuation notices will need to be issued as soon as feasible, and communicated by multiple, inclusive methods. Population totals for the Central Region are shown in the table below.

Table 4-26 Central Region Population Located in the 1% Annual Chance Floodplain

County	Population
Blackfeet Tribe	563
Blaine	355
Cascade	2,960
Chouteau	492
Fergus	1,112
Fort Belknap (FBIC)	2
Glacier	578
Hill	121

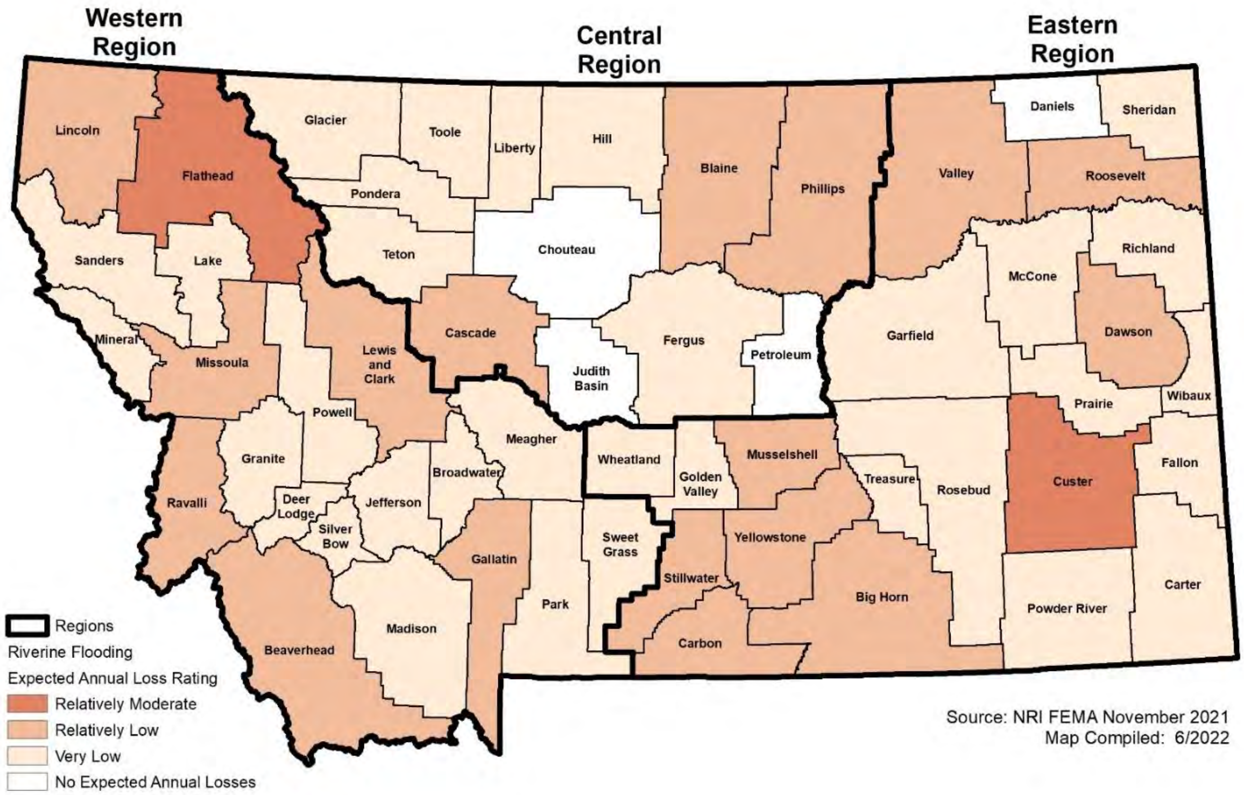
County	Population
Judith Basin	26
Liberty	347
Petroleum	22
Phillips	305
Pondera	132
Teton	422
Toole	513
Total	**7,950**

Sources: DNRC, Hazus, FEMA NFHL

Property

The NRI defines risk as the potential for negative impacts as a result of a natural hazard and determines a community's risk relative to other communities by examining the expected annual loss and social vulnerability in a given community in relation to that community's resilience. This information is categorized in Figure 4.34 below. Montana's Central Region has three counties with what's considered to be a relatively low annual expected loss rating due to floods. These three counties are Blaine, Cascade and Phillips counties. This also coincides with Cascade County being one of the most populous areas within Montana overall.

Figure 4.34 Expected Annual Loss Rating Riverine Flooding by County



GIS analysis was used to further estimate Montana's Western Region potential property and economic losses. The April 2022 MSDI Cadastral Parcel layer was used as the basis for the inventory of developed parcels. GIS was used to create a centroid, or point, representing the center of each parcel polygon, which was overlaid on the best available floodplain layer. Multiple flood layers from different sources were used in the analysis to create a full coverage of the Region's flood hazard, through the utilization of FEMA's NFHL (as of 6/1/2022), and other sources. The DNRC provided digitized flood mapping from paper maps that FEMA has not yet converted over to the NFHL. FEMA also provided 1% annual chance flood risk areas based on Hazus flood models to help fill in areas where FEMA has not mapped. For the purposes of this analysis, the flood zone that intersected the centroid was assigned as the flood zone for the entire parcel. Another assumption with this model is that every parcel with an improvement value greater than zero was assumed to be developed in some way. Only improved parcels, and the value of those improvements, were analyzed and aggregated by region, county, jurisdiction, property type and flood zone. The summarized results for the Region are shown below. More detailed summarized results for each county and community by property type are shown in the tables and maps provided within each jurisdictional annex.

Table 4-27 below summarizes the counts and improved value of parcels in the region, broken out by each county, that fall within the 1% chance floodplains. Table 4-27 also shows loss estimate values which are calculated based upon the improved value and estimated contents value.

Cascade County has the highest number of properties exposed to flooding and an Estimated Loss Value with over $111M. Fergus County is a distant second in loss values with $28M. Blaine, Chouteau, Glacier, Phillips, Teton, and Toole all have potential for more than $10M in losses. Overall Montana's Central Region has $937M in total value and a combined estimated loss of $234M for 1% annual chance flooding. There are 3,955 parcels located in the floodplain and 7,385 people at risk in the Central Region. The jurisdictional break down for each county is located within each annex.

Table 4-27 Central Region Parcels at Risk to 1% Flood Hazard by County and Jurisdiction

County	Improved Parcels	Improved Value	Content Value	Total Value	Estimated Loss
Blackfeet Tribe	247	$26,676,288	$27,117,568	$54,235,136	$13,558,784
Blaine	316	$27,223,932	$22,301,097	$49,525,029	$12,381,257
Cascade	1,421	$287,997,529	$157,578,850	$445,576,379	$111,394,095
Chouteau	258	$33,617,442	$20,634,719	$54,252,161	$13,563,040
Fergus	594	$72,319,943	$41,169,577	$113,489,520	$28,372,380
Fort Belknap	3	$21,360	$20,580	$41,940	$10,485
Glacier	256	$28,213,293	$27,827,976	$56,041,269	$14,010,317
Hill	81	$14,098,176	$11,893,088	$25,991,264	$6,497,816
Judith Basin	32	$3,747,710	$2,989,425	$6,737,135	$1,684,284
Liberty	149	$13,417,517	$8,159,564	$21,577,081	$5,394,270
Petroleum	37	$4,671,830	$4,305,745	$8,977,575	$2,244,394
Phillips	270	$26,455,836	$19,845,968	$46,301,804	$11,575,451
Pondera	75	$10,442,869	$7,594,580	$18,037,449	$4,509,362
Teton	221	$29,908,381	$19,066,372	$48,974,753	$12,243,688
Toole	245	$24,458,143	$16,849,637	$41,307,780	$10,326,945
Total	**4,205**	**$603,270,249**	**$387,354,746**	**$991,066,275**	**$247,766,568**

Sources: DNRC, Hazus, FEMA NFHL

Critical Facilities and Lifelines

To estimate the potential impact of floods on critical facilities, a GIS overlay was performed of the flood hazard layer with critical facility point locations data. Critical facilities at-risk to the 1% annual chance flood by county and Lifeline are listed in Table 4-28 below. Impacts to any of these facilities could have wide ranging ramifications, in addition to property damage and other cascading impacts.

Table 4-28 Central Region Critical Facilities at 1% Annual Risk of Flooding by Facility Type

County	Communications	Energy	Food, Water, Shelter	Hazardous Materials	Health and Medical	Safety and Security	Transportation	Total
Blaine	0	4	5	0	0	0	61	**70**
Cascade	0	3	5	1	0	6	51	**66**
Chouteau	0	0	2	0	0	1	26	**29**
Fergus	2	2	2	0	1	5	93	**105**
Glacier	4	1	2	0	0	3	41	**51**
Hill	0	1	1	0	0	0	25	**27**
Judith Basin	0	0	1	0	0	0	28	**29**
Liberty	0	4	0	0	0	2	5	**11**
Petroleum	0	2	0	0	0	0	18	**20**

County	Communications	Energy	Food, Water, Shelter	Hazardous Materials	Health and Medical	Safety and Security	Transportation	Total
Phillips	0	3	3	0	1	6	41	**54**
Pondera	0	0	0	0	0	1	51	**52**
Teton	2	0	1	0	0	0	33	**36**
Toole	0	0	2	1	0	3	11	**17**
Total	**8**	**20**	**24**	**2**	**2**	**27**	**484**	**567**

Source: Montana DNRC, FEMA, HAZUS, HIFLD 2022, Montana DES, NBI

The 1% annual chance of flooding for the Central Region shows that the majority of facilities that have the most critical facilities at risk to flood damage are within the Transportation lifelines with 484 total. It should be noted that the majority of these are bridges and have a lower risk of flooding. Bridges like these can be a cause of concern. Mainly due to scour being critical meaning a bridge with a foundation element determined to be unstable for the observed or evaluated scour condition. Also, structurally deficient (when key components like the superstructure are inspected and rated 'poor' or worse by a bridge engineer), and functionally obsolete (when design components are outdated) facilities. Safety and Security facilities have the second highest Lifeline facilities at risk with 27 total. These can be facilities such as police, fire and medical and are usually the first responders in the nature of an emergency. Food, Water and Shelter facilities are close third with 24 total facilities.

Economy

Flooding can have major negative impacts on the local and regional economy, including indirect losses such as business interruption, lost wages, reduced tourism and visitation, and other downtime costs. Flood events can cut off customer access to a business as well as close a business for repairs or permanently. A quick response to the needs of businesses affected by flood events can help a community maintain economic vitality in the face of flood damage. Responses to business damages can include funding to assist owners in elevating or relocating flood-prone business structures. Tourism and outdoor recreation are an important part of the Region's economy. If part of the planning area were damaged by flooding, tourism and outdoor recreation could potentially suffer. Additionally, flooding can impact the economy through the direct damages and losses to property and costs to recover, as summarized in the property section above.

Historic and Cultural Resources

Floodplains and their adjacent areas are regularly used for different types of cultural and economic resources such as environmental conservation, leisure, recreation, and tourism. In the event of a major flooding event, damages to communities and different industries in the Central Region could be monumental.

Natural Resources

Natural resources are generally resistant to flooding and floodplains provide many natural and beneficial functions. Wetlands, for example, exist because of natural flooding incidents. Nonetheless, with human development factored in or in areas after periods of previous disasters such as drought and fire, flooding can impact the environment in negative ways. Areas that are no longer wetlands may suffer from oversaturation of water, as will areas that are particularly impacted by drought. Areas recently suffering from wildfire damage may erode because of flooding, which can permanently alter an ecological system. Fish can wash into roads or over dikes into flooded fields, with no possibility of escape.

Pollution from roads, such as oil, and hazardous materials can wash into rivers and streams. During floods, these can settle onto normally dry soils, polluting them for agricultural uses. Human development such as bridge abutments can increase stream bank erosion, causing rivers and streams to migrate into non- natural courses.

Development Trends Related to Hazards and Risk

Potential expansion in the future and construction overall in Central Montana's floodplain can heighten the susceptibility of the region to flooding by expanding the amount of people and value of the property inventory within the planning area. Development in Central Montana's floodplains should be enforced using hazard mitigation measures available through the NFIP and local floodplain activities such as floodproofing, relocation, elevation or demolition and relocation to low-risk areas.

Risk Summary

The Central Region averages 0.5 flood events per year; using past occurrences as an indicator of future probability, flooding has the probability of future occurrence rating of **likely** throughout the Central Region. Flooding is a medium significance hazard overall in the region but there is significant variability by jurisdiction.

- There are 7,950 total people located within the 1% Annual Chance of Flooding within the Central Region. Cascade makes up more than a third of these people with 2,960. Followed by Fergus with 1,112 and Glacier with 578 people. These three counties make up more than half of the people located within the floodplain.
- The Central Region has a total of $247,766,568 in property losses due to flood damages. Cascade, Fergus, and Glacier counties have the highest estimated loss totals with the study area. These three counties make up more than half of the potential property losses within the region.
- Flooding can have major negative impacts on the local and regional economy, including indirect losses such as business interruption, lost wages, reduced tourism and visitation, and other downtime costs.
- There are a total of 567 critical facilities in the Central Region exposed to flood hazards. 105 of these are in Fergus County, 70 are in Blaine County and 66 are located in Cascade County. The highest exposure of Lifeline facilities are transportation (bridges) with 484 of the 567 total critical facilities.
- Related hazards: Dam Failure, Wildfire

Table 4-29 Risk Summary Table: Flooding

Jurisdiction	Overall Significance	Additional Jurisdictions	Jurisdictional Differences?
Central Region	Medium	NA	Flood risk is more prevalent along the Maria, Milk, Missouri and Teton River waterways and watersheds.
Blackfeet Tribe	High	NA	Blackfeet Tribe is roughly 75% of Glacier County. Hazus data has the majority of the reservation within the floodplain.
Blaine County	High	Chinook and Harlem	Relies on NFHL data and falls directly within the floodplain.
Cascade County	High	Great Falls, Belt, Cascade, and Neihart	Cascade falls directly with the FEMA 1% Floodplain

Jurisdiction	Overall Significance	Additional Jurisdictions	Jurisdictional Differences?
Chippewa Cree Tribes Rocky Boy's Reservation	High	NA	Chippewa Cree Tribes has a portion of its southwest tribal land in the 1% floodplain.
Chouteau County	Medium	Fort Benton, Big Sandy	Big Sandy and Fort Benton follow along the Milk River and is mapped with the 1% floodplain.
Fergus County	High	Lewistown, Denton, Grass Range, Moore, Winifred	The Town of Denton is located almost entirely in the 1% floodplain. The Towns of Grass Range, Moore, and Winifred, the City of Lewistown, and additional structures in the unincorporated County intersect with the 1% floodplain.
Fort Belknap Indian Community	Low	NA	The Fort Belknap Tribe is directly below the Milk River NFHL FEMA 1% floodplain
Glacier County	Medium	Cut Bank	The City of Cut Bank is largely surrounded by the 1% floodplain, although only structures outside of the City boundaries and in the unincorporated County intersect with the 1% floodplain.
Hill County	Medium	Havre, Hingham	Havre falls directly within the NFHL 1% Floodplain
Judith Basin County	Medium	Stanford, Hobson	The entire county is minimally flood prone and not mapped by the NFIP. Hobson and Stanford do not show risk to the Hazus 1% floodplain.
Liberty County	Medium	Chester	High for the Town of Chester, which largely intersects with the 1% floodplain. Structures in the unincorporated County also fall within the 1% floodplain.
Petroleum County	Low	Winnett	Winnett falls with the 1% floodplain
Phillips County	Low	Malta, Saco	Dodson, Harlem, Malta, and Saco fall directly within the NFHL 1% Floodplain. Along the Milk River
Pondera County	Medium	Conrad	The City of Conrad tangentially intersects with the 1% floodplain, while floodplain remains outside the City of Valier boundaries. The unincorporated County has several structures in the floodplain, largely along the Pondera Coulee.
Teton County	Medium	Choteau	Substantial portions of Choteau are mapped within the FEMA 1% and 0.2% floodplain of the Teton River, as are portions of the unincorporated area
Toole County	Medium	Shelby, Kevin, and Sunburst	Kevin, Shelby, and Sunburst are all mapped within the 1% floodplain and are located above the Marias River watershed.

4.2.8 Hazardous Materials Incidents

Hazard/Problem Description

A hazardous material incident is defined as any actual or threatened uncontrolled release of a hazardous material, its hazardous reaction products or the energy released by its reactions that pose a significant risk to human life and health, property and/or the environment. Hazardous materials incidents may also include chemical, biological, radiological, nuclear, and explosive (CBRNE) incidents. CBRNE incidents can cause a variety of impacts with Montana, depending on the nature of the incident, material used, and environmental factors.

Hazardous materials incidents can occur anywhere hazard materials are stored or transported. There are no designated transportation routes throughout the region. Although there are several fixed facilities within some of the city limits. Routes that are used for transporting nuclear and hazardous materials through the Central Montana Region by vehicle are Interstate 15 and State Highways 2, 87m, 191, and 200. In the 2018 Montana State Plan, it's noted that a 0.25-mile buffer is placed around all highways, major roadways, railroads, and RMP facilities as a proxy for potential impact areas. The major highways and railways within Montana and it's Central Region are shown in Figure 4.35 and Figure 4.36 below.

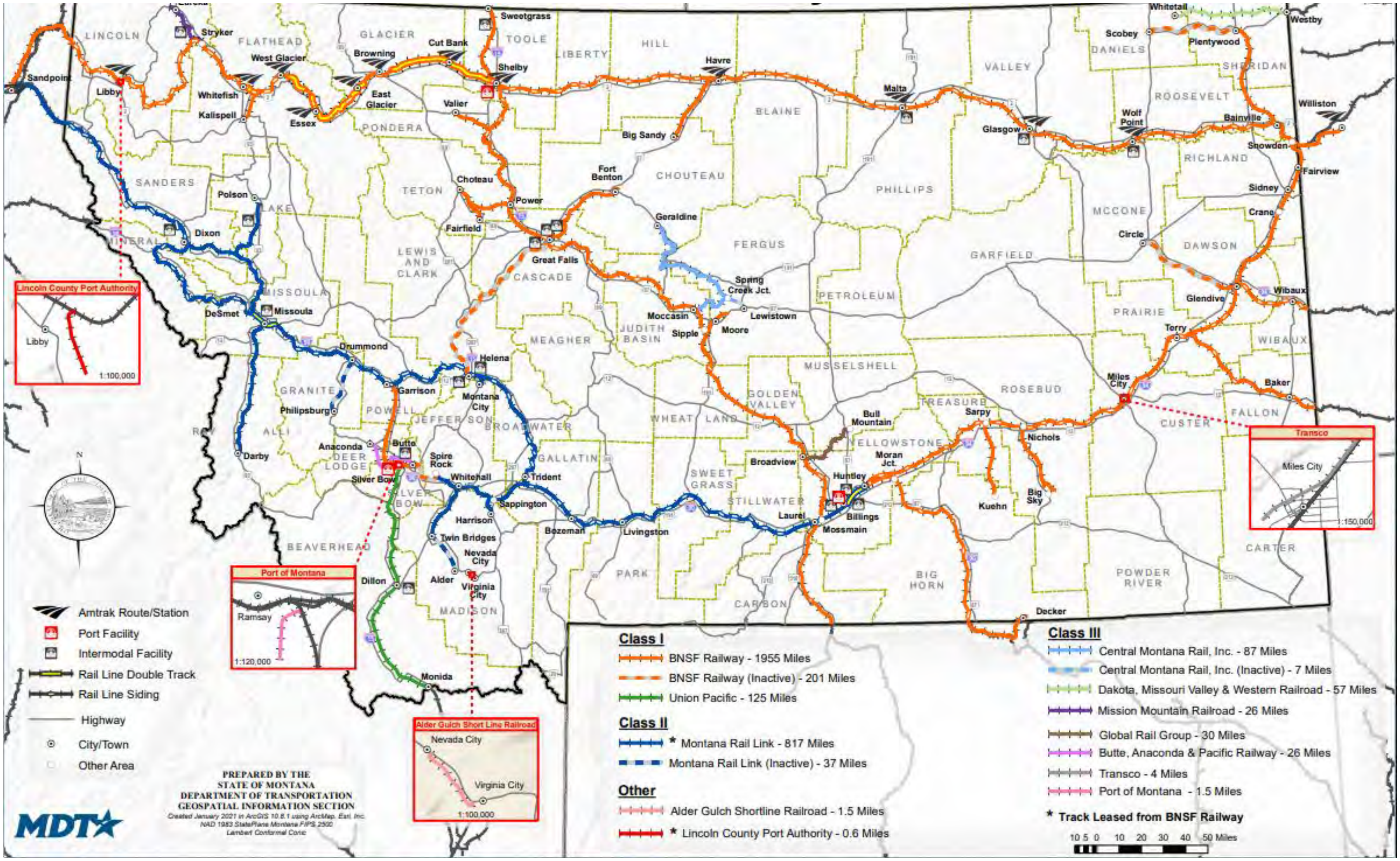
The EPA also requires facilities containing certain extremely hazardous substances to generate Risk Management Plans (RMPs) and resubmit these plans every five years. As of 2022 there are 12 RMP facilities located in the Montana's Central Region.

In 2020 there were 12 Tier II facilities located throughout Central Montana, although most are located along Interstate 15 and State Highways 2, 87, 191, and 200 see Figure 4.36 below.

As a general rule, any hazmat release is anticipated to have an impact of no more than one mile around the spill area. The impact to life and property from any given release depends primarily on:

- The type and quantity of material released.
- The human act(s) or unintended event(s) necessary to cause the hazard to occur.
- The length of time the hazard is present in the area.
- The tendency of a hazard, or that of its effects, to either expand, contract, or remain confined in time, magnitude, and space.
- Characteristics of the location and its physical environment that can either magnify or reduce the effects of a hazard.

Figure 4.35 Montana's Rail Systems



Source: MDT

Geographical Area Affected

Hazmat incidents can occur at a fixed facility or during transportation. Hazardous materials facilities are identified and mapped by the counties they reside in, along with the types of materials stored there; facilities generally reside in and around communities. Some facilities contain extremely hazardous substances; these facilities are required to generate Risk Management Plans (RMPs) and resubmit these plans every five years by the EPA.

In transit, hazardous materials generally follow major transportation routes where possible (including road, rail, and pipelines), creating a risk area immediately adjacent to these routes. Information provided by the National Pipeline Mapping System (NPMS) indicate several pipelines conveying gas or hazardous liquids across the planning area. Most notably in Cascade County where nearly 40% of the Hazardous Material incidents in Central Montana have previously occurred with 156 incidents. There have also been 73 events in Glacier and 37 events in Hill County. Pipeline ruptures can result in major spills, or even explosions. These pipelines also pass through areas where denser populations of people and property are located. The designated transportation routes, gas and hazardous liquid pipelines for these counties are shown in Figure 4.36, Figure 4.37, Figure 4.38 and Figure 4.39 below. (Source: National Response Center Incident Report Database.)

Figure 4.36 Central Region Hazardous Materials Transportation Routes

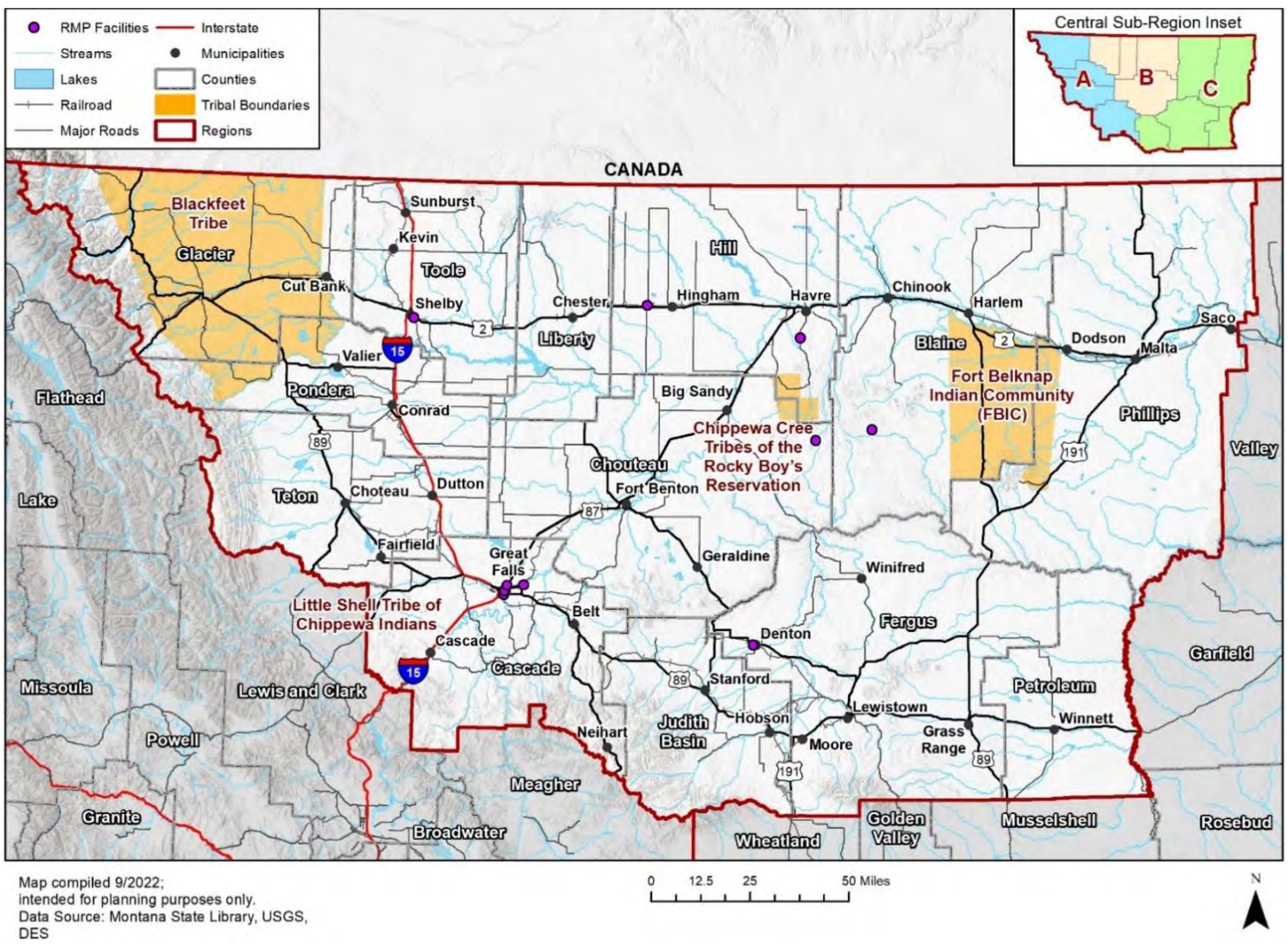
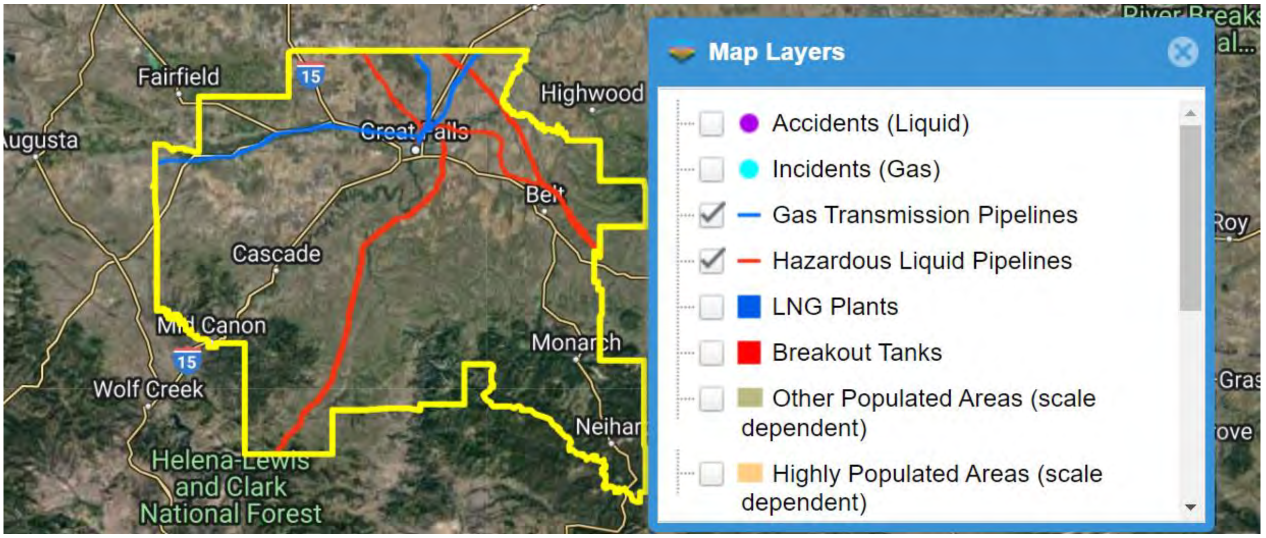
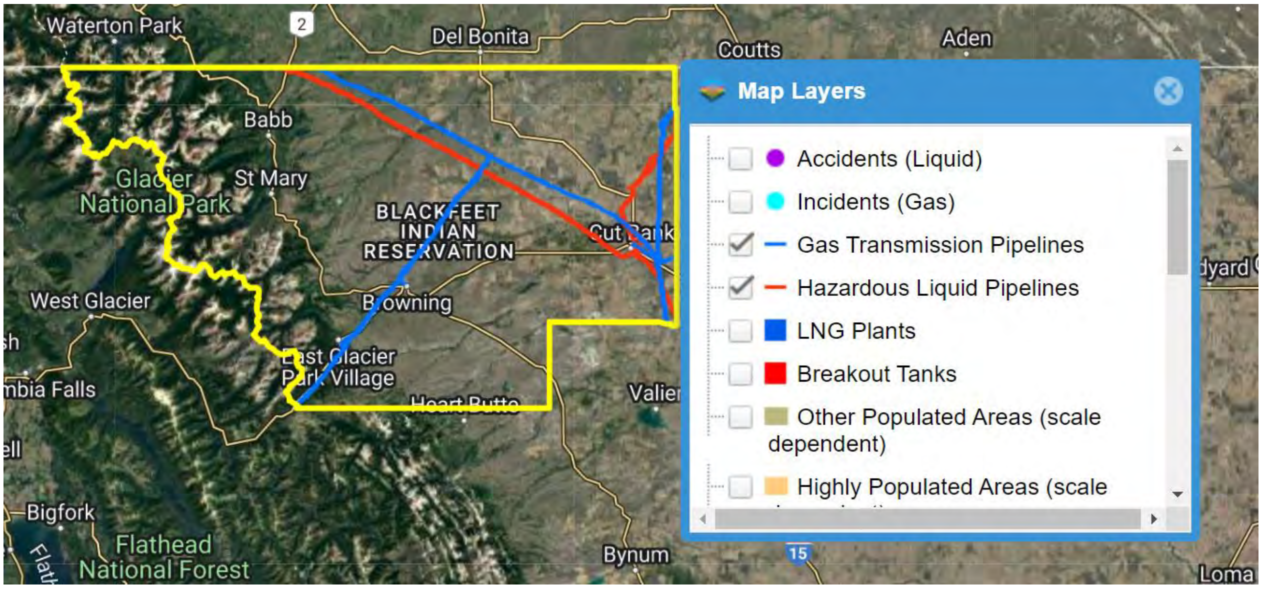


Figure 4.37 Pipelines Located Within Cascade County



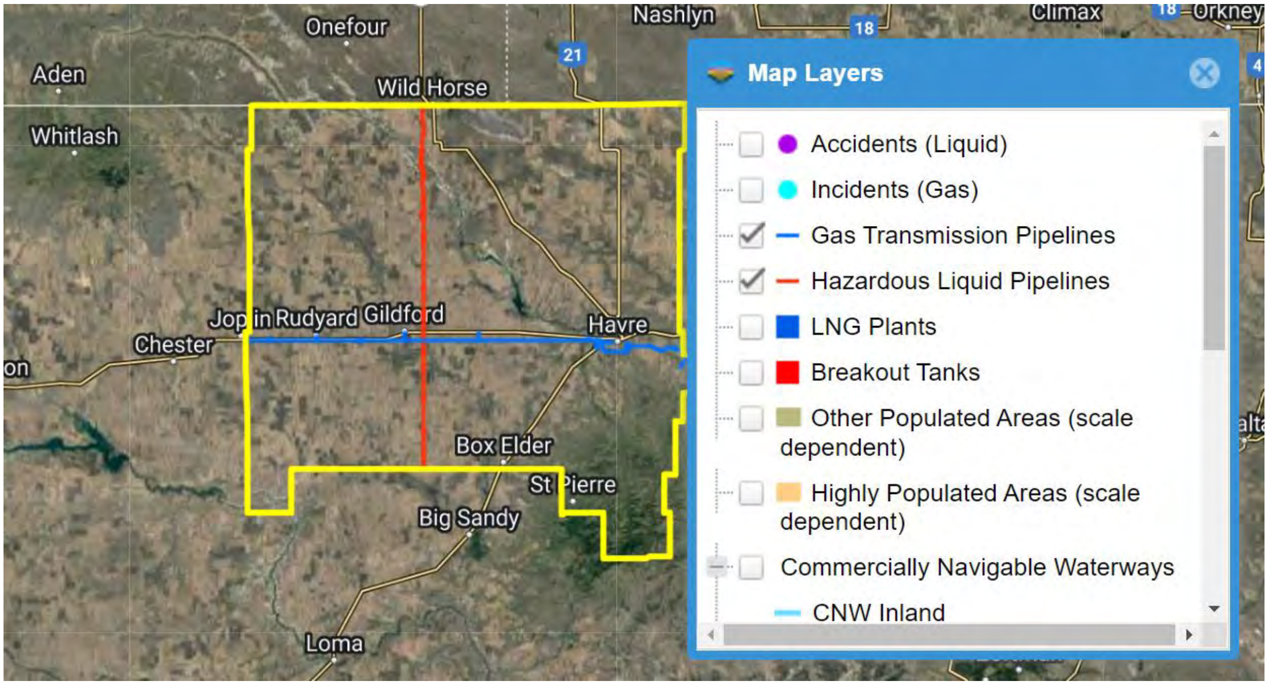
Source: National Pipeline Mapping System

Figure 4.38 Pipelines Located Within Glacier County



Source: National Pipeline Mapping System

Figure 4.39 Pipelines Located Within Hill County



Source: National Pipeline Mapping System

Past Occurrences

There are a variety of mechanisms to get an idea of the number and types of past hazardous materials incidents in the Central Region. One such repository is the catalog of hazardous materials spill and accident reports at the National Response Center (NRC) as part of the Right to Know Network (RTK NET). According to this database, between 1990 and 2022 there were 397 incidents reported across the two Indian Reservations and 13 counties within the region. Table 4-30 below shows the 32-year record for reported incidents in Montana's Central Region.

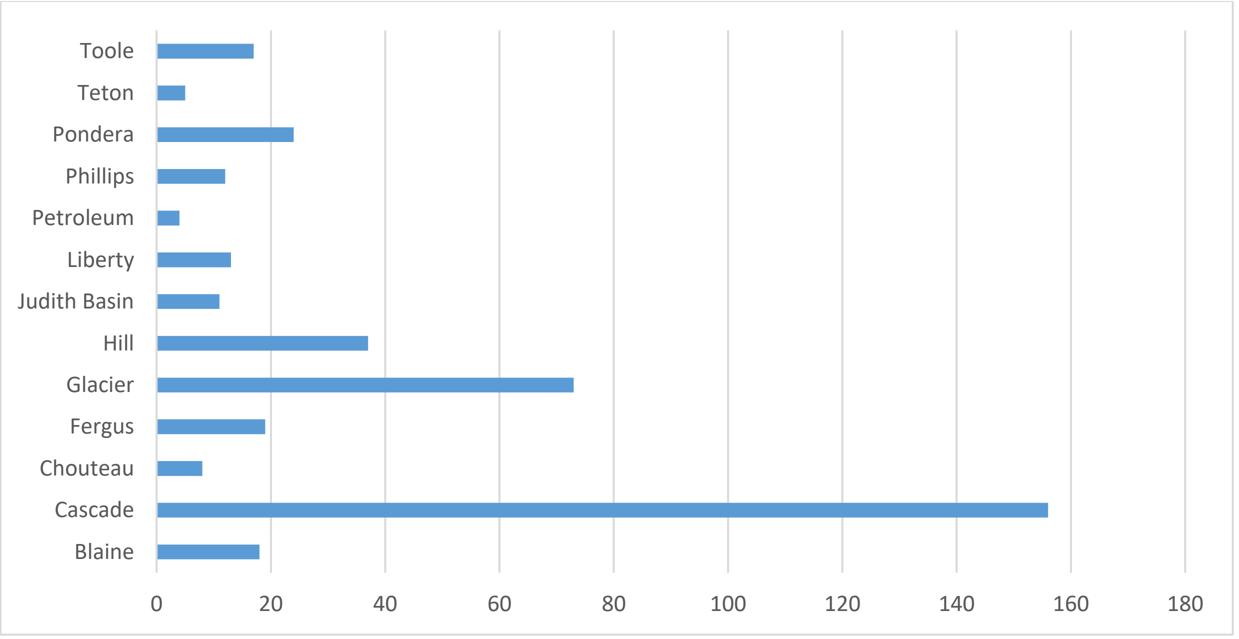
Table 4-30 NRC Reported Incidents Central Montana Region 1990-2022

County	# of Incidents		County	# of Incidents
Blaine	18		Liberty	13
Cascade	156		Petroleum	4
Chouteau	8		Phillips	12
Fergus	19		Pondera	24
Glacier	73		Teton	5
Hill	37		Toole	17
Judith Basin	11		**Total**	**397**

Source: National Response Center Incident Report Database

According to the data, during the time period between 1990 and 2022 the Region saw an average of 31 NRC-reported incidents per year, which means that each county can reasonably expect multiple hazardous materials responses annually. Cascade, Glacier, and Hill counties have had the highest amount of hazmat incidents and spills. Figure 4.40 shows the number of hazardous material incidents by county between 1990 and 2022. Great Falls, which is located within Cascade County, is the third largest city in Montana and has gas and hazardous pipelines passing through this populous area. Glacier County also has multiple pipelines that transports hazardous materials throughout it's county and surrounding region. These pipelines also run northeast of the Blackfoot Indian Reservation.

Figure 4.40 Hazardous Materials Incidents by County - Central Region: 1990-2022

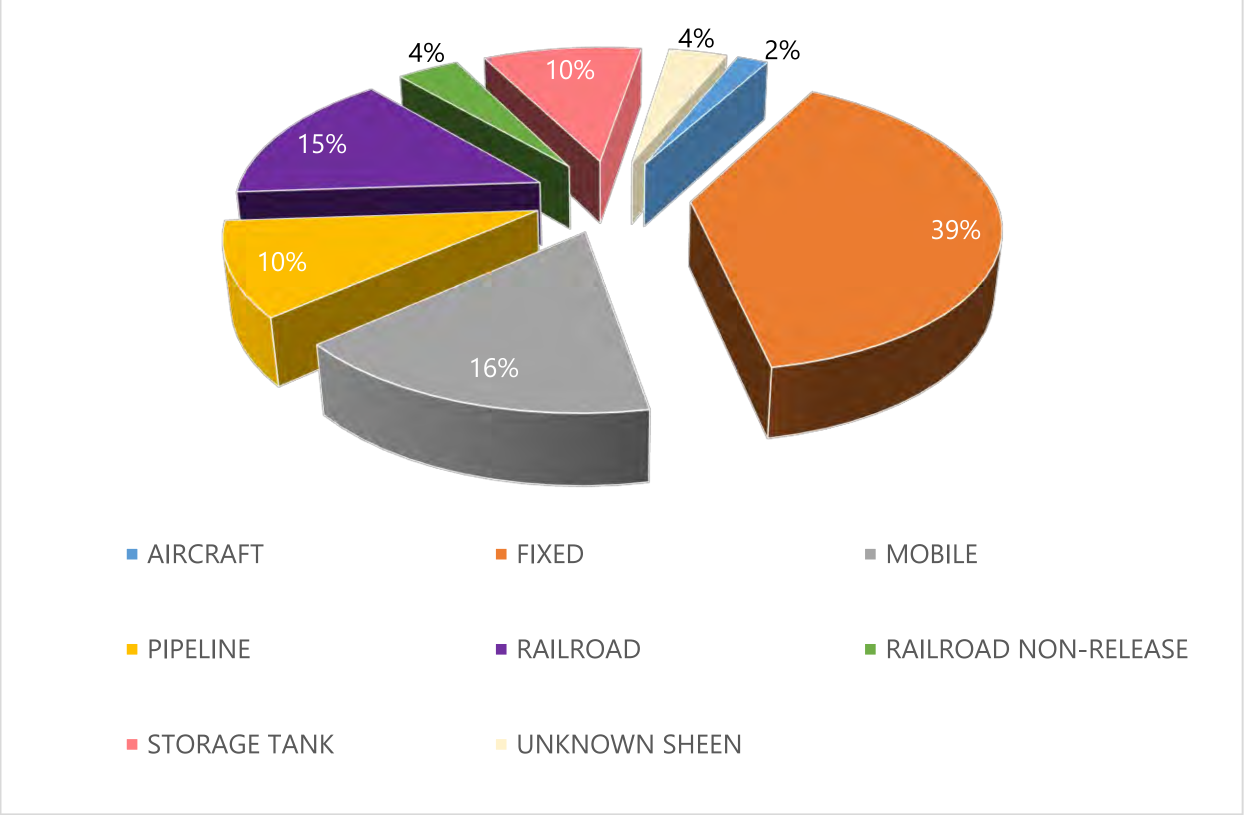


Source: National Response Center Incident Report Database

Figure 4.41 shows the percentage of each type of incident over the 32-year period between 1990 and 2022. Spills from fixed non-mobile facilities such as Tier II or RMP facilities have the highest percentage of hazmat incidents reported, accounting for 39% total. The second most common percentage of incident types accrued are mobile incidents with 16%. These can occur when hazmat materials are being transported along state highways and interstates and where injuries or fatalities are more likely to potentially occur in the process of transporting hazardous materials.

Railroads are third with 15 percent and can also have an impact on the transportation sector when materials that are hazardous are in the process of being transported. These incidents can occur rapidly, and reliable communication and warnings are needed to inform communities in the study area when incidents such as these may take place. Pipeline spills and storage tanks are fourth in types of incidents with 10 percent each. Regular maintenance and detailed planning locations are necessary to ensure that these incident types are properly accounted and prepared for.

Figure 4.41 Hazardous Materials Incidents by Type - Central Region: 1990-2022



Source: National Response Center Incident Report Database

Frequency/Likelihood of Occurrence

The study area experiences multiple hazardous materials incidents each year, with different degrees of effect. Based on the history of past occurrences, there is a 100% chance that the Central Region will see a hazardous materials incident in any given year. Hazardous material spills and releases, both from fixed facilities and during transport, will continue to occur in each county in Montana's Central Region annually.

Climate Change Considerations

Modifications in future conditions are unlikely to impact the rates of occurrence for human-caused hazards, such as hazardous material incidents. Nevertheless, it is possible that an increase or change in the occurrence of other hazards, such as severe storms and fire events, may increase the likelihood of an accidental hazardous materials releases from transportation events.

Potential Magnitude and Severity

Potential effects that could occur from hazardous waste spills or releases include:

- Injury
- Loss of life (human, livestock, fish, and wildlife)
- Evacuations
- Property damage
- Air pollution

- Surface or ground water pollution/contamination
- Interruption of commerce and transportation

Various considerations go into the impacts of a hazardous materials release, including method of release, the type of material, location of release, weather conditions, and time of day. This makes it complicated to pinpoint definite impacts. It can still be ascertained that items found in the study area will have at least one of the impacts listed above.

The vast majority of hazardous materials incidents in the Central Region are minor spills with no significant impacts beyond localized cleanup. Of the 397 incidents in the NRC database, only 59 (15%) caused significant impacts. Those 59 significant incidents resulted in a total of 21 fatalities, 42 injuries, 11 evacuations and $920,150 in property damage associated with the. Annualized over 32 years, that equates to an average of 0.66 fatalities, 1.3 injuries, 0.3 evacuations, and $27,883 of property damage per year. However, it is important to note that the NRC counts all injuries or damages resulting from an accident where hazardous materials were involved, whether or not the injuries or damages were caused by exposure to the hazardous substance; closer analysis shows that a majority of the injuries, fatalities, and property damages were from the physical impacts of the accident that caused the release, rather from exposure to hazardous materials themselves.

Vulnerability Assessment

The Central Region has energy pipelines, railroad tracks which carry many types of hazardous materials, and state highways running through its boundaries. A variety of hazardous materials originating in the Region or elsewhere are transported along these routes and could be vulnerable to accidental spills. Consequences can vary depending on whether the spill affects a populated area vs an unpopulated but environmentally sensitive area.

No specific hazardous materials routes are designated in Central Region; any routes used to carry hazardous materials introduce an element of risk of materials release to the area immediately adjacent to them. The Region noted that many petroleum and other flammable products are transported by truck, and many have mixed payloads that don't list material amounts. Extractive industries were identified as the biggest source of hazardous materials within and moving through the Region.

People

Hazardous materials incidents can cause injuries, hospitalizations, and even fatalities to people nearby. People living near hazardous facilities and along transportation routes may be at a higher risk of exposure, particularly those living or working downstream and downwind from such facilities. For example, a toxic spill or a release of an airborne chemical near a populated area can lead to significant evacuations and have a high potential for loss of life.

In addition to the immediate health impacts of releases, a handful of studies have found long term health impacts such as increased incidence of certain cancers and birth defects among people living near certain chemical facilities such as Residential Proximity to Environmental Hazards and Adverse Health Outcomes - PMC (nih.gov). However there has not been sufficient research done on the subject to allow detailed analysis.

Property

The impact of a fixed hazardous facility, such as a chemical processing facility is typically localized to the property where the incident occurs. The impact of a small spill (i.e., liquid spill) may also be limited to the extent of the spill and remediated if needed. A blanket answer for potential impacts is hard to quantify, as different chemicals may present different impacts and issues. Property within a half mile in either direction of designated hazardous materials routes is at increased risk of impacts. While cleanup costs from major spills can be significant, they do not typically cause significant long-term impacts to property. However, some larger incidents involving pipelines, railroads, or explosive materials may cause significant and overwhelming damage to the surrounding communities.

Critical Facilities and Lifelines

There are 12 RMP facilities located throughout the Central Region, as noted in table below. Some of these are discussed in more detail in the County Annexes. There is a total of 12 RMP facilities within the study area. Cascade has four of these 12 and both Glacier and Hill counties each have two. These three counties possess almost 75% of the RMP facilities within the study area. The RMP facilities for each county in the Central Region are summarized in Table 4-31 below.

Table 4-31 RMP Facilities in the Central Region

County	Jurisdiction	Number of Facilities
Blaine	Blaine County	1
Cascade	Great Falls	4
Chouteau	Chouteau County	1
Fergus	Fergus County	1
Glacier	Glacier County	2
Hill	Hill County	2
Toole	Shelby	1
Total		**12**

Source: http://www.rtknet.org/db/erns, HIFLD 2022

Economy

Potential losses can vary greatly for hazardous material incidents. For even a small incident, there are cleanup and disposal costs. In a larger scale incident, cleanup can be extensive and protracted. Deaths or illnesses resulting from hazmat incidents can occur, as well as soil and water contamination, necessitating costly remediation. Evacuations can disrupt home and business activities. Large-scale incidents can easily reach $1 million or more in direct damages, such as the 2011 oil spill into the Yellow Stone River. (Exxon Mobil says Montana spill to cost $135 million | Reuters)

Historic and Cultural Resources

Historic and cultural facilities can be impacted by hazardous materials spills the same as other facilities or areas.

Natural Resources

Hazardous material incidents may affect a small area at a regulated facility or cover a large area outside such a facility. Widespread effects occur when hazards contaminate the groundwater and eventually a potential county or jurisdiction's water supply, or they migrate to a major waterway or aquifer. Impacts on wildlife and natural resources can also be significant. These types of widespread events may be more likely to occur during a transportation incident, such as a pipeline spill, and can have far reaching and devastating impacts on the natural environment and habitats if they occurred near one of the several wildlife refuges in the planning area.

Development Trends Related to Hazards and Risk

Future development is expected to increase the number of people potentially exposed to the impacts of hazardous materials incidents. The number of hazardous materials that are stored, used, and transported across the County may continue to increase over the coming years if regional growth continues.

Risk Summary

The study area experiences multiple hazardous materials incidents each year, with different degrees of effect; based on the history of past occurrences, there is a 100% chance that the Central Region will see a hazardous materials incident in any given year.

- Hazardous materials incidents can cause injuries, hospitalizations, and even fatalities to people nearby. In addition to the immediate health impacts of releases, a handful of studies have found long term health impacts such as increased incidence of certain cancers and birth defects among people living near certain chemical facilities. (Millions of Americans Live Near Toxic Waste Sites. How Does This Affect Their Health? | Housing Matters (urban.org)
- The impact of a fixed hazardous facility, such as a chemical processing facility is typically localized to the property where the incident occurs. The impact of a small spill (i.e., liquid spill) may also be limited to the extent of the spill and remediated if needed.
- Potential losses can vary greatly for hazardous material incidents. For even a small incident, there are cleanup and disposal costs. In a larger scale incident, cleanup can be extensive and protracted.
- There is a total of 12 RMP facilities within the study area. Cascade has four of these 12 and both Glacier and Hill counties each have two. These three counties possess almost 75% of the RMP facilities within the study area.
- Related Hazards: Cyber- Attack, Human Conflict, Transportation Accidents

Table 4-32 Risk Summary Table: Hazardous Materials Incidents

Jurisdiction	Overall Significance	Additional Jurisdictions	Jurisdictional Differences?
Central Region	Low	NA	Major interstates, state highways and rail systems located throughout the study area.
Blackfeet Tribe	Low	NA	
Blaine County	Medium	Chinook and Harlem	BNSF Railways
Cascade County	High	Great Falls, Belt, Cascade, and Neihart	Cascade has the highest amount of RMP facilities with 4. Also has the highest concentration of railways and transportation routes. This also coincides with Cascade Co. having the highest hazmat accidents.
Chippewa Cree Tribes Rocky Boy's Reservation	Low	NA	
Chouteau County	Low	Fort Benton, Big Sandy	Medium in Fort Benton
Fergus County	Low	Lewistown, Denton, Grass Range, Moore, Winifred	
Fort Belknap Indian Community	Low	NA	
Glacier County	Medium	Cut Bank	Alder Gulch Shortline Railroad located within Glacier Co.
Hill County	Low	Havre, Hingham	BNSF Railways also has a higher concentration of transportation routes.

Jurisdiction	Overall Significance	Additional Jurisdictions	Jurisdictional Differences?
Judith Basin County	Low	Stanford, Hobson	BNSF Railway and Montana Rail Link and transportation routes concentrated here.
Liberty County	Low	Chester	BNSF Railways
Petroleum County	Low	Winnett	
Phillips County	Low	Malta, Saco	BNSF Railways
Pondera County	High	Conrad	
Teton County	Low	Choteau, Dutton, Fairfield	
Toole County	Medium	Shelby, Kevin, and Sunburst	BNSF Railways. High for City of Shelby due to BNSF railways and the Interstate 15 & Highway 2 interchange.

4.2.9 Landslide

Hazard/Problem Description

A landslide is a general term for a variety of mass movement processes that generate a downslope movement of soil, rock, and vegetation under gravitational influence. Landslides are a serious geologic hazard common to almost every state in the United States. It is estimated that nationally they cause up to $2 billion in damage and 25 to 50 deaths annually.

Some landslides move slowly and cause damage gradually, whereas others move so rapidly that they can destroy property and take lives suddenly and unexpectedly. Gravity is the force driving landslide movement. Factors that allow the force of gravity to overcome the resistance of earth material to landslide movement include saturation by water, steepening of slopes by erosion or construction, alternate freezing or thawing, earthquake shaking, and volcanic eruptions.

Landslides are typically associated with periods of heavy rainfall or rapid snow melt and tend to worsen the effects of flooding that often accompanies these events. In areas burned by forest and brush fires, a lower threshold of precipitation may initiate landslides, rockfall or other geological events.

Landslides are defined as a rapid slipping of a mass of earth or rock from a higher elevation to a lower level under the influence of gravity and water lubrication. More specifically, rockslides are the rapid downhill movement of large masses of rock with little or no hydraulic flow, similar to an avalanche. Water-saturated soil or clay on a slope may slide downhill over a period of several hours. Earthflows of this type are usually not serious threats to life because of their slow movement, yet they can cause blockage of roads and do extensive damage to property.

Geographical Area Affected

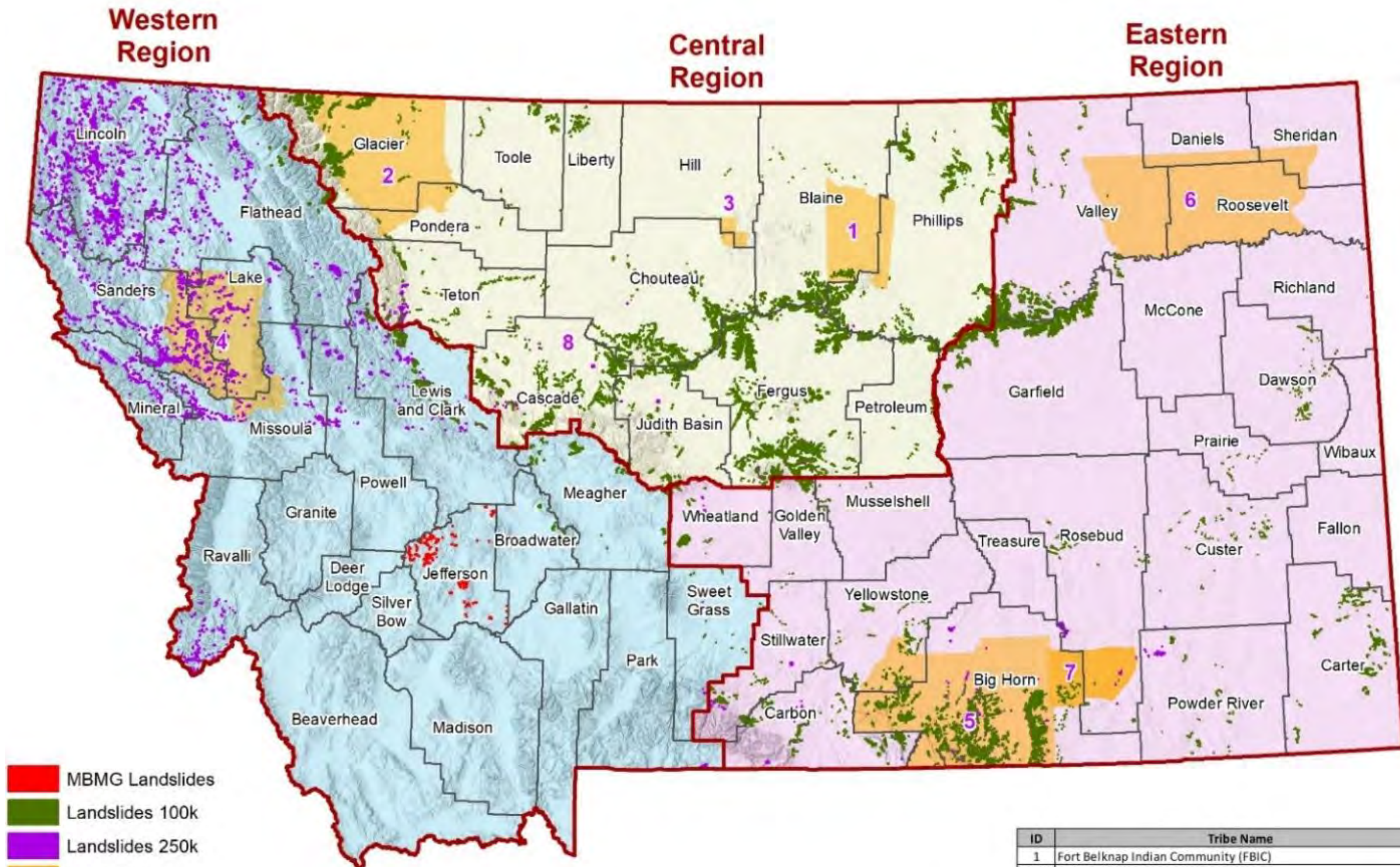
Areas that are generally prone to landslide hazards include existing old landslides, the bases of steep slopes, the bases of drainage channels, and developed hillsides where leach-field septic systems are used.

Areas that are typically considered safe from landslides include areas that have not moved in the past, relatively flat-lying areas away from sudden changes in slope, and areas at the top or along ridges, set back from the tops of slopes.

Landslides are infrequent events but not unknown in Montana. Over the years, several landslides have been dealt with by the State of Montana. In particular the Montana Department of Transportation (MDT) has spent a lot of time stabilizing landslides throughout the State, primarily along the federal and state highways. The confidence of landslides ranges from possible, probable, and likely in several areas with Montana's Central region.

The Montana Bureau of Mines and Geology's (MBMG) Landslide Hazards Program aims to identify, map, and categorize landslide areas across the State of Montana to better understand spatial distribution and causes of ground failure to help mitigate against landslide hazards. Figure 4.42 shows areas mapped by MBMG as susceptible to landslides, as well as areas where debris indicates past landslide events in the last 100,000 and 250,000 years.

