4 Hazard Identification and Risk Assessment

Note to reviewers: Green highlights: Areas that WSP will address in future versions

Yellow highlights: Areas that require verifications, data gap, or special attention/review of HMPC

44 CFR 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 the 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.

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

Requirement 201.6(c)(2)(i):
[The risk assessment shall include a] description of the type of all natural hazards that can affect the jurisdiction.

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 Western 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 Western Region Multi-Hazard Mitigation Plan includes:

- Avalanche
- 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

Hazards identified and added to the Regional Plan during the update process include cyber-attack due to the prevalence of the threat that has emerged worldwide and increasing interconnectedness and reliance on cyber infrastructure. Human conflict was added to include terrorism (previously identified in most of the prior hazard mitigation plans [HMPs]) as well as active shooter and civil unrest due to concerns arising from national trends.

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 and tribal annexes include further details on hazard significance by county and municipality or tribe.

Table 4-1 Western Region Hazard Significance Summary Table

Hazard	Geographic Area	Magnitude/ Severity	Probability	Significance
Avalanche	Limited	Negligible	Highly Likely	Low
Communicable Disease	Extensive	Critical	Occasional	Medium
Cyber-Attack	Significant	Critical	Occasional	Medium
Dam Failure	Limited	Critical	Unlikely	Medium
Drought	Extensive	Moderate	Likely	Medium
Earthquake	Significant	Critical	Likely	Medium
Flooding	Significant	Critical	Likely	Medium

Hazard	Geographic Area	Magnitude/ Severity	Probability	Significance
Hazardous Material Incidents	Limited	Negligible	Likely	Low
Landslide	Limited	Negligible	Likely	Low
Severe Summer Weather: hail, excessive heat, heat, heavy rain, lightning	Extensive	Moderate	Highly Likely	Medium
Severe Winter Weather: blizzard, cold/wind chill, extreme cold/wind chill, heavy snow, ice storm, winter storm, winter weather	Extensive	Moderate	Highly Likely	Medium
Human Conflict (Terrorism, Civil Unrest, etc.)	Significant	Critical	Occasional	Medium
Tornadoes & Windstorms	Extensive	Moderate	Highly Likely	Medium
Transportation Accidents	Significant	Negligible	Highly Likely	Low
Volcanic Ash	Extensive	Moderate	Unlikely	Low
Wildland and Rangeland Fire	Extensive	Critical	Highly Likely	High

Geographic Area

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

Potential Magnitude/Severity

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.

Frequency/Likelihood of Occurrence

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.

Overall Significance

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.

Moderate: 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.	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.
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.	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.
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.	

4.1.1.1 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 were noted at the regional kickoff meeting in May 2022 and included mass casualty incidents, widespread power or communications disruptions, resource shortages/supply chain disruptions, and industrial accidents. The group concluded that many of these incidents are often consequences of other hazards and thus were not profiled individually but noted where appropriate in other hazard profiles.

4.1.1.2 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 Western Region counties between 1953 and 2022. The hazards that have historically resulted in disaster declarations in the Region include wildfires, flooding, severe storms, drought, and pandemic.

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

Year	Declaration Title	Disaster Number	Area Impacted
1974	Montana Severe Storms, Flooding, Landslides	DR-417-MT	Deer Lodge, Flathead, Lincoln, Mineral, Missoula, Sanders
1975	Montana Rains, Snowmelt, Storms, Flooding	DR-472-MT	Broadwater, Flathead, Jefferson, Lewis and Clark, Meagher, Powell
1977	Montana Drought	EM-3050-MT	Lincoln, Missoula
1981	Montana Severe Storms, Flooding	DR-640-MT	Broadwater, Gallatin, Granite, Jefferson, Lewis and Clark, Meagher, Missoula, Powell, and Silver Bow
1986	Montana Heavy Rains, Flooding, Landslides	DR-761-MT	Deer Lodge, Powell, Sanders
1996	Montana Flooding	DR-1113-MT	Blaine, Flathead, Hill, Lincoln, Phillips, Toole
1997	Montana Severe Storms, Ice Jams, Snowmelt, Flooding, Extreme Soil Saturation	DR-1183-MT	Broadwater, Deer Lodge, Flathead, Madison, Meagher, Missoula, Park, Ravalli, Sanders, Stillwater, Sweetgrass
2000	Montana Wildfires Montana SW Zone 2 Fire Complex Montana South Central Zone 4 Fire Complex Montana Northwest Zone 1 Fire Complex Montana Central Zone 3c Fire Complex Montana Central Zone 3b Fire Complex	DR-1340-MT FSA-2317-MT FSA-2321-MT FSA-2320-MT FSA-2318-MT FSA-2314-MT	Beaverhead, Broadwater, Deer Lodge, Flathead, Gallatin, Granite, Jefferson, Lake, Lewis & Clark, Lincoln, Madison, Meagher, Mineral, Missoula, Park, Powell, Ravalli, Sanders, Silver Bow, Sweet Grass Deer Lodge, Granite, Mineral, Missoula, Powell, Ravalli, Silver Bow Gallatin, Park Flathead, Lincoln, Lake, Sanders Beaverhead, Madison Broadwater, Jefferson, Lewis and Clark, Meagher
2001	Montana Severe Storms	DR-1385-MT	Gallatin, Missoula, Powell
2003	Montana Wedge Canyon Fire Montana Robert Fire Montana Missoula/Mineral Fire Zone Montana Lincoln Fire Complex Montana Hobble Fire Montana Flathead Fire Zone Montana Cherry Creek Fire	FM-2485-MT FM-2484-MT FM-2490-MT FM-2492-MT FM-2488-MT FM-2494-MT FM-2489-MT	Flathead Flathead Mineral, Missoula Lewis and Clark, Powell Sweet Grass Flathead Sanders
2005	Montana Hurricane Katrina Evacuation	EM-3253-MT	Statewide
2006	Montana Derby Fire	FM-2671-MT	Stillwater, Sweet Grass
2007	Montana Jocko Lakes Fire Montana Country Club Fire	FM-2718-MT FM-2730-MT	Missoula Lewis and Clark

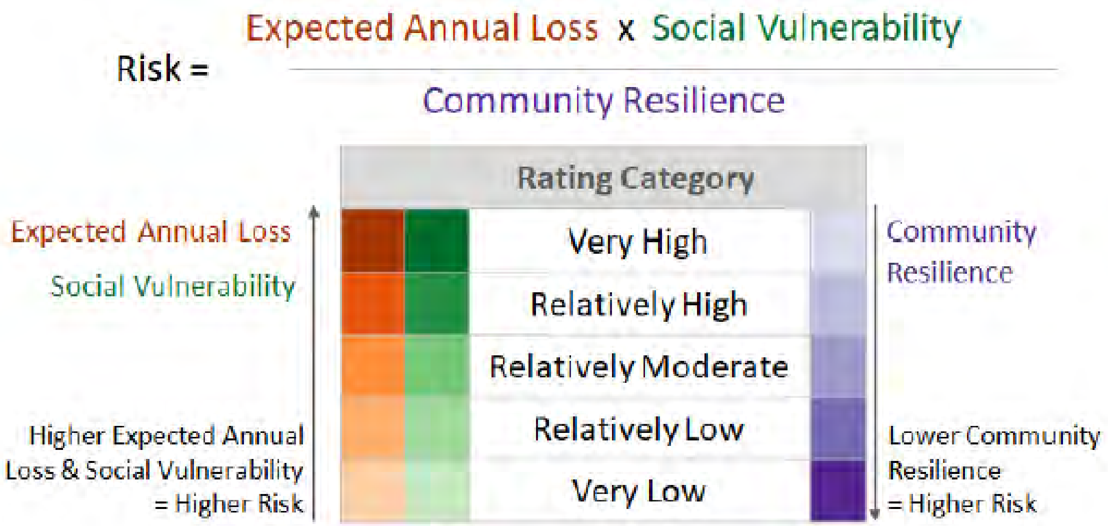
Year	Declaration Title	Disaster Number	Area Impacted
	Montana Black Cat Fire	FM-2721-MT	Missoula
2011	Montana Nineteen Mile Fire Montana Corral Fire Montana Severe Storms and Flooding	FM-5008-MT FM-2987-MT DR-1996-MT	Jefferson Lewis and Clark Broadwater, Flathead, Missoula, Powell, Lewis and Clark, Ravalli, Granite, Deer Lodge, Silver Bow, Madison, Jefferson, Park, Meagher
2012	Montana Sawtooth Fire	FM-5016-MT	Ravalli
2013	Montana West Mullan Fire Montana Lolo Creek Fire Complex	FM-5035-MT FM-5047-MT	Mineral Missoula
2014	Montana Ice Jams and Flooding	DR-4172-MT	Broadwater, Jefferson, Lake, Park, Ravalli, Sanders
2016	Montana Roaring Lion Fire	FM-5143-MT	Ravalli
2017	Montana West Fork Fire Montana Rice Ridge Fire Montana Moose Peak Fire Montana Lolo Peak Fire Montana Highway 200 Fire Complex Montana Alice Creek Fire	FM-5209-MT FM-5207-MT FM-5211-MT FM-5197-MT FM-5210-MT FM-5208-MT	Lincoln Missoula, Powell Lincoln Missoula, Ravalli Sanders Lewis and Clark
2018	Montana Flooding	DR-4405-MT	Lewis and Clark, Missoula, Park, Powell
2019	Montana North Hills Fire Montana Flooding	FM-5286-MT DR-4437-MT	Lewis and Clark Lake, Park
2020	Covid-19 Pandemic Covid-19 Montana Bridger Foothills Fire	DR-4508-MT EM-3476-MT FM-5346-MT	Statewide Statewide Gallatin
2022	Severe Storm and Flooding	DR-4655-MT	Carbon, Park, Stillwater, Yellowstone

4.1.1.3 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: EAL, 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 Western Region Hazard Identification and Risk Assessment (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 such as 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, Flooding, Severe Summer Weather, Severe Winter Weather, Tornadoes & Windstorms, and Wildfire contain the following aggregate risk products, mapped by WSP using NRI data:

- Annualized Frequency
- Composite Risk Index Rating
- EAL

Sources of hazards and exposure data includes SHELDUS, National Oceanic Atmospheric Administration (NOAA), United States Geological Survey (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/.

4.1.1.4 Assets Summary

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. An 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 and tribal 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 Region can be found in Table 4-3 below.

Table 4-3 Summary of Critical Facilities Exposure Summarized by FEMA Lifelines

County	Communications	Energy	Food, Water, Shelter	Hazardous Materials	Health and Medical	Safety and Security	Transportation	Total
Anaconda-Deer Lodge	34	7	5	2	2	20	72	**142**
Beaverhead	43	19	23	1	5	27	237	**355**
Broadwater	37	12	4	3	0	13	41	**110**
Butte-Silver Bow	88	36	26	8	2	53	67	**280**
Flathead	187	59	65	6	21	133	235	**706**
Granite	36	13	10	0	2	13	78	**152**
Jefferson	92	15	5	4	3	37	134	**290**
Lake	46	26	9	1	7	61	125	**275**
Lewis and Clark	184	32	48	12	5	113	225	**619**
Lincoln	41	16	16	2	7	49	198	**329**
Madison	41	20	8	0	5	27	100	**201**
Meagher	6	6	3	0	1	11	56	**83**
Mineral	23	10	7	1	1	18	152	**212**
Missoula – CSKT Flathead Nation	4	0	0	0	0	0	10	**14**
Park	109	29	30	0	6	37	128	**339**
Powell	37	19	9	1	2	23	117	**208**
Ravalli	126	22	19	3	12	66	168	**416**
Sanders	45	21	10	3	8	37	131	**255**
Sweet Grass	31	16	9	1	2	9	92	**160**
Total	**1,210**	**378**	**306**	**48**	**91**	**747**	**2,366**	**5,146**

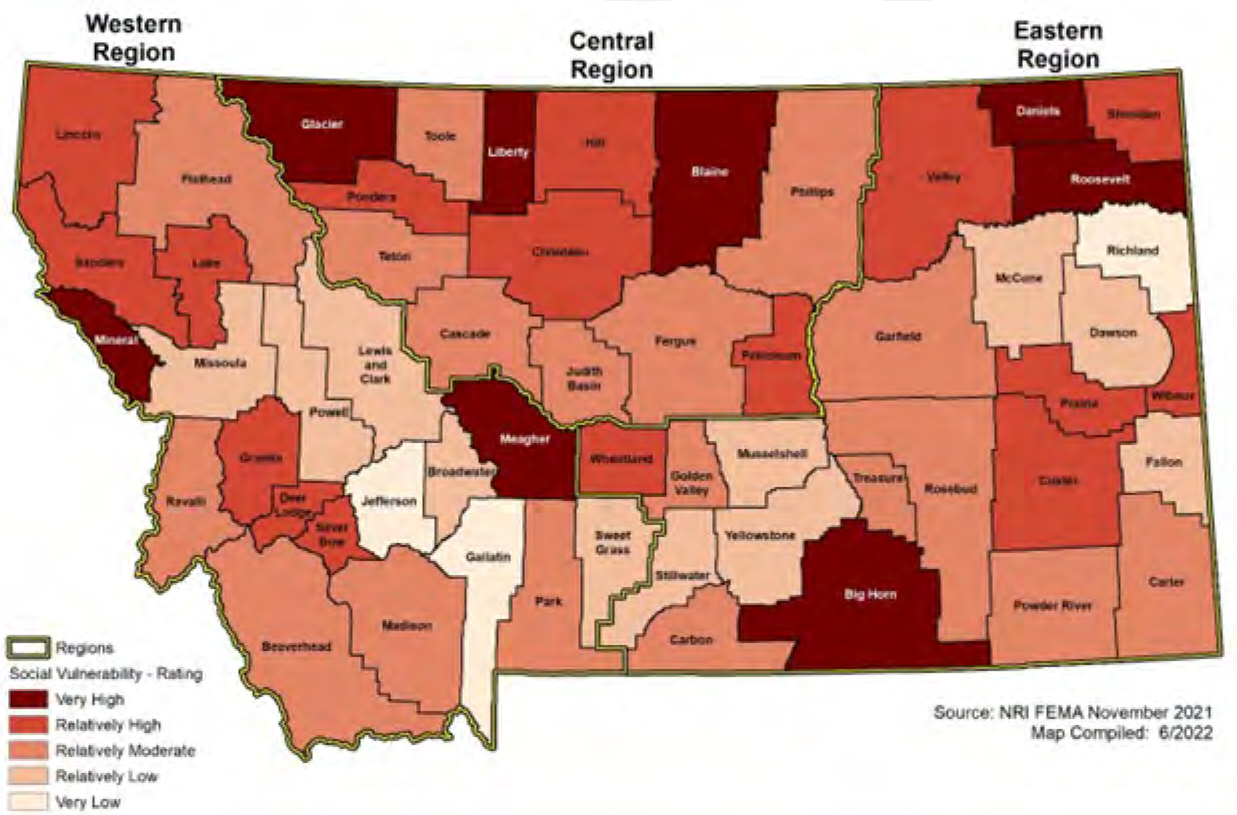
Source: HIFLD 2022, Montana DES, NBI

4.1.1.5 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 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.

Figure 4-3 Social Vulnerability Rating by County in Montana



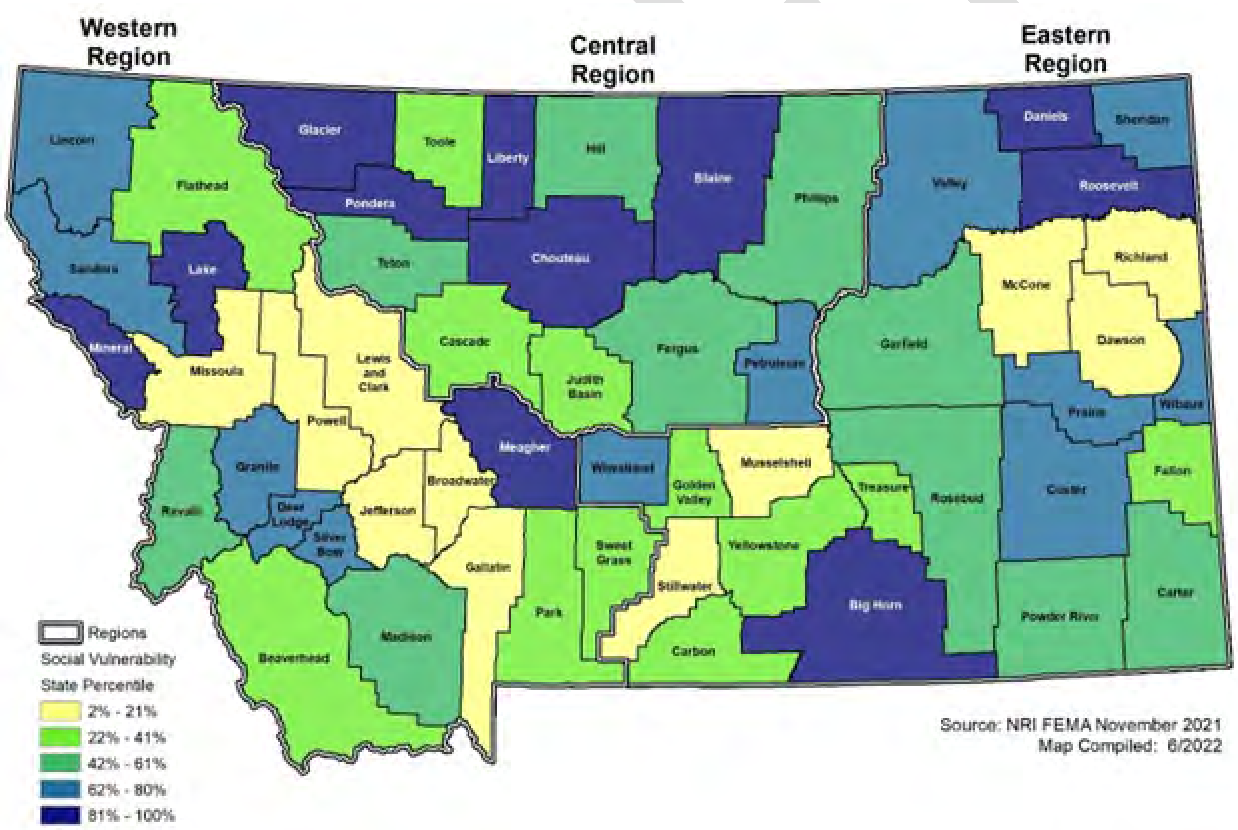
The index can be used by the State to help determine where social vulnerability and exposure to hazards overlaps and how and where mitigation resources might best be used. The SoVI provides a score between 0.01 and 100, with higher scores indicative of higher levels of social vulnerability. According 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

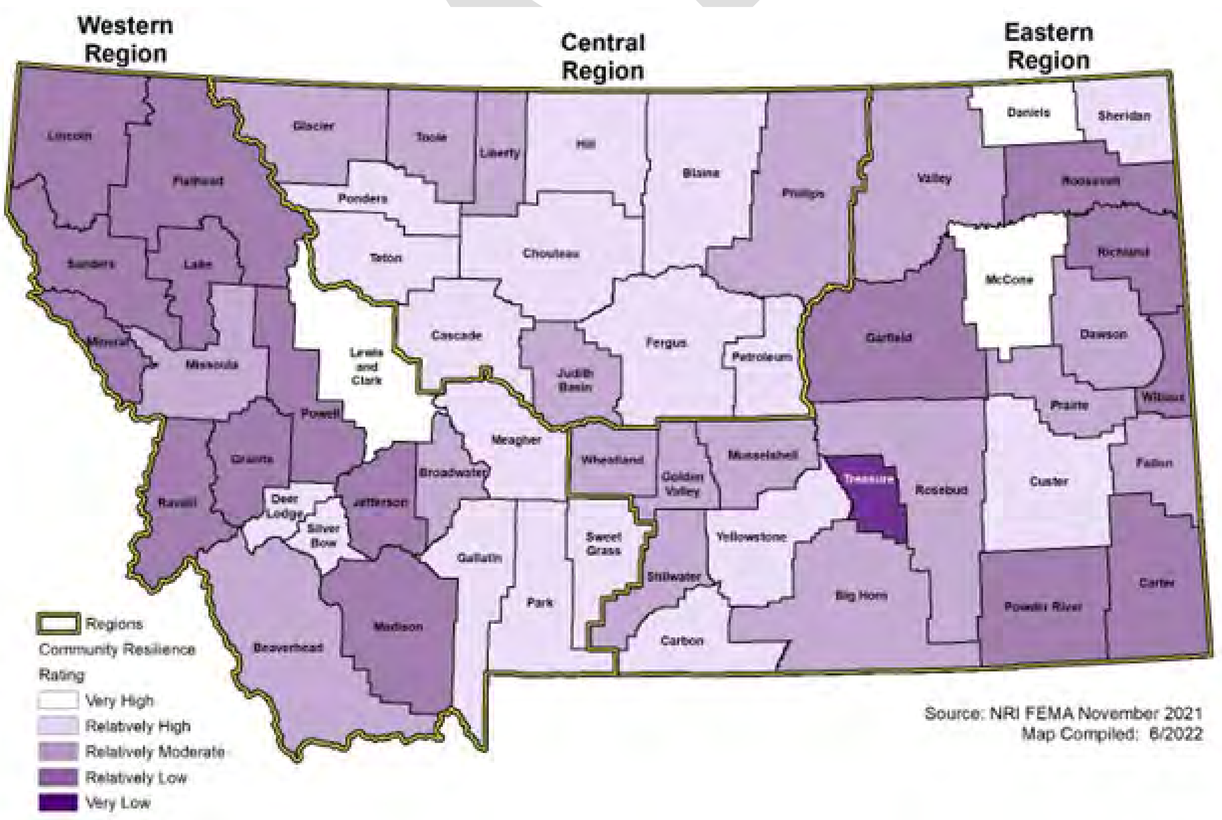


Community Resilience

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

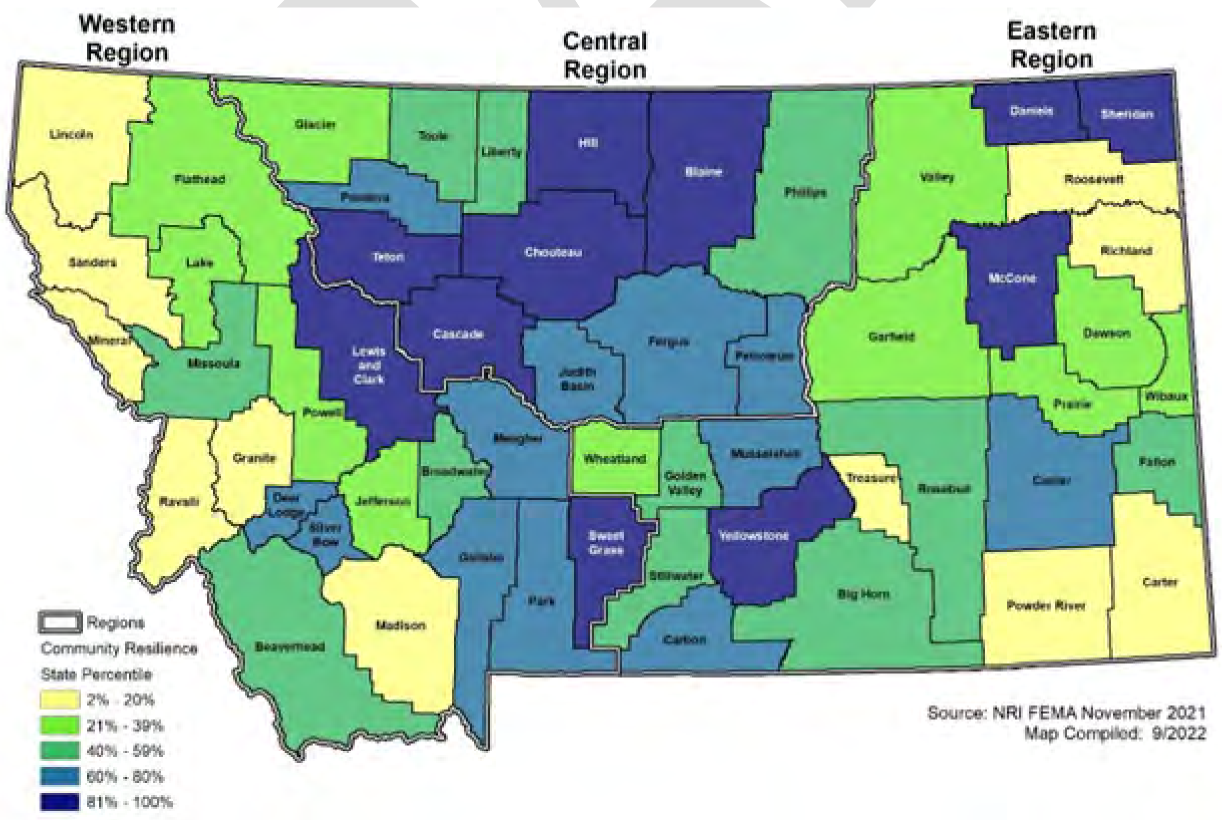


The community resilience rating can be useful in determining counties which have higher levels of ability to cope with hazards and identify success stories for building resilience. According to the index, the following, listed in order, are Montana’s ten most resilient counties:

1. Daniels County (58.16)
2. Lewis and Clark County (57.80)
3. liberty 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)

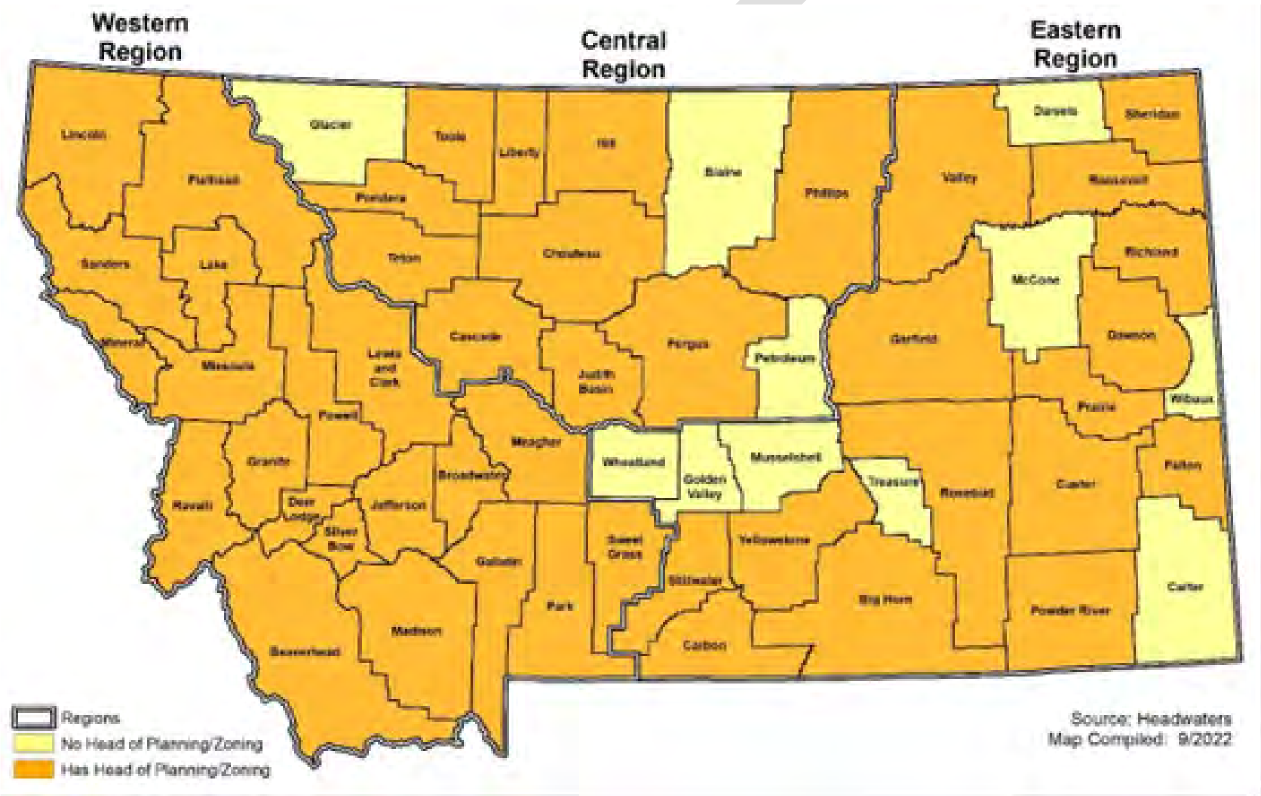
Only a select few of the above counties are in the top 20 percent in the nation in terms of community resilience with those being limited to Daniels, Lewis and Clark, and McCone counties. The average community resilience score for the State of Montana is 54.43, which is slightly lower than the national 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.

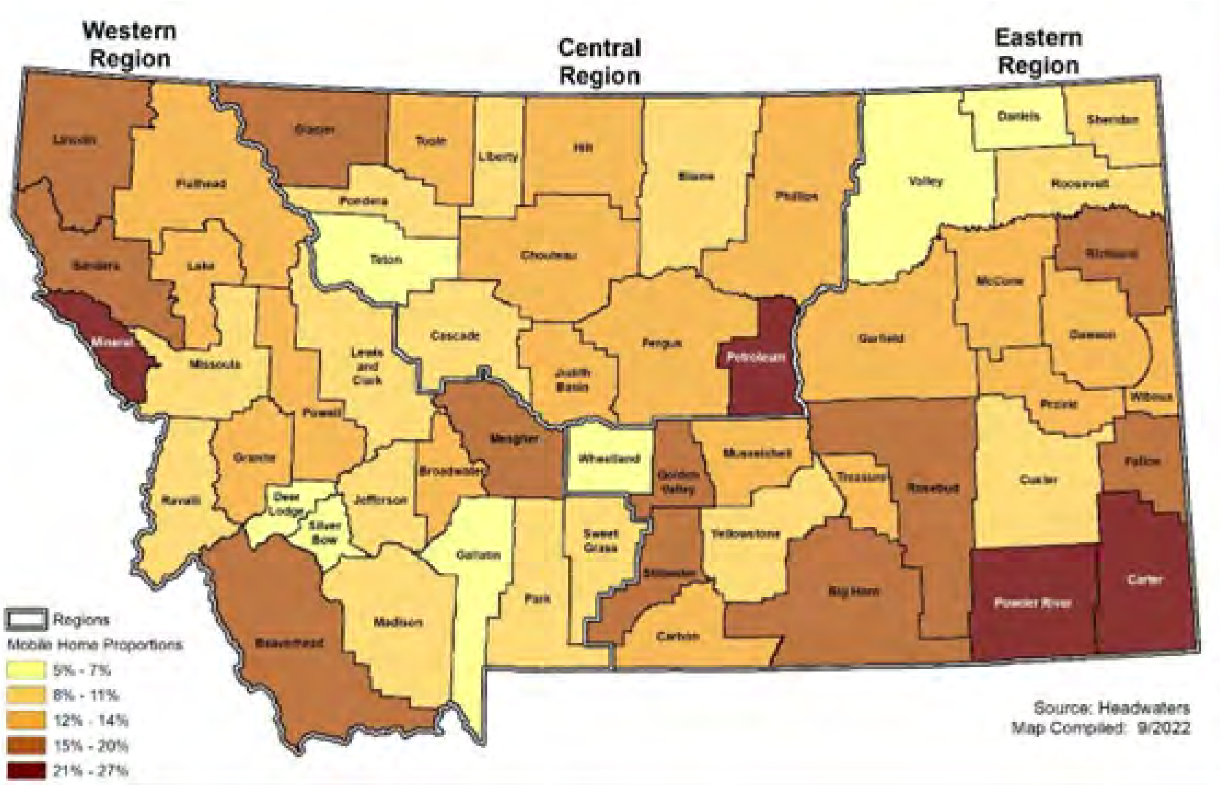
Figure 4-7 Counties in Montana that Lack a Planning Department



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

Requirement §201.6I(2)(i):
[The risk assessment shall include a] description of the…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.

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 a similar format that is described below:

4.2.1.1 Hazard/Problem Description

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

4.2.1.2 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.

4.2.1.3 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.

4.2.1.4 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.

4.2.1.5 Climate Change Considerations

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

4.2.1.6 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.

4.2.1.7 Vulnerability Assessment

Vulnerability is the measurement of exposed structures, critical facilities, or populations relative to the risk of the hazard. For most hazards, vulnerability is a best estimate. Some hazards, such as flood, affect specific areas so that exposure can be quantified, and vulnerability assessments result in a more specific approximation. Other hazards, such as tornadoes, are random and unpredictable in location and duration that only approximate methods can be applied. The assessment was conducted through the study of potential impacts to the following specific sectors:

- People
- Property
- Critical Facilities and Infrastructure
- Economy
- Historic and Cultural Resources
- Natural Resources

4.2.1.8 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.

4.2.1.9 Risk Summary

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 Avalanche

4.2.2.1 Hazard/Problem Description

An avalanche is a release or slide of a mass of snow that moves rapidly down a slope, often as a result of severe weather and when they occur, they can cause damage to or threaten the safety of people. While most avalanches in Montana occur on mountains above the timberline and in sheltered regions where snow is most prone to accumulate, they can also occur on slight slopes well below the timberline, such as gullies and road cuts. For an avalanche to occur, four factors must be present: a slope, a snow cover, a weak layer in the snow cover, and a trigger.

They occur when weak layers in the snowpack fail to support the weight of the snow above and collapse. The weak layer causes the overlying snow to break free and flow downhill.

Snow avalanches can release loose or slabslides and can be classified as wet or dry events, depending on the moisture content of the snowpack. Loose avalanches involve snow near the surface and release when cohesion is lost between the snow grains. Slab avalanches extend into deeper snow and release cohesiveness when a lower and weaker layer of snow fails. Both types can flow downhill for long distances on gentle terrain and often damage or destroy buildings, cabins, and electrical transmission lines. Lastly, avalanches are triggered by human activity or environmental factors, such as wind loading, precipitation, or warm weather. Human-caused avalanches mostly occur in the backcountry and involve backcountry skiers, hikers, or other recreationists. Once triggered, an avalanche path consists of a starting zone where they begin, a track where they develop speed and velocity, and a runout zone at lower gradient slopes where the slides slow down and the debris zone forms.