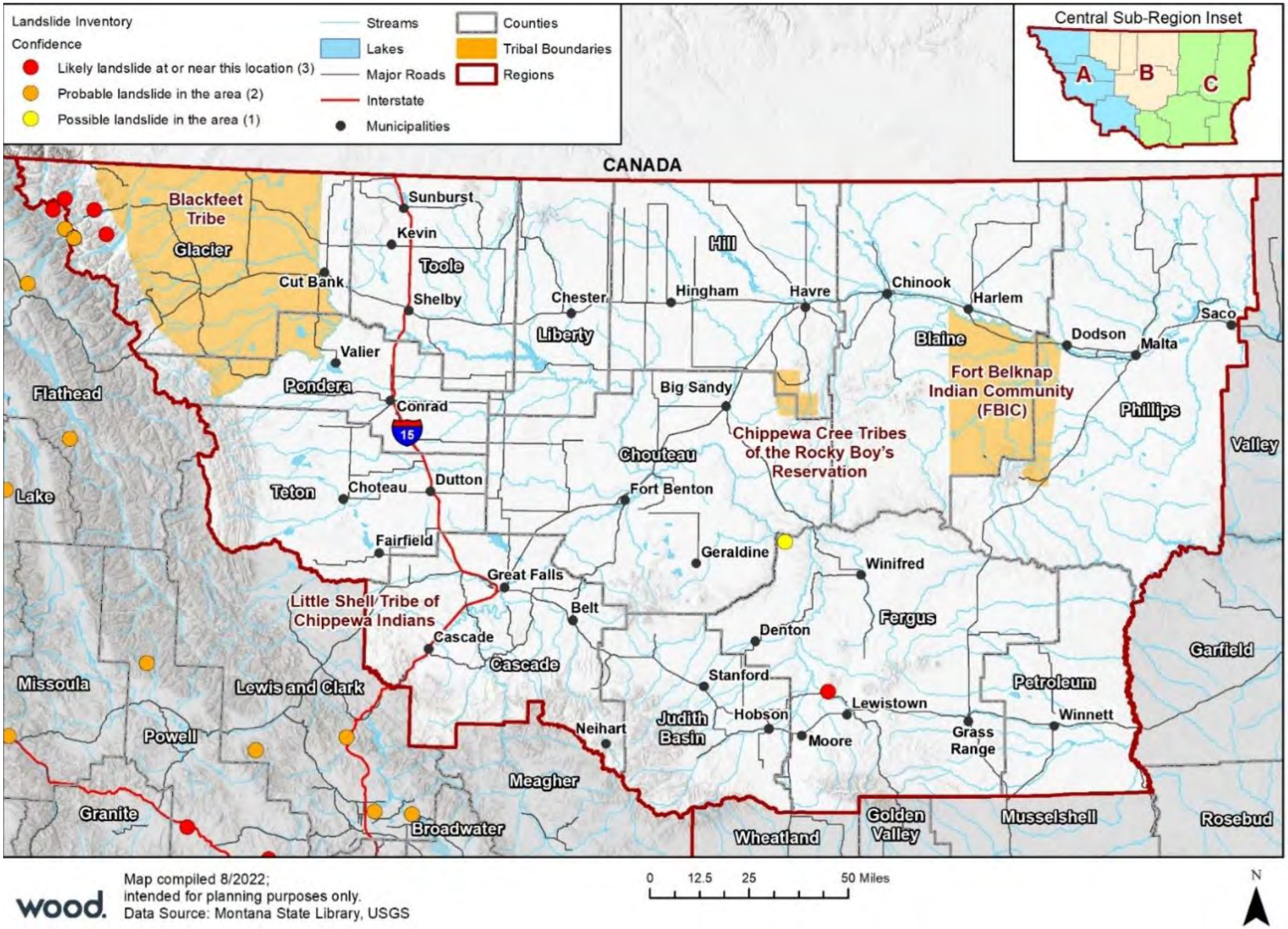
Figure 4.42 Montana Hazard Mitigation Planning Region Landslides



Source: Landslide source data modified from Gavillot, Y., in review Landslide and Slope Map of Jefferson and Deer Lodge Counties, Southwest Montana: Montana Bureau of Mines and Geology Geologic Map. Gavillot, Y., Sanford, J., Ekberg, P., Li, Y., and Rossi, A., in review, Landslide Inventory Database for Jefferson County, Southwest Montana: MBMG. Gavillot, Y., Sanford, J., Maendel, A., Elliott, C., J., Ekberg, P., Li, Y., and Rossi, A., in review, Landslide Inventory Database for Deer Lodge County, Southwest Montana: MBMG.

ID	Tribe Name
1	Fort Belknap Indian Community (FBIC)
2	Blackfeet Tribe
3	Chippewa Cree Tribes of the Rocky Boy's Reservation
4	Confederated Salish and Kootenai Tribes of the Flathead Nation
5	Crow Tribe
6	Fort Peck Assiniboine and Sioux Tribes
7	Northern Cheyenne Indian Reservation
8	Little Shell Tribe of Chippewa Indians

Figure 4.43 Landslide Inventory Confidence Montana Central Region



There is a total of six confidence marker locations in or near Glacier County and the Blackfeet Tribal Reservation. Four of these confidence markers within Glacier County have a confidence marker of likely and the other two a confidence marker of probable. Fergus County has two confidence markers, one of which is where a landslide is considered to be likely near Lewistown, Montana. The other is located in the northwest portion of Fergus County and has a landslide confidence marker of possible. The areas where landslides have a confidence of occurring throughout the study area are depicted in Figure 4.43 above.

Past Occurrences

Table 4-33 provides information regarding past landslides in the central region of Montana. There have been two federally declared events within the project area from 1974 to present.

Table 4-33 Central Montana Landslides

Date	Counties Affected	Comments
January 29, 1974 DR-417	Glacier	A disaster declaration was declared after severe storms, landslides, and flooding in the affected areas.
March 15, 1986 DR-761	Chouteau, Fergus, Glacier, Petroleum, Phillips, Pondera, Toole	A disaster declaration was declared after heavy rains, landslides, and flooding in the affected areas.
August 14, 2013	Cascade	Several sections of Roadways in Cascade County were heavily eroded by seasonal rainfall, making routes impassable in some locations.

Source: HMPC, FEMA

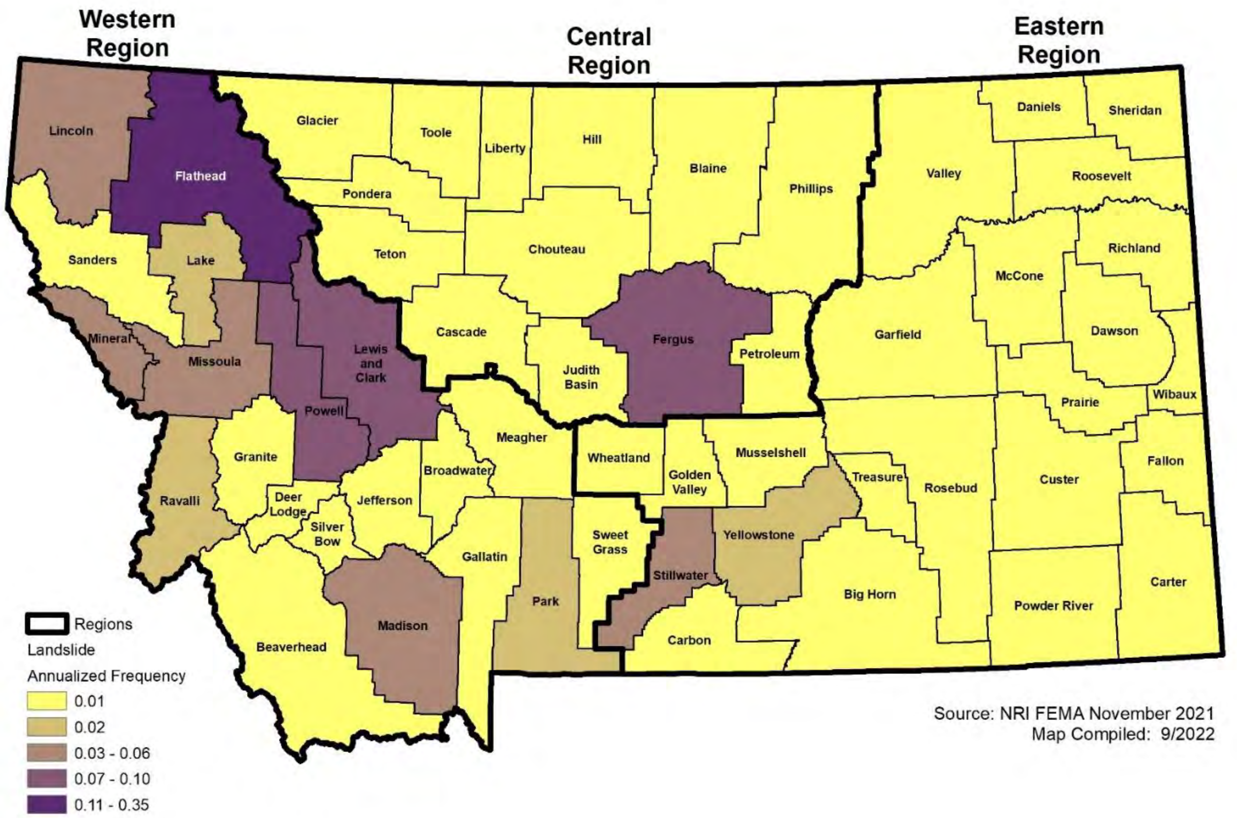
Frequency/Likelihood of Occurrence

Although historical landslide occurrence data is limited it can be assumed that these geological processes will continue to occur **occasionally** in the future. Landslides and expansive soils may typically occur most often during wet climate cycles or following heavy rains, but in certain areas of the study area. It's plausible to presume that destructive events have among a 10 and 100 percent chance of occurrence with the next year, or a recurrence interval of 10 years or less. Hence, landslides, rockfalls or debris flows are **likely** to occur. Heavy periods of precipitation or substantial development could have an influence on slope strength. Characteristically, there is a landslide/rockfall "season" that correlates with enhanced freeze-thaw phases and wetter weather in the spring and summer.

Within the Central Region, Fergus has the highest estimated annualized frequency of 0.11 – 0.35. This is believed to be due to sloughing in Lewistown and Moore area related to a heavy rainfall event in 1986, resulting in the disaster declaration mentioned above. However, a search of newspaper archives could find no additional information on landslide activity in that area, or indeed anywhere in Fergus County.

The other 12 counties in the study area have an annualized frequency of 0.01 which is considered to be the lowest risk estimation. The expected frequency results for the Central Region are shown in Figure 4.44 below.

Figure 4.44 NRI Annualized Landslide Frequency Montana Central Region



Climate Change Considerations

Landslides or mudflows can be triggered by climatic events, especially periods of intense rainfall and runoff. Climate change appears to be increasing early spring rainfall (see Section 4.2.5 Drought, subsection Climate Change Considerations, especially Figure 4.21). This trend is likely to continue for the foreseeable future and could amplify landslide hazards.

In addition, the increased wildfire occurrence expands the area affected by burn scars. Burn scar areas are especially prone to landslide and debris flows. Soils in these areas can become hydrophobic and dramatically increase rainfall runoff at the same time that slopes lack vegetation to stabilize soils. While this process is well known and has led to disastrous flooding and debris flows in other areas, it is not clear that the issue has been explicitly studied in north-central Montana. This issue is potentially serious and worthy of monitoring in future HMPs.

Potential Magnitude and Severity

The extent of landslides and debris flow events within the Central Montana Region range from negligible to significant, depending on the event. While landslides and rockslides can result in the destruction of infrastructure such as roadways, water, and sewer lines, electrical and telecommunications utilities and drainage where they are present, the potential magnitude of landslides, rockfall and debris flows would typically be isolated in most counties in the region. However even a small, isolated event has potential to close state or US highways in the region that can result in long detours for days or weeks. With the added cost of detours, and the potential for life safety impacts, some landslides could have greater costs. There is relatively limited potential for complete destruction of buildings and death and injury from landslides and debris flow.

Landslides can be classified using the Alexander Scale, shown in Table 4-34. The scale is predicated on landslide debris impacting the built environment. Based on the history the highest extent level expected within the planning area is level 5 (Very Serious), but this is likely to be isolated to limited areas in where maintenance is limited and wooden buildings, roofs, or porches are collapsed or disconnected from foundations.

Table 4-34 Alexander Scale for Landslide Scale Damage

Level	Damage	Description
0	None	Building is intact
1	Negligible	Hairline cracks in walls or structural members; no distortion of structure or detachment of external architectural details
2	Light	Buildings continue to be habitable; repair not urgent. Settlement of foundations, distortion of structure, and inclination of walls are not sufficient to compromise overall stability.
3	Moderate	Walls out of perpendicular by one or two degrees, or there has been substantial cracking in structural members, or the foundations have settled during differential subsidence of at least 6 inches; building requires evacuation and rapid attention to ensure its continued life.
4	Serious	Walls out of perpendicular by several degrees; open cracks in walls; fracture of structural members; fragmentation of masonry; differential settlement of at least 10 inches compromising foundations; floors may be inclined by one or two degrees or ruined by heave. Internal partition walls will need to be replaced; door and window frames are too distorted to use; occupants must be evacuated, and major repairs carried out.
5	Very Serious	Walls out of plumb by five or six degrees; structure grossly distorted; differential settlement has seriously cracked floors and walls or caused major rotation or slewing of the building [wooden buildings are detached completely from their foundations]. Partition walls and brick infill will have at least partly collapsed; roofs may have partially collapsed; outhouses, porches, and patios may have been damaged more seriously than the principal structure itself. Occupants will need to be re-housed on a long-term basis, and rehabilitation of the building will probably not be feasible.
6	Partial Collapse	Requires immediate evacuation of the occupants and the cordoning off of the site to prevent accidents with falling masonry.
7	Total Collapse	Requires clearance of the site.

Source: FEMA

The severity of landslides or rockslides depends on the amount of material (soil, debris, or rocks) moves and where it stops moving (e.g. on roadway). Although the extent of the hazard is geographically small, the severity of landslides and rockfalls can be critical with potential to cause severe injuries, shutdown transportation corridors to critical infrastructure, and damage property.

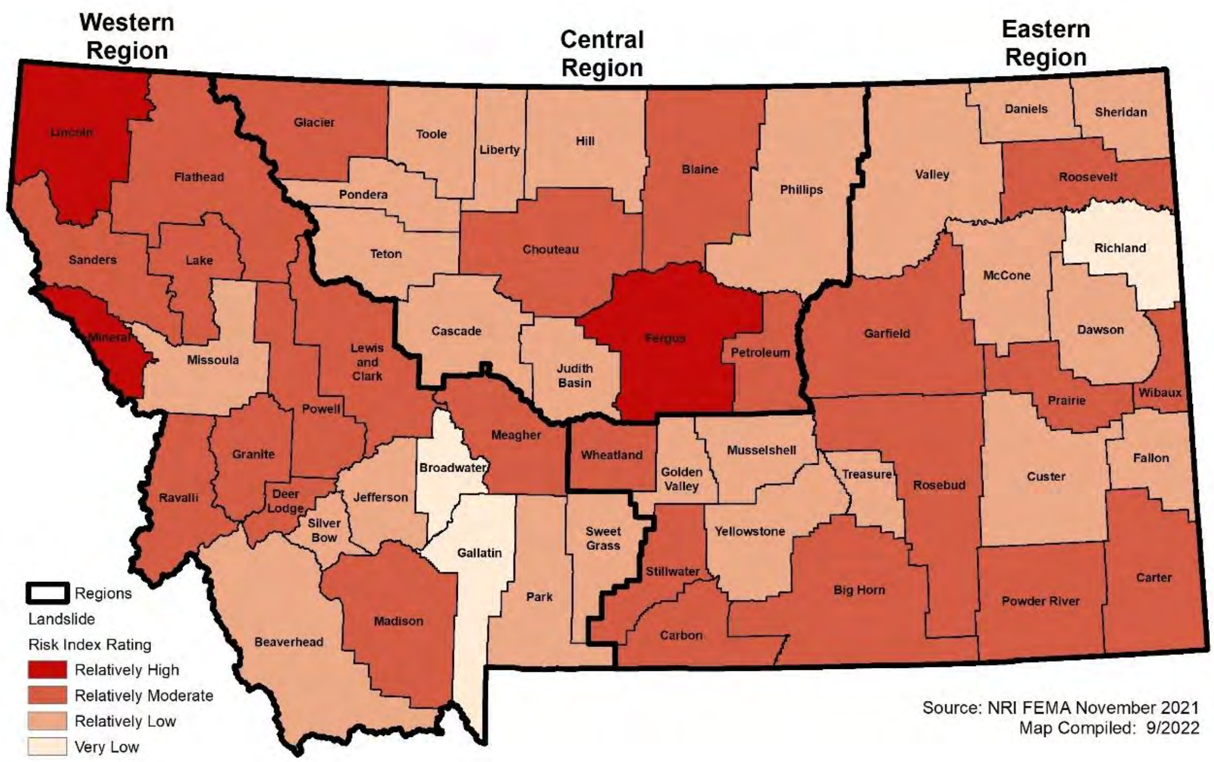
Vulnerability Assessment

The landslide *Vulnerability Assessment* identifies, or at least discusses, *assets* that are more *likely to be exposed* to landslide hazards and are *susceptible* to damage from that exposure. In this context, *assets* are (1) people, (2) property, (3) critical facilities and lifelines, (4) the economy, (5) historic and cultural resources, and (6) natural resources. *Exposure* indicates interacting with landslide hazards, and *likely to be exposed* indicates a presence in areas deemed to be especially likely to experience landslide hazards. *Susceptible* indicates a strong likelihood of damage from exposure to landslide hazards and is described in greater detail in Section 4.2.1, subsection titled *Vulnerability Assessment*. Finally, vulnerability under future conditions is considered as it relates to both climate change and development.

The role of climate change in future vulnerability to landslide is discussed above in the section titled, *Climate Change Considerations*, while the effect of future development is considered below in the section titled *Development Trends Related to Hazards and Risk*.

Data describing high hazard zones are not available for landslide. NRI data convey this hazard exists to some degree throughout the Central Region, especially in Blaine, Chouteau, Fergus, Glacier, and Petroleum counties (Figure 4.45). The *relatively high* risk rating for Fergus County in the NRI Risk Index is likely an artifact of sloughing in Lewistown and Moore area related to a heavy rainfall event in 1986, resulting in the disaster declaration mentioned above. The planning team was unable to find any additional information on landslide activity in Fergus County. For the purposes of this plan we assume the entire region experiences landslide hazards, but these five counties have a higher likelihood of experiencing landslide hazards.

Figure 4.45 Risk Index Rating for Landslide by County



People

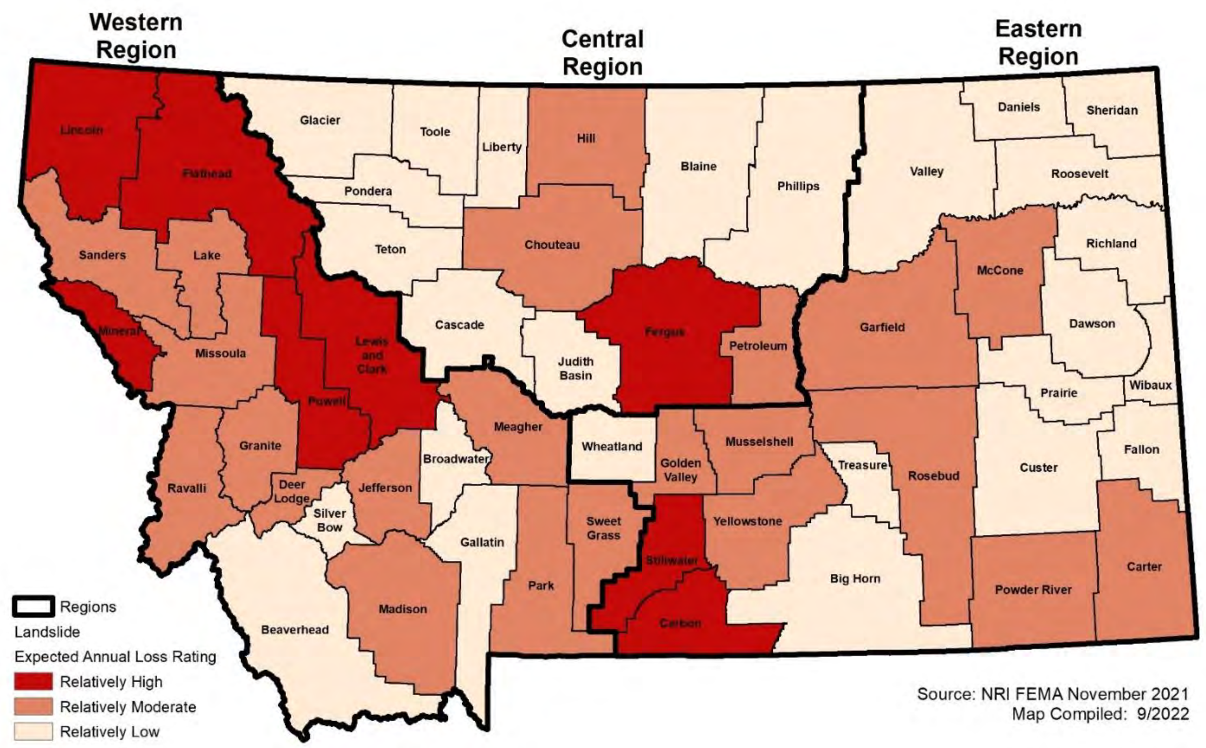
People living in, traveling through, or recreating in landslide areas are all potentially exposed to this hazard. There have been no recorded deaths or injuries due to landslides in Montana. However, people are conceivably susceptible to death or injury from these hazards, such as when traveling in a vehicle where rockfall has a higher confidence of occurring. Overall, there is some vulnerability of people to landslide.

Property

Landslides are more known for damaging structures. This happens in two general ways: 1) disruption of structural foundations caused by differential movement and deformation of the ground upon which the structure sits, and 2) physical impact of debris moving downslope against structures located in the travel path. Landslides have been known to create temporary dams in some locations, partially or fully blocking rivers at the toe of the slide. These dams can subsequently burst as the pressure of the impounded water builds, leading to flood damage for structures and communities downstream as well.

Within the Central Region, NRI data indicates Fergus County has a relatively high expected annual loss rating due to landslides. Choteau, Hill and Petroleum Counties have a relatively moderate annualized loss due to landslide damages. The other nine counties in the central region have a relatively low expected annual loss due to landslide hazards. The expected annual loss is an indicator of risk for each county and is shown in Figure 4.46.

Figure 4.46 NRI Expected Annual Loss Rating Montana Central Region



Critical Facilities and Lifelines

Transportation systems are usually unprotected and especially susceptible to rockfall, landslide and debris flow incidents. Residents and visitors alike are impacted when roads are damaged by rockfall and landslides. The loss of transportation networks could potentially cause secondary damage to the overall region's infrastructure, including revenue, transportation availability, emergency response mechanisms and other essential capabilities by preventing the means of these resources from activating or moving between locations.

Pipelines and other buried infrastructure are notably susceptible to extension, bending, and compression caused by ground deformation. Failure of any component along a pipeline or other buried utility line can result in failure to deliver service over a large region. This type of failure can have very significant consequences, such as loss of power to critical facilities, impaired disposal of sewage, contamination of water supplies, disruption of all forms of transportation, release of flammable fuels, and so on.

Economy

Losses as a result of geologic hazards can result in economic damages sustained to buildings and property. These losses can also result in indirect losses, such as lowered property values in hazard exposure areas, the extended closing of businesses that are damaged, and as a result lost wages and revenue if workers are not able to go to work. Tourism can also be interrupted.

Historic and Cultural Resources

Landslides can damage or destroy historic or cultural sites the same as general property. The biggest impact would likely be on older properties such as wooden or masonry buildings, though reinforced masonry structures are less susceptible to landslide hazards.

Natural Resources

Landslides and other geologic hazards are considered a natural process; however, they can have varying impacts to the natural environment, with the potential to permanently alter the natural landscape. For example, landslide effects on the environment and natural resources could be very destructive depending on the size of the landslide event and secondary/cascading effects from an event (e.g., rockfall). Additionally, rockfalls to rivers can cause blockages causing flooding, damage rivers or streams, potentially harming water quality, fisheries, and spawning habitat. Also, hillsides that provide wildlife habitat can be lost for prolonged periods of time.

Development Trends Related to Hazards and Risk

In general, the Central Region has a lower risk for landslide and other geological hazards in comparison to the entire state of Montana. For most of the geologic hazards profiled, the greatest risk is along the Missouri River where geography makes processes such as landslides and mudflows more likely. As counties such as Glacier and Cascade see growth in population and housing units the exposure could increase as well unless careful consideration of landslide hazards is included in land use decisions. Steps to mitigate landslide hazards should be taken to reduce susceptibility new development in areas exposed to landslide hazards. Examples include mapping of hazard areas, adoption and enforcement of engineering and building codes for soil hazards, and ordinances to limit development on steep slopes.

Risk Summary

- Although historical landslide occurrence data is limited it can be assumed that these geological processes will continue to occur occasionally in the future.
- People exposed to landslide hazards are most at risk to death or injury from these hazards. This includes not only people residing in areas prone to landslides but also outdoor recreationists and travelers in the region.
- Within the Central Region, Fergus has an expected annual loss rating due to landslides of relatively high. Choteau, Hill, and Petroleum counties have relatively moderate expected annualized losses due to landslides.
- Losses as a result of geologic hazards can result in economic damages sustained to buildings and property.
- Transportation systems are usually the most unprotected critical facility type in the region to rockfall, landslide and debris flow incidents. Residents and visitors alike are impacted when roads are damaged by rockfall and landslides.
- Related Hazards: Earthquake, Floods, Severe Summer Weather, Wildland and Rangeland Fire

Table 4-35 Risk Summary Table: Landslide

Jurisdiction	Overall Significance	Additional Jurisdictions	Jurisdictional Differences?
Central Region	Low	NA	None
Blackfeet Tribe	Low	NA	NA
Blaine County	Low	Chinook and Harlem	Relatively Moderate Landslide Risk Rating See Figure 4.45.
Cascade County	Low	Great Falls, Belt, Cascade, and Neihart	None
Chippewa Cree Tribes Rocky Boy's Reservation	Low	NA	NA
Chouteau County	Low	Fort Benton, Big Sandy	Relatively Moderate Landslide Risk Rating See Figure 4.45.
Fergus County	Medium	Lewistown, Denton, Grass Range, Moore, Winifred	The NRI assigns Fergus County the highest estimated annualized frequency in the Central Region. This is believed to be due to sloughing in Lewistown and Moore area related to a heavy rainfall event in 1986. A search of newspaper archives could find no additional information on landslide activity in that area, or indeed anywhere in Fergus County.
Fort Belknap Indian Community	Low	NA	NA
Glacier County	Medium	Cut Bank	Higher level of landslide probability. See Figure 4.44 and Figure 4.46. Also, Relatively Moderate Landslide Risk Rating See Figure 4.45.
Hill County	Low	Havre, Hingham	None
Judith Basin County	Low	Stanford, Hobson	None
Liberty County	Low	Chester	
Petroleum County	Low	Winnett	Has a relatively moderate expected annual loss rating. See Figure 4.46.
Phillips County	Low	Malta, Saco	None
Pondera County	Low	Conrad	None
Teton County	Low	Choteau, Dutton, Fairfield	None
Toole County	Low	Shelby, Kevin, and Sunburst	None

4.2.10 Severe Summer Weather

Hazard/Problem Description

For this plan, severe summer weather in Montana includes extreme heat events, hail, heavy rain, and lightning. A brief description of these weather phenomena is presented below. More information on thunderstorm winds, high winds, and tornadoes, which typically are associated with summer weather, can be found in the Tornadoes and Windstorms section of the plan.

Extreme Heat

Extreme heat occurs from a combination of high temperatures (significantly above normal) and high humidity. At certain levels, the human body cannot maintain proper internal temperatures and may experience heat stroke. The NWS heat index (Table 4-36) is a measure of what the temperature feels like to the human body when relative humidity is combined with the air temperature, in shade conditions. In most of the United States, extreme heat is defined as a long period (2 to 3 days) of high heat and humidity with temperatures above 90 degrees. In extreme heat, evaporation is slowed and the body must work extra hard to maintain a normal temperature. This can lead to health impacts by overworking the human body. Extreme heat often results in the highest number of annual deaths among all weather-related hazards.

Table 4-36 NWS Heat Index and Potential For Health Effects

Temperature (°F)

Relative Humidity (%)	80	82	84	86	88	90	92	94	96	98	100	102	104	106	108	110
40	80	81	83	85	88	91	94	97	101	105	109	114	119	124	130	136
45	80	82	84	87	89	93	96	100	104	109	114	119	124	130	137	
50	81	83	85	88	91	95	99	103	108	113	118	124	131	137		
55	81	84	86	89	93	97	101	106	112	117	124	130	137			
60	82	84	88	91	95	100	105	110	116	123	129	137				
65	82	85	89	93	98	103	108	114	121	128	136					
70	83	86	90	95	100	105	112	119	126	134						
75	84	88	92	97	103	109	116	124	132							
80	84	89	94	100	106	113	121	129								
85	85	90	96	102	110	117	126	135								
90	86	91	98	105	113	122	131									
95	86	93	100	108	117	127										
100	87	95	103	112	121	132										

Likelihood of Heat Disorders with Prolonged Exposure and/or Strenuous Activity

Caution | Extreme Caution | Danger | Extreme Danger

Image adapted from https://www.weather.gov/ama/heatindex

Note: Heat index values shown here are for shady locations. Exposure to direct sunlight can increase these values by up to 15°F.

Hail

Hail forms when updrafts carry raindrops into extremely cold areas of the atmosphere where the drops freeze into ice. Hail falls when it becomes heavy enough to overcome the strength of the updraft and is pulled by gravity towards the earth. The process of falling, thawing, moving up into the updraft and refreezing before falling again may repeat many times, increasing the size of the hailstone. The severity of hail is often measured in inches and referred to by objects of similar size (Table 4-37). Hailstones are usually less than two inches in diameter but have been reported much larger and may fall at speeds of up to 120 mph. Severe hail is classified as hail 1-inch in diameter or large. Hail is typically associated with thunderstorms and occurs in the summer months in the Central Region.

Table 4-37 Hail Diameter and Common Description

Hail Diameter (inches)	Object Analog Reported
0.50	Marble, moth ball
0.75	Penny
0.88	Nickel
1.00	Quarter
1.25	Half dollar
1.50	Walnut, ping pong ball
1.75	Golf ball
2.00	Hen egg
2.50	Tennis ball
2.75	Baseball
3.00	Tea cup
4.00	Softball
4.50	Grapefruit

Data attained from
https://www.spc.noaa.gov/misc/tables/hailsize.htm

Heavy Rain

Heavy rain is typically associated with thunderstorm conditions and can result in flash flooding. Rainfall severity is typically measured in inches of rainfall or inches or rainfall per hour. In Central Montana, more than 0.1” of rain per hour is considered moderate, and more than 0.3” per hour is considered heavy rain. The reviewed history of heavy rain events in the Central Region of Montana mentions roads and ditches being flooded due to heavy rains, but there was no repeated location given in the dataset. On occasion, heavy rains and melting snow have been reported to cause ice jams and flash flooding. It is rarely reported that flash floods cause an accumulation of water in structures in the planning area.

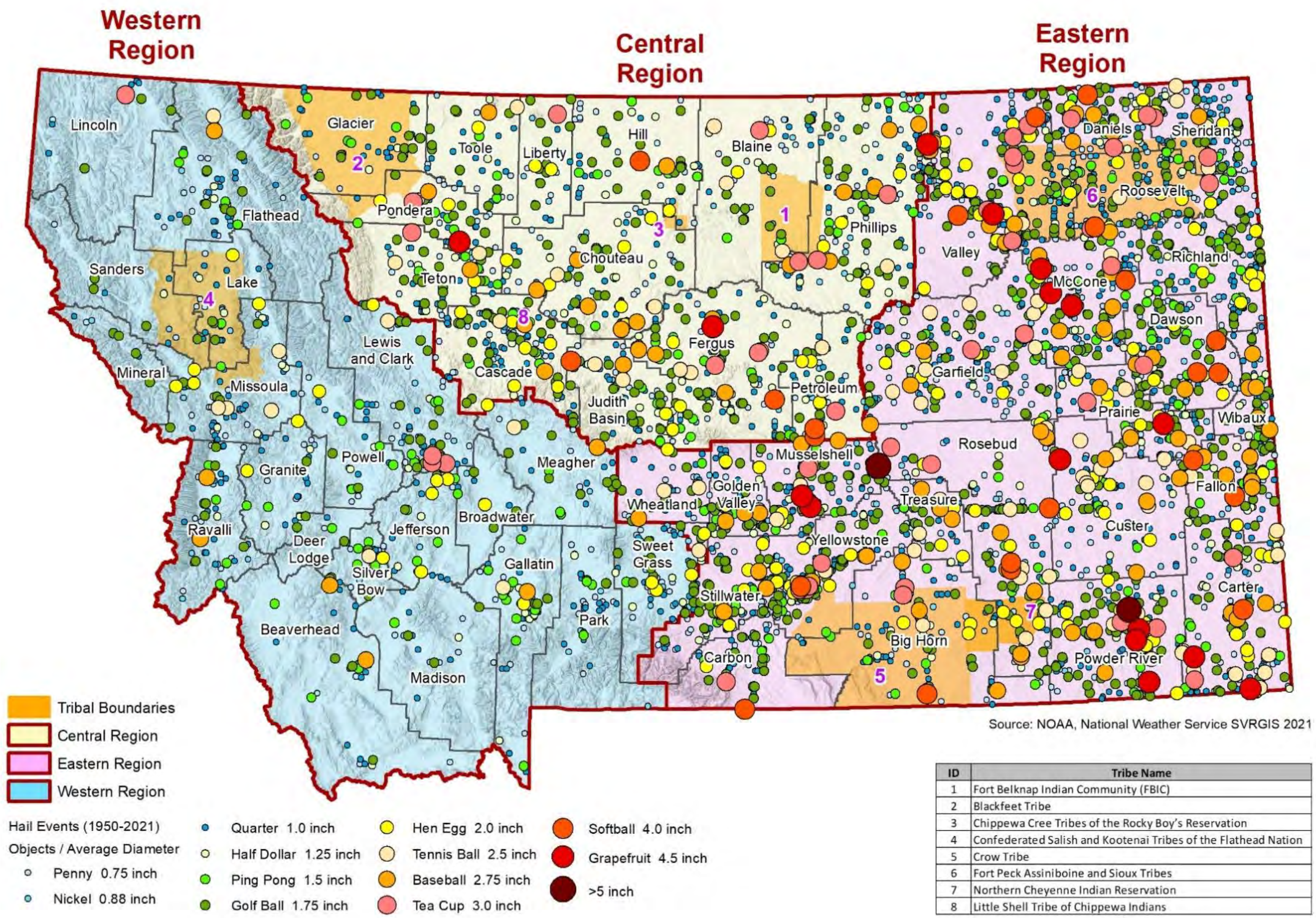
Lightning

Lightning is an electrical discharge that results from the buildup of positive and negative charges within a thunderstorm and the earth’s surface. When the buildup becomes strong enough, lightning appears as a "bolt." This visible electrical discharge produced by a thunderstorm can occur within or between clouds, between the cloud and air, between a cloud and the ground or between the ground and a cloud. Cloud-to-ground lightning is the most damaging and dangerous type of lightning, though it is also less common. It frequently strikes away from the rain core, either ahead or behind the thunderstorm, and can strike 5-10 miles from the storm in areas that most people do not consider to be a threat. Lightning's electrical charge and intense heat can electrocute on contact, split trees, ignite fires, and cause electrical failures. The severity of lightning can be measured on a scale of lightning activity level (Table 4-38).

Table 4-38 Lightning Threat Levels

Lightning Threat Level	Threat Level Descriptions
Extreme	**"An Extreme Threat to Life and Property from Lightning."** • Within 12 miles of a location, a moderate likelihood of CG lightning (or 50% thunderstorm probability), with storms capable of excessive CG lightning. • AND/OR...a high likelihood of CG lightning (or 60% to 70% thunderstorm probability), with storms capable of frequent CG lightning. • AND/OR...a very high likelihood of CG lightning (or 80% to 90% thunderstorm probability), with storms capable of occasional CG lightning.
High	**"A High Threat to Life and Property from Lightning."** • Within 12 miles of a location, a low likelihood of CG lightning (or 30% to 40% thunderstorm probability), with storms capable of excessive CG lightning. • AND/OR...a moderate likelihood of CG lightning (or 50% thunderstorm probability), with storms capable of frequent CG lightning. • AND/OR...a high likelihood of CG lightning (or 60% to 70% thunderstorm probability), with storms capable of occasional CG lightning.
Moderate	**"A Moderate Threat to Life and Property from Lightning."** • Within 12 miles of a location, a very low likelihood of CG lightning (or 10% to 20% thunderstorm probability), with storms capable of excessive CG lightning. • AND/OR...a low likelihood of CG lightning (or 30% to 40% thunderstorm probability), with storms capable of frequent CG lightning. • AND/OR...a moderate likelihood of CG lightning (or 50% thunderstorm probability), with storms capable of occasional CG lightning.
Low	**"A Low Threat to Life and Property from Lightning."** • Within 12 miles of a location, a very low likelihood of CG lightning (or 10% to 20% thunderstorm probability), with storms capable of frequent CG lightning. • AND/OR...a low likelihood of CG lightning (or 30% to 40% thunderstorm probability), with storms capable of occasional CG lightning.
Very Low	**"A Very Low Threat to Life and Property from Lightning."** • Within 12 miles of a location, a very low likelihood of CG lightning (or 10% to 20% thunderstorm probability), with storms capable of occasional CG lightning.
Non-Threatening	**"No Discernable Threat to Life and Property from Lightning."** • Within 12 miles of a location, environmental conditions do not support CG lightning.
Note: • With cloud-to-ground (CG) lightning, every strike is potentially lethal • Occasional - CG lightning at the rate of 1 to 3 flashes per minute • Frequent - CG lightning at the rate of 4 to 11 flashes per minute • Excessive - CG lightning rate of 12 flashes or more per minute	

Figure 4.47 Hail Events in Montana by Region (1955-2021)



ID	Tribe Name
1	Fort Belknap Indian Community (FBIC)
2	Blackfeet Tribe
3	Chippewa Cree Tribes of the Rocky Boy's Reservation
4	Confederated Salish and Kootenai Tribes of the Flathead Nation
5	Crow Tribe
6	Fort Peck Assiniboine and Sioux Tribes
7	Northern Cheyenne Indian Reservation
8	Little Shell Tribe of Chippewa Indians

Source: NOAA

Geographical Area Affected

The geographic extent of summer weather is **extensive**. The entire Central Region is vulnerable to experiencing severe summer weather, but there are regional variations apparent when looking at the frequency of events. Some types of hazards, such as extreme heat events, occur on a regional scale and typically impact several/all counties in the planning area at once. Other hazards, such as lightning, hail, and heavy rain, impact more local areas. Lightning tends to strike a single point and it is rare for lightning to strike people or property multiple times in one storm event. Hail and heavy rain generally occur in small pockets of an accompanying storm. Figure 4.47 displays the locations of past hail events in the State of Montana.

Past Occurrences

The National Centers for Environmental Information (NCEI) database was used to gather information on historic severe summer weather events in the Central Region of Montana. The NCEI data is a comprehensive list of oceanic, atmospheric, and geophysical data across the United States and aggregated by county and zone. It is important to note that weather events that occurred on Native American Reservations such as Blackfeet Tribe, Fort Belknap Tribe, and Chippewa Cree (Rocky Boys) Tribe, are also included in the dataset tables down below. However, instead of individual records, tribal data records were grouped into the closest/nearest County.

The NCEI dataset contains information on hail events from 1955 to March of 2022, in addition to lightning, heavy rain, and excessive heat events from 1996 to March of 2022. Table 4-39 summarizes the data from NCEI. It is important to note that not all severe summer weather events get reported by the NCEI and losses are estimates, therefore actual losses may be higher than those reported below. Based on this data, hail is the most frequently occurring and damaging severe summer weather event in the Central Region. Excessive heat and heavy rain had no reported damages in the NCEI dataset, and lightning events resulted in minimal property damage.

Table 4-39 Summary of Historic Summer Weather Events, 1996-2022

	Deaths	Injuries	Property Loss	Crop Loss	Days with Events	Total Events
Excessive Heat	0	0	$0	$0	2	9
Hail	0	2	$2,565,600	$2,287,000	561	1,598
Heavy Rain	0	0	$0	$0	58	113
Lightning	1	5	$20,000	$0	7	7
Total	**1**	**7**	**$2,585,600**	**$2,287,000**	**629**	**1,726**

Source: NCEI

There are variations in losses and frequency of hazards across the Central Region. According to the NCEI database, the counties of Phillips, Fergus, and Cascade experienced significantly more hail events than the rest of the planning area. Cascade County also experienced the greatest number of reported heavy rain and lightning events in the planning area. The only two counties with documented excessive heat events are Petroleum and Phillips Counties. Table 4-40 and Figure 4.48 display the summary of total severe weather events by county.

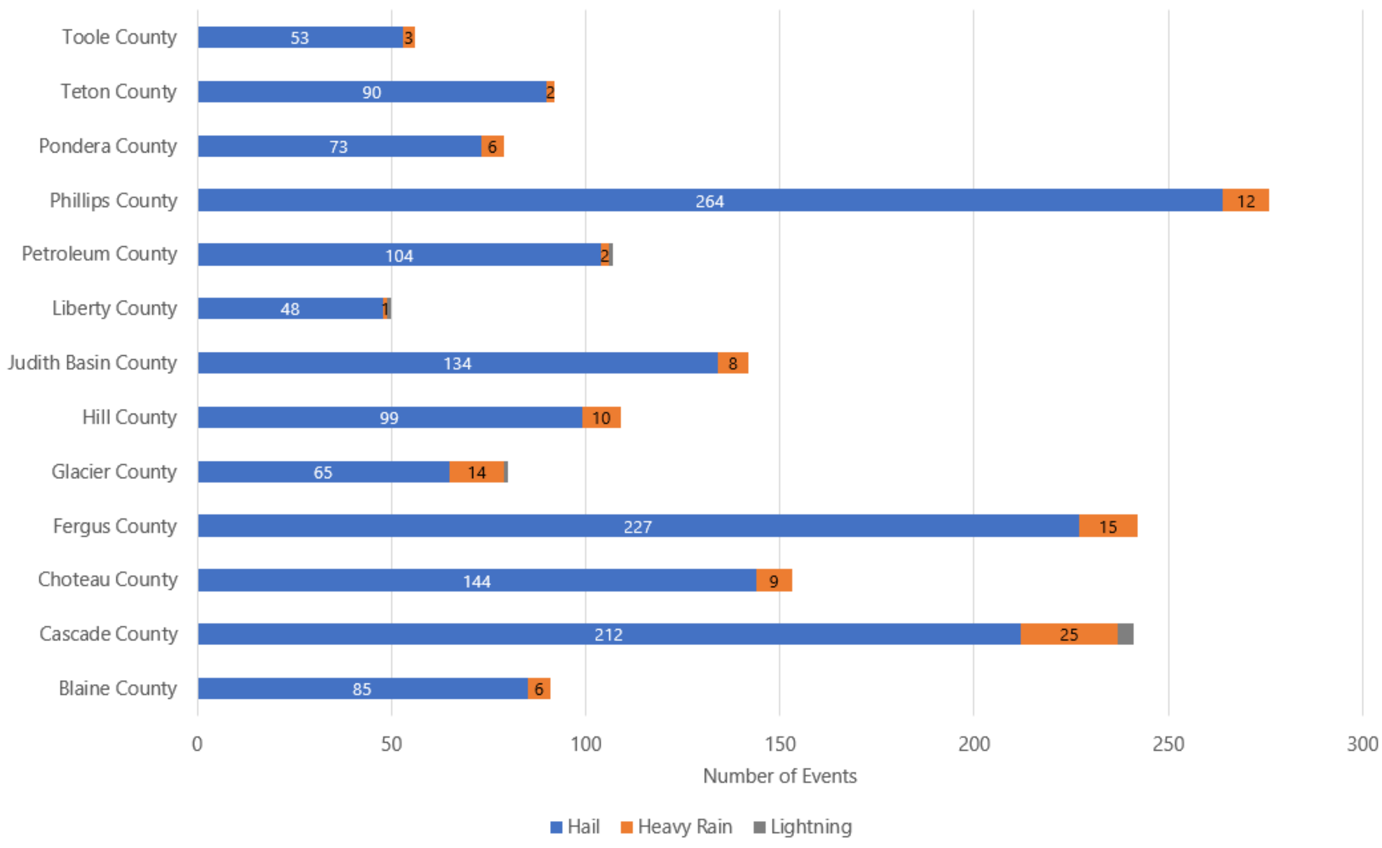
Table 4-40 Number of Severe Summer Weather Events by County and Hazard, 1996-2022

County	Excessive Heat	Hail	Heavy Rain	Lightning
Blaine County	0	85	6	0
Cascade County	0	212	25	4
Choteau County	0	144	9	0

County	Excessive Heat	Hail	Heavy Rain	Lightning
Fergus County	0	227	15	0
Glacier County	0	65	14	1
Hill County	0	99	10	0
Judith Basin County	0	134	8	0
Liberty County	0	48	1	1
Petroleum County	2	104	2	1
Phillips County	7	264	12	0
Pondera County	0	73	6	0
Teton County	0	90	2	0
Toole County	0	53	3	0
Total	**9**	**1,598**	**113**	**7**

Source: NCEI

Figure 4.48 Summary of Severe Summer Weather Events by County in the Central Region



Source: NCEI, Chart by WSP

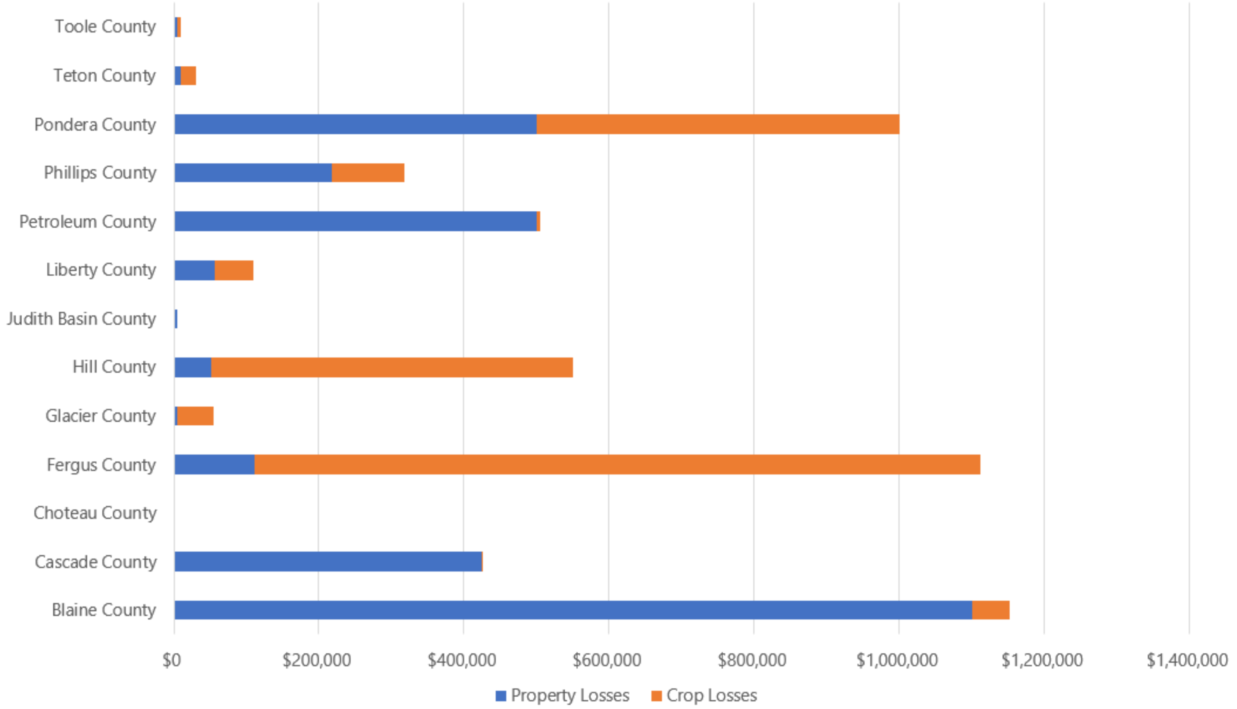
There are also variations between counties in the Central Region in terms of losses from severe summer weather events. A summary of losses reported by the NCEI dataset by county is displayed in Table 4-41 and Figure 4.49. Based on this data, Blaine County has experienced the greatest property loss and Fergus County has experienced the greatest crop loss from severe summer weather events. All crop losses and nearly all property losses are due to hail events in the Central Region. There have also been seven reported injuries due to hail and lightning in the Central Region, and one death due to lightning in Petroleum County.

Table 4-41 Summary of Losses by County in the Central Region

County	Deaths	Injuries	Prop. Loss	Crop Loss
Blaine County	0	0	$1,100,000	$53,000
Cascade County	0	2	$423,600	$1,000
Chouteau County	0	0	$0	$0
Fergus County	0	0	$112,000	$1,000,000
Glacier County	0	3	$5,000	$50,000
Hill County	0	0	$51,000	$500,000
Judith Basin County	0	0	$5,000	$0
Liberty County	0	0	$56,000	$53,000
Petroleum County	1	1	$500,000	$5,000
Phillips County	0	0	$218,000	$100,000
Pondera County	0	1	$500,000	$500,000
Teton County	0	0	$10,000	$20,000
Toole County	0	0	$5,000	$5,000
Total	**1**	**7**	**$2,585,600**	**$2,287,000**

Source: NCEI

Figure 4.49 Summary of Severe Summer Weather Events by County in the Central Region



Source: NCEI, Graph by WSP

The NCEI dataset reports details on several of the severe summer weather events in the Central Region:

- **August 11, 2019** (Cascade County): Great Falls Fire department reported a structure fire caused by lightning striking a tree and adjacent house. Estimated losses totaled $10,000.
- **June 9, 2016** (Petroleum County): Petroleum County Emergency Manager reported hen egg-sized hail, wind gusts to 50 mph, trees downed, roofs and siding damaged, and power outages. The event also resulted in 1 injury when a man was blown off his horse and later transported with injuries to Billings, MT. Estimated losses totaled $500,000.
- **July 17, 2013** (Glacier County): Thunderstorms over Glacier Park injured 3 people hiking on the St Mary Falls trail.
- **June 20, 2005** (Phillips County): Hail reached 2.75 inches in diameter and caused extensive damage to the roof, siding, window, and gutter of eight houses. Estimated property damage totaled $100,000.
- **August 4, 2004** (Cascade County): One person was injured when lightning struck the ground and traveled to the metal machine he was operating. Lightning also struck a residence and blasted a large hole in the roof above a bedroom. Many branches and power lines were downed by the storm. Lightning also knocked out power to 2500 Great Falls area residents. Another citizen was injured in the storm by 1.5-inch hail. $1,000 was reported in estimated damages.
- **September 18, 1998** (Petroleum County): One man died after lightning struck him and a friend while the two were bow hunting. The two were hunting between Crooked Creek and Barrel Springs when a thunderstorm moved overhead. The two took cover under a tree. Lightning struck the pair knocking both unconscious. When the one man awoke, he tried to revive his friend and then went for help. Help arrived in the remote area about two hours after the strike. The second man was pronounced dead at 9:50 p.m.
- **June 19, 1995** (Blaine County): Golf ball-size hail damaged cars at car dealerships in Chinook. Total damage was estimated at upwards of $1 million.

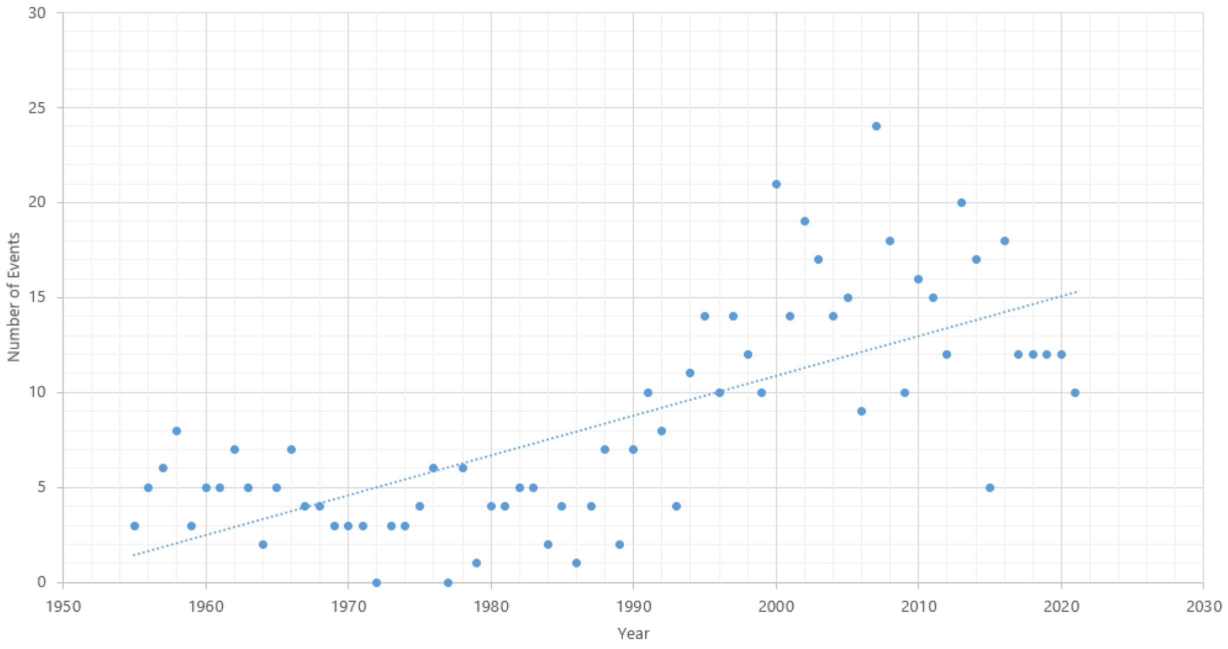
Frequency/Likelihood of Occurrence

The frequency of severe summer weather events in the Central Region is ranked as **highly likely**. All counties in the planning area are likely to experience a severe summer hazard yearly. Since 1955, 1,726 severe summer weather events over 629 days have been recorded in the Central Region. As discussed above, there are variations in frequency and severity of damage from severe summer weather across the Central Region. Cascade County was rated as one of the counties in Montana with the highest exposure to severe weather in the 2018 State HMP. Phillips and Fergus County also experience a higher frequency of reported events than the rest of the Counties in the Central Region.

A total of 1,598 hail events on 561 days have been recorded in the planning area over the course of 67 years, from 1955-2022. While there is some variation between counties in Central Region, all counties are likely to experience at least one hail event per year. Counties such as Toole County averages slightly less than one extreme hail event per year, while some counties, such as Phillips and Fergus Counties, average nearly four extreme hail events per year. Figure 4.50 displays the trend of hail events by year in the Central Region, showing a generally increasing trend in the frequency of hail events from 1955 to 2021.

While all counties in the Central Region will experience lightning throughout the year, some counties have historically higher numbers of reported damaging lightning events than others. According to the NCEI dataset, Cascade County most frequently experiences damaging lightning events, while most of the other counties have no recorded events. Moreover, while most counties in the planning area have a comparatively low number of recorded heavy rain and excessive heat events, this is more likely due to the fact the events were not reported to the NCEI dataset.

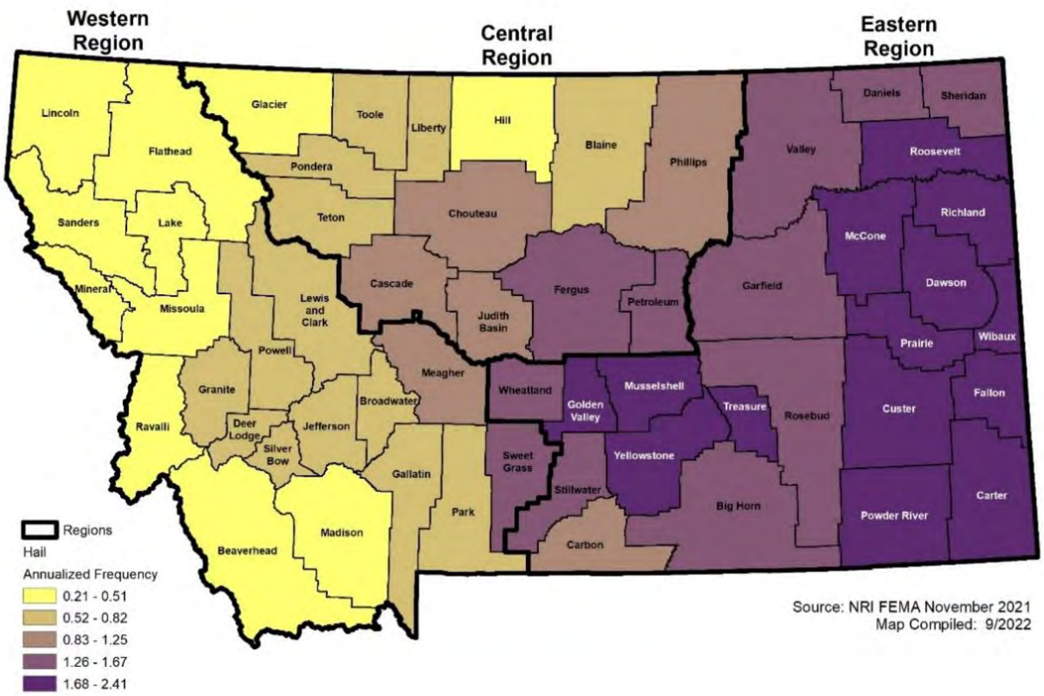
Figure 4.50 Hail Events by Year in the Central Region (1955-2021)



Source: NCEI, Chart by WSP

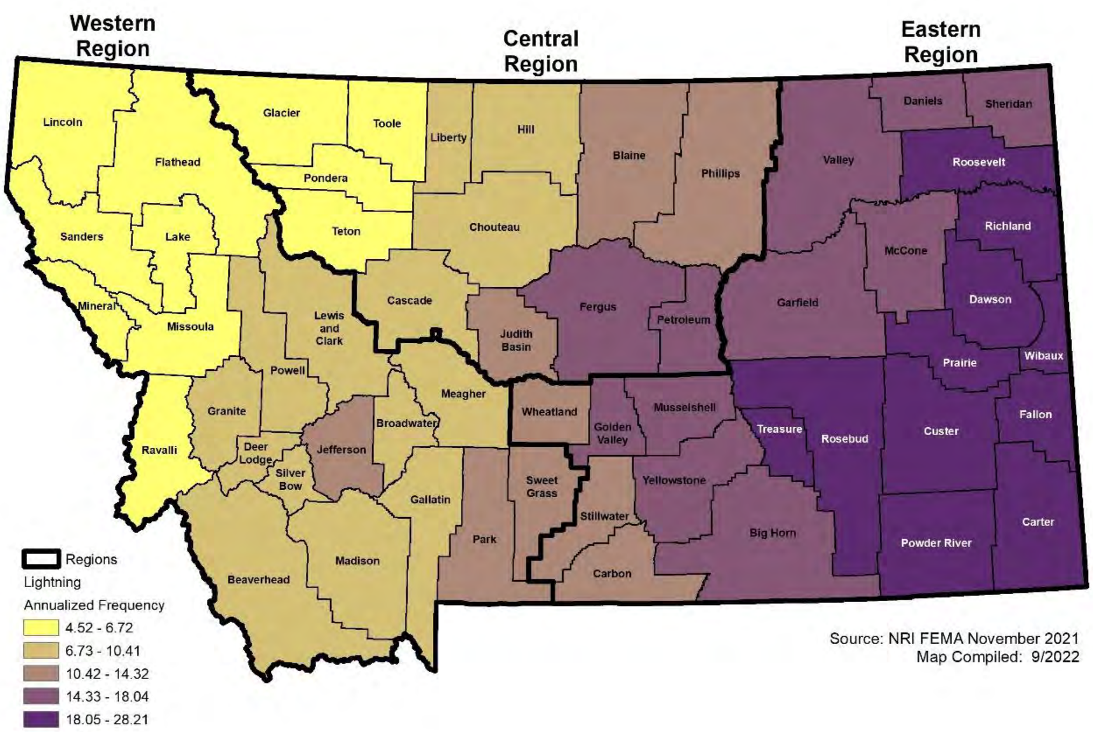
The figures below depict annualized frequency of hail and lightning at a county level based on the NRI. The mapping shows a trend towards increased likelihood in the southern portion of the region, particularly Fergus and Petroleum counties.

Figure 4.51 NRI Annualized Frequency of Hail Events by County



Map by WSP, Data Source: FEMA National Risk Index, https://hazards.fema.gov/nri/determining-risk

Figure 4.52 NRI Annualized Frequency of Lightning Events by County



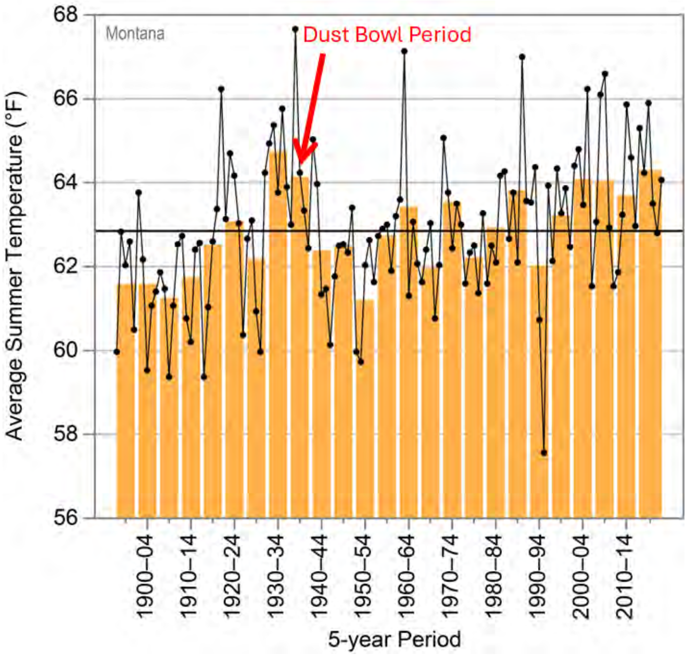
Map by WSP, Data Source: FEMA National Risk Index, https://hazards.fema.gov/nri/determining-risk

Climate Change Considerations

This plan considers the effects of climate change on hazards related to extreme heat, hail, heavy rain, and lightning.

The planning area is warming due to climate change and even conservative estimates indicate the trend will continue and even accelerate in the future. Increasing exposure to extreme heat is described as the #1 greatest concern for human health in the 2021 Montana Climate Change and Human Health study. This study documented statewide average temperatures have increased 2-3 °F from the 65-year period from 1950-2015 and are projected to increase 4-6 °F by 2069 relative to average temperatures 1971-2000, roughly 85 years of warming. The Montana Climate Change and Human Health study provides state-wide estimates, but states that changes between climate divisions are slight. Seasonally, temperature increases were greatest in summer and winter (Figure 4.53), with August having the greatest average temperature increase in all climate divisions.

Figure 4.53 Observed Average Summer Temperature, 1895-2020



Dots represent summer average temperature for a specific year. Bars are 5-year averages of summer temperature.
Black horizontal line is the average summer temperature for all years, 1895-2020.
Figure adapted from: 2022 NOAA State Climate Summaries, Montana. https://statesummaries.ncics.org/chapter/mt/

Exposure to extreme heat will increase due to climate change, heat-related health impacts will increase, but it is useful to keep the situation in perspective; the fifth National Climate Assessment notes that extreme heat in the Northern Great Plains region remains modest relative to much of the country. The NRI rates the planning area as having a *relatively low* or *very low* risk of Heat Wave impacts for current conditions. Even under future warming scenarios, it appears unlikely the NRI ratings will change dramatically.

Hail is presently a relatively low impact hazard according to the National Risk Assessment and little is known about how it will be affected by climate change. The 2022 NOAA Climate Summary for Montana simply acknowledges that hail exists in Montana. The Fifth National Climate Assessment, chapter 25 has more to say about hail and includes projections of large hail increasing in frequency and season length throughout the Northern Great Plains. The 2021 Montana Climate Change and Human Health report mentions hail three times, acknowledging it exists, that it can damage crops, and that the link between severe summer storms and climate change is not well understood or easily predicted, though there is a solid physics-based linkage between the two. Hail can be an extremely damaging hazard and the linkages with climate change are worthy of monitoring in future HMP updates.

To date, climate change has apparently not increased the frequency or severity of heavy rain and it is unclear if it ever will. Increasing rainfall intensity is a commonly cited impact of climate change. However, neither the 2021 Montana Climate Change and Human Health study, the Fifth National Climate Assessment Chapter on the Northern Great Plains, or NOAA's 2022 Climate Summary address rainfall intensity directly. As described in Section 4.2.7 *Flooding*, subsection *Climate Change Considerations*, multiple sources document spring rainfall has increased slightly and/or is projected to increase substantially in the future. However, none of these sources document an observed or projected climate-change caused increase in heavy rainfall.

Lightning is another summer-weather hazard that is relatively modest in scale. The NRI rates counties in the planning area either *relatively low* or *very low* for lightning risk. There are presently no data or studies that document lightning is increasing in the planning are as a result of climate change. Likewise, no projections exist to suggest the hazard is likely to increase or decrease in the future due to climate change. The 2022 NOAA Climate Summary simply acknowledges that lightning exists. The Fifth National Climate Assessment, Chapter 25 on the Northern Great Plains region only mentions lightning once, as a potential source of ignition for wildfire. The 2021 Montana Climate Change and Human Health study states both that lightning exists in the planning area and that it is a potential source of ignition of wildfire.

Potential impacts are discussed in the Vulnerability subsection of this hazard profile, as well as the impacts of population changes and development trends. Current variability in vulnerability by jurisdiction, based on existing conditions, is discussed in these sections and jurisdictional annexes. Due to the uncertainty with climate change on severe summer weather, it is not possible to define with further specificity the impacts related to climate change on each jurisdiction within the Region. Future updates to this plan should revisit this topic as scientific knowledge progresses, and note any trends that may emerge over time.

Potential Magnitude and Severity

As mentioned in the 2018 State of Montana Hazard Mitigation Plan, severe summer weather can cause damage to buildings, homes, and other property but rarely cause death, serious injury, or long-lasting health effects. However, significant economic losses from property and crop damage, as well as several reported injuries and deaths, have occurred in the Central Region; therefore, severity of summer weather is ranked as **critical** for the Central Region. The NWS reports that severe summer weather has caused $51.5 million in property damage and $26.3 million in crop damage over the past 60 years in the State of Montana. Eight deaths and 31 injuries were attributed to lightning strikes. Across the country, large hail results in nearly $1 billion in damage annually to property and crops. In the Central Region alone, 1 fatality, 7 injuries, $2,585,600 in property damages and $2,287,000 crop damages have been recorded since 1955.

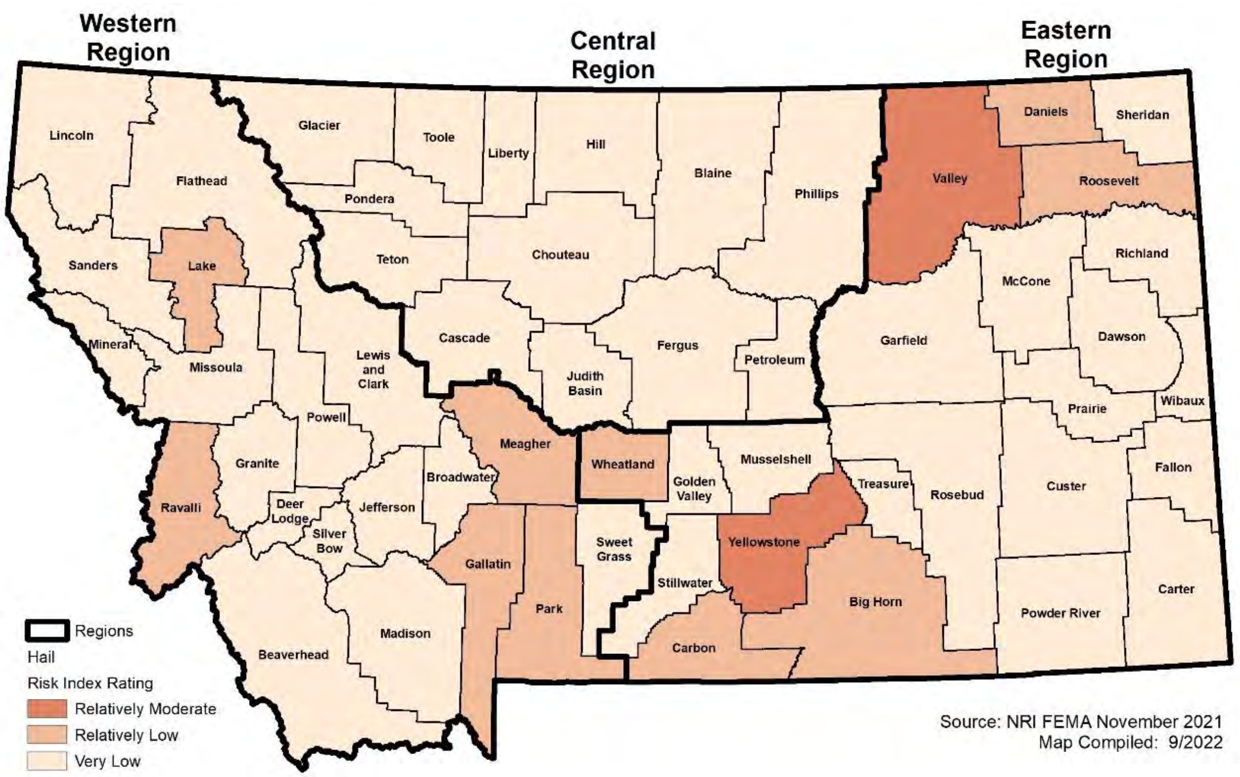
Vulnerability Assessment

The severe summer weather *Vulnerability Assessment* identifies, or at least discusses, *assets* that are in a *high hazard area* for severe summer weather and are *susceptible* to damage from that exposure. In this context, *assets* are (1) people, (2) property, (3) critical facilities and lifelines, (4) the economy, (5) historic and cultural resources, and (6) natural resources. *Exposure* indicates interacting with severe summer weather hazards, and *likely to be exposed* indicates a presence in areas deemed to be especially likely to experience severe summer weather hazards. *Susceptible* indicates a strong likelihood of damage from exposure to severe summer weather hazards and is described in greater detail in Section 4.2.1, subsection titled *Vulnerability Assessment*. Finally, vulnerability under future conditions is considered as it relates to both climate change and development.

High hazard areas for severe summer weather are widespread and lack clear delineations. Individual hazard events may occur over limited areas, but over time exposure to these hazards is typically similar or uniform across the Central Region. The susceptibility of assets to extreme summer weather follows the same pattern. For example, cars and houses are especially vulnerable to hail throughout the Central Region. Vulnerability to extreme summer weather, a measure of assets in high hazard areas that are susceptible to damage, is correspondingly stable throughout the Central Region.

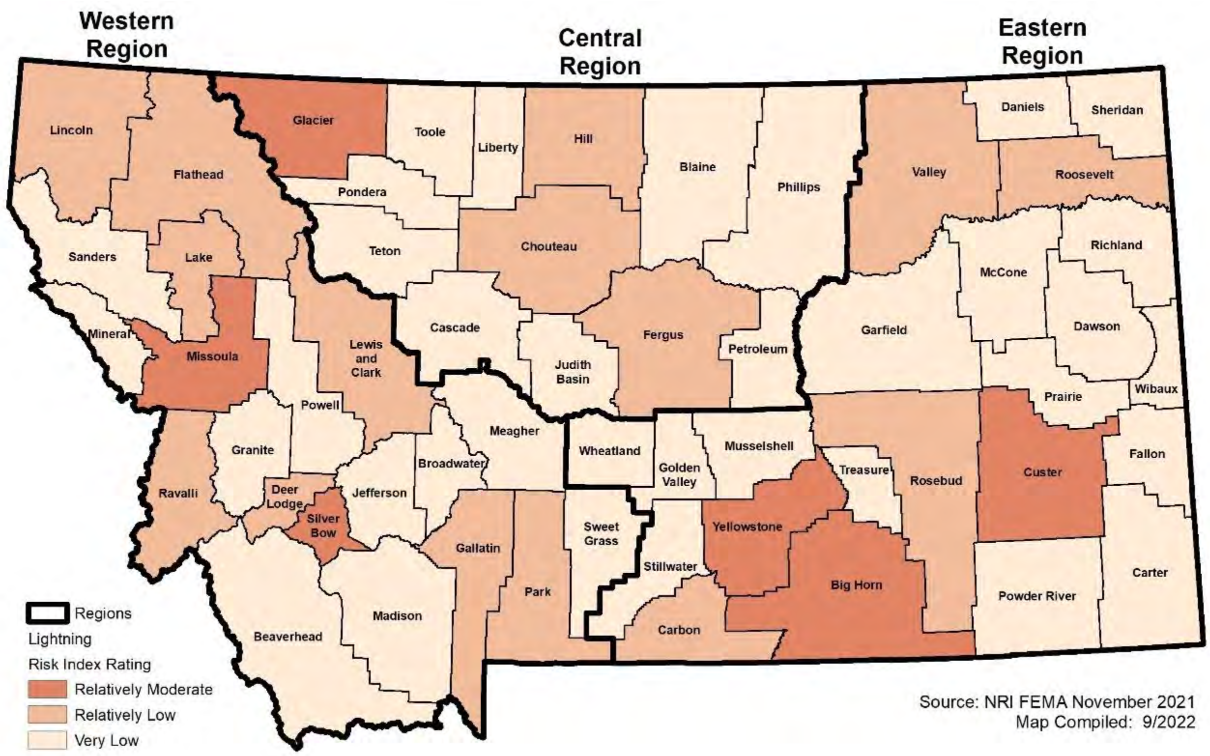
The impacts of severe summer hazards are relatively stable, except that lightning impacts are notably higher in Glacier County. Figure 4.54 and Figure 4.55 illustrate the National Risk Index rating for hail and lightning events in Montana counties, respectively. The NRI risk data are a rating based on the expected annual loss multiplied by social vulnerability, divided by community resilience. Most counties in the region have a relatively low to moderate rating; none have a high or very high risk rating.

Figure 4.54 NRI Risk Index Rating for Hail



Map by WSP, Data Source: FEMA National Risk Index, https://hazards.fema.gov/nri/determining-risk

Figure 4.55 NRI Risk Index Rating for Lightning



Map by WSP, Data Source: FEMA National Risk Index, https://hazards.fema.gov/nri/determining-risk

People

Extreme summer weather poses some formidable hazard to people in the Central Region. The entire Central Region is exposed to extreme heat. The *heat island effect* can further increase temperatures in urban areas. Hail and lightning also occur throughout the region and pose a threat to people unable to take shelter with little or no notice. Heavy rain will generally not cause injuries but does pose a threat if it results in flash flooding.

All people are potentially susceptible to injury or possibly death from summer weather. Some groups, such as the aged and people with weakened immune systems are typically the most susceptible to especially extreme heat, especially if they lack access to air conditioning. Outdoor enthusiasts and workers are most likely to be caught outdoors and exposed to hail and lightning. Young children playing outdoors are also a concern. Unhoused persons are more vulnerable to heavy rain, especially if they inhabit floodplain areas prone to flash flooding.

Property

Individual storms have a limited extent, but over time all outdoor property is likely to be exposed to heavy rain, extreme heat, and hail. Lightning typically strikes the highest objects in an area but can cause hazardous power surges that extend much further. Lightning strikes can also start fires. The secondary effects of fire are discussed in the section below titled *Wildfire*.

Some property is especially susceptible to damage. Houses and cars have a reputation for receiving expensive-to-repair damage from hail events. One of the most significant damaging property events from severe summer weather events occurred when a golf ball-sized hail event significantly damaged an entire lot of cars a car dealership in Blaine County causing over $1 million of damage. Electrical equipment is often susceptible to the effects of lightning far from the strike location. Lightning can cause power outages with potentially serious secondary effects.

Susceptibility of property to heat and heavy rain is less of a problem in the planning area. Heat can expand metal and cause problems with infrastructure. Heavy rain can damage foundations, especially where water is allowed to accumulate near a foundation rather than being channeled away. Secondary effects of heavy rain include flash flooding and are discussed in the section above titled *Flooding*. Despite the hazards of heat and heavy rain, there are no reported property damages from excessive heat or heavy rain in the planning area.

Critical Facilities and Lifelines

All infrastructure and critical facilities located outdoors are similarly exposed to heat and hail. Lightning typically strikes the highest objects in an area but can cause hazardous power surges that extend throughout electrical circuits.

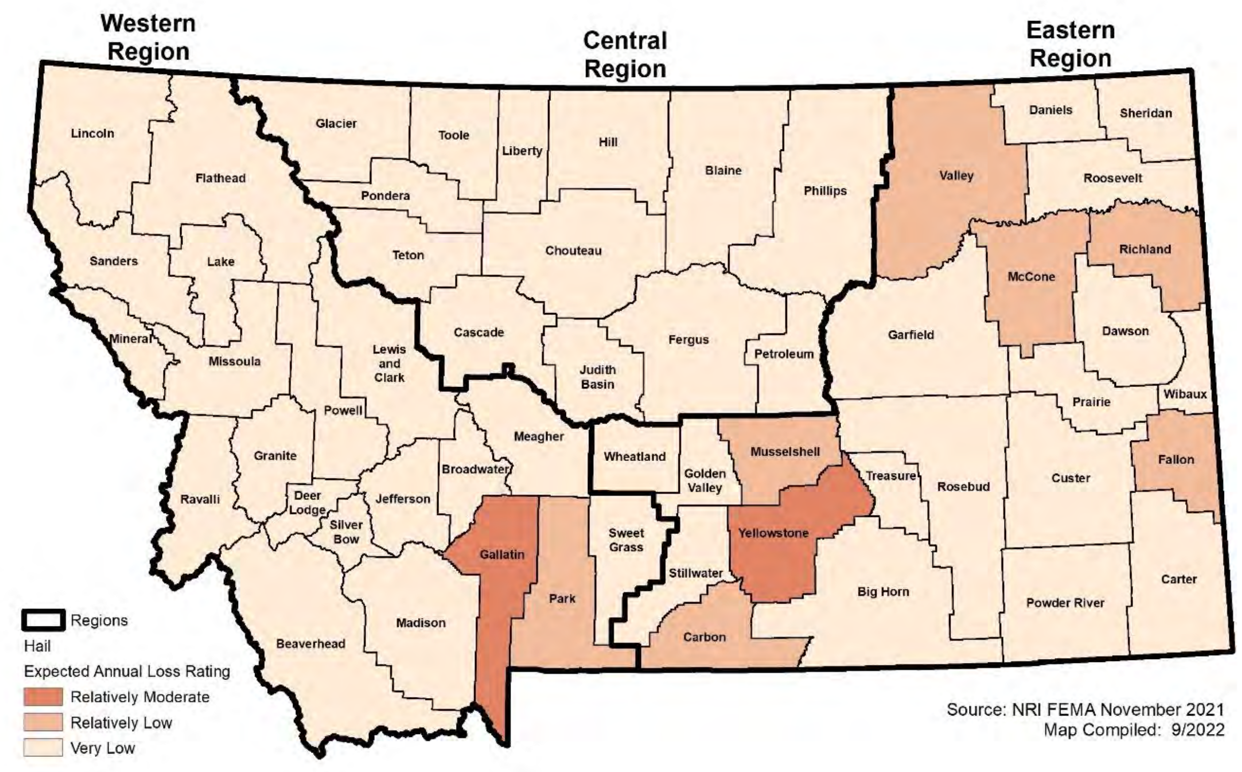
Infrastructure can be susceptible to damage from extreme heat. Heat expands roadbuilding materials and can cause road surfaces to crack. Power infrastructure is especially susceptible to heat. Heat expands above-ground power lines, causing them to lengthen and sag. Sagging power lines are a well-known fire hazard and were at least partially at fault for recent catastrophic fires in California and Colorado. A mitigation technique in certain states is to simply turn off power distribution during these times. Heat also reduces the efficiency of power generation, transmission, and distribution. This happens at the same time that demand peaks due largely to the increased use of air conditioners. The result of this puts stress on the power delivery system. The full range of heat effects on power infrastructure is complex and far reaching.

The use of roads is also susceptible to hail accumulation, which can temporarily impair traffic.

Economy

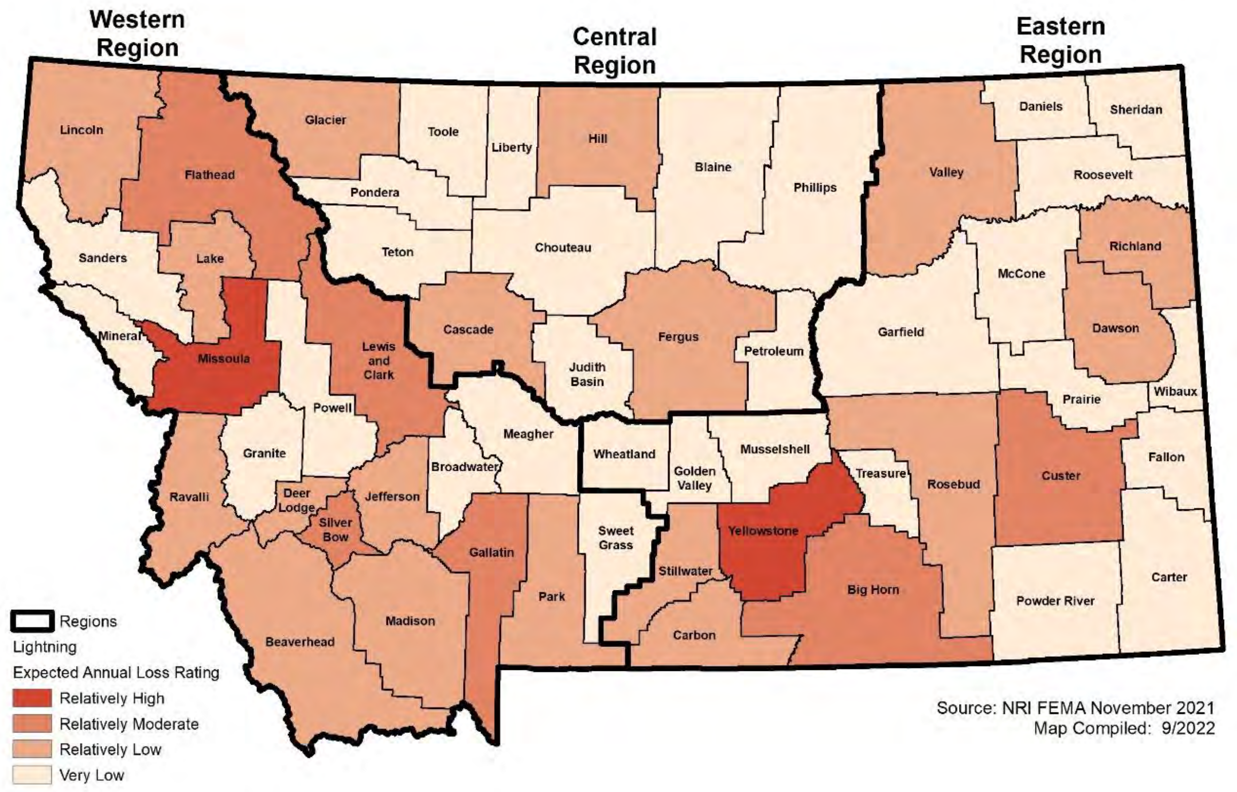
The economy can be susceptible to severe summer weather. Direct losses, especially from hail damage to crops, can be large. The figures below illustrate the relative risk of Expected Annual Loss (EAL) rating due to hail and lightning for Montana counties based on data in the NRI. For hail, all counties in the region have a very low EAL rating. For lightning, Glacier, Hill, Cascade, and Fergus Counites have a relatively low rating, and all other counties are rated as very low. The EAL calculation takes into account agriculture value exposed to hail and lightning, annualized frequency for hail and lightning, and historical losses. Indirect losses can also be substantial, though difficult to quantify. The 2018 State of Montana Hazard Mitigation Plan notes that increasing extreme temperature events will disrupt local economies by impacting tourism.

Figure 4.56 NRI Hail Expected Annual Loss Rating



Map by WSP, Data Source: FEMA National Risk Index, https://hazards.fema.gov/nri/determining-risk

Figure 4.57 NRI Lightning Expected Annual Loss Rating



Map by WSP, Data Source: FEMA National Risk Index, https://hazards.fema.gov/nri/determining-risk

Historic and Cultural Resources

Historic and cultural resources are all exposed to severe summer weather. Susceptibility of historic and cultural resources to is variable. For example, historic buildings are, by definition, old. Old buildings were likely built to old building codes, or no building codes at all, and many are in poor condition. This increases their susceptibility to severe summer weather. This pattern exists throughout the Central Region.

Natural Resources

Vegetation such as trees, crops, and landscape are vulnerable to extreme heat events. Similarly, hail has been documented to cause significant crop damage in the planning area and was also documented to break branches off trees. The most significant crop damages reported by the NCEI occurred in Pondera, Hill, and Fergus Counties. Lightning has also been documented to strike trees and cause fires, which can cause considerable secondary impact.

Development Trends Related to Hazards and Risk

There are not clear trends that development in recent years is changing vulnerability to severe summer weather one way or the other. According to the 2018 State of Montana Hazard Mitigation Plan, the State of Montana has adopted the 2012 International Building Code (IBC). The IBC includes a provision that buildings must be constructed to withstand a wind load of 75 mph constant velocity and three-second gusts of 90 mph.

Risk Summary

In summary, the Severe Summer Weather hazard is considered to be overall medium significance for the Region. Variations in risk by jurisdiction are summarized in the table below, followed by key issues noted in the vulnerability assessment.

- The hazard significance of severe summer weather (excessive heat, hail, heavy rain, and lightning) in the Central Region is ranked as **medium**
- The entire Central Region can be impacted by severe summer weather; therefore, the geographic extent is rated as **extensive**
- The NCEI dataset recorded 629 days of severe summer weather events in the Central Region over the course of 67 years, from 1955 to March 2022. This averages roughly 9.4 events per year; therefore, the probability of future occurrence is ranked as **highly likely.**
- The NCEI data recorded 1 death, 7 injuries, $2,585,600 in property damages, and $2,287,000 in crop damages from severe weather events since 1955, therefore the potential magnitude is ranked as **critical.**
- People most vulnerable to severe summer weather events are children, the elderly, individuals with preexisting medical conditions, outdoor workers/enthusiasts, and people living in dense urban areas.
- All outdoor property is vulnerable to severe weather events. Vehicles and roofs are most frequently reported as damaged property in the Central Region.
- Critical infrastructure such as roadways and electric equipment are especially vulnerable to severe summer weather. Power outages, house fires, and damages to vehicles have been documented by the NCEI dataset.
- Economic losses typically occur from severe hail events and associated cost of repairs from hail damage. Areas with high infrastructure, such as major cities, are more likely to experience economic damages from hail than urban areas due to greater quantity of property to be damaged.
- Related hazards: Drought, Wildfire, Wind & Tornadoes

Table 4-42 Risk Summary Table: Severe Summer Weather

Jurisdiction	Overall Significance	Additional Jurisdictions	Jurisdictional Differences?
Central Region	Medium	NA	NA
Blackfeet Tribe	Medium	NA	NA
Blaine County	High	Chinook and Harlem	None
Cascade County	Medium	Great Falls, Belt, Cascade, and Neihart	Great Falls is likely to experience greater losses due to greater population and more concentrated infrastructure
Chippewa Cree Tribes Rock Boy's Reservation	Medium	NA	NA
Chouteau County	Medium	Fort Benton, Big Sandy	None
Fergus County	High	Lewistown, Denton, Grass Range, Moore, Winifred	Higher vulnerability in the City of Lewistown, where people and infrastructure are concentrated
Fort Belknap Indian Community	High	NA	NA

Jurisdiction	Overall Significance	Additional Jurisdictions	Jurisdictional Differences?
Glacier County	Medium	Cut Bank	NA
Hill County	High	Havre, Hingham	None
Judith Basin County	Medium	Stanford, Hobson	None
Liberty County	High	Chester	NA
Petroleum County	Medium	Winnett	NA
Phillips County	High	Malta, Saco	None
Pondera County	High	Conrad	NA
Teton County	Medium	Choteau, Dutton, Fairfield	None
Toole County	High	Shelby, Kevin, and Sunburst	None

4.2.11 Severe Winter Weather

Hazard/Problem Description

Severe winter weather presents one of the greatest threats to life of any hazard in Montana. Statistics on winter deaths are difficult to obtain, but nationwide there are on average 100 lives directly and indirectly lost to winter weather, more than lightning or tornadoes. Winter storms are considered to be deceptive killers because most deaths are indirectly related to the storm. People die in traffic accidents on snow- or ice-covered roads, from hypothermia due to prolonged exposure to cold, and from heart attacks due to overexertion.

Winter storms may be categorized as blizzards, heavy snow, ice storms, winter storms, and winter weather. These storms vary in size and intensity and may affect a small part of the state or several states at once. The National Weather Service Glossary defines common winter storm characteristics as follows:

Blizzard: A blizzard means that the following conditions are expected to prevail for a period of 3 hours or longer:

- Sustained wind or frequent gusts to 35 miles an hour or greater; and
- Considerable falling and/or blowing snow (i.e., reducing visibility frequently to less than ¼ mile).

Cold/Wind Chill: Increased wind speeds accelerate heat loss from exposed skin, and the wind chill is a measure of this effect. No specific rules exist for determining when wind chill becomes dangerous. As a general rule, the threshold for potentially dangerous wind chill conditions is about -20°F.

Heavy Snow: This generally means:

- Snowfall accumulating to 4" or more in depth in 12 hours or less; or
- snowfall accumulating to 6" or more in depth in 24 hours or less.
- In forecasts, snowfall amounts are expressed as a range of values, e.g., "8 to 12 inches." However, in heavy snow situations where there is considerable uncertainty concerning the range of values, more appropriate phrases are used, such as "...up to 12 inches..." or alternatively "...8 inches or more...”

Ice Storm: An ice storm is used to describe occasions when damaging accumulations of ice are expected during freezing rain situations. Significant accumulations of ice pull down trees and utility lines resulting in loss of power and communication. These accumulations of ice make walking and driving extremely dangerous.

Winter Storm: A winter weather event that has more than one significant 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. Normally, a Winter Storm would pose a threat to life or property.

Winter Weather: 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. A Winter Weather event could result from one or more winter precipitation types (snow, or blowing/drifting snow, or freezing rain/drizzle). The Winter Weather event can also be used to document out-of-season and other unusual or rare occurrences of snow, or blowing/drifting snow, or freezing rain/drizzle.

Geographical Area Affected

All counties in the Montana Central Region are impacted by severe winter weather; therefore, the geographic extent of severe winter storms is ranked as **extensive**. The 2018 Montana State Hazard Mitigation Plan explains that the entire State is considered equally vulnerable to severe winter weather. Arctic cold fronts typically enter the state from the northeast and may cross the Continental Divide, affecting the western portion of the State. Arctic fronts meeting wet maritime fronts often combine to cause heavy snowfall, which can occur in all parts of the State. The lowest temperatures are typically experienced in the northeast, whereas the heaviest snowfall most often occurs in the mountain regions.

Past Occurrences

The National Centers for Environmental Information (NCEI) database was used to gather information on historic severe winter weather events in the Central Region of Montana. The NCEI data is a comprehensive list of oceanic, atmospheric, and geophysical data across the United States and aggregated by county and zone. It is important to note that weather events that occurred on Native American Reservations such as Blackfeet Tribe, Fort Belknap Tribe, and Chippewa Cree (Rocky Boys) Tribe, are also included in the dataset tables down below. However, instead of individual records, tribal data records were grouped into the nearest County. The NCEI dataset contains information on severe winter weather events from 1996 to March of 2022. The specific hazards selected for severe winter weather consist of blizzard, cold/wind chill, heavy snow, ice storm, winter storm, and winter weather events.

Table 4-43 summarizes the data from NCEI. Not all severe winter weather events get reported by the NCEI and losses are estimates, therefore actual losses may be higher than those reported below. Based on this data, winter storms are the most frequently occurring and damaging type of severe winter weather event in the Central Region. Heavy snow is another frequently occurring event in the Region. Blizzards, heavy snow, and winter storms are the only types of severe winter weather with documented property losses. Blizzards and winter weather events have resulted in a total of 10 injuries and one death in the Central Region.

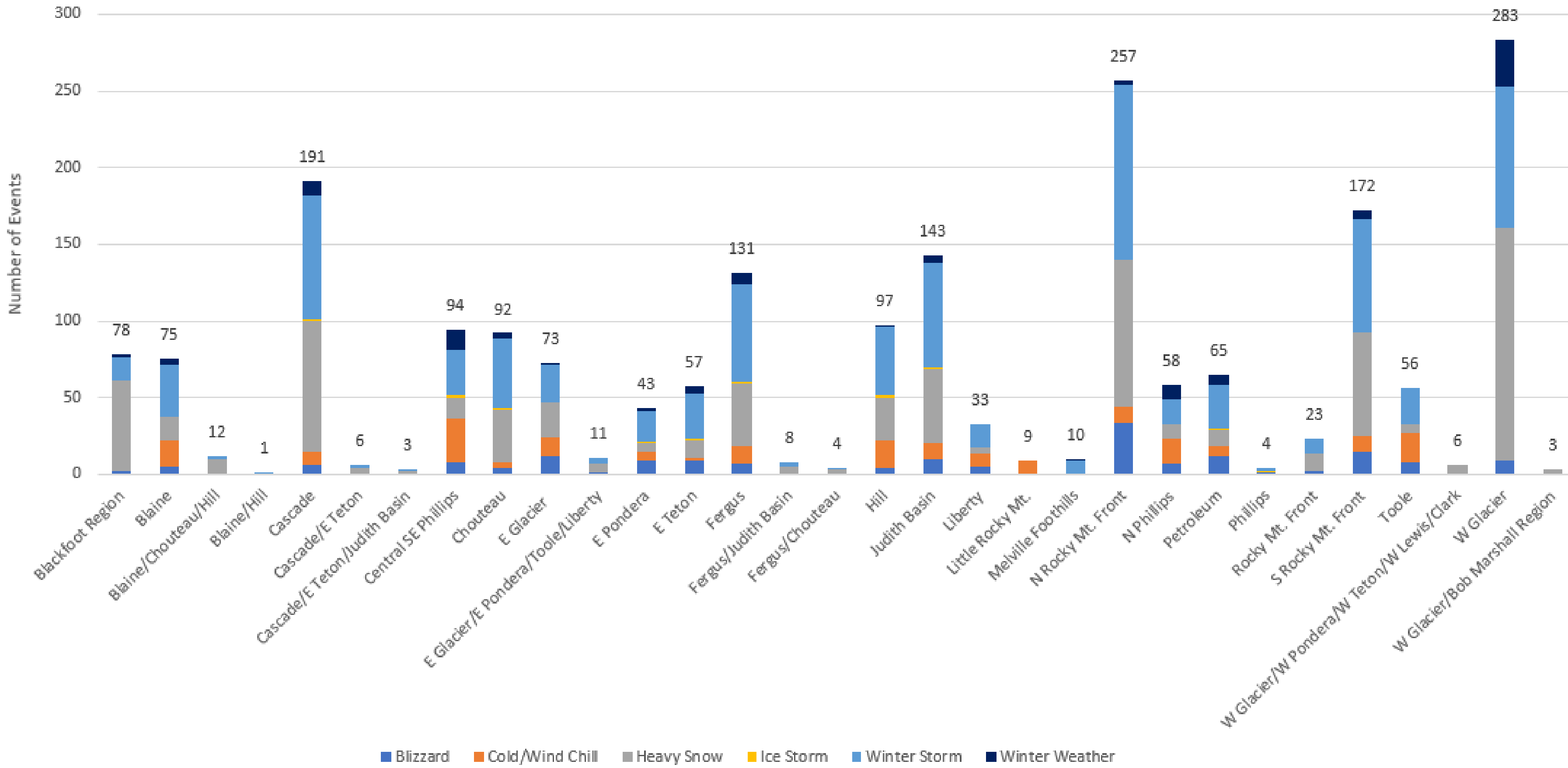
Table 4-43 Summary of Losses by Hazard in the Central Region

	Deaths	Injuries	Property Loss	Days with Events	Total Events
Blizzard	1	7	$50,000	60	170
Cold/Wind Chill	0	0	$0	52	196
Heavy Snow	0	0	$1,000	380	760
Ice Storm	0	0	$0	6	12
Winter Storm	0	0	$8,249,000	316	855
Winter Weather	0	3	$0	65	105
Total	**1**	**10**	**$8,300,000**	**882**	**2,098**

Source: NCEI

There are variations in losses and frequency of hazards across the Central Region. Due to the regional nature of severe winter storms, the NCEI records all severe winter weather events by zone rather than by county. The zones used by NCEI can extend over county lines, and many counties contain more than one zone. Figure 4.58 and Table 4-44 display the total number of severe winter weather events by zone, and show the variation between zones, with the West Glacier Region having the most significant number of events.

Figure 4.58 Summary of Severe Winter Weather Events by Zone in the Central Region



Source: NCEI, Chart by WSP

Table 4-44 Summary of Severe Winter Weather Events by Zone in the Central Region

	Blizzard	Cold/ Wind Chill	Heavy Snow	Ice Storm	Winter Storm	Winter Weather	Total
Blackfoot Region (Zone)	2	0	59	0	15	2	**78**
Blaine (Zone)	5	17	15	0	35	3	**75**
Blaine / Chouteau / Hill (Zone)	0	0	10	0	2	0	**12**
Blaine/Hill (Zone)	0	0	0	0	1	0	**1**
Cascade (Zone)	6	9	85	1	81	9	**191**
Cascade / Eastern Teton (Zone)	0	0	4	0	2	0	**6**
Cascade/Eastern Teton/ Judith Basin (Zone)	0	0	2	0	1	0	**3**
Central And Se Phillips (Zone)	8	28	14	2	29	13	**94**
Chouteau (Zone)	4	4	34	1	46	3	**92**
Eastern Glacier (Zone)	12	12	23	0	25	1	**73**
Eastern Glacier / Eastern Pondera / Toole / Liberty (Zone)	1	0	6	0	4	0	**11**
Eastern Pondera (Zone)	9	6	5	1	20	2	**43**
Eastern Teton (Zone)	9	2	11	1	30	4	**57**
Fergus (Zone)	7	11	41	1	64	7	**131**
Fergus / Judith Basin (Zone)	0	0	5	0	3	0	**8**
Fergus/Chouteau (Zone)	0	0	3	0	1	0	**4**
Hill (Zone)	4	18	28	2	44	1	**97**
Judith Basin (Zone)	10	10	49	1	68	5	**143**
Liberty (Zone)	5	9	3	0	16	0	**33**
Little Rocky Mountains (Zone)	0	9	0	0	0	0	**9**
Melvillle Foothills (Zone)	0	0	0	0	9	1	**10**
North Rocky Mountain Front (Zone)	34	10	96	0	114	3	**257**
Northern Phillips (Zone)	7	16	10	0	16	9	**58**
Petroleum (Zone)	12	6	11	1	28	7	**65**
Phillips (Zone)	1	0	0	1	2	0	**4**
Rocky Mountain Front (Zone)	2	0	12	0	9	0	**23**
Southern Rocky Mountain Front (Zone)	15	10	67	0	75	5	**172**
Toole (Zone)	8	19	6	0	23	0	**56**
W Glacier/W Pondera/ W Teton/N Lewis/Clark (Zone)	0	0	6	0	0	0	**6**
West Glacier Region (Zone)	9	0	152	0	92	30	**283**

	Blizzard	Cold/ Wind Chill	Heavy Snow	Ice Storm	Winter Storm	Winter Weather	Total
West Glacier/Bob Marshall Region (Zone)	0	0	3	0	0	0	**3**
Total	**170**	**196**	**760**	**12**	**855**	**105**	**2,098**

Source: NCEI

The NCEI dataset reported $8,300,000 in total property losses in the Central Region since 1996. There was no crop damage reported in the Region. Only four zones accounted for the over $8 million in property damages. Table 4-45 below summarizes property loss by zone in the Central Region.

Table 4-45 Summary of Property Losses from Winter Weather Events by Zone

Zone	Total Property Damage
North Rocky Mountain Front (Zone)	$1,600,000
Petroleum (Zone)	$50,000
Southern Rocky Mountain Front (Zone)	$1,615,000
West Glacier Region (Zone)	$5,035,000
Total	**$8,300,000**

Source: NCEI

The NCEI reported details on several significant events in the Central Region:

- **April 28, 2019:** Belt Rural and Belt Ambulance responded mutual aid to MM 15 on US Highway 87 in Judith Basin County for an MVA. The accident involved a semi and passenger car and was dispatched as extrication required. Visibility was greatly reduced, and the road was icy and snow-covered. Extrication was completed by JB County units prior to the responders' arrival. 5 patients were transported to the hospital.
- **February 8, 2018:** A winter storm in West Glacier that resulted in dangerous driving conditions was observed on U.S. Highway 2 due to a combination of falling snow and blowing snow as winds gusted to 50 mph. Power outages were also noted around Bad Rock Canyon and Swan Lake due to falling trees. Estimated damages totaled $5,000,000.
- **May 10, 2016:** Icy conditions and strong winds on US Highway 200 resulted in a semi-truck accident in Petroleum County. Estimated property damages totaled $50,000.
- **December 6, 2014:** A bus carrying the Minot State University wrestling team was traveling east on Highway 2. They slid off the road just after crossing the Milk River bridge 2 miles west of Dodson in Phillips County. Three people sustained injuries.
- **November 28, 2014:** A winter storm in West Glacier resulted in 20 structures damaged by large falling trees including a vehicle and six homes. No injuries were reported because of the damage. Estimated losses totaled $20,000.
- **June 8, 2002:** A winter storm produced snow with a very high moisture content, which caused 301 power poles to break, 232 power pole cross arms to snap off, 521 splices, and over 30 miles of destroyed power lines. The power was out to over 2,500 customers, some for several days. Roads were closed over the entire Rocky Mountain Front region for 2 days. The deep snow cover resulted in the loss of over 3,200 livestock. Estimated losses totaled $1,600,000.

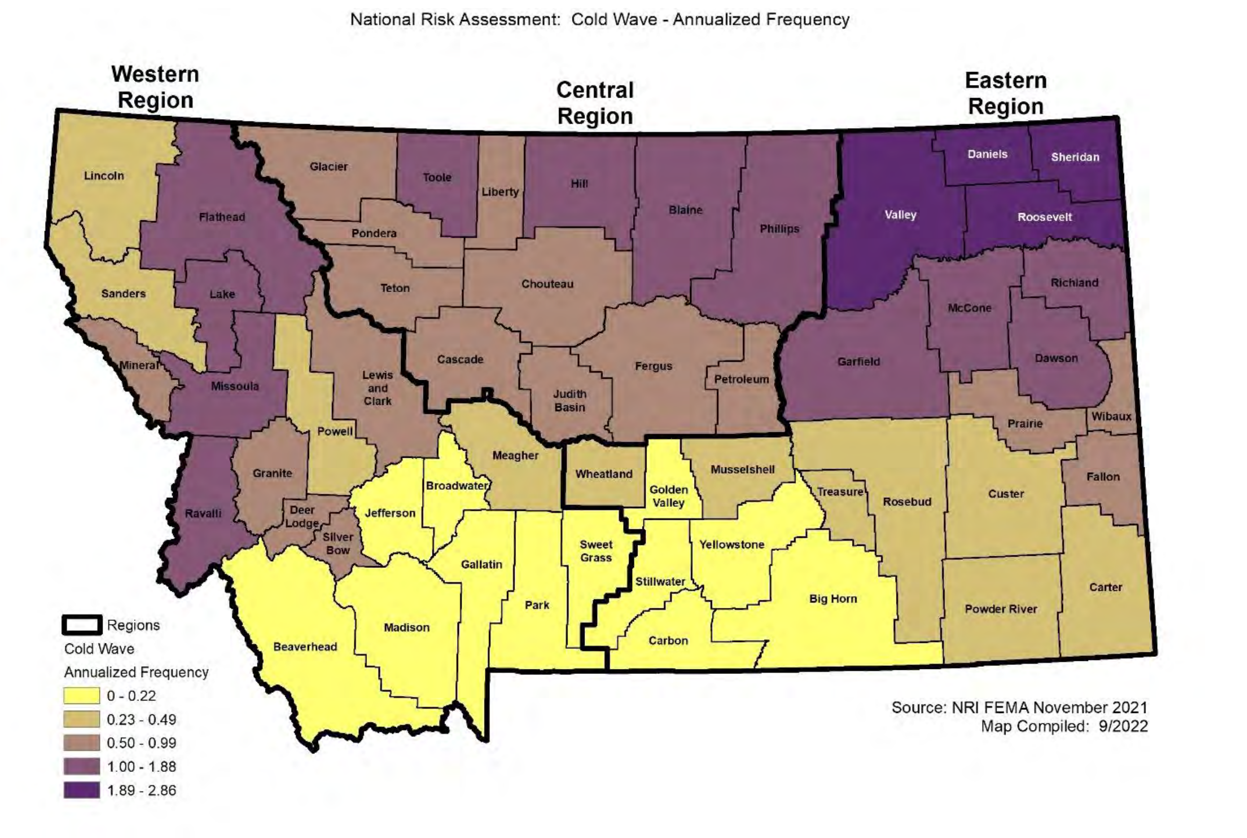
- **February 15, 2001:** A blizzard in the Blackfoot Region zone caused whiteout conditions in the morning near the continental divide and continued throughout the day, closing several highways at times. Along Interstate 90 the blizzard was accountable for one traffic-related death and two injuries.

Frequency/Likelihood of Occurrence

The frequency of severe winter weather in the Central Region is ranked as **highly likely**. Severe winter weather impacts the state annually with blowing and drifting snow, extreme cold, hazardous driving conditions, and utility interruption. The NCEI dataset reported 882 days with severe weather events over 26 years, which averages to nearly 34 days a year with severe winter weather events in the Central Region. According to the Montana State HMP 2018, winter weather typically affects the state from November to April each year, but late storms can extend into June, causing extreme impacts to the agricultural industry.

Figure 4.59 below depicts the annualized frequency of cold events at a county level based on the NRI. The mapping shows a trend toward increased likelihood in the northern part of the Region, particularly Tool, Hill, Blaine, and Philips counties.

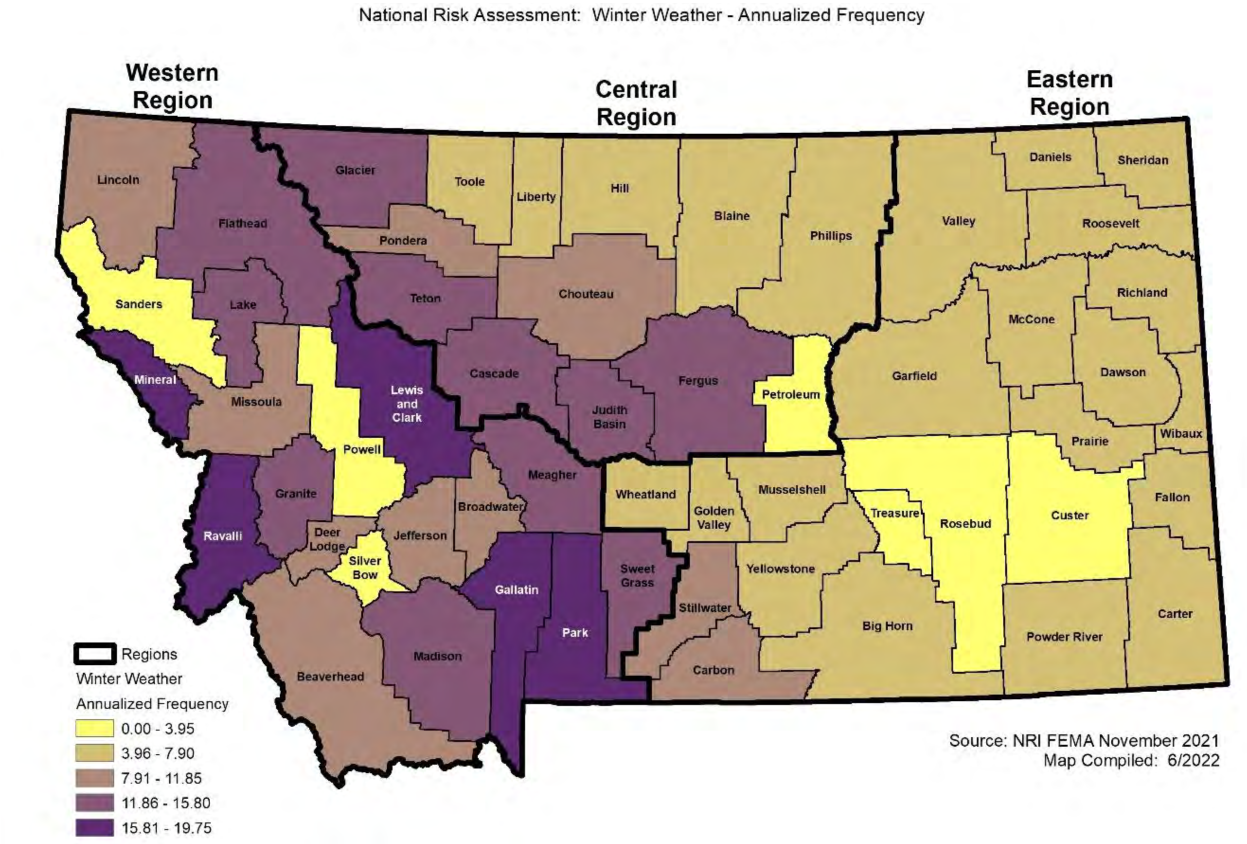
Figure 4.59 NRI Annualized Frequency of Cold Events by County



Map by WSP, Data Source: FEMA National Risk Index, https://hazards.fema.gov/nri/determining-risk

Figure 4.60 below depicts annualized frequency of winter weather events at a county level based on the NRI. The mapping shows a trend towards increased likelihood in the western and southern region, particularly Glacier, Teton, Cascade, Judith Basin, and Fergus counties.

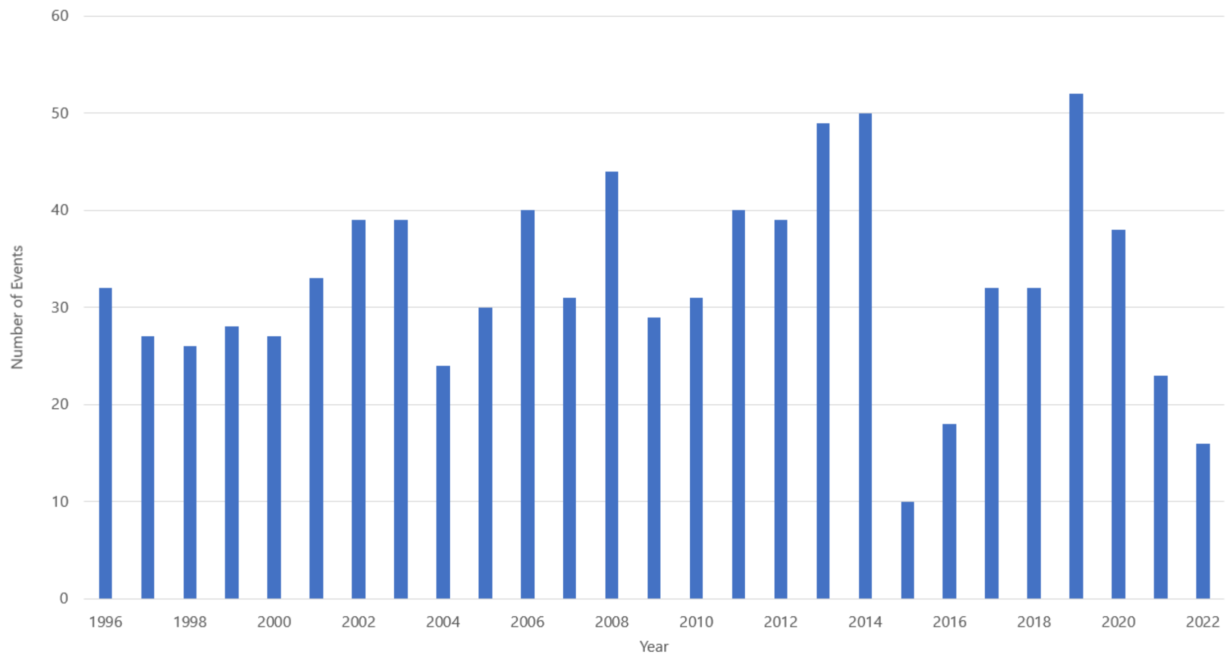
Figure 4.60 NRI Annualized Frequency of Winter Weather Events by County



Map by WSP, Data Source: FEMA National Risk Index, https://hazards.fema.gov/nri/determining-risk

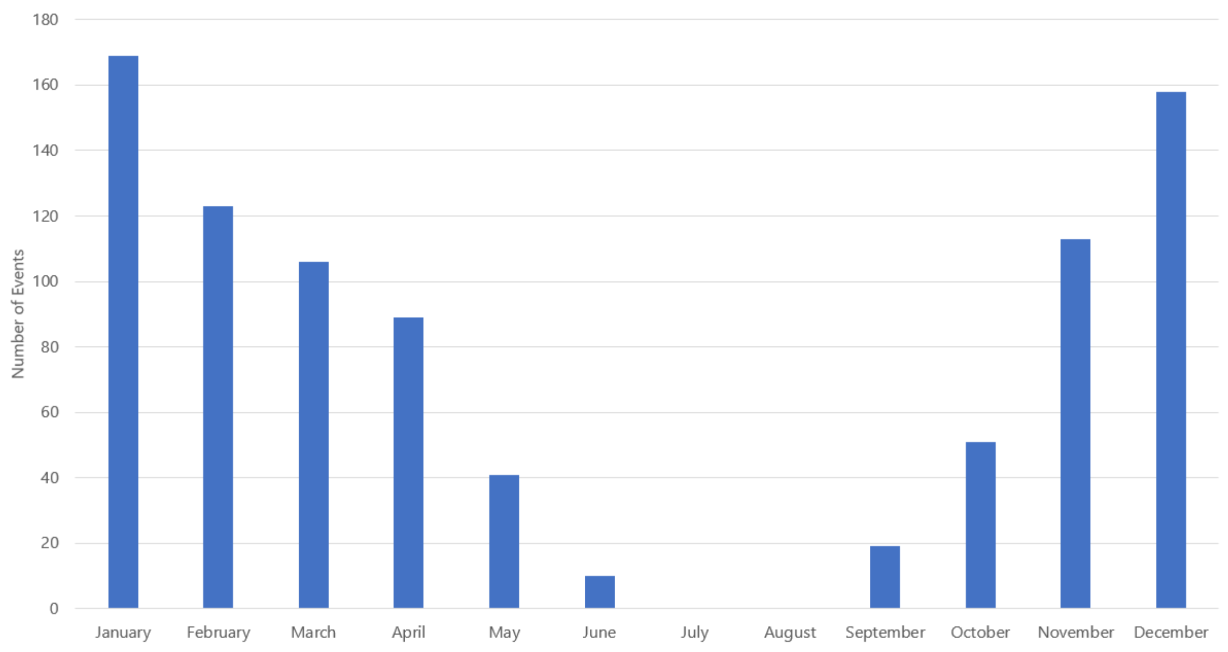
Figure 4.61 displays the yearly trend of severe winter weather event from 1996 to March of 2022 and Figure 4.62 displays the monthly trend of severe winter weather events in the Central Region. There is evident variation in the frequency of events between years in the Region. While most events occur from November to April, severe winter weather has been recorded in the region from September to June.

Figure 4.61 Yearly Trend of Winter Weather Events in the Central Region (1996-2022)



Source: NCEI, Chart by WSP

Figure 4.62 Monthly Trend of Winter Weather Events in the Central Region (1996-2022)



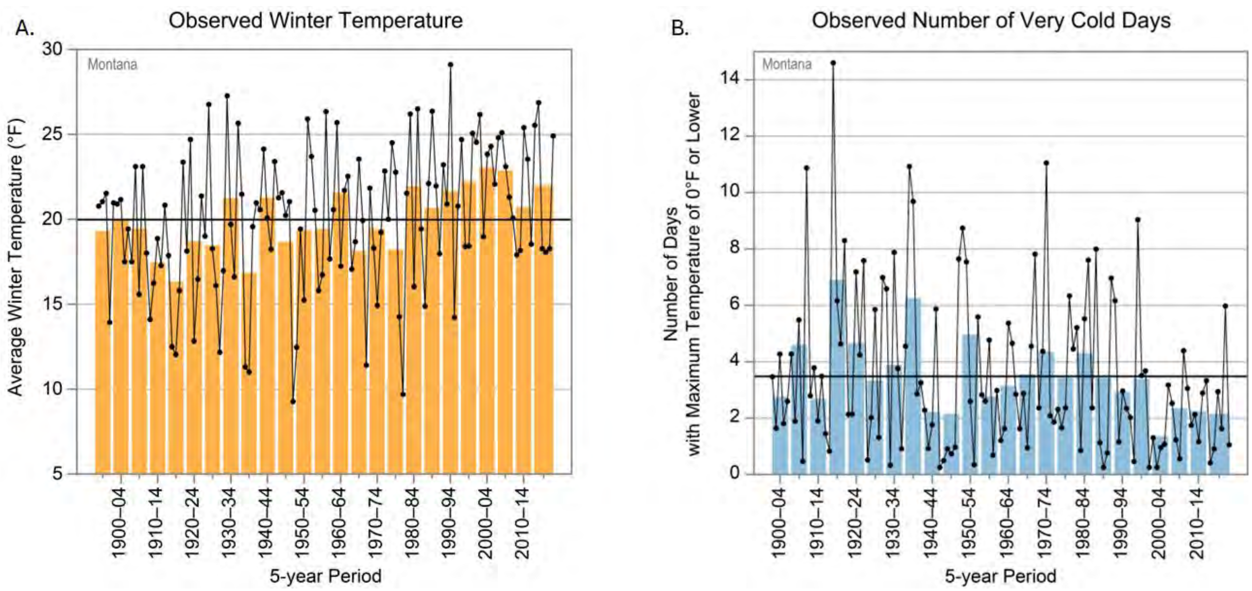
Source: NCEI, Chart by WSP

Climate Change Considerations

The 2021 Climate Change and Human Health in Montana report (Montana Climate Assessment, 2021) documents that annual average temperatures have increased in Montana 2-3 °F since 1950 in both summer and winter. This is greater than most of the U.S. due to the mid-continent location of the state. This trend is expected to continue and by mid-century the Montana Climate Assessment anticipates Montana will be 4.5-6.0 °F warmer than it was from 1971-2000. Precipitation has not changed significantly, but the 2021 Montana Climate Change and Human Health report anticipates precipitation to increase slightly, perhaps an inch/year, mostly from March-May.

With regard to winter weather, NOAA's 2022 National Climate Assessment documents that average winter temperatures in Montana have increased, with a striking reduction in the observed number of very cold days, especially in the last 20 years (Figure 4.63). Both the Montana Climate Assessment and NOAA reports anticipate the number of cold days will continue to decline. Recent academic research also indicates the frequency of blizzards are on the decline in Montana (Browne and Chen, 2023)[4], including a dramatic reduction in the number of blizzards in 2011-2020 relative to 2000-2010.

Figure 4.63 Winter Temperature Observations in Montana



Dots represent annual average temperature (A.) and the number of days with a high temperature of 0°F or lower (B.).
Bars are 5-year averages (both A. and B.).
Black horizontal line is the average summer temperature for all years, 1895-2020.
Figure adapted from: 2022 NOAA State Climate Summaries, Montana. https://statesummaries.ncics.org/chapter/mt/

Potential impacts are discussed in the Vulnerability subsection of this hazard profile, as well as the impacts of population changes and development trends. Current variability in vulnerability by jurisdiction, based on existing conditions, is discussed in these sections and jurisdictional annexes. Due to the uncertainty with climate change on severe winter weather, it would be speculative to define with further specificity the impacts related to climate change on each jurisdiction within the Region. Future updates to this plan should revisit this topic as scientific knowledge progresses, and note any trends that may emerge over time.