Although most avalanches do not result in damage, risk occurs when people or property cross their paths. The greatest risk is to communication and transportation networks, as well as to winter recreationists. Increases in encroachment into mountainous areas, as well as gains in the popularity of winter sports, has increased the risk posed by avalanches. Bridger Bowl and Big Sky ski areas, both located in Western Montana, are the second and fourth most avalanche prone ski resorts in the United States (Montana Emergency Response Framework, 2017) and regularly perform avalanche mitigation.

4.2.2.2 Geographical Area Affected

Extensive – Due to the mountainous terrain of Western Montana, much of the Region is at risk of avalanche. Nearly every county in the Region has areas of avalanche susceptibility, though the majority of these areas are in remote or wilderness areas. Any slope that is gradual enough to collect snow but steep enough to allow for the rapid acceleration of snow once put into motion is subject to avalanches, although about 98 percent of all avalanches occur on slopes of 30-45 degrees. Due to the largely immutable nature of the landscape, avalanches are more likely to occur in areas where they have previously occurred. The paths avalanches have historically taken down mountains are known as avalanche chutes, and the chutes in Western Montana are well-known. Avalanches also commonly occur above 7,000 feet where snow is more likely to accumulate throughout the winter snowfall season.

4.2.2.3 Past Occurrences

Avalanches occur frequently in Western Montana. However, due to the isolated nature of these incidents few avalanches are widely recorded. Still, avalanches have the capability to incur major damages when people are involved, and Western Montana is especially susceptible due to its mountainous terrain and popularity among winter recreationists.

According to the 2017 Montana Emergency Response Framework, 70 people were killed by avalanches in Montana between 1998 and 2012, representing more than 15% of nationwide avalanche fatalities (Montana Emergency Response Framework, 2017). Approximately 26 additional avalanche-related fatalities occurred between 2013 and 2021. According to nationwide data tracked by the Colorado Avalanche Information Center, at least two recreationists were killed after being partially buried in avalanches during the first two months of 2022 in Western Montana.

Table 4-4 Avalanche Fatalities in Montana 2017-2022

Date	Location/Name	Activity	Number Caught/Buried/Killed
2022-02-19	Miller Mountain Avalanche Fatality	Snowbiking	One caught, partially buried, and killed
2022-02-06	Ski Hill Avalanche Fatality	Snowmobiling	One caught, partially buried, and killed
2021-12-27	Double Avalanche Fatality, Cooke City	Snowmobiling	Two caught, buried, and killed
2021-02-14	Beehive Basin Avalanche Fatality	Splitboarding	Two caught, one partially buried and killed
2021-02-06	Wounded Buck Lake	Snowmobiling	Five caught, one partially buried and killed
2020-01-01	Lake Dinah Accident	Snowmobiling	Three snowmobilers caught and buried, two killed

Date	Location/Name	Activity	Number Caught/Buried/Killed
2019-02-26	Avalanche Fatality, Truman Gulch	Skiing	One caught, partially buried, and killed
2019-01-25	Bell Lake Avalanche Fatality	Skiing	Four caught, two partially buried, one killed
2019-01-05	South Waldron Creek	Snowmobiling	Two caught, one buried and killed
2018-04-15	Saddle Peak Avalanche Fatality	Skiing	One caught, partially buried, and killed
2018-02-17	Canyon Creek, Whitefish Range	Skiing	One caught, buried, and killed
2018-01-02	Cabin Creek, SE Madison Range	Snowmobiling	One caught, buried, killed
2017-10-07	Imperial Peak, S Madison Range	Skiing	Two caught and buried, one killed
2017-01-05	Mt. Stanton, North of W. Glacier	Skiing	One caught, buried, and killed

Source: Colorado Avalanche Information Center, https://avalanche.state.co.us/accidents/us/; Gallatin National Forest Avalanche Center, https://www.mtavalanche.com/accidents

While substantial property damage due to an avalanche is rare, it does occur. On January 28, 2004, following heavy snowfall in the area, two separate avalanches hit a freight train near Glacier National Park in Western Montana. The first avalanche knocked seven cars off the track and while the train was stopped a second avalanche hit and knocked an additional eight cars off the track. Fortunately, there were no reported injuries (Associated Press, 2004).

An "urban avalanche" occurred in Missoula on February 28, 2014. Triggered by a snowboarder on Mount Jumbo, the avalanche swept up available snow and picked up speed as it advanced across the terrain. The snow captured two children, ages 8 and 10, and carried them several feet before partially burying one and completely burying the other. The avalanche slammed into a two-story home, knocking it down completely, with its two residents inside. Three other homes, several vehicles, and an apartment building were also reported to be damaged. Rescue operations began swiftly. However, they were complicated by live power lines, broken natural gas lines, and the possibility of a subsequent avalanche. Both the two children and two home residents were rescued, although one resident died in the following days from traumatic injuries.

Figure 4-9 The Path of the Urban Avalanche in Missoula

Source: The West Central Montana Avalanche Foundation, missoulaavalanche.org

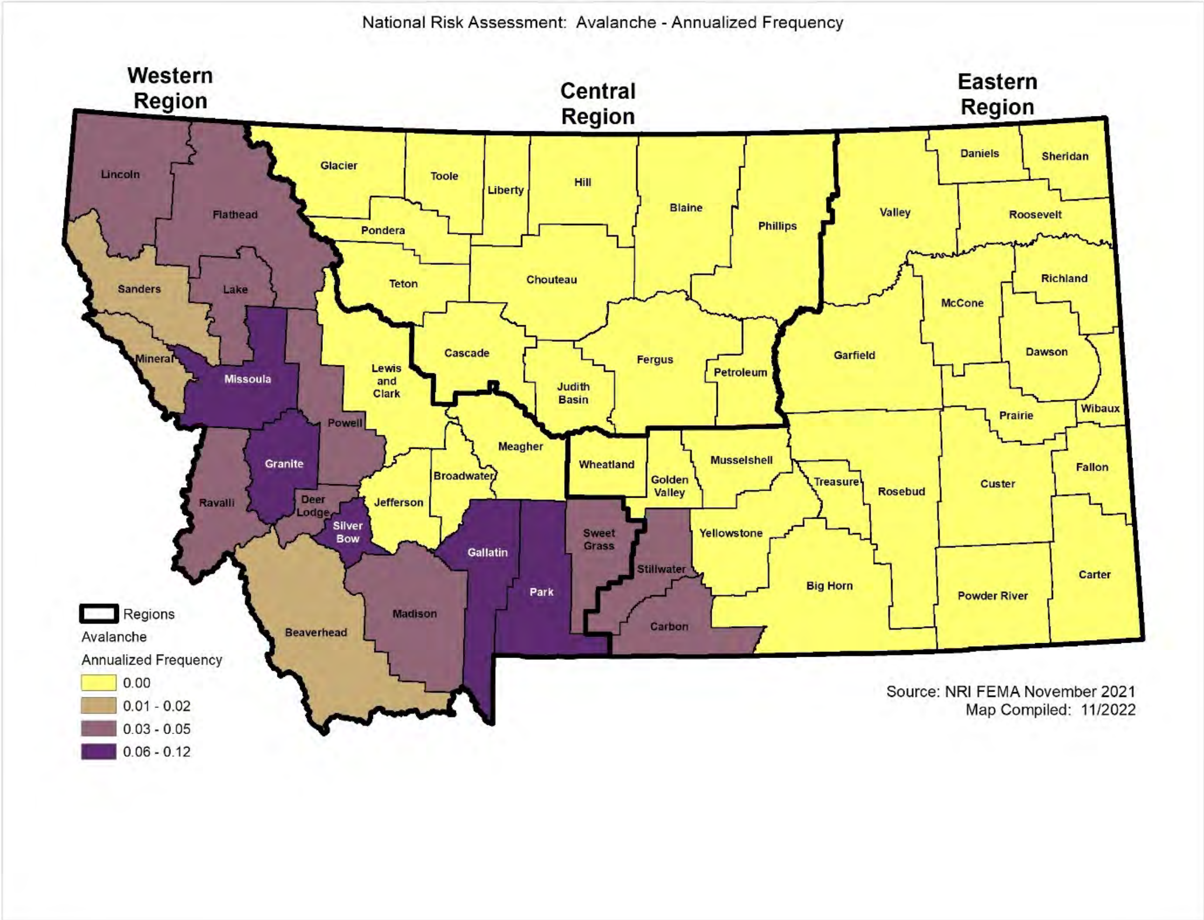
4.2.2.4 Frequency/Likelihood of Occurrence

Highly Likely – According to the Gallatin National Forest Avalanche Center, in the Gallatin Forest alone over 100 avalanches occurred in 2021. This makes the probability of future avalanches in the Region a certainty. However, during that same time frame only four avalanches involving people were reported in Western Montana. Using the formula described in Section 4.2.1.4, it is highly likely that an avalanche that results in injury or death will occur each year.

The impacts of these avalanches are generally very isolated to higher hazard areas with steeper terrain. According to state level statistics tracked by the Colorado Avalanche Information Center, most avalanches in Montana resulting in injury involve one or two persons. However, that number can be as high as eight nationwide. Avalanches cannot be prevented, but the damage incurred by them can be minimized and their impacts should continue to be limited.

Figure 4-10 depicts the annualized frequency of avalanche events at a county level based on NRI data. The greatest probability is in Missoula, Granite, Butte-Silverbow, Gallatin, and Park counties.

Figure 4-10 Annualized Frequency of Avalanche Events by County



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

4.2.2.5 Climate Change Considerations

Experts are expecting an increase in avalanche risk due to changing precipitation and accumulation patterns, coupled with overall warmer winters. As precipitation patterns tend toward more extremes, the frequency of avalanches may be expected to increase. Many avalanches take place following unusually heavy snowfall.

Scattered snowfall early in winter may result in an increase in avalanche activity by creating a thin snowpack that becomes structurally weaker as winter progresses. New layers of snow may not bond well to the weak base layer at the bottom of the snowpack, creating prime conditions for avalanches. Similar conditions in early to mid-spring may replicate this process, leading to increased avalanche activity as snow accumulation has already begun to thaw with the warmer season. In other words, as more snow piles on top of the weak layer, and temperatures remain warm, the upper moisture-laden layers become vulnerable to sliding.

Increasing temperatures will also result in more precipitation falling as rain instead of snow. Overtime this may decrease the risk of avalanche due to a dramatically reduced snowpack. However, in the near future this will likely result in more wet snow avalanches, those which are caused by a decrease in the strength of the snowpack and due to large amounts of snow accumulation over a short period of time, as opposed to dry snow avalanches which are caused by an increase in stress on the snowpack.

4.2.2.6 Potential Magnitude and Severity

A number of weather and terrain factors determine avalanche severity.

- Weather:
  - Storms – A large percentage of avalanches occur during and shortly after storms.
  - Rate of snowfall – Snow falling at a rate of 1 inch or more per hour significantly increases avalanche danger.
  - Temperature – Storms starting with low temperatures and dry snow, followed by rising temperatures and wet snow, are more likely to cause avalanches than storms that start warm and then cool.
  - Wet snow –Spring weather with warm, moist winds and cloudy nights, as well as rainstorms, can cause wet snow avalanches by warming the snowpack and decreasing its strength. Wet snow avalanches are more likely to occur on sun-exposed terrain and under exposed rocks or cliffs.
- Terrain:
  - Ground cover – Large rocks, trees, and heavy shrubs anchor snow.
  - Slope profile – Dangerous slab avalanches are more likely to occur on convex slopes.
  - Slope aspect – Leeward facing slopes are dangerous because windblown snow adds depth and creates dense slabs. South-facing slopes are more dangerous in the springtime.
  - Slope steepness – Avalanches are most common on slopes of 30 to 45 degrees.

Additional factors contributing to avalanche hazard are old snow depth, old snow surface, new snow depth, new snow type, density, precipitation intensity, settlement, wind direction and speed, temperature, and subsurface snow crystal structure. The danger of an avalanche can be described in terms of its likelihood, size, which includes its width, length it travels, or the depth of the debris, and distribution. While there are a few scales that rate avalanches based on their destructive force, such as the D-Scale, a commonly used scale for search and rescue, ski patrollers, and backcountry traveler's measures avalanche severity based on size, the mass, length, and pressure of the slide.

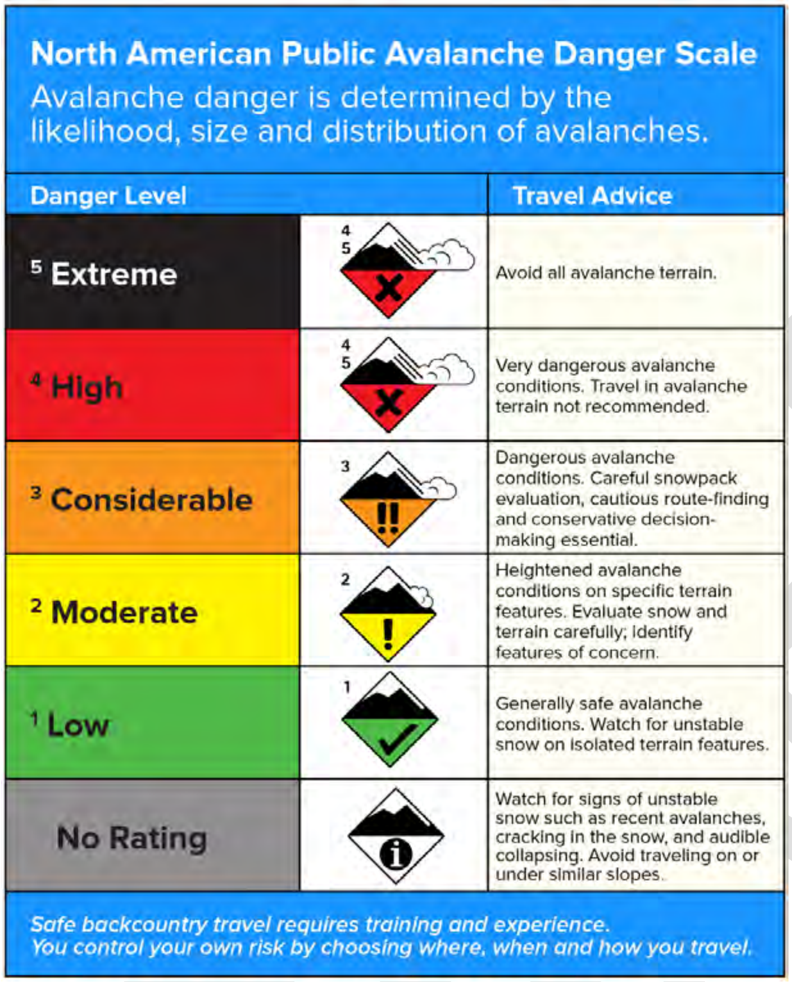
Table 4-5 Avalanche Danger Scale

Danger Level	Travel Advice	Likelihood of Avalanches	Avalanche Size and Distribution
5 – Extreme	Avoid all avalanche terrain.	Natural and human-triggered avalanches certain.	Large to very large avalanches in many areas.
4 – High	Very dangerous avalanche conditions. Travel in avalanche terrain not recommended.	Natural avalanches likely; human-triggered avalanches very likely.	Large avalanches in many areas; or very large avalanches in specific area.
3 – Considerable	Dangerous avalanche conditions. Careful snowpack evaluation, cautious route-finding and	Natural avalanches possible; human-triggered avalanches likely.	Small avalanches in many areas; or large avalanches in specific areas; or very large avalanches in isolated area.

Danger Level	Travel Advice	Likelihood of Avalanches	Avalanche Size and Distribution
	conservative decision-making essential.		
2 – Moderate	Heightened avalanche conditions on specific terrain features. Evaluate snow and terrain carefully; identify features of concern.	Natural avalanches unlikely; human-triggered avalanches possible.	Small avalanches in specific areas; or large avalanches in isolated areas.
1 – Low	Generally safe avalanche conditions. Watch for unstable snow on isolated terrain features.	Natural and human-triggered avalanches unlikely.	Small avalanches in isolated areas or extreme terrain.

The overall potential magnitude of impacts from avalanches in the Western Montana Region is **Limited**. While historic damages from avalanches in the Region include fatalities and property destruction, these impacts have affected no more than a handful of people per year. With the exception of outdoor recreationist, threats to human lives are minimal. Major damage could occur if an avalanche impacted critical facilities such as hospitals or evacuation routes. However, since avalanches are well understood, any emergency declaration has been avoided through zoning, engineering, and advanced warning systems.

Figure 4-11 Avalanche Danger Scale

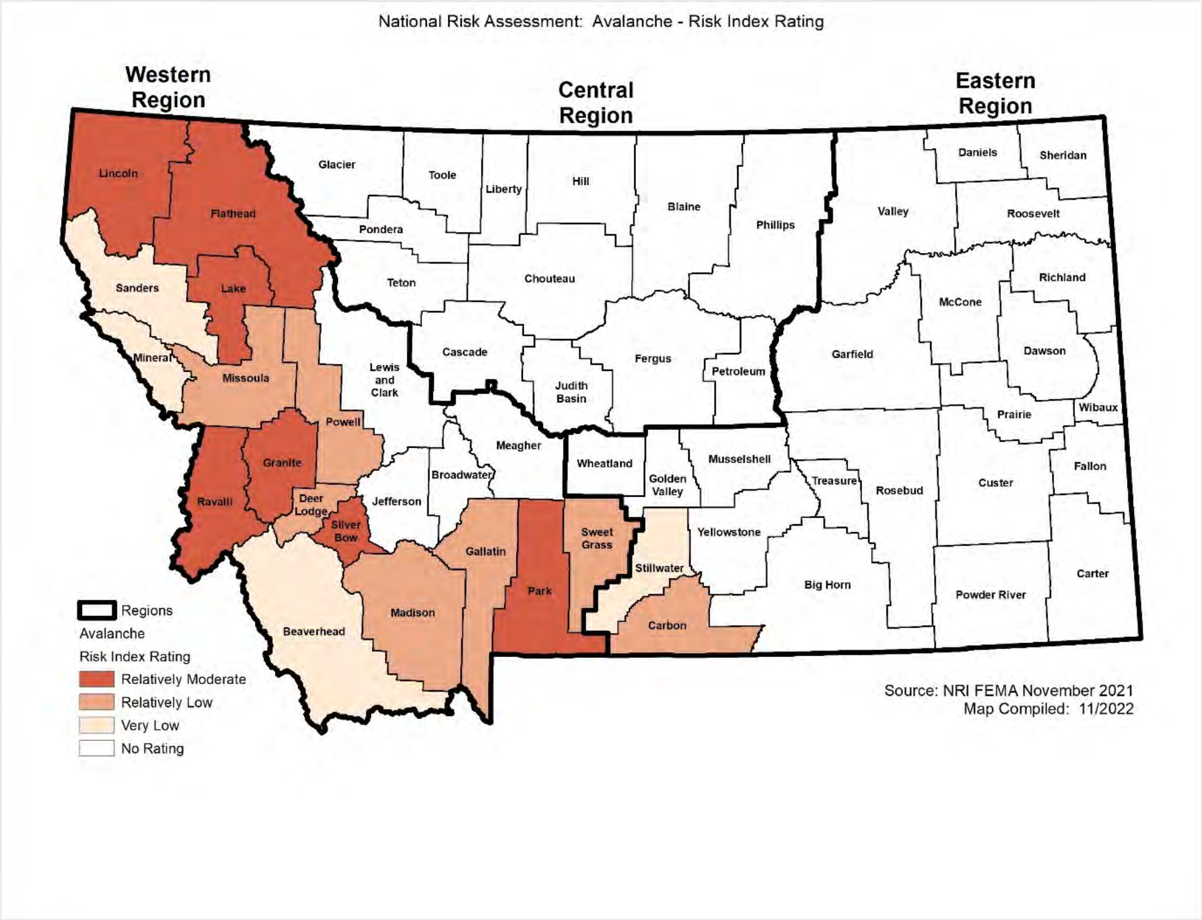


Source: American Avalanche Association. https://avalanche.org/avalanche-encyclopedia/danger-scale/

4.2.2.7 Vulnerability Assessment

Figure 4-12 shows the overall Risk Index rating for avalanches at a county level based on NRI data. The NRI calculation takes into account various factors, including the EALes from these events, social vulnerability, and community resilience in each county across Montana. This data shows that most of the Western Region has a relatively low to relatively moderate avalanche Risk Index rating.

Figure 4-12 Risk Index Rating for Avalanche by County



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

People

Public safety is most threatened by this hazard. Outdoor recreationists who travel into backcountry areas are most at risk. Additionally, avalanche incidents involving search and rescue teams can put these personnel at risk. The key actions to limiting impacts to individuals recreating in avalanche prone areas include spreading knowledge and awareness of the hazard and being properly equipped for self-rescue.

Property

Increased encroachment into wildlands will increase the risk of damage caused by avalanche. With the exception of Lincoln and Powell, all counties in Western Montana have experienced rapid population growth from 2010 to 2022. The average rate of increase was 6.57%, well above the national average, with Gallatin County experiencing a staggering 39.5% rate of increase (World Population Review, 2022). As infrastructure expands to accommodate the growing population, people and property will move closer to mountainous terrains, increasing vulnerability to the damaging effects of avalanches unless considered in planning and site development.

Critical Facilities and Lifelines

Most avalanches occur in undeveloped, mountainous locations. This makes their potential impact on critical facilities and lifelines minimal. However, some facilities may be at risk if an avalanche disrupts the transportation network, electric grid, or communication towers. Additionally, if urban sprawl pushes critical facilities further wildlands, future developments may be threatened. Interstate 90 on the Montana side of Lookout Pass (Missoula County) has been blocked by avalanches before (including an incident on January 7, 2022), disrupting traffic, and potentially posing a public safety risk. The HMPC noted that the John Stevens Canyon/Hwy 2 Corridor in Flathead County are vulnerable to avalanche, with the BNSF and Amtrak Rail Lines present.

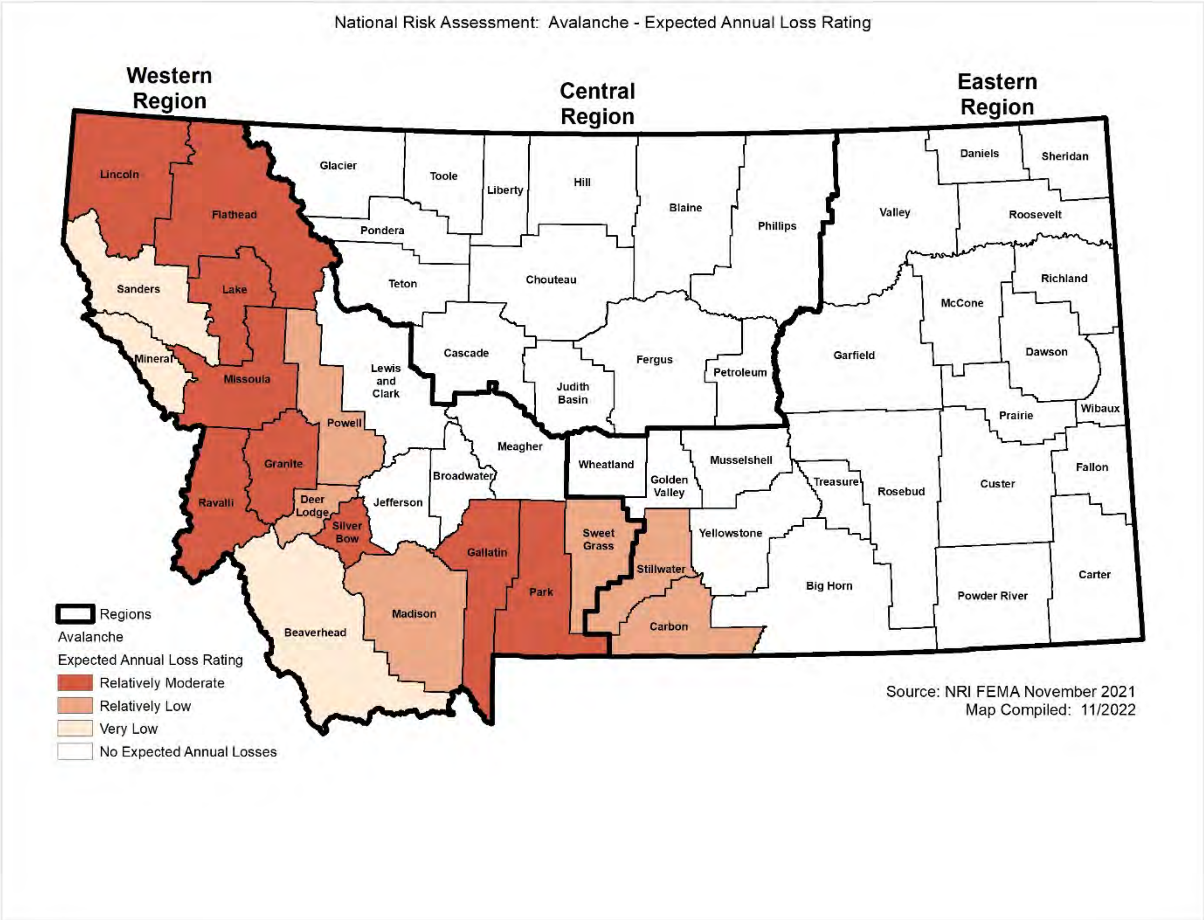
Currently, transportation networks are likely most vulnerable to avalanches. Transportation obstruction can prevent the transportation of goods, as well as disrupt commuting and emergency response and service provision. Avalanches also have the capacity to destroy power lines and natural gas pipes, complicating long-term reconstruction efforts.

Economy

According to the U.S. Bureau of Labor Statistics, "Trade, transportation, and utilities" is the largest industry in Montana, and "Leisure and hospitality" is the fourth (Economy at a Glance, 2022). Given the remote nature of nearly all avalanches, other industries may be affected by obstructing commuters or impacting communication or electric grids. The impact an avalanche would have on the economy is dependent upon the amount of time it would take to restore impacted areas, although direct losses may be felt by the timber industry.

Figure 4-13 below illustrates the relative risk of EAL rating of avalanches for Montana counties based on data in the NRI. Most counties in the Region have a relatively moderate rating; none have a high or very high-risk EAL rating. The EAL calculation takes into account agriculture value exposed to avalanches, annualized frequency for avalanches, and historical loss for avalanches. Therefore, the EAL rating is heavily based on agricultural impacts.

Figure 4-13 Expected Annual Loss Rating for Avalanche by County



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

Historic and Cultural Resources

The impact on historic and cultural resources in the Region is unknown.

Natural Resources

Avalanches are a natural process in landscapes where they occur. However, large avalanches may alter the natural landscape, damaging trees and in some cases removing areas of forest and creating piles of woody debris. Loss of vegetation on the mountains may expose soil, leading to secondary impacts such as landslides and debris flows.

Development Trends Related to Hazards and Risk

Avalanche vulnerability could increase with future development and population growth as there will be a higher number of people driving on roadways and taking part in backcountry recreation, thereby increasing exposure to avalanche risk. It is unlikely that risk to structures will increase as long as future development is planned outside of mapped or suspected avalanche hazard zones.

4.2.2.8 Risk Summary

In summary, the avalanche hazard is considered to be overall low 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, avalanches are rated as a low significance in the planning area.
- Avalanches generally occur in isolated areas.
- Historically, there has been at least one fatality due to avalanche annually, making the likelihood of future occurrence **Highly Likely**.
- Due to the remote location of most avalanches economic impacts are generally minor; therefore, magnitude is negligible.
- Winter recreationists and first responders are most likely to be affected by avalanches, although rare urban avalanches have occurred.
- Additionally, as a popular recreation spot for tourists, a high risk exists for individuals unfamiliar with recognizing avalanche terrain.
- Related hazards: Severe Winter Weather.

Table 4-6 Avalanche Hazard Risk Summary

Jurisdiction	Overall Significance	Additional Jurisdictions	Jurisdictional Differences?
Western Region	Low	NA	See below
Anaconda-Deer Lodge	Low	NA	none
Beaverhead	Low	City of Dillon Town of Lima	none
Broadwater	Low	City of Townsend	none
Butte-Silver Bow County	Low	City of Butte Town of Walkerville	none
Confederated Salish and Kootenai Tribes of the Flathead Reservation	Low		none
Flathead	Medium	City of Columbia Falls City of Kalispell Town of Whitefish	Flathead County has one of the largest populations in Western Montana and is home to multiple popular ski resorts. Incorporated areas are low
Granite County	Low	Town of Drummond Town of Philipsburg	
Jefferson	Low	City of Boulder Town of Whitehall	none
Lake	Medium	City of Polson City of Ronan Town of St. Ignatius	Incorporated areas have low rating
Lewis and Clark	Low	City of Helena City of East Helena	none
Lincoln	Low	City of Libby City of Troy	none

Jurisdiction	Overall Significance	Additional Jurisdictions	Jurisdictional Differences?
		Town of Eureka Town of Rexford	
Madison	Medium	Town of Ennis Town of Sheridan Town of Twin Bridges Virginia City	Incorporated areas have low rating. The Big Sky Ski Resort in Madison and Gallatin Counties is the fourth most avalanche prone ski resort in the U.S but regularly controlled.
Meagher	Low	City of White Sulphur Springs	none
Mineral	Low	Town of Superior Town of Alberton	none
Park	Medium	City of Livingston Town of Clyde Park	Park County has the highest avalanche fatality rate in Montana. Rating is low for Livingston and Clyde Park.
Powell	Low	City of Deer Lodge	none
Ravalli	Low	City of Hamilton Town of Darby Town of Stevensville Town of Pinesdale	none
Sanders	Low	City of Thompson Fall Town of Plains Town of Hot Springs	none
Sweet Grass	Low	City of Big Timber	none

4.2.3 Communicable Disease

4.2.3.1 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 spread easily 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 a significant outbreak. The Western 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. While most people have mild symptoms, some people develop acute respiratory distress syndrome with roughly one in five requiring hospitalization and a fatality rate of approximately 1%. Recent studies, however, have shown the average country/territory-specific COVID-19 case fatality rate to be 2% - 3% worldwide and higher than previously reported estimates (Cao, Hiyoshi and Montgomery 2020). Case fatality rate, also called case fatality risk or case fatality ratio, in epidemiology, is the proportion of people who die from a specified disease among all individuals diagnosed with the disease over a certain period of time (Harrington 2022). The key challenge in containing the spread has been the fact that it can be transmitted by asymptomatic people.

2022 U.S. Monkeypox Outbreak

According to CDC, monkeypox is a rare disease caused by infection with the monkeypox virus. Monkeypox virus is part of the same family of viruses as smallpox. Monkeypox symptoms are similar to smallpox symptoms but milder, and monkeypox is rarely fatal. Symptoms of monkeypox can include fever, headache, muscle aches and backache, swollen lymph nodes, chills, and exhaustion; moreover, a rash that can look like pimples or blisters that appear on the face, inside the mouth, and on other parts of the body, like the hands, feet, chest, genitals, or anus. The rash goes through different stages before healing completely. The illness typically lasts 2-4 weeks. Sometimes, people get a rash first, followed by other symptoms. Others only experience a rash.

Monkeypox spreads in different ways. The virus can spread from person-to-person through:

- Direct contact with the infectious rash, scabs, or body fluids
- Respiratory secretions during prolonged, face-to-face contact, or intimate physical contact, such as kissing, cuddling, or sex
- Touching items (such as clothing or linens) that previously touched the infectious rash or body fluids
- Pregnant people can spread the virus to their fetus through the placenta

It is also possible for people to get monkeypox from infected animals, either by being scratched or bitten by the animal or by preparing or eating meat or using products from an infected animal.

Moreover, monkeypox can spread from the time symptoms start until the rash has fully healed and a fresh layer of skin has formed. The illness typically lasts 2-4 weeks. People who do not have monkeypox symptoms cannot spread the virus to others. At this time, it is not known if monkeypox can spread through semen or vaginal fluids.

Monkeypox 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 monkeypox was recorded in 1970. Before the 2022 outbreak, monkeypox had been reported in people in several Western and Western African countries. Previously, almost all monkeypox 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.

As of October 2, 2022, there are 68,428 cases all over the world. There are 25,851 cases in the U.S. The State of Montana has reported six monkeypox cases. The World Health Organization (WHO) declared Monkeypox Spread a Global Health Emergency on July 23, 2022.

Hantavirus Pulmonary Syndrome (HPS)

Moreover, according to the State of Montana's Department of Public Health and Human Services (DPHHS), HPS is another communicable disease of concern to the State of Montana. HPS is an illness caused by a family of viruses called hantaviruses. 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.