Potential Magnitude and Severity

The 2018 Montana State Hazard Mitigation Plan explains that the magnitude of severe weather is measured by the severity of the event and the resulting damage. Winter storms are generally slow in developing and advance notice often lessens their effects on the population. Severe winter weather that

[4] Browne, A., & Chen, L. (2023). Investigating the occurrence of blizzard events over the contiguous United States using observations and climate projections. *Environmental Research Letters*, *18*(11), 114044.

results in loss of life, extended road closures, long-term power outages, or significant isolation problems represent high-magnitude weather events for Montana. Routine damages to property are largely due to frozen pipes. Collapsed roofs from snow loads are not common due to the low percent moisture in typical snow loads. In the Central Region, millions of dollars have been lost in property damage, in addition to the loss of life and several injuries, most of which occurred from a transportation accident due to severe winter weather. On April 15, 2016, a disaster declaration was issued in the Central Region due to winter weather and straight-line winds. In the Central Region, NCEI reported one death, 10 injuries, and $8.3 million in property losses; therefore, magnitude of severe winter weather is ranked as **critical**.

In 2001, the NWS implemented an updated Wind Chill Temperature index (Figure 4.64). This index was developed to describe the relative discomfort/danger resulting from the combination of wind and temperature. Wind chill is based on the rate of heat loss from exposed skin caused by wind and cold. As the wind increases, it draws heat from the body, driving down skin temperature and eventually the internal body temperature.

Figure 4.64 National Weather Service Wind Chill Chart

NWS Windchill Chart

Wind (mph)	Temperature (°F)																	
Calm	40	35	30	25	20	15	10	5	0	-5	-10	-15	-20	-25	-30	-35	-40	-45
5	36	31	25	19	13	7	1	-5	-11	-16	-22	-28	-34	-40	-46	-52	-57	-63
10	34	27	21	15	9	3	-4	-10	-16	-22	-28	-35	-41	-47	-53	-59	-66	-72
15	32	25	19	13	6	0	-7	-13	-19	-26	-32	-39	-45	-51	-58	-64	-71	-77
20	30	24	17	11	4	-2	-9	-15	-22	-29	-35	-42	-48	-55	-61	-68	-74	-81
25	29	23	16	9	3	-4	-11	-17	-24	-31	-37	-44	-51	-58	-64	-71	-78	-84
30	28	22	15	8	1	-5	-12	-19	-26	-33	-39	-46	-53	-60	-67	-73	-80	-87
35	28	21	14	7	0	-7	-14	-21	-27	-34	-41	-48	-55	-62	-69	-76	-82	-89
40	27	20	13	6	-1	-8	-15	-22	-29	-36	-43	-50	-57	-64	-71	-78	-84	-91
45	26	19	12	5	-2	-9	-16	-23	-30	-37	-44	-51	-58	-65	-72	-79	-86	-93
50	26	19	12	4	-3	-10	-17	-24	-31	-38	-45	-52	-60	-67	-74	-81	-88	-95
55	25	18	11	4	-3	-11	-18	-25	-32	-39	-46	-54	-61	-68	-75	-82	-89	-97
60	25	17	10	3	-4	-11	-19	-26	-33	-40	-48	-55	-62	-69	-76	-84	-91	-98

Frostbite Times: 30 minutes, 10 minutes, 5 minutes

$$\text{Wind Chill (°F)} = 35.74 + 0.6215T - 35.75(V^{0.16}) + 0.4275T(V^{0.16})$$

Where, T= Air Temperature (°F) V= Wind Speed (mph)

Effective 11/01/01

Source: NWS

The severity of ice storms can be measured with the Sperry-Piltz Ice Accumulation (SPIA) Index, shown in Table 4-46. The SPIA Index is a forecasting of ice accumulation and ice damage that uses various parameters that can help predict the projected extent of ice storms. Historical measurements of ice storms using the SPIA Index are unavailable.

Table 4-46 Sperry-Piltz Ice Accumulation Index

ICE DAMAGE INDEX	DAMAGE AND IMPACT DESCRIPTIONS
0	Minimal risk of damage to exposed utility systems; no alerts or advisories needed for crews, few outages.
1	Some isolated or localized utility interruptions are possible, typically lasting only a few hours. Roads and bridges may become slick and hazardous.
2	Scattered utility interruptions expected, typically lasting 12 to 24 hours. Roads and travel conditions may be extremely hazardous due to ice accumulation.
3	Numerous utility interruptions with some damage to main feeder lines and equipment expected. Tree limb damage is excessive. Outages lasting 1 – 5 days.
4	Prolonged & widespread utility interruptions with extensive damage to main distribution feeder lines & some high voltage transmission lines/structures. Outages lasting 5 – 10 days.
5	Catastrophic damage to entire exposed utility systems, including both distribution and transmission networks. Outages could last several weeks in some areas. Shelters needed.

Source: NWS

The extent rating of winter storms that cause issues in Montana includes storms forecasted with Winter Storm Warnings or Blizzard Warnings. The NWS issues a Winter Storm Warning when conditions that can quickly become life threatening and are more serious than an inconvenience are imminent or already occurring. Heavy snows, or a combination of snow, freezing rain or extreme wind chill due to strong wind, may bring widespread or lengthy road closures and hazardous travel conditions, plus threaten temporary loss of community services such as power and water. Deep snow and additional strong wind chill or frostbite may be a threat to even the appropriately dressed individual or to even the strongest person exposed to the frigid weather for only a short period.

The most dangerous of all winter storms is the blizzard. A blizzard warning is issued when winds of 35 miles an hour will occur in combination with considerable falling and/or blowing snow for at least 3 hours. Visibilities will frequently be reduced to less than 1/4 mile and temperatures are usually 20 degrees Fahrenheit or lower. The blizzard marks the upper extent of severe winter storms that could be experienced in Montana.

NOAA's National Centers for Environmental Information is now producing the Regional Snowfall Index (RSI) for significant snowstorms that impact the eastern two thirds of the U.S. The RSI ranks snowstorm impacts on a scale from 1 to 5, similar to the Fujita scale for tornadoes or the Saffir-Simpson scale for hurricanes (see table below). The RSI is a regional index; a separate index is produced for each of the six NCEI climate regions in the eastern two-thirds of the nation. Montana is included in the Northern Rockies and Plains

Region, along with Nebraska, North Dakota, Wyoming, and South Dakota.[5] RSI ratings from 1 to 5 are possible in Montana. RSI values for historical events are unavailable for the state of Montana or are ambiguous as to the geographic extent of storms in the northern Rockies and Plains states.

Table 4-47 Regional Snowfall Index (RSI) Ratings For Significant Snowstorms

Category	Description
1	Notable
2	Significant
3	Major
4	Crippling
5	Extreme

Winter storms and blizzards can result in multiple injuries and illnesses; major or long-term property damage that threatens structural stability; and/or interruption of essential facilities and services for 24-72 hours. This can include property damage, local and regional power and phone outages, and closures of streets, highways, schools, businesses, and nonessential government operations. People can also become isolated from essential services in their homes and vehicles. A winter storm can escalate, creating life threatening situations when emergency response is limited by severe winter conditions. Other issues associated with severe winter weather include hypothermia and the threat of physical overexertion that may lead to heart attacks or strokes. Snow removal costs can impact budgets significantly. Heavy snowfall during winter can also lead to flooding or landslides during the spring if the area snowpack melts too quickly and contribute to high ground water tables and seepage into foundations. High snow loads also cause damage to buildings and roofs.

Vulnerability Assessment

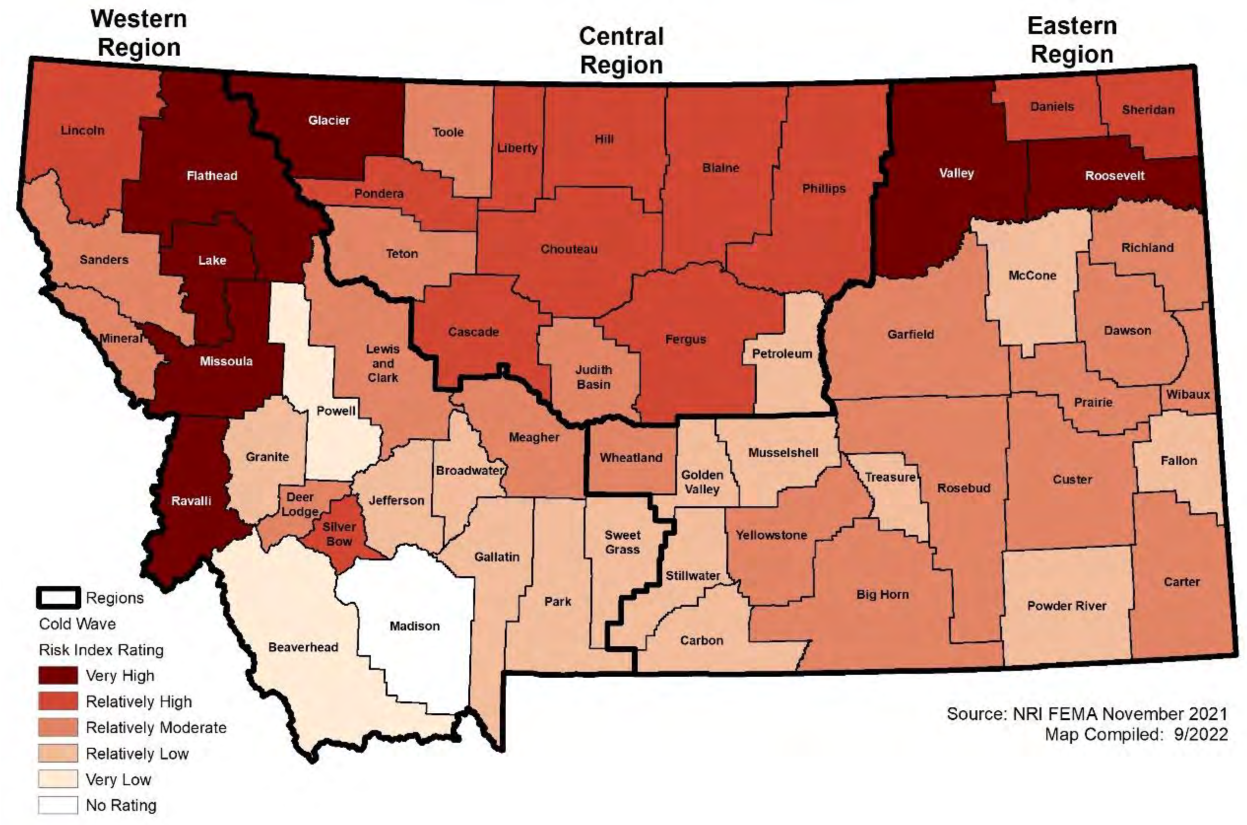
Severe winter weather essentially occurs in the planning area as extreme cold, ice storm, or severe snow, which can be combined with high winds. Snow events can be classified several ways, including winter weather, snow, heavy snow, winter storm, snow and blowing snow, or blizzard if accompanied by high winds. Conveniently, the National Risk Index lumps all of these conditions together as *winter weather*, and also has layers for extreme cold and ice storm. The NRI is useful to simplify the vulnerability analysis by providing information on the exposure of assets to these hazards and to some extent the susceptibility of those assets to damage from exposure.

The figures below show NRI risk index data for severe winter weather in the planning area. The NRI risk index is calculated as expected annual loss Figure 4.66 (EAL) multiplied by social vulnerability, divided by community resilience and provides a measure of how severely extreme winter weather is experienced. Figure 4.65 provides NRI risk index rating for cold and Figure 4.66 provides NRI risk index rating for winter weather. The NRI risk index rating for ice storm is not shown below. The ice storm risk is the lowest possible rating, very low, for the entire planning area except Cascade County which earned a relatively low rating.

[5] The RSI is assigned according to methods outlined in:
Squires et al. (2014) The regional snowfall index. Bulletin of the American Meteorological Society, 95(12), 1835-1848.
For more information see https://www.ncei.noaa.gov/access/monitoring/rsi/.

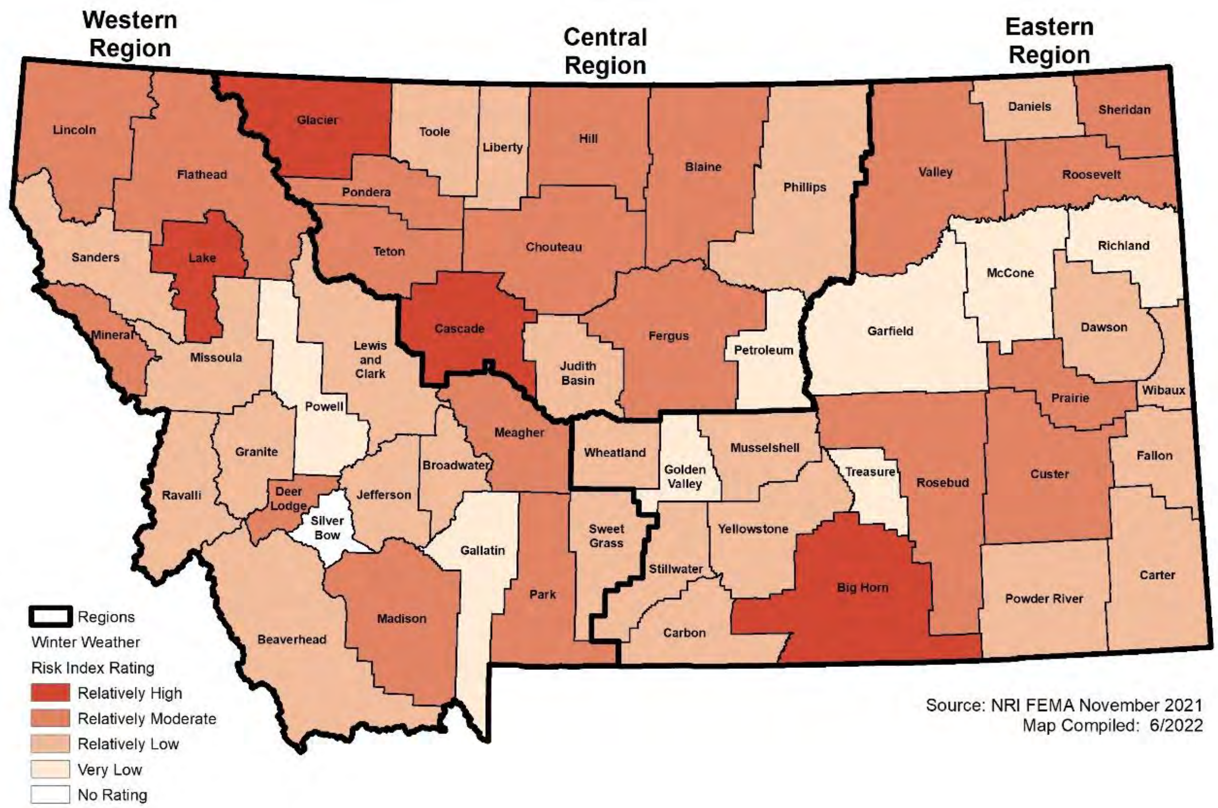
Glacier and Cascade counties stand out as being the only two counties in the planning area to earn a relatively high rating for winter weather. Glacier County was the only county in the planning area to earn a very high rating for cold, while Cascade County was among the 8 counties in the planning area to earn a relatively high rating. Conversely, Petroleum County is the only county in the planning area to earn a very low rating for both cold and winter weather.

Figure 4.65 NRI Risk Index Rating for Cold



Map by WSP, Data Source: FEMA National Risk Index, https://hazards.fema.gov/nri/determining-risk

Figure 4.66 NRI Risk Index Rating for Winter Weather



Map by WSP, Data Source: FEMA National Risk Index, https://hazards.fema.gov/nri/determining-risk

People

People are susceptible to severe winter weather hazards. However, these hazards are well known to residents in this part of the country and people are largely well adapted to them. Major problems typically only occur during record snowfalls and extended periods of below-zero temperatures. However, some populations are notably susceptible to the indirect effects of winter-storm associated utility interruption, freezing pipe damage, and either the cost or physical toll related to snow removal. Individuals who depend on electricity are vulnerable during blackouts caused by severe winter weather. People without appropriate shelter or who work outside are more vulnerable to cold-related illnesses. In all the cases of injury or death reported by the NCEI due to winter weather events, the impacted individuals were on the road during a severe winter weather event and suffered injuries due to an accident. The NCEI reported one death and ten injuries due to severe winter weather events.

Property

All property located outdoors is exposed to severe winter weather events. Accumulation of snow and ice on roofs can cause collapse, especially on old or poorly constructed facilities. Ice storms can coat the exterior of a facility and can cause superficial damages. Prolonged cold can cause significant damages to poorly insulated facilities. The NCEI reported property losses in the Central Region were primarily due to blackouts caused by downed powerlines and poles, as well as damages to cars from automobile crashes.

Critical Facilities and Lifelines

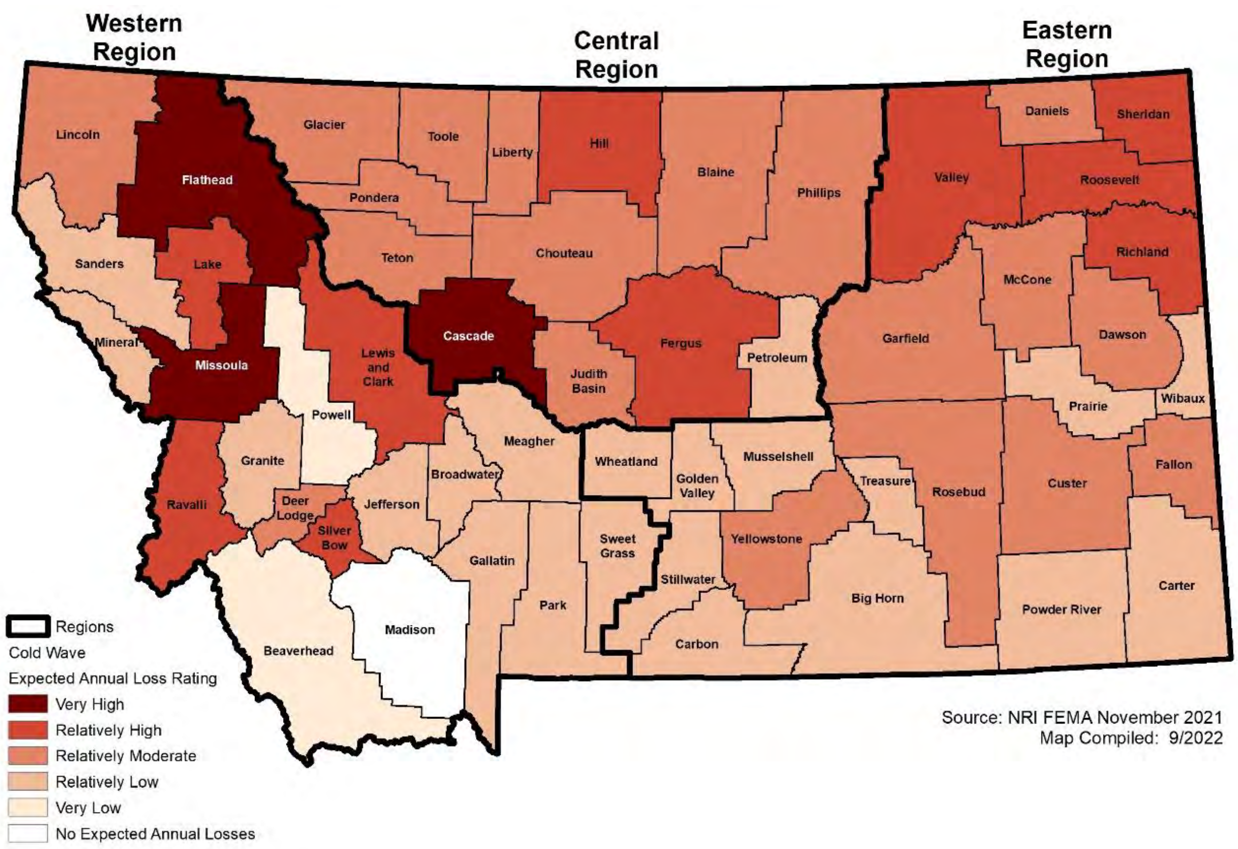
The safe and efficient flow of traffic is susceptible to extreme winter weather. Automobile crashes are more frequent during extreme winter weather and roads can become difficult or impossible to travel. These problems can isolate many people and create a dangerous situation for stranded motorists. Additionally, overhead power lines are susceptible to damage from the accumulation of snow and ice. This can cause power outages that lead to a dangerous loss of heat or electricity needed to operate medical equipment, all during periods likely to be extremely cold and possibly windy.

Economy

The economy is susceptible to extreme winter weather hazards. Examples include lower economic activity due to business interruptions associated with poor road conditions. Indirectly, power outages can cause very costly impacts. The NCEI reported $8.3 million in property losses in the Central Region.

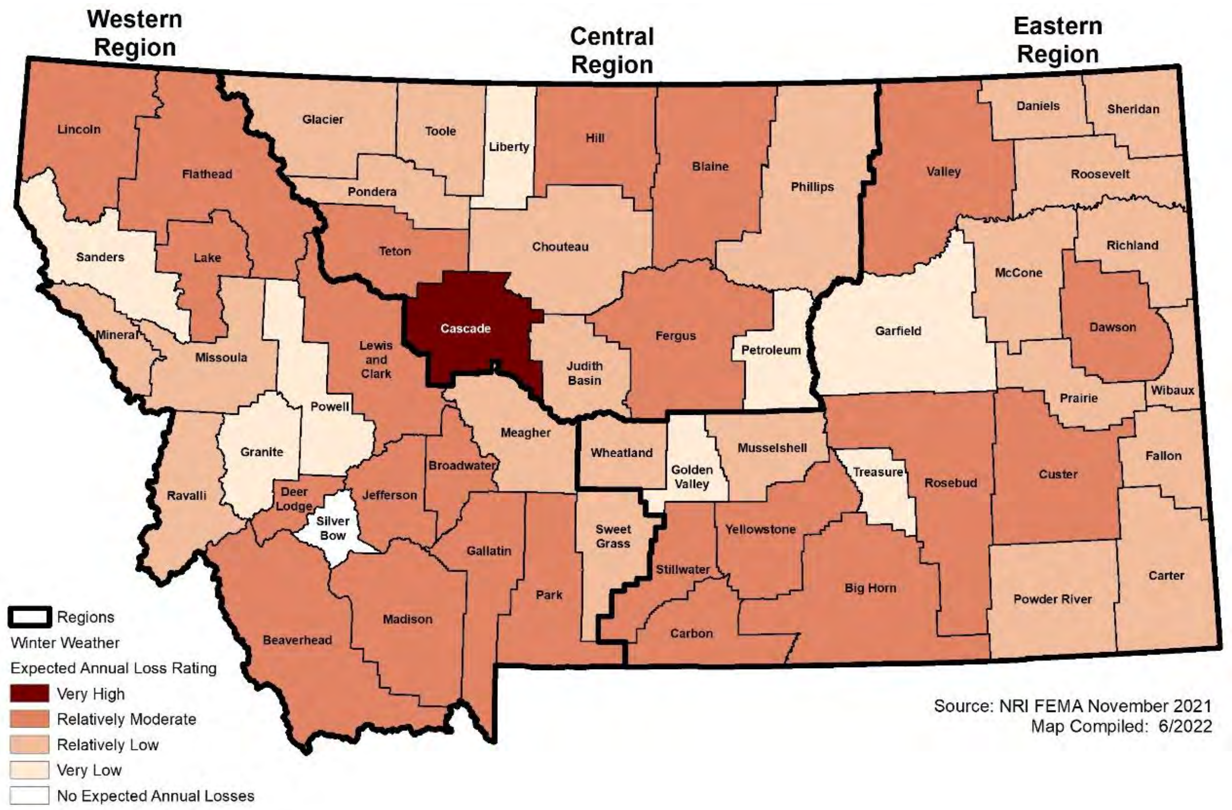
The figures below illustrate NRI data for the Expected Annual Loss (EAL) rating due to cold waves (Figure 4.67) and winter weather (Figure 4.68) for the planning area. EAL is based on exposure to buildings, agriculture, and people multiplied by the annualized frequency of hazard events, multiplied by the historic loss ratio, a value that represents the estimated percentage of exposed buildings, agriculture, or people expected to be lost during a hazard event. Cascade County again stands out as being the only county in the planning area to earn a very high rating for both cold and winter weather. Likewise, Petroleum County was the only county in the planning area to receive a very low rating for EAL due to cold and one of two counties (along with Liberty County) to earn a very low rating for EAL due to winter storm.

Figure 4.67 NRI Expected Annual Loss Rating from Cold Waves



Map by WSP, Data Source: FEMA National Risk Index, https://hazards.fema.gov/nri/determining-risk

Figure 4.68 NRI Expected Annual Loss Rating from Winter Weather



Map by WSP, Data Source: FEMA National Risk Index, https://hazards.fema.gov/nri/determining-risk

Historic and Cultural Resources

Historic and cultural resources are somewhat susceptible to extreme winter weather. Historic buildings, in particular, are unlikely to be insulated to the standard common to new construction. This leads to less protection for property and people inside the buildings from extreme cold temperatures and wind, greater susceptibility to damage from power outages, and increased probability of damage to or caused by frozen pipes.

Natural Resources

Trees, landscaping, and crops are susceptible to damage from prolonged periods of extreme cold weather, wind associated with blizzards, and the accumulation of snow and ice. Trees that break due to the weight of snow and ice have been reported in the NCEI dataset.

Development Trends Related to Hazards and Risk

The Montana State Hazard Mitigation Plan 2018 reports that Montana snow is generally dry and snow loads do not threaten roof collapse in most areas. The State of Montana has adopted the 2012 International Building Code (IBC). The IBC includes a provision that buildings must be constructed to withstand a wind load of 75 mph constant velocity and three-second gusts of 90 mph. Buildings must be designed to withstand a snow load of 30 pounds per square foot minimum.

Risk Summary

In summary, the Severe Winter Weather hazard is considered to be overall high significance for the Region. Variations in risk by jurisdiction are summarized in the table below, followed by key issues noted in the vulnerability assessment.

- Severe winter weather includes blizzards, cold/wind chill, heavy snow, ice storm, winter weather, and winter storm. The hazard significance rating for this hazard is a **High**
- These events can impact anywhere in the planning region; therefore, the hazard extent is rated as **Extensive**
- The NCEI data reported 882 days with severe weather events over 26 years, which averages to nearly 34 days a year with severe winter weather events in the Central Region; therefore, the future occurrence is rated as **Highly Likely**
- The NCEI reported 1 death, 10 injuries, and $8,300,000 in property damages, therefore the magnitude is rated as **Critical**
- People who are dependent on electricity and populations who work outdoors or in transportation are most vulnerable to severe winter weather events. People who do not have appropriate shelter or who live in homes without proper insulation from winter weather, such as homeless populations and those in mobile homes, are most vulnerable to winter weather.
- Power outages and poor road conditions are likely impacts of severe winter storms. Structures can collapse under the weight of snow and ice. Most property damage in the Region occurred due to car accidents because of poor road conditions from winter storms.
- Significant economic losses can occur from business and transportation disruptions, as well as from repairing damaged infrastructure
- Related hazards: Extreme Temperatures, Windstorms, Transportation Accidents

Table 4-48 Risk Summary Table: Severe Winter Weather

Jurisdiction	Overall Significance	Additional Jurisdictions	Jurisdictional Differences?
Central Region	High	NA	NA
Blackfeet Tribe	Medium	NA	NA
Blaine County	Medium	Chinook and Harlem	None
Cascade County	High	Great Falls, Belt, Cascade, and Neihart	Great Falls is likely to experience greater losses due to greater population and more concentrated infrastructure
Chippewa Cree Tribes Rocky Boy's Reservation	High	NA	NA
Chouteau County	Medium	Fort Benton, Big Sandy	None
Fergus County	High	Lewistown, Denton, Grass Range, Moore, Winifred	None
Fort Belknap Indian Community	Medium	NA	NA
Glacier County	High	Cut Bank	NA
Hill County	High	Havre, Hingham	None

Jurisdiction	Overall Significance	Additional Jurisdictions	Jurisdictional Differences?
Judith Basin County	High	Stanford, Hobson	None
Liberty County	Medium	Chester	NA
Petroleum County	Medium	Winnett	NA
Phillips County	High	Malta, Saco	None
Pondera County	High	Conrad	NA
Teton County	High	Choteau, Dutton, Fairfield	None
Toole County	High	Shelby, Kevin, and Sunburst	None

4.2.12 Human Conflict

Hazard/Problem Description

Human conflict includes terrorism, active shooters, and civil unrest. Descriptions of these hazards are presented below:

Terrorism

The FBI defines terrorism, domestic or international, as the unlawful use of force or violence against persons or property to intimidate or coerce a government or civilian population in furtherance of political or social objectives. The US State Department designates 72 groups as Foreign Terrorist Organizations around the world. There is no similar list of domestic terrorist groups. The Global Terrorism Database (GTD) maintained by the National Consortium for the Study of Terrorism and Responses to Terrorism lists 241 groups known or suspected of carrying out terrorist attacks on US soil since 1970.

Incidents involving weapons of mass destruction (WMDs) are a special subset of terrorism and mass violence incidents. Such incidents may involve chemical, biological, radioactive, nuclear, or explosive (CBRNE) weapons with the potential to cause high numbers of injuries or fatalities.

Historically explosives have been the most common terrorist weapon, accounting for 51% of all attacks since 1970. Hazard impacts are typically instantaneous; secondary devices may be used, lengthening the duration of the hazard until the attack site is determined to be clear. The extent of damage is determined by the type and quantity of explosive. Effects are generally static other than cascading consequences and incremental structural failures. Some areas could experience direct weapons' effects: blast and heat; others could experience indirect weapons' effect.

Biological terrorism is the use of biological agents against persons or property. Liquid or solid contaminants can be dispersed using sprayers/aerosol generators or by point of line sources such as munitions, covert deposits and moving sprayers. Biological agents vary in the amount of time they pose a threat. They can be a threat for hours to years depending upon the agent and the conditions in which it exists.

Another type of biological attack is agroterrorism, directed at causing societal and economic damage through the intentional introduction of a contagious animal disease or fast-spreading plant disease that affects livestock and food crops and disrupts the food supply chain. Such an attack could require the agriculture industry to destroy livestock and food crops, disrupt the food supply both nationally and globally, and could also affect consumer confidence in the food supply resulting in tremendous economic damage for potentially an extended period.

Chemical terrorism involves the use or threat of chemical agents against persons or property. Effects of chemical contaminants are like biological agents. Radiological terrorism is the use of radiological materials against persons or property. Radioactive contaminants can be dispersed using sprayers/aerosol generators, or by point of line sources such as munitions, covert deposits and moving sprayers or by the detonation of a nuclear device underground, at the surface, in the air or at high altitude.

Active Shooter

The FBI defines an active shooter as one or more individuals actively engaged in killing or attempting to kill people in a populated area. Implicit in this definition is the shooter's use of one or more firearms. The "active" aspect of the definition inherently implies the ongoing nature of the incidents, and thus the potential for the response to affect the outcome. FEMA reported on their active shooter online page that, unlike organized terrorist attacks, most active shooter incidents are carried out by one or two individuals. School shootings are a special subset of active shooter incidents.

The US Department of Homeland Security notes that "in most cases, active shooters use firearms(s) and there is no pattern or method to their selection of victims…situations are unpredictable and evolve quickly…and are often over within 10 to 15 minutes." However, the presence or suspected presence of secondary devices can lengthen the duration of the event until the attack site is determined to be clear. Although this definition focuses on an active shooter, the elements remain the same for most active threat situations.

Civil Unrest

The federal law defines civil disorder, or civil unrest, as "any public disturbance involving acts of violence by assemblages of three or more persons, which causes an immediate danger of or results in damage or injury to the property or person of any other individual" (18 U.S. Code 232). FEMA noted that civil unrest can be triggered by a variety of reasons, including "disputes over exploitation of workers, standard living conditions, lack of political representation, poor health care and education, lack of employment opportunities, and racial issues" (FEMA, 1993).

Geographical Area Affected

Although human conflict events can occur anywhere in the Region, individual events will typically only impact localized cities. Past events indicate that these events in the Central Region have only occurred in the City of Great Falls; therefore, geographic extent of these events is rated as **limited**. The FBI report Active Shooter Incidents, 20-Year review noted that acts of terrorism are typically a pre-meditated, targeted attack on a specific place or group such as religious or ethnic groups or sites of significant economic, strategic, military, or cultural significance. Consequently, areas of higher risk include densely populated cities and counties and military facilities. Large venue events, such as a sporting event attended by tens of thousands of people might be considered a desirable target. Again, such events typically occur in densely populated areas since those areas can provide the infrastructure support (hotels, eateries, etc.) for large numbers of people. Even a small-scale terrorist incident in one of these locations would likely cause cascading impacts to the communities in Central Montana. Like terrorist attacks, active shooter incidents frequently occur in high-population areas. The FBI report Active Shooter Incidents, 20-Year Review 2000-2019 found that 29% of active shooter incidents in the U.S. occur in businesses open to pedestrians, 15% in open spaces, 13% in schools (Pre-K-12), and 12% in businesses closed to pedestrians.

Past Occurrences

Terrorism

The Global Terrorism Database (GTD) catalogues more than 200,000 domestic and international terrorist attacks from 1970 to 2020. Table 4-49 displays a list of the seven events reported by GTD in the State of Montana since 1970. While none of these events occurred in the Central Region, the events provide an understanding of the trend in terrorist attack in the State. These events are listed in the table below:

Table 4-49 Terrorist Attacks in the State of Montana 1970-2020

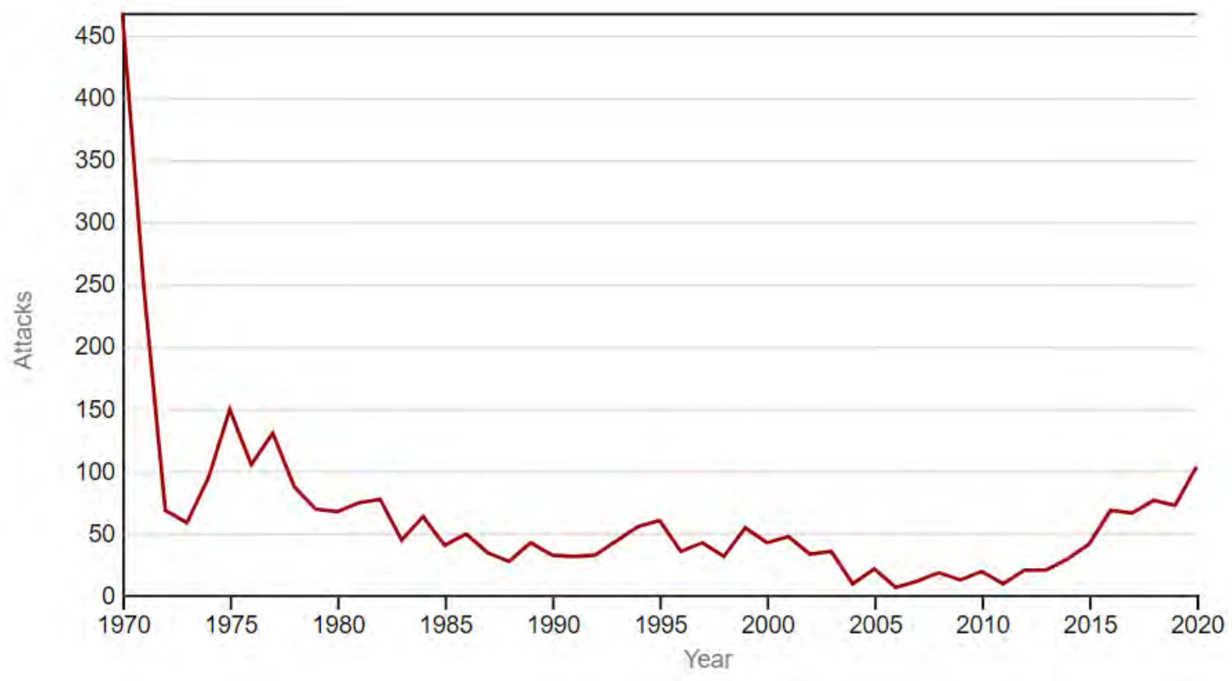
Date	City	Perpetrator Group	Fatalities	Injuries	Target Type
2017-05-16	Three Forks	Anti-Police extremists	2	5	Police
1997-04-02	Bozeman	Anti-Abortion extremists	0	0	Abortion Related
1994-10-11	Kalispell	Anti-Abortion extremists	0	0	Abortion Related
1994-01-00	Helena	Anti-Abortion extremists	0	0	Abortion Related
1992-01-18	Helena	Anti-Abortion extremists	0	0	Abortion Related
1987-04-19	Missoula	Aryan Nation (suspected)	0	0	Police

Date	City	Perpetrator Group	Fatalities	Injuries	Target Type
1970-03-15	Billings	Unknown	0	0	Police

Source: Global Terrorism Database 1970-2020, Global Terrorism Database (umd.edu)

As shown in Figure 4.69, GTD data shows that there was an overall decreasing trend in the number of terrorist attacks from 1970 to 2005. However, since 2010, there has been an uptake in the number of terrorist attacks in the United States once again.

Figure 4.69 Terrorist Attacks on US Soil, 1970-2020



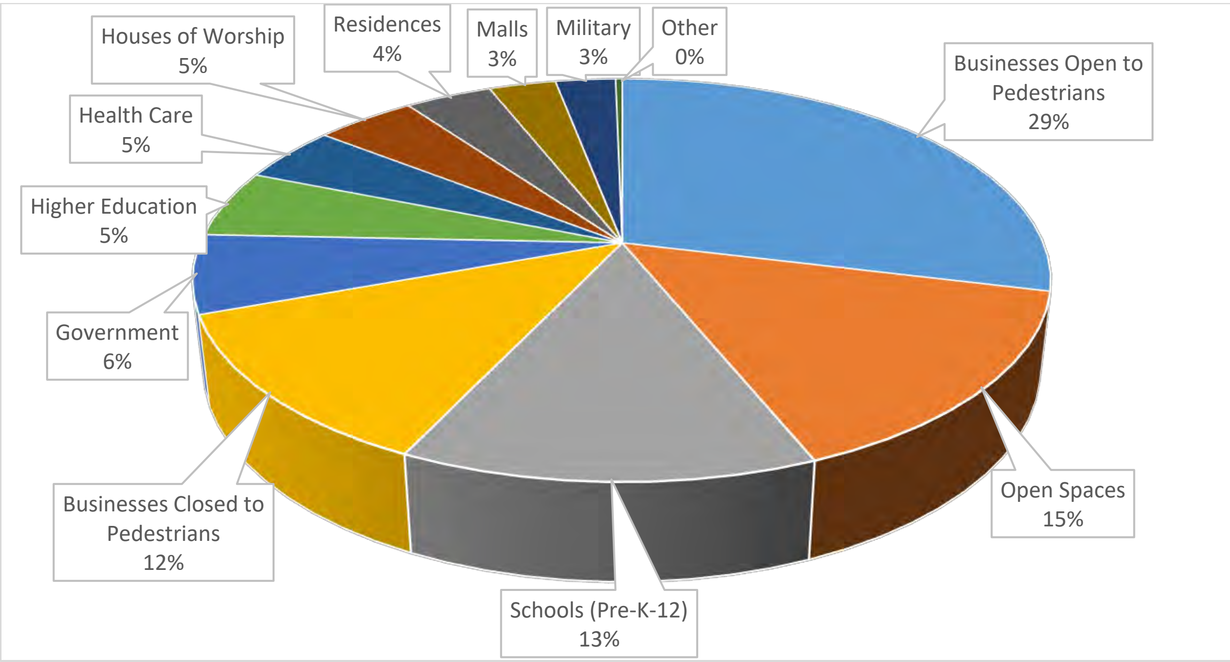
Source: GTD, https://www.start.umd.edu/gtd/

The increase in attacks over the last decade in the United States has been driven primarily by domestic, not international, terrorism. A domestic terrorist attack is a terrorist attack in which victims "within a country are targeted by a perpetrator with the same citizenship as the victims" (*Predicting Malicious Behavior: Tools and Techniques for Ensuring Global Security*). A recent report by the Center for Strategic and International Studies records 980 domestic terrorist attacks in the US since 1994, with sharp growth over the last 10-15 years.

Active shooters

The FBI reported 434 active shooter incidents from 2000-2021 in the United States: 333 of these events occurred between 2000-2019 and were reported in the FBI 20-year active shooter review. Figure 4.70 shows the location of where these incidents took place. The FBI reported an additional 40 incidents in 2020 and 61 incidents in 2021. While none of these 434 incidents took place in the State of Montana, trends from past events can be used to predict the likelihood of future events.

Figure 4.70 Active Shooter Incident Locations, 2000-2019



Source: FBI report Active Shooter Incidents, 20-Year Review 2000-2019

Civil Unrest

Count Love is an open-source database containing a comprehensive list of U.S. protests from January 20th, 2017, to January 21st, 2021. The dataset reported 27,270 protests across 4,042 cities in the United States. In Montana alone, 293 protests were reported across the State: 221 in the Western Region, 49 in the Eastern Region, and 23 in the Central Region. All 23 recorded protests in the Central Region occurred in the City of Great Falls. Table 4-50 provides details on these events.

Table 4-50 Protests in the Central Region, Jan. 2017 – Jan. 2021

Date	Location	Attendees	Event
10/3/2020	Gibson Park, Great Falls, MT	100	Supporting Local Police
8/22/2020	Great Falls, MT	25	Executive (Post Office)
6/12/2020	Great Falls, MT	200	Racial Injustice (George Floyd)
6/12/2020	Great Falls, MT	3	Civil Rights (For White Supremacy, Counter Protest)
6/5/2020	Great Falls, MT	500	Racial Injustice (George Floyd)
6/5/2020	Great Falls, MT	No Data	Civil Rights (For White Supremacy, Counter Protest)
5/31/2020	Great Falls, MT	200	Racial Injustice (George Floyd)
3/6/2020	Great Falls, MT	20	Environment (Against Fossil Fuels)
1/19/2020	Great Falls, MT	No Data	Civil Rights (Against Abortion Rights)
12/17/2019	Great Falls, MT	No Data	Executive (Against President Trump)
7/13/2019	Great Falls Civic Center, Great Falls, MT	20	Immigration

Date	Location	Attendees	Event
5/21/2019	Great Falls, MT	No Data	Civil Rights (Abortion Rights)
1/19/2019	Great Falls, MT	No Data	Civil Rights (Women's Rights)
7/5/2018	Great Falls, MT	300	Executive (Against President Trump)
7/5/2018	Great Falls, MT	No Data	Executive (President Trump, Counter Protest)
6/30/2018	Great Falls, MT	20	Immigration (Families Belong Together)
6/30/2018	Great Falls, MT	3	Immigration (Counter Protest)
3/24/2018	Great Falls, MT	50	Guns (March for Our Lives)
3/1/2018	Great Falls, MT	No Data	Civil Rights
1/20/2018	Great Falls, MT	300	Civil Rights (Women's March)
10/11/2017	Great Falls, MT	No Data	Environment (Pipeline)
8/13/2017	Great Falls, MT	No Data	Racial Injustice (Charlottesville)
3/2/2017	Great Falls, MT	No Data	Budget Cuts

Source: https://countlove.org/

Frequency/Likelihood of Occurrence

The probability of a terrorist attack, active shooter attack, and civil unrest can be difficult to quantify, largely due to different definitions and data collection methods. In Montana, seven terrorist attacks have been reported in the State since 1970, none of which took place in the Central Region. The FBI recorded 434 active shooter incidents from 2000-2021, none of which occurred in the State of Montana. While both terrorist attack and active shooter attacks are rare in Montana, civil unrest is a more common occurrence. Over the course of 4 years from 2017-2021, 23 protest events were recorded in the Central Region of Montana, all of which occurred in the City of Great Falls. This averages out to about 5 or 6 protests per year in the Central Region. Based on these past events, the likelihood of these events is **occasional**.

Climate Change Considerations

There is limited research conducted on the link between climate change and its impacts on human conflict.

Potential Magnitude and Severity

The severity of these incidents can be measured in multiple ways including length of incident, fatalities, casualties, witnesses, and number of perpetrators. Although an active threat may only directly impact one specific piece of infrastructure (e.g., a school, theater, or concert venue), it indirectly impacts the community in many ways, including ongoing closures for investigation, local and national media logistics, VIP visits, mental health concerns, need for additional support services, avoidance of similar infrastructure, and subsequent impacts to businesses. The psychological impact may be much worse than the direct impacts and can continue to affect a community for years. However, due to the lack of reported events with significant damages in the Central Region, the overall significance of this hazard is **limited**.

Terrorism

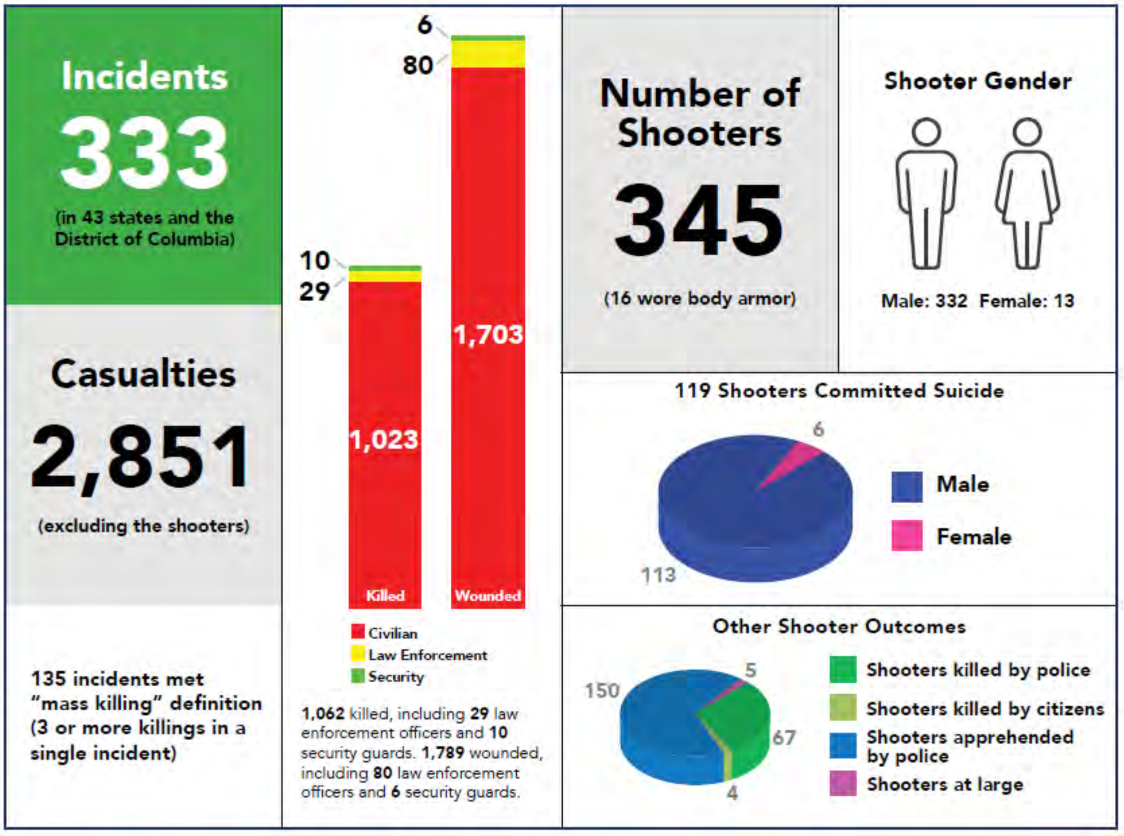
The GTD catalogues more than 200,000 terrorist attacks between 1970 and 2020 (the most recent year the GTD has analyzed). Those incidents averaged roughly one fatality and five injuries per incident. However, this data is to a large extent skewed by a handful of deadly attacks. These five attacks account for 64% of the fatalities and 87% of the injuries from terrorist attacks in the US (none of which occurred in the state of Montana):

- **The September 11, 2001**, attacks on New York and Washington, DC, which killed 1,385 and injured 10,878 – more than all other terrorist attacks in the US since 1970 combined.
- **The October 1, 2017,** shooting at the Route 91 Harvest Festival concert in Las Vegas, Nevada, which killed 59 and wounding 851.
- **The April 4, 2013,** Boston Marathon Bombing killed three and injured 264.
- **The April 19, 1995**, bombing of the Murrah Federal Building in Oklahoma City, killing 168 and injuring 650.
- **The September–October 1984** salmonella food poisoning attack in Dalles, Oregon, which sickened 751 people.

Active Shooter

Figure 4.71 summarizes the outcomes of 333 active shooter incidents in the US from 2000-2019 studied by the FBI. Casualties for active shooter incidents vary widely, with 2,851 casualties from 333 incidents, averaging over 8 deaths per incident. None of these incidents occurred in the state of Montana.

Figure 4.71 Active Shooter Incident Outcomes, 2000-2019



Source: FBI report Active Shooter Incidents, 20-Year Review 2000-2019

Civil Unrest

Civil unrest resulting in large scale protests and demonstrations can have significant impacts to people and infrastructure in a community. The U.S. Crisis Monitor is a database to facilitate efforts in tracking, preventing, and mitigation political violence in America in partnership with the Armed Conflict Location and Event Data Project (ACLED). The U.S. Crisis Monitor reported that in 2020, 11 people in the United States were killed while participating in political demonstrations and another 14 died in incidents linked to political unrest. Property damage, such as broken windows and vandalism, are also commonly reported during violent protests in the United States. However, none of these damages were recorded during protests in the state of Montana.

Vulnerability Assessment

People

Most terrorist attacks are primarily intended to kill and injure as many people as possible. Physical harm from a firearms attack or explosive device is not completely dependent on location, but risk is greater in areas where higher numbers of people gather. If a biological or chemical agent were released indoors, it could result in exposure to a high concentration of pathogens, whereas an outdoors release could affect many more people but probably at a lower dose. Symptoms of illness from a biological or chemical attack could go undetected for days or even weeks. Local healthcare workers may observe a pattern of unusual illness or early warning monitoring systems may detect airborne pathogens. People could also be affected by an attack on food and water supply. In addition to impacts on physical health, any terrorist attack would likely cause significant stress and anxiety.

Similarly, most active shooters primarily target people, attempting to kill or injure large numbers of individuals. The number of injuries and fatalities are highly variable, dependent on many factors surrounding the attack including the location, the number of type of weapons used, the shooter's skill with weapons, the amount of people at the location, and law enforcement response time. Psychological effects of the incident, on not only victims and responders but also the public, may last for years. Civil unrest and large political demonstrations can also result in death or injuries to protestors, responders, and community members.

Property

The potential for damage to property is highly dependent on the type of attack. Terrorist attacks involving explosives or other weapons, may damage buildings and infrastructure. For most attacks, impacts are highly localized to the target of the attack, although attacks could potentially have much broader impacts. Active shooter incidents rarely result in significant property damage, although crime scene measures may deny the use of targeted facilities for days after the incident. Civil unrest can result in damaged property such as broken windows, vandalisms, damaged vehicles, stolen property, and fires.

Critical Facilities and Lifelines

Impacts to critical infrastructure would depend on the site of the attack. Short or long-term disruptions in operations could occur, as well as gaps in continuity of business or continuity of government, depending on who the victims of the attack are, and whether a continuity plan is in place. While active shooter incidents rarely cause major property damage directly, indirect effects can be significant, such as the loss of critical facilities for days or weeks due to crime scene concerns. Terrorists could disrupt communication and electric systems through cyber-attacks. Additionally, terrorism, active shooter incidents, and civil unrest can result in a drain on first responder resources and personnel for days to weeks following the incident.

Economy

Active shooter or terrorist incidents could have significant economic impacts. Specific examples could include short-term or permanent closing of the site of the attack. Another economic impact could be caused by general fear – as an example, an attack in a crowded shopping center could cause potential patrons to avoid similar places and disrupt economic activity. Potential economic losses could include cost of repair or replacement of damaged facilities, lost economic opportunities for businesses, loss of food supplies, disruption of the food supply chain, and immediate damage to the surrounding environment.

As an extreme example, after the September 11, 2001, terrorist attacks in New York and Washington the U.S. stock market lost $1.4 trillion, the Gross Domestic Product of New York City lost an estimated $27 billion, and commercial air travel decreased by 20%. No economic losses were documented in the state of Montana due to human conflict.

Historic and Cultural Resources

Terrorists have been known to target sites with historic or cultural significance. Civil unrest and protests also target historically or politically significant areas, such as capital buildings, which can be damaged during a civil unrest event if a protest turns violent. Additionally, active shooters can target cultural significant areas if the motive is for religious or political reasons.

Natural Resources

Generally, active shooter incidents would not have an impact on the natural environment. Agro-terrorism or chemical terrorism could result in significant damage to the environment in areas near the attack. These events can pollute the environment and cause nearby plants and animals to get sick or die. Contaminated material that gets into the air or water supply can affect humans further away from the incident site.

Development Trends Related to Hazards and Risk

The link between increased development and terrorist attacks is uncertain at best. Many terrorist attacks have targeted larger metropolitan areas, so a larger population could potentially make public events more attractive targets. Population growth and development could expose more people and property to the impacts of an explosive or other large-scale attack.

Depending on the motivation behind the attack, incidents will most likely be focused on so-called “soft targets.” Protective design of buildings can reduce the risk of an active shooter incident, and if one occurs, can mitigate, or reduce the impacts and number of potential victims.

Risk Summary

In summary, the human conflict hazard is considered to be overall low significance for the Region. Variations in risk by jurisdiction are summarized in the table below, followed by key issues noted in the vulnerability assessment.

- There were no recorded incidents of active shooters or terrorist attacks in the Central Region, and only 23 recorded civil unrest cases, all of which occurred in Great Falls; therefore, the ranking of frequency for human conflict is rated as **occasional.**
- Based on potential for death, injury, and significant damage to critical infrastructure and property, magnitude is ranked as **critical.**
- Although human conflict events can occur anywhere in the Region, individual events will typically only impact localized cities. Past events indicate that these events in the Central Region have only occurred in the City of Great Falls; therefore, geographic extent of these events is rated as **limited.**
- Impacts on people from human conflict could include injury and death, as well as psychological damage from being in an incident. None of these impacts occurred in the Central Region.
- Impacts on property include vandalism, theft, and damage. Total destruction of property is possible in the case of an extreme terrorist attack.
- Significant economic damages are possible in the case of a significant terrorist attack due to repairs and business closures.
- In a severe human conflict case, it would be possible for significant disruption of critical facilities including loss of power, transportation interruptions, and disruption of first responders.

- Unique jurisdictional vulnerability: the City of Great Falls was the only jurisdiction in the Central Region to experience civil unrest.
- Related Hazards: Cyber-attack

Table 4-51 Risk Summary Table: Human Conflict

Jurisdiction	Overall Significance	Additional Jurisdictions	Jurisdictional Differences?
Central Region	Low	NA	NA
Blackfeet Tribe	Low	NA	NA
Blaine County	Low	Chinook and Harlem	None; County noted factors that may lead to human conflict included increased cost of living, homelessness, drug use and sales, and mental health.
Cascade County	Medium	Great Falls, Belt, Cascade, and Neihart	All protest events were documented in Great Falls
Chippewa Cree Tribes Rocky Boy's	Low	NA	NA
Chouteau County	Medium	Fort Benton, Big Sandy	None
Fergus County	Low	Lewistown, Denton, Grass Range, Moore, Winifred	None
Fort Belknap Indian Community	Low	NA	NA
Glacier County	Low	Cut Bank	NA
Hill County	Low	Havre, Hingham	None
Judith Basin County	Low	Stanford, Hobson	None
Liberty County	Low	Chester	NA
Petroleum County	Low	Winnett	NA
Phillips County	Low	Malta, Saco	None
Pondera County	Low	Conrad	NA
Teton County	Low	Choteau, Dutton, Fairfield	None
Toole County	Low	Shelby, Kevin, and Sunburst	None

*Rocky Boy's Reservation

4.2.13 Tornadoes & Windstorms

Hazard/Problem Description

Windstorms

Windstorms represent the most common type of severe weather. Often accompanying severe thunderstorms (convective windstorms), they can cause significant property and crop damage, threaten public safety, and disrupt utilities and communications. Straight-line winds are generally any wind not associated with rotation and in rare cases can exceed 100 miles per hour (mph). The National Weather Service defines high winds as sustained wind speeds of 40 mph or greater lasting for one hour or longer, or wind gusts of 58 mph or greater for any duration. Windstorms can be produced by super-cell thunderstorms or a line of thunderstorms that typically develop on hot and humid days. According to the 2018 State of Montana HMP, high winds can occur with strong pressure gradients or gusty frontal passages. These winds can affect the entire State with wind speeds of more than 75-100 mph.

For this hazard, three different classifications of windstorms were analyzed: high winds, strong winds, and thunderstorm winds. The most significant distinction between high winds and thunderstorm winds in the NCEI dataset is that high winds are most frequently reported in the winter months (December, January, and February) and are recorded on a zonal scale, whereas thunderstorm winds are most reported in the summer months (June, July, and August) and recorded on a local county or city scale. Strong winds are another type of windstorm, which originates from thunderstorms and are any wind exceeding 58 mph. Strong winds are the least frequently documented category of wind in the Central Region. Despite these differences, the wind speeds and associated impacts from these winds are comparable.

Wind speed can also be rated on the Beaufort wind scale (Table 4-52). The Beaufort wind scale is particularly useful for estimating wind speed in the absence of instrumentation. This LHMP update uses the aforementioned NCEI wind speed classifications and data to evaluate wind hazard extent.

Table 4-52 Beaufort Wind Scale

Force	Speed (mph)	Description
0	0-1	Calm
1	1-3	Light Air
2	4-7	Light Breeze
3	8-12	Gentle Breeze
4	13-18	Moderate Breeze
5	19-24	Fresh Breeze
6	25-31	Strong Breeze
7	32-38	Near Gale
8	39-46	Gale
9	47-54	Severe Gale
10	55-63	Storm
11	64-72	Violent Storm
12	72-83	Hurricane

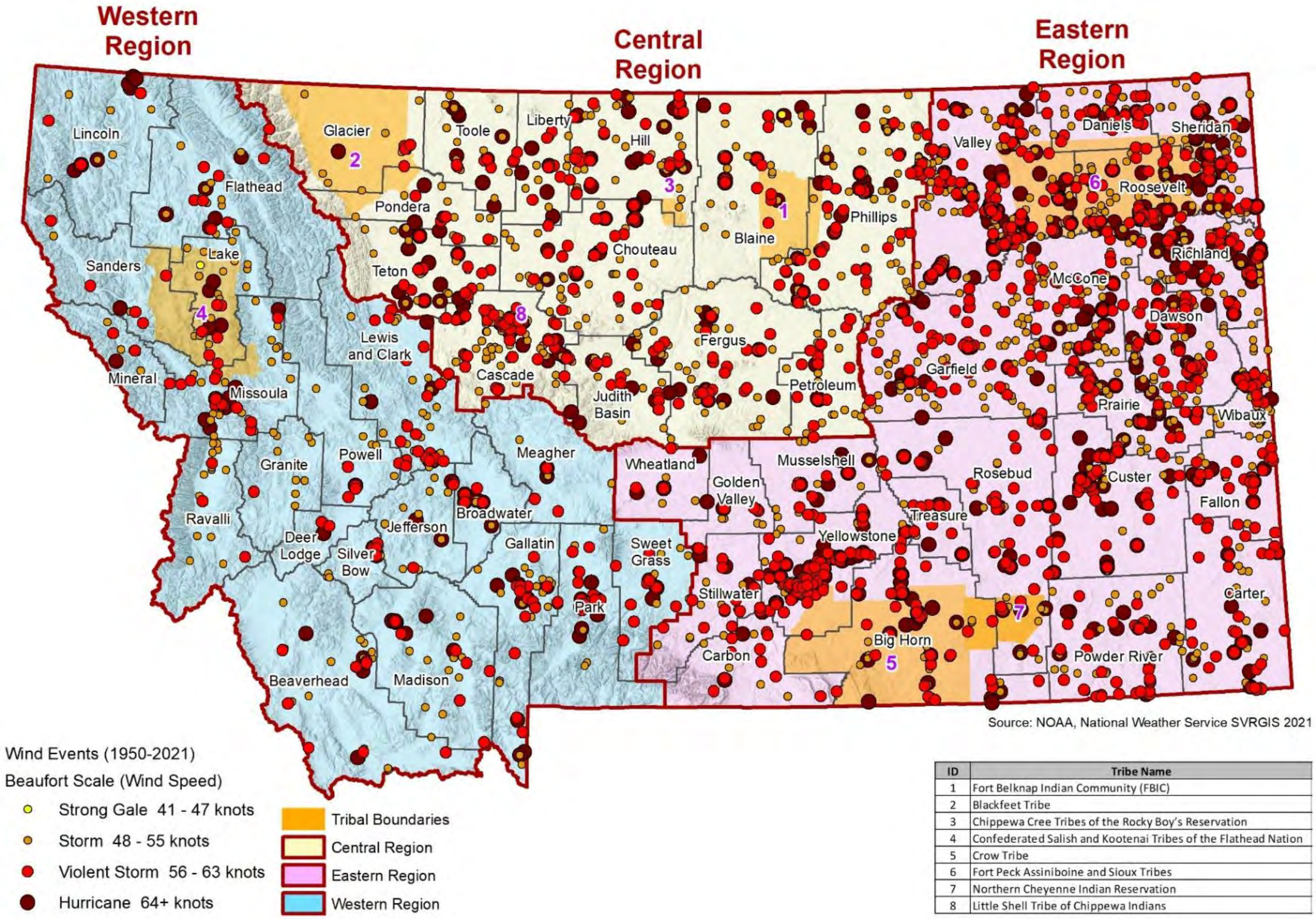
Tornadoes

Tornadoes are one of the most destructive types of severe weather. According to the 2018 State of Montana HMP, a tornado is a violently rotating column of air in contact with the ground and extending from the base of a thunderstorm. Until 2006, tornadoes were categorized by the Fujita scale based on the tornado's wind speed. The Enhanced Fujita (EF) Scale was implemented in place of the Fujita scale and began operational use on February 1, 2007. The EF scale has six categories from zero to five representing increasing degrees of damage. It was revised to better align wind speeds closely with associated storm damage. It also adds more types of structures as well as vegetation, expands degrees of damage, and better accounts for variables such as differences in construction quality. The EF-scale is a set of wind estimates based on damage. It uses three-second estimated gusts at the point of damage. These estimates vary with height and exposure. Forensic meteorologists use 28 damage indicators and up to 9 degrees of damage to assign estimated speeds to the wind gusts. Table 4-53 describes the EF-scale ratings versus the previous Fujita Scale used prior to 2007 (NOAA 2007).

Table 4-53 The Fujita Scale and Enhanced Fujita Scale

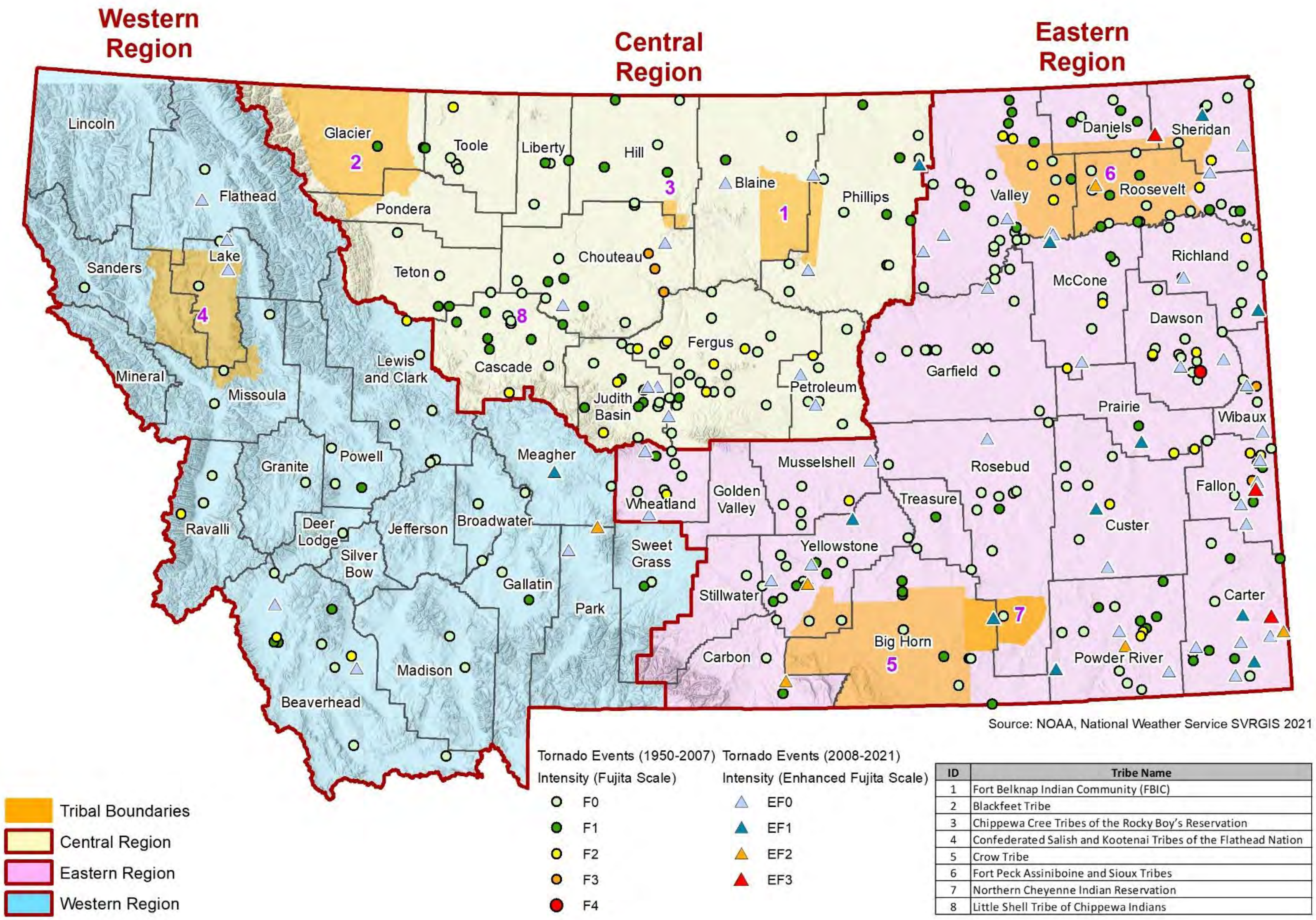
Fujita Scale	Derived		Operational EF Scale	
F Number	Fastest ¼ mile (mph)	3-second gust (mph)	EF Number	3-second gust (mph)
0	40-72	45-78	0	65-85
1	73-112	79-117	1	86-109
2	113-157	118-161	2	110-137
3	158-207	162-209	3	138-167
4	208-260	210-261	4	168-199
5	261-318	262-317	5	200-234
Notes: EF = Enhanced Fujita; F = Fujita; mph = Miles per Hour				

Figure 4.72 Wind Events in Montana by Region 1955-2021



ID	Tribe Name
1	Fort Belknap Indian Community (FBIC)
2	Blackfeet Tribe
3	Chippewa Cree Tribes of the Rocky Boy's Reservation
4	Confederated Salish and Kootenai Tribes of the Flathead Nation
5	Crow Tribe
6	Fort Peck Assiniboine and Sioux Tribes
7	Northern Cheyenne Indian Reservation
8	Little Shell Tribe of Chippewa Indians

Figure 4.73 Past Tornado Events in Montana by Region (1950-2021)



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5	Crow Tribe
6	Fort Peck Assiniboine and Sioux Tribes
7	Northern Cheyenne Indian Reservation
8	Little Shell Tribe of Chippewa Indians

Geographical Area Affected

The spatial extent rating for both tornadoes and wind hazards is **extensive**. Windstorms and tornadoes can occur anywhere in the Central Region. The rural, unpopulated areas of the County will experience the highest frequency of wind events due to flat, open land. However, the Montana State Hazard Mitigation Plan 2018 highlights that greatest monetary losses due to property damages are likely to occur in cities with concentrated infrastructure. Tornadoes could also potentially occur anywhere in the planning area. Figure 4.72 and Figure 4.73 display the historic wind and tornado events in the State of Montana by region.

Past Occurrences

The National Centers for Environmental Information (NCEI) database was used to gather information on historic severe summer weather events in the Central Region of Montana. The NCEI data is a comprehensive list of oceanic, atmospheric, and geophysical data across the United States and aggregated by county and zone. It is important to note that tornado and wind events that occurred on Native American Reservations such as Blackfeet Tribe, Fort Belknap Tribe, and Chippewa Cree (Rocky Boys) Tribe, are also included in the dataset tables down below. However, instead of individual records, tribal data records were grouped into the nearest County. The NCEI uses unique methods of recording various hazards. High wind and strong wind are recorded by zone rather than by county and these datasets begin in 1996. Thunderstorm wind is recorded by county and the dataset starts in 1955. Tornadoes are also recorded by county and the dataset begins in 1950. All these datasets contain information up to March 2022.

The NCEI database reported 4,136 windstorm events on 1,325 days and 119 tornado events on 87 days. A summary of these events is captured in Table 4-54. In total, over $24 million was lost in property damages and $1.6 million in crop losses. Two fatalities and 23 injuries were also reported in the Central Region. It is important to note that due to the nature of the NCEI data, losses from unreported events are not included in the dataset and some losses may be duplicated between counties; therefore, the real losses from severe windstorms and tornadoes are likely different than what is displayed in the table below, but estimates are useful for planning purposes.

Table 4-54 Summary of Losses by Hazard in the Central Region

	Deaths	Injuries	Property Loss	Crop Loss	Days with Events	Total Events
High Wind	2	10	$1,526,000	$0	853	2,838
Strong Wind	0	0	$20,000	$0	5	12
Thunderstorm Wind	0	2	$12,364,700	$1,555,000	467	1,286
Tornadoes	0	11	$10,969,810	$50,000	87	119
Total	**2**	**23**	**$24,880,510**	**$1,605,000**	**1,412**	**4,255**

Source: NCEI

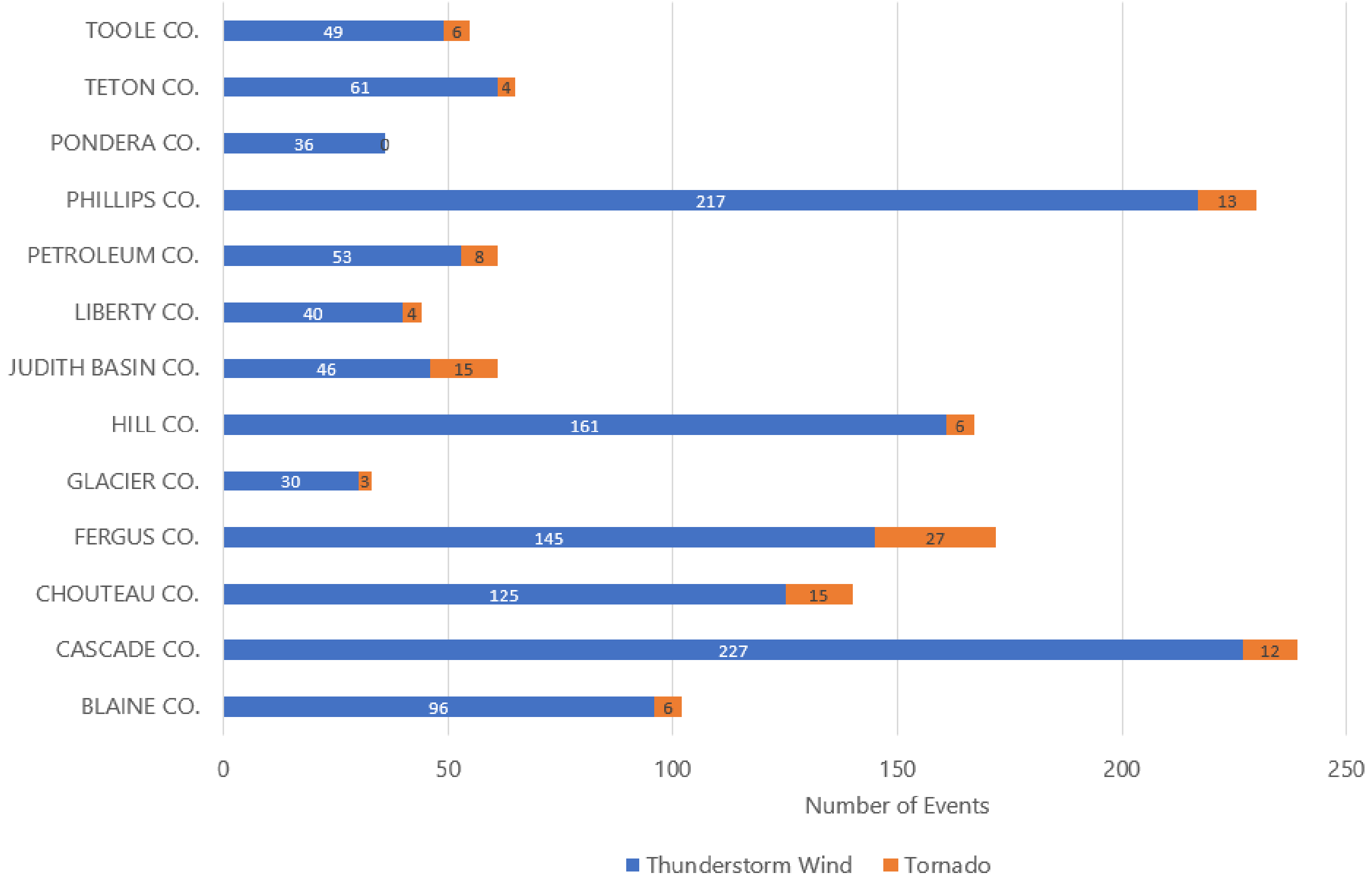
The NCEI dataset reports variation in the frequency of events across the Central Region. High winds are the most common type of windstorm event, and the North Rocky Mountain Front Zone experiences the highest frequency of these events. The Southern Rocky Mountain Front Zone and Cascade Zone also experience a high frequency of wind events in comparison to the other counties in the planning area. Table 4-55 and Figure 4.74 below displays a summary of high wind and strong wind events by zone.

Table 4-55 Total High Wind and Strong Wind Events by Zone (1996 to 2022)

	High Wind	Strong Wind	Total
Blaine (Zone)	141	0	**141**
Blaine / Chouteau / Hill (Zone)	36	0	**36**
Blaine/Hill (Zone)	6	0	**6**
Cascade (Zone)	268	4	**272**
Cascade / Eastern Teton (Zone)	20	0	**20**
Cascade/Eastern Teton/Judith Basin (Zone)	3	0	**3**
Central And SE Phillips (Zone)	53	0	**53**
Chouteau (Zone)	122	1	**123**
Eastern Pondera (Zone)	108	0	**108**
Eastern Teton (Zone)	139	0	**139**
Fergus (Zone)	162	0	**162**
Fergus / Judith Basin (Zone)	26	0	**26**
Fergus/Chouteau (Zone)	2	0	**2**
Hill (Zone)	139	0	**139**
Judith Basin (Zone)	147	2	**149**
Liberty (Zone)	119	2	**121**
Little Rocky Mountains (Zone)	124	0	**124**
North Rocky Mountain Front (Zone)	569	1	**570**
Northern Phillips (Zone)	28	0	**28**
Petroleum (Zone)	29	0	**29**
Phillips (Zone)	7	0	**7**
Rocky Mountain Front (Zone)	15	0	**15**
Southern Rocky Mountain Front (Zone)	372	1	**373**
Toole (Zone)	202	1	**203**
W Glacier/W Pondera/W Teton/N Lewis/ Clark (Zone)	1	0	**1**
Total	**2,838**	**12**	**2,850**

Source: NCEI

Figure 4.74 Total Thunderstorm Wind and Tornado Events by Zone (1996 to 2022)



Source: NCEI, Chart by WSP

Similar to high wind and strong wind, there are variations in thunderstorm wind between counties in the Central Region. Cascade County experienced the greatest number of thunderstorm wind events and Fergus County experienced the greatest number of tornado events. In total, there were 1,286 thunderstorm wind events since 1955 and 119 tornado events since 1950 in the Central Region. Table 4-56 displays a summary of these events.

Table 4-56 Total Thunderstorm Wind and Tornado Events by Zone

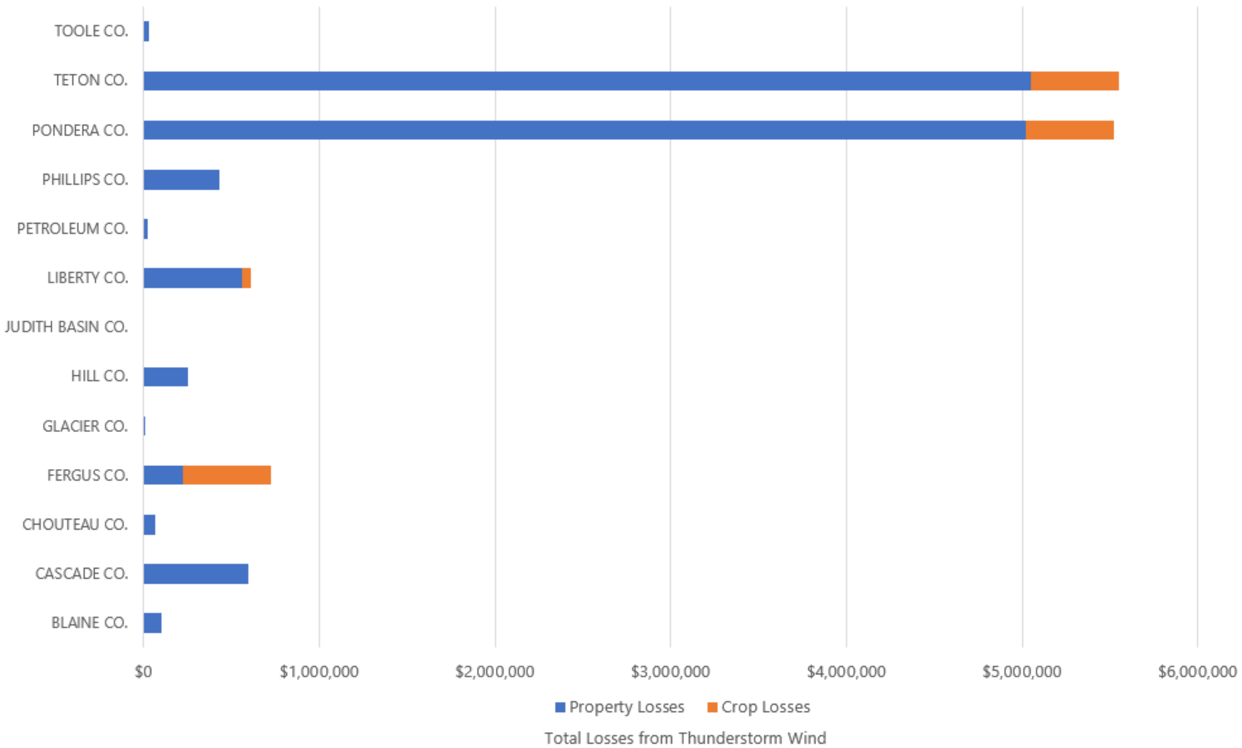
County	Thunderstorm Wind	Tornadoes
Blaine County	96	6
Cascade County	227	12
Chouteau County	125	15
Fergus County	145	27
Glacier County	30	3
Hill County	161	6
Judith Basin County	46	15
Liberty County	40	4

County	Thunderstorm Wind	Tornadoes
Petroleum County	53	8
Phillips County	217	13
Pondera County	36	0
Teton County	61	4
Toole County	49	6
Total	**1,286**	**119**

Source: NCEI

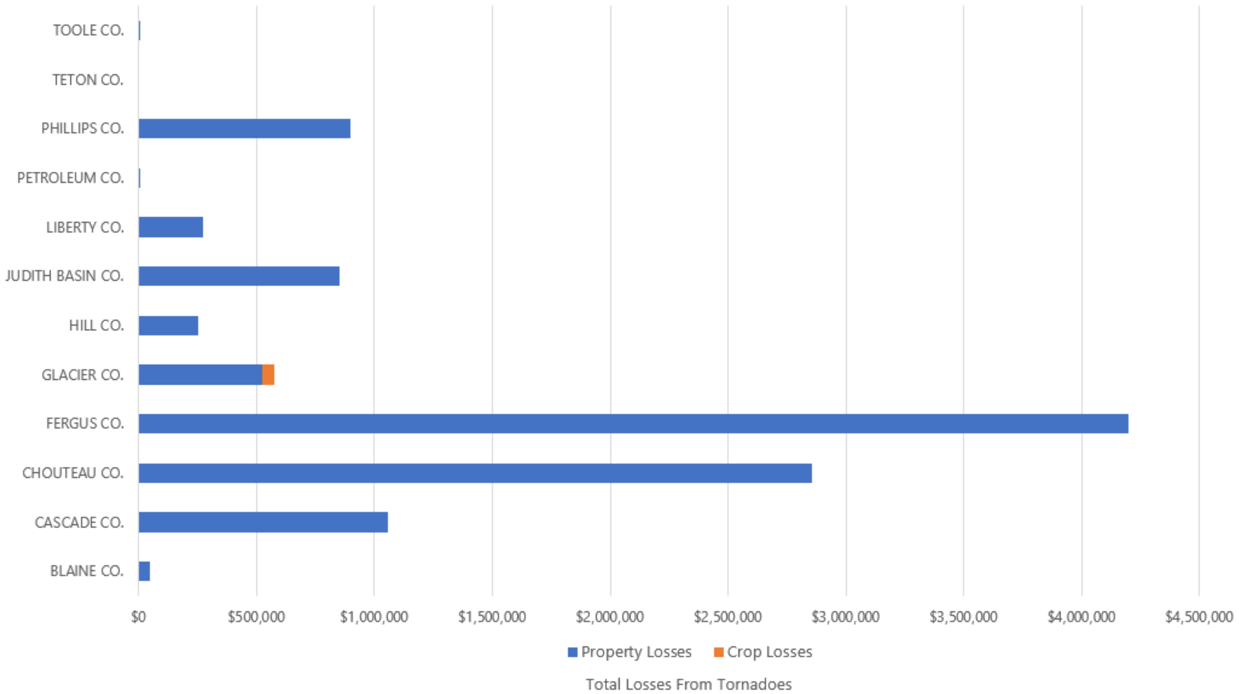
Figure 4.75 and Figure 4.76 display crop and property losses by county from tornado and thunderstorm wind events. According to the dataset, Teton and Pondera Counties experienced the highest property loss and Fergus and Chouteau Counties experienced the greatest crop loss. It is important to note that the over $5 million in property damages from thunderstorm wind recorded in Teton and Pondera Counties is due to the same event that impacted both areas.

Figure 4.75 Total Losses from Thunderstorm Wind by County



Source: NCEI, Chart by WSP

Figure 4.76 Total Losses from Tornadoes by County



Source: NCEI, Chart by WSP

The NCEI reported details on significant events in the Central Region:

- **April 11, 2022**: Mission Valley Power reported downed trees on Finley Point and in the Snyder Hill and Addy Lane areas. Utility crews reported two broken power poles and multiple downed lines. Downed trees in Bigfork and Ferndale led to power outages in Flathead County. Reported losses totaled $50,000.
- **April 4, 2022:** High winds knocked down trees in Thompson Falls; 500 customers lost power. High winds downed a ponderosa pine tree, injuring and hospitalizing a local resident. Estimated losses totaled $5,000.
- **November 15, 2021:** Multiple trees were reported down, some damaging power lines, due to high winds along US-2 and US-93. A Facebook dashcam video showed a vehicle hitting a falling tree during the storm. Several thousand citizens were without power for close to 12 hours after the event across western Montana. Estimated losses totaled $262,000.
- **July 6, 2021:** A supercell moved southeast across Blaine County early Tuesday evening. This storm produced a large hail of nearly two inches in diameter along its path. As the severe storm approached Hays, rotation strengthened slightly to where a brief tornado occurred. The tornado occurred over open ranchland to the west of Montana and Highway 66.
- **June 13, 2006:** A farm/ranch was significantly damaged by a EF1 tornado and damaging downburst winds in Glacier County. The storm stripped trees bare. Four car garages were either destroyed or damaged. A 1,000-gallon fuel tank that was filled that day was blown off its stand. The houses received significant damage from hail and the high winds, and the majority of the windows on the two homes were busted out by the wind and hail. A 2x6 piece of lumber was blown and implanted

into the side of one of the houses. The peak gust was recorded at 86 mph before the sensor was destroyed. Losses totaled $300,000.

- **September 1, 2003:** A severe thunderstorm produced a wind gust of 65 mph in Hill County. A roofer sustained minor injuries when he was blown off the building he was working on. The thunderstorm overturned an unoccupied trailer, knocked down numerous power and phone lines, and broke the windshields of a dozen vehicles at two car dealerships.

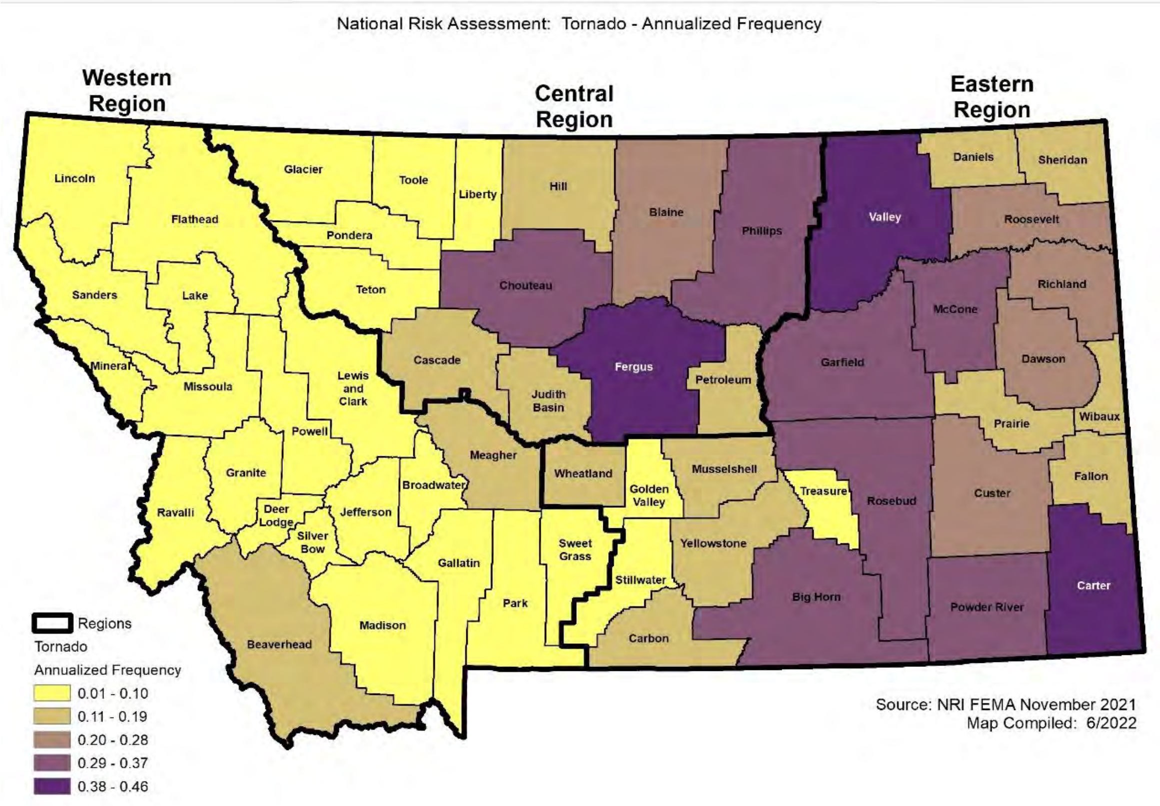
Frequency/Likelihood of Occurrence

According to the NCEI dataset, there has been 4,255 total recorded severe windstorm and tornado events on 1,412 days over the past 72 years in the Central Region; therefore, there is an average of nearly 20 days with severe wind and tornado events per year in the planning area. This corresponds to a **highly likely** probability of occurrence.

Strong wind is the least documented type of windstorm in the Region and high winds are the most common. Based on the NCEI dataset, tornadoes are likely to occur somewhere in the Region around 1.2 times a year on average. Fergus County has the most documented reports of tornado events. The highest number of wind events occur along the Rocky Mountain Front (Glacier, Teton, and Cascade Counties), according to the 2018 Montana State Hazard Mitigation Plan.

Figure 4.77 below depicts annualized frequency of tornado events at a county level based on the NRI. The mapping shows a trend towards increased likelihood in the eastern and southern region, particularly in Fergus, Chouteau, and Phillips Counties. Counties in the northwestern portion of the Region have lowest frequency of tornado events.

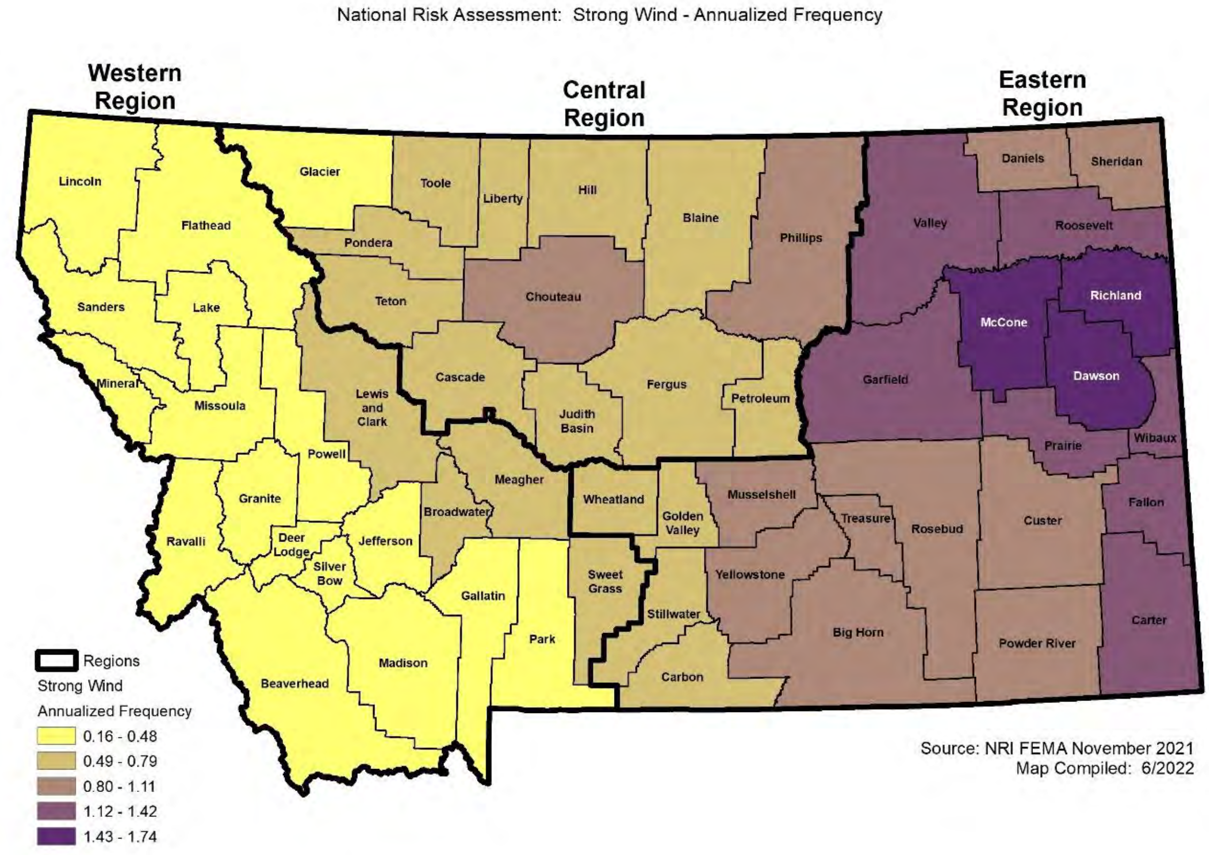
Figure 4.77 Annualized Frequency of Tornado Events by County



Map by WSP, Data Source: FEMA National Risk Index, https://hazards.fema.gov/nri/determining-risk

Figure 4.78 depicts annualized frequency of strong wind events at a county level based on the NRI. A majority of the counties in the region are ranked as relatively low frequency, with greatest frequency of events occurring in Chouteau and Phillips Counties.

Figure 4.78 Annualized Frequency of Strong Wind Events by County



Map by WSP, Data Source: FEMA National Risk Index, https://hazards.fema.gov/nri/determining-risk

Climate Change Considerations

There is apparently no documentation of how climate change may be affecting present or future summertime windstorms or tornadoes. This is perhaps not surprising, these events occur over relatively small scales, which makes observations and modeling more challenging. Projecting the future influence of climate change on these events can be complicated by the fact that some of the risk factors for these events may increase with climate change, while others may decrease.

The 2022 NOAA Climate Summary acknowledges summertime high winds exist but provides no indication if a trend currently exists. The Fifth National Climate Assessment, chapter 25 on the Northern Great Plains region does not directly address climate-change impacts on summertime wind. This chapter also did not suggest a trend in wind conditions exists, or is anticipated, based on a review of a lengthy discussion of developing wind turbine generated electricity. The 2021 Montana Climate Change and Human Health report does not directly address the issue of summertime high winds. Interestingly, this report discusses an increase in wind erosion of soil in wheat production, but attributes this to increased summer drought and changing precipitation patterns, without mention of changes in wind conditions.

Potential impacts are discussed in the Vulnerability subsection of this hazard profile, as well as the impacts of population changes and development trends. Current variability in vulnerability by jurisdiction, based on existing conditions, is discussed in these sections and jurisdictional annexes. Due to the uncertainty with climate change on tornadoes and windstorms, it would be speculative to define with further specificity the impacts related to climate change on each jurisdiction within the Region. Future updates to this plan should revisit this topic as scientific knowledge progresses.

Potential Magnitude and Severity

To calculate a magnitude and severity rating for comparison with other hazards, and to assist in assessing the overall impact of the hazard on the planning area, information from the event of record is used. In some cases, the event of record represents an anticipated worst-case scenario, and in others, it reflects common occurrence. Based on NCEI records, $24.8 million was recorded in property damages, $1.6 in crop losses, 23 injuries and 2 fatalities has been recorded in the Central Region. While it is possible these estimates are greater than actual losses due to potential duplicates in the dataset, these losses provide an understanding of the likely magnitude in the planning area.

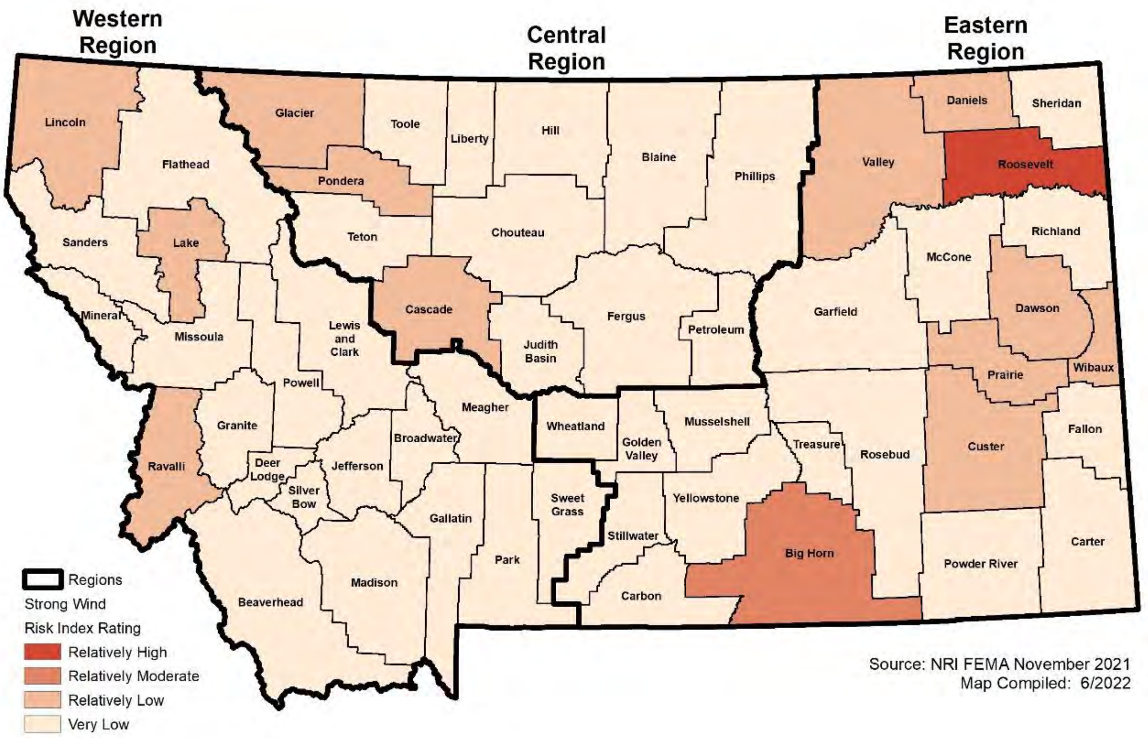
Overall, windstorm or tornado impacts in Central Region are generally **limited**, with less than 10 percent of the planning area affected. While wind occurs rather frequently in the area, most events cause little to no damage. The impact on quality of life or critical facilities and functions in the affected area would be minimal. Injuries or deaths are possible due to wind-thrown trees in the backcountry or from other blown debris.

Vulnerability Assessment

The situation in the Central Region with regard to tornadoes and windstorms is that Cascade County has cause for mild concern, while the rest of the planning area has very low vulnerability to these hazards. Cascade County is one of three counties in the Central Region with an NRI risk rating of relatively low for strong wind, all other counties received the minimum rating of very low (Figure 4.79) and the only county with an NRI risk rating of relatively low for tornado, all other counties in the Central Region earned the minimum value of very low (Figure 4.80). The NRI risk index is calculated as expected annual lossFigure 4.66 (EAL) multiplied by social vulnerability, divided by community resilience and provides a measure of how severely the rated hazard is experienced.

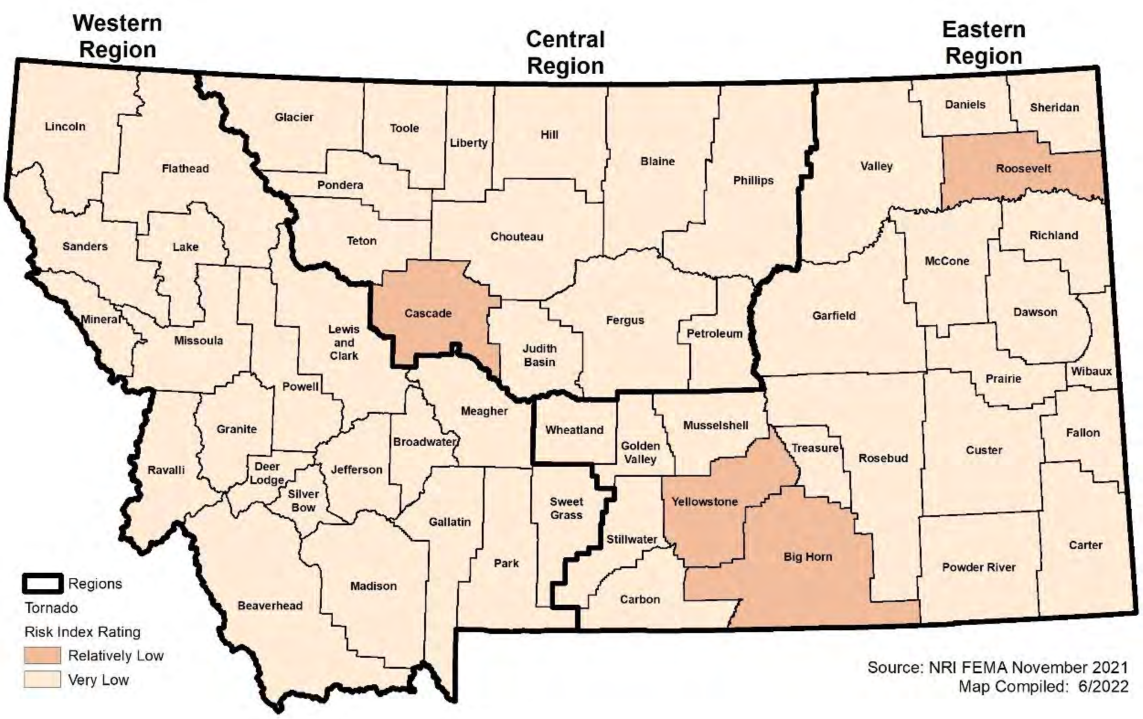
In addition, Cascade County was the only county in the planning area to earn a rating of relatively low for EAL due to either strong wind (Figure 4.81) or tornado (Figure 4.82). All other counties earned the minimum rating of very low for both hazards. EAL is based on exposure to buildings, agriculture, and people multiplied by the annualized frequency of hazard events, multiplied by the historic loss ratio, a value that represents the estimated percentage of exposed buildings, agriculture, or people expected to be lost during a hazard event.

Figure 4.79 NRI Risk Index Rating for Strong Wind



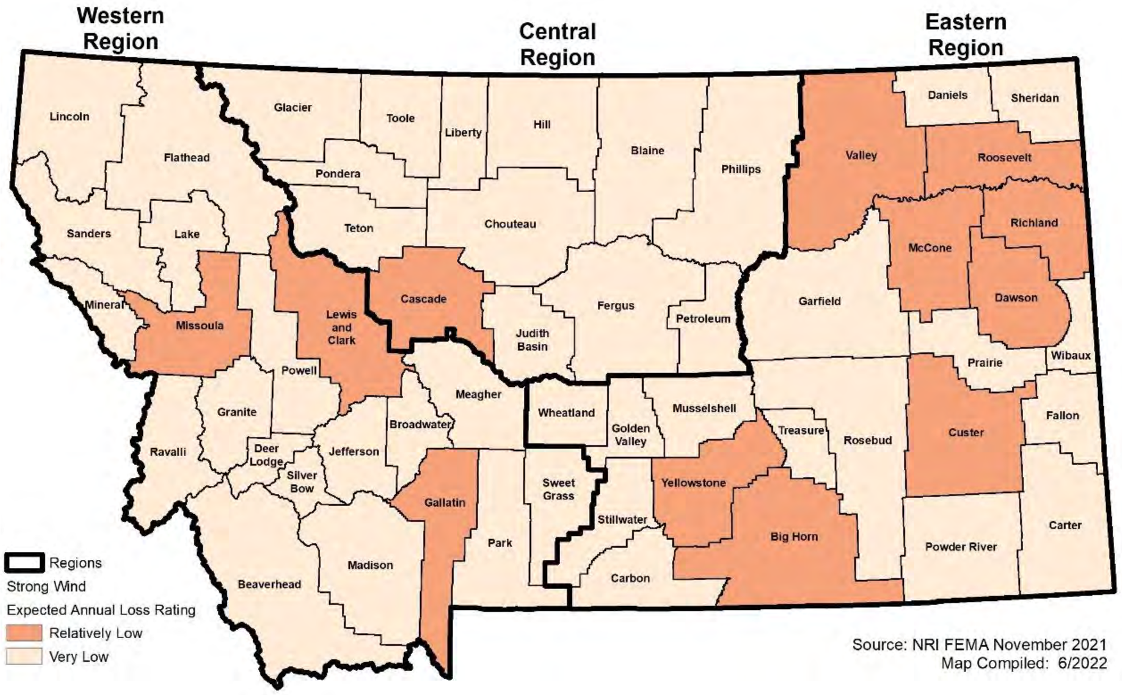
Map by WSP, Data Source: FEMA National Risk Index, https://hazards.fema.gov/nri/determining-risk

Figure 4.80 NRI Risk Index Rating for Tornadoes



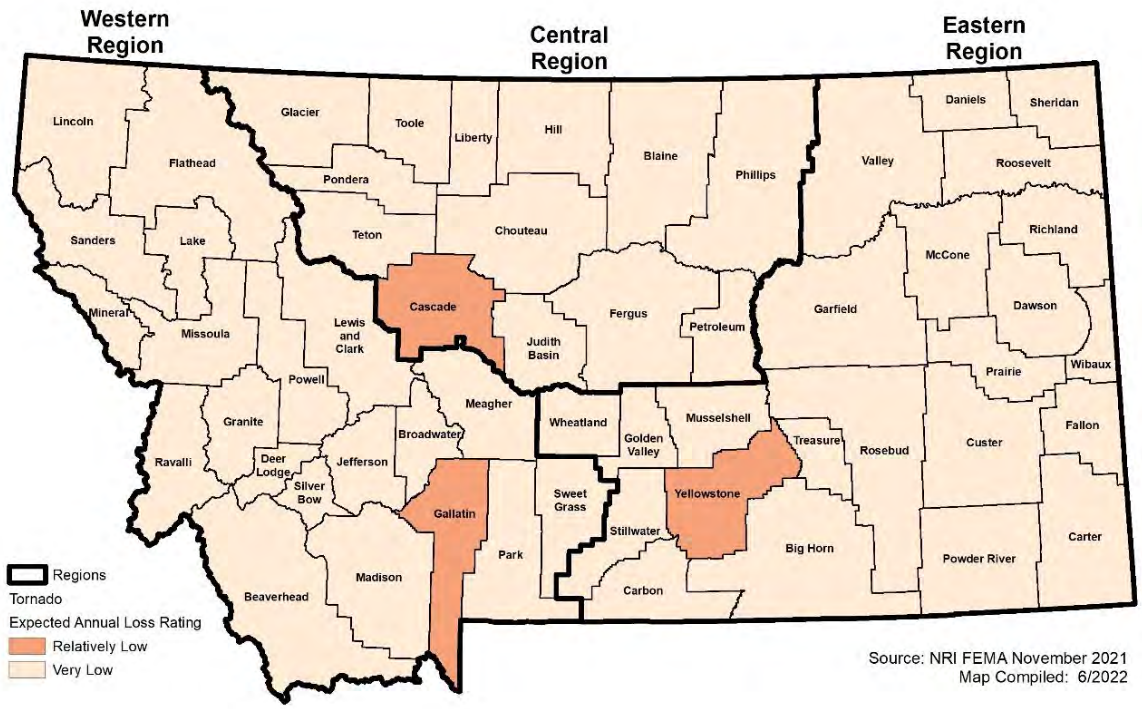
Map by WSP, Data Source: FEMA National Risk Index, https://hazards.fema.gov/nri/determining-risk

Figure 4.81 NRI Strong Wind Expected Annual Loss Rating



Map by WSP, Data Source: FEMA National Risk Index, https://hazards.fema.gov/nri/determining-risk

Figure 4.82 NRI Tornado Events Expected Annual Loss Rating



Map by WSP, Data Source: FEMA National Risk Index, https://hazards.fema.gov/nri/determining-risk

People

As described above, the planning area is only slightly exposed to windstorm and tornadoes, with the majority of concern being isolated to Cascade County. Some populations are susceptible to these hazards, notably the unhoused and those living in mobile homes. Overall, however, the vulnerability of people to these hazards is low.

Property

While exposure to windstorms and tornadoes is low throughout the planning area, property in poor condition or in particularly vulnerable locations may be susceptible to damage when these hazards do occur. Property located at higher elevations and on ridges may be more prone to wind damage. Property located under or near overhead powerlines or large trees may be damaged in the event of a collapse.

Older buildings in the planning area may be built to low code standards or none at all, making them more susceptible to severe wind and tornado events. Mobile homes are disproportionately at risk due to the design of homes. Tornadoes often create flying debris which can cause damages to homes, vehicles, and landscape. In the Central Region, property damages due to wind and tornadoes totaled over $24 million. Reported impacts from high wind in the planning area include damage to trees, mobile homes, roofs, power lines, and vehicles.

Critical Facilities and Lifelines

Temporary blockage of roads by downed trees or power lines is the primary susceptibility of transportation failures to windstorms and tornadoes. Of particular concern are roads providing access to isolated areas and the elderly. Temporary loss of utilities, most notably power, is a susceptibility. Downed power lines can cause blackouts, leaving large areas isolated, which was reported several times in the NCEI dataset. Phone, water, and sewer system service can be interrupted. Loss of phone connection, cellular or landline, would leave populations isolated and unable to call for assistance. Ultimately, however, exposure to these hazards is very low, except for a slightly elevated exposure in Cascade County.

Economy

Exposure of the economy of the Central Region to ill effects is somewhat different for tornado and windstorm hazards. Windstorms are more frequent in the Central Region and have less intense impact over a wider area. In contrast, tornadoes are relatively rare, effect a relatively small area, but have a well-deserved reputation for causing intense destruction over a relatively narrow area. Both hazards expose local economies to potential property damage, business closures, loss of services such as power and transportation, displacement of people, loss of tourism and difficult to predict cascading effects. However, the economy is exposed to these factors somewhat differently depending on the storm type. For example, tornadoes are more likely to cause displacement of people, while windstorms can cumulatively cause very expensive damage, especially to housing.

In addition, the economy of the central region is susceptible to damage from exposures such as property damage, business closures, loss of services such as power and transportation, displacement of people, loss of tourism. The economy is also susceptible to cascading effects caused by these exposures.

When exposure and susceptibility is considered together, most economic loss due to wind and tornadoes is related to direct property damage and subsequent debris removal, response, and repair activities. Business closures, displacement of people, and loss of tourism also reduce economic activity and can cause substantial damage to local economies. The loss of services related to lifelines (Figure 4.2) can have a profound effect on the extent of damage to the economy. Loss of power and shelter/housing are particularly important in this regard.

Most counties in the region have a relatively moderate rating; none has high or very high-risk EAL rating. The EAL calculation takes into account the consequence of strong wind and tornado on agriculture, the population, and buildings that are exposed to these events, as well as the annualized frequency, and historical losses.

Historic and Cultural Resources

Historic and cultural resources are exposed to tornadoes and windstorms similarly to other assets. In terms of susceptibility, historic buildings are typically built to old building codes or no codes at all and are more likely to sustain damage than newer buildings. This causes historic buildings and their contents to be more vulnerable to windstorms and tornadoes than newer buildings. Historic assets within newer buildings, such as a more recently built museum, are likely no more vulnerable to windstorm and tornadoes than non-historic assets.

Natural Resources

All natural resources are exposed to severe winds and tornadoes. In terms of susceptibility, tree blowdown occurs, especially in the beetle-killed forests prevalent in the area. Crops are also susceptible, especially to windstorm. The NCEI dataset reported $1.6 million in crop losses from windstorm and tornado events in the Central Region, which provides some insight to the extent of crop vulnerability. Natural resources are also vulnerable to indirect effects of windstorm and tornadoes. For example, severe winds can trigger or spread destructive wildfires.

Development Trends Related to Hazards and Risk

All future development will be exposed to severe winds and tornadoes.

The State of Montana has adopted the 2012 International Building Code (IBC). The IBC includes a provision that buildings must be constructed to withstand a wind load of 75 mph constant velocity and three-second gusts of 90 mph.

The building code described above mitigates the susceptibility of new development to these hazards to a considerable degree. However, as discussed in the subsection above titled *Property*, mobile homes, roofs, power lines, and vehicles are commonly damaged by windstorms and are susceptible to tornadoes.

In concept, building regulations that require safe rooms, basements, or other structures that reduce risk to people from tornado hazards would decrease the vulnerability of people. However, this may not be cost-effective given the relative infrequency of damaging tornadoes in the Central Region.

Risk Summary

In summary, the tornadoes and windstorms hazard is considered to be overall medium significance for the Region. with key issues summarized below. Variations in risk by jurisdiction are summarized in the table below.

- Severe windstorms (high wind, strong wind, thunderstorm wind) and tornado events are rated as **high** overall significance for the Central Region
- These events can impact anywhere in the planning region; therefore, the hazard extent is rated as **extensive**.
- The NCEI data reported 1,412 days with severe weather events over 72 years, which averages to nearly 20 days a year with severe winter weather events in the Central Region; therefore, the future occurrence is rated as **highly likely.**
- The NCEI reported 2 deaths, 23 injuries, $24.8 million in property damages and $1.6 million in crop damages, therefore the magnitude is rated as **limited.**
- People who are dependent on electricity and populations who work outdoors or in transportation are most vulnerable to severe windstorm events and tornadoes. Individuals living in mobile homes are also disproportionately likely to experience losses from wind and tornado events.

- Power outages and damage to buildings are frequently reported impacts to property of severe windstorm events and tornadoes.
- Downed power lines resulting in communication and electricity failures are the most common impacts on critical facilities
- Significant economic losses are possible in the event of a severe windstorm or tornado due to infrastructure repair and business/service disruptions
- Related Hazards: Wildfire, Severe Summer Weather, Severe Winter Weather, Transportation Accidents

Table 4-57 Risk Summary Table: Tornadoes and Windstorms

Jurisdiction	Overall Significance	Additional Jurisdictions	Jurisdictional Differences?
Central Region	High	NA	NA
Blackfeet Tribe	Medium	NA	NA
Blaine County	Medium	Chinook and Harlem	None
Cascade County	High	Great Falls, Belt, Cascade, and Neihart	Great Falls is likely to experience greater losses due to greater population and more concentrated infrastructure
Chippewa Cree Tribes Rocky Boy's Reservation	Medium	NA	NA
Chouteau County	High	Fort Benton, Big Sandy	None
Fergus County	High	Lewistown, Denton, Grass Range, Moore, Winifred	Medium in Denton, Grass Range, and Winifred
Fort Belknap Indian Community	Medium	NA	NA
Glacier County	High	Cut Bank	NA
Hill County	Medium	Havre, Hingham	Havre population is significantly larger, more infrastructure, so losses likely to be higher
Judith Basin County	High	Stanford, Hobson	None
Liberty County	Medium	Chester	NA
Petroleum County	Medium	Winnett	NA
Phillips County	Medium	Malta, Saco	None
Pondera County	High	Conrad	NA
Teton County	High	Choteau, Dutton, Fairfield	None
Toole County	High	Shelby, Kevin, and Sunburst	None

4.2.14 Transportation Accidents

Hazard/Problem Description

This hazard encompasses air transportation, highway transportation, waterway transportation, railway transportation, and wild animal vehicle collisions. The transportation incidents can involve any mode of transportation that directly threatens life and which results in property damage and/or death(s)/injury(s) and/or adversely impact a community's capabilities to provide emergency services. Incidents involving buses and other high occupancy vehicles could trigger a response that exceeds the normal day-to-day capabilities of response agencies.

Air Transportation

An air transportation incident may involve a military, commercial or private aircraft. Airplanes and helicopters are used to transport passengers for business and recreation as well as thousands of tons of cargo. A variety of circumstances can result in an air transportation incident; mechanical failure, pilot error, enemy attack, terrorism, weather conditions and on-board fire can all lead to an air transportation incident.

Highway Transportation

Highway transportation incidents are very complex. Contributing factors can include a roadway's design and/or pavement conditions (e.g., rain, snow, and ice), a vehicle's mechanical condition (e.g., tires, brakes, lights), a driver's behavior (e.g., speeding, inattentiveness, and seat belt usage), the driver's condition (e.g., alcohol use, age-related conditions, physical impairment) and driver inattention by using a wireless device.

Railway Transportation

A railway transportation incident is a train accident that directly threatens life and/or property, or adversely impacts a community's capabilities to provide emergency services. Railway incidents may include derailments, collisions and highway/rail crossing accidents. Train incidents can result from a variety of causes; human error, mechanical failure, faulty signals, and/or problems with the track. Results of an incident can range from minor "track hops" to catastrophic hazardous material incidents and even human/animal casualties.

Waterway Transportation

A waterway incident is an accident involving any water vessel that threatens life, property, or adversely affects a community's capability to provide emergency services. Waterway incidents primarily involve pleasure craft on rivers and lakes. Waterway incidents may also include events in which a person, persons, or object falls through the ice on partially frozen bodies of water. Impacts include fuel spillage, drowning, and property damage.

Wild Animal Vehicle Collisions

Wild animal vehicle collisions consist of any roadway transportation accident where an animal is involved in the accident. These accidents typically occur at dusk, from 6pm-9pm, when deer and other wildlife are most active and when the visibility of drivers decreases (Hothorn et al, 2015). Deer are the most common wild animal involved in roadway transportation accidents in the United States and in the Central Region.

Geographical Area Affected

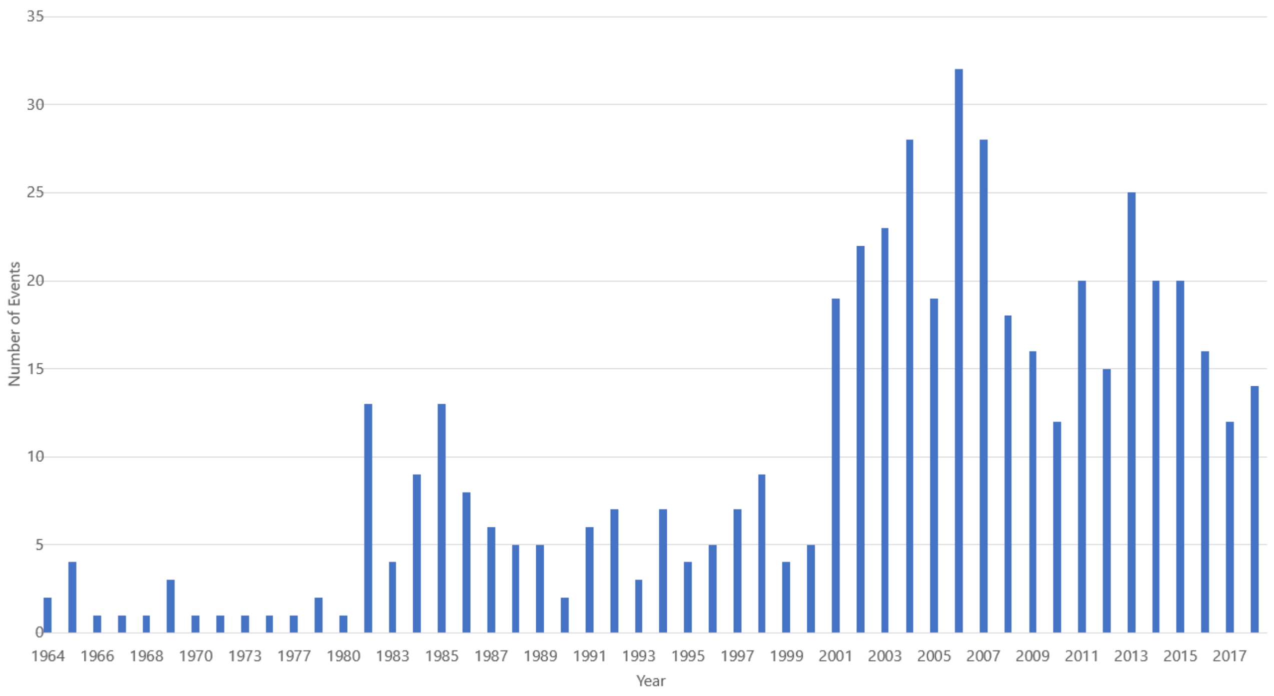
All counties in the Central Region are subject to transportation incidents. Due to transportation accidents typically occurring along roadways, waterways, or near airports, the significance rating for the geographic area affected in the Central Region is rated as **significant** (10-50% of planning area). Roads with frequently reported roadway transportation accidents in the Central Region include Highway 2, U.S. Route 191, U.S. Route 87, and Interstate 15. The BNSF railway is the most significant railway running through the Central Region; therefore, the counties that contain the BNSF will be more likely to experience railway accidents. There are also several major airports in the region, including the Bert Mooney Airport in Butte, the Great Falls International Airport in Great Falls, and the Glacier Park International Airport in Kalispell. However, documented aircraft crashes have happened across the planning area and are most frequently documented as being small civilian aircrafts.