4.2.3.2 Geographical Area Affected

The entire geographic area of the Montana Western 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 311,000 cases of COVID-19 and 3,520 deaths as of October 2, 2022. The current COVID-19 pandemic has affected all the counties in the Western Region. Table 4-7 below shows the total cases and deaths specific to the Western Region. Data specific to tribes are included in the nearest Counties. Western 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 4-7 COVID-19 Cases and Deaths by County (as of July 22, 2022)

County	Cases	Cases Per Total Pop*.	Deaths	Deaths Per Total Pop.
Anaconda-Deer Lodge	2,971	32%	30	0.3%
Beaverhead	2,365	25%	30	0.3%
Broadwater	1,463	24%	2,310	38.0%
Butte-Silver Bow	9,340	27%	135	0.4%
Flathead	32,460	32%	295	0.3%
Granite	628	19%	10	0.3%
Jefferson	2,960	25%	25	0.2%
Lake	7,709	25%	104	0.3%
Lewis and Clark	20,707	30%	194	0.3%
Lincoln	5,344	27%	91	0.5%
Madison	2,251	26%	22	0.3%
Meagher	547	30%	10	0.6%
Mineral	1,261	29%	17	0.4%
Park	4,910	30%	36	0.2%
Powell	2,130	31%	30	0.4%
Ravalli	7,935	18%	166	0.4%
Sanders	2,357	20%	52	0.4%
Sweet Grass	862	23%	13	0.4%

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

4.2.3.3 Past Occurrences

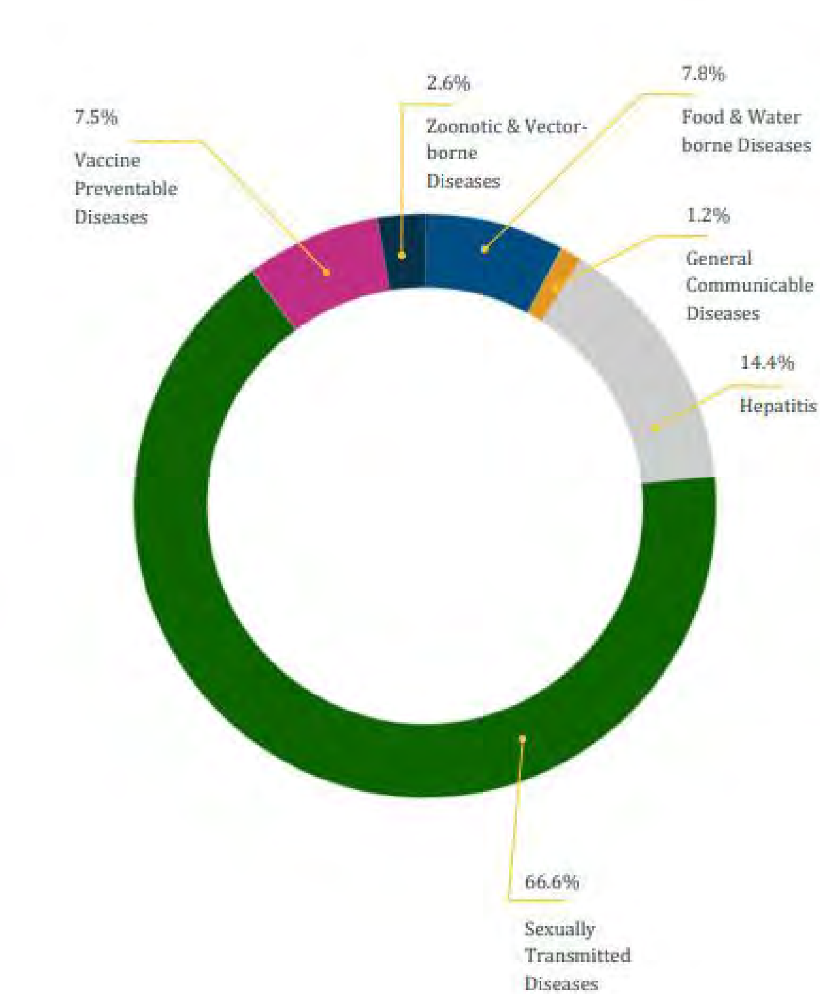
Since the early 1900s, five lethal pandemics have swept the globe:

- **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 were 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 U.S. on April 26. By June, approximately 18,000 cases had been reported in the U.S. 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, there were 122 reported cases. As of January 21, 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 October 2, 2022, over 614 million cases have been

reported around the world with 6.5 million deaths, including almost 95 million cases and 1.05 million deaths in the U.S. Worldwide there have been more than 12.7 billion vaccine doses administered. The Montana DPHHS has reported 310,731 cases of COVID-19 and 3,520 deaths as of October 2, 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. Moreover, Montana's news leader KTVQ noted on December 2021 that COVID-19 was the leading cause of death among Montana's Native Americans in 2020. A report released by the State's DPHHS 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).

Furthermore, as shown in the 2019 Montana DPHHS Communicable Disease in Montana Annual Report 2019, 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 4-14 below:

Figure 4-14 Reported Communicable Diseases by Category, Montana, 2019



Source: Montana Department of Public Health and Human Services

The 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. It is believed that the increase in reported cases is partially due to an increase in screening tests being performed all across the State, which suggests that gonorrhea has been underreported for many years.

In addition, the 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.

4.2.3.4 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 those who are not vaccinated, 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.

4.2.3.5 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 will 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 will become the biggest upstream risk factor for disease emergence — exceeding higher-profile issues like deforestation, wildlife trade and industrial agriculture. The authors say 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)

4.2.3.6 Potential Magnitude and Severity

The magnitude of a disease outbreak or public health emergency will range significantly depending on the aggressiveness of the virus in question and the ease of transmission. Pandemic influenza is more easily transmitted from person to person but advances in medical technologies have greatly reduced the number of deaths caused by influenza over time.

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. Most experts believe we will have just one to six months between the time that a dangerous new influenza strain is identified and the time that outbreaks begin to occur in the United States. 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 and many other aspects make influenza pandemic unlike most other public health emergencies or community disasters. Pandemics typically last for several months to 1-2 years.

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 more contagious strains of COVID such as the recent Omicron, BA.5 and Delta B.1.617.2 variant can quickly lead to even more outbreaks.

The Pandemic Intervals Framework (PIF) 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 inform 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 correlate 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 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.

4.2.3.7 Vulnerability Assessment

People

Pandemics can affect large segments of the population for long periods. The number of hospitalizations and deaths will depend on the virulence of the virus. Risk groups cannot be predicted with certainty; the elderly, people with underlying medical conditions, and young children are usually at higher risk, but as discussed above this is not always true for all influenza strains. People without health coverage or access to good medical care are also likely to be more adversely affected. According to data collected from the ACS five-year estimates for 2016-2020, in the Western Region, the elderly (those over 65 years of age) make up 20.1% of the population; the young (those under five years of age) make up 5.2% of the population, and 14% of the Western 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 Western Region and the State. These populations are 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, the most positive cases occurred in the 20-39 age group. Hospitalizations and deaths, however, happened more within the 60+ age groups.

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 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 would likely be affected in various ways.

Economy

A widespread communicable disease outbreak could have devastating impacts on Western 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 Western

Region. This could last for a protracted amount of time, compounding economic loss. Economic costs are also associated with incident response. Two of the biggest areas of cost are public information efforts and mass prophylaxis.

According to an article published on November 15, 2018, by GlobeNewswire with the source from Integrated Benefits Institute, in a normal year, lost productivity due to illness costs U.S. employers an estimated $530 billion. During a pandemic, that figure would likely be considerably high and could trigger a recession or even a depression. According to an October 2020 report by the Journal of American Medical Association (JAMA) Network, 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 U.S. 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 Western 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 would have little to no warning, whereas the population further away in the dispersion path may have some time to prepare and mitigate against disease depending on the hazard, its transmission, and public notification.

4.2.3.8 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, followed by key issues noted in 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 are usually at higher risk.
- Effects on property are typically minimal, although quarantines could result in short-term closures.
- Effects on economy: lost productivity due to illness and potential business closures could potentially have severe economic impacts. Social distancing requirements 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 will 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.
- The hazard is considered **Medium** significance across the Western Region.

- Unique jurisdictional vulnerability: As mentioned above, COVID-19 was the leading cause of death in Montana's Native American tribes; it could be inferred that tribes are more vulnerable to communicable diseases.
- Ongoing mitigation activities should focus on disease prevention, especially during flu season. 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 4-8 Risk Summary Table: Communicable Disease

Jurisdiction	Overall Significance	Additional Jurisdictions	Jurisdictional Differences?
Western Region	Medium	NA	None
Anaconda-Deer Lodge	Medium	NA	None
Beaverhead	Medium	Dillon, Lima	None
Broadwater	Medium	Townsend	None
Butte-Silver Bow	Medium	NA	None
CSKT	Medium	NA	None
Flathead	Medium	Columbia Falls, Kalispell, Whitefish	None
Granite	Medium	Drummond, Philipsburg	None
Jefferson	Medium	Boulder, Whitehall	None
Lake	Medium	Polson, Ronan, St. Ignatius	None
Lewis and Clark	Medium	East Helena, Helena	None
Lincoln	Medium	Eureka, Libby, Rexford, Troy	None
Madison	Medium	Ennis, Sheridan, Twin Bridges, Virginia City	None
Meagher	Medium	White Sulphur Springs	None
Mineral	Medium	Alberton, Superior	None
Park	Medium	Clyde Park, Livingston	None
Powell	Medium	Deer Lodge	None
Ravalli	Medium	Darby, Hamilton, Pinesdale, Stevensville	None
Sanders	Medium	Hot Springs, Plains, Thompson Falls	None
Sweet Grass	Medium	Big Timber	None

*Rocky Boy's Reservation

4.2.4 Cyber-Attack

4.2.4.1 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.

Cyber-attacks are rapidly increasing in the United States. The FBI Internet Crime Complaint Center (IC3) was developed to provide the public with a direct way to report cybercrimes to the FBI. In 2021, the FBI Internet Crime Report reported a record number of cyber-attacks, with 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.

4.2.4.2 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 Western Region. All servers in the Western 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**.

4.2.4.3 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 cyber-crime 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 Privacy Rights Clearinghouse. 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. The database lists 35 data breaches against systems located in Montana totaling almost 1.5 million impacted records; it is difficult to know how many of those affected residents in the Montana Western Region. Attacks happening outside of the State can also impact local businesses, personal identifiable information, and credit card information. Table 4-9shows several of the most significant cyber-attacks 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."

Table 4-9 Major Cyber-Attacks Impacting Montana (10,000+ Records), 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, memory stick, CDs, hard drive, data tape, etc.)
4/14/2017	Western Health Screening	-	Healthcare	15,326	PHYS

Source: The Privacy Rights Clearinghouse

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 Western Region.

The Montana Department of Agriculture temporarily took the USAHERDS web-based software offline in the year 2021 to allow the application's developer to beef up security following a suspected Chinese state-sponsored cyber-attack. USAHERDS is used to track livestock by at least 18 US states. The suspected attacker – APT41, had carried out a hacking campaign that comprised the networks of at least six US state governments (Power 2022).

Logan Health Medical Center in Kalispell, Montana suffered a hacking incident that impacted 213,543 individuals, according to the Maine Attorney General's Office. Logan Health discovered suspicious network activity on November 22, 2021, and later found evidence of unauthorized access to one file server containing information about patients, employees, and business associates (McKeon 2022).

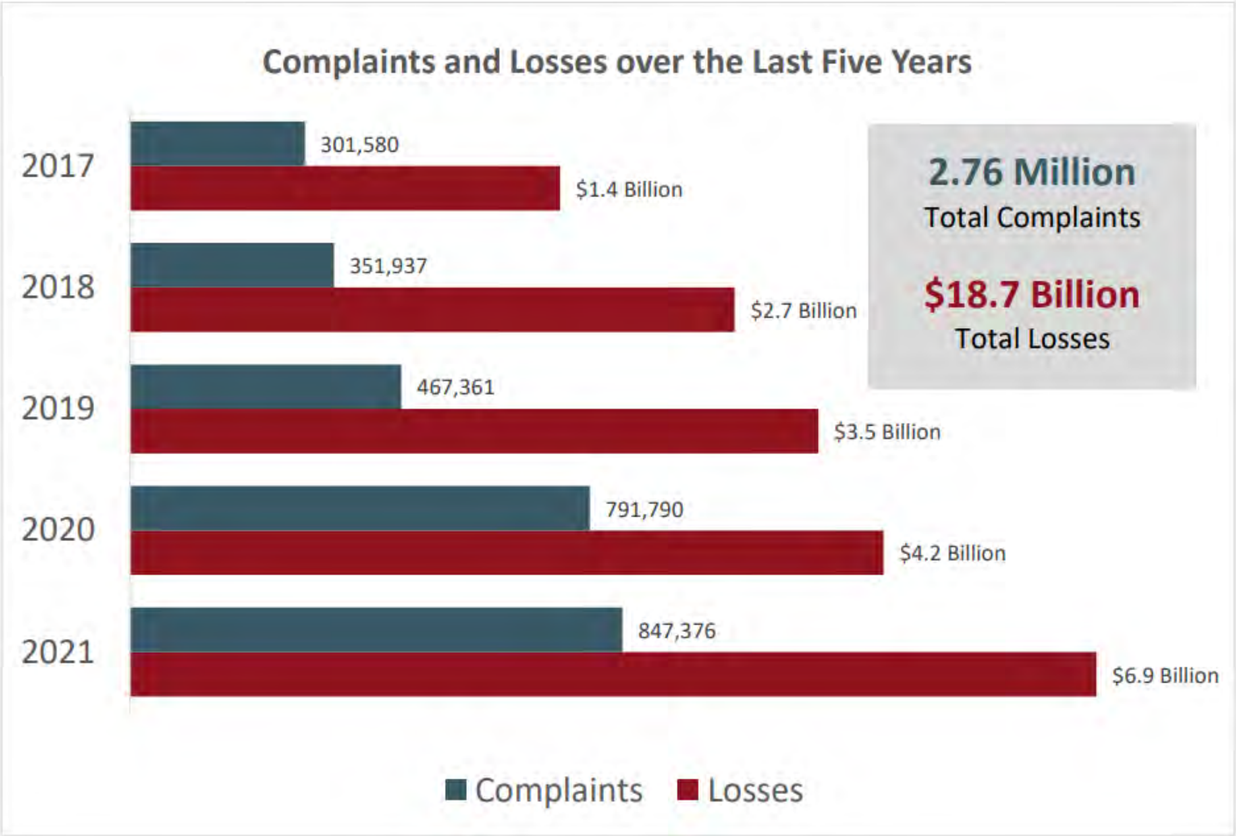
In February 2020, it is reported that Ryuk ransomware hacked the computer system of the Havre Public Schools. Despite the major scare, it was eventually concluded that the hackers did not gain access to student and employee information (Dragu 2020).

On April 3, 2015, Western Montana Clinic notified almost 7,000 patients of a payment data hack. The hacker bypassed the Clinic website's security measures and obtained access to the demographic and credit card information of 6,994 patients who paid their bill(s) via the link on the Clinic's website. The information available to the hacker included patient names, addresses, telephone numbers, email addresses, date(s), and amount(s) of credit card transaction(s), and the last four (4) digits of patients' credit card numbers. In addition, approximately 44 patients' full credit card information was compromised. The Clinic took steps to mitigate any further harm to patients from this security incident ("Western Montana Clinic Notifies Almost 7,000 Patients of Payment Data Hack" 2015).

4.2.4.4 Frequency/Likelihood of Occurrence

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 extremely common, but again most have only minor impacts on government services. Additionally, the FBI Internet Crime Report 2021 found that there is a trend of increasing cyber-attacks over the past 5 years. These trends are shown in Figure 4-15

Figure 4-15 Trends of the Frequency of Cyber-attacks, 2017-2021



Source: The FBI Internet Crime Report 2021

Perhaps of greatest concern to the Western Region are ransomware attacks, which are becoming increasingly common. It is difficult to calculate the odds of the Western Region or one of its jurisdictions being hit with a successful ransomware attack in any given year, but it is likely to be attacked in the coming years.

The possibility of a larger disruption affecting systems within the Region 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 Western Region cannot be ruled out. Therefore, the probability of future cyber-attack is **Occasional**.

4.2.4.5 Climate Change Considerations

Climate change is not projected to have an impact on the threat, vulnerability, and consequences of a cyber-attack.

4.2.4.6 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, including Amazon, Netflix, PayPal, Twitter, and several news organizations.

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 are of a smaller scale, ranging from 201 records 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 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**.

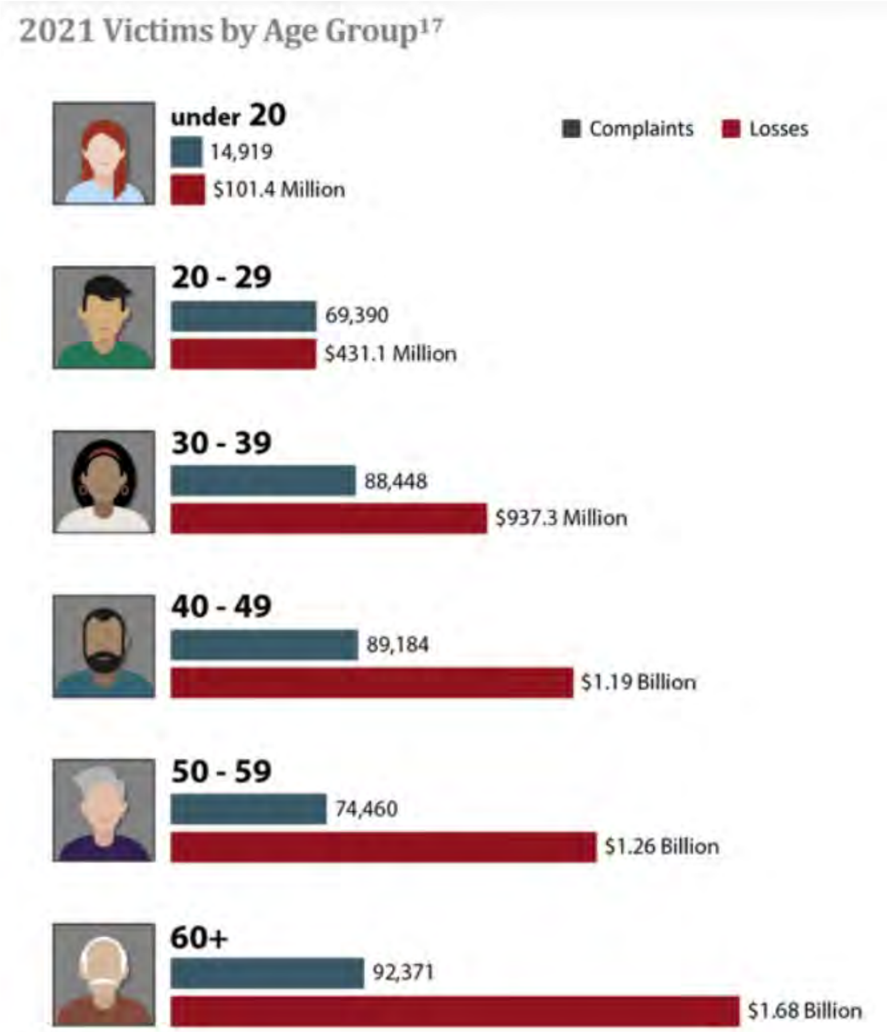
4.2.4.7 Vulnerability Assessment

People

Injuries or fatalities from cyber-attacks would generally only be possible from a major cyber-terrorist attack against critical infrastructure. More likely impacts on 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 or other infrastructure.

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 the greatest losses. This is likely due to seniors being less aware of cyberthreats, lack of the tools to identify cyberthreats, and "Grandparent Scams", which is a cyber-attack where criminals impersonate a loved one in need, such as a grandchild, and ask for money. In the Western Region, 37.6% of the population was reported to be 60+ in 2020, according to the U.S. Census. Figure 4-16 displays the breakdown of victims by age group in 2021.

Figure 4-16 Victims by Age Group in 2021



Source: The FBI Internet Crime Report 2021

Property

Most cyber-attacks affect only data and computer systems and have minimal impact on the general property. However, sophisticated attacks have occurred against the 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. 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. The 2003 Northeast Blackout, while not the result of a cyber-attack, caused 11 deaths and an estimated $6 billion in economic loss.

Critical Facilities and Lifelines

An article posted on July 31, 2022, by government technology mentions that despite the lack of major headline-grabbing cyber-attacks against U.S. critical infrastructure so far in 2022, our global cyber battles continue to increase. Worldwide cyber actions are becoming less covert. Besides, according to IBM's 2022 annual Cost of a Data Breach Report, almost 80 percent of critical infrastructure organizations studied do not adopt zero-trust strategies, seeing average breach costs rise to $5.4 million – a $1.17 million increase compared to those that do. All while 28 percent of breaches amongst these organizations were ransomware or destructive attacks (Lohrmann 2022).

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.

Moreover, 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 Western Region will be significantly impacted.

In addition, public confidence in the government will likely 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. The 2018 cyber-attack on the Colorado Department of Transportation (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. 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.

4.2.4.8 Risk Summary

In summary, the cyber-attack 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 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
- Small businesses worth less than $10 million and local governments are increasingly becoming targets for cyber-attack, with criminals assuming these smaller organizations will lack the resources to prevent an attack
- 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 Butte or Helena, are most likely to experience cyber-attacks, but rural areas can also be targets.

Table 4-10 Risk Summary Table: Cyber-Attack

Jurisdiction	Overall Significance	Additional Jurisdictions	Jurisdictional Differences?
Western Region	Medium	NA	
Anaconda-Deer Lodge	Medium	NA	
Beaverhead	Medium	Dillon, Lima	
Broadwater	Medium	Townsend	
Butte-Silver Bow	Medium	NA	
CSKT	Medium	NA	
Flathead	Medium	Columbia Falls, Kalispell, Whitefish	
Granite	Medium	Drummond, Philipsburg	
Jefferson	Medium	Boulder, Whitehall	
Lake	Medium	Polson, Ronan, St. Ignatius	
Lewis and Clark	Medium	East Helena, Helena	
Lincoln	Medium	Eureka, Libby, Rexford, Troy	
Madison	Medium	Ennis, Sheridan, Twin Bridges, Virginia City	
Meagher	Medium	White Sulphur Springs	
Mineral	Medium	Alberton, Superior	
Park	Medium	Clyde Park, Livingston	
Powell	Medium	Deer Lodge	

Jurisdiction	Overall Significance	Additional Jurisdictions	Jurisdictional Differences?
Ravalli	Medium	Darby, Hamilton, Pinesdale, Stevensville	
Sanders	Medium	Hot Springs, Plains, Thompson Falls	
Sweet Grass	Medium	Big Timber	

4.2.5 Dam Failure

4.2.5.1 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. Detailed in Table 4-11 below are the high, significant, and low hazard dams located throughout Montana's Western Region summarized by county. Lewis and Clark, Madison, Powell, Ravalli, and Lake Counties have the highest numbers of high hazard dams.

Table 4-11 Western Region Dam Summary Table

County	High Hazard Dam Total	Significant Hazard Dam Total	Low Hazard Dam Total	Total	Percentage of High Hazard Dams with Emergency Action Plan
Beaverhead	7	4	32	43	43%
Broadwater	1	0	4	5	100%
Deer Lodge	3	3	5	11	100%
Flathead	8	1	3	12	88%
Gallatin	4	0	5	9	50%
Granite	2	1	8	11	100%
Jefferson	7	0	4	11	71%
Lake	9	3	5	17	100%
Lewis and Clark	16	2	17	35	94%
Lincoln	6	4	9	19	100%
Madison	11	6	13	30	64%
Meagher	8	5	36	49	100%
Missoula	5	9	7	21	100%
Park	3	4	16	23	100%
Powell	9	3	25	37	89%
Ravalli	9	1	11	21	56%
Sanders	3	0	8	11	100%
Silver Bow	3	2	5	10	100%
Sweet Grass	4	3	11	18	100%
Total	118	51	224	393	87%

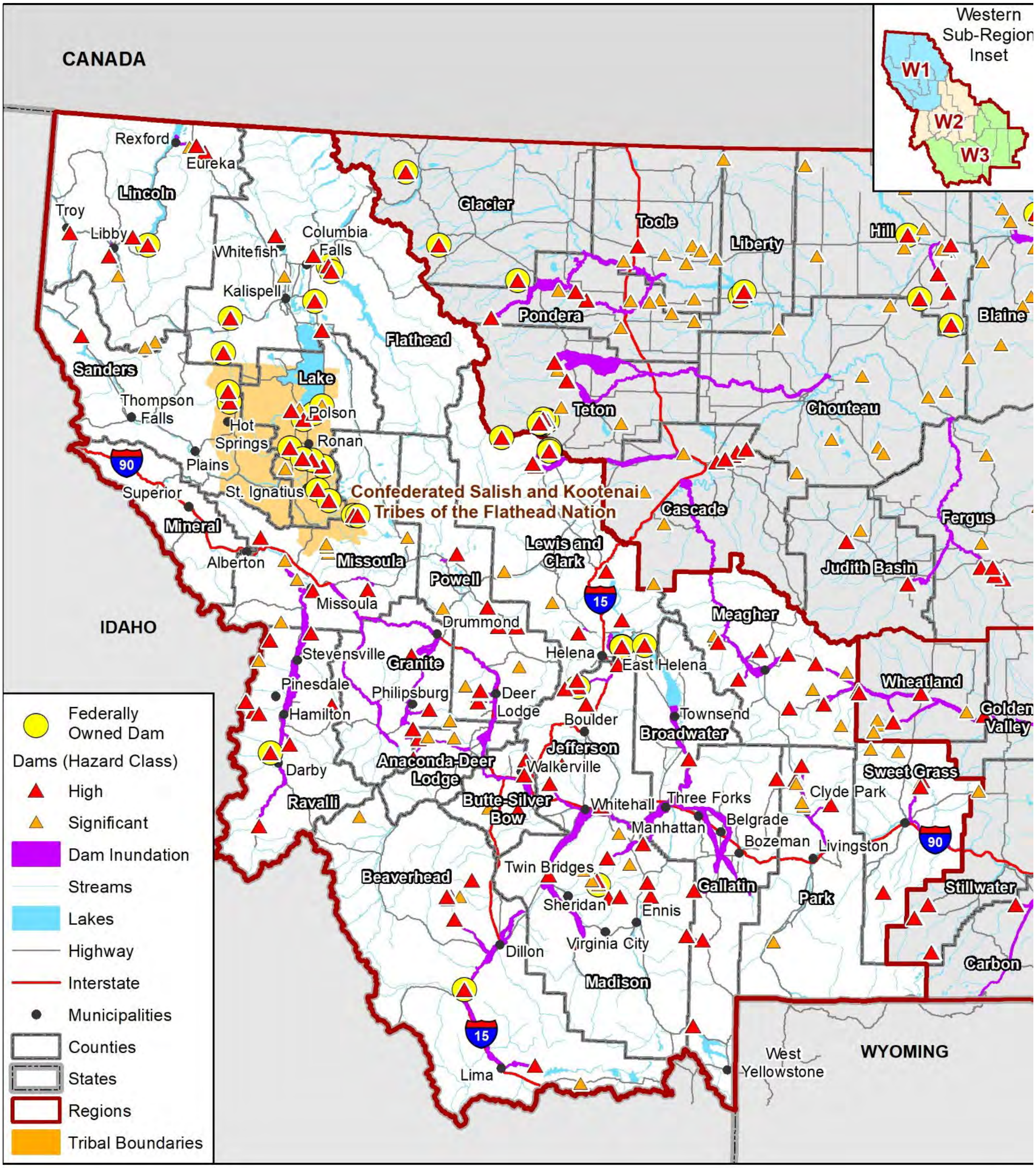
Source: Montana Department of Natural Resources and Conservation (DNRC) Dam Safety Program, Montana State Library, NID, HIFLD 2022, Montana DES, NBI

NOTE: There is one low hazard dam which is directly on the Madison/Silver Bow County line, and it is counted in the totals of both counties here

4.2.5.2 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 393 dams throughout the counties of the Western Region. 118 of these dams are high hazard, and 51 are significant hazard dams, with the remainder being low hazard dams. 102 of the high hazard dams in the Western Region have Emergency Action Plans (EAP) on file. High and significant hazard dams located in and adjacent to the Region are shown on the map below. In some cases, there is inundation mapping, limited to privately owned high hazard dams, based on data from the MT Department of Natural Resources and Conservation (DNRC). Additionally, there are inundation zones for dams owned by the Bureau of Indian Affairs, used with permission. Other federally owned dams are highlighted in yellow and do not have publicly available inundation mapping.

Figure 4-17 Western Region Dams



Map compiled 10/2022;
intended for planning purposes only.
Data Source: Montana State Library, NID, MT DNRC Dam Safety Program

4.2.5.3 Past Occurrences

Dam failure floods in Montana have primarily been associated with riverine and flash flooding. According to the 2018 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.

There have been two instances of dam failure flooding in the Western Region. The Hauser Dam located in Lewis and Clark County. Failed on 04/14/1908 and the Mike Horse Dam, also located in Lewis and Clark County failed on 01/01/1975. The 1908 failure of the Hauser Dam was a result of the dam not being anchored to bedrock. The 70-foot-high steel dam collapsed at 2:45 pm of that day and had only been operational for a year at that point. A new concrete anchored dam was built at the site in 1911. Regarding the Mike Horse Dam failure, in 1975 heavy rains caused a partial failure of the dam and high creek waters. This caused erosion and contaminated wastewater to be deposited into Beartrap Creek and Upper Blackfoot River. Today Mike Horse Dam is one of Montana’s most prominent environmental cleanup sites.

4.2.5.4 Frequency/Likelihood of Occurrence

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

- Overtopping of the primary dam structure, which 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. 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. Terrorism and vandalism are 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**. The entire Region remains at risk to dam failures from the high and significant hazard dams located throughout the Western Region counties. In addition, the other low hazard dams could potentially fail more frequently and but cause fewer issues downstream.

4.2.5.5 Climate Change Considerations

The potential for climate change to affect the likelihood of dam failure is not fully understood at this point in time. With a potential for more extreme precipitation events a result of climate change, this could result in large inflows to reservoirs. However, this could be offset by generally lower reservoir levels if storage water resources become more limited or stretched in the future due to climate change, increasing droughts, and/or population growth. Owners and operators of dams may need to alter current maintenance and operational procedures in order to account for changes in the hydrograph as well as increased sedimentation.

According to the 2018 State of Montana Multi-Hazard Mitigation Plan population and property exposure to dam failure is not likely to change significantly due to climate change.

4.2.5.6 Potential Magnitude and Severity

As noted above, dams are classified as High Hazard Potential 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.

Information from parcel-level GIS analysis and 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 Western Region could be considered to be the 1908 and 1975 Hauser and Mike Horse Dam failures which resulted in numerous ecological impacts. Overall, dam failure impacts could be **critical** in the Western 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

4.2.5.7 Vulnerability Assessment

While dam failures are unlikely, a major failure could have severe consequences. People, buildings, aboveground infrastructure, critical facilities, and natural environments downstream are potentially vulnerable to dam failure. Roads closed due to dam failure floods could result in serious transportation disruptions due to the limited number of roads in many of the counties. Information for the exposure analysis provided in the sections below is based on dam inundation GIS layers (private dams only) provided by the State.

The most significant issue associated with dam failure involves the properties and populations in the inundation areas. Flooding as a result of a dam failure would significantly impact these areas. There is often limited warning time for dam failure. These events are frequently associated with other natural hazard events such as earthquakes, landslides, or severe weather, which limits their predictability and compounds the hazard.

People

Vulnerable populations are all populations downstream from dam failures that are incapable of escaping the area within the allowable timeframe. This population includes the elderly and young who may be unable to get themselves out of the inundation area. The vulnerable population also includes those who would not have adequate warning from an emergency warning system.

According to GIS analysis conducted for this vulnerability assessment, there are an estimated 10,594 people residing in dam inundation zones throughout the Western Region. 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 4-12 below.

Property

Vulnerable properties are those within and close to the dam inundation area. These properties would experience the largest, most destructive surge of water. Low-lying areas adjacent to riparian areas are also vulnerable since they are where the dam waters would collect.

Communities located below a high or significant hazard dam and along a waterway are potentially exposed to the impacts of a dam failure. High hazard dams threaten lives and property, while significant hazard dams threaten property only. Inundation maps that identify anticipated flooded areas (which may not coincide with known floodplains) are produced for many high hazard dams. Table 4-12 summarizes the estimated number of improved parcels, building values, and people within inundation zones (private dams only) for each county in the Western Region. Counties with the highest exposure of people and property include Butte-Silver Bow, Gallatin, Missoula, and Ravalli Counties. Note: Lake County and the Confederated Salish and Kootenai Tribes of the Flathead Reservation potentially have risk from BIA-owned dams not represented in this analysis. Other counties with federal owned dams that are not represented in the analysis include Flathead, Lincoln, Lewis and Clark, and Beaverhead Counties.

Table 4-12 Western Region Parcels at Risk to Overall Dam Inundation by County and Jurisdiction

Jurisdiction	Improved Parcels	Improved Value	Content Value	Total Value	Population
Deer Lodge County	180	$25,369,769	$13,640,621	$39,010,390	336
Total	**180**	**$25,369,769**	**$13,640,621**	**$39,010,390**	**336**
Dillon	702	$120,078,835	$62,798,201	$182,877,036	1,439
Beaverhead County	425	$89,114,714	$58,749,147	$147,863,861	791
Total	**1,127**	**$209,193,549**	**$121,547,348**	**$330,740,897**	**2,230**
Townsend	822	$114,144,869	$62,826,134	$176,971,003	1,974
Broadwater County	110	$26,757,902	$18,719,876	$45,477,778	186
Total	**932**	**$140,902,771**	**$81,546,010**	**$222,448,781**	**2,160**
Butte-Silver Bow County	3,013	$579,428,201	$310,064,536	$889,492,737	6,603
Total	**3,013**	**$579,428,201**	**$310,064,536**	**$889,492,737**	**6,603**
Flathead County	78	$12,525,896	$6,262,948	$18,788,844	197
Total	**78**	**$12,525,896**	**$6,262,948**	**$18,788,844**	**197**
Gallatin County	3,460	$1,279,159,431	$747,875,409	$2,027,034,840	7,476
Total	**3,460**	**$1,279,159,431**	**$747,875,409**	**$2,027,034,840**	**7,476**
Drummond	37	$2,800,592	$1,401,371	$4,201,963	86
Granite County	446	$79,062,095	$48,660,605	$127,722,700	888
Total	**483**	**$81,862,687**	**$50,061,976**	**$131,924,663**	**974**
Whitehall	308	$42,312,192	$22,926,928	$65,239,120	761
Jefferson County	309	$63,554,988	$41,812,220	$105,367,208	647
Total	**617**	**$105,867,180**	**$64,739,148**	**$170,606,328**	**1,407**
East Helena	184	$21,465,724	$11,279,940	$32,745,664	409
Lewis and Clark County	546	$76,082,310	$44,370,424	$120,452,734	1,163

Jurisdiction	Improved Parcels	Improved Value	Content Value	Total Value	Population
Total	**730**	**$97,548,034**	**$55,650,363**	**$153,198,397**	**1,572**
Eureka	45	$5,721,710	$3,346,070	$9,067,780	98
Libby	1,070	$148,933,066	$83,372,721	$232,305,787	2,351
Lincoln County	153	$20,577,255	$10,738,149	$31,315,404	337
Total	**1,268**	**$175,232,031**	**$97,456,940**	**$272,688,971**	**2,786**
Twin Bridges	242	$24,923,196	$13,922,081	$38,845,277	495
Madison County	491	$98,534,844	$66,099,852	$164,634,696	857
Total	**733**	**$123,458,040**	**$80,021,933**	**$203,479,973**	**1,353**
White Sulphur	192	$25,051,517	$15,164,639	$40,216,156	435
Meagher County	116	$21,774,701	$18,010,536	$39,785,237	168
Total	**308**	**$46,826,218**	**$33,175,174**	**$80,001,392**	**604**
Missoula County	2,129	$514,837,938	$278,087,750	$792,925,688	4,763
Total	**2,129**	**$514,837,938**	**$278,087,750**	**$792,925,688**	**4,763**
Park County	82	$32,849,148	$20,808,199	$53,657,347	126
Total	**82**	**$32,849,148**	**$20,808,199**	**$53,657,347**	**126**
Deer Lodge	293	$24,483,055	$13,484,858	$37,967,913	568
Powell County	91	$17,183,280	$13,121,855	$30,305,135	158
Total	**384**	**$41,666,335**	**$26,606,713**	**$68,273,048**	**726**
Darby	180	$23,815,009	$12,638,546	$36,453,555	407
Hamilton	242	$126,164,530	$106,688,646	$232,853,176	508
Stevensville	1	$289,990	$144,995	$434,985	2
Ravalli County	1,434	$363,270,514	$225,795,056	$589,065,570	2,919
Total	**1,857**	**$513,540,043**	**$345,267,242**	**$858,807,285**	**3,836**
Sweet Grass County	13	$2,392,251	$1,827,521	$4,219,772	12
Total	**13**	**$2,392,251**	**$1,827,521**	**$4,219,772**	**12**
Grand Total	**17,394**	**$3,982,659,522**	**$2,334,639,827**	**$6,317,299,349**	**37,161**

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

Critical Facilities and Lifelines

A total dam failure can cause catastrophic impacts to areas downstream of the water body, including critical infrastructure. Any critical asset located under the dam in an inundation area would be potentially susceptible to the impacts of a dam failure. 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 535 critical facilities throughout the Western Region which lie within mapped dam inundation areas. These at-risk facilities are listed in the table below by critical facility classification as based on the FEMA Lifeline categories (FEMA Community Lifelines, 2019).

Table 4-13 Western Region Critical Facilities at Risk to Dam Inundation by Jurisdiction and FEMA Lifeline

County	Communications	Energy	Food, Water, Shelter	Hazardous Materials	Health and Medical	Safety and Security	Transportation	Total
Anaconda-Deer Lodge	3	1	3	0	0	3	41	**51**
Beaverhead	4	3	2	0	1	6	60	**76**
Broadwater	5	4	3	0	0	10	8	**30**
Butte-Silver Bow	9	2	2	1	0	6	15	**35**
CSKT	-	-	-	-	-	-	-	**-**
Flathead	-	-	-	-	-	-	-	**-**
Granite	1	8	0	0	0	1	40	**50**
Jefferson	2	2	2	1	1	4	23	**35**
Lake	-	-	-	-	-	-	-	**-**
Lewis and Clark	3	1	2	2	1	9	18	**36**
Lincoln	5	0	6	0	1	13	6	**31**
Madison	1	6	1	0	2	10	22	**42**
Meagher	0	0	1	0	0	2	14	**17**
Mineral	-	-	-	-	-	-	-	**-**
Park	0	0	0	0	0	0	18	**18**
Powell	1	2	3	0	0	2	30	**38**
Ravalli	6	1	3	2	4	11	47	**74**
Sanders	-	-	-	-	-	-	-	**-**
Sweet Grass	0	0	0	0	0	0	2	**2**
Total	**40**	**30**	**28**	**6**	**10**	**77**	**344**	**535**

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

Economy

Extensive and long-lasting economic impacts could result from a major dam failure or inundation event, including the long-term loss of water in a reservoir, which may be critical for potable water needs. A major dam failure and loss of water from a key structure could bring about direct business and industry damages and potential indirect disruption of the local economy. A dam failure can have long-lasting economic impacts and could deter visitors from the Region for an extended period of time.

Historic and Cultural Resources

Reservoirs held behind dams are often significant cultural and economic resources for tourism and recreation. The loss of these resources in the event of dam failure which empties the reservoir would be substantial.

Natural Resources

Reservoirs held behind dams affect many ecological aspects of a river. River topography and dynamics depend on a wide range of flows, but rivers below dams often experience long periods of very stable flow conditions or saw-tooth flow patterns caused by releases followed by no releases. Water releases from dams usually contain very little suspended sediment; this can lead to scouring of riverbeds and banks.

Dam failure can cause severe downstream flooding, depending on the magnitude of the failure. Other potential secondary hazards of dam failure are landslides around the reservoir perimeter, bank erosion on the rivers. The inundation could introduce many foreign elements into local waterways, potentially causing the destruction of downstream habitats. Loss of the water resource from dam failure could cause water shortages and result in downstream curtailment.

Development Trends Related to Hazards and Risk

Several areas experiencing growth and development in Montana are within dam inundation areas. Future development below dams can 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.

Without consideration of dam failure during the subdivision permitting process, future development could place residences and businesses in high hazard areas. Knowledge they are living in a dam inundation area may not be known by homeowners. Reclassification of some of the State's dams should be considered in areas where development is planned.

4.2.5.8 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, with an overall significance **Medium** though this rating varies by county. Major impacts to downstream populations, property, infrastructure, and natural and cultural resources could occur.

- 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 Butte-Silver Bow and Ravalli Counties.
- 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 $4,394,070,494 in total property value located within inundation areas in the Western 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.
- Unique jurisdictional vulnerability: See table below.
- Related hazards: Flooding, landslide, earthquake.

Table 4-14 Risk Summary Table: Dam Failure

Jurisdiction	Overall Significance	Additional Jurisdictions	Jurisdictional Differences?
Western Region	Medium	NA	Has 118 high, 51 significant and 224 low hazard dams within its

Jurisdiction	Overall Significance	Additional Jurisdictions	Jurisdictional Differences?
			jurisdiction. Also 37,161 people at risk to Dam Failure. See Table 4-11 and Table 4-12..
Anaconda-Deer Lodge	Low	NA	N/A
Beaverhead	Medium	Dillon, Lima	2 high hazard dams in proximity to Lima. One being federally owned
Broadwater	Low	Townsend	N/A
Butte-Silver Bow	Medium	Walkerville	2 high hazard dams located near Walkerville. 6,603 people at risk of dam inundation.
CSKT	Medium	Hot Springs, Polson, Ronan, St. Ignatius	Multiple high hazard dams in proximity to Hot Springs, Polson, Ronan, and St. Ignatius.
Flathead	Medium	City of Columbia Falls City of Kalispell Town of Whitefish	Columbia Falls has several high hazard dams within its vicinity. Whitefish also has a high hazard dam north of its jurisdiction.
Gallatin	High	Belgrade, Bozeman, Three Forks	All three cities at high risk to dam inundation. With a major highway also traversing through the risk area.
Granite	Low	Drummond, Philipsburg	Drummond and Philipsburg are both in proximity to high hazard dams. With three high hazard dams south of Philipsburg.
Jefferson	Low	Boulder, Whitehall	Boulder has several high hazard dams north of the city.
Lake	Medium	Polson, Ronan, St. Ignatius	Multiple high hazard dams in proximity to Hot Springs, Polson, Ronan, and St. Ignatius.
Lewis and Clark	High	East Helena, Helena	East Helena and Helena have multiple high hazard dams and have a high risk of dam inundation.
Lincoln	Medium	Eureka, Libby, Rexford, Troy	Eureka, Libby, Rexford, and Troy all have high hazard dams at risk to dam inundation with Libby being centrally located and have the highest amount of exposure.
Madison	High	Ennis, Sheridan, Twin Bridges, Virginia City	Ennis, Sheridan, Twin Bridges and Virginia City all have dam inundation risk with multiple high and significant hazard dams being centrally located within the county.

Jurisdiction	Overall Significance	Additional Jurisdictions	Jurisdictional Differences?
Meagher	Medium	N/A	N/A
Mineral	Low	Superior	N/A
Missoula*	High	Missoula	Missoula has a high hazard dam within its jurisdiction.
Park	Low	Clyde Park, Livingston	Clyde Park is located next to multiple high hazard dams with Livingston being located south of these dams and being exposed to downstream exposures.
Powell	Low	Deer Lodge	Deer Lodge has two high hazard and one significant hazard dam to the west and northwest of its city. Putting the jurisdiction at severe dam inundation risk.
Ravalli	High	Darby, Hamilton, Philipsburg, Pinesdale, Stevensville	Darby has two high hazard dams located near its city limits. With Hamilton, Pinesdale and Stevensville being in the dam inundation risk areas.
Sanders	Low	Hot Springs, Plains, Thompson Falls	N/A
Sweet Grass	Low		N/A

4.2.6 Drought

4.2.6.1 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 Western Region is usually signaled by a lack of significant winter snowfall. 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.

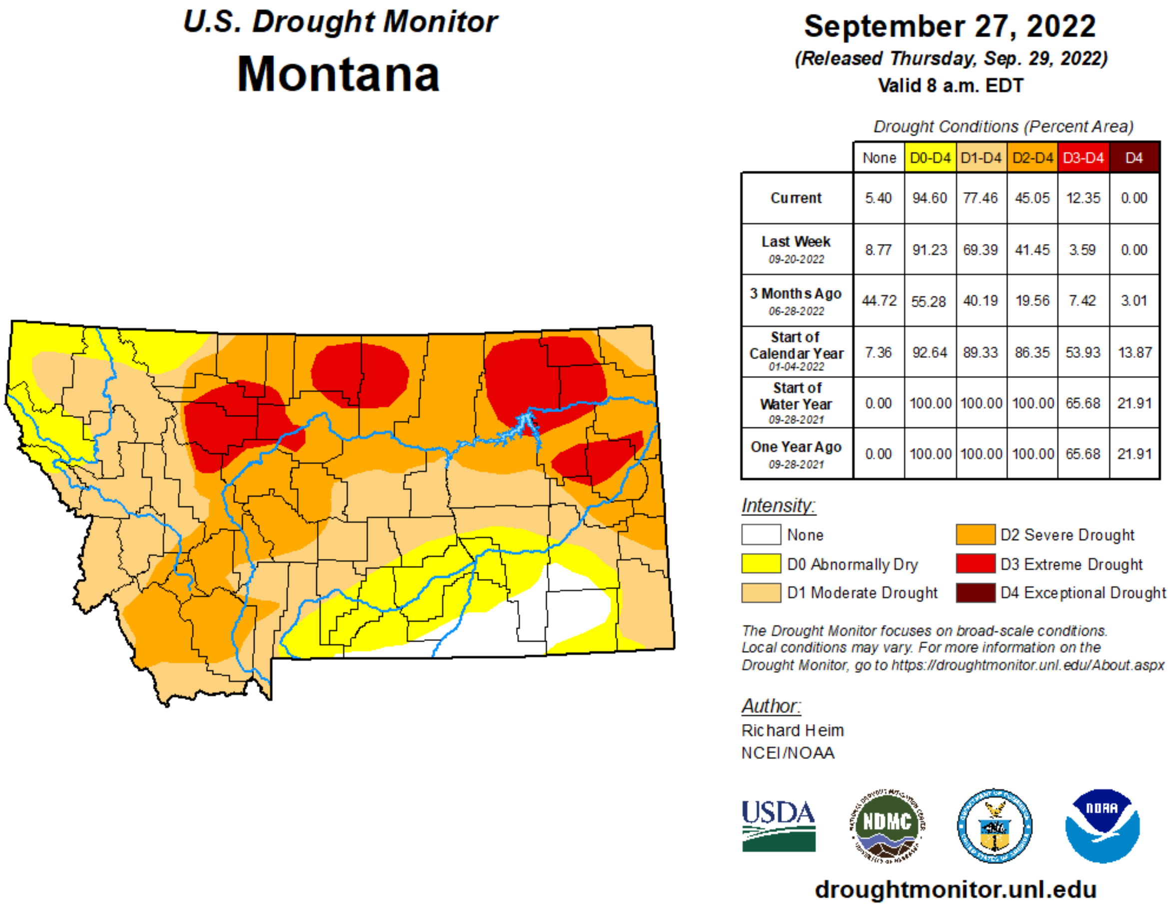
Much of the State of Montana was in a drought during the late 1980's. In response to this, and to assist with increasing awareness of and planning for drought in the future, the Governor's Drought Advisory Committee was formed in 1991. This committee, comprised of state and federal water supply and moisture 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.

4.2.6.2 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**.

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 4-18.

Figure 4-18 Drought Status September 2022 in the State of Montana



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

4.2.6.3 Past Occurrences

Between 2012 and 2021, there were 58 USDA disaster declarations due to drought that affected counties in the Western Region. Table 4-15 provides a list of these events with details on impacted counties.

Table 4-15 USDA Drought Disaster Declarations (2012-2021)

Year	Declaration	Counties Included
2012	S3350	Park
	S3356	Beaverhead, Madison
	S3362	Beaverhead, Ravalli
	S3365	Beaverhead, Granite, Jefferson, Madison, Ravalli, Silver Bow
	S3376	Beaverhead, Broadwater, Jefferson, Lewis and Clark, Madison, Meagher, Park, Powell, Silver Bow
	S3391	Broadwater, Lewis and Clark, Meagher, Park, Sweet Grass
	S3416	Beaverhead, Flathead, Jefferson, Lewis and Clark, Madison, Meagher, Silver Bow
	S3435	Beaverhead
	S3437	Broadwater, Flathead, Jefferson, Lewis and Clark, Meagher, Powell

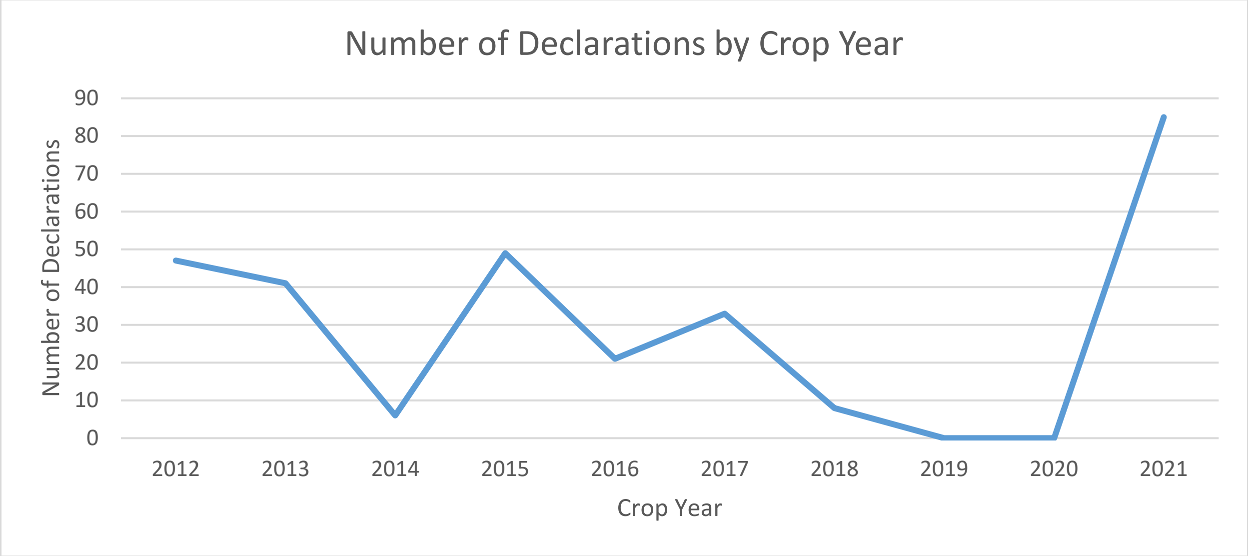
Year	Declaration	Counties Included
2013	S3508	Gallatin, Park
	S3521	Park, Sweet Grass
	S3525	Beaverhead, Broadwater, Deer Lodge, Gallatin, Jefferson, Lewis and Clark, Madison, Meagher, Ravalli, Silver Bow
	S3527	Beaverhead, Broadwater, Deer Lodge, Gallatin, Jefferson, Lewis and Clark, Madison, Powell, Silver Bow
	S3535	Broadwater, Gallatin, Jefferson, Madison, Meagher, Park
	S3552	Beaverhead
	S3557	Beaverhead, Deer Lodge, Jefferson, Madison, Silver Bow
	S3559	Beaverhead, Gallatin, Madison, Ravalli
	S3587	Mineral, Missoula
2014	S3701	Beaverhead
	S3716	Beaverhead, Gallatin, Madison
	S3730	Beaverhead, Ravalli
2015	S3838	Beaverhead
	S3843	Beaverhead, Gallatin, Madison
	S3848	Lincoln, Mineral, Missoula, Sanders
	S3849	Beaverhead, Broadwater, Deer Lodge, Flathead, Granite, Jefferson, Lake, Lewis and Clark, Lincoln, Madison, Meagher, Mineral, Missoula, Powell, Ravalli, Sanders, Silver Bow
	S3855	Mineral, Sanders
	S3857	Lincoln, Missoula, Ravalli
	S3861	Beaverhead, Ravalli
	S3877	Beaverhead, Broadwater, Deer Lodge, Flathead, Gallatin, Jefferson, Lewis and Clark, Madison, Powell, Silver Bow
	S3918	Broadwater, Gallatin, Jefferson, Lewis, and Clark. Madison, Meagher, Park
2016	S4061	Meagher, Sweet Grass
	S4066	Broadwater, Deer Lodge, Flathead, Gallatin, Granite, Jefferson, Lake, Lewis and Clark, Lincoln, Meagher, Mineral, Missoula, Park, Powell, Ravalli, Sanders, Sweet Grass
	S4070	Gallatin, Park
2017	S4217	Lewis and Clark, Meagher, Sweet Grass
	S4221	Broadwater, Deer Lodge, Flathead, Gallatin, Jefferson, Lewis and Clark, Madison, Meagher, Park, Powell, Silver Bow, Sweet Grass
	S4226	Flathead
	S4231	Lincoln
	S4232	Flathead, Lake, Lewis and Clark, Lincoln, Mineral, Missoula, Powell, Sanders
	S4235	Lincoln, Sanders
	S4236	Flathead, Lake, Missoula, Sanders
	S4259	Mineral, Sanders
2018	S4411	Flathead, Lake, Lewis and Clark, Lincoln, Mineral, Missoula, Powell, Sanders
2021	S4931	Gallatin, Park
	S4992	Beaverhead, Ravalli,
	S4993	Beaverhead, Deer Lodge, Madison, Ravalli, Silver Bow, Sweet Grass
	S4998	Gallatin

Year	Declaration	Counties Included
	S5000	Lincoln, Mineral, Missoula, Ravalli, Sanders
	S5001	Meagher, Sweet Grass
	S5007	Gallatin, Madison, Park, Sweet Grass, Beaverhead, Broadwater, Jefferson, Meagher, Silver Bow
	S5014	Mineral, Sanders
	S5016	Broadwater, Jefferson, Meagher, Silver Bow, Beaverhead, Deer Lodge, Gallatin, Lewis and Clark, Madison, Park, Powell, Sweet Grass
	S5022	Flathead, Lewis and Clark, Lincoln, Mineral, Sanders, Broadwater, Jefferson, Lake, Meagher, Missoula, Powell
	S5029	Deer Lodge, Ravalli, Beaverhead, Granite, Jefferson, Missoula, Powell, Silver Bow
	S5039	Deer Lodge, Flathead, Granite, Jefferson, Lewis and Clark, Missoula, Powell, Ravalli
	S5044	Beaverhead, Gallatin, Madison
	S5057	Flathead
	S5071	Missoula, Flathead, Granite, Lake, Mineral, Powell, Ravalli, Sanders
	S5085	Lake, Flathead, Lewis and Clark, Missoula, Sanders

Source: USDA

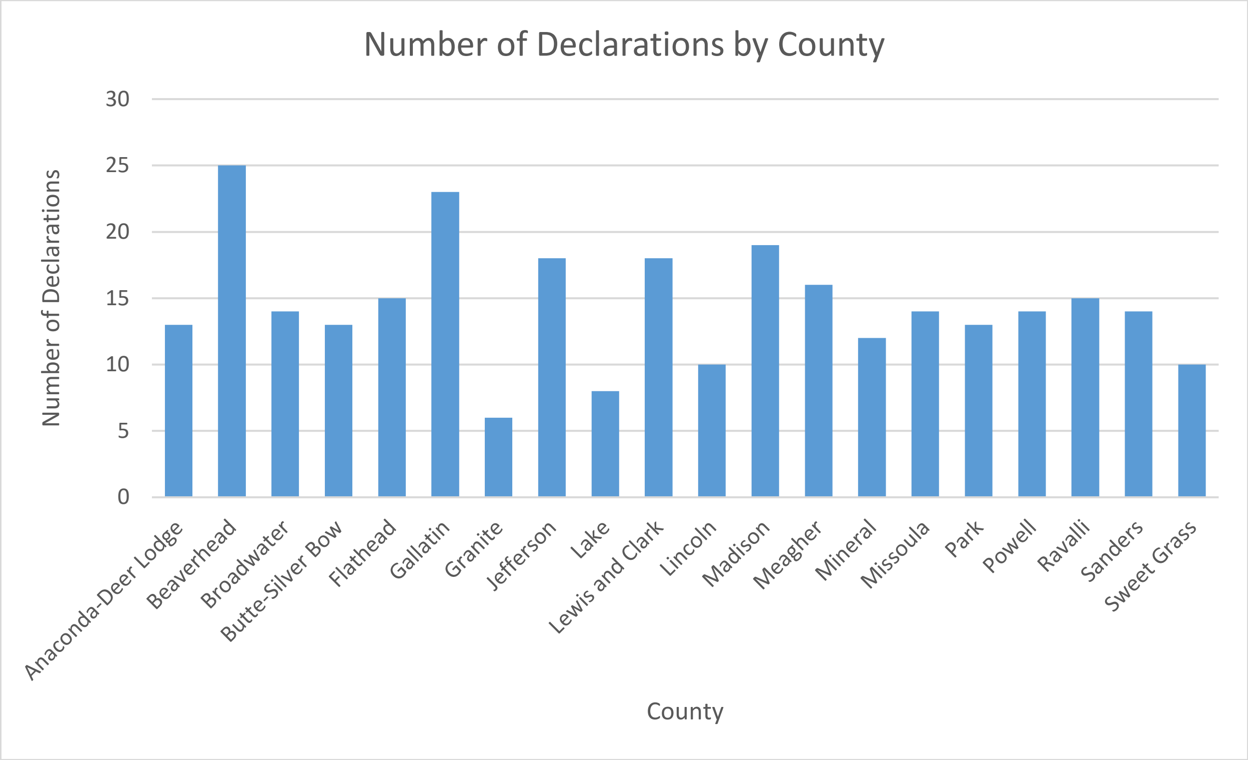
Figure 4-19 displays the temporal trend in USDA disaster declarations from drought by year in the Western Region. While there is evident variability in the number of declarations from year to year, the greatest number of declarations occurred in 2021. Figure 4-20 displays the breakdown of declarations by county. In the Western Region, Beaverhead County has experienced the greatest number of USDA disaster declarations, followed by Gallatin and Madison Counties

Figure 4-19 USDA Drought Disaster Declarations by Year (2012-2021)



Source: USDA

Figure 4-20 USDA Drought Disaster Declarations by County (2012-2021)



Source: USDA

The State of Montana Hazard Mitigation Plan 2018 provides details of drought history in the State of Montana:

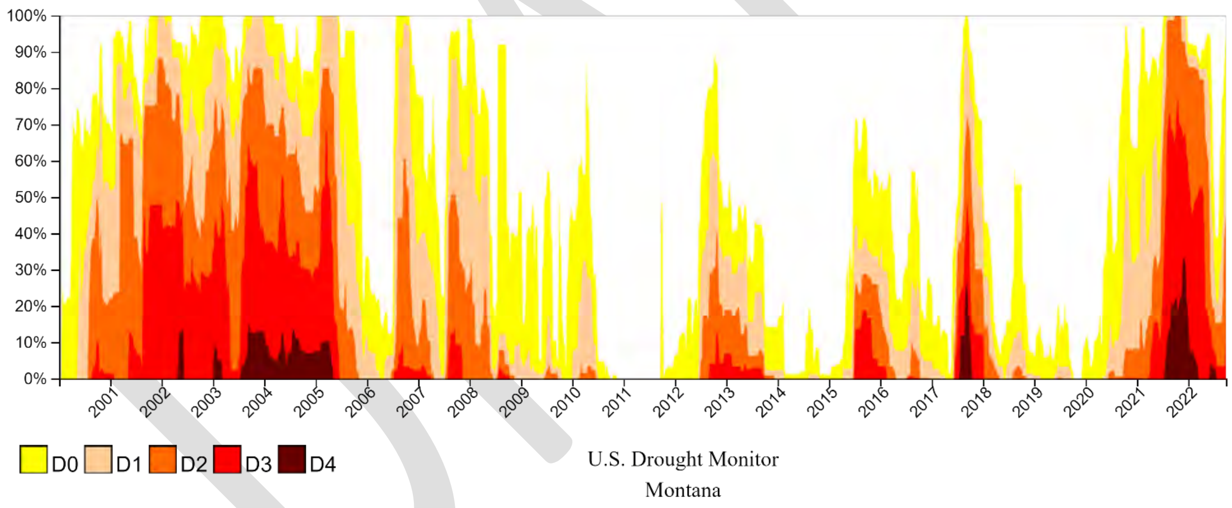
- **1917-1923:** Rising wheat prices encouraged farmers to transform grasslands into farmland for wheat, corn, and row crops. Significant loss of soil and overconsumption of water for crops.
- **1928-1939:** Driest period in the historic record, the Palmer Hydrologic Drought Index (PHDI) showed the entire 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 4-21 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 2001-2005, 2017, and 2021-2022 across the State. The majority of the State was in drought from 2001-2005.

Figure 4-21 U.S. Drought Monitor: State of Montana Drought Conditions (2000-2022)



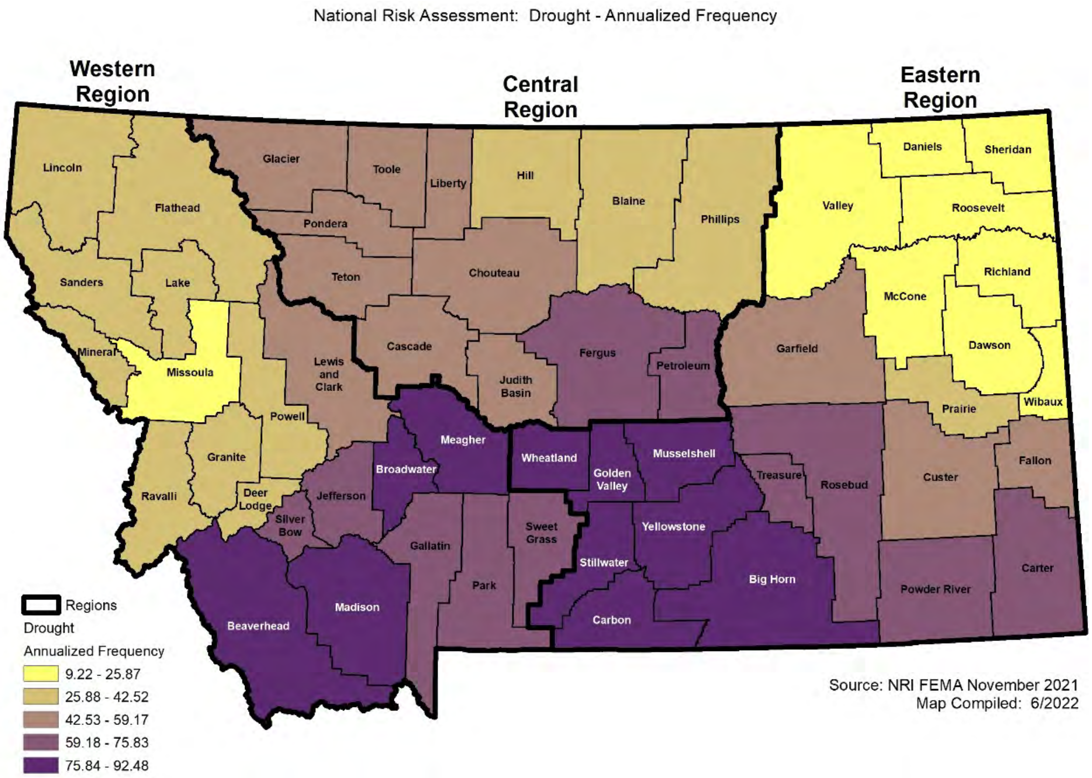
Source: U.S. Drought Monitor

4.2.6.4 Frequency/Likelihood of Occurrence

The likelihood of drought in the Western Region is ranked as **Highly Likely**. Based on historic drought events, there is continued probability that drought will occur in the future in the Western Region. Although there may be periods of higher-than-average precipitation, the Palmer Drought Severity Index (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.

The figure below depicts annualized frequency of drought at a county level based on the NRI. The mapping shows a trend towards increased likelihood in the southern portions of the Region, particularly Beaverhead, Broadwater, and Madison Counties.

Figure 4-22 Annualized Frequency of Drought Events by County



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

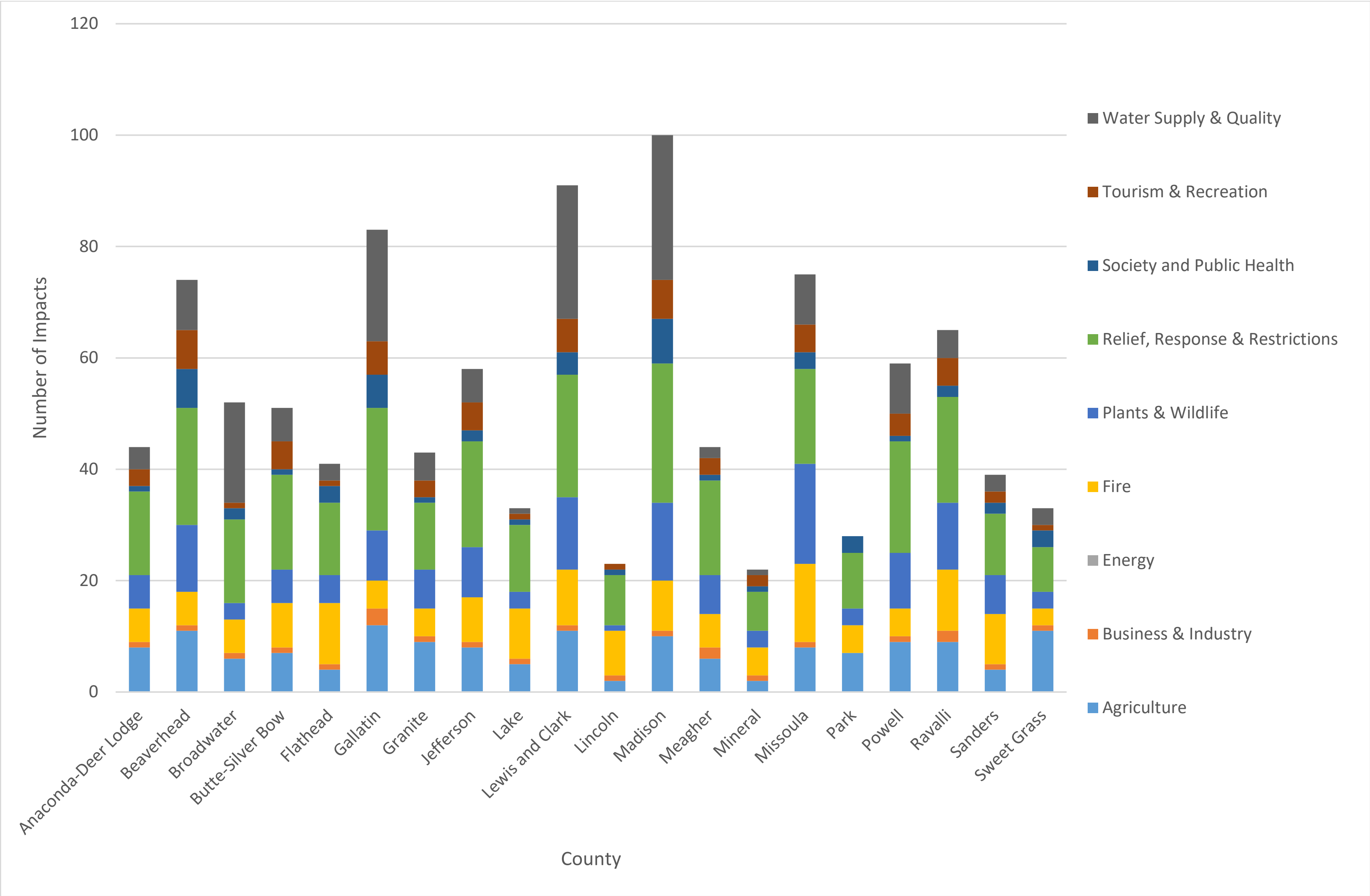
4.2.6.5 Climate Change Considerations

The USGS reports that climate change has already altered the natural pattern of droughts. Climate change has made droughts longer, more frequent, and more severe. Montana is likely to see drier summers and less precipitation falling as snow in the winter. The State of Montana Hazard Mitigation Plan 2018 noted that Montana has been steadily warming for decades, with a 3 °F average increase in temperatures since 1950. All projections indicate that this trend is likely to continue, which will exacerbate future drought conditions. The area impacted by drought is not likely to shift due to climate change, but severity, duration, and frequency are expected to increase with changing conditions.

4.2.6.6 Potential Magnitude and Severity

Drought impacts are wide-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 Western 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 4-23 displays number of impacts from drought in the Western Region by impact type and county.