Past Occurrences

Air Transportation Incidents:

The National Transportation Safety Board reported 505 air transportation incidents in the State of Montana from 1964 to 2018. Figure 4.83 displays the annual trends of total fatal air transportation accidents. The greatest number of incidents were reported in 2006 with 32 total incidents. Since 2001, there has been a significant increase in the number of events reported. Most crashes have been small, private planes. Small Cessna and Piper aircrafts were frequently reported in the dataset.

Figure 4.83 Annual Aircraft Incidents in the State of Montana



Source: National Transportation Safety Board, Chart by WSP

According to the National Transportation Safety Board, details on the following air transportation incidents were reported in the Central Region:

- June 17, 2021 - A Toole County plane crash killed two people on June 17, 2021. A preliminary report from the NTSB says the pilot was traveling with her granddaughter in an almost 1,000-mile trip from Montana to California that was planned as Father's Day surprise for the pilot's father.
- September 4, 2018 - An aircraft accident occurred near Cut Bank in Glacier County. The pilot reported that, while flying west to check some fields and circle a friend's house, he began a right, descending turn about 200 ft above ground. He added that he was aware of power wires in the area, but the sun was in his eyes and the airplane was lower than he thought. The airplane struck power wires and the airplane impacted terrain. The airplane sustained damage to wings and fuselage.
- September 2, 2014 - A Cascade County plane crash resulted in the private pilot and one passenger sustained minor injuries, one passenger was seriously injured, and one passenger was fatally injured. The airplane was destroyed during the accident sequence and subsequent post

impact fire. The airplane was registered to, and operated by, the pilot under the provisions of 14 Code of Federal Regulations Part 91 as a personal flight. Visual meteorological conditions prevailed for the flight and no flight plan had been filed. The flight originated from Great Falls International Airport (GTF), Great Falls, Montana at about 1200.

Highway Transportation Incidents:

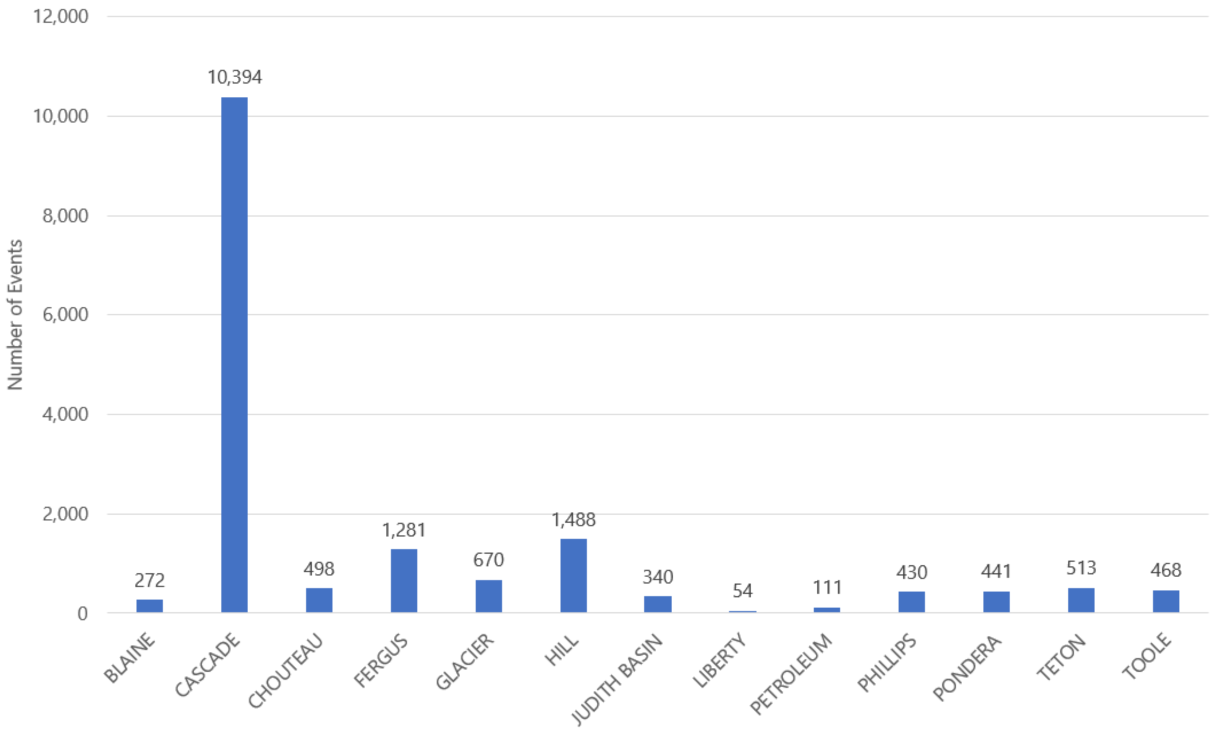
The Montana Department of Transportation's (DOT) Office of Traffic and Safety maintains traffic crash statistics and location maps by county. Table 4-58 and Figure 4.84 shows the trend of crashes in the Central Region between 2016 and 2020. This dataset was extracted from the MDT's Crash Database compiled for the purpose of safety enhancement of potential accident sites, hazardous roadway conditions, or railway-highway crossings. The dataset has reported 16,960 road transportation events over the course of 4 years across the counties in the Central Region. Cascade County had the greatest number of reported crash events, with a total of 10,394 reported events, nearly 10x that of any other county in the Central Region.

Table 4-58 Roadway Crash Statistics by County in the Central Region (2016-2020)

County	Number of Accidents (2016-2020)
Glacier	670
Toole	468
Liberty	54
Hill	1,488
Blaine	272
Phillips	430
Cascade	10,394
Teton	513
Pondera	441
Chouteau	498
Fergus	1,281
Judith Basin	340
Petroleum	111
Total	**16,960**

Source: Montana Department of Transportation 2016-2020

Figure 4.84 Roadway Crash Statistics by County in the Central Region (2016-2020)



Source: Montana Department of Transportation 2016-2020

The Montana DOT also reported crash severity from 2011-2020 for the entire state of Montana. Figure 4.85 displays the temporal trends of crash severity. Throughout the state, accidents with no injury are most commonly reported, followed by accidents with minimal injuries. Since 2011, 499 fatal crashes have been reported across the state and 858 serious injury crashes. There is an average of 49.9 fatal crashes per year in the State of Montana.

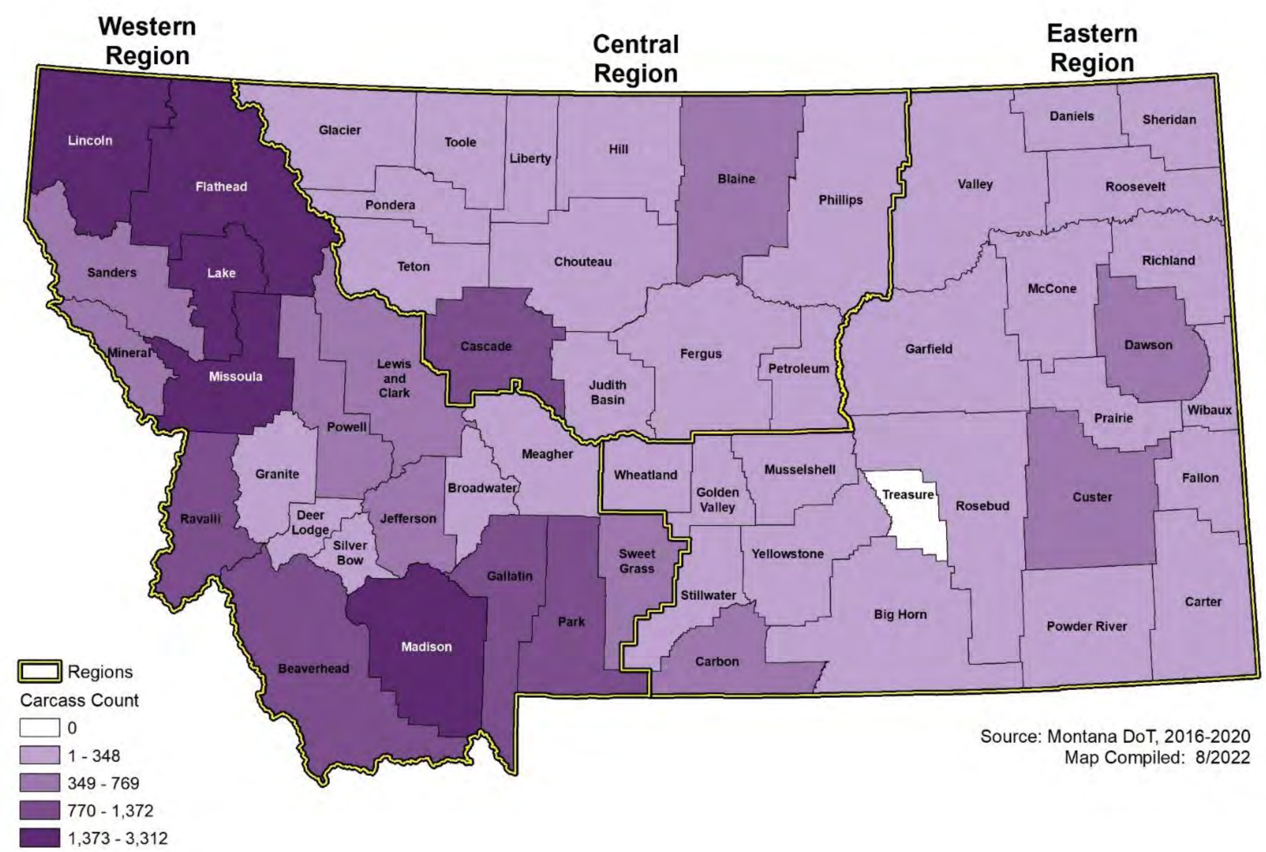
Figure 4.85 Roadway Crash Severity in Montana (2011-2020)

- *Source: Montana Department of Transportation 2011-2020*

Wildlife Car Accidents

The Montana DOT also documented the number of accidents caused by wildlife and the animal carcasses recovered. The Montana DoT emphasizes that this dataset is best used to identify patterns in wildfire car accidents, but the data is incomplete due to not all carcasses being reported on a regular schedule or some carcasses not being reported at all. According to the Montana DoT dataset, there were 28,652 wildlife car accidents from 2016-2020. Figure 4.86 displays the animal carcass data by county in Montana. Most of the Central Region has experienced between 1-348 wildlife car accidents, however, Blaine and Cascade County have experienced significantly more.

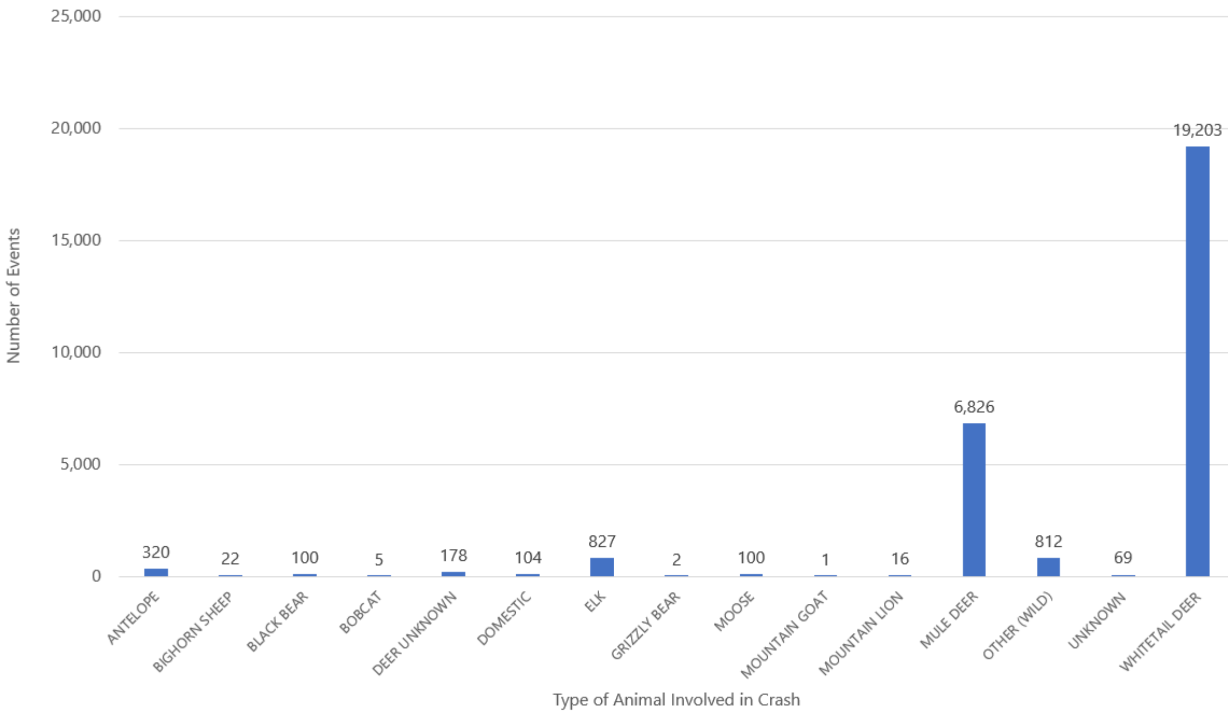
Figure 4.86 Wildlife Crash Statistics by County in Montana (2016-2020)



Source: Montana DoT, Map by WSP

Figure 4.87 displays a breakdown of the crashes by type of animal involved. Whitetail deer was by far the most reported animal with 19,203 incidents in the past 4 years, followed by mule deer in second place with 6,826 reported incidents.

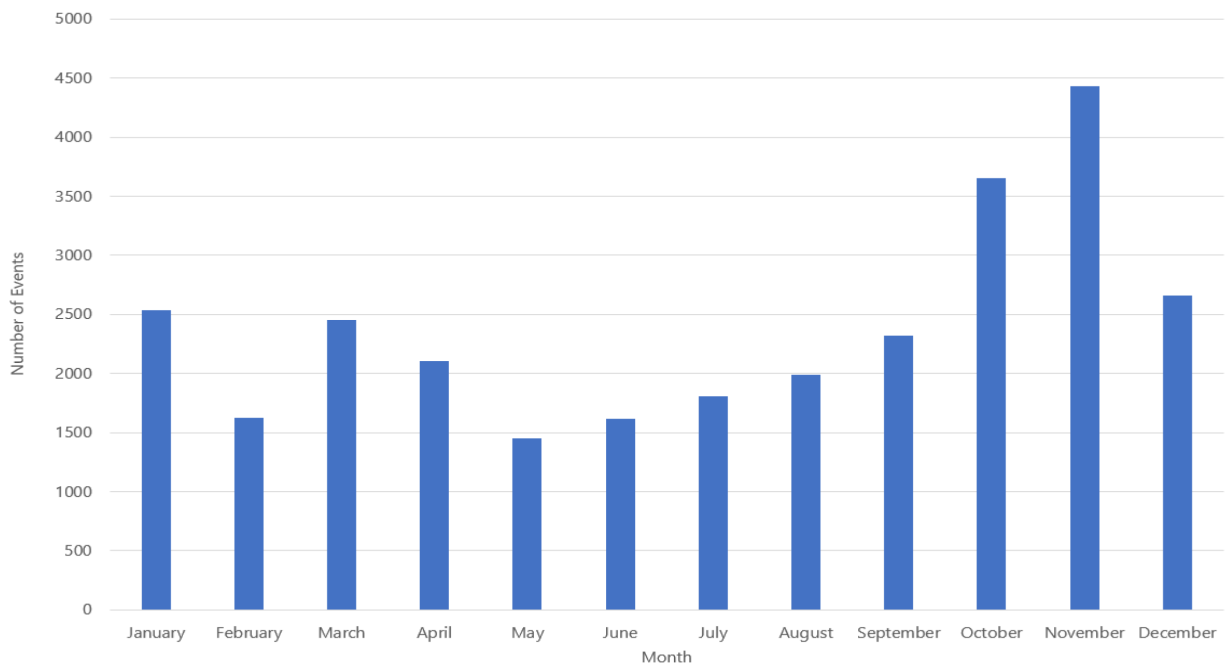
Figure 4.87 Wildlife Crash Statistics by Carcass Type in Montana (2016-2020)



Source: Montana Department of Transportation 2016-2020

The Montana DOT also reported on the date that these wildlife accidents occurred. Figure 4.88 displays the temporal trends of these crashes. The greatest frequency of events occurs in the months of October and November. This is likely because deer mating season occurs at this time of year and therefore, they are more active and likely to wonder onto roadways. Accidents with deer are most likely to occur from 6 pm – 9 pm due to the crepuscular nature of deer, meaning that they are most active during twilight (Hothorn et al, 2015).

Figure 4.88 Wildlife Crash Statistics by Month in the Central Region (2016-2020)



Source: Montana Department of Transportation 2016-2020

Waterway Transportation Incidents

The state of Montana has a variety of glacial-fed lakes and free-flowing rivers that provide opportunities for tourism. Several major rivers in the Central Region include the Yellowstone River, Missouri River, and Musselshell River. The Fort Peck Lake, Nelson Reservoir, and Fresno Reservoir also provide space for outdoor recreation in the Central Region. With extensive opportunities for water recreation in the state, there are associated risks including boating accidents and drownings.

The U.S. Coast Guard documents annual recreational boating statistics across the United States. Table 4-59 below displays information from the annual reports for the State of Montana from 2017-2021. In total, 82 accidents have been reported in Montana over the past 5 years, resulting in 32 deaths and 41 injuries, as well as $450,925.95 in property damages.

Table 4-59 Boating Accidents by Year in Montana (2017-2021)

	Number of Accidents				Persons Involved			
Year	**Total**	**Fatal**	**Non-Fatal**	**Property Damage**	**Total**	**Deaths**	**Injured**	**Damages**
2021	16	4	6	6	12	5	7	$56,050.00
2020	25	7	9	9	20	7	13	$178,600.00
2019	13	4	6	3	13	5	8	$59,275.95
2018	19	9	6	4	22	13	9	$144,900.00
2017	9	2	3	4	6	2	4	$12,100.00
Total	**82**	**26**	**30**	**26**	**73**	**32**	**41**	**$450,925.95**

Source: U.S. Coast Guard 2017-2021 Recreational Boating Statistics

Frequency/Likelihood of Occurrence

Overall, transportation accidents are likely to occur on a yearly basis; therefore, the frequency/likelihood of occurrence is rated as **highly likely** for the Central Region. Air traffic overall is limited and any planes that crash are likely to be small planes with no more than a pilot and one passenger. However, since there are many commercial planes that fly over the region, there is always a chance for a major crash. More and more people are utilizing air travel now than in the past. The National Transportation Safety Board documented 505 aircraft accidents over 54 years, which averages over 9 aircraft accidents per year across the region.

Although traffic engineering, inspection of traffic facilities, land use management of areas adjacent to roads and highways, and the readiness of local response agencies have increased, highway incidents continue to occur. As the volume of traffic on the state's streets, highways, and interstates increases, the number of traffic accidents will likely also increase. The combination of large numbers of people on the road, wildlife, unpredictable weather conditions, potential mechanical problems, and human error always leaves open the potential for a transportation accident. Local jurisdictions continue to look at where traffic signals and speed limit changes are needed to protect the public. The Montana DoT reported 16,960 roadway traffic accidents from 2016 to 2020, or an average of 4,240 accidents per year. Collisions involving wildlife is commonly reported in Montana. The Montana DoT carcass database reported 28,652 accidents resulting in an animal carcass from 2016 to 2020, or an average of 9 accidents a year.

Several ponds, rivers, and lakes are used for recreation, including angling, boating, and swimming. The number of users of Montana lakes and rivers is increasing with increased tourism and population growth in the area. Minor incidents involving one or two boats and/or individuals can occur that tie up response resources and cause death and injury are possible but unlikely each year. Incidents will be recreational-related, as opposed to transportation-related, because the waterways are too small to support barges. Waterway accidents are less likely to occur than roadway incidents. However, the U.S. Coast Guard reported 82 waterway accident events from 2017 to 2021 across the State of Montana, or an average of 16 events per year.

Based on the available information, the probability of air transportation, highway, waterway, or railway incident that directly threatens life and which results in property damage and/or death(s)/injury(s) and/or adversely impact a community's capabilities to provide emergency services is "Highly Likely" as multiple occurrences happen each year.

Climate Change Considerations

If projections regarding milder winters come to fruition, climate change impacts may reduce the number of transportation incidents associated with some severe weather. However, if ice occurs, rather than snow, this could result in higher incidents of weather-related accidents. Extreme heat can also impact the performance of motor vehicles, especially planes (McFadden, 2021). Increasing temperatures due to climate change could therefore pose threats to aircrafts.

Potential Magnitude and Severity

The U.S. Department of Transportation Federal Highway Administration issued a technical advisory in 1994 providing suggested estimates of the cost of traffic crashes to be used for planning purposes. These figures were converted from 1994 dollars to 2020 dollars. The costs are listed below in Table 4-60. Injuries and deaths are also impacts of transportation accidents. While transportation accidents are frequent in the Central Region, most accidents result in minor property injuries to vehicles involved; therefore, the magnitude ranking for transportation incidents in Central County is **limited**.

Table 4-60 Costs of a Traffic Crash

Severity	Cost per injury (in 2020 $)
Fatal	$4,645,467
Evident Injury	$64,320
Possible Injury	$33,948
Property Damage Only	$3,573

Source: U.S. Department of Transportation Federal Highway Administration Technical Advisory T 7570.2, 1994. Adjusted to 2020 dollars

Vulnerability Assessment

People

All people are vulnerable to transportation accidents in the Central Region. Travelers, truckers, delivery personnel, and commuters are always at risk on the road. During rush hours and holidays the number of people on the road is higher. This is also true before and after major gatherings such as sporting events, concerts, and conventions. Consumption of alcohol or other substances can also increase the likelihood of an accident. The Montana Department of Transportation reported that data from 2020 indicates that 66% of all fatalities were the result of impaired driving. Any individual incident could have a direct impact on only a few people. Individuals involved in a transportation accident can have a range of minor and major injuries, including death. It is also possible for individuals involved in an accident to experience psychological effects from a severe accident (Ameratunga et al, 2003).

Not all people are equally vulnerable to transportation incidents. According to a study, An Analysis of Traffic Fatalities by Race and Ethnicity 2021, by the Governors Highway Safety Association, found that traffic fatalities are more common in low-income areas and among Native and Black Americans. The study found that in 2020, total traffic deaths in the United States rose by 7.2%, but total traffic deaths among Black Americans increased by 23%. The study reported several reasons for this, including poor road quality in low-income areas, pedestrians being disproportionally Black, and members of the low-income population being unable to stay home from work during the pandemic.

Property

All property is vulnerable to transportation accidents, including the modes of transportation themselves and all associated equipment. Roadway accidents can impact surrounding infrastructure, including surrounding buildings, poles, or guardrails. Railway accidents frequently result in damages to the railway tracks which can be expensive to repair and result in delays in the transportation of goods. Aircraft accidents frequently result in damaged or destroyed planes, as well as damage to infrastructure in the landing area. One aircraft accident case documented in the Central Region damaged powerlines. Boating incidents can cause extensive damage to ships, bridges, and docks. Vehicles that crash into property along roadways can also cause extensive damages in repairs.

Critical Facilities and Lifelines

Transportation accidents can result in delayed responses for emergency vehicles and severe or multi-car accidents can put a strain on response services and hospital capacity. The transportation of goods can also be delayed due to road closures from an accident. Power outages are also possible due to damages infrastructure.

Economy

There can be significant economic impacts likely to result from transportation accidents. Cost of repairing property and hospital bills for those impacted by the accident can be substantial. The U.S. DoT reported the estimated cost of a fatality is over $4.6 million in damages. Additionally, lost revenue from business disruptions and disruptions in the transportation of goods can be significant.

Historic and Cultural Resources

Historic and cultural resources are equally vulnerable to transportation accidents as other types of property.

Natural Resources

The impacts of transportation accidents to natural resources is typically minimal. These accidents can result in debris and fuel leakage into the environment, which can harm the surrounding ecosystem. Trees and other landscaping can be damaged when a vehicle leaves the roadway. Wildlife is also at risk to injury or death due to vehicles on the road. Significant threat to natural resources could occur if a transportation accident involving hazardous materials occurs.

Development Trends Related to Hazards and Risk

Increasing roadway infrastructure and number of cars on the road will likely result in an increase in the number of transportation accidents in the Central Region. Increase in air travel is likely to continue and therefore the increase in number of aircraft disasters. Construction and re-routing of local roads also increases the chances of a traffic accident.

Risk Summary

In summary, the transportation accidents hazard is considered to be overall medium significance for the Region. Variations in risk by jurisdiction are summarized in the table below, as well as key issues noted in the vulnerability assessment.

- These events typically impact areas along roadways, railways, waterways, or near airports; therefore, the hazard extent is rated as **significant**.
- The data sources used for each type of transportation accidents reported significantly more than one accident a year, therefore, frequency is rated as **highly likely.**
- While transportation accidents commonly occur, most accidents impact only the people and vehicles involved and therefore magnitude is ranked as **limited.**
- People who work in transportation and spend extensive time on the road, such as truck drivers or deliver drivers, are most likely to experience transportation accidents. Studies have found that Black and Native Americans are disproportionately likely to be involved in a transportation accidents and accidents are more likely to occur in low-income areas.
- Transportation accidents are likely to cause damage to the vehicles involved as well as surrounding infrastructure. Emergency services may be delayed by major accidents or significant train derailments.
- Significant economic losses can result from business interruptions due to delays in the transportation of goods and from repairs to transportation vehicles and infrastructure.
- Critical infrastructure such as bridges and major roads can be blocked off or closed due to major roadway accidents. Railroads can also be closed for extended periods of time due to track damage, which would limit the movement of goods in and out of the areas impacted.
- Transportation accidents happen frequently across jurisdictions, but some counties such as Cascade, Liberty, Teton, and Toole Counties are likely to experience greater losses due to larger populations and greater concentration of transportation systems
- Related Hazards: Hazardous Materials Accident

Table 4-61 Risk Summary Table: Transportation Accidents

Jurisdiction	Overall Significance	Additional Jurisdictions	Jurisdictional Differences?
Central Region	Medium	NA	NA
Blackfeet Tribe	Low	NA	NA
Blaine County	Medium	Chinook and Harlem	None
Cascade County	Medium	Great Falls, Belt, Cascade, and Neihart	Greater frequency of car accidents likely in Great Falls due to large population. Railway and International Airport in Great Falls
Chippewa Cree Tribes Rocky Boy's Reservation	Low	NA	NA
Chouteau County	Medium	Fort Benton, Big Sandy	Railway in Big Sandy
Fergus County	Low	Lewistown, Denton, Grass Range, Moore, Winifred	Airport in Lewistown
Fort Belknap Indian Community	Low	NA	NA
Glacier County	Medium	Cut Bank	NA
Hill County	Medium	Havre, Hingham	Havre population is significantly larger than Hingham, therefore higher likelihood of roadway transportation accidents
Judith Basin County	Medium	Stanford, Hobson	Airport located in Stanford
Liberty County	High	Chester	NA
Petroleum County	Low	Winnett	NA
Phillips County	Medium	Malta, Saco	Airport located in Malta
Pondera County	High	Conrad	NA
Teton County	High	Choteau, Dutton, Fairfield	Interstate though Dutton
Toole County	High	Shelby, Kevin, and Sunburst	Medium for Shelby, Low for Kevin and Sunburst

4.2.15 Volcanic Ash

Hazard/Problem Description

A volcano is a vent in the earth's crust, or a mountain formed by the eruption of subsurface material including lava, rock fragments, ash, and gases, onto the earth's surface. Volcanoes produce a wide variety of hazards that can damage and destroy property and cause injury and death to people caught in its path. These hazards related to volcanic activities include eruption columns and clouds, volcanic gases, lava/pyroclastic flows, volcanic landslides, and mudflows or debris flows (called lahars). Large explosive eruptions can cause damage several hundred miles away from the volcano, primarily from ashfall.

Volcanic eruptions are generally not a major concern in Montana due to the relatively low probability of events in any given year. However, Montana is within a region with a significant component of volcanic activity and has experienced the effects of volcanic activity as recently as 1980 during the eruption of Mount St. Helens in the State of Washington.

Based on the evidence of past activity, volcanoes can be considered "active", "dormant", or "extinct." "Active" volcanoes usually have evidence of eruption during historic times. Volcanoes have a wide degree of variability in their eruptions, from mild lava flows to large explosions that eject tons of material and ash into the air. The degree of volcano hazard depends largely on if the volcano has a reasonable probability of erupting, the nature of the eruption, and the associated hazards that may be triggered. There are 20 active or potentially active volcanoes in the United States. The two volcanic centers affecting Montana in recent geologic time are: 1) the Cascade Range of Washington, Oregon, and California; and 2) the Yellowstone Caldera in Wyoming and eastern Idaho. Based on the historic trends of past eruptions, volcanic eruptions in the Cascade Mountains are more likely to impact Montana than Yellowstone eruptions. The primary effect of the Cascade volcanic eruptions in Montana would be ash fall.

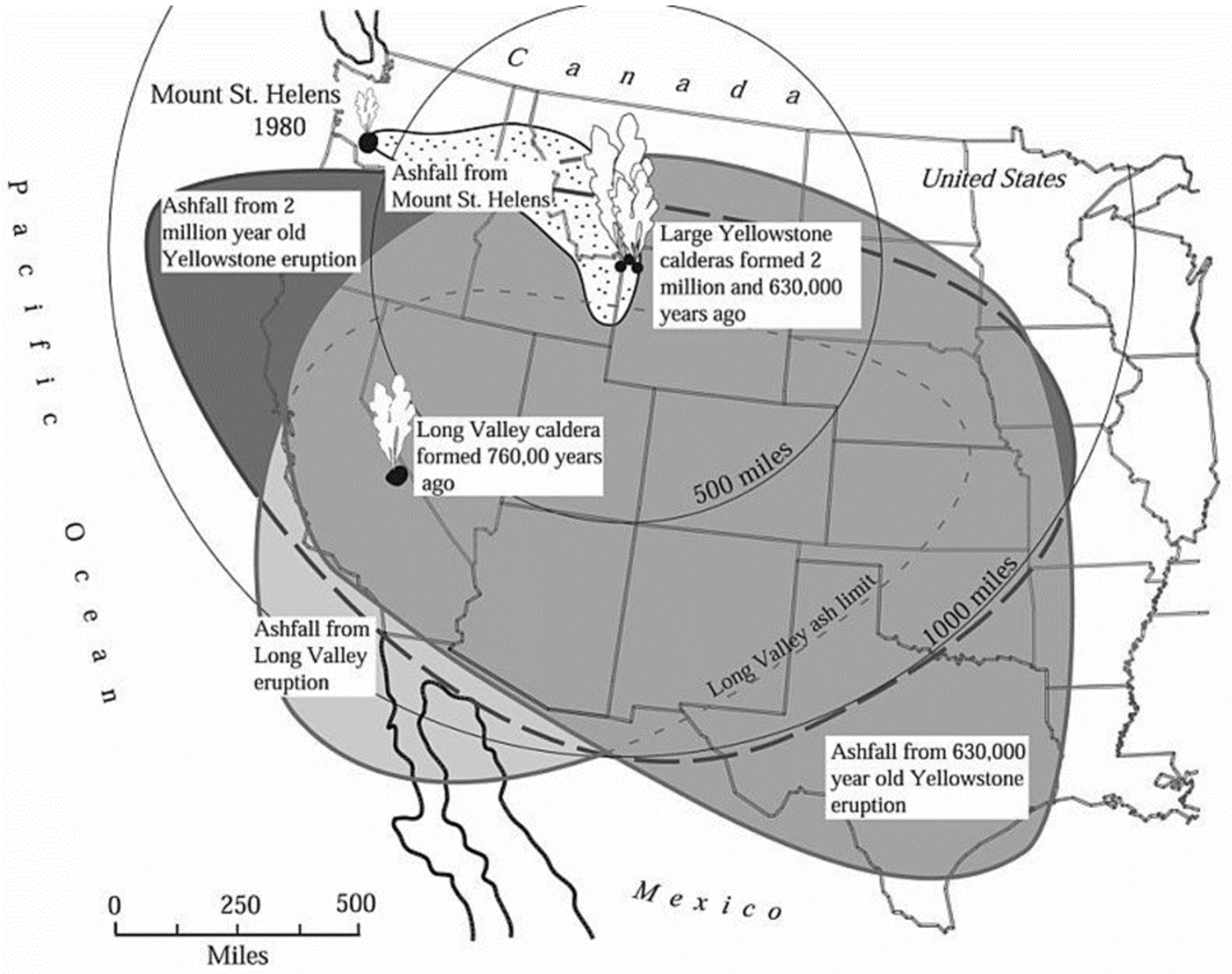
The distribution of ash from a violent eruption is a function of the weather, particularly wind direction and speed and atmospheric stability, and the duration of the eruption. As the prevailing wind in the mid-latitudes of the northern hemisphere is generally from the west, volcanic ash is usually spread eastward from the volcano. Exceptions to this rule do, however, occur. Ash fall, because of its potential widespread distribution, offers some significant volcanic hazards.

According to the U.S. Geological Survey, Yellowstone National Park has been identified as a prominent hot spot for geologic activity. The hot spot is presumed to exist under the continental crust in the region of Yellowstone National Park and northwestern Wyoming. Large calderas under the park were produced by three gigantic eruptions during the past 2 million years, the most recent of which was approximately 600,000 years ago. That particular volcanic eruption blasted molten rock into the air at 1,000 times the volume of the 1980 Mount St. Helen's eruption subsequently collapsing to create the Yellowstone Caldera (Tracking Changes in Yellowstone's Restless Volcanic System, USGS Website). Ash deposits from these volcanic eruptions have been mapped in Iowa, Missouri, Texas, and northern Mexico. Thermal energy from the hot spots fuel hot pools, springs, geysers, and mud pots are found in the park today. "Recent surveys demonstrate that parts of the Yellowstone region rise and fall as much as 1 centimeter a year, indicating the area is still geologically restless. However, these measurable ground movements, which most likely reflect hydrothermal pressure changes, do not necessarily signal renewed volcanic activity in the area." (Kious, Jacqueline and Robert Tilling, The Dynamic Earth: The Story of Plate Tectonics, USGS website)

Geographical Area Affected

The geographical extent of volcanic ash is **extensive**. All areas of the Central Region would be affected by a volcanic eruption of the Yellowstone caldera. According to the 2018 State of Montana Hazard Mitigation Plan, western and southwestern Montana are most vulnerable to eruptions and ashfall from the Cascade Volcanoes. As shown in Figure 4.89 below, almost all of the state of Montana has been covered with volcanic ash at some point in the recent geologic history.

Figure 4.89 Areas of the United States Once Covered By Volcanic Ash From Major Eruptions



Source: U.S. Geological Survey

Past Occurrences

Since the late 1700s, volcanic eruptions in the continental United States have occurred in Oregon, Washington, and California. The most recent volcanic activity in the Yellowstone region occurred 70,000 years ago in the form of a lava flow. However, the volcanic ash fallout from the eruption of Mount St. Helens in 1980 was the most recent occurrence of volcanic activity to impact the region. Local news sources reported the sky appeared to be foggy, and a thin layer of gritty, dull, grey powder was deposited in many areas of Montana. The 2018 State Hazard Mitigation Plan notes travel was restricted in western Montana for over a week because of concerns for public health, and that the main hazards associated with ash were reduced visibility (resulting in closed roads and airports), clogging of air filters, and a health risk to children, the elderly, and people with cardiac or respiratory conditions.

Frequency/Likelihood of Occurrence

The frequency of volcanic as in the Central Region is ranked as **unlikely**. Ashfall from a Cascade Volcano is the primary hazard to which the State may be vulnerable in the future. Future eruptions in the Cascades are certain and have occurred at an average rate of 1-2 times per century during the last 4,000 years. Seven volcanoes in the Cascades have erupted in the last 200 years. The next eruption in the Cascades could affect hundreds of thousands of people. The effect in Montana would depend on the interaction of such variables as source location, frequency, magnitude and duration of eruptions, the nature of the ejected material and the weather conditions. Therefore, the entire state may be considered vulnerable to ashfall to some degree in the event of a volcanic eruption.

Three major periods of activity in the Yellowstone system have occurred at intervals of approximately 600,000 years, with the most recent occurring about 600,000 years ago. The evidence available is not sufficient to confirm that calderas such as the one in Yellowstone erupt at regular intervals, so the amount of time elapsed is not necessarily a valid indicator of imminent activity. There is no doubt, however, that a large body of molten magma exists, probably less than a mile beneath the surface of Yellowstone National Park. The presence of this body has been detected by scientists who discovered that earthquake waves passing beneath the park behave as if passing through a liquid. The only liquid at that location that could absorb those waves is molten rock. The extremely high temperatures of some of the hot springs in the park further suggest the existence of molten rock at shallow depth. A small upward movement in the magma could easily cause this magma to erupt at the surface. If a major eruption occurred, the explosion would be "comparable to what we might expect if a major nuclear arsenal were to explode all at once, in one place" (Roadside Geology of Montana, Alt and Hyndman, 1986).

Climate Change Considerations

While climate change is not expected to impact the size or frequency of eruptions, eruptions themselves can have a huge impact on climate. Eruptions can inject millions of tons of gases and debris into the atmosphere, which can circulate far away from the incident site and disrupt normal climate patterns. Large-scale volcanic activity may only last a few days, but the massive outpouring of gases and ash can influence climate patterns for years, influencing both heating and cooling.

For example, the 1883 eruption of the Krakatoa volcano in Indonesia resulted in far reaching global climate impacts, with the average summer temperatures in the Northern Hemisphere falling by 0.72 degrees Fahrenheit the year after the eruption. The 1815 Mt. Tambora eruption, also in Indonesia, was the deadliest volcanic eruption in recorded history. It also led to global climate impacts resulting in 1816 being referred to as “the Year Without a Summer”. According to NASA, average global temperatures dropped with frost and snow experienced in the middle of summer as far away as New England and Europe, leading to massive crop losses and famine. A similar scale eruption of the Yellowstone Caldera would also likely eject massive amounts of gasses which could affect the global climate, as well as the nearby regions of Montana.

Potential Magnitude and Severity

The potential magnitude and severity of volcanic ash is **limited**. Populations living near volcanoes are most vulnerable to volcanic eruptions and lava flows, although volcanic ash can travel and affect populations many miles away and cause aviation issues. The USGS notes specific characteristics of volcanic ash. Volcanic ash is composed of small, jagged pieces of rocks, minerals, and volcanic glass the size of sand and silt. Very small ash particles can be less than 0.001 millimeters across. Volcanic ash is not the product of combustion, like the soft fluffy material created by burning wood, leaves, or paper. Volcanic ash is hard, does not dissolve in water, is extremely abrasive and mildly corrosive, and conducts electricity when wet.

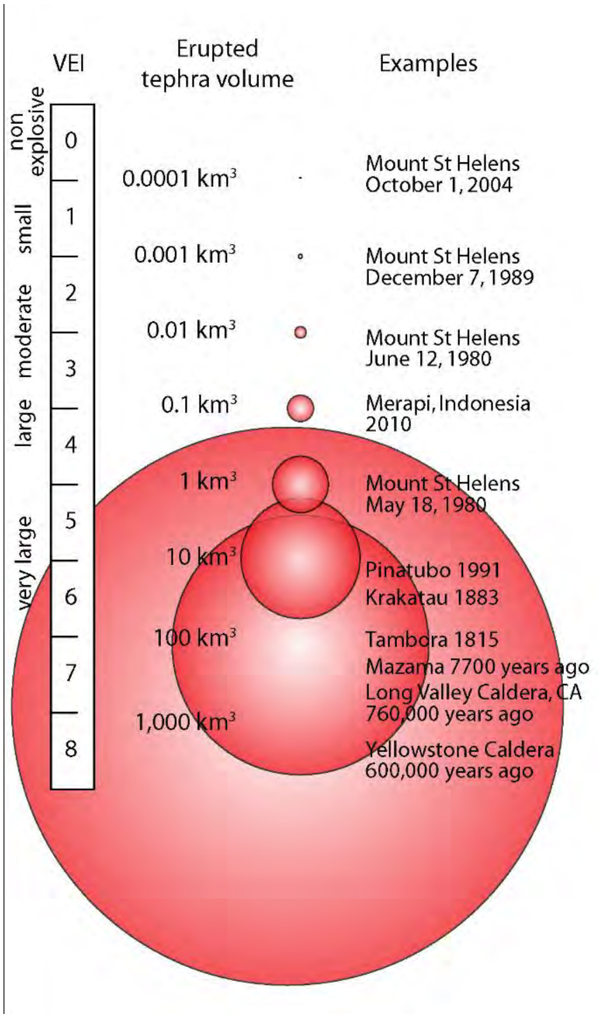
Volcanic ash is formed during explosive volcanic eruptions. Explosive eruptions occur when gases dissolved in molten rock (magma) expand and escape violently into the air, and also when water is heated by magma and abruptly flashes into steam. The force of the escaping gas violently shatters solid rocks. Expanding gas also shreds magma and blasts it into the air, where it solidifies into fragments of volcanic rock and glass. Once in the air, wind can blow the tiny ash particles thousands of miles away from the volcano.

Many characteristics of volcanic ash may present hazards. Important parameters include the ash particle size, shape, mineral composition and crystallization of ash. The density and hardness of ash particles, their acidity, and the solubility of its components also affect the hazards caused by ash fallout. The hazards presented by volcanic ash vary in different locations due to other factors, such as how wind disperses the ash, the style of volcanic eruption involved, and the thickness of ash deposited. The reader is directed to a particularly helpful USGS webpage dedicated to the impacts and mitigation of volcanic hazards (https://volcanoes.usgs.gov/volcanic_ash/ash.html).

Cataclysmic eruptions of the Yellowstone volcano 2.0, 1.3, and 0.6 million years ago ejected huge volumes of rhyolite magma; each eruption formed a caldera and extensive layers of thick pyroclastic-flow deposits. The caldera is buried by several extensive rhyolite lava flows that erupted between 75,000 and 150,000 years ago.

The magnitude of volcanic eruptions can be measured on the Volcanic Explosivity Index (Figure 4.90, VEI). Similar to the Richter Scale, every This index is a semi-quantitative eruption magnitude scale used to rate volcanic eruptions based primarily on the volume of ash ejected. The duration of the eruption is incorporated into the VEI, but only makes a significant difference for especially long-duration eruptions. For example, the 9-year eruption of a volcano in Paracutin, Mexico in the 1940's, ejected enough ash to qualify as a VEI 5, but was downgraded somewhat to a VEI 4. Eruptions with no ash, such as in the Hawaiian Islands, typically are assigned VEI of zero regardless of the volume of lava produced. For context, the May 18, 1980 eruption of Mount St. Helens was a VEI 5, while the largest eruptions in the geologic record for the Yellowstone area were VEI 8 events.

Figure 4.90 Historic Volcanic Eruptions Measured on the Volcanic Explosivity Index Scale



Historic eruptions measured on the Volcanic Explosivity Index scale. Red spheres indicate the volume of ash ejected. Image adapted from USGS.

Vulnerability Assessment

People

All people in the planning area are potentially exposed to volcanic ash fallout, as well as indirect effects of volcanic ash. Direct exposure to volcanic ash can be reduced, though not eliminated, for people inside buildings.

People are susceptible to complex health risks, related to both the physical effects of ash and secondary impacts related to disruption caused by the ash fallout. The health impacts of volcanic ash are complex. The abrasiveness of the volcanic ash particles can scratch the surface of skin and eyes and in general cause discomfort and inflammation. Inhaling volcanic ash can cause a wide range of health impacts, including death. The International Volcanic Health Hazard Network (IVHHN) provides a good reference to the current research and information on the health hazards and impacts of volcanic eruptions (http://www.ivhhn.org/).

Populations that are especially vulnerable include children, the elderly, and individuals with cardiac and respiratory considerations. The US Department of Health and Human Services tracks Medicare beneficiaries who rely on electricity-depending medical equipment, such as ventilators, oxygen concentrator equipment, and implanted cardiac devices. Many of these same individuals will be vulnerable to effects of volcanic ash.

Property

Virtually all property is potentially exposed to volcanic ash. Building exteriors and property located outdoors are exposed to a greater degree, but property located indoors is also exposed. In fact, the USGS website on impacts & mitigation of volcanic ashfall impacts contains a page dedicated to indoor cleanup procedures (https://volcanoes.usgs.gov/volcanic_ash/cleaning_up_inside.html).

Susceptibility of property to damage caused by exposure to volcanic ash hazards is variable but potentially extensive. Paint in general and especially on cars is susceptible to the abrasive nature of volcanic ash. Non-structural elements of rooftops, such as gutters and drains, are susceptible to damage from as little as a few millimeters of ashfall. Gutters tend to collect ash from the rooftop, can become blocked, and collapse from the weight, especially when the ash becomes wet. In extreme cases, roofs have collapsed from the weight of wet ash.

Building interiors can also be susceptible to damage from ash. Ash may clog ventilation grills and cooling fans, which may cause overheating of buildings. Ash certainly passes through ventilation systems and can coat interior surfaces. Some electronic equipment is especially susceptible, such as keyboards an mice. Hard drives, however, are well sealed and not particularly susceptible to damage. Damage may become apparent months or years later due to corrosion that is chemically accelerated by ash.

Generally speaking, nearly everything is exposed to ashfall hazards and susceptibility to damage is extensive. Cleanup is complex, difficult, and expensive. After the Mount Saint Helen eruption in 1980 extensive cleanup efforts were required throughout Montana. Vulnerability of property to ash is high, but is fortunately muted somewhat by the low probability of ashfall occurring.

Critical Facilities and Lifelines

Critical facilities and infrastructure are most vulnerable to the effects of ashfall. As stated earlier, nearly everything is potentially exposed to volcanic ash following an eruption. As is the case with property, susceptibility is widespread. The supply of electricity is susceptible to ashfall. Air intakes for backup generators are also susceptible to becoming clogged by airborne ash post eruption. Telephone and radio communications can also be susceptible to interruption due to ashfall.

Potable water supply can be susceptible to ash. Water treatment is susceptible to decreased quality of raw water sources, both from increased turbidity and from chemical changes in the water, both caused by ash. Cleanup also creates a high demand for water, which puts additional stress on the water supply.

Stormwater systems collect great amounts of ash from a broad area and can become clogged and cause surface flooding. Clearing underground accumulation of ash in stormwater systems can be extremely difficult. Pumps used in stormwater systems are especially susceptible to damage from volcanic ash.

Wastewater collection systems are also susceptible to damage from ashfall. Buildup of ash in drainage systems can result in stormwater flooding. Ash-laden sewage that makes its way to wastewater treatment plants can cause mechanical damage and, if it makes it further through the system, it will settle and reduce the capacity of biological reactors, increasing the volume of sludge and changing its composition.

Transportation infrastructure is also vulnerable to the impacts of ashfall. Roads, highways, and airport runways can be made impassable due to the slippery ash and reduction of visibility. The abrasive volcanic ash can have damaging effects on aircraft, notably causing the engine(s) to stall. Volcanic ash can also lead to the failure of critical navigational and operational instruments.

Economy

Virtually everything that affects the economy is potentially exposed to volcanic ash. The economy is susceptible to both the direct costs of damage and cleanup, as well as indirect effects of reduced economic activity following ashfall. The economy can be impacted for years following a significant ashfall. Vulnerability is difficult to calculate, but is fortunately muted to a large degree by the low probability of ashfall occurring.

Historic and Cultural Resources

All historic and cultural resources are potentially exposed to ashfall. Historical buildings and historical assets within and outside of buildings all are susceptible similarly to what is described above in the subsection titled *Property*. Terrestrial and especially aquatic ecosystems are vulnerable to ashfall, which damages recreation and tourism.

Natural Resources

Volcanic ash can collect carbon dioxide and fluorine gases that can be toxic to humans and have significant impacts on the natural environment. Windblown ash can spread and pollute areas that had previously been unaffected. Vegetation is also vulnerable to the impacts of ashfall. Ashfall can result in decreased plant photosynthesis and reduced pollination, impacting the overall vegetative population in the region. Visual inspection of vegetation in a large area of the State of Washington impacted by the Mount Saint Helens eruption showed three broad categories of plant damages: (1) Breakage due to the weight of ash (2) physiological changes such as decreased plant growth and (3) chemical damages to the leaves (Ayris, Delmelle, 2012).

Water bodies are also vulnerable to the effects of ashfall and can cause chemical changes that can affect water quality. The following table from the USGS Volcanic Ashfall Impacts Working Group show the typical effects of ashfall on the quality of surface waterbodies.

Table 4-62 Typical Effects of Ashfall on the Quality of Surface Water Bodies

Turbidity	Ash suspended in water will increase turbidity in lakes, reservoirs, rivers, and streams. Very fine ash will settle slowly, and residual turbidity may remain in standing water bodies. In streams, ash may continue to be mobilized by rainfall events, and lahars may be a hazard in some regions.
Acidity (pH)	Fresh ashfall commonly has an acidic surface coating. This may cause a slight depression of pH (not usually below pH 6.5) in low-alkalinity surface waters.
Potentially Toxic Elements	Fresh ash has a surface coating of soluble salts that are rapidly released on contact with water. The most abundant soluble elements are typically Ca, Na, K, Mg, Al, Cl, S and F. Compositional changes depend on the depth of ashfall and its 'cargo' of water-soluble elements; the area of the catchment and volume available for dilution; and the pre-existing composition of the water body. • In rivers and streams, there will be a short-lived pulse of dissolved constituents • In lakes and reservoirs, the volume is usually large enough that changes in composition are not discernible

	The constituents most likely to be elevated above background levels in natural waters are Fe, Al, and Mn, because these are normally present at very low levels. Thus, water is likely to become unpalatable due to discoloration or a metallic taste before it becomes a health hazard.

Source: USGS Volcanic Ashfall Impacts Working Group, Volcanic Ash Impacts & Mitigation - Water Supply (usgs.gov)

Development Trends Related to Hazards and Risk

All development that occurs in the planning area will be exposed to volcanic ash hazards. Susceptibility is widespread. Overall, vulnerability of development to ashfall is high, but muted to some extent by the low probability of occurring.

Risk Summary

Overall volcanic ash is considered a low significance hazard throughout the Central Region due to the long recurrence intervals between events. While low probability, effects can be widespread and cause serious impacts.

- Effects on people: Serious adverse health impacts can occur, such as scratches and abrasion to the skin and eyes from direct contact with ash, and ultimately death potentially if ash is inhaled and cements in the lungs.
- Effects on property: exterior of buildings can have abrasive damage to roofs and gutters can be blocked, and the collapse of roofs if too much ash accumulates.
- Effects on the economy: ashfall can lead to disruptions in the tourism industries, through the prevention of travel and access to affected areas, as well as massive losses to agriculture if heavy ashfall were to occur during the growing season.
- Effects on critical facilities and infrastructure: ash can seriously damage electrical and mechanical components of infrastructure, disrupt air travel and EMS/first responder operations, and lead to backups and damage of wastewater systems.
- Unique jurisdictional vulnerability: the vulnerability is largely uniform as this hazard would likely result in impacts on a large scale, regionwide manner.
- Related hazards: earthquake

Table 4-63 Risk Summary Table: Volcanic Ash

Jurisdiction	Overall Significance	Additional Jurisdictions	Jurisdictional Differences?
Central Region	Low	NA	None
Blackfeet Tribe	Low	NA	None
Blaine County	Low	Chinook and Harlem	None
Cascade County	Low	Great Falls, Belt, Cascade, and Neihart	None
Chippewa Cree Tribes Rocky Boy's Reservation	Low	NA	None
Chouteau County	Low	Fort Benton, Big Sandy	None
Fergus County	Low	Lewistown, Denton, Grass Range, Moore, Winifred	None

Jurisdiction	Overall Significance	Additional Jurisdictions	Jurisdictional Differences?
Fort Belknap Indian Community	Low	NA	None
Glacier County	Low	Cut Bank	None
Hill County	Low	Havre, Hingham	None
Judith Basin County	Low	Stanford, Hobson	None
Liberty County	Low	Chester	None
Petroleum County	Low	Winnett	None
Phillips County	Low	Malta, Saco	None
Pondera County	Low	Conrad	None
Teton County	Low	Choteau, Dutton, Fairfield	None
Toole County	Low	Shelby, Kevin, and Sunburst	None

4.2.16 Wildfire

Hazard/Problem Description

As defined by the National Wildfire Coordinating Group (NWCG), a "wildland fire" is any non-prescribed, non-structure fire that occurs in the wildland" (NWGC 2012). Central Montana's semi-arid to mesic climate and rural setting make most of the region vulnerable to frequent and potentially severe wildfire. As such, wildfire is an ongoing concern for the residents of central Montana. The two main types of wildfire effecting Central Montana are rangeland fires (wildfires occurring on rangeland) and forest fires (wildfires occurring within a forest). Fires can occur at any time of the year in Montana, but historically, the fire season extends from spring to fall, with large fires being more common in the later summer months and early fall months when fire conditions are more probable. Prime wildfire conditions occur when accumulated fuels become sufficiently dry from high temperatures and drought and can more easily ignite. Furthermore, high winds during the summer and fall can favor the chance of wildfire spreading. Climate change has led to hotter summers and has caused an increase in fuel drying, which has resulted in increases to wildfire intensity, frequency, and fire season length. These trends are expected to be exacerbated as climate change progresses (Whitlock et al 2017).

Historically, wildfire has been an important and normal component of the forest and rangeland ecosystems in Central Montana. Wildfires are necessary for maintaining the natural conditions and ecology of the region (MT DNRC 2020a). Until the latter 20th century, fire suppression was the dominant fire management policy across state and federal lands across the western U.S. As a result, high levels of fuels have built up in many fire prone ecosystems, including Central Montana (MT DNRC 2020a). Management goals in wildland areas typically are focused on bringing fire regimes back to their natural historic range of variation. However, in areas with heavy human use, fuel maintenance and land management strategies will be required to replace the historic role of wildfires. These can include, but are not limited to, prescribed burns, targeted livestock grazing, and mechanical fuel removal treatments (MT DNRC 2020).

Generally, there are three major factors that predict wildfire behavior and predict a given area's potential to burn. These factors include fuel, topography, and weather.

Fuel: Fuel is what feeds a fire and is generally determined by fuel type and volume. Generally, the various fuel types and fuel characteristics that cover a landscape have significant impacts on wildfire behavior. Fuel sources can vary from dead fine grasses, leaves, and needles to live large trees. Combustible manmade structures also contribute to fuel sources. Fuels can be modified by humans through land use and land management (e.g., prescribed burns, mechanical fuel removal, invasive plant management, and grazing, among others). The primary fuel types in the central region are grass and grass-shrub fuels (Figure 4.91). GR2 (grass) fuels are the commonly observed fuels. Scott and Burgan (2005) describe GR2 fuels as moderately coarse continuous grass with an average depth of about 1 foot. Wildfire spread rate is usually high and flame lengths are moderate. GS2 (grass-shrub) fuels are also commonly observed and are characterized as lands with up to 50% shrub cover with shrub height ranging from 1 to 3 feet high and accompanied with a moderate grass load. Wildfire spread rate is usually high and flame lengths are moderate. In the forested portions (e.g., the western edge and the scattered island mountain ranges of the region) of the Central Region primary fuel types are TU2 and TU5 (timber-understory) fuels (Scott and Burgan (2005)). TU2 fuels are characterized by fuelbeds with a moderate litter load with a shrub component where wildfire spread rate is usually moderate and flame lengths are predicted to be low. TU5 fuels are characterized by fuelbeds with a high load of conifer litter and a shrub understory where wildfire spread rate and flame lengths are moderate.

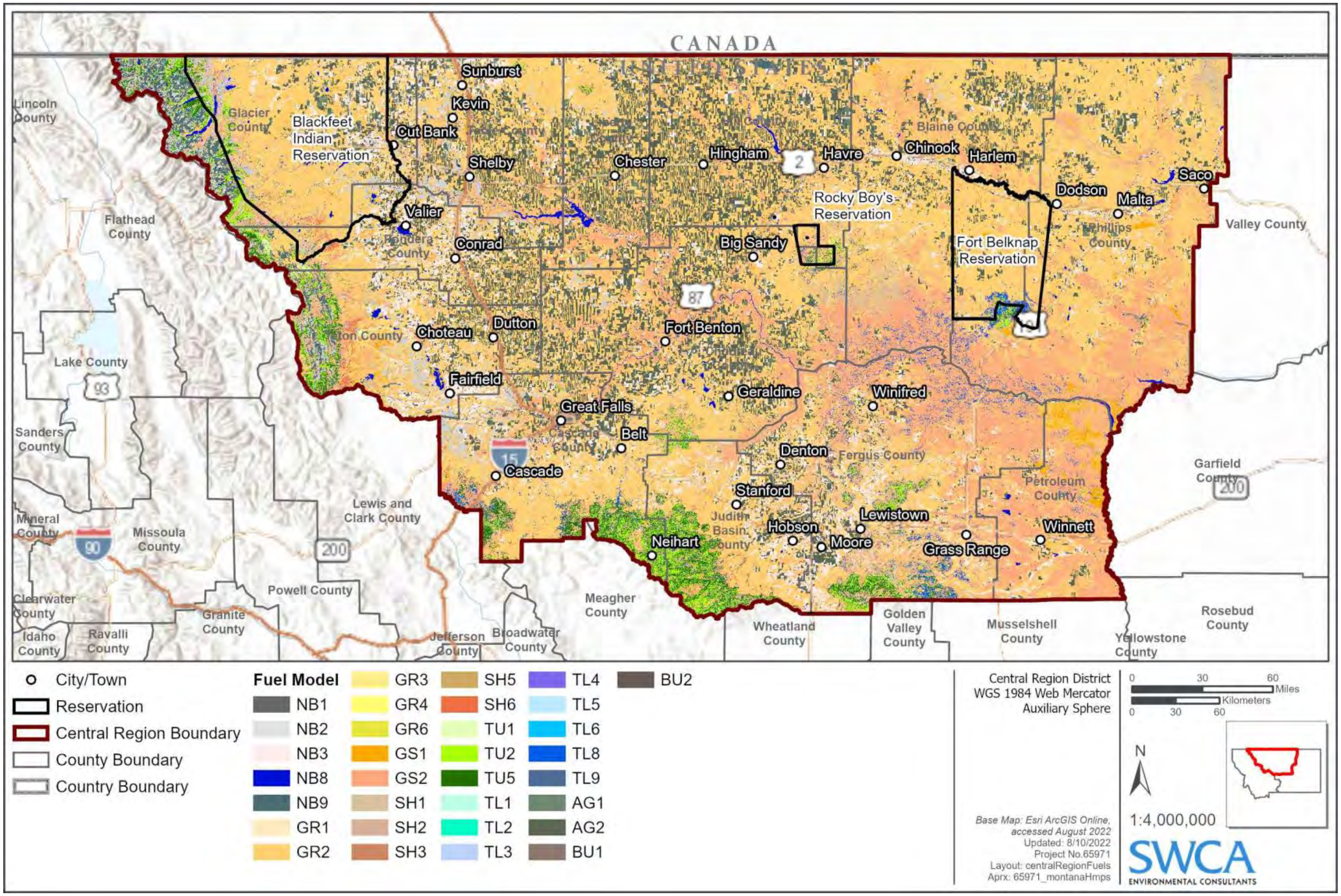
Topography: A region's topography is determined by slope and aspect. Normally, wildfire behavior, such as fire intensity and rate of spread, is more pronounced on steep slopes due to convective heat transfer (i.e., heat rising up the slope). South facing slopes are typically drier due to receiving more sunlight than north facing slopes. Thus, they normally contain drier and finer fuels that are more prone to producing faster rates of spread than the fuels seen on wetter north facing slopes. The Central Montana Region's topography is diverse. It contains steep mountains, flat plains, rolling hills, and steep grasslands.