Figure 4-23 Drought Impacts by County and Impact Type (2000-2021)

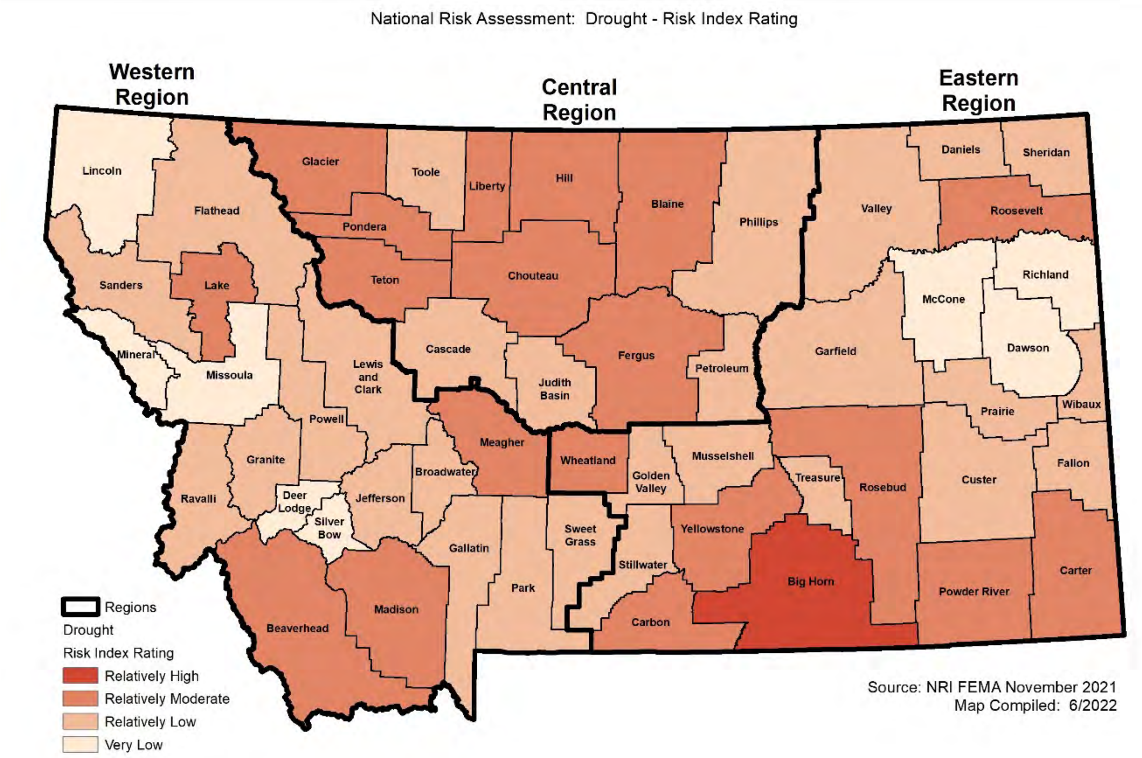


Source: The Drought Impact Reporter (2000-2021), Chart by WSP

4.2.6.7 Vulnerability Assessment

The figure below illustrates the relative Risk Index (RI) rating to drought for Montana counties based on data in the NRI. The RI calculation takes into account various factors, including the EALs from drought, social vulnerability, and community resilience in each county across Montana. Most counties in the Region have a relatively low to moderate rating; none have a high or very high RI rating.

Figure 4-24 NRI Risk Index Rating for Drought



Map by WSP, Data Source: FEMA NRI, 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, 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. 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 as a result of declined air quality.

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 socioeconomic 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.*

Property

Direct structural damage from drought is rare, though it can happen. Drought can affect soil shrinking and swelling cycles and can result in cracked foundations and infrastructure damage. Droughts can also have significant impacts on landscapes, which could cause a financial burden to property owners. There is a greater threat of structure damage in a drought-affected area due to secondary hazards because of drought. For example, drought increases the risk of wildfire and may create water shortages that inhibit adequate fire response. Additionally, heavy rains after prolonged drought conditions can result in significant flooding, which can damage property.

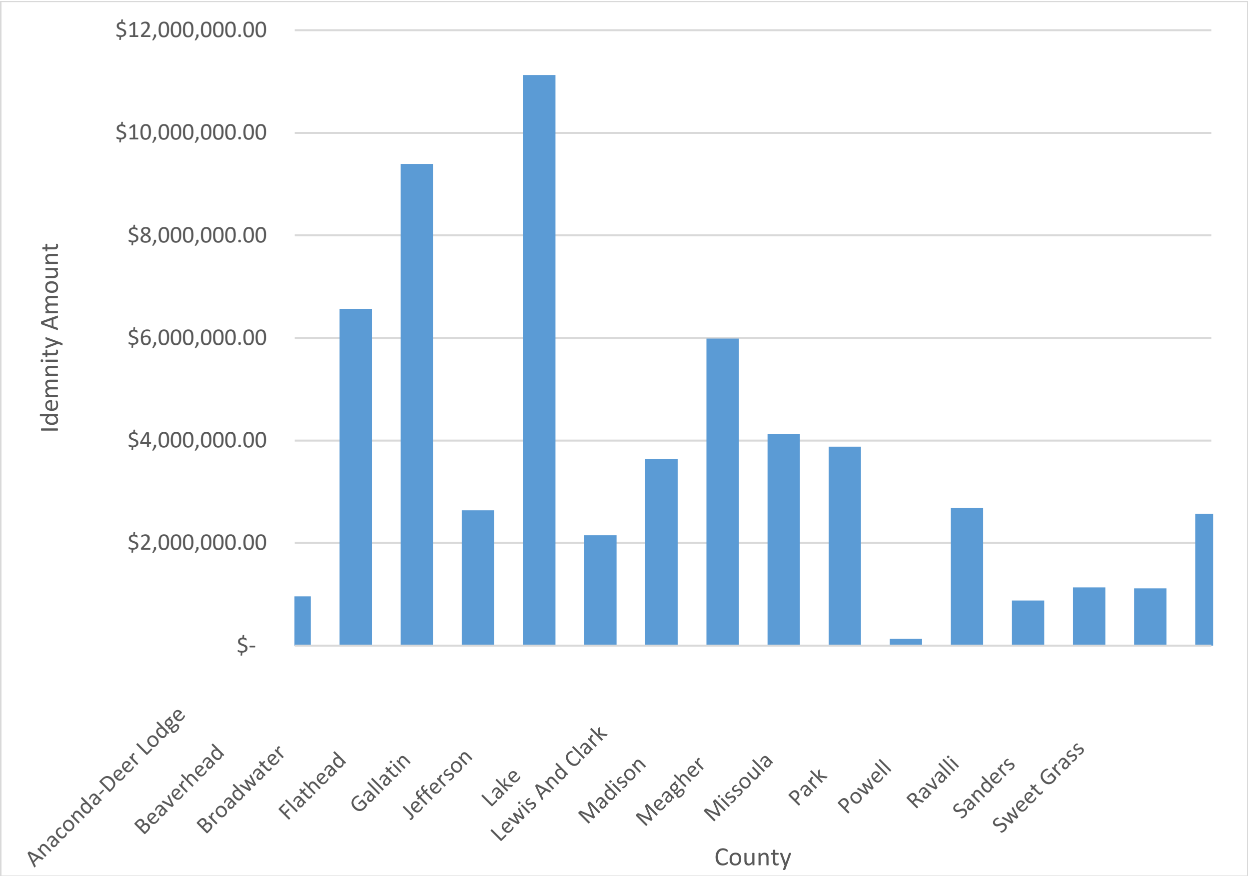
Critical Facilities and Lifelines

Water systems are the most likely critical infrastructure to be impacted by drought. As shown in Figure 4-23 above, nearly every county in the Western Region, with the exception of Lincoln and Park Counties, have experienced impacts to water supply and quality due to drought. Additionally, hydroelectric power is reduced during periods of drought, as well as the reduction of biofuel seedstock, which can cause energy conservation mandates. Like general property, most critical facility infrastructure is more likely to experience losses due to the secondary hazards caused by drought, such as wildfire and flooding.

Economy

Economic impact will be largely associated with industries that depend on water for their business. In Western Montana, this may include ski resorts that rely on fresh and reliable snow to attract tourists. Additionally, drought can exacerbate the risk of wildfires and flooding, increase the cost of municipal water usage, and deplete water resources used for recreation. Agricultural industries will be impacted if water usage is restricted for irrigation. The Risk Management Agency (RMA) reported that from 2007-2021, $58,980,292 was lost as indemnity payments to farmers due to lost crops from drought in the Western Region. Figure 4-25 displays indemnity payments by county from 2007-2021.

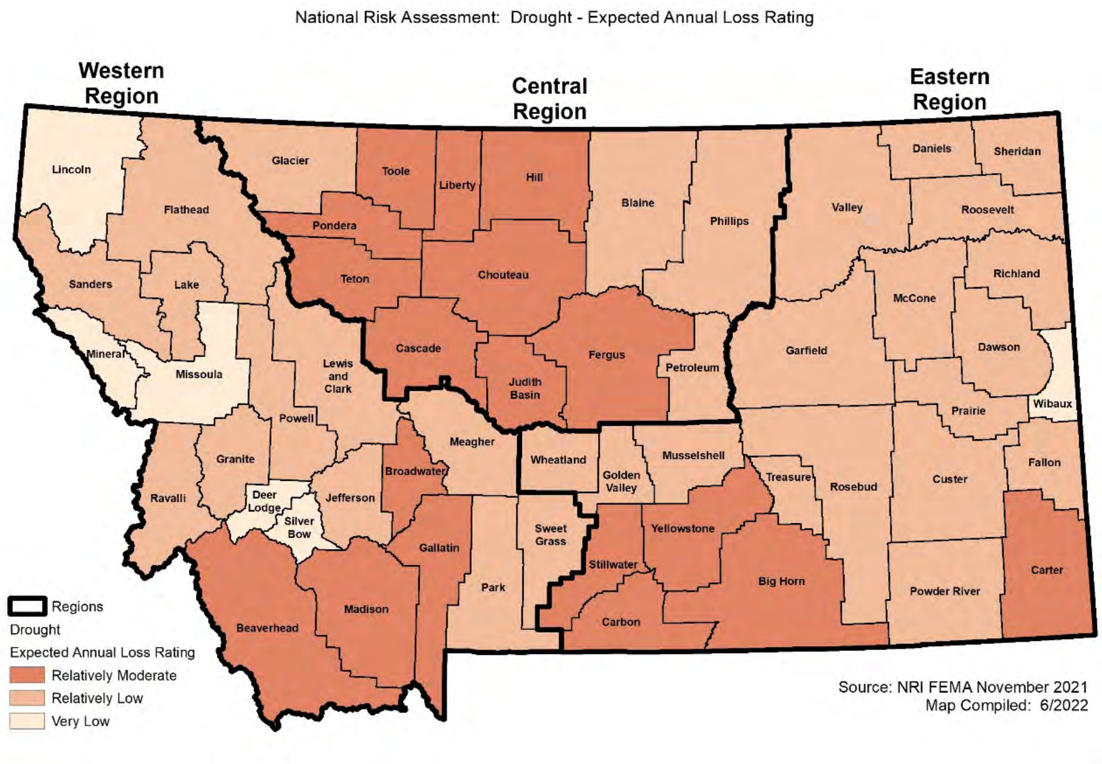
Figure 4-25 Losses to Agricultural Commodities 2007-2021



Source: RMA, Chart by WSP

The figure below illustrates the relative risk of EAL rating due to drought for Montana counties based on data in the NRI. Most counties in the Region have a relatively moderate rating; none have a high or very high-risk EAL rating. The EAL calculation takes into account agriculture value exposed to drought, annualized frequency for drought, and historical loss for drought. The EAL rating is thus heavily based on agricultural impacts.

Figure 4-26 NRI Drought Expected Annual Loss Rating



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

Historic and Cultural Resources

The biggest threat to historic and cultural resources due to drought is to the long-standing farms and ranches existing in the Western Region. Past droughts have threatened to bankrupt farmers and ranchers and alter the farming tradition in the State.

Natural Resources

Environmental losses from drought are associated with damage to plants, animals, wildlife habitat, 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. The degradation of landscape quality, including increased soil erosion, may lead to a more permanent loss of biological productivity. 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.

Development Trends Related to Hazards and Risk

An increasing population would put greater demand on water supply. However, as the Montana Department of Environmental Quality (DEQ) carefully monitors and regulates public water systems, the impact of future development with respect to drought is low. The Governor's Drought Advisory Committee was established so that state, local, and federal officials who monitor water supply and moisture conditions can be brought together on a regular basis, and ahead of the seasons when impacts are most likely to occur to Montana's economy and natural resources, to implement measures to lessen the degree of those impacts.

4.2.6.8 Risk Summary

In summary, drought is considered to be **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.

- Frequency of drought is rated as **Highly Likely** because the Western 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 Western Region, and large reliance on agricultural and tourism economies, the magnitude of drought is ranked as critical.
- Drought, like other climate hazards, occurs on a regional scale and can impact every county in the Western 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.
- 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 particularly the water-dependent recreation industry including skiing, rafting, and fishing.
- Water systems are at significant risk to drought, as well as energy systems that depend on biofuels or hydropower.
- Related Hazards: Wildfire, Flooding, Severe Summer Weather.

Table 4-16 Risk Summary Table: Drought

Jurisdiction	Overall Significance	Additional Jurisdictions	Jurisdictional Differences?
Western Region	High	NA	See below
Anaconda-Deer Lodge	Medium	NA	None
Beaverhead	High	City of Dillon Town of Lima	Beaverhead County has had more USDA drought declarations than any other county in Western Montana and has a high frequency of events based and moderate EAL based on the NRI.
Broadwater	High	City of Townsend	Has a high frequency of events based and moderate EAL based on the NRI.
Butte-Silver Bow County	Medium	City of Butte Town of Walkerville	None
Confederated Salish and Kootenai Tribes of the Flathead Reservation	High		In 2021, Energy Keepers of the Confederated Salish and Kootenai Tribes began refilling Flathead Lake earlier than scheduled due to a historically dry season.
Flathead	High	City of Columbia Falls City of Kalispell Town of Whitefish	None

Jurisdiction	Overall Significance	Additional Jurisdictions	Jurisdictional Differences?
Granite County	High	Town of Drummond Town of Philipsburg	None
Jefferson	High	City of Boulder Town of Whitehall	Poor crop yields due to drought have been reported in 2021 and 2022.
Lake	Medium	City of Polson City of Ronan Town of St. Ignatius	None
Lewis and Clark	High	City of Helena City of East Helena	None
Lincoln	Medium	City of Libby City of Troy Town of Eureka Town of Rexford	Lincoln County is the only county in Western Montana with no reported drought impacts on water supply and quality.
Madison	High	Town of Ennis Town of Sheridan Town of Twin Bridges Virginia City	Madison County has had the most reported impacts due to drought in Western Montana. Ranchers have reported selling off cattle due to lack of forage and groundwater. Has a high frequency of events based and moderate EAL based on the NRI.
Meagher	High	City of White Sulphur Springs	None
Mineral	Medium	Town of Superior Town of Alberton	None
Park	Medium	City of Livingston Town of Clyde Park	None
Powell	High	City of Deer Lodge	None
Ravalli	High	City of Hamilton Town of Darby Town of Stevensville Town of Pinesdale	None
Sanders	High	City of Thompson Fall Town of Plains Town of Hot Springs	None
Sweet Grass	Medium	City of Big Timber	Lincoln and Sweet Grass Counties have had the fewest drought declarations of all counties in Western Montana.

4.2.7 Earthquake

4.2.7.1 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, because the shocks shake, damage, or demolish buildings and other structures. 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 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 scientists think only about 95 of these faults have been active in the past 1.6 million years (the Quaternary Period). 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 Madison County in 1959 and dozens of active faults have generated magnitude 6.5-7.5 earthquakes during recent geologic time.

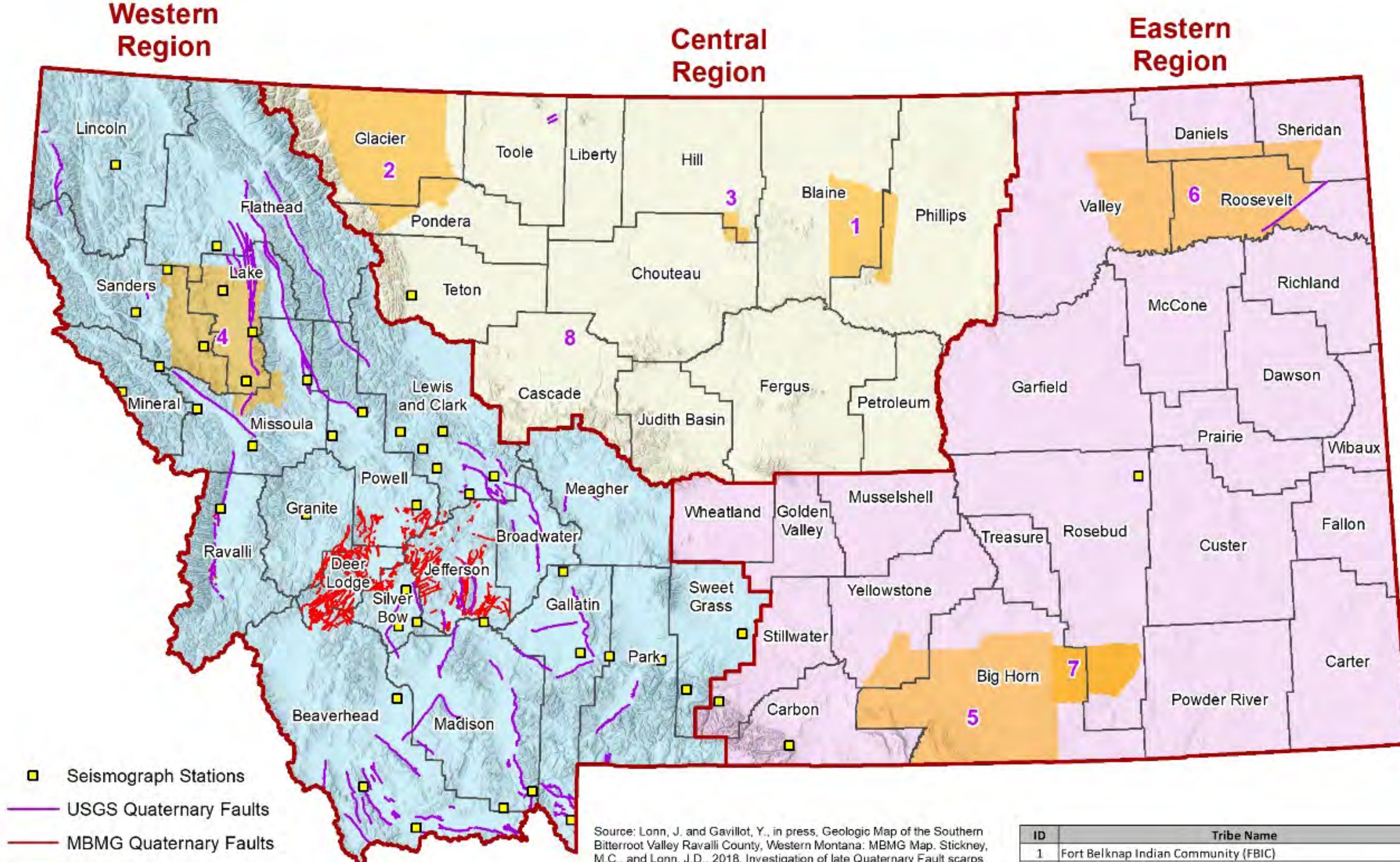
4.2.7.2 Geographical Area Affected

The geographic extent of earthquakes in the planning area is **Extensive**. Montana is one of the most seismically active states in the United States according to the USGS. 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.

All of the Western Region could be impacted by earthquakes, but the probability of a damaging earthquake is greater in the counties that contain faults, as shown in Figure 4-27 and Figure 4-31. These two maps indicate that the highest risk counties in the Western Region are in the southwest portion of Region, including Beaverhead, Madison, Anaconda Deer-Lodge, Butte-Silverbow, Jefferson, and Broadwater Counties. Additionally, counties located in the northern portion of the Rocky Mountains are likely to experience earthquakes as well, specifically Flathead and Lake Counties. 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.

Liquefaction is the process by which water-saturated sediment temporarily loses strength due to strong ground shaking and acts as a fluid. Damages due to liquefaction are common during earthquake events. Buildings and road foundations may lose load-bearing strength and cause major damage if liquefaction occurs beneath them. The increased pore-water pressure that accompanies liquefaction can also cause landslides and dam failure. Figure 4-28 displays that counties throughout the Western Region have the susceptibility to liquefaction, with the greatest risk in the southern and northern counties in the Region.

Figure 4-27 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

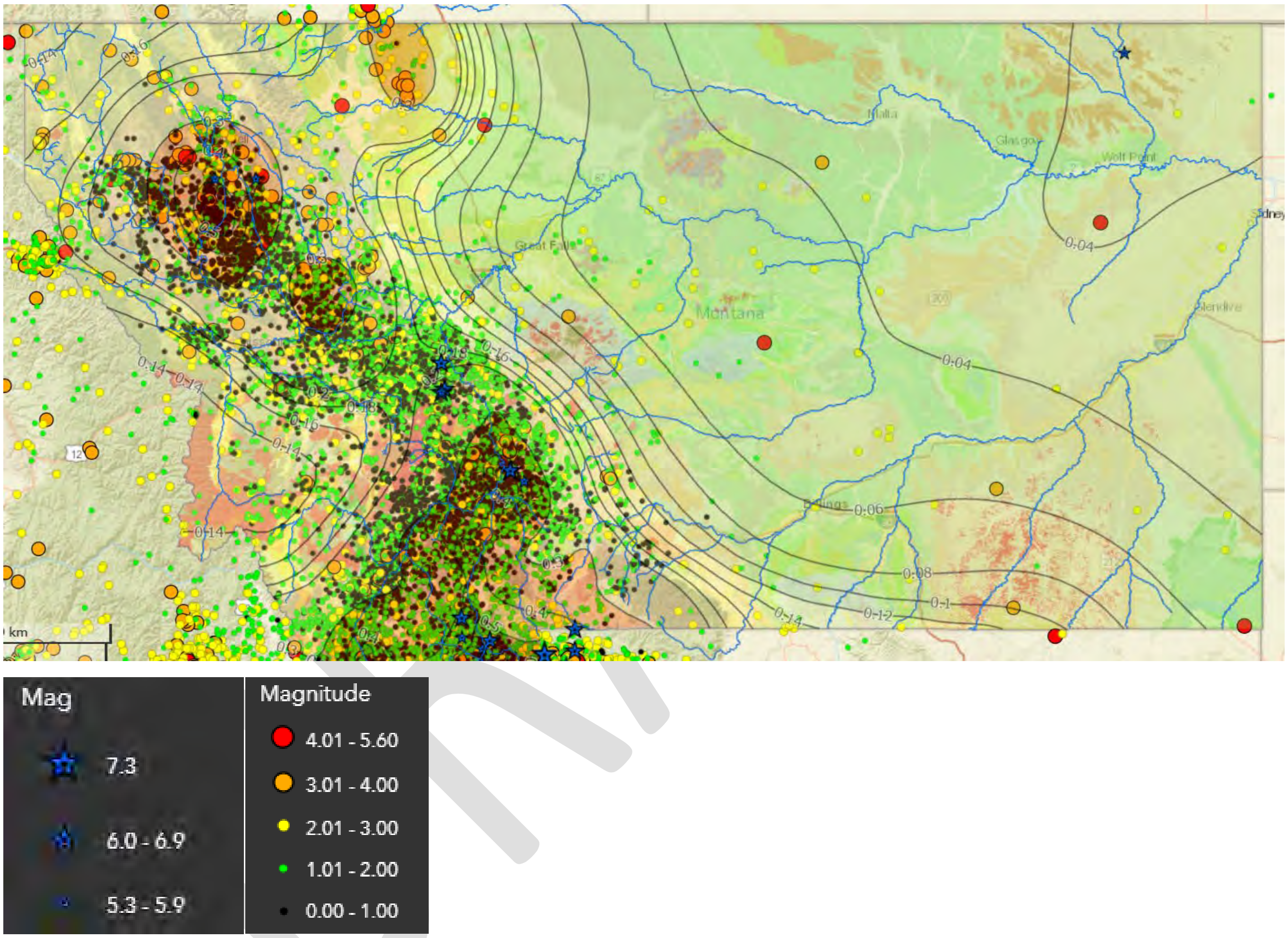
Figure 4-28 Liquefaction Map of the Western Region

Map compiled 10/2022;
intended for planning purposes only.
Data Source: DEM source data from the
Montana State Library - Liquefaction susceptibility source data modified from Li, Y., Stickney, M., Sadeghi, M., Yakovlev, P., and Thale, P., 2021, Liquefaction susceptibility in Montana: Montana Bureau of Mines and Geology Digital Publication 4

4.2.7.3 Past Occurrences

The Montana Bureau of Mines and Geology records the magnitude of historic earthquake events across Montana. In the Western Region, there have been various severe earthquakes with a magnitude above 5.3, indicated by stars in Figure 4-29. These severe types of earthquakes can cause structural damage, injuries, and even death. A map of recorded earthquakes is presented below based an online mapping tool developed by the Montana Bureau of Mines and Geology.

Figure 4-29 Statewide Map of Earthquake Epicenters



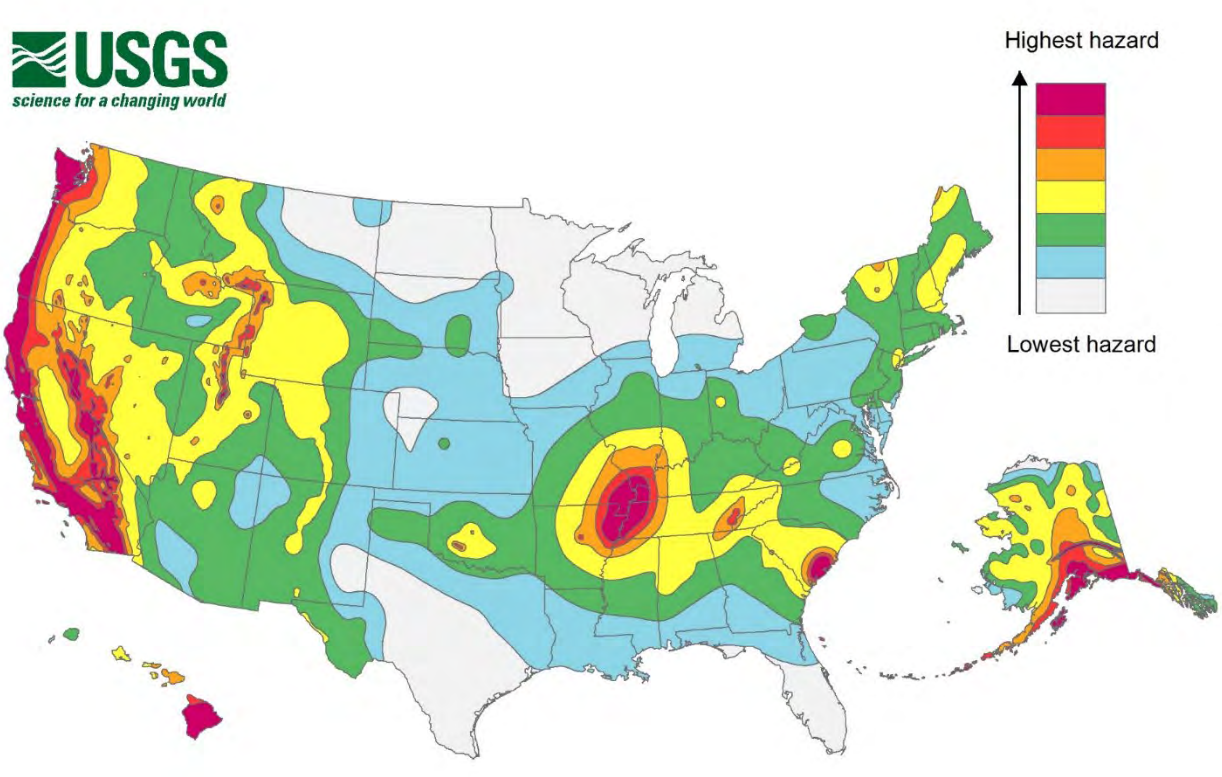
Source: Montana Bureau of Mines and Geology (https://mbmg.mtech.edu/mapper/mapper.asp?view=Quakes&).

4.2.7.4 Frequency/Likelihood of Occurrence

The frequency of earthquakes in the Western Region is ranked as **likely**. 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 Western Region will experience a greater frequency of earthquake events than the Central or Eastern Region in Montana.

The U.S. Geological Survey (USGS) issues National Seismic Hazard Maps as reports every few years. These maps provide various acceleration and probabilities for time periods. Figure 4-30 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 consider 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 current International Building Code, however, uses a 2,500-year map as the basis for building design.

Figure 4-30 USGS Long-Term National Seismic Hazard Map



Source: USGS

4.2.7.5 Climate Change Considerations

The impacts of global climate change on earthquake intensity and probability are largely unknown, but there is not expected to be a direct correlation.

4.2.7.6 Potential Magnitude and Severity

The expected magnitude of earthquakes in the Western Region is **critical**. 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 4-17 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.

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 earthquake magnitudes.

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 4-18 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

Magnitude	Mercalli Intensity	Effects	Frequency
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
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

4.2.7.7 Vulnerability Assessment

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 Western 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.

People

The entire population of the Western Region is potentially exposed to direct and indirect impacts from earthquakes. The degree of exposure is dependent on many factors, including the age and construction type of the structures people live in, soil types beneath the structures, their proximity to fault location and earthquake epicenter, etc. Whether impacted directly or indirectly, the entire population will 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 magnitude 5.0 2,500-Year Probabilistic Earthquake. Table 4-19 summarizes the results, estimating over

1,600 people would be displaced from their homes and in need of shelter after a significant earthquake in the Western Region.

Additionally, the model estimated that in a 2 p.m. time of occurrence scenario, which is likely to be a worst-case scenario, that there would be a total of 2,382 injuries across the Region. Of these injuries, 1,823 would not require hospitalization, 483 would require hospitalization but would not be life threatening, and 76 considered life threatening injuries. The model also estimates that 147 people would be killed. 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 and tribal annexes.

Table 4-19 Estimated Earthquake Impacts on Persons and Households

	Number of Displaced Households	Number of Persons Requiring Short-Term Shelter
5.0 2,500-Year Earthquake	2,809	1,612

Source: Hazus-MH Global Summary Report, WSP Analysis

Property

The Hazus analysis estimates that there are an estimated 193,000 buildings in the Region with a total replacement value of over $39.8 billion dollars. Because all structures in the planning area are susceptible to earthquake impacts to varying degrees, this total represents the region-wide property exposure to seismic events. Most of the buildings and most of the associated building value are residential. According to the model, 97,370 (50.2%) of the buildings in the planning area will experience some level of damage, with 2,616 buildings being completely destroyed.

Table 4-20 Estimated Building Damage by Occupancy

	None		Slight		Moderate		Extensive		Complete	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Agriculture	557.81	0.58	269.45	0.53	258.68	0.78	132.85	1.19	45.21	1.73
Commercial	3667.93	3.80	1959.73	3.87	2578.16	7.82	1490.40	13.40	545.79	20.86
Education	171.29	0.18	78.14	0.15	88.47	0.27	48.58	0.44	15.53	0.59
Government	246.35	0.26	112.22	0.22	132.25	0.40	62.78	0.56	16.40	0.63
Industrial	1104.79	1.14	572.84	1.13	787.71	2.39	460.80	4.14	167.86	6.42
Other Residential	8916.89	9.24	6608.69	13.05	9136.28	27.70	4840.09	43.51	1255.05	47.97
Religion	385.79	0.40	182.78	0.36	207.24	0.63	115.58	1.04	37.61	1.44
Single Family	81490.41	84.41	40868.53	80.68	19790.29	60.01	3971.98	35.71	532.79	20.36
Total	96,541		50,652		32,979		11,123		2,616	

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.

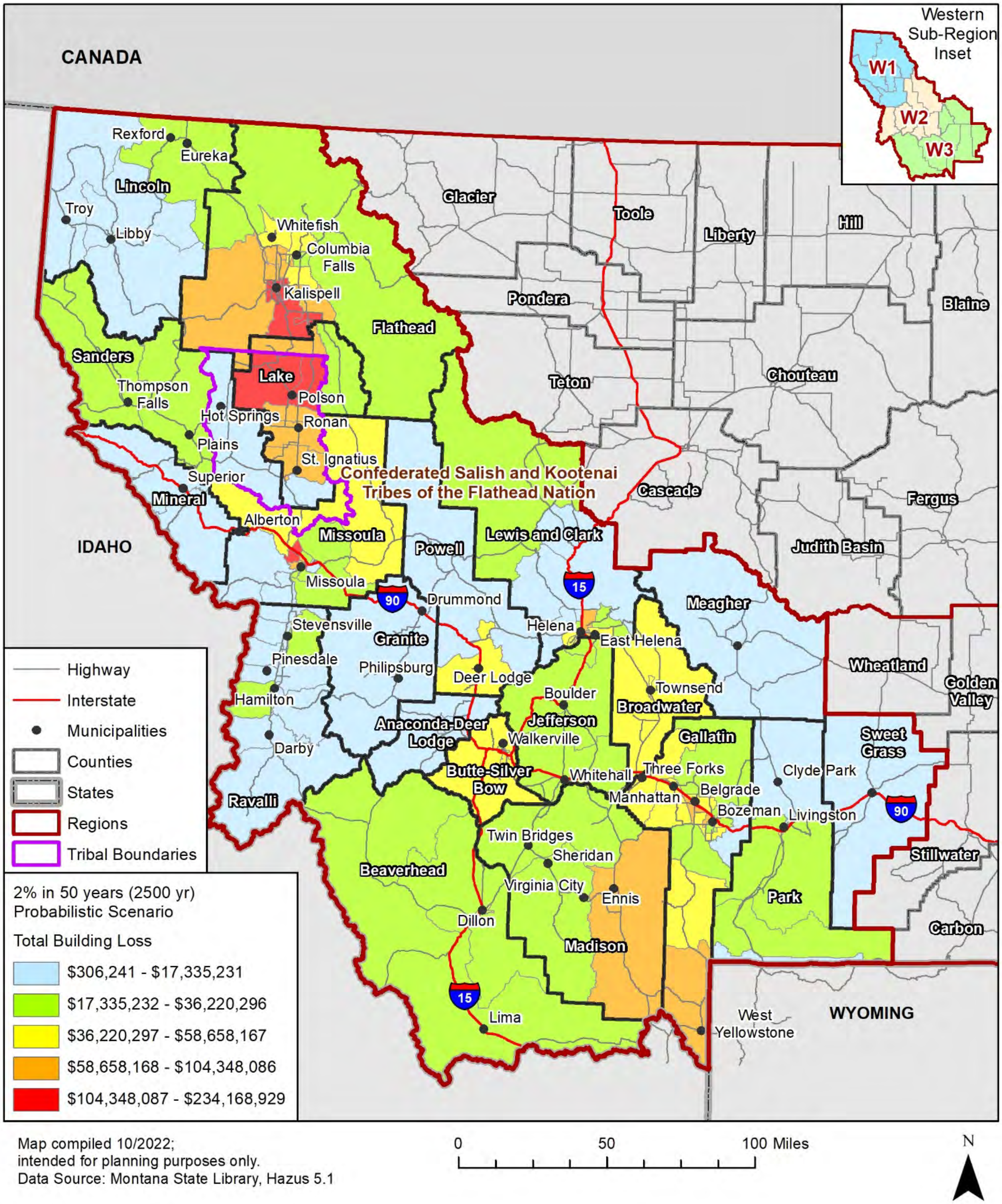
For the 2,500-year probabilistic earthquake scenario, the total building related losses for the entire planning area is an estimated $4.52 billion. Of this total, direct building losses are estimated at $3.51 billion and $1.01 billion in income-related losses, shown in Table 4-21. The Hazus analysis 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 1.2 million tons. A map of these losses per county is shown in Figure 4-31 below, indicating that Lake and Flathead Counties are most likely to experience direct economic losses from an earthquake event.

Table 4-21 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	33.9417	174.6671	5.4868	14.9535	229.0491
	Capital-Related	0.0000	14.4582	159.3525	3.3421	2.9711	180.1239
	Rental	48.2086	50.8675	82.4734	1.6452	7.5470	190.7417
	Relocation	173.1149	47.8664	126.7766	10.0340	49.8249	407.6168
	Subtotal	**221.3235**	**147.1338**	**543.2696**	**20.5081**	**75.2965**	**1007.5315**
Capital Stock Losses							
	Structural	216.8433	104.8751	176.9852	31.4204	56.5070	586.6310
	Non_Structural	1034.8607	400.5875	457.8731	97.0437	134.3399	2,124.7049
	Content	348.8832	86.5669	217.5777	59.2451	69.2699	781.5428
	Inventory	0.0000	0.0000	6.3278	12.0875	1.7301	20.1454
	Subtotal	**1600.5872**	**592.0295**	**858.7638**	**199.7967**	**261.8469**	**3513.0241**
	Total	**1821.91**	**739.16**	**1402.03**	**220.30**	**337.14**	**4520.56**

Source: Hazus-MH Global Summary Report, WSP Analysis

Figure 4-31 Western Region Hazus 2,500-Year Probabilistic Scenario Direct Economic Loss



Critical Facilities and Lifelines

All 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 model indicated that an earthquake would cause moderate damages to 38% of the wastewater facilities, 20% of electrical power facilities, and 28% of communication facilities in the Western Region. The model did not indicate that any facilities would be completed damaged.

Table 4-22 Expected Utility System Facility Damage in the Western Region

System	# of Locations				
	Total #	With at Least Moderate Damage	With Complete Damage	with Functionality > 50 %	
				After Day 1	After Day 7
Potable Water	0	0	0	0	0
Waste Water	174	66	0	26	164
Natural Gas	1	0	0	0	1
Oil Systems	0	0	0	0	0
Electrical Power	10	2	0	9	10
Communication	53	15	0	44	53

Source: Hazus-MH Global Summary Report, WSP Analysis

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 18,614 pipeline leaks and 4,653 complete fractures in the potable water, wastewater, and natural gas systems. This is expected to leave 5,428 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 $29.9 billion and utility lifelines at $35 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.

Table 4-23 summarizes the Hazus-MH models many other estimated impacts and Table 4-24 displays the direct economic losses by county in the Western Region. While Flathead County would experience the greatest total direct losses from an earthquake event, Lake County has the greatest loss ratio.

Table 4-23 Hazus-MH Earthquake Loss Estimation 2,500-Year Scenario Results

Type of Impact	Impacts to Region
Total Buildings Damaged	Slight: 50,652 Moderate: 32,979 Extensive: 11,123 Complete: 2,616
Building and Income-Related Losses	$4.52 billion 57% of damage related to residential structures 22% of loss due to business interruption
Total Economic Losses (includes building, income, and lifeline losses)	Total: $9.09 billion Building: $4.52 billion Income: $1.01 billion Lifeline losses: $167 million
Casualties (based on 2 a.m. time of occurrence)	Without requiring hospitalization: 658 Requiring hospitalization: 120 Life threatening: 11 Fatalities: 20
Casualties (based on 2 p.m. time of occurrence)	Without requiring hospitalization: 1,823 Requiring hospitalization: 483 Life threatening: 76 Fatalities: 147
Casualties (based on 5 p.m. time of occurrence)	Without requiring hospitalization: 1,234 Requiring hospitalization: 320 Life threatening: 60 Fatalities: 92
Fire Following Earthquake	0 Ignitions
Debris Generation	1.2 million tons of debris generated 48,760 estimated truckloads to remove
Displaced Households	2,809
Shelter Requirements	1,612

Source: Hazus-MH Global Summary Report, WSP Analysis

Table 4-24 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										
Park	12,453	56,833	21,905	421	3.57	8,211	5,132	6,419	4,889	116,263
Mineral	2,103	7,108	2,693	54	2.27	1,659	669	948	638	15,873
Ravalli	15,193	51,932	20,463	584	1.75	10,776	4,580	5,719	4,642	113,889
Beaverhead	13,204	50,774	19,526	497	6.31	8,753	4,127	5,334	4,277	106,491
Powell	5,782	21,247	8,489	136	3.61	4,360	9,090	8,097	2,306	59,506
Lewis and Clark	69,268	238,946	92,669	1,602	4.28	50,701	20,050	27,254	24,067	524,558
Lincoln	11,700	38,889	15,069	351	2.61	9,016	4,396	5,746	3,890	89,057
Sweet Grass	768	3,114	1,277	56	0.87	444	152	206	207	6,223
Meagher	1,245	3,732	1,490	43	1.72	741	240	364	339	8,193
Silver Bow	45,316	148,375	55,636	1,289	5.30	31,526	19,160	25,142	18,086	344,529
Jefferson	10,881	40,449	15,812	323	4.55	7,362	2,234	3,153	2,827	83,041
Deer Lodge	4,467	17,323	6,656	69	2.00	3,131	2,126	2,450	1,638	37,861
Madison	15,729	74,583	27,532	598	7.10	10,284	2,847	3,988	5,302	140,862
Sanders	8,978	31,757	11,889	242	3.74	6,768	2,085	3,084	2,841	67,646
Flathead	255,335	927,510	335,801	10,621	12.30	172,283	74,372	96,590	79,700	1,952,212
Granite	2,279	8,117	3,084	82	2.37	1,626	411	591	599	16,789
Broadwater	13,417	40,703	15,548	385	9.15	8,561	3,689	3,866	3,652	89,820
Lake	98,514	363,313	126,004	2,795	14.42	71,414	24,765	30,099	30,841	747,744
Total	586,631	2,124,705	781,543	20,145	4.88	407,617	180,124	229,049	190,742	4,520,557
Region Total	586,631	2,124,705	781,543	20,145	4.88	407,617	180,124	229,049	190,742	4,520,557

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, will typically be more vulnerable to damage in an earthquake. Historic building stock is commonly made of unreinforced masonry, which is more vulnerable to damage from earthquakes, in addition to being constructed before the adoption of modern building and seismic codes.

Natural Resources

Secondary hazards associated with earthquakes will likely have some of the most damaging effects on the environment and natural resources. Earthquake-induced landslides can significantly impact surrounding habitat. Streams can be rerouted after an earthquake. This can change the water quality, possibly damaging habitat and feeding areas. There is a possibility of streams fed by groundwater drying up because of changes in underlying geology.

Development Trends Related to Hazards and Risk

Future population growth and building development in general will increase the vulnerability of the Region to earthquake by increasing the number of people and value of building inventory in the planning area. Development in the planning area will be regulated through building standards and performance measures so that the degree of risk will be reduced with modern code adoption and enforcement, which includes seismic standards appropriate to the Region.

4.2.7.8 Risk Summary

Overall earthquake is considered a **Medium** significance hazard due to the presence of multiple faults and a history of damaging earthquakes, and Hazus modeling that predicts significant losses; potential risk is tempered by a less frequent recurrence interval for earthquakes that result in damaging events, compared to other hazards; smaller earthquakes will happen more frequently but are not likely to cause damage.

- Thousands of faults have been mapped in Montana, but scientists think only about 95 of these faults have been active in the past 1.6 million years.
- 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. Region-wide, 2,382 injuries and 147 fatalities are estimated by the Hazus scenario, as well as 2,809 displaced households.
- Effects on property: Impacts on property include direct damage to structures from the shaking. Region-wide, 97,370 buildings are estimated to experience some level of damage, with 2,616 of them completely destroyed.
- Flathead and Lake Counties have the highest loss ratios and direct economic losses from an earthquake event.
- 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 $9.09 billion.
- Effects on critical facilities and infrastructure: Linear facilities, such as pipelines, railroads, and roadways, are largely at much greater risk than other facility types. Damage to the transportation system is estimated at $29.9 billion and utility lifelines at $35 billion.
- Unique vulnerability: See the table below; areas with historic buildings and unreinforced masonry common to the downtown areas of many towns in the Western Region will be more prone to damage and pose a risk to public safety.
- Related hazards: Landslide, dam incidents.

Table 4-25 Risk Summary Table: Earthquake

Jurisdiction	Overall Significance	Additional Jurisdictions	Jurisdictional Differences?
Western Region	Low	N/A	See below
Anaconda-Deer Lodge	Low	N/A	N/A
Beaverhead	Low	City of Dillon, Town of Lima	The City of Dillion has a greater population and concentration of infrastructure to be damaged, but the Town of Lima is in a higher frequency area
Broadwater	Medium	City of Townsend	None
Butte-Silver Bow	Medium	Town of Walkerville	None
CSKT	Low	N/A	N/A
Flathead	High	Columbia Falls, Kalispell, Whitefish	The City of Kalispell has the greatest estimated direct losses and greatest population
Granite	Low	Towns of Drummond and Philipsburg	None
Jefferson	Low	City of Boulder, Town of Whitehall	None
Lake	Medium	City of Polson, City of Ronan, Town of St. Ignatius	City of Polson has the greatest estimated direct losses and greatest population
Lewis and Clark	Medium	City of Helena, City of East Helena	The City of Helena has a significantly greater population than East Helena, but they are very close in proximity and will experience similar types of impacts
Lincoln	Low	City of Libby, City of Troy, Town of Eureka	Town of Eureka has greater estimated direct losses
Madison	Medium	Town of Ennis, Town of Sheridan, Town Virginia City	Town of Ennis has greater estimated direct losses
Meagher	Low	City of White Sulphur Springs	None
Mineral	Low	N/A	N/A
Park	Low	City of Livingston, Town of Clyde Park	City of Livingston has greatest estimated direct losses
Powell	Low	City of Deer Lodge	None
Ravalli	Medium	City of Hamilton, Town of Darby, Town of Stevensville	City of Hamilton and Town of Stevensville have greater estimated direct losses than the Town of Darby
Sanders	Low	City of Thompson Fall, Town of Plains, Town of Hot Springs	None

Jurisdiction	Overall Significance	Additional Jurisdictions	Jurisdictional Differences?
Sweet Grass	Low	City of Big Timber	None

4.2.8 Flooding

4.2.8.1 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:

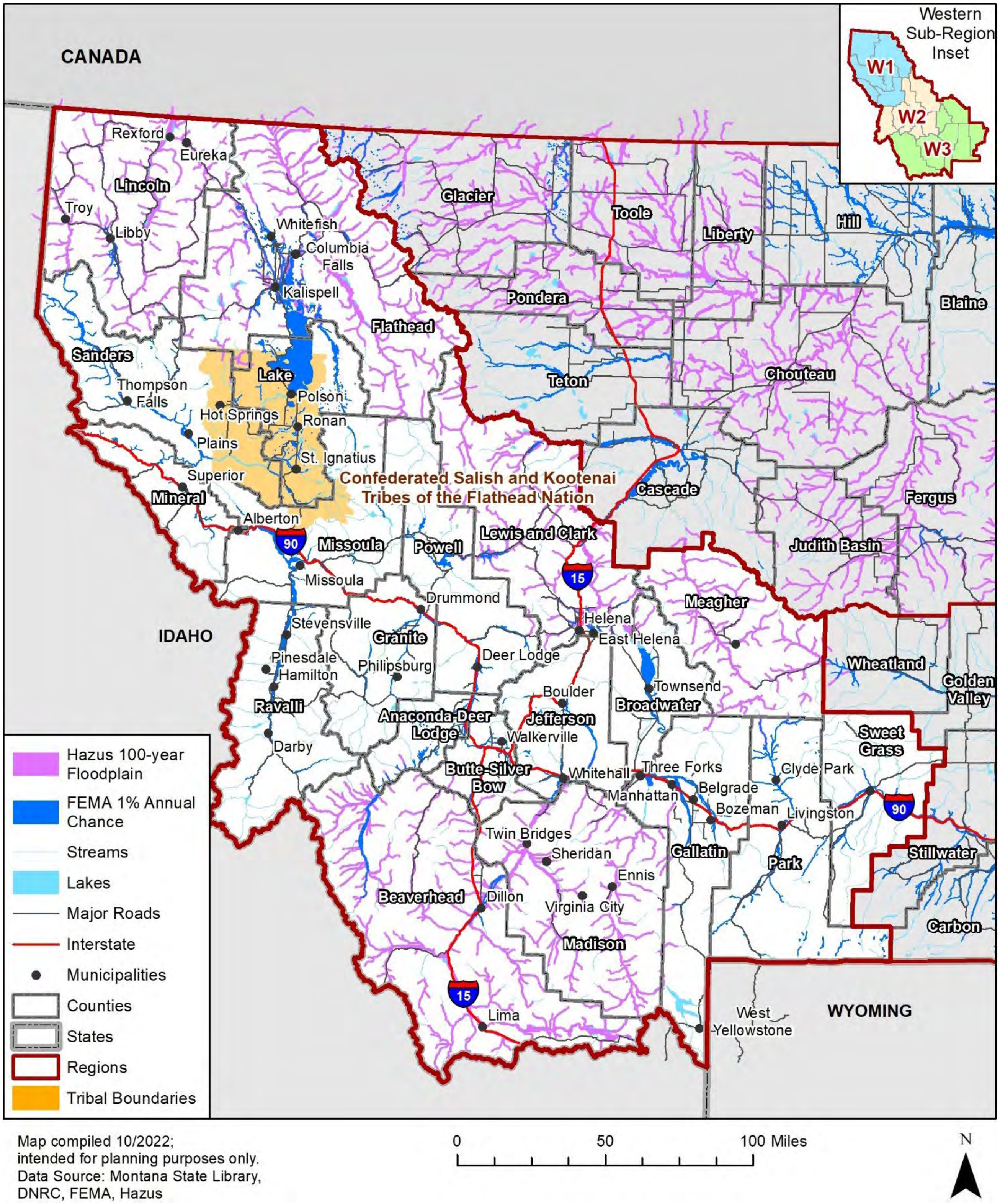
- Rain in a general storm system
- Rain in a localized intense thunderstorm
- Melting snow
- Rain on melting snow
- Ice Jams
- Dam failure
- Urban stormwater drainage
- Rain on fire damaged watersheds

Slow rise floods associated with snowmelt and sustained precipitation usually are preceded with adequate warning, though the event can last several days. Flash floods are also characteristic. Flash floods, by their nature, occur very suddenly but usually dissipate within hours. Even flash floods are usually preceded with warning from the NWS 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 Montana, four counties within the Western Region are in the top five for average precipitation per year. Mineral is first, averaging 24.96 inches of rain per year. Followed by Sanders County with 22.10 inches in precipitation. Third is Lincoln with 20.52 inches and Flathead is fourth with 19.77 inches of rain per year in Montana's Western Region.

4.2.8.2 Geographical Area Affected

Figure 4-32 Western Region Flood Hazards (National Flood Hazard Level [NFHL] and Hazus)



Map compiled 10/2022; intended for planning purposes only.
Data Source: Montana State Library, DNRC, FEMA, Hazus

Flood hazards for the Western Region are pictured in Figure 4-32 above, based on a combination of digital flood hazard maps from FEMA and those modeled with Hazus. The major river basins in the Region include the upper Missouri River, Clark Fork, Kootenai, and Yellowstone. Among the rivers and tributaries are the Blackfoot, Beaverhead, Bitteroot, Clark Fork, Kootenai and Flathead and Yellowstone rivers. Flooding along typically occurs during the spring and is caused by long rainstorms. Flooding may also occur during the spring and early summer due to snowmelt runoff. Localized thunderstorms during the summer can also result in flash flooding throughout the planning area.

An elevated flash flood and debris flow risk in watersheds affected by wildfire can be present in the years following an event. The map below shows areas of the Western Region that have been impacted by wildfires that have an elevated debris flow risk. The maps show USGS debris flow modeling data for wildfires in Montana from 2017 through 2022 from their Post Wildfire Debris Flow Hazard Assessment Viewer.

4.2.8.3 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 8 federally declared disasters within the 18 counties and one Indian Reservation located in the Western Region from 1974 to 2022. The federal declarations since 1974 to present are summarized in Table 4-26 below.

An atmospheric river, a narrow band of tropical moisture, overwhelmed the Pacific Northwest in mid-June 2022. It resulted in several inches of rain to parts of southern Montana, coinciding with above-normal temperatures that caused snowmelt. Extreme rain and melting snow led to catastrophic flooding at Yellowstone National Park. On June 13, park officials closed Yellowstone, evacuating more than 10,000 visitors due to safety concerns over flooding.

Table 4-26 Federally Declared Flooding Events Montana Western Region 1974-2022

Year	Declaration Title	Disaster Number	County/Reservation Impacted
1974	SEVERE STORMS, FLOODING & LANDSLIDES	DR-417-MT	Anaconda-Deer Lodge, Flathead, Lincoln, Mineral, Missoula, Sanders
1975	RAINS, SHOWMELT, STORMS & FLOODING	DR-472-MT	Broadwater, Flathead, Jefferson, Lewis and Clark, Powell, Meagher
1981	SEVERE STORMS & FLOODING	DR-640-MT	Broadwater, Gallatin, Granite, Jefferson, Lewis and Clark, Meagher, Missoula, Powell
1986	HEAVY RAINS, LANDSLIDES & FLOODING	DR-761-MT	Anaconda-Deer Lodge, Granite, Powell, Sanders
2014	ICE JAMS AND FLOODING	DR-4172-MT	Broadwater, Jefferson, Lake, Park, Ravalli, Sanders
2019	FLOODING	DR-4405-MT	Lewis and Clark, Missoula, Park, Powell
2019	FLOODING	DR-4437-MT	Lake, Park
2022	SEVERE STORM AND FLOODING	DR-4655-MT	Flathead, Park, Sweet Grass

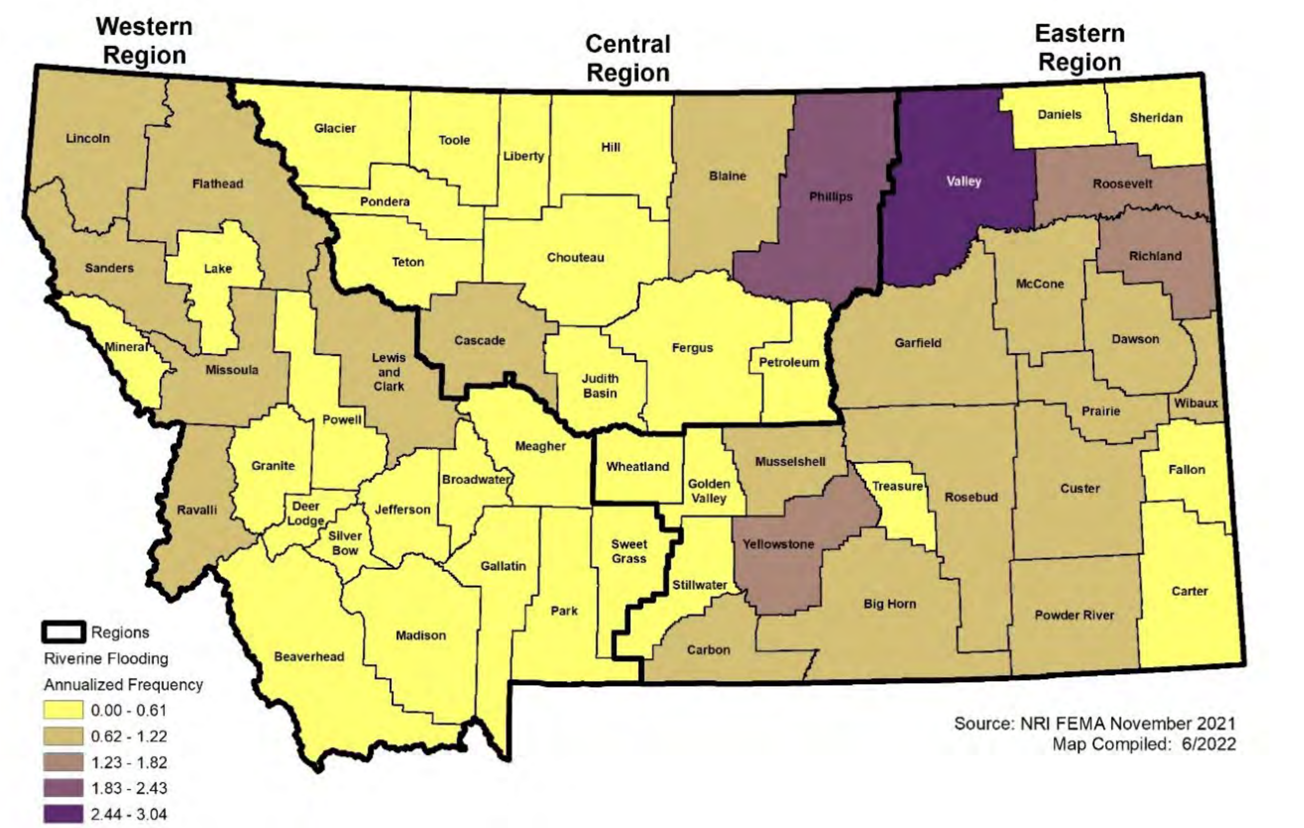
Source: FEMA.gov

4.2.8.4 Frequency/Likelihood of Occurrence

The Western Region has experienced multiple catastrophic flood event 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 eight federally declared events in the past 12 years from 1974 to present within the Western Region. The Western Region has averaged three FEMA flood events per year since 2010. Using past occurrences as an indicator of future probability, flooding has the probability of future occurrence rating of **likely** throughout the Western Region.

Figure 4-33 depicts the annualized frequency of riverine flooding at a county level based on the NRI. The mapping shows a higher risk of annualized frequency in the Northwestern Region. Counties like Flathead, Lincoln and Sanders have an annual chance of flooding in 0.6 to 1.2 percent chance of flooding hazard based on NRI data in comparison to the southern portion of the Western Region. In comparison counties like Beaverhead, Gallatin and Madison counties have a 0.0 to 0.6 percent annualized chance of a flood occurring, showcasing the contrast of risk.

Figure 4-33 Annualized Frequency of Riverine Flooding by County



4.2.8.5 Climate Change Considerations

To date, projections from climate models have been mixed about whether climate warming will increase or decrease precipitation in Montana. However, because warmer air can hold more moisture, events producing heavy rainfall and flooding can be expected to increase as temperatures rise in the years to come. In general, heavier rains lead to a larger fraction of potential rainfall overflow and, depending on the surface conditions, more potential for flash flooding.

Warming is likely to directly affect flooding in many mountain settings, as catchment areas receive increasingly more precipitation as rain rather than snow, or more rain falling on existing snowpack. In some such settings, river flooding may increase as a result – even where precipitation and overall river flows decline.

According to the 2018 National Climate Assessment, river basins including the Missouri River Basin will experience gradual runoff declines during this century but flooding in the Region is generally expected to increase. In Montana, however, there are no specific projections or trends that have been noted to indicate that more substantial or more frequent flooding events can be expected to occur.

Global warming may also lead to more ice-jam flooding 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. Global warming could create conditions ripe for ice-jam floods. The increasing possibility of midwinter thaws and heavy rainfall events could increase the risk of sudden ice break up. Flooding can be further exacerbated if the ground is still frozen and unable to soak up rainwater.

Other influences on flood generation that should be considered in projections of future flood risks are land cover, flow and water-supply management, soil moisture and channel conditions. In addition to discouraging development in flood-prone areas and protecting natural systems such as wetlands, local government planners and engineers should design infrastructure with the capacity to accommodate heavy rains and manage stormwater runoff during extreme events.

4.2.8.6 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 Western 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 Western Region with the greatest flood risk. Montana's Western Region flood-loss information was obtained from FEMA's "Montana's Coverage Claims" for Montana's Western Region, which documents losses from 1978. This section was updated based on information obtained from FEMA through Montana Dept. of Military Affairs current as of August 10th, 2022.

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

- Only losses to participating NFIP communities are represented,
- 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.

Missoula County has the highest amount of dollars paid out due to flood claims with $976,035, followed by Flathead with $690,320 in flood insurance payouts due to flood losses. Third and fourth are Lincoln and Lewis and Clark County with $446,923 and 432,256 respectively. Flathead, Gallatin, and Missoula Counties have the highest amount of current policies with 495, 333 and 259. Focusing on floodplain and hazard mitigation activities on a local, state, and federal level will allow each of these enlisted counties to better their Community Rating System (CRS) scores. The Western Region has a total of $303,590,400 in NFIP coverage. There are 807 total flood claims, 1,788 current polices and $6,111,295 dollars paid out total due to flood damage and losses. NFIP data and statistics for the Western Region is summarized in Table 4-27 below.

Table 4-27 Montana Western Region NFIP Statistics

County	Date Joined	Effective Firm Date	Dollars Paid (Historical)	Flood Claims	Current Policies	Coverage ($)
Anaconda-Deer Lodge	9/30/1982	9/30/1982	$8,283	9	11	$2,275,000
Beaverhead	9/30/1982	9/30/1982	$2,464	12	22	$4,856,600
Broadwater	12/1/1986	8/18/2014	-	2	8	$2,318,000
Butte-Silver Bow	9/28/1979	6/1/2022	$8,245	10	24	$8,004,000
CSKT	-	-	-	-	-	-
Flathead	9/5/1984	11/4/2015	$690,321	131	495	$118,260,200
Gallatin	05/16/78	08/01/84	$323,244	73	333	$86,865,600
Granite	9/5/1984	11/4/2015	$16,934	7	18	$4,810,500
Jefferson	6/17/1986	06/17/86(M)	$6,966	5	22	$4,205,500
Lake	12/17/1987	2/6/2013	$20,285	12	35	$10,546,000
Lewis and Clark	4/1/1981	9/19/2012	$432,257	102	169	$40,762,300
Lincoln	8/1/1980	9/29/2006	$446,923	38	57	$16,698,600

County	Date Joined	Effective Firm Date	Dollars Paid (Historical)	Flood Claims	Current Policies	Coverage ($)
Madison	(NSFHA)	(NSFHA)	$26,091	6	39	$11,963,500
Meagher	11/13/1985	(NSFHA)	$78,057	5	12	$4,979,300
Mineral	11/1/1996	11/01/96(L)	$10,768	5	15	$3,228,900
Missoula*	08/30/74	08/15/83	$976,035	174	259	$71,288,900
Park	1/1/1987	10/18/2011	$2,227,355	141	87	$22,226,700
Powell	6/3/1981	9/30/1994	$66,564	17	19	$3,049,800
Ravalli	7/19/1982	1/16/2015	$115,489	36	116	$33,694,300
Sanders	3/1/1996	6/5/2012	$223,490	10	32	$6,619,000
Sweet Grass	8/2/1982	5/18/2015	$431,524	12	15	$5,092,200
Total			$6,111,295	807	1788	$461,744,900

Source: FEMA Pivot NFIP Data as of August 10th, 2022; FEMA Community Status Book Report
* Results include county overall, not analyzed further for loss by jurisdiction

Repetitive Loss

Repetitive losses are NFIP-insured structures that has had at least two paid flood losses of more than $1,000 each in any 10-year period since 1978. The Western Region has a total of 82 repetitive loss properties. With the majority being located in Lewis and Clark, Missoula, and Park Counties. There are currently three Severe Repetitive Loss (SRL) properties in the Western Region, one in Missoula County and two in Parks County.

SRL properties are defined as properties, that have incurred flood-related damage for which four or more separate claims payments have been made. To date there has been a repetitive loss cumulative payout of $1,301,148 with $95,642.83 of this being SRL property loss payouts. Repetitive loss properties within Montana's Western Region are shown in Table 4-28 below.

Table 4-28 Western Region Repetitive Loss Properties by County

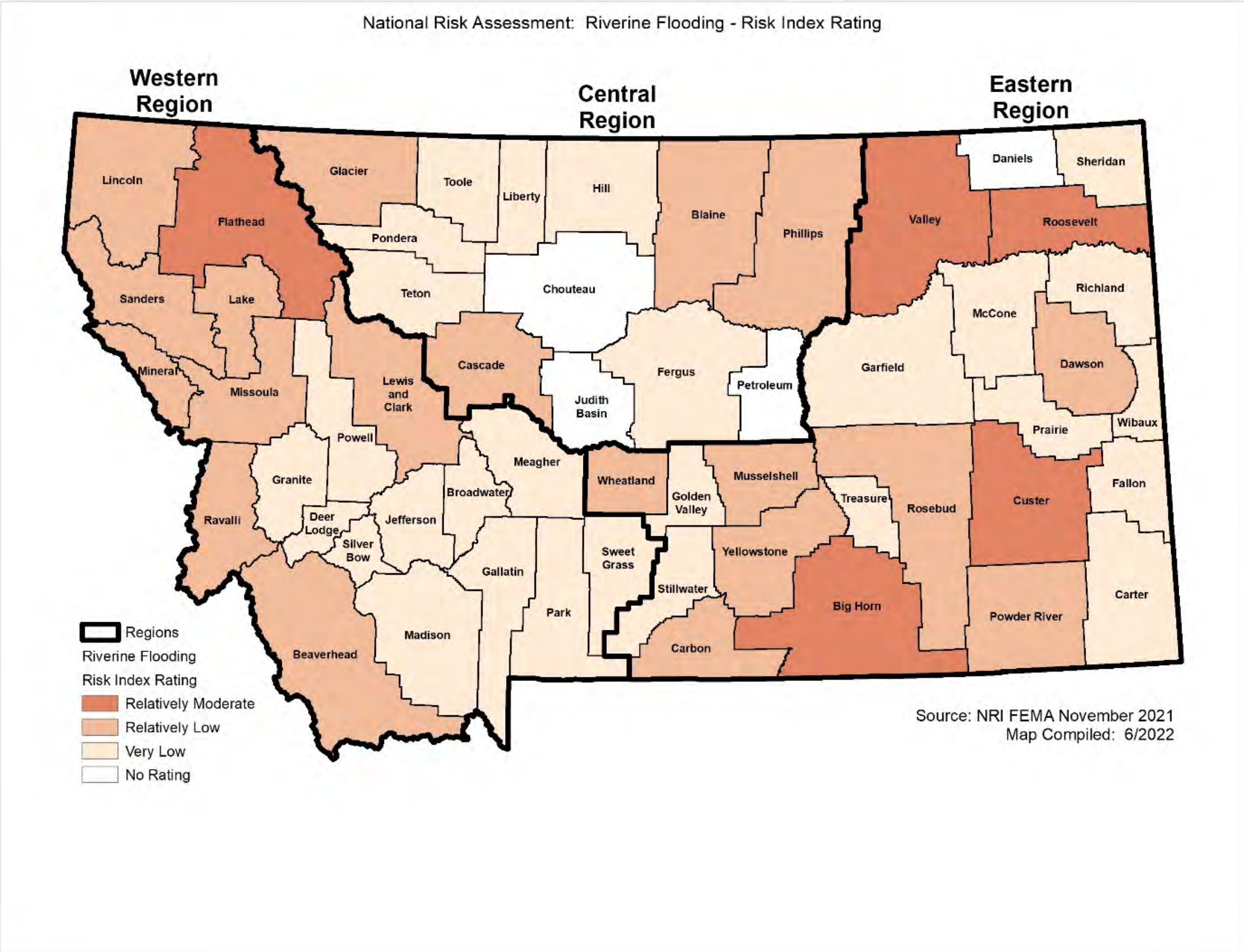
County	Repetitive Loss Structures per County	Repetitive Loss Claims	Total Paid Out
FLATHEAD COUNTY	3	7	$89,602.81
GALLATIN COUNTY	3	6	$88,477.61
LEWIS AND CLARK COUNTY	7	15	$110,881.17
LINCOLN COUNTY	3	6	$288,961.59
MEAGHER COUNTY	1	2	$56,021.23
MISSOULA COUNTY*	12	27	$252,928.28
PARK COUNTY*	9	15	$381,697.83
RAVALLI COUNTY	3	4	$32,577.63
Total	**41**	**82**	**$1,301,148.15**

Source: FEMA Pivot NFIP Data as of August 10th, 2022; FEMA Community Status Book Report
*Totals include SRL properties

4.2.8.7 Vulnerability Assessment

Figure 4-34 depicts the RIs rating for riverine flooding based on the 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 EAL and social vulnerability in a given community in relation to that community's resilience. The Western Region trends toward relatively low to very low ratings, with the highest ratings being in Flathead County.

Figure 4-34 Risk Index Rating for Riverine Flooding by County



Flooding becomes a hazard when people compete with nature for the use of floodplains. 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 riverbanks 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 an 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 Western 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. Certain populations are particularly vulnerable. Within the Western Region Flathead County has the highest amount of people located in the floodplain with 11,481. This is followed by Lewis and Clark County with 3,694. Third is Gallatin County with 2,181. 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. 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 Western Region are shown in Table 4-29 below.