Weather: Important weather characteristics, such as precipitation, wind speed, wind direction, temperature, relative humidity, and lightning can affect both the potential for wildfire. Low precipitation, high temperatures, and low relative humidity in drought years dry out live and dead fuels. These dry fuels feed wildfire and result in more extreme fire behavior. Additionally, antecedent wet years can build up finer fuels that may contribute to extreme wildfire behavior during summer or fall droughts. Weather regimes in the central Montana region vary drastically between the mountainous regions and the rangelands (PRISM 2022).

Wildland Urban Interface: The wildland/urban interface (WUI) is defined as the zone where structures and other human development meet or intermingle with undeveloped wildland or vegetative fuel (MT MHMP 2018). Starting in 2011, Montana DNRC compiled WUI boundaries for all counties within the state based upon information provided from countywide CWPPs or through consultation between the County and the MT DNRC. The methods for WUI delineation vary by County (MT DNRC, 2020b), which is why some WUI areas encompass an entire county land mass and some areas are more nuanced, based on fuels, hazards, population density etc. (Figure 4.92).

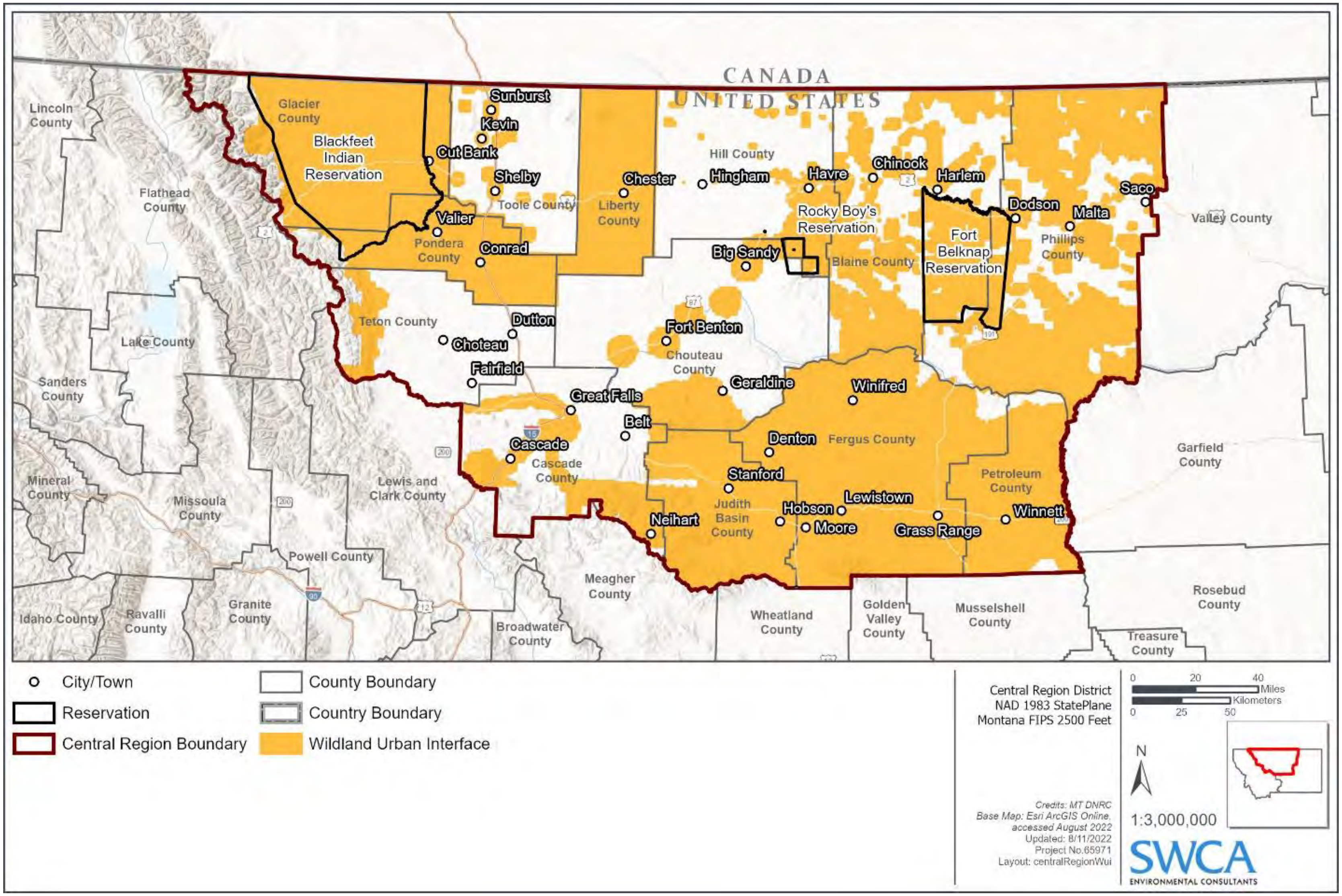
Wildfire risk is normally associated with the wildland urban interface (WUI), an area of uninhabited land that normally experience wildfire that either has dispersed development or is adjacent to human inhabited areas. Humans are currently the primary sources of wildfire ignition in Central Montana, especially in the WUI (e.g., utilities and vehicle/roadside ignitions); however, lighting strikes during thunderstorms are also a source of ignition (MT DNRC 2022). Currently, Central Montana has a large portion of development and infrastructure located within the WUI. Development within the WUI combined with increasing drought, high levels of fuel, and a higher likelihood of ignition is resulting in increased wildfire risk in the WUI.

Figure 4.91 Wildfire Fuel Model of the Central Region



Source: MT DNRC 2022

Figure 4.92 Wildland Urban Interface Delineation



Source: MT DNRC 2020b

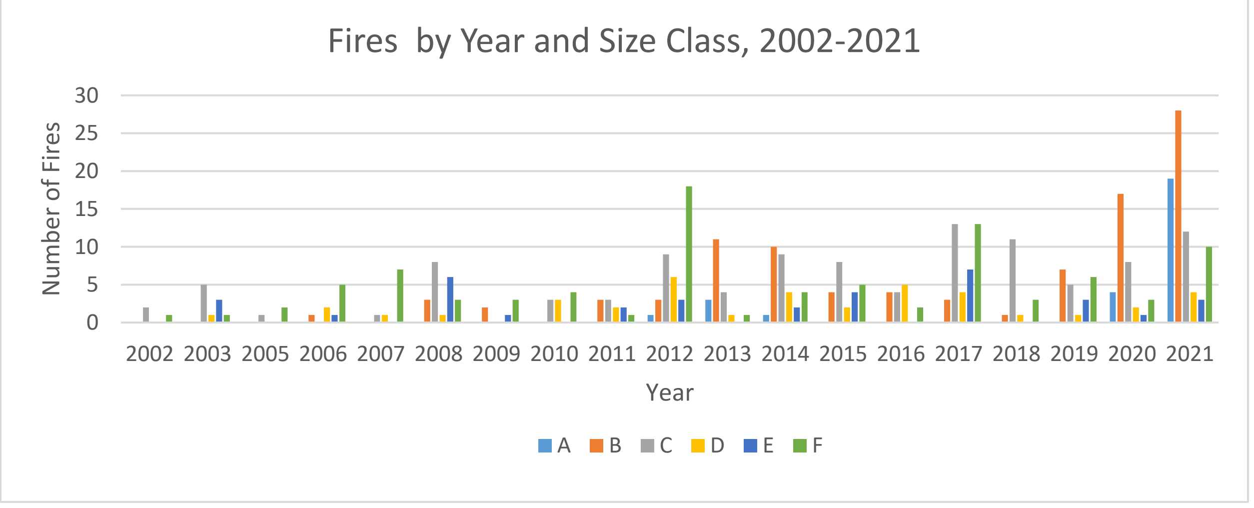
Geographical Area Affected

The climate of the Central Montana region varies from arid to semi-arid to mesic. All climates, combined with continuous fuel loading in some areas, make much of the region susceptible to wildfire (PRISM, 2022). The two main types of fires that can occur in the region are forest fires and rangeland fires. These fire types are reflected in the mapped risks from wildfire. The regions that have historically been most at risk from wildfire are the forested lands within Glacier, Pondera, and Teton Counties; and the Missouri River Breaks, a region of rolling hills with a matrix of rangelands and Ponderosa Pine (*Pinus ponderosa*) savannah, in Petroleum, Philipps, and Fergus Counties. The areas in the regions with a low threat are those that are above tree line and those with substantial agricultural crop cover.

Past Occurrences

The Montana Wildfire Risk Assessment (MWRA) database, maintained by the Montana Department of Natura Resources and Conservation, includes perimeter GIS layers for recent wildfires throughout the state of Montana (MT DNRC 2022). According to the MWRA, wildfires in the Central Region occur on an annual basis (Figure 4.94) and are usually contained early with little to no damage. Most wildfires are usually less than 100 acres. However, between 2002 and 2021 there have been 98 wildfires greater than 1,000 acres (Figure 4.93). Generally, there has been a substantial and consistent increase in the number and size of wildfires per year since 2002.

Figure 4.93 Number of Wildfire in Central Montana Region by Year and Size Class, 2002 to 2021



* Size Class: A = 0.25 acre or less; B = greater than 0.25 to 10 acres; C = 10 to 100 acres; D = 100 to 300 acres; E = 300 to 1,000 acres; F = 1,000+ acres.

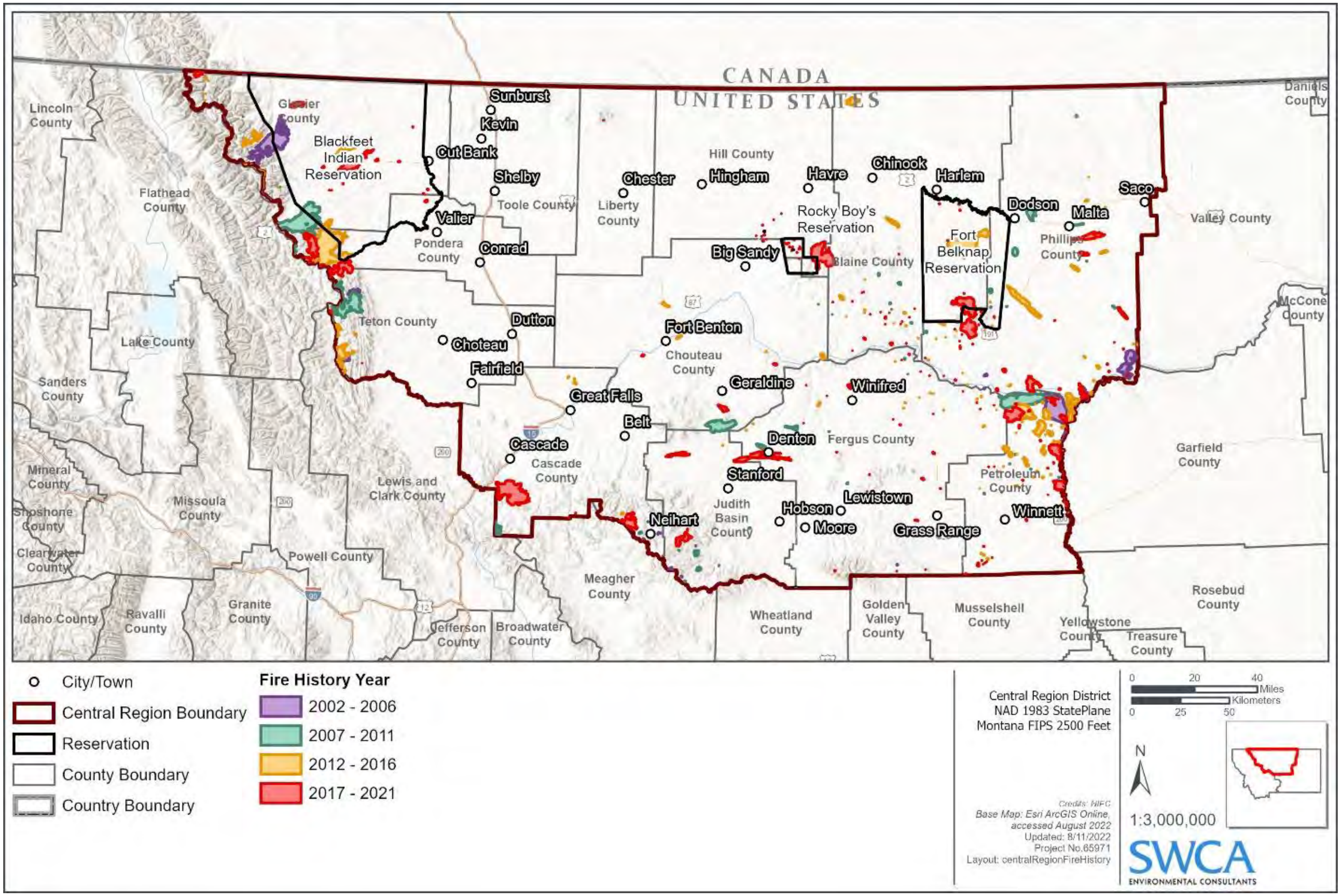
Source: MT DNRC 2022

Over the last 20 years, the most notable fires in the regions have occurred on the eastern divide of Glacier National Park and the Rocky Mountain Front in Glacier, Pondera, and Teton Counties. There have also been notable rangeland fires along the Missouri river in Petroleum and Phillips Counties (Figure 4.94; MT DNRC 2022). The largest rangeland fire in recent history was the Blaine Complex of 1991, shown in Figure 4.95, that occurred at the base of the Bears Paw Mountains in Hill and Chinook Counties and burned 138,192 acres of predominantly grass and grass-shrub fuels. Additionally, the Lodgepole Complex of 2017 burned

270,000 acres of Rangeland and Ponderosa Pine savannah in Petroleum and Garfield Counties. While predominantly outside of the planning region, the fire destroyed 16 homes and 16 structures. In total, the state spent $6 million fighting this fire. To emphasize that wildfire risk is year-round, the West Wind Fire of Late November and early December of 2021 occurred in and around Denton, MT and was started by a powerline. This fire burned 10,644 acres of grasslands, pasture, and riparian wetlands. The fire was particularly destructive as it destroyed 25 primary structures, 18 secondary structures and 6 commercial structures in and around Denton (NWCG 2022). Among the structures lost were family homes, historic grain elevators, and a bridge (3KRTZ 2021). The consequences of these rangeland fires exemplify the threats that wildfire can pose in Central Montana's rangelands.

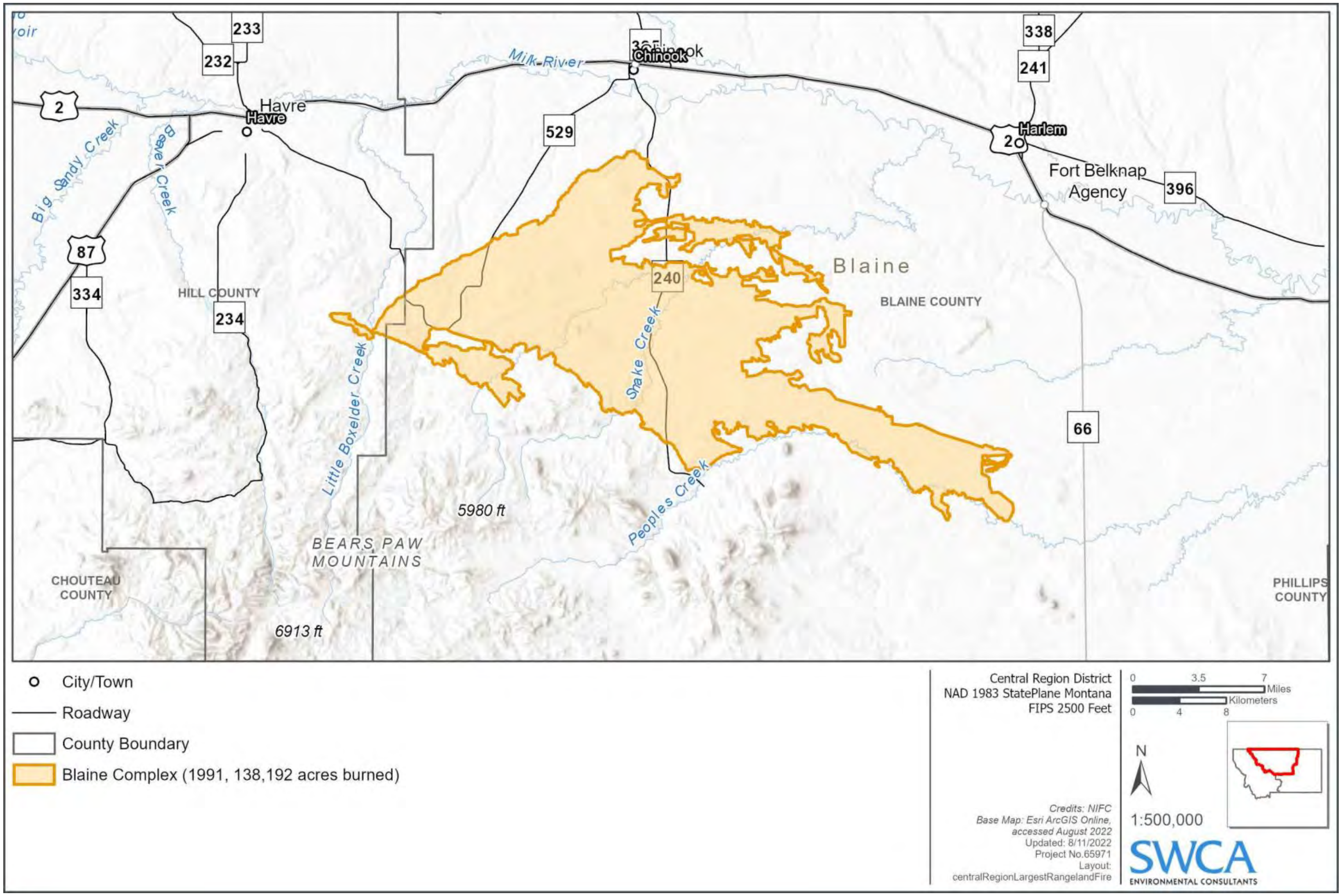
For the region's forests, the Family Peak complex of 2015 burned 54,146 acres (Figure 4.96). This land primarily burned in the Bob Marshall Wilderness; however, it also burned into the Blackfeet reservation. Other forested lands in the Central Region, generally found in the regions isolated island mountain ranges, are also prone to wildfire. In the last 20 years, notable fires have occurred in the following mountain island ranges: the Bears Paw Mountains, the Little Rockies, the Big Belts, and the Little Belts (Figure 4.94).

Figure 4.94 Fire History of Central Montana, 2002-2021



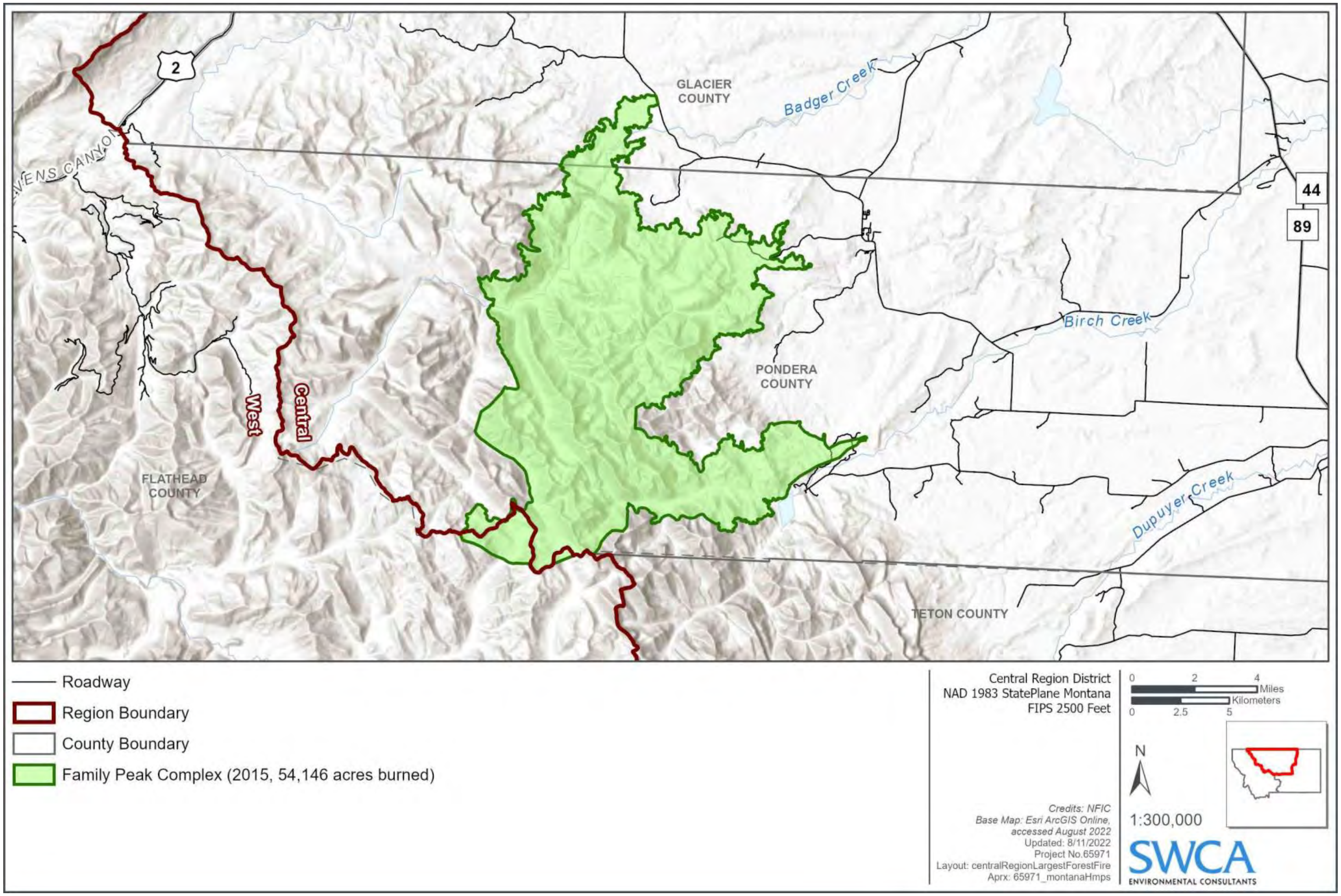
Source: MT DNRC 2022

Figure 4.95 Representative Large Rangeland Wildfire in the Central Region – Blaine Complex of 1991



Source: MT DNRC 2022

Figure 4.96 Representative Forest Fire in Central Montana Region – 2015 Family Peak Complex



Source: MT DNRC 2022

Frequency/Likelihood of Occurrence

As noted previously, between 2002 and 2021 the Central Region experienced 98 wildfires greater than 1,000 acres, an average of nearly 5 per year. Based on this, the probability of future occurrence rating for wildfire is **highly likely** throughout the Central Region.

Wildfires occur every year throughout the region and could occur in any county in any given year. Generally, the forested and rangeland portions of Central Montana are more likely to experience wildfire in a given year, while agricultural areas and alpine areas above tree line are less likely to experience wildfire (Figure 4.98). The counites that experience the largest amount of land burned in any given year are located in the forested and rangeland areas in the western and southeastern portion of the region (Pondera, Glacier, Teton, Cascade Counties, Phillips, Petroleum, and Fergus Counties). However, wildfires are more frequent in the undeveloped rangelands in the eastern portion of the regions (Phillips, Petroleum, and Fergus Counties). In counties with a higher proportion of agricultural land (predominantly farmland), there is low frequency of wildfires and the acreage of these wildfires is likely to be small (Toole and Liberty Counties) (Table 4-64). It is important to note that the risk from wildfire is substantially higher during drought years. The years with the largest wildfires in Montana have normally occurred during periods of drought with associated high temperatures (Whitlock et al 2017).

Figure 4.97 depicts the annualized frequency of wildfire at a county level based on the NRI. The mapping shows the greatest likelihood of occurrence in Petroleum County.

Figure 4.97 Annualized Frequency of Wildfire Events by County

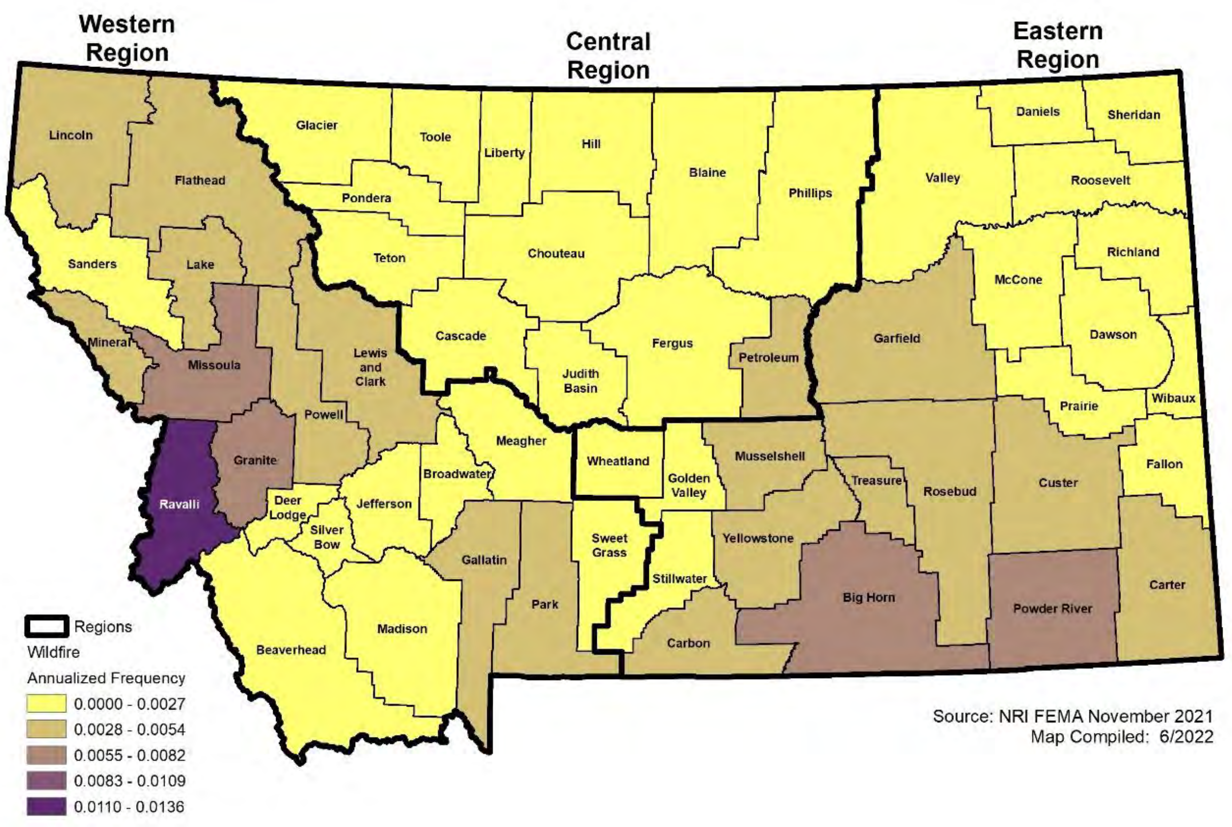
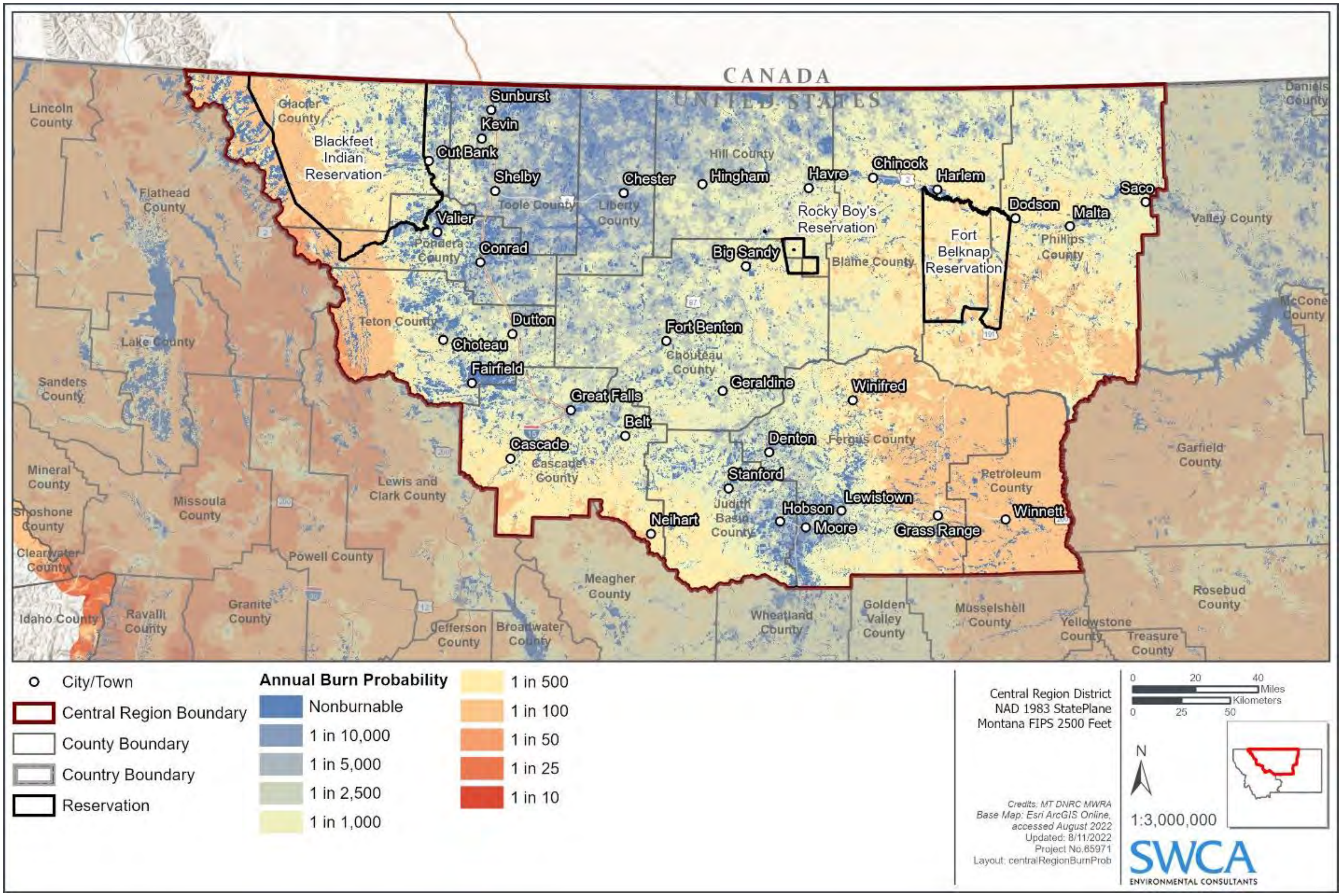


Figure 4.98 Central Montana Region Annual Burn Probability



Source: MT DNRC 2022

Table 4-64 Average Number of Wildfires per year for Central Region Counties, 2002-2021

County/ Reservation	Annual Number of Wildfires (average)	Annual Average Size of Total Acreage of Wildfires
Blaine	2.4	6,564.49
Blackfeet Nation	1.80	11,951.34
Cascade	0.75	4,633.92
Chippewa Cree Rocky Boy's	1.15	193.68
Chouteau	1.25	2,062.47
Fergus	3.4	2,419.49
Fort Belknap Reservation	0.80	5,104.07
Glacier	2.2	20,732.44
Hill	1.3	1,856.40
Judith Basin	0.7	1,378.63
Liberty	0.05	13.18
Petroleum	3.8	13,600.92
Phillips	4.85	9,825.29
Pondera	0.45	9,646.95
Teton	0.6	5,154.36
Toole	0	0
Total	**21.75**	**77,876.03**

Source: MT DNRC 2022

Climate Change Considerations

The 2021 Montana Climate Change and Human Health report is blunt, thorough, and leaves no room for doubt that climate change is and will continue to increase wildfire and smoke hazards throughout Montana. The report declares reduced air quality due to wildfire smoke to be the #2 greatest concern for human health related to climate change, after extreme heat. Similarly, NOAA's 2022 Climate Summary cites the increase in severity and frequency of wildfires as its "Key Message #3."

Climate change impacts on wildfire are complex and often indirect. Climate change impacts on forest and rangeland health are especially important. Hotter and longer summers and prolonged drought are known to put increased physiological stress on trees and increase mortality caused by diseases such as, mountain pine beetle, Douglas-fire beetle, and spruce budworm, among others. As climate change exacerbates diseases outbreaks in the Central Region's forested areas there will be an increased build up in hazardous fuels[6]. Additionally, climate change can result in an increase in invasive grass and weed abundance in

[6] Whitlock, C. et al., 2017, 2017 Montana Climate Assessment. Accessed 6-5-24 at: http://sites.nationalacademies.org/cs/groups/depssite/documents/webpage/deps_189008.pdf

grasslands and rangelands, which can contribute to increased wildfire risk in these systems. Wetter winters and springs combined with hotter and drier summers will also likely result in higher loading of dry fine fuels, which will also contribute to increased wildfire risk. As the fire season increases there will be a higher likelihood of wildfires coinciding with high winds events during fall, winter, and spring storms, especially during drought years. When wildfire, wind, and drought converge they can create conditions for particularly destructive wildfires, even outside of the traditional wildfire season (e.g., the Denton, MT West Wind Fire of December 2021).

While the idea that climate change has worsened wildfire hazards, it is less clear how bad the situation will get in coming decades. There are apparently no projections for wildfire ignitions or acreage burned specific to the planning area. Projections of future wildfire exist, but are at large spatial scales with limited applicability to the specific situation of the planning area. For example, a well-cited 2022 report by the UN Environment Programme[7] presented results from modeling studies that predict a 20%-30% increase in wildfire events from 2020 to 2050 and a 31%-57% increase by 2100. These ranges reflect modeling uncertainty and the use of different climate change scenarios. It's noteworthy that the scenarios modeled were in the low to mid-range climate projections (RCP2.6 and RCP6.0). Despite the coarse scale of this study, it serves to provide an indication of the magnitude of future wildfire in the study area. It also highlights the potential for a future study to model wildfire potential under various climate change scenarios.

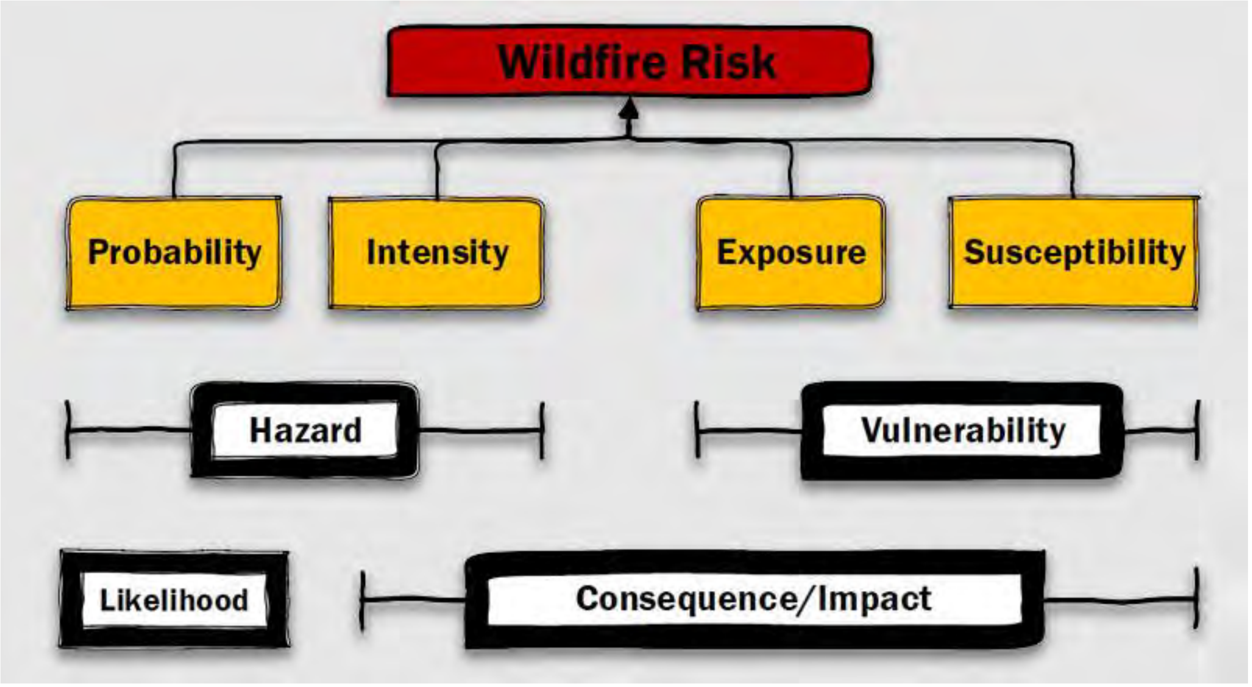
Potential Magnitude and Severity

Montana Wildfire Risk Assessment

The Montana Wildfire Risk Assessment (MWRA) provides information about the wildfire hazard and risk to highly values resources and assets (HVRAs) across Montana. This information is essential for planning wildfire response, fuel management, and land planning. The MWRA is a quantitative assessment of how human and natural resources are both influenced and affected by wildfire. The MWRA considers the following state-wide spatial components when quantifying wildfire risk: likelihood of fire burning, the intensity of a potential fire, the exposure of assets and resources based on their location, and the susceptibility of those assets and resources (MT DNRC 2020c). Wildfire vulnerability to wildfire is determined by wildfire exposure and susceptibility, whereas wildfire hazard is determined by wildfire intensity and wildfire probability.

[7] Sullivan, Andrew, et al., 2022, Spreading like wildfire: The rising threat of extraordinary landscape fires. Accessed 6-5-24 at: https://www.unep.org/resources/report/spreading-wildfire-rising-threat-extraordinary-landscape-fires

Figure 4.99 Conceptual Breakdown of the Components and Meaning of the Montana Wildfire Risk Assessment



Source: MT DNRC 2022

MWRA Components

Wildfire Hazard

Wildfire hazard is determined by wildfire intensity and wildfire probability (MT DNRC 2022). Areas that experience frequent and intense wildfire have the greatest wildfire hazard, while areas that experience low intensity fires over longer time scales have the lowest wildfire hazard.

Wildfire likelihood is the annual probability of wildfire burning in a specific location. At the community level, wildfire likelihood is averaged where housing units occur. It is the probability that any specific location may experience wildfire in any given year. It does not say anything about the intensity of fire if it occurs. Wildfire likelihood is derived from fire behavior modeling across thousands of simulations of possible fire seasons. Factors contributing to the model, such as weather, topography, and ignitions are varied based on trends observed in recent decades. It is important to note that wildfire likelihood is not predictive and does not reflect any currently forecasted weather or fire danger conditions (MT DNRC 2022). The forested and rangeland portions of Central Montana are more likely to experience wildfire in a given year, while agricultural areas and alpine areas above tree line are less likely to experience wildfire (Figure 4.98).

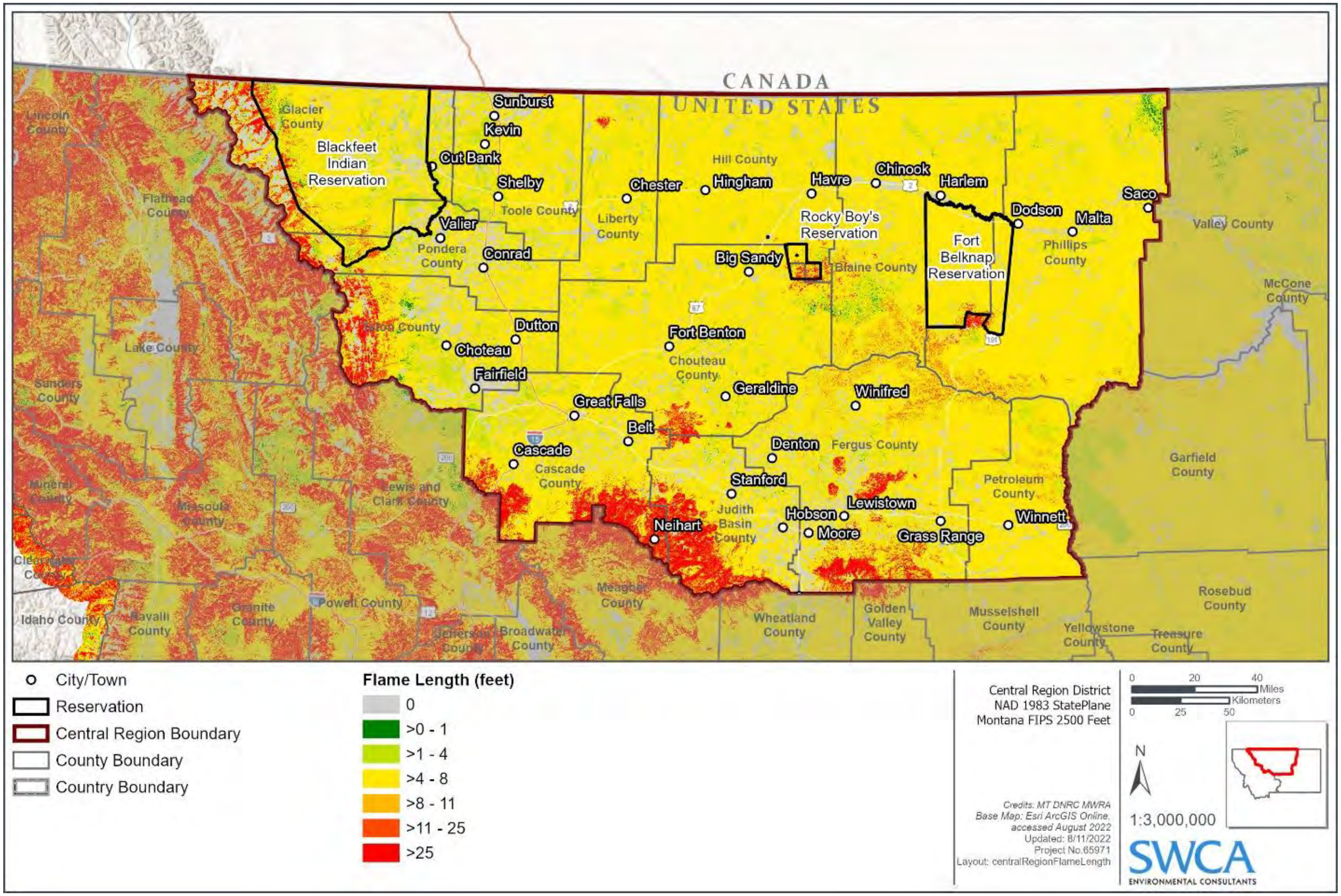
Wildfire intensity is a measure of the energy expected from a wildfire and is mainly determined by the topography and vegetative fuels of a landscape. Greater fuel loads (e.g., forests compared to grass lands), especially on steeper terrain, typically produce greater wildfire intensity. Wildfire intensity is technically measured in units of heat transfer per length of fire perimeter. However, it can also be observed and expressed in terms of flame length (MT DNRC 2022). The MWRA (MT DNRC 2022) uses wildfire intensities calculated in fire behavior modeling simulations. Tall flame lengths (i.e., more intense fires) are more likely to occur in regions comprised of forested areas (Figure 4.100). More intense and taller fires are usually more difficult to control (Table 4-65).

Table 4-65 Control Efforts Associated with Different Flame Lengths

Flame Length	Interpretations
Less than 4 feet	• Fires can generally be attacked at the head or flanks by firefighters using hand tools. • Handline should hold fire.
4 to 8 feet	• Fires are too intense for direct attack in the head with hand tools. • Handline cannot be relied on to hold the fire. • Dozers, tractor-plows, engines, and retardant drops can be effective.
8 to 11 feet	• Fires may present serious control problems: torching, crowning, and spotting. • Control efforts at the head will probably be ineffective.
over 11 feet	• Crowning, spotting, and major fire runs are probable. • Control efforts at the head of the fire are ineffective.

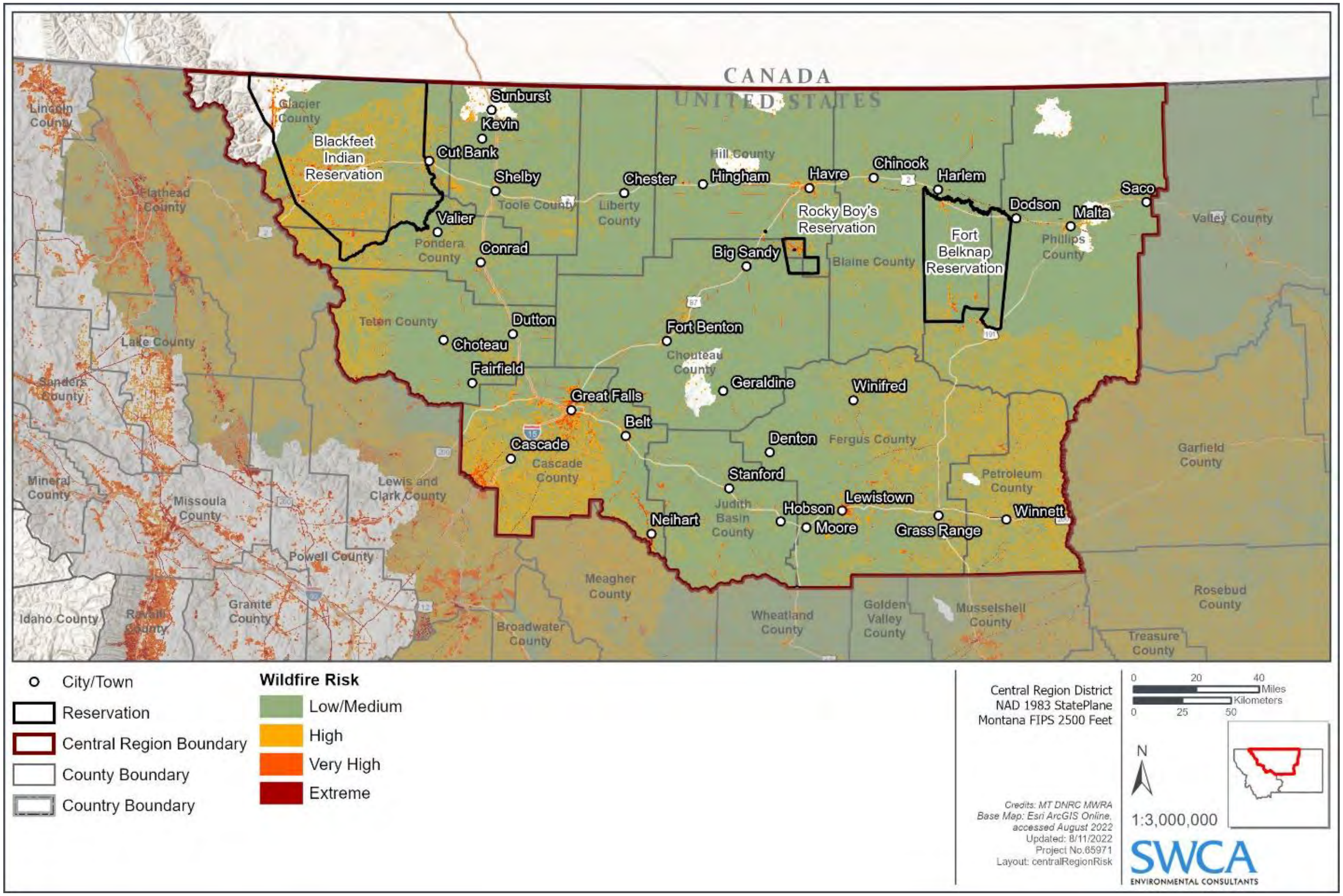
Source: Andrews et al. 2011

Figure 4.100 Central Montana Region Estimated Flame Length



Source: MT DNRC 2022

Figure 4.101 Central Region Wildfire Risk Summary as Determined by eNVC Analysis



*Blank areas have burnable fuels but no HVRAs have been mapped for the area (MT DNRC 2020c).
Source: MT DNRC 2022

Vulnerability to wildfire is determined by wildfire exposure and susceptibility (MT DNRC 2022). For example, fire susceptible structures and/or infrastructure located in high fire intensity and high fire likelihood environments would have high exposure and high susceptibility to fire. In other words, they would be vulnerable to wildfire.

Wildfire exposure is the spatial coincidence of wildfire likelihood and intensity to homes and communities. Homes are exposed to wildfire if they are located where there is any chance wildfire could occur (i.e., burn probability is greater than zero). Communities can be directly exposed to wildfire from adjacent wildland vegetation (e.g., homes situated in a forest), or indirectly exposed to wildfire from embers and home-to-home ignition (MT DNRC 2022).

Wildfire susceptibility is the propensity of a home or community to be damaged if a wildfire occurs. The susceptibility of a Highly Valued Resource or Asset (HVRA) to wildfire is determined by how easily it is damaged by varying degrees of wildfire intensity and type. Assets that are fire-hardened and can withstand very intense fires without damage (i.e., low susceptibility), whereas non-fire hardened structures are more easily damaged by fire (i.e., high susceptibility). The MWRA generalizes the concept of susceptibility. The MWRA assumes all homes that encounter wildfire will be damaged, and the degree of damage is directly related to wildfire intensity. The greater the wildfire intensity, the greater the percent damage to the structure. A community's wildfire risk is the combination of likelihood and intensity (together called "hazard") and exposure and susceptibility (together called "vulnerability") (MT DNRC 2022).

Wildfire Risk

As described previously, wildfire risk is calculated by combining the following components: likelihood of fire burning, the intensity of a potential fire, the exposure of assets and resources based on their location, and the susceptibility of those assets and resources (MWRA 2022). To quantitatively assess wildfire risk MWRA utilized an expected net value change (eNVC) analysis. The eNVC is an effects analysis that helps to quantify wildfire risk to various highly valued resources and assets (HVRA) for example homes, infrastructure, water resources, utility lines etc. (Finney, 2005; Scott et al., 2013; MT DNRC 2020c). The methodology is described in detail in the MWRA Report (https://mwra-mtdnrc.hub.arcgis.com/documents/montana-wildfire-risk-assessment-report/explore) The overall risk of loss to those HVRAs is categorized from low to extreme (Figure 4.101).

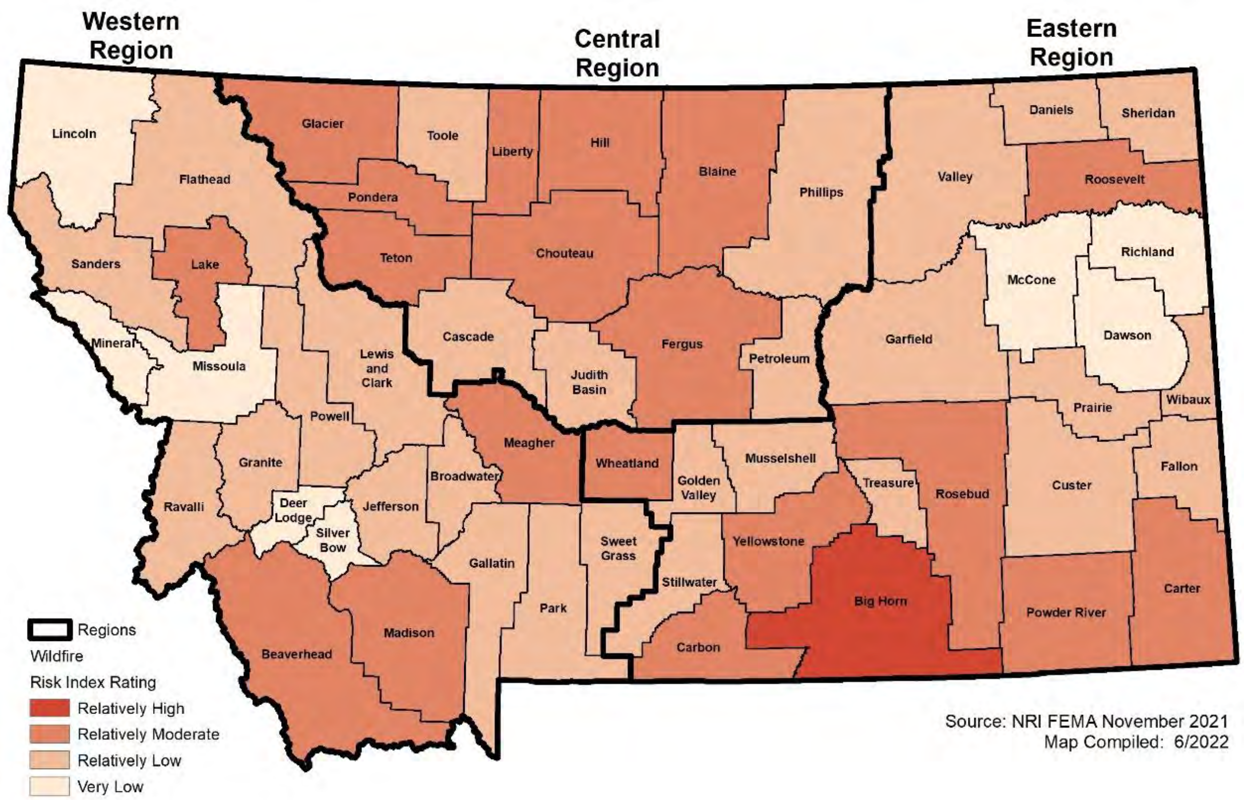
The risk from wildfire is region-wide and varies from low to extreme, but the risk from wildfire to people and property is usually greatest within and near the inhabited areas (Figure 4.101). The municipalities most notably at risk from wildfire include Great Falls, Lewistown, Browning, Shelby, and Havre. Across the region, agricultural areas generally have low risk to wildfire, while the rangelands and forested areas have higher risk to wildfire (predominantly moderate risk). Forests and mostly undeveloped rangelands in areas with complex topography generally have higher risk than forests and rangelands on flatter or less complex topography. Overall, Cascade, Glacier, and Petroleum Counties have the greatest wildfire risk. The Blackfeet Indian Reservation and the Rocky Boy's Reservation are also at moderate risk from wildfire.

It is important to note, however, that most of the towns and municipalities throughout the region have high to extreme risk from wildfire, regardless of the risk of surrounding landscape. Generally, however, towns/municipalities surrounded by undeveloped rangelands and forests have higher risk to wildfire (e.g., Rocky Boy's Reservation, East Glacier Park Village, Great Falls, Winnett, and the exurban areas near Lewistown). This trend is mainly driven by risk to structures and infrastructure within the region's towns and municipalities (Figure 4.103 and Figure 4.104). Most of these structures/infrastructures are susceptible to fire and are exposed, to some degree, to wildfire occurrence, which accounts for the high risk overall overserved (Figure 4.101).

Vulnerability Assessment

Figure 4.102 depicts the risk index rating for wildfire at a county level based on the NRI. The western and southeastern parts of the region show a trend towards a relatively low rating, while the central, northern, and northeastern parts of the region trend towards a relatively moderate rating.

Figure 4.102 Risk Index Rating for Wildfire by County



People

The most exposed population are those that are living within the WUI. The WUI in the Central Region is expansive, but generally, population densities within the WUI are highest in the region's more populated municipalities/towns. More populated areas, generally, have more property and, thus, a greater degree of property exposure to wildfire. The greater property exposure (e.g., greater wildfire risk to structures and infrastructure) puts greater portions of the population in a vulnerable position to negative effects of wildfire. The vulnerability to property is discussed further below.

People can also experience deleterious physical and mental health impacts from fire. A study conducted in California found that particulate air pollution from wildfire had greater impacts on respiratory health than particulate air pollution from traditional sources (e.g., vehicle and power plant emissions) (Aguilera et al 2021). An additional study conducted in California found that extreme wildfire (and it associated impacts) can result in post-traumatic stress disorder, depression, and exacerbate pre-existing mental illness (Silveira et al 2021). In the Western US, ten of the largest years for wildfire (by total acres burned) have occurred since 2004. These large wildfires have been directly linked to poor air quality and have led to adverse physical and mental health effects and costs to society (EPA 2022). As climate change progresses, it is likely Central Montana will have more and larger wildfires. Planning to address the needs of populations at risk will be become increasingly important to mitigate property damage and health impacts from wildfire.

Populations especially at risk from wildlife include socially vulnerable populations. As defined by the US Forest Services Wildfire Risk to Communities (USFS 2022) socially vulnerable populations include the following: families living in poverty, people with disabilities, people over 65 years, people who have difficulty with English, households with no car, and people living in mobile homes. In order to determine the total general population living in wildfire risk areas, the structure count of residential buildings within the various wildfire risk areas and applying the census estimated household size for each county to the total number of structures. This provides an estimated figure for the number of residents living in areas exposed to elevated wildfire risk. Across the central region counties, there are an estimated 9,997 residents exposed to High-risk wildfire areas, 71,277 residents exposed to Very-high risk wildfire areas, and 17,027 residents exposed to Extreme-risk wildfire areas, as summarized in Table 4-66 below.

Table 4-66 Population Within Wildfire Risk Areas

County	High Risk Population	Very High Risk Population	Extreme Risk Population
Blaine	311	1,491	1,229
Cascade	4,377	33,803	3,439
Chouteau	367	3,314	426
Fergus	1,263	5,391	2,596
Glacier	377	3,172	3,629
Hill	548	9,591	1,734
Judith Basin	292	1,410	254
Liberty	203	1,389	16
Petroleum	7	90	315
Phillips	303	2,208	970
Pondera	572	4,175	66
Teton	718	2,249	1,799
Toole	660	2,995	554
Total	**9,997**	**71,277**	**17,027**

Source:

Property

The potential impacts of wildfire on property include crop loss, injury and death of livestock and pets, and damage to infrastructure, homes and other buildings located throughout the wildfire risk area. The greatest potential impact on property, buildings and infrastructure is likely to occur to those structures located within high and very high hazard zones including the WUI, and buildings and infrastructure located within forested lands, to include national forests and parks.