Table 4-29 Western Region Population Located in the 1% Annual Chance Floodplain

County	Population
Anaconda-Deer Lodge	184
Beaverhead	1117
Broadwater	102
Butte-Silver Bow	437
CSKT	-
Flathead	11,481
Gallatin*	2,181
Granite	274
Jefferson	466
Lake	570
Lewis and Clark	3,694
Lincoln	1,518
Madison	1,065
Meagher	115
Missoula*	1,612
Mineral	294
Park	669
Powell	406
Ravalli	900
Sanders	543

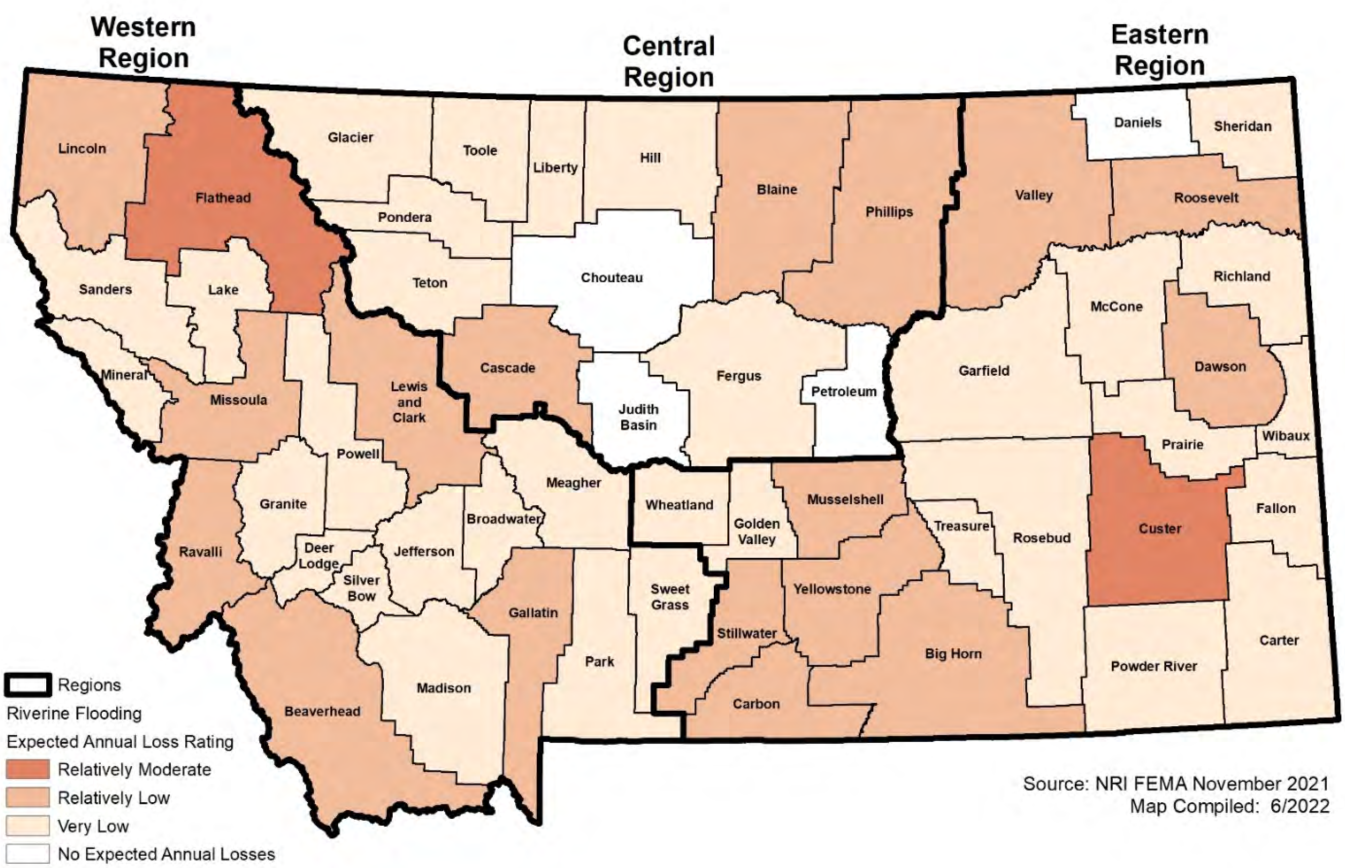
County	Population
Sweet Grass	96
Total	**27,724**

Sources: DNRC, Hazus, FEMA NFHL
* Results include county overall, not analyzed further for loss by jurisdiction

Property

Montana's Western Region has six counties with what is considered to be a relatively low annual expected loss rating due to floods. These counties are Beaverhead, Gallatin, Lewis and Clark, Lincoln, Missoula, and Ravalli counties. Flathead County is the only jurisdiction in the Western Region that has a relatively moderate annual expected loss rating. Which also coincides with Flathead Co. having the highest amount of people located in the Special Flood Hazard Area (SFHA) see Table 4-29. To help summarize this, NRI data was used. 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 EAL and social vulnerability in a given community in relation to that community's resilience. This information is categorized in Figure 4-35 below.

Figure 4-35 Expected Annual Loss Rating Riverine Flooding by County



GIS analysis was used to estimate Montana's Western Region potential property and economic losses from flooding. 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 try and create a complete full coverage of risk for the Region, through the utilization of FEMA's NFHL with the effective date of 6/1/2022, and other sources. The DNRC provided digitized flood mapping from paper maps that FEMA has not converted over to the NFHL yet. FEMA Region VIII also provided Hazus flood models to help fill in areas where FEMA has not mapped flooding within the State. 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. The summarized results for each county and community are shown in the tables and maps provided within each county or tribal annex.

Table 4-30 below summarize the counts and improved value of parcels in the Region, broken out by each county, that fall within the 1% chance floodplains. Additionally, Table 4-30 summarizes the table also shows loss estimate values which are calculated based upon the improved value and estimated contents value.

Flathead County has the highest amount of estimated losses due to flooding with $494,289,508. Lewis and Clark County has the second highest property exposure to flooding with an Estimated Loss Value of over $161,808,429. Gallatin County is third in loss values with $119,866,299. Overall Montana's Western Region has $4,916,220,125 in total value and a combined estimated loss of $1,229,055,031 for 1% annual chance flooding. There are 13,179 parcels located in the floodplain and 27,724 people at risk in the Western Region. The jurisdictional break down for each county is located within each annex. The summarized results for the Region are shown in Table 4-30 below.

Table 4-30 Western Region Parcels at Risk to 1% Flood Hazard by County and Jurisdiction

County	Improved Parcels	Improved Value	Content Value	Total Value	Estimated Loss
Anaconda-Deer Lodge	106	$12,303,639	$7,126,725	$19,430,364	$4,857,591
Beaverhead	615	$110,527,891	$65,729,691	$176,257,582	$44,064,395
Broadwater	63	$13,059,075	$8,424,203	$21,483,278	$5,370,819
Butte-Silver Bow	222	$53,878,704	$34,272,577	$88,151,281	$22,037,820
CSKT	127	$26,592,359	$16,315,210	$42,907,569	$10,726,892
Flathead	5,116	$1,279,788,861	$697,369,170	$1,977,158,031	$494,289,508
Gallatin*	1,028	$306,928,837	$172,536,359	$479,465,196	$119,866,299
Granite	135	$20,931,697	$12,534,501	$33,466,198	$8,366,550
Jefferson	233	$39,132,931	$26,037,496	$65,170,427	$16,292,607
Lake	267	$71,895,835	$39,532,313	$111,428,148	$27,857,037
Lewis and Clark	1,694	$412,970,355	$234,263,360	$647,233,715	$161,808,429
Lincoln	704	$108,631,571	$61,757,575	$170,389,146	$42,597,287
Madison	587	$112,975,153	$72,354,280	$185,329,433	$46,332,358
Meagher	70	$8,513,470	$6,474,705	$14,988,175	$3,747,044
Mineral	141	$28,107,461	$16,014,056	$44,121,517	$11,030,379
Missoula*	763	$172,559,054	$95,729,539	$268,288,593	$67,072,148
Park	379	$133,391,064	$79,363,842	$212,754,906	$53,188,727

County	Improved Parcels	Improved Value	Content Value	Total Value	Estimated Loss
Powell	233	$32,135,558	$21,300,919	$53,436,477	$13,359,119
Ravalli	464	$144,387,729	$96,208,844	$240,596,573	$60,149,143
Sanders	293	$47,408,482	$27,031,653	$74,440,135	$18,610,034
Sweet Grass	66	$19,203,097	$13,427,859	$32,630,956	$8,157,739
Total	13,306	$3,155,322,823	$1,803,804,877	$4,959,127,700	$1,249,781,925

Sources: DNRC, Hazus, FEMA NFHL

* Results include county overall, not analyzed further for loss by jurisdiction

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 FEMA Lifeline are listed in Table 4-31 below. Impacts to any of these facilities could have wide ranging ramifications, in addition to property damage and other cascading impacts.

Table 4-31 Western Region Critical Facilities at Risk to 1% Annual Chance of Flood by Facility Type

County	Communications	Energy	Food, Water, Shelter	Hazardous Materials	Health and Medical	Safety and Security	Transportation	Total
Anaconda-Deer Lodge	3	-	1	-	-	-	40	44
Beaverhead	0	1	1	0	0	0	2	4
Broadwater	0	2	1	0	0	1	13	17
Butte-Silver Bow	1	0	2	0	0	2	11	16
CSKT	-	-	-	-	-	-	-	-
Flathead	12	6	5	0	0	5	108	136
Granite	1	5	1	0	0	0	24	31
Jefferson	0	0	2	0	0	1	49	52
Lake	0	0	1	0	0	0	27	28
Lewis and Clark	10	7	2	0	0	7	92	118
Lincoln	0	0	3	0	1	1	66	71
Madison	0	2	1	0	1	5	57	70
Meagher	0	0	0	0	0	0	32	32
Mineral	0	0	0	0	0	1	67	68
Park	1	0	1	0	0	0	55	57
Powell	0	0	1	0	0	1	45	47
Ravalli	1	0	1	0	0	0	32	34
Sanders	0	3	2	0	0	0	40	45
Sweet Grass	0	0	1	0	0	0	27	28
Total	29	26	26	0	2	24	787	898

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

* Results include county overall, not analyzed further for loss by jurisdiction

The 1% annual chance of flooding for the Western Region shows that the majority of facilities that have the most critical facilities at risk to flood damage are within the transportation lifelines with 787 total. It should be noted that the majority of these are bridges and have a lower risk of flooding. Although, bridges like these can still be a cause of concern due to not being usable during a flood event or being washed out. Scour can be 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. There are 29 communication facilities exposed to the FEMA 1% annual chance of flooding with 29 total, of which the majority are located in Flathead and Lewis and Clark Counties. Energy and the Food, Water and Shelter facilities have the third highest FEMA Lifelines at risk with 26 each. These can be facilities such as power plants, wastewater treatment plants and food assistance buildings. Fourth with 24 total facilities are safety and security facilities. These can be first responder entities such as fire, medical and police stations.

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 Western Region could be monumental.

Natural Resources

Natural resources are generally resistant to flooding and floodplains provide many natural and beneficial functions. 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. Wetlands, for example, exist because of natural flooding incidents. 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 HAZMAT 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 Western 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 Western Montana's SFHA 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.

4.2.8.8 Risk Summary

- The Western Region averages on record a major presidential disaster declaration due to flooding every six years; using past occurrences as an indicator of future probability, significant flooding has the probability of future occurrence rating of **likely** throughout the Western Region.
- Flooding is a high significance hazard overall in the Region but there is significant variability by jurisdiction.
- There is an estimated 27,724 total people located within the 1% Annual Chance of Flooding within the Western Region. Flathead County makes up more than a third of these people with 11,481, followed by Lewis and Clark County with 3,694 and Missoula with 1,612 people. These three counties make up more than half of the population located within the floodplain in the entire Region.
- The Western Region has a total of $1.2B in estimated property losses due to flood damages.
- 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 is a total of 898 critical facilities in the Western Region exposed to flood hazards. 136 of these are in Flathead County, 118 are in Lewis and Clark County and 71 are located in Lincoln County. The highest exposure of FEMA Lifeline facilities are transportation (bridges) with 787 of the 898 total critical facilities.
- Related hazards: Dam Failure, Landslide, Wildfire.

Table 4-32 Risk Summary Table: Flooding

Jurisdiction	Overall Significance	Additional Jurisdictions	Jurisdictional Differences?
Western Region	High	NA	NA
Anaconda-Deer Lodge	Medium	NA	N/A
Beaverhead	Medium	Dillon, Lima	Beaverhead Co. has 1,117 people located within the SFHA with Dillon having $15,870,495 in total property value
Broadwater	Medium	Townsend	None
Butte-Silver Bow	Medium	Walkerville	None
CSKT	Medium	Hot Springs, Polson, Ronan, St. Ignatius	City of Polson located in the SFHA; 127 improved parcels in SFHA
Flathead	High	Columbia Falls, Kalispell, Whitefish	All cities within Flathead located in the SFHA. They also have the highest population located in the SFHA with 11,481. Three cities combined as $92,030,656. in estimated property losses
Gallatin	High	Belgrade, Bozeman, Three Forks	N/A
Granite	Medium	Drummond, Philipsburg	Drummond and Philipsburg have 52 improved parcels in the floodplain and $788,793 in estimated property losses

Jurisdiction	Overall Significance	Additional Jurisdictions	Jurisdictional Differences?
Jefferson	Medium	Boulder, Whitehall	Has 466 people located within the SFHA with $65,170,427 in total property value. Boulder and Whitehall have 132 people combined within the floodplain
Lake	Medium	Polson, Ronan, St. Ignatius	Polson has SFHA
Lewis and Clark	High	East Helena, Helena	East Helena and Helena have 484 people within the floodplain combined. With $70,086,895 in estimated losses within both cities combined
Lincoln	High	Eureka, Libby, Rexford, Troy	Eureka, Libby, and Troy have 244 people combined in the floodplain. 113 improved parcels and $7,504,883 in estimated property losses
Madison	High	Ennis, Sheridan, Twin Bridges, Virginia City	Ennis, Sheridan, and Twin Bridges have 484 people in the floodplain. These three cities also have 10,157,272 in estimated property losses to flooding
Meagher	Medium	City of White Sulphur Springs	None
Mineral	Medium	Superior	Superior has 16 improved parcels in the floodplain and $821,892 in estimated property losses
Missoula	Medium	Missoula	Missoula Co. has $268,288,593 in estimated total value susceptible to flood damages
Park	High	Clyde Park, Livingston	None
Powell	Medium	Deer Lodge	None
Ravalli	High	Darby, Hamilton, Philipsburg, Pinesdale, Stevensville	Ravalli Co. has $240,596,573 in estimated total value susceptible to flood damages. Hamilton has $2,405,321 in estimated property losses
Sanders	Medium	Hot Springs, Plains, Thompson Falls	None
Sweet Grass	Medium	City of Big Timber	N/A

4.2.9 Hazardous Materials Incidents

4.2.9.1 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. HAZMAT incidents may also include chemical, biological, radiological, nuclear, and explosive (CBRNE) incidents. CBRNE incidents can cause a variety of impacts within Montana, depending on the nature of the incident, material used, and environmental factors.

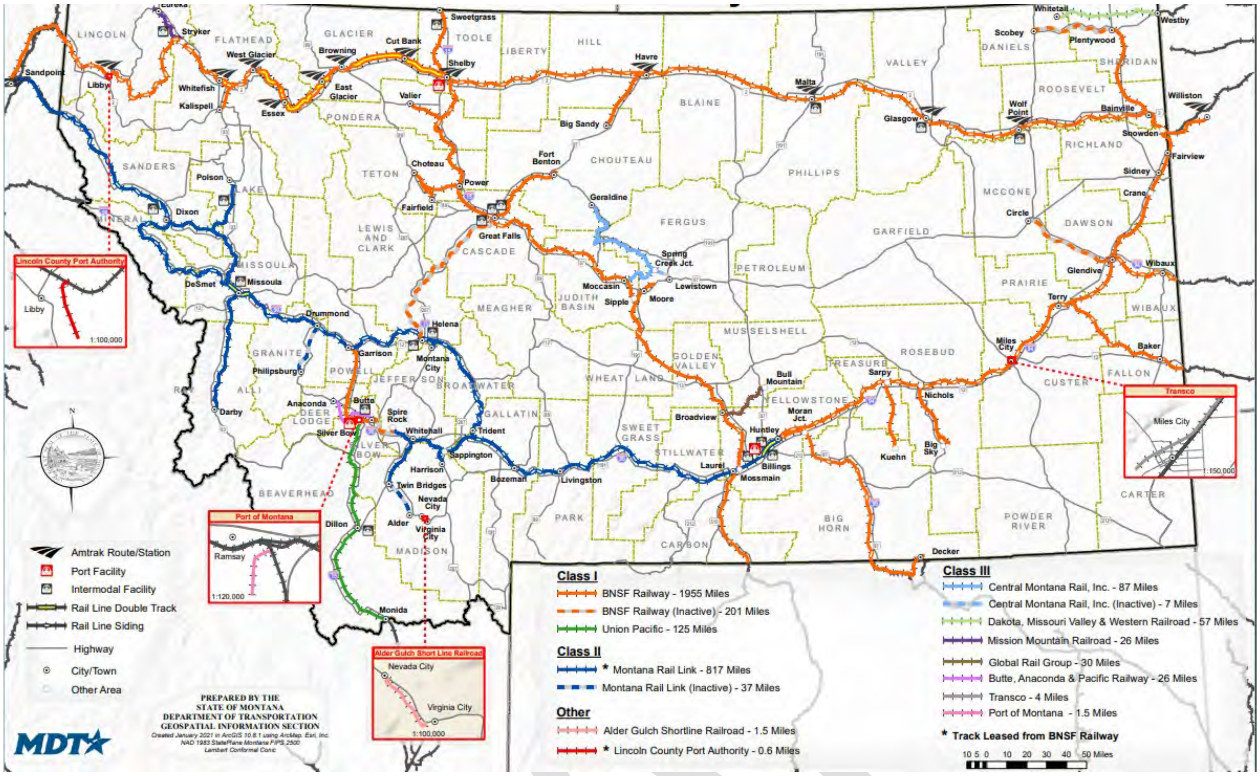
HAZMAT incidents can occur anywhere hazardous materials are stored or transported. There are no designated transportation routes throughout the Region. Although there are several fixed facilities within some of the city limits. Routes that are used for transporting nuclear and HAZMAT through the Western Montana Region by vehicle are Interstates 90 and 15, and U.S. Highways 2, 93, 12, and 287, and state highways throughout the Region. In the 2018 State Plan, it is noted that a 0.25-mile buffer is placed around all highways, major roadways, railroads, and Risk Management Plans (RMP) facilities as a proxy for potential impact areas. The major highways and railways within Montana and its Western Region are shown in Figure 4-36 and Figure 4-37 below.

The Environmental Protection Agency (EPA) also requires facilities containing certain extremely hazardous substances to generate RMPs and resubmit these plans every five years. As of 2022 there were 12 RMP facilities located in the Montana's Western Region. In 2022 there were also 58 Tier II facilities located throughout Western Montana. Although most are located along the Region's transportation routes, there are several within close proximity to population centers in the Western Region.

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 4-36 Montana's Rail Systems



4.2.9.2 Geographical Area Affected

HAZMAT incidents can occur at a fixed facility or during transportation. HAZMAT facilities are identified and mapped by the counties they reside in, along with the types of materials stored there; facilities generally are located in and around communities. Some facilities contain extremely hazardous substances; these facilities are required to generate RMPs and resubmit these plans every five years. In transportation, HAZMAT generally follows major shipping routes where possible (including road, rail, and pipelines), creating a hazard area immediately neighboring these routes.

Information provided by the National Pipeline Mapping System (NPMS) indicate several pipelines conveying gas or hazardous liquids across the planning area. 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 three counties with the highest number of documented pipeline incidents are Butte-Silver Bow, Lewis & Clark, and Flathead Counties. Maps of each counties pipeline networks from the NPMS are shown in Figure 4-38, Figure 4-39 & Figure 4-40 below, respectively.

Figure 4-37 Western Region Hazardous Materials & Transportation Routes

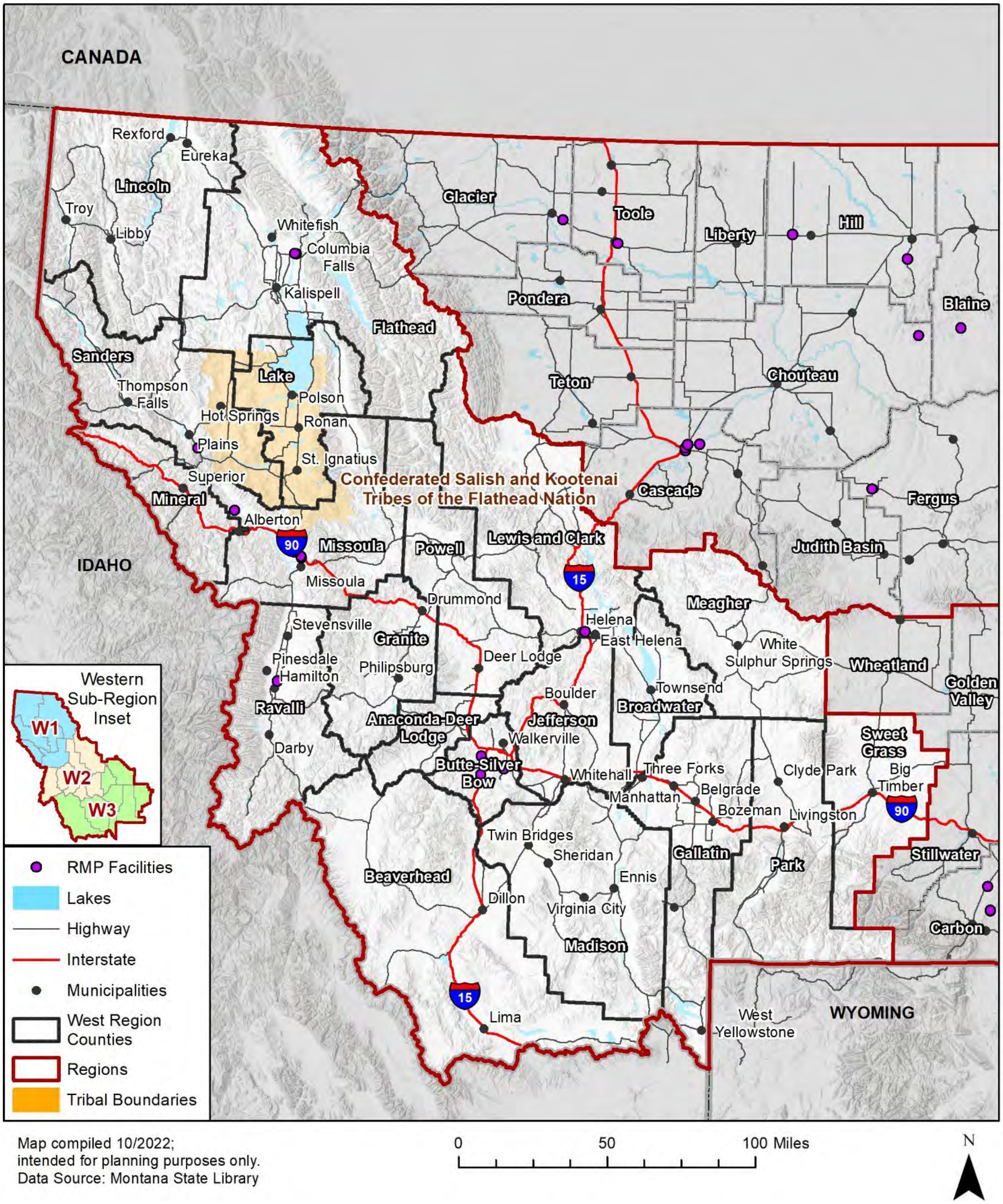
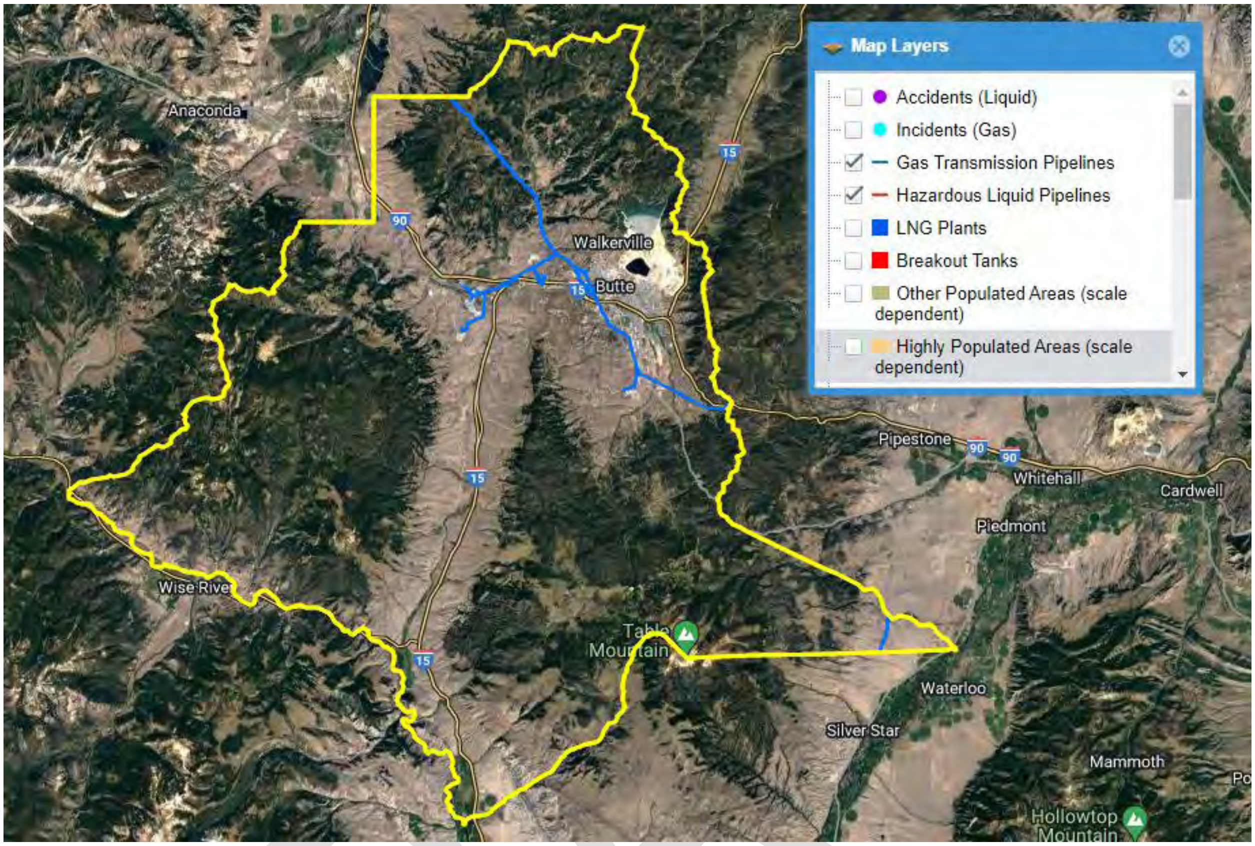
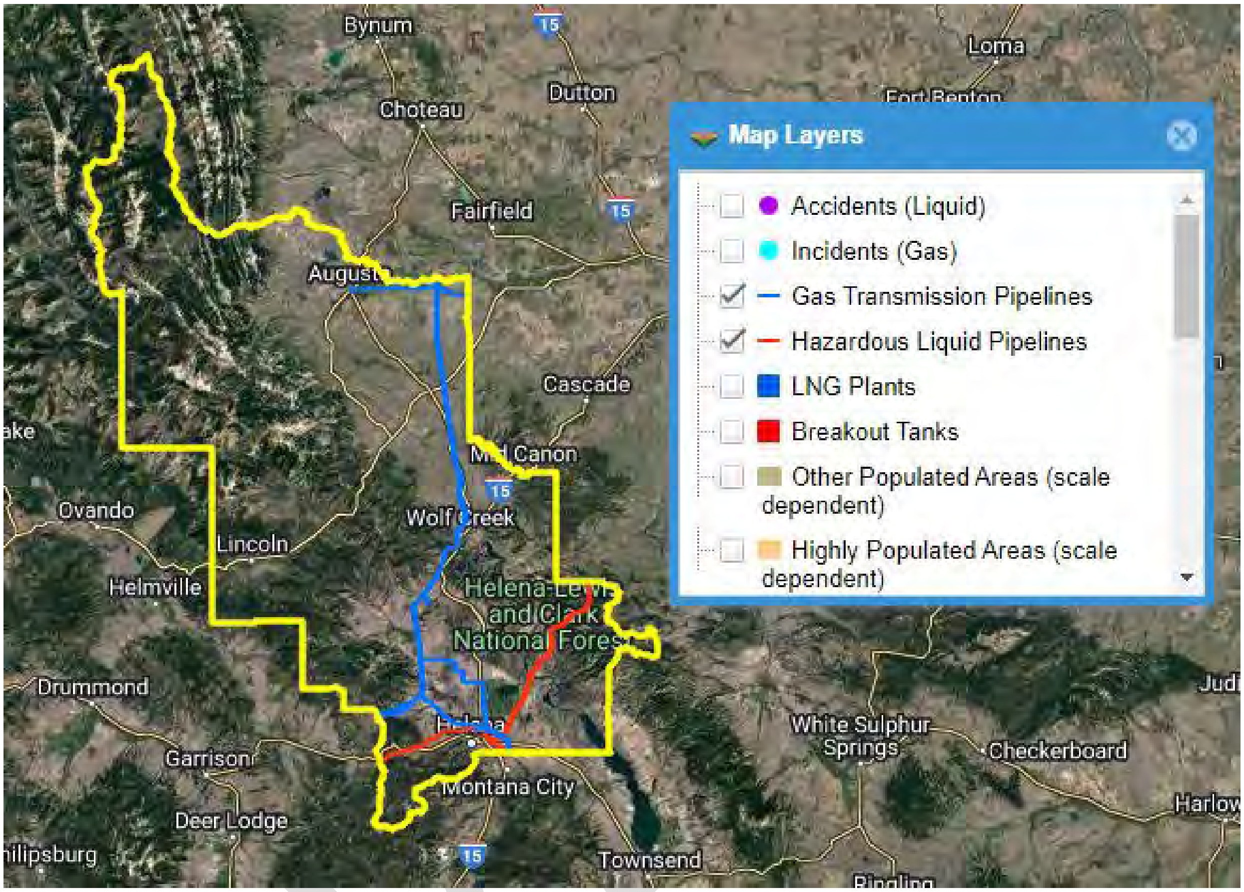


Figure 4-38 Pipelines Located Within Butte-Silver Bow County



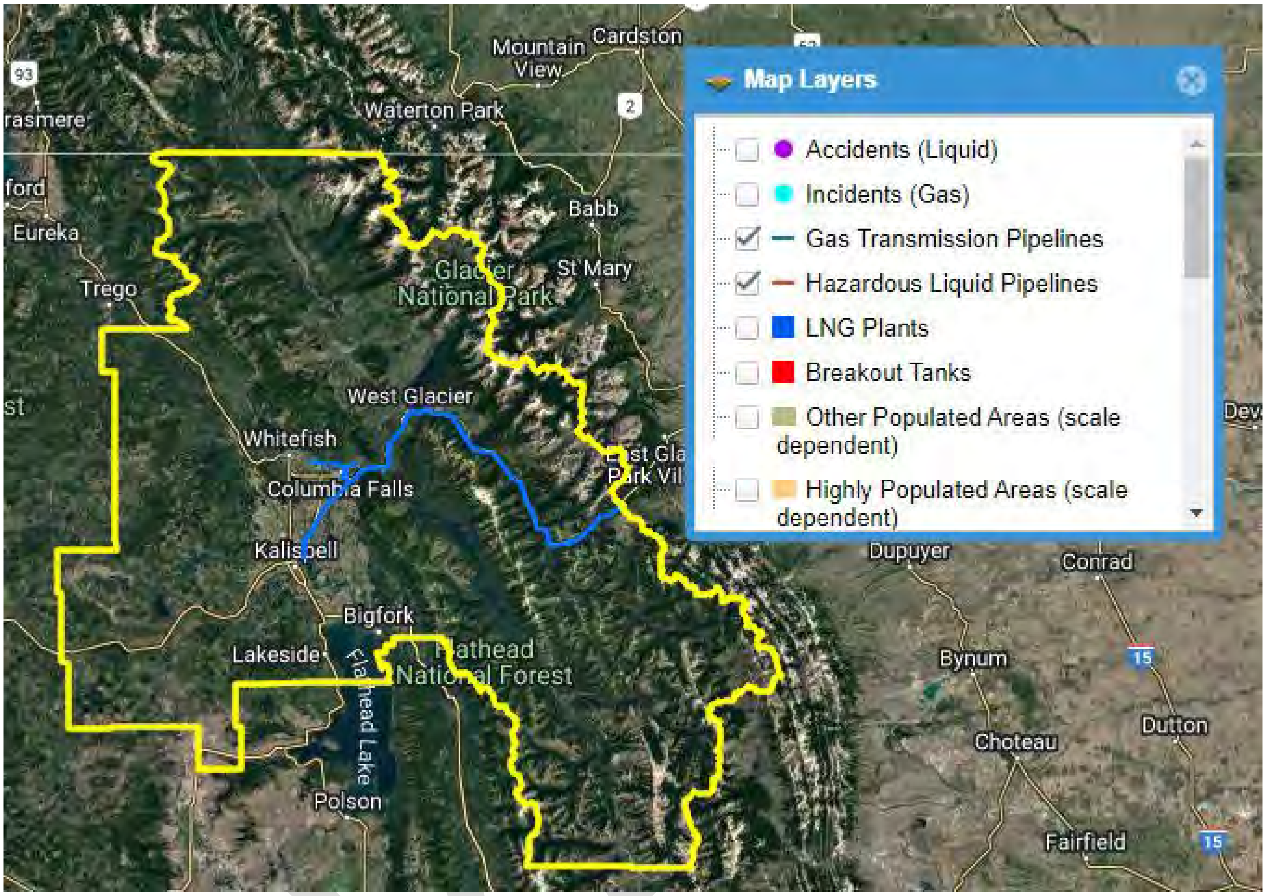
Source: NPMS

Figure 4-39 Pipelines Located Within Lewis & Clark County



Source: NPMS

Figure 4-40 Pipelines Located Within Flathead County



Source: NPMS

4.2.9.3 Past Occurrences

There are a variety of mechanisms to get an idea of the number and types of past HAZMAT incidents in the Western Region. One such repository is the catalogue of HAZMAT 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 649 incidents reported across the 18 participating counties within the Region. Table 4-33 below shows the 32-year record for reported incidents in Montana's Western Region.