Another method of estimating vulnerability is to determine the number and value of structures that are located within wildfire risk areas. For this plan update loss estimations for the wildfire hazard were modeled by using April 2022 MSDI Cadastral Parcel layer as the basis for the inventory of developed parcels. GIS was used to create a centroid, or point, representing the center of each parcel polygon, which was then intersected with the Montana Wildfire Risk Assessment (MWRA) data. Wildfires typically result in a total building loss, including contents. Content values were estimated as a percentage of building value based on their property type, using FEMA/HAZUS estimated content replacement values. This includes 100% of the structure value for commercial and exempt structures, 50% for residential structures and 100% for vacant improved land. Improved and contents values were summed to obtain a total exposure value. Table 4-67 through Table 4-69 below summarizes the estimated exposed value of improvements in each wildfire risk category.

Table 4-67 Exposure and Value of Structures at High Risk to Wildfire by County

County	Improved Parcels	Improved Value	Content Value	Total Value	Loss Ratio
Blaine	285	$41,009,602	$33,865,530	$74,875,132	13%
Cascade	2,409	$774,453,415	$528,358,146	$1,302,811,561	8%
Chouteau	410	$98,029,072	$105,687,814	$203,716,886	12%
Fergus	918	$189,616,660	$125,775,385	$315,392,045	14%
Glacier	273	$44,651,636	$36,624,195	$81,275,831	9%
Hill	438	$118,336,307	$95,951,054	$214,287,361	7%
Judith Basin	236	$48,185,516	$43,246,298	$91,431,814	14%
Liberty	159	$26,798,121	$21,910,561	$48,708,682	15%
Petroleum	42	$4,561,990	$4,469,100	$9,031,090	11%
Phillips	274	$44,619,766	$36,190,663	$80,810,429	11%
Pondera	386	$70,127,830	$54,618,650	$124,746,480	14%
Teton	515	$117,238,280	$83,607,074	$200,845,354	15%
Toole	454	$91,022,746	$82,556,953	$173,579,699	18%
Total	**6,799**	**$1,668,650,941**	**$1,252,861,421**	**$2,921,512,362**	**10%**

Source: MSDI 2022, MWRA

Table 4-68 Exposure and Value of Structures at Very High Risk to Wildfire by County

County	Improved Parcels	Improved Value	Content Value	Total Value	Loss Ratio
Blaine	587	$48,776,479	$26,817,503	$75,593,982	27%
Cascade	15,150	$3,195,738,469	$1,795,841,433	$4,991,579,902	48%
Chouteau	1,472	$160,158,103	$97,621,402	$257,779,505	45%
Fergus	2,682	$337,970,597	$184,329,996	$522,300,593	42%
Glacier	1,099	$119,728,018	$70,813,251	$190,541,269	37%
Hill	4,058	$696,755,410	$400,104,531	$1,096,859,941	66%
Judith Basin	706	$55,077,083	$31,360,647	$86,437,730	42%
Liberty	554	$57,655,214	$33,587,862	$91,243,076	51%
Petroleum	73	$8,773,250	$6,678,315	$15,451,565	19%

County	Improved Parcels	Improved Value	Content Value	Total Value	Loss Ratio
Phillips	1,053	$111,338,242	$62,482,983	$173,821,225	42%
Pondera	1,582	$204,308,542	$123,640,000	$327,948,542	59%
Teton	1,038	$158,754,606	$96,772,170	$255,526,776	29%
Toole	1,369	$162,753,992	$103,625,811	$266,379,803	54%
Total	**31,423**	**$5,317,788,005**	**$3,033,675,901**	**$8,351,463,906**	**47%**

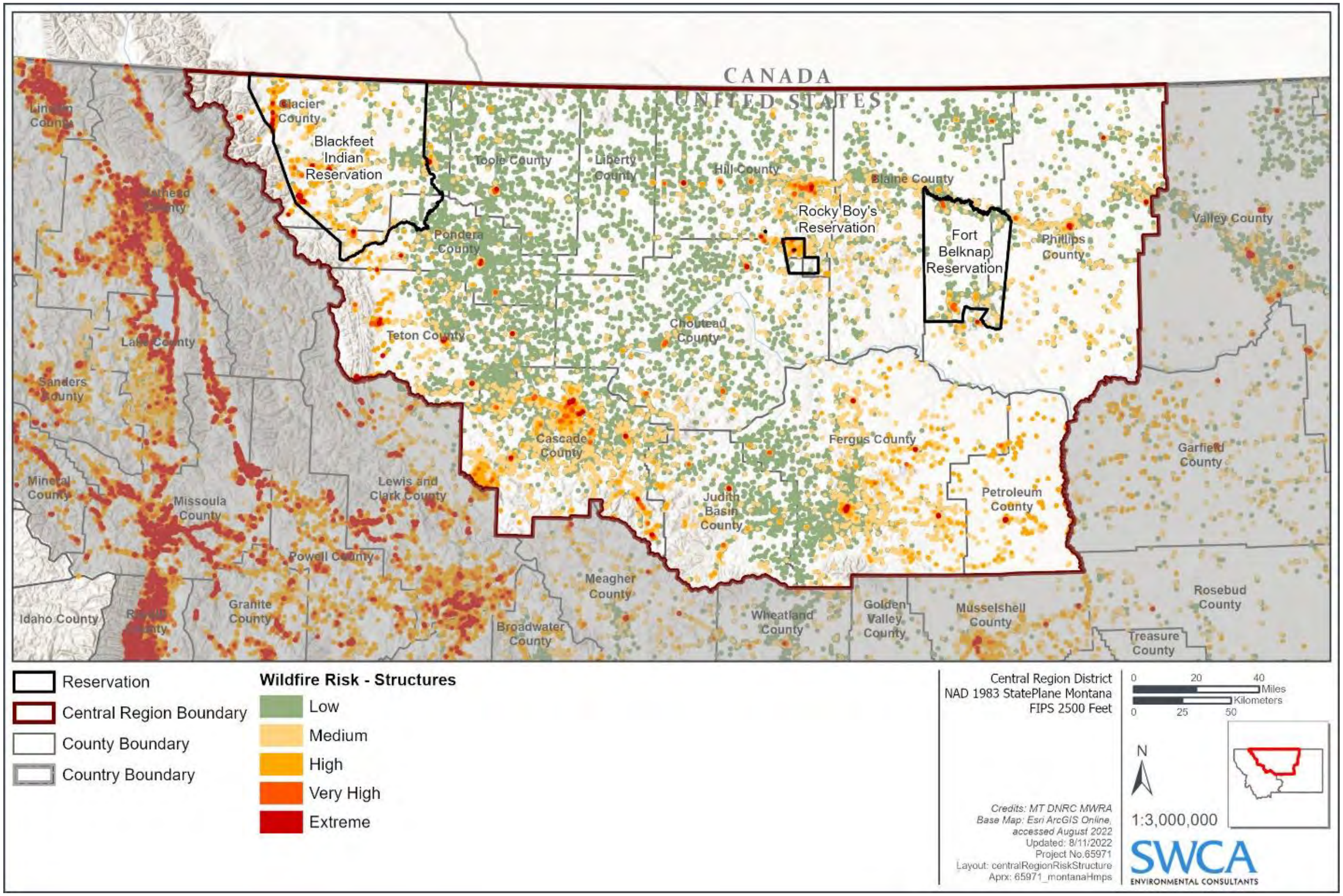
Source: MSDI 2022, MWRA

Table 4-69 Exposure and Value of Structures at Extreme Risk to Wildfire by County

County	Improved Parcels	Improved Value	Content Value	Total Value	Loss Ratio
Blaine	464	$50,981,226	$26,961,623	$77,942,849	21%
Cascade	1,536	$319,625,388	$162,492,545	$482,117,933	5%
Chouteau	185	$20,737,052	$13,276,546	$34,013,598	6%
Fergus	1,262	$153,510,525	$81,417,223	$234,927,748	20%
Glacier	1,254	$127,955,403	$69,028,269	$196,983,672	42%
Hill	727	$87,422,192	$45,924,689	$133,346,881	12%
Judith Basin	127	$10,047,319	$5,434,600	$15,481,919	8%
Liberty	6	$479,118	$239,559	$718,677	1%
Petroleum	167	$11,625,245	$8,156,330	$19,781,575	44%
Phillips	459	$47,199,901	$29,821,830	$77,021,731	18%
Pondera	25	$1,792,836	$915,123	$2,707,959	1%
Teton	797	$92,535,814	$52,494,177	$145,029,991	23%
Toole	252	$33,686,409	$19,595,155	$53,281,564	10%
Total	**7,261**	**$957,598,428**	**$515,757,668**	**$1,473,356,096**	**11%**

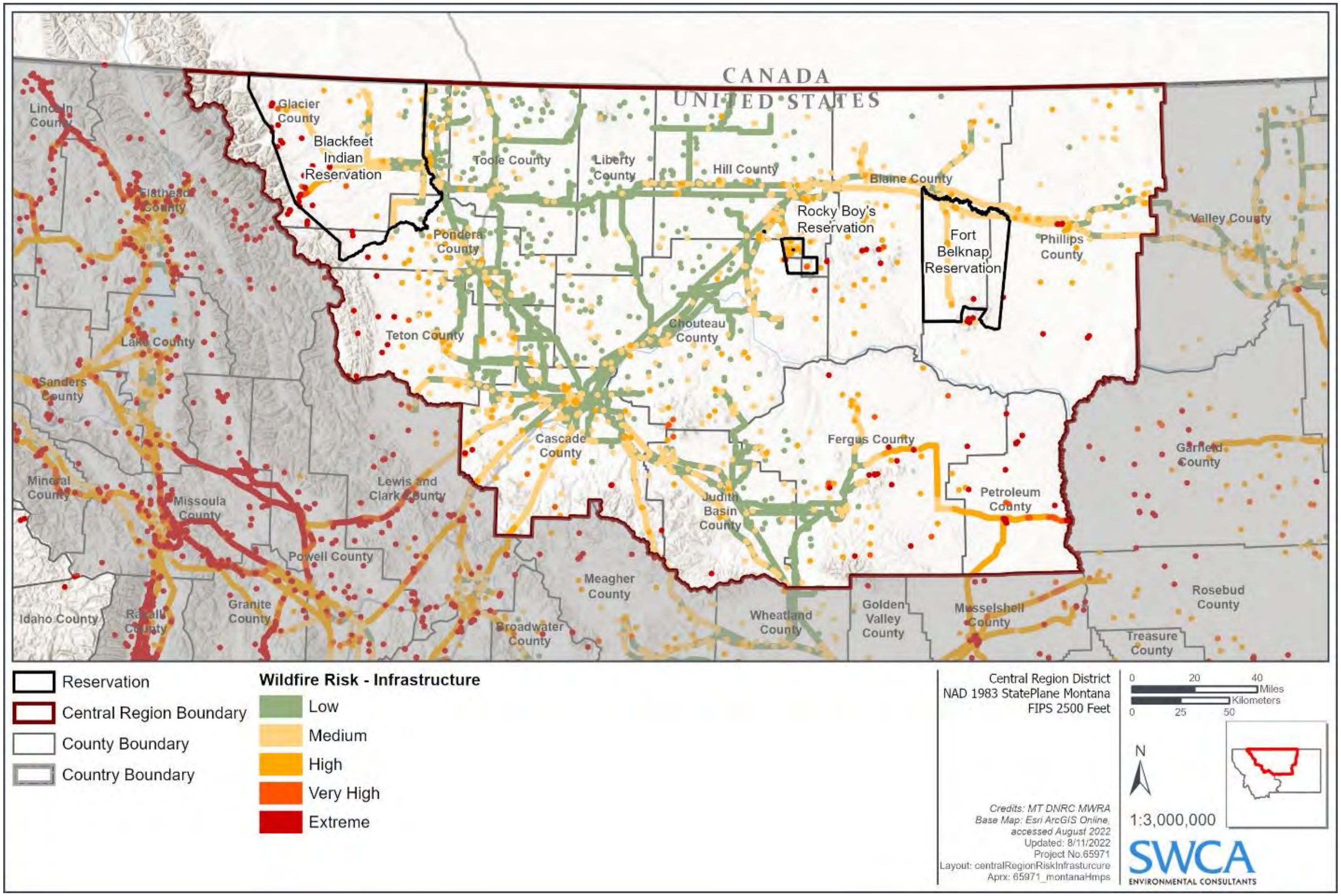
Source: MSDI 2022, MWRA

Figure 4.103 Wildfire Risk to Structures in the Central Region



Source: MT DNRC 2022

Figure 4.104 Wildfire Risk to Infrastructure in the Central Region



Source: MT DNRC 2022

Critical Facilities and Lifelines

Buildings, equipment, vehicles, and communications and utility infrastructure are exposed and lost to wildfires every year. Potential risk exists to water treatment facilities, government buildings, public safety facilities and equipment, and healthcare services. Scour on bridge pilings may result in bridge and road closures. Wildfire impacts to critical facilities can include structural damage or destruction, risk to persons located within facilities, disruption of transportation, shipping, and evacuation operations, and interruption of facility operations and critical functions. To estimate the potential impact of wildfire on critical facilities and lifelines a GIS vulnerability analysis was performed similarly to the property vulnerability analysis, by intersecting the Montana Wildfire Risk Assessment (MWRA) data with critical facility data from HIFLD, Montana DES, and National Bridge Inventory (NBI). Summary tables of these results are shown below in Table 4-70 through Table 4-72, highlighting the type and number of facilities in each county that are located in High, Very High, or Extreme Wildfire risk areas.

Table 4-70 Critical Facilities at Risk to Extreme Wildfire Hazards

County	Communications	Energy	Food, Water, Shelter	Hazardous Materials	Health and Medical	Safety and Security	Transportation	Total
Blaine	11	5	4	0	1	6	4	**31**
Cascade	28	2	2	0	0	9	5	**46**
Chouteau	13	0	0	0	1	3	0	**17**
Fergus	25	4	2	0	2	19	18	**70**
Glacier	23	8	4	1	2	19	7	**64**
Hill	13	2	0	0	0	11	0	**26**
Judith Basin	2	2	0	0	0	1	0	**5**
Liberty	-	-	-	-	-	-	-	**-**
Petroleum	1	5	1	0	1	7	8	**23**
Phillips	11	3	0	0	2	9	5	**30**
Pondera	1	0	0	0	1	4	1	**7**
Teton	12	4	0	0	0	5	0	**21**
Toole	3	0	1	0	1	1	0	**6**
Total	**143**	**35**	**14**	**1**	**11**	**94**	**48**	**346**

Source: HIFLD 2022, Montana DES, NBI, MWRA

Table 4-71 Critical Facilities at Risk to Very High Wildfire Hazards

County	Communications	Energy	Food, Water, Shelter	Hazardous Materials	Health and Medical	Safety and Security	Transportation	Total
Blaine	7	9	3	0	3	16	25	**63**
Cascade	73	42	11	2	6	54	65	**253**
Chouteau	18	24	1	0	2	17	10	**72**
Fergus	3	18	4	0	2	16	36	**79**
Glacier	12	17	7	0	0	12	28	**76**
Hill	26	25	10	2	1	21	16	**101**
Judith Basin	5	23	0	0	2	12	5	**47**
Liberty	5	11	0	0	1	8	2	**27**
Petroleum	0	0	0	0	0	0	5	**5**
Phillips	12	8	0	0	0	8	14	**42**
Pondera	11	14	5	0	2	21	16	**69**
Teton	5	17	6	0	3	7	9	**47**
Toole	17	15	1	0	0	11	6	**50**
Total	**194**	**223**	**48**	**4**	**22**	**203**	**237**	**931**

Source: HIFLD 2022, Montana DES, NBI, MWRA

Table 4-72 Critical Facilities at Risk to High Wildfire Hazards

County	Communications	Energy	Food, Water, Shelter	Hazardous Materials	Health and Medical	Safety and Security	Transportation	Total
Blaine	9	0	3	1	0	1	42	**56**
Cascade	13	1	4	2	3	7	55	**85**
Chouteau	6	0	5	0	0	1	21	**33**
Fergus	5	0	2	1	0	12	39	**59**
Glacier	1	0	0	2	0	1	16	**20**
Hill	3	0	1	1	0	3	13	**21**
Judith Basin	1	0	0	0	0	1	15	**17**
Liberty	2	0	2	0	0	0	7	**11**
Petroleum	1	0	0	0	0	0	7	**8**

County	Communications	Energy	Food, Water, Shelter	Hazardous Materials	Health and Medical	Safety and Security	Transportation	Total
Phillips	10	0	0	0	0	1	17	**28**
Pondera	0	0	0	0	0	0	33	**33**
Teton	0	1	2	0	0	1	30	**34**
Toole	2	1	1	1	0	2	14	**21**
Total	**53**	**3**	**20**	**8**	**3**	**30**	**309**	**426**

Source: HIFLD 2022, Montana DES, NBI, MWRA

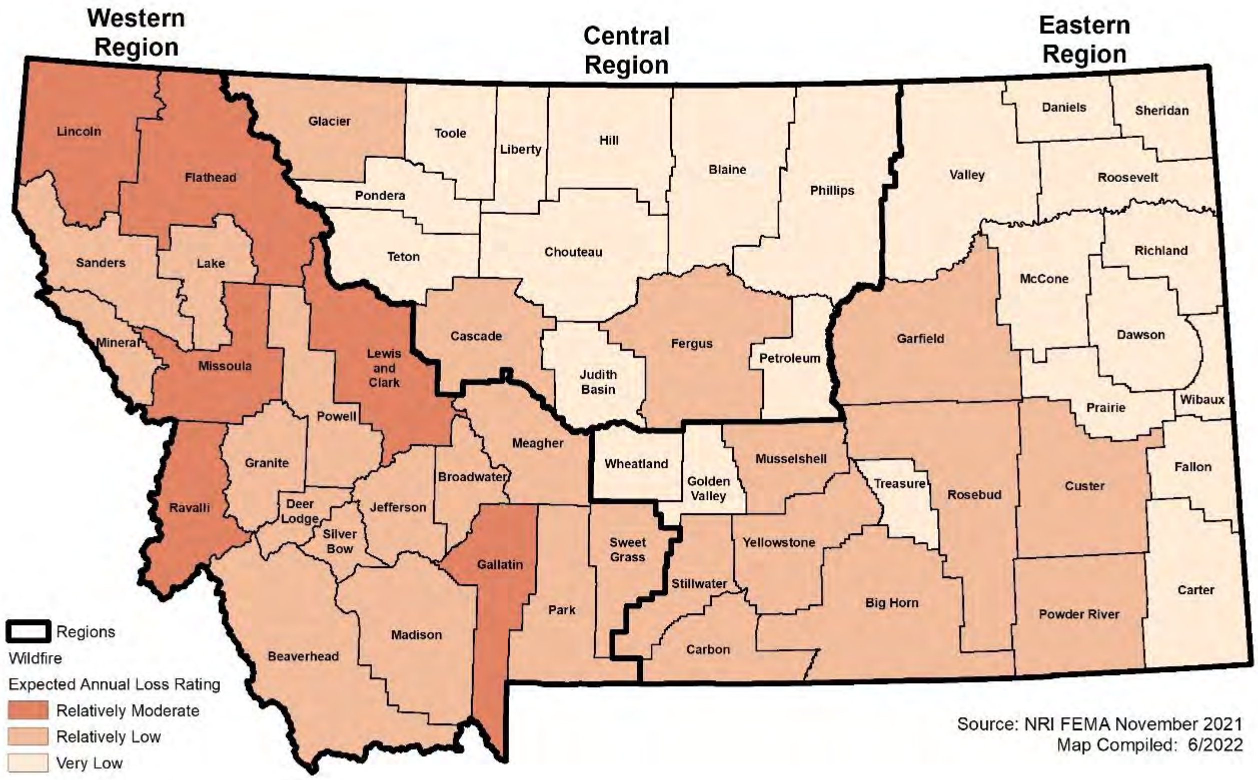
Economy

The economic impacts of wildfire include loss of property, direct agricultural sector job loss, secondary economic losses to businesses in or near wildland resources like parks and national forests, and loss of public access to recreational resources. Damage to these assets or disruption of access to them can have far reaching negative impacts to the local economy in the form of reduced revenues, in addition to the monetary losses resulting from direct building losses. Fire suppression may also require increased cost to local and state government for water acquisition and delivery, especially during periods of drought when water resources are scarce.

Tourism and outdoor recreation are vital components of the Central Region economy. Wildland fires can have a direct impact on the County's scenery and environmental health, adversely affecting the presence of tourism activities and the ability of the regions residents to earn a living from the related industries. The Central Region's scenic beauty and cultural resources are a main draw for tourism, so the entire region can suffer economic losses from tourists not coming to the area due to wildfires.

Figure 4.105 illustrates the relative risk of EAL rating due to wildfire. Most counties in the Central Region have very low risk, although Glacier, Cascade, and Fergus Counties have a slightly higher risk score.

Figure 4.105 NRI Wildfire Expected Annual Loss Rating by County



Historic and Cultural Resources

Historic structures are often at high risk to wildfire due to wood frame construction methods and being constructed long before modern building and fire codes. Cultural resources include the natural and recreational resources also mentioned in the Economy and Natural Resources sections. These resources add not only monetary value and ecosystem goods and services to the region but can also serve as a source of regional identity and pride for the residents of the Central Region. This makes these vital resources for the various communities which are vulnerable to wildfire.

Natural Resources

Wildfire can be both beneficial and destructive to natural resources. In the rangeland and forested systems of Central Montana fire is an essential component of the region's ecosystems and is necessary to maintain its native ecology (MT DNRC 2020a). However, in recent decades fire suppression, fuel buildup, climate change, and non-native invasive plant species have altered the natural fire regimes and increased the likelihood of high severity wildfire. These changing conditions have put much of the region's natural resources at risk (MT DNRC 2020a).

Across the western US, watersheds vulnerability wildfire has increased with the increasing wildfire conditions. Larger and more extreme, high severity wildfires have resulted in degradation to watershed quality. High severity wildfires can result in increased flows (due to increased hydrophobicity of the burned soil); higher amounts of sedimentation and contamination (due to destabilization of topsoil), loss of aquatic habitat, and degradation of aquatic ecology (Montana Free Press 2022; Rhoades et al 2019). As watersheds become more vulnerable to wildfire more mitigation efforts will be required to protect watershed health.

Recreation is a valuable natural resource in the region. The region contains vast areas of highly valued public lands, which include, but are not limited to, the eastern portion of Glacier National Park, part of the Bob Marshall Wilderness, the Rocky Mountain Front, the Missouri River Breaks National Monument, portions of Lewis and Clark National Forest, and Bureau of Land Management managed rangelands. Increasing wildfire conditions can put these recreational resources at risk. Increasing wildfire conditions, especially extreme large fires, can threaten access (due to temporary closures), impact air and water quality, and alter visual aesthetics. Taken together, these impacts can potentially deter visitation and hurt the region's tourist economy (Kim and Jakus 2019).

Timber extraction in the Central region is carried out in limited capacity and predominantly occurs in the Little Belts of Lewis and Clark National Forest. Increasing wildfire conditions can halt timber sales (due to closures) and damage and potentially destroy harvestable trees, impacting the timber industry. In recent years forest wildfires have become larger and more severe. Historically, however, wildfires of all frequencies and severities occurred in the regions forests and were necessary for maintaining stand structure and native forest ecology (MT DNRC 2020c). Timber management should be aligned with fire management, such that it allows natural fire regimes and their dependent ecology to be restored and/or persist while minimizing the vulnerability of region's timber industry.

Public and privately managed rangelands across the Central Region provide ample grazing for livestock grazing, making it highly valued for ranching. Increasing, wildfire conditions can put ranches and livestock at risk and threaten this region's industry in the event of large fires. However, it is important to note that, historically, the rangelands throughout the region required a mosaic of conditions created by wildfire (i.e., a landscape that exhibits different severities of wildfire and time since wildfire) to maintain their native ecology. For instance, wildfire can clear woody shrubs, favor the growth of grasses and forbs, and increase vegetative productivity (Cooper et al 2011); all of which can bolster ranching in the region. Wildfire should be carefully managed to both maintain the regions natural ecology and to help minimize risk to local ranchers.

Wildfire can also threaten the region's farmlands. Currently counties with a proportion of farmlands are less vulnerable to wildfire. However, much of the region has an intermix of farmland and undeveloped rangelands. These would likely be more vulnerable to wildfire. For example, wildfire on undeveloped rangelands could threaten nearby farms and their crops. This is especially possible in the later summer and early fall when wildfire could threaten dry fields of wheat. When wheatfields do catch fire they spread at fast rates, are hard to control, and can be highly destructive (Western Farm Press 2017). Increasing wildfire risk also threatens the Central Region's farmlands.

Development Trends Related to Hazards and Risk

Throughout the region there has been no meaningful trends in population growth. However, trends across the state and the Western US have demonstrated that the WUI is a popular building location. Thus, there remains a potential for homes to be developed within the WUI in the Central Montana region. Building future homes/structures in high-risk WUI areas would put lives and property in the path of wildfires. Regulating growth in these areas will be a delicate balance between protecting private property rights and promoting public safety. Local governments may wish to consider regulation of subdivision entrance/exit roads and bridges for the safety of property owners and fire personnel, building considerations pertaining to land on slopes greater than 25% (in consideration of access for fire protection of structures), and water supply requirements set forth to include ponds, evacuation routes, access by apparatus, pumps, and backup generators. Such standards serve to protect residents and property, as well as emergency services personnel. Additionally, as climate change progresses, the wildfire conditions will likely be exacerbated. Regional planners and property owners should also consider efforts to improve the wildfire resiliency of homes, structures, and critical infrastructures currently situated in the WUI to prepare for potential increased risk from wildfire.

Risk Summary

In summary, wildland and rangeland fire is considered to be overall High significance for the Region. Variations in risk by jurisdiction are summarized in the table below, as well as key issues from the vulnerability assessment. The frequency of wildfires in the Central Region overall is **highly likely**, although the forested and rangeland areas have a higher burn probability.

- Wildfire ignitions occur most frequently in the southeastern portions of the Central Region, where there are large portions of mostly undeveloped rangelands.
- The counties with large areas of forests and rangelands are likely to experience the most acres burned in any given year.
- Socially vulnerable populations are likely to experience heightened effects of wildfire.
- Property, structures, and critical infrastructure is at moderate to extreme risk from throughout the region.
- Jurisdictions surrounded by more fire prone landscapes (e.g., forests and rangelands), generally, have structures and critical infrastructure most at risk to extreme wildfire.
- As climate change increases, drought could be more likely and the detrimental impacts on human health and the built environment from wildfire could increase.
- Related Hazards: Drought, Flooding, Severe Summer Weather (lightning)

Table 4-73 Risk Summary Table: Wildland and Rangeland Fire

Jurisdiction	Overall Significance	Additional Jurisdictions	Jurisdictional Differences?
Central Region	Medium	NA	None
Blackfeet Tribe	Medium	NA	None
Blaine County	High	Chinook and Harlem	None
Cascade County	High	Great Falls, Belt, Cascade, and Neihart	None
Chippewa Cree Tribes Rocky Boy's Reservation	Medium	NA	None
Chouteau County	Low	Fort Benton, Big Sandy	High in Fort Benton, Low in Highwood
Fergus County	Medium	Lewistown, Denton, Grass Range, Moore, Winifred	None
Fort Belknap Indian Community	Low	NA	None
Glacier County	Medium	Cut Bank	None
Hill County	High	Havre, Hingham	None
Judith Basin County	High	Stanford, Hobson	None
Liberty County	Low	Chester	None
Petroleum County	Medium	Winnett	None

Jurisdiction	Overall Significance	Additional Jurisdictions	Jurisdictional Differences?
Phillips County	High	Malta, Saco	None
Pondera County	High	Conrad	None
Teton County	Medium	Choteau, Dutton, Fairfield	None
Toole County	High	Shelby, Kevin, and Sunburst	None

5 Mitigation Strategy

Local Plan Requirement §201.6(c)(3): [The plan shall include] a mitigation strategy that provides the jurisdiction's blueprint for reducing the potential losses identified in the risk assessment, based on existing authorities, policies, programs and resources, and its ability to expand on and improve these existing tools. This section shall include:

(i) A description of mitigation goals to reduce or avoid long-term vulnerabilities to the identified hazards.

(ii) A section that identifies and analyzes a comprehensive range of specific mitigation actions and projects being considered to reduce the effects of each hazard, with particular emphasis on new and existing buildings and infrastructure.

(iii) An action plan describing how the actions identified in section (c)(3)(ii) will be prioritized, implemented, and administered by the local jurisdiction. Prioritization shall include a special emphasis on the extent to which benefits are maximized according to a cost-benefit review of the proposed projects and their associated costs.

Tribal Requirement §201.7(c)(3): A mitigation strategy that provides the Indian tribal government's blueprint for reducing the potential losses identified in the risk assessment, based on existing authorities, policies, programs and resources, and its ability to expand on and improve these existing tools. This section shall include:

(i): A description of mitigation goals to reduce or avoid long-term vulnerabilities to the identified hazards.

(ii): A section that identifies and analyzes a comprehensive range of specific mitigation actions and projects being considered to reduce the effects of each hazard, with particular emphasis on new and existing buildings and infrastructure.

(iii): An action plan describing how the actions identified in paragraph (c)(3)(ii) of this section will be prioritized, implemented, and administered by the Indian Tribal government.

5.1 Mitigation Strategy: Overview

This section describes the mitigation strategy process and mitigation action plan for the Central Montana Region Hazard Mitigation Plan. It describes how the participating jurisdictions in the Region met the following requirements from the 10-step planning process:

- Planning Step 6: Set Goals
- Planning Step 7: Review Possible Activities
- Planning Step 8: Draft an Action Plan

The results of the planning process, the risk assessment, the goal setting, the identification of mitigation actions, and the hard work of each jurisdiction's CPT/TPT led to this mitigation strategy and action plan. Section 5.2 below identifies the goals of this plan and Section 5.4 describes the mitigation action plan.

5.2 Mitigation Goals

Up to this point in the planning process, each jurisdiction's CPT/TPT has organized resources, assessed hazards and risks, and documented mitigation capabilities. The resulting goals and mitigation actions were reviewed and updated based on these tasks. During the 2022-2023 update of this plan, each CPT/TPT held a series of meetings designed to achieve a collaborative mitigation strategy as described further throughout this section.

Goals were defined for the purpose of this mitigation plan as broad-based public policy statements that:

- Represent basic desires of the community;
- Encompass all aspects of community, public and private;

- Are nonspecific, in that they refer to the quality (not the quantity) of the outcome;
- Are future-oriented, in that they are achievable in the future; and
- Are time-independent, in that they are not scheduled events.

Goals are stated without regard to implementation. Implementation cost, schedule, and means are not considered. Goals are defined before considering how to accomplish them so that they are not dependent on the means of achievement. Goal statements form the basis for objectives and actions that will be used as means to achieve the goals.

During the mitigation strategy workshops held in October of 2022, the jurisdictions reviewed the results of the hazard identification, vulnerability assessment, and capability assessment. They then reviewed the goals of the previous county and tribal hazard mitigation plans in the Central Region, as well as the State of Montana Hazard Mitigation Plan. This analysis of the risk assessment identified areas where improvements could be made and provided the framework for the counties and tribes to update planning goals and to base the development of new or updated mitigation strategies for the counties and tribes in the Region. The participating jurisdictions decided to collaborate and develop a set of new, uniform goals, which were adopted by all counties in the Region:

Goal 1: Reduce impacts to people, property, the environment, and the economy from hazards.

Goal 2: Protect community lifelines and critical infrastructure to ensure the continuity of essential services.

Goal 3: Increase public awareness and participation in hazard mitigation.

Goal 4: Sustain and enhance jurisdictional capabilities to enact mitigation activities.

Goal 5: Integrate hazard mitigation into other plans, processes, and regulations.

Goal 6: Promote regional cooperation and leverage partnerships in mitigation solutions where possible.

Objectives are an optional intermediate step between goals and mitigation actions that define strategies to attain the goals and are more specific and measurable. After discussion, the HMPC decided not to include regional objectives. Each county and tribe were given the opportunity to set objectives to meet their unique situation and complement the regional goals. See the jurisdictional annexes for details.

5.3 Identification and Analysis of Mitigation Actions

The next step in the mitigation strategy is to identify and analyze a comprehensive range of specific mitigation actions and projects to reduce the effects of each hazard on new and existing buildings and infrastructure. During the 2022-2023 Regional Plan update, each jurisdiction's CPT/TPT analyzed viable mitigation options by hazard that supported the identified goals. The CPTs/TPTs were provided with the following list of categories of mitigation actions, which originate from the Community Rating System:

- **Plan and Regulations (Prevention):** Administrative or regulatory actions or processes that influence the way land and buildings are developed and built.
- **Property Protection:** Actions that involve the modification of existing buildings or structures to protect them from a hazard or remove them from the hazard area.
- **Structural and Infrastructure Projects:** Actions that involve the construction of structures to reduce the impact of a hazard.
- **Natural Resource Protection:** Actions that, in addition to minimizing hazard losses, also preserve or restore the functions of natural systems.

- **Public Information/Education and Awareness:** Actions to inform and educate citizens, elected officials, and property owners about the hazards and potential ways to mitigate them.
- **Emergency Services:** Actions that protect people and property during and immediately after a disaster or hazard event.

To identify and select mitigation actions in support of the mitigation goals, the HMPC evaluated each hazard identified and profiled in Chapter 3.4. A link to reference documents titled "Mitigation Ideas" and "Mitigation Action Portfolio" developed by FEMA was made available in the meeting presentation. These documents list common alternatives for mitigation by hazard and best practices. The jurisdictions considered both future and existing buildings in considering possible mitigation actions. A facilitated discussion then took place to examine and analyze the options.

The mitigation strategy is based on existing local and tribal authorities, policies, programs, and resources, as well as the ability to expand on and improve these existing tools. As part of the Regional Plan development, the county planning teams reviewed existing capabilities for reducing long-term vulnerability to hazards. Those capabilities are noted by jurisdiction in the county and reservation annexes and can be assessed to identify gaps to be addressed and strengths to enhance through new mitigation actions. For instance, gaps in design or enforcement of existing regulations be addressed through additional personnel or a change in procedure or policy.

Based upon the key issues identified in the risk assessment, including the capability assessment, the counties came to consensus on proposed mitigation actions for each hazard for their jurisdictions. Certain hazards' impacts were best reduced through multi-hazard actions. A lead for each new action, where applicable, was identified to provide additional details on the project so they could be captured in the plan. Final action strategies are summarized in Section 5.4 and detailed within the respective jurisdictional annexes.

5.3.1 Prioritization Process

Once the mitigation actions were identified, the county and tribal planning teams were provided FEMA's recommended prioritization criteria STAPLEE to assist in deciding why one recommended action might be more important, more effective, or more likely to be implemented than another. STAPLEE is an acronym for the following:

- **Social**: Does the measure treat people fairly? (e.g., different groups, different generations)
- **Technical**: Is the action technically feasible? Does it solve the problem?
- **Administrative**: Are there adequate staffing, funding, and other capabilities to implement the project?
- **Political**: Who are the stakeholders? Will there be adequate political and public support for the project?
- **Legal**: Does the jurisdiction have the legal authority to implement the action? Is it legal?
- **Economic**: Is the action cost-beneficial? Is there funding available? Will the action contribute to the local economy?
- **Environmental**: Does the action comply with environmental regulations? Will there be negative environmental consequences from the action?

Other criteria used to assist in evaluating the priority of a mitigation action included:

- Does the action address hazards or areas with the highest risk?
- Does the action protect lives?
- Does the action protect infrastructure, community assets or critical facilities?
- Does the action meet multiple objectives?

At the mitigation strategy workshops, the counties and tribes used STAPLEE to determine which of the new identified actions were most likely to be implemented and effective. Keeping the STAPLEE criteria in mind, each jurisdiction prioritized the new mitigation actions by giving an indication of relative priority, which was then translated into 'high,' 'medium' and 'low.' The results of the STAPLEE evaluation process produced prioritized mitigation actions for implementation within the planning area. Continued actions were also assessed to see if priority changes were needed; most of these remained the same but in some cases priorities were changed.

The process of identification and analysis of mitigation alternatives allowed the county and tribal planning teams to come to consensus and to prioritize recommended mitigation actions for their jurisdictions. During the voting process, emphasis was placed on the importance of a benefit-cost review in determining project priority as this is a requirement of the Disaster Mitigation Act regulations; however, this was a planning level analysis as opposed to a quantitative analysis. Quantitative cost-benefit analysis will be considered in additional detail when seeking FEMA mitigation grant funding for eligible projects identified in this plan.

Each mitigation action developed for this plan contains a brief description of the problem and proposed project, the entity with primary responsibility for implementation, a cost estimate, and a schedule for implementation. Development of these project details further informed the determination of a high, medium, or low priority for each. During the plan update, the jurisdictions in the Central Region identified some mitigation actions to be carried forward from previous regional hazard mitigation plan. Priority levels on these actions were revisited and, in some cases, modified to reflect current priorities based on the STAPLEE principles.

5.4 Mitigation Action Plan

This section outlines the development of the mitigation action plan. The action plan consists of the specific projects, or actions, designed to meet the plan's goals. Over time the implementation of these projects will be tracked as a measure of demonstrated progress on meeting the plan's goals.

5.4.1 Progress on Previous Mitigation Actions

This Regional Plan represents a plan update for all counties and tribes. As part of the update process the jurisdictions reviewed actions identified in their previous plans to assess progress on implementation. These reviews were completed using worksheets to capture information on each action including if the action was completed or deferred to the future. Actions that were not completed were discussed for continued relevance and were either continued into the Regional Plan or in some cases recommended for deletion.

The participating jurisdictions have been working steadily towards meeting the goals of their previous plans. While several remain to be completed, many were noted as in-progress. Progress on mitigation actions previously identified in these planning mechanisms are detailed in the jurisdictional annexes. These action plans were also shared amongst the regional plan participants to showcase progress and stimulate ideas amongst the respective planning committees in each county and tribe. Reasons that some actions have not been completed include low priority, lack of funding, or lack of administrative resources.

Table 5-1 summarizes progress implementing mitigation actions by tribe and county (including the municipalities). In total, there were 756 mitigation actions in the jurisdictions' previous HMPs. Of those, 43 actions have been completed, and 75 were deleted as being no longer relevant or feasible. A total of 638 actions have been carried over into the Regional Plan, along with 96 new actions developed for the Regional Plan.

Table 5-1 Mitigation Action Progress Summary by Jurisdiction

County/Reservation	Actions in Prior HMP	Completed	Deleted	Continuing	New Actions in 2023	Total Continuing and New Actions
Blackfeet Nation	70	5	7	58	7	65
Blaine County	55	5	6	43	5	48
Cascade County	71	0	1	69	11	80
Chippewa Cree Tribe	80	0	0	80	3	83
Chouteau County	98	0	2	96	8	104
Fergus County	34	4	4	13	37	50
Glacier County	34	2	5	27	3	30
Hill County	85	0	20	65	6	71
Judith Basin County	26	6	0	20	4	24
Liberty County	13	3	2	8	4	12
Petroleum County	26	9	1	16	7	23
Phillips County	48	3	8	38	14	52
Pondera County	37	0	14	23	3	26
Teton County	50	4	0	46	11	57
Toole County	19	3	6	10	17	27
Total	**746**	**44**	**76**	**612**	**140**	**752**

See the jurisdictional annexes for their list of mitigation actions, as well as more details on progress on implementation of previous actions.

5.4.2 Continued Compliance with NFIP

Given the significance of the flood hazard throughout the planning area, an emphasis will be placed on continued compliance with the National Flood Insurance Program (NFIP). Jurisdictions that participate in the NFIP are noted in the respective annexes' Capability Assessment and will continue to make every effort to remain in good standing with the program. This includes continuing to comply with the NFIP's standards for adopting floodplain maps and maintaining and periodically updating local floodplain regulations. Actions related to continued compliance include:

- Continued designation of a local floodplain manager whose responsibilities include reviewing floodplain development permits to ensure compliance with the local floodplain management ordinances and rules;
- Suggest changes to improve enforcement of and compliance with regulations and programs;
- Participate in Flood Insurance Rate Map updates by adopting new maps or amendments to maps;
- Utilize Digital Flood Insurance Rate Maps in conjunction with GIS to improve floodplain management, such as improved risk assessment and tracking of floodplain permits;
- Promote and disperse information on the benefits of flood insurance.

Also, to be considered are the flood mitigation actions contained in this Regional Plan that support the ongoing efforts by participating jurisdictions to minimize the risk and vulnerability of the community to the flood hazard, and to enhance their overall floodplain management program.

5.4.3 Mitigation Action Plan

The action plan presents the recommendations developed by the county and tribal planning teams, outlining how each jurisdiction and the Region can reduce the risk and vulnerability of people, property, infrastructure, and natural and cultural resources to future disaster losses. The mitigation actions developed by each participating jurisdictions are detailed in the jurisdictional annexes in Section 10. These details include the action description, hazard(s) mitigated, lead and partner agencies responsible for initiating implementation, costs, and timeline. Many of the action items included in this plan are a collaborative effort among local, state, tribal, and federal agencies, and stakeholders in the planning area.

Table 5-2 summarizes the mitigation actions that address each hazard relevant to that jurisdiction.

Table 5-2 Mitigation Actions by Hazard and Jurisdiction

County/Reservation	Communicable Disease	Cyber-Attack	Dam Failure	Drought	Earthquake	Flooding	Hazmat Incident	Human Conflict	Landslide	Severe Summer Weather	Severe Winter Weather	Tornadoes & Windstorms	Transportation Accidents	Volcanic Ash	Wildfire
Blackfeet Nation	11	6	28	6	24	36	26	12	25	27	27	8	22	39	11
Blaine County	1	5	9	10	6	22	4	2	12	12	12	13	1	9	16
City of Chinook	1	5	9	10	6	20	4	2	12	12	12	13	1	9	15
City of Harlem	1	4	9	10	6	18	5	2	12	12	12	14	2	9	15
Cascade County	6	8	11	8	9	24	15	12	9	11	11	11	11	9	22
City of Great Falls	6	8	9	7	8	20	15	10	8	10	10	10	10	8	14
Town of Belt	6	3	8	7	9	21	14	8	8	11	11	10	11	8	15
Town of Cascade	6	3	9	8	8	16	16	7	8	10	10	10	11	8	14
Chippewa Cree Tribe	11	13	18	6	11	27	15	18	14	18	20	12	13	25	11
Chouteau County	27	17	69	15	69	78	75	72	69	71	71	69	69	76	27
City of Fort Benton	2	2	2	1	2	5	2	2	2	2	2	2	2	2	2
Town of Big Sandy	3	3	6	4	6	7	6	6	6	6	7	6	6	6	7
Fergus County	1	2	7	3	4	12	5	4	3	4	6	6	4	11	10
City of Lewistown	1	1	1	2	1	9	1	1	1	5	4	1	1	4	5
Town of Denton	1	1	2	3	2	5	3	2	2	2	2	3	2	4	4
Town of Grass Range	1	1	2	3	2	3	3	2	2	2	2	3	2	4	4
Town of Moore	1	1	2	3	2	3	3	2	2	2	2	3	2	4	4
Town of Winifred	1	1	2	3	2	3	3	2	2	2	2	3	2	4	4
Glacier County	1	1	3	3	2	5	2	2	2	3	6	7	2	3	10
City of Cut Bank	1	2	4	3	3	7	2	3	2	4	7	82	2	4	10
Hill County	9	7	16	6	9	24	11	7	7	11	12	11	10	9	24
City of Havre	6	4	10	1	4	18	7	4	5	8	9	8	6	7	20
Town of Hingham	5	3	9	2	4	16	6	4	5	8	9	8	5	7	20
Judith Basin County	6	4	5	8	4	6	4	4	4	5	5	6	5	11	6
Town of Hobson	3	4	5	4	4	5	3	4	3	5	5	4	5	7	3
Town of Stanford	3	5	6	5	5	6	3	5	3	6	6	4	6	7	3
Liberty County	3	3	3	3	3	6	4	3	3	3	3	3	4	3	4
Town of Chester	3	3	3	3	3	6	3	3	3	3	3	3	4	3	3
Petroleum County	2	2	2	7	3	6	5	2	2	3	7	2	5	7	2
Town of Winnett	2	2	2	4	3	6	6	2	2	5	8	2	5	4	2
Phillips County	4	6	16	13	7	17	6	4	4	14	14	14	5	9	30
City of Malta	2	2	4	3	4	7	5	5	4	5	5	5	4	4	21
Town of Saco	1	1	2	2	2	2	2	2	2	2	2	2	2	2	4

County/Reservation	Communicable Disease	Cyber-Attack	Dam Failure	Drought	Earthquake	Flooding	Hazmat Incident	Human Conflict	Landslide	Severe Summer Weather	Severe Winter Weather	Tornadoes & Windstorms	Transportation Accidents	Volcanic Ash	Wildfire
Pondera County	1	3	8	5	3	7	2	3	1	8	10	2	5	9	1
City of Conrad	2	4	6	6	4	8	3	4	2	9	12	3	6	9	2
Teton County	1	5	6	4	8	13	3	6	2	6	6	2	6	10	1
City of Choteau	2	3	5	2	5	13	4	5	4	5	6	4	5	6	2
Town of Dutton	2	3	5	2	5	6	6	5	4	6	7	4	5	7	2
Town of Fairfield	1	5	6	2	6	6	3	6	2	6	7	2	6	8	1
Toole County	1	1	1	1	1	4	4	2	1	3	2	4	2	3	4
Town of Kevin	1	1	1	1	1	4	3	1	1	2	2	2	1	1	1
Town of Shelby	3	2	3	2	3	6	5	3	3	4	4	3	3	3	3
Town of Sunburst	1	1	2	2	4	4	2	1	2	4	4	6	4	4	4
Total	**153**	**161**	**336**	**203**	**277**	**537**	**319**	**256**	**270**	**357**	**384**	**390**	**285**	**386**	**383**

The actions included in this mitigation strategy are subject to further review and refinement; alternatives analyses; and reprioritization due to funding availability and/or other criteria. The participating jurisdictions are not obligated by this document to implement any or all these projects. Rather, this mitigation strategy represents the desires of the communities to mitigate the risks and vulnerabilities from identified hazards. The jurisdictions realize that new needs and priorities may arise as a result of a disaster or other circumstances and reserves the right to support new actions, as necessary, as long as they conform to their overall goals, as listed in this plan.

6 Plan Adoption, Implementation, and Maintenance

Requirement §201.6(c)(4): [The plan maintenance process shall include a] section describing the method and schedule of monitoring, evaluating, and updating the mitigation plan within a five-year cycle.

Tribal Requirement §201.7(c)(4): [The plan maintenance process shall include a] section describing the method and schedule of monitoring, evaluating, and updating the mitigation plan.

Requirement §201.6(c)(5): [The hazard mitigation plan shall include] documentation that the plan has been formally approved by the governing body of the jurisdiction requesting approval of the plan (e.g., City Council, county commissioner, Tribal Council).

Implementation and maintenance of the plan is critical to the overall success of hazard mitigation planning. This is Planning Step 10 of the 10-step planning process. This chapter provides an overview of the strategy for plan implementation and maintenance, and outlines the method and schedule for monitoring, updating, and evaluating the regional plan. The chapter also discusses methods for incorporating the plan into existing planning mechanisms and how to address continued public involvement. The system for implementation and maintenance was created during the 2022-2023 creation of the regional plan.

6.1 Formal Adoption

The purpose of formally adopting this plan is to secure buy-in from participating jurisdictions, raise awareness of the plan, and formalize the plan's implementation. The adoption of this plan completes Planning Step 9 of the 10-step planning process: Adopt the Plan. The governing board for each participating jurisdiction has adopted this local hazard mitigation plan by passing a resolution. A copy of the generic resolution and the executed copies are included in Appendix D, Plan Adoptions. This plan will be updated and re-adopted every five years in concurrence with the required DMA local and tribal plan update requirements.

6.2 Implementation

Once adopted, the plan faces the truest test of its worth: continued implementation. While this plan contains many worthwhile actions, each county, jurisdiction, and tribe will need to decide which action(s) to undertake or continue. Two factors will help with making that decision: the priority assigned the actions in the planning process and funding availability. Low or no-cost actions most easily demonstrate progress toward successful plan implementation.

Mitigation is most successful when it is incorporated into the day-to-day functions and priorities of government and development. Implementation will be accomplished by adhering to the schedules identified for each action and through constant, pervasive, and energetic efforts to network and highlight the benefits to the counties, tribes, communities, and stakeholders. This effort is achieved through the routine actions of monitoring meeting agendas for hazard mitigation related initiatives, coordinating on the topic at meetings, and promoting a safe, sustainable community. Additional mitigation strategies could include consistent and ongoing enforcement of existing policies and vigilant review of programs for coordination and multi-objective opportunities.

Simultaneous to these efforts, it is important to maintain a constant monitoring of funding opportunities that can be leveraged to implement some of the more costly recommended actions. This will include creating and maintaining a bank of ideas on how to meet local match or participation requirements. When funding does become available, the Region and its counties and tribes will be in a position to capitalize on the opportunity. Funding opportunities to be monitored include special pre- and post-disaster funds, state and federal earmarked funds, benefit assessments, and other grant programs, including those that can serve or support multi-objective applications.

6.2.1 Role of Hazard Mitigation Planning Committee in Implementation and Maintenance

With adoption of this plan, the Region, its counties, municipalities, and the tribes will be responsible for the plan implementation and maintenance. Each county and tribe, led by their Emergency Management Coordinators, will reconvene their HMPC for plan implementation and maintenance. MTDES staff will assist in the coordination of the regional HMPCs. This HMPC will be the same committee (in form and function, if not actual individuals) that developed this Plan and will also be responsible for the next formal update to the plan in five years.

The county level and tribal HMPCs will:

- Act as a forum for hazard mitigation issues;
- Disseminate hazard mitigation ideas and activities to all participants;
- Pursue the implementation of high-priority, low/no-cost recommended actions;
- Ensure hazard mitigation remains a consideration for community decision-makers;
- Maintain a vigilant monitoring of multi-objective cost-share opportunities to help the community implement the plan's recommended actions for which no current funding exists;
- Monitor and assist in implementation and update of this plan;
- Report on plan progress and recommended changes to county and municipal officials; and
- Inform and solicit input from the public.

MTDES staff will:

- Assist with procurement of consultant support/additional technical assistance.
- Provide technical assistance and support to the delivery of an effective stakeholder and public engagement/outreach strategy. This includes providing assistance with the planning and facilitation of stakeholder and public outreach/ engagement meetings both in person and virtual. This also includes coordinating with other Montana State agencies (e.g., Dept. of Commerce, Dept. of Natural Resources and Conservation, Dept. of Environmental Quality, etc.) and their field staff and stakeholders to ensure a whole government approach to participation, involvement, and regional planning outcomes. This includes assistance in how underserved communities and socially vulnerable populations will be engaged in tangible activities throughout plan implementation and maintenance and in the next plan update (see also Section 6.3.4).
- Provide technical assistance and support with data and resources needed to meet the mitigation planning requirements.
- Assist during the mitigation action phase of the planning process and help guide communities/stakeholders on the development of holistic and comprehensive mitigation actions.

Each HMPC will not have any powers over respective county or tribal staff; it will be purely an advisory body. The primary duty is to see the plan successfully carried out and to report to the county commissioners, municipal boards, tribal councils, and the public on the status of plan implementation and mitigation opportunities. Other duties include reviewing and promoting mitigation proposals, considering stakeholder concerns about hazard mitigation, passing concerns on to appropriate entities, and posting relevant information on county websites (and others as appropriate).

6.3 Plan Maintenance

Plan maintenance implies an ongoing effort to monitor and evaluate plan implementation and to update the plan as progress, roadblocks, or changing circumstances are recognized. The regulation at 44 CFR§201.6(d)(3) requires that a local jurisdiction must review and revise its plan to reflect changes in development, progress in local mitigation efforts, and changes in priorities, and resubmit it for approval within five (5) years to continue to be eligible for mitigation project grant funding.

Similarly, tribal governments are required by 44 CFR 201.7(d)(3) to review and revise its plan to reflect any changes in development, progress in mitigation efforts, and changes in priorities and to resubmit it for approval within 5 years to continue eligibility for FEMA assistance.

6.3.1 Maintenance Schedule

MTDES will work with the Emergency Management Coordinators to initiate annual plan reviews, in consultation with the heads of participating departments in their own counties and tribes. In order to monitor progress and update the mitigation strategies identified in the action plan, each county and tribe and their standing CPT/TPT will conduct an annual review of this plan and/or following a hazard event. An annual mitigation action progress report will be prepared by the Emergency Management Coordinators based on the HMPC input and kept on file to assist with future updates. The annual review will be conducted by reconvening each HMPC in November of each year in coordination with MTDES.

This plan will be updated, approved, and adopted within a five-year cycle as per Requirement §201.6(c)(4)(i) (for local governments) and §201.7(d)(3) (for tribes) of the Disaster Mitigation Act of 2000 unless disaster or other circumstances (e.g., changing regulations) require a change to this schedule. The Region and its counties and tribes will inquire with MTDES and FEMA for funds and or technical assistance to assist with the update. The next plan update should be completed and reapproved by MTDES and FEMA Region VIII within five years of the FEMA final approval date. The planning process to prepare the update should begin no later than 12 months prior to that date.

6.3.2 Maintenance Evaluation Process

Evaluation of progress can be achieved by monitoring changes in vulnerabilities identified in the plan. Changes in vulnerability can be identified by noting:

- Decreased vulnerability as a result of implementing recommended actions;
- Increased vulnerability as a result of new or altered hazards;
- Increased vulnerability as a result of new development.

To best evaluate any changes in vulnerability as a result of plan implementation, each county and tribe will adhere to the following process:

- A representative from the responsible office identified in each mitigation action will be responsible for tracking and reporting on an annual basis to the department lead on action status and provide input on whether the action, as implemented, meets the defined objectives and is likely to be successful in reducing vulnerabilities.
- If the action does not meet identified objectives, the lead will determine what additional measures may be implemented, and an assigned individual will be responsible for defining action scope, implementing the action, monitoring success of the action, and making any required modifications to the plan.

Evaluation is used not only to measure progress, but to evaluate the effectiveness of the plan itself and if goals are being achieved. Changes will be made to the plan to accommodate for actions that were not successful or were not considered feasible after a review of their consistency with established criteria, time frame, community priorities, and/or funding resources. Actions that were not ranked high but were identified as potential mitigation activities will be reviewed as well during the monitoring and update of this plan to determine feasibility of future implementation.

Updating of the plan will be by written changes and submissions, as each HMPC deems appropriate and necessary, and as approved by the respective participating agencies. In keeping with the five-year update process, the HMPC will convene public meetings to solicit public input on the plan and its routine maintenance and the final product will be adopted by the governing council of each participating jurisdiction. Updates to this plan will:

- Consider changes in vulnerability due to action implementation;
- Document success stories where mitigation efforts have proven effective;
- Document areas where mitigation actions were not effective;
- Document any new hazards that may arise or were previously overlooked;
- Incorporate new data or studies on hazards and risks;
- Incorporate new capabilities or changes in capabilities;
- Incorporate growth and development-related changes to infrastructure inventories; and
- Incorporate new action recommendations or changes in action prioritization.

The jurisdictional annexes explain in further detail the monitoring system for tracking the initiation and status of projects as well as project closeouts, indicating who will be responsible for implementing and maintaining this system for the respective tribes.

6.3.3 Incorporation into Existing Planning Mechanisms

Another important implementation mechanism that is highly effective and low-cost is incorporation of the hazard mitigation plan recommendations and their underlying principles into other county or tribal plans and mechanisms. Where possible, plan participants will use existing plans and/or programs to implement hazard mitigation actions. As described in each county and reservation annex capability assessment, the jurisdictions already implement policies and programs to reduce losses to life and property from hazards. This plan builds upon the momentum developed through previous and related planning efforts and mitigation programs and recommends implementing actions, where possible, through these other program mechanisms. Where applicable, these existing mechanisms could include:

- County, tribal or community comprehensive plans
- County, tribal or community land development codes
- County, tribal or community Emergency Operations Plans (EOPs)
- Threat and Hazard Identification and Risk Assessments (THIRA)
- Community Wildfire Protection Plans (CWPP)
- Transportation plans
- Capital improvement plans and budgets
- Recovery planning efforts
- Watershed planning efforts
- Wildfire planning efforts on adjacent public lands
- Master planning efforts
- River corridor planning efforts
- Future updates to the Montana State Water Plan
- Other plans, regulations, and practices with a mitigation aspect

The jurisdictional annexes note where the previous versions of the individual county hazard mitigation plans have been incorporated into existing planning mechanisms in the past 5 years. Each annex notes specific opportunities to integrate the mitigation plan into other mechanisms in the future in Section 11.

HMPC members involved in these other planning mechanisms will be responsible for integrating the findings and recommendations of this plan with these other plans, programs, etc., as appropriate. As described in Section 6.2 Implementation, incorporation into existing planning mechanisms will be done through the process of:

- Monitoring other planning/program agendas;
- Attending other planning/program meetings;
- Participating in other planning processes;
- Ensuring that the related planning process cross-references the hazard mitigation plan, where appropriate, and
- Monitoring community budget meetings for other community or tribal program opportunities.

The successful implementation of this mitigation strategy will require constant and vigilant review of existing plans and programs for coordination and multi-objective opportunities that promote a safe, sustainable community.

Efforts should continuously be made to monitor the progress of mitigation actions implemented through these other planning mechanisms and, where appropriate, their priority actions should be incorporated into updates of this hazard mitigation plan.

6.3.4 Continued Public Involvement

Continued public involvement is imperative to the overall success of the plan's implementation. The update process provides an opportunity to solicit participation from new and existing stakeholders and to publicize success stories from the plan implementation and seek additional public comment. The plan maintenance and update process will include continued public and stakeholder involvement and input through attendance at designated committee meetings, web postings, social media postings, press releases to local media, and through public hearings.

To ensure the meaningful participation during continued involvement activities of underserved communities and socially vulnerable populations, including the elderly, youth, veterans, homeless individuals, and low-income families, the HMPC will employ targeted outreach strategies. Partnerships with CBOs, NGOs, and individual government agencies—such as the faith based organizations, and social service providers—will be key to facilitating communication and engagement, as this strategy was successful for outreach in the Central Region as noted in Section 3.3.1. Meetings will be held in accessible locations like senior centers and healthcare clinics, and materials will be provided in multiple languages to overcome barriers like transportation, childcare, and language differences.

These communities will also be encouraged to participate in various activities that will be led by county staff and representatives from CBOs and NGOs. Activities will include public meetings, focus groups, and surveys with each regional CPT or TPT. Their feedback will be used to evaluate mitigation actions and shape future plan updates. The feedback from underserved communities and socially vulnerable populations will also be used to develop HMA grant applications, where applicable. CPTs and TPTs will ensure an open line of communication and that feedback is recorded and addressed. Additionally, potential training and capacity-building initiatives can empower these communities to take a more active role in future hazard mitigation planning processes. Feedback will be documented and integrated into future updates, with follow-up reports demonstrating how community input has influenced the plan.

When each HMPC reconvenes for the update, they will coordinate with all stakeholders participating in the planning process—including those that joined the committee since the planning process began—to update and revise the plan. Public notice will be posted, and public participation will be invited, at a minimum, through available website postings and press releases to the local media outlets, primarily newspapers. Per DMA requirements the public will be provided an opportunity to provide input during the plan update process, and before the plan is finalized. This can be accomplished through public surveys or meetings. Public comments will be solicited on the plan update draft by posting the plan online and soliciting review and comment for a minimum of two weeks.