Table 4-33 NRC-Reported Incidents Western Montana Region 1990-2022

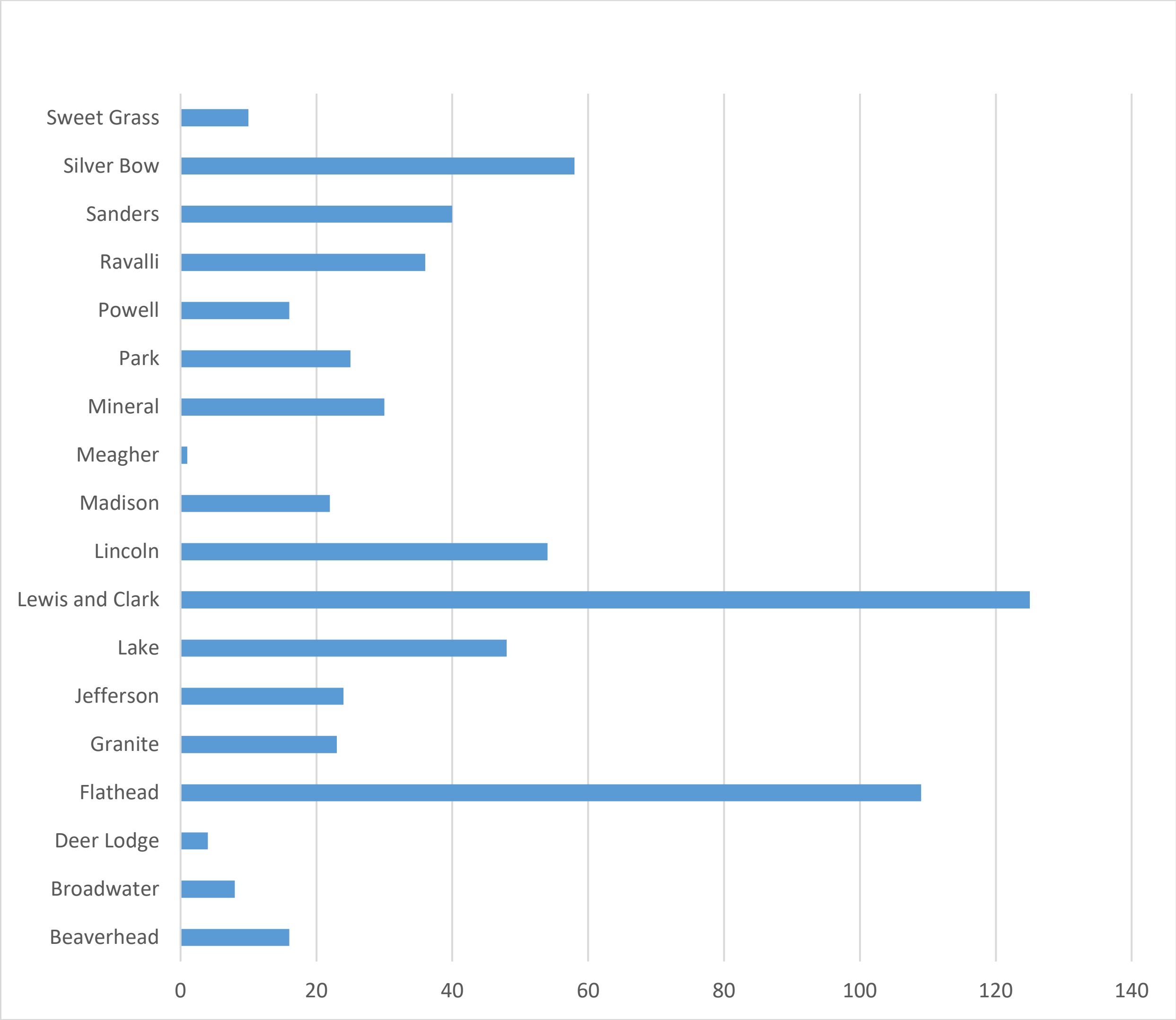
County	# of Incidents
Anaconda-Deer Lodge	4
Beaverhead	16
Broadwater	8
Butte-Silver Bow	58
Flathead	109
Granite	23
Jefferson	24
Lake	48

County	# of Incidents
Lewis and Clark	125
Lincoln	54
Madison	22
Meagher	1
Mineral	30
Park	25
Powell	16
Ravalli	36
Sanders	40
Sweet Grass	10
Total	**649**

Source: NRC Incident Report Database

According to the data, during the time period between 1990 and 2022 the Region saw an average of approximately 20 NRC-reported incidents per year, which means that each county can reasonably expect multiple HAZMAT incidents annually. Lewis & Clark, Flathead, and Butte-Silver Bow Counties have had the highest number of hazmat incidents and spills. Figure 4-41 shows the number of hazardous material incidents by county between 1990 and 2022.

Figure 4-41 Hazardous Materials Incidents Reported to the NRC by County - Western Region: 1990-2022

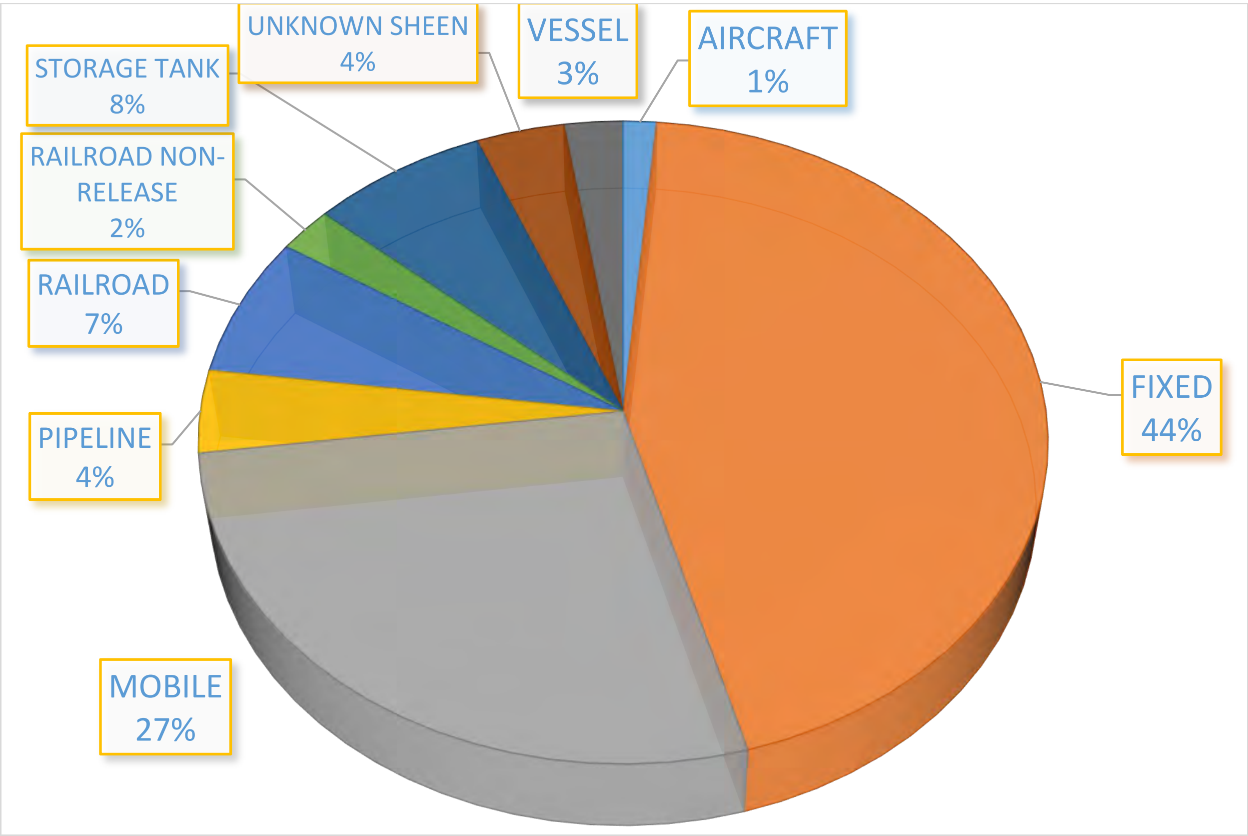


Source: NRC Incident Report Database

Figure 4-42 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 44% total. The second most common percentage of incident types accrued are mobile incidents with 27%. 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.

Leakage or spills from storage tanks rank third with, with 8% of incidents. Railroad spills make up 7% of incidents and can also have an impact on the transportation sector. 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 are fifth in types of incidents with 4%. Regular maintenance and detailed planning locations are necessary to ensure that these incident types are properly accounted and prepared for.

Figure 4-42 Hazardous Materials Incidents Reported to the NRC by Type - Western Region: 1990-2022

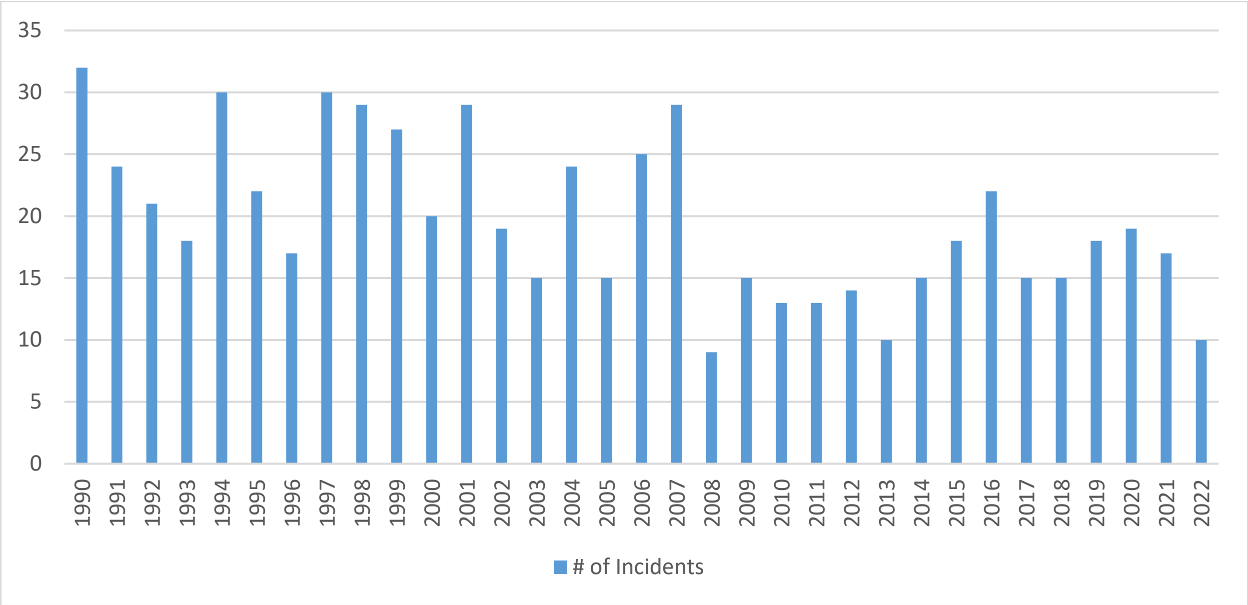


Source: NRC Incident Report Database

4.2.9.4 Frequency/Likelihood of Occurrence

The study area experiences multiple HAZMAT incidents each year, with different degrees of effect; based on the history of past occurrences, there is a 100% chance that the Western Region will see a HAZMAT 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 Western Region annually. Figure 4-43 below depicts the number of HAZMAT incidents reported each year in the Western Region counties, which shows that while the rates of incidents were generally higher in the 1990s, HAZMAT incidents do still occur throughout the Region on an annual basis and can be expected to continue occurring in the future.

Figure 4-43 HAZMAT Incidents per year in Montana Western Region, 1990-2022



Source: NRC Incident Report Database

4.2.9.5 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 HAZMAT releases from transportation events.

4.2.9.6 Potential Magnitude and Severity

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 HAZMAT releases from transportation events.

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 HAZMAT 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.

4.2.9.7 Vulnerability Assessment

The Western Region has energy pipelines, railroad tracks which carry many types of HAZMAT, and state highways running through its boundaries. A variety of HAZMAT 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 HAZMAT routes are designated in the Western Region; any routes used to carry HAZMAT 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 do not list material amounts. Extractive industries were identified as the biggest source of HAZMAT within and moving through the Region.

People

HAZMAT 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. 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 HAZMAT 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

Impacts of hazardous material incidents on critical facilities are most often limited to the area or facility where they occurred, such as at a transit station, airport, fire station, hospital, or railroad. There are 12 RMP facilities located throughout the Western Region, as noted in table below. Some of these are discussed in more detail in the county annexes. It should be noted that four of these facilities are located in Missoula County, which is not participating in this planning process.

Table 4-34 RMP Facilities in the Western Region

County	Jurisdiction	Number of Facilities
Flathead	Flathead County	2
Lewis and Clark	Lewis and Clark County	1
Missoula	Missoula County	4
Ravalli	Hamilton	1
Sanders	Sanders County	1
Butte-Silver Bow	Butte-Silver Bow County	3

County	Jurisdiction	Number of Facilities
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. There can be deaths or injuries requiring doctor's visits and hospitalization, disabling chronic injuries, soil and water contamination can occur, necessitating costly remediation. Evacuations can disrupt home and business activities. Large-scale incidents can easily reach $1 million or more in direct damages.

Historic and Cultural Resources

Hazardous material incidents may affect a small area at a regulated facility or cover a large area outside such a facility. Impacts to cultural resources could include contamination of important cultural sites for the tribes of the Western Region. Additionally, loss of access to outdoor recreation opportunities could result from HAZMAT incidents.

Natural Resources

Widespread effects occur when HAZMAT 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 HAZMAT incidents. The number of HAZMAT that are stored, used, and transported across the County may continue to increase over the coming years if regional growth continues.

4.2.9.8 Risk Summary

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

- HAZMAT 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.
- 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. These are located in Flathead, Lewis & Clark, Sanders, Butte-Silver Bow, Ravalli, and Missoula Counties. (Missoula County is not participating in this plan).
- Related Hazards: Cyber- Attack, Human Conflict, Transportation Accidents.

Table 4-35 Risk Summary Table: HAZMAT Incidents

Jurisdiction	Overall Significance	Additional Jurisdictions	Jurisdictional Differences?
Western Region	Low	NA	Major interstates, state highways and rail systems located throughout the study area
Anaconda-Deer Lodge County	Low	NA	BNSF Railways
Beaverhead County	Low	Dillon, Lima	BNSF Railways
Broadwater County	Low	Townsend	BNSF Railways
Butte-Silver Bow County	Low	NA	BNSF Railways, also has a higher concentration of transportation routes. Higher rates of past occurrences in this County. Highest Concentration of RMP facilities
CKST	Low	NA	
Flathead County	Medium	Columbia Falls, Kalispell, Whitefish	BNSF Railways. Has the second highest number of recorded incidents in the Region
Granite County	Low	Drummond, Philipsburg	BNSF Railways
Jefferson County	Low	Boulder, Whitehall	BNSF Railways
Lake County	Low	Polson, Ronan, St. Ignatius	BNSF
Lewis & Clark County	Medium	East Helena, Helena	BNSF Railway and Montana Rail Link and transportation routes concentrated here. Also has the highest number of recorded incidents in the Region
Lincoln County	Low	Eureka, Libby, Rexford, Troy	BNSF Railways
Madison County	Low	Ennis, Sheridan, Twin Bridges, Virginia City	BNSF Railways
Meagher County	Low	White Sulphur Springs	
Mineral County	Low	Alberton, Superior	BNSF Railways
Park County	Low	Clyde Park, Livingston	BNSF Railways
Powell County	Low	Deer Lodge	BNSF Railways
Ravalli County	Low	Darby, Hamilton, Pinesdale, Stevensville	BNSF Railways
Sanders County	Low	Hot Springs, Plains, Thompson Falls	BNSF Railways
Sweet Grass County	Low	Big Timber	BNSF Railways

4.2.10 Landslide

4.2.10.1 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 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. Debris flows are fast-moving landslides that are particularly dangerous to life and property because they move quickly, destroy objects in their paths, and often strike without warning.

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.

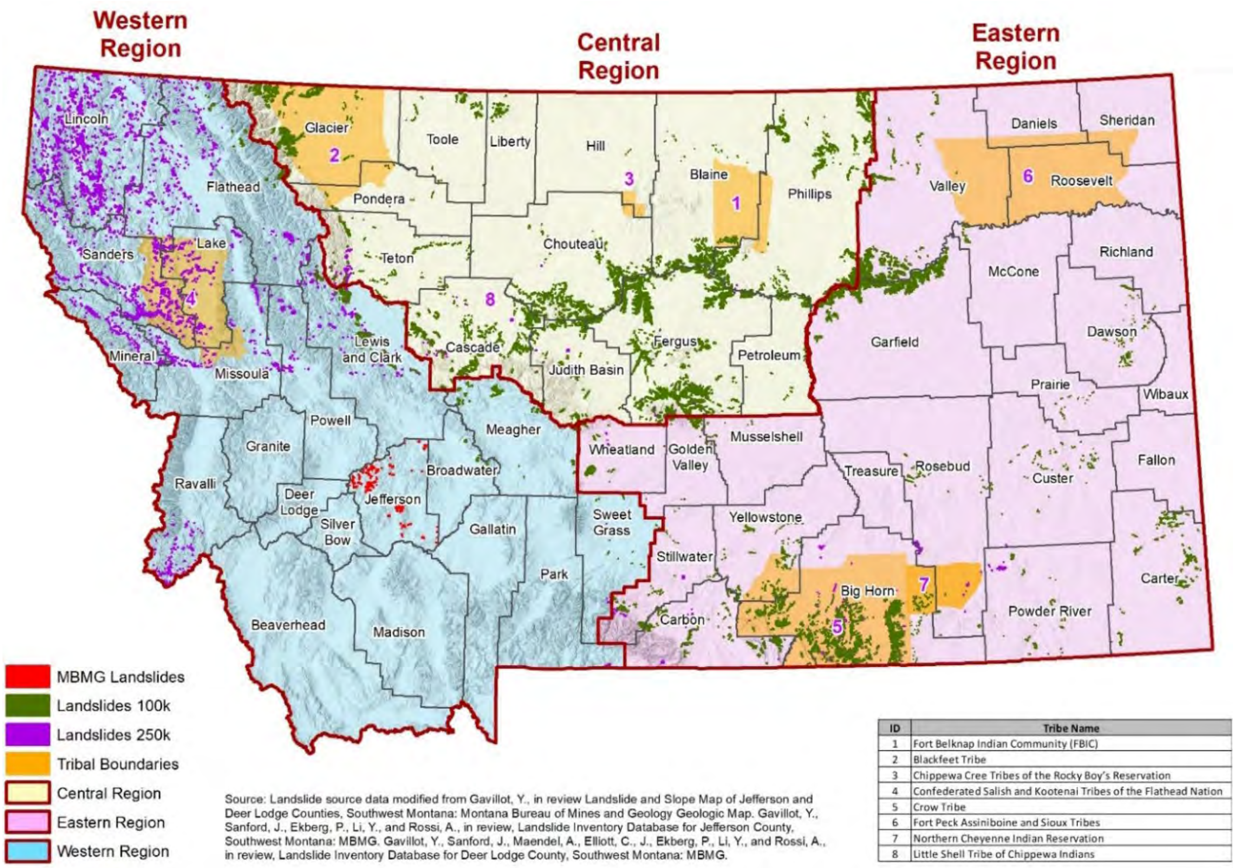
Landslides are typically associated with periods of heavy rainfall or rapid snow melt and tend to worsen the effects of flooding that often accompanies these events. In areas burned by forest and brush fires, a lower threshold of precipitation may initiate landslides, rockfall or other geological events. Freeze-thaw cycles loosen rock on steep slopes, thus many landslides and rockfalls occur in the spring and following wet periods. Large earthquakes, particularly in the rugged mountainous terrain of Western Montana, can trigger numerous and massive landslides.

4.2.10.2 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. Additionally, slopes that have recently suffered wildfires are at increased risk for landslides due to the removal of slope stabilizing vegetation and root structures. Burn scars often see devastating landslides and debris flows following major wildfires.

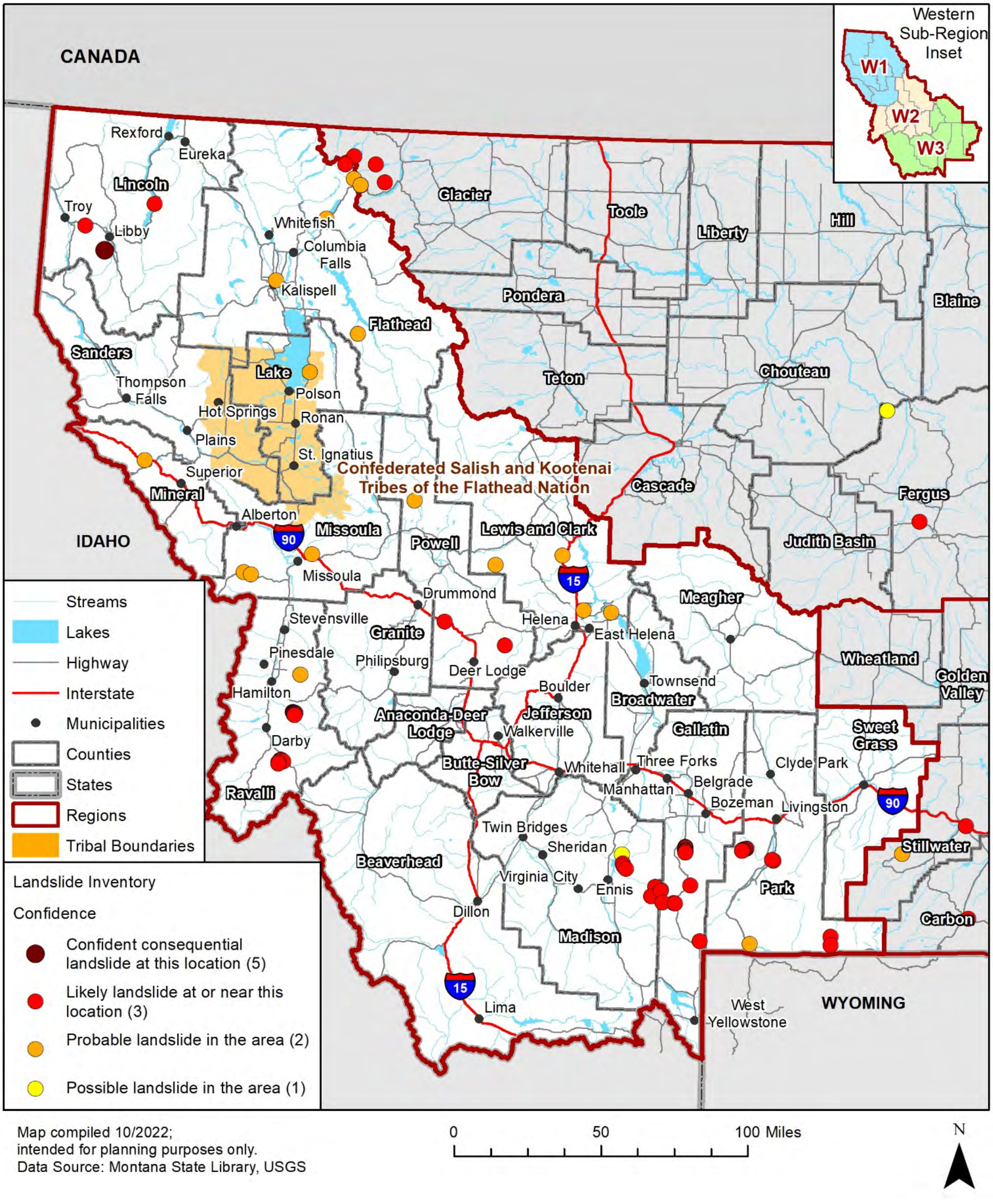
Areas that are typically considered safe from landslides include areas that have not moved in the past, relatively flat-lying areas away from sudden changes in slope, and areas at the top or along ridges, set back from the tops of slopes.

Figure 4-44 Montana Hazard Mitigation Planning Regions and Landslide Hazards



In certain areas of Montana landslides do occur. Over the years, several landslides have been dealt with by the State of Montana and in particular the Montana Department of Transportation (MDT). MDT has spent a lot of time stabilizing landslides throughout the State. The confidence of landslides ranges from possible, probable, and likely in many areas throughout Montana's Western Region.

Figure 4-45 Landslide Inventory Confidence Montana Western Region



4.2.10.3 Past Occurrences

According to the data displayed in Figure 4-45 above, there are a total of 63 confidence markers for past landslides in the participating counties of the Western Region, more than the other two regions of the State combined. Table 4-36 below lists the counties which have recorded past landslides in this database in. Ravalli County has recorded the highest number of past landslide incidents, followed by Park County.

Table 4-36 Past Landslide Inventory in the Western Region

County	Number of Landslides
Ravalli	21
Park	16
Flathead	7
Madison	7
Lewis & Clark	4
Lincoln	3
Powell	3
Lake	1
Mineral	1
Total	**63**

Source: Montana State Library, USGS

Each of these events listed above are typically larger or more impactful landslides, which may occur much more sporadically. Smaller landslides, such as rockfalls or mudslides, may occur much more often throughout the Region on an almost annual basis. The Flathead County HMPC provided details on impacts of past events in their county, including a landslide which occurred in the Still Water State Forest in June 2022. There were roads washed out, damage to timber lands, additional costs travel to recreational locations due to road closures, and environmental impacts to rivers and streams. Impacts such as these are not necessarily unique to Flathead County and can be expected to occur in every county in the Region which experiences a landslide.

One of the most significant landslides in the history of the State of Montana was triggered by the 1959 Hebgen Lake earthquake on August 17, 1959, near the border of Madison and Gallatin Counties. The earthquake measured 7.5 on the Richter magnitude scale (revised by USGS to 7.3) and caused an 80-million-ton landslide, which formed a landslide dam on the Madison River. The earthquake was the most powerful to hit the State of Montana in historic times. The landslide traveled down the north flank of Sheep Mountain, at an estimated 100 miles per hour, killing 28 people who were camping along the shores of Hebgen Lake and downstream along the Madison River (Wikipedia). In less than a month, the landslide dam had created what is now known as Earthquake Lake, or Quake Lake, which remains to this day.

Table 4-37 provides information regarding past landslides in the Western Region of Montana. There has been two federally declared events within the project area from 1974 to present.

Table 4-37 Western Montana Disaster Declarations Involving Landslides

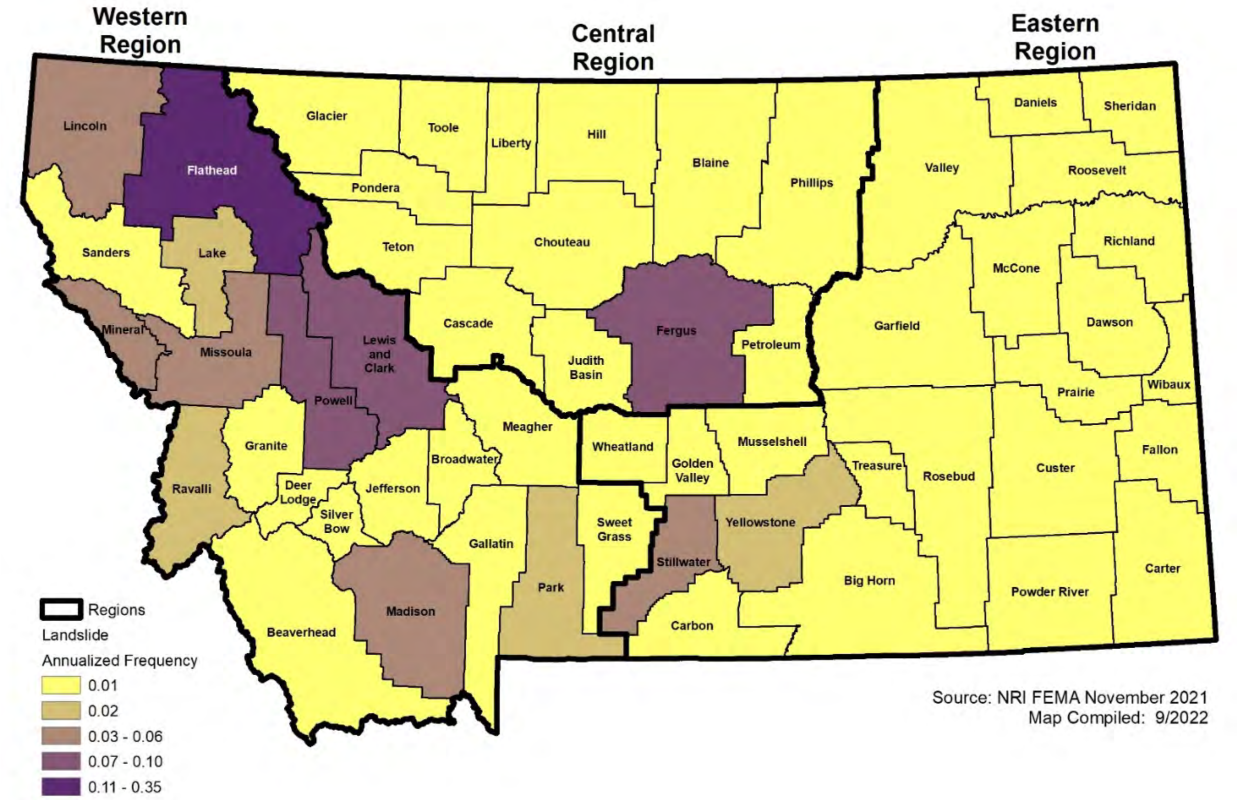
Date	Counties Affected	Comments
January 29, 1974 DR-417	Anaconda-Deer Lodge, Flathead, Lincoln, Mineral, Sanders	A disaster declaration was declared after severe storms, landslides, and flooding in the affected areas.
March 15, 1986 DR-761	Anaconda-Deer Lodge, Granite, Powell, Sanders	A disaster declaration was declared after heavy rains, landslides, and flooding in the affected areas.

4.2.10.4 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 is 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.

According to the NRI, Flathead County has the highest expected annualized frequency for landslides in the Western Region, followed by Powell and Lewis & Clark Counties. The expected frequency results for the Western Region are shown in Figure 4-46 below.

Figure 4-46 NRI Annualized Landslide Frequency Montana Statewide



4.2.10.5 Climate Change Considerations

Landslides or debris flows can be triggered by climatic events, such as periods of intense rainfall and runoff events. Projected climate change-associated variance in rainfall events may result in more high intensity events, which may increase landslide frequency. In addition, the increased potential of wildfire occurrence also escalates the risk of landslide and debris flows in the period following a fire, when slopes lack vegetation to stabilize soils and burned soil surfaces create more rainfall runoff. As climate change affects the length of the wildfire season, it is possible that a higher frequency of large fires may occur into late fall, when conditions remain dry, and then be followed immediately by more intense rainfall in the winter and spring months.

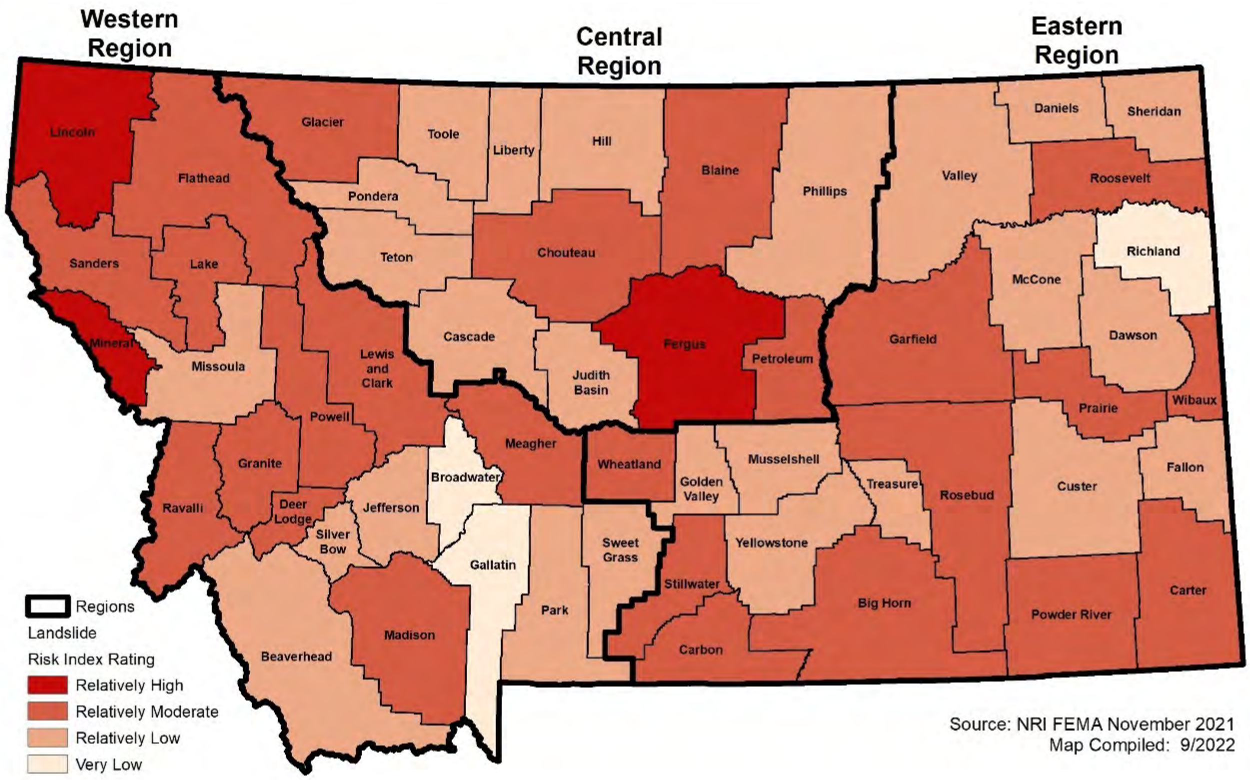
4.2.10.6 Potential Magnitude and Severity

The extent of landslides and debris flow events within the Western 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 U.S. 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.

4.2.10.7 Vulnerability Assessment

Figure 4-47 depicts the overall RIs rating for landslide at a county level based on the NRI. The mapping shows that most of the Western Region is rated as relatively moderate to high. Lincoln and Mineral Counties are rated as having the highest relative risk for landslides overall. Flathead, Sanders, Lake, Powell, Lewis & Clark, Granite, Ravalli, Anaconda-Deer Lodge, Meagher, and Madison Counties are each rated as relatively moderate risk for landslides.

Figure 4-47 Risk Index Rating for Landslide by County



People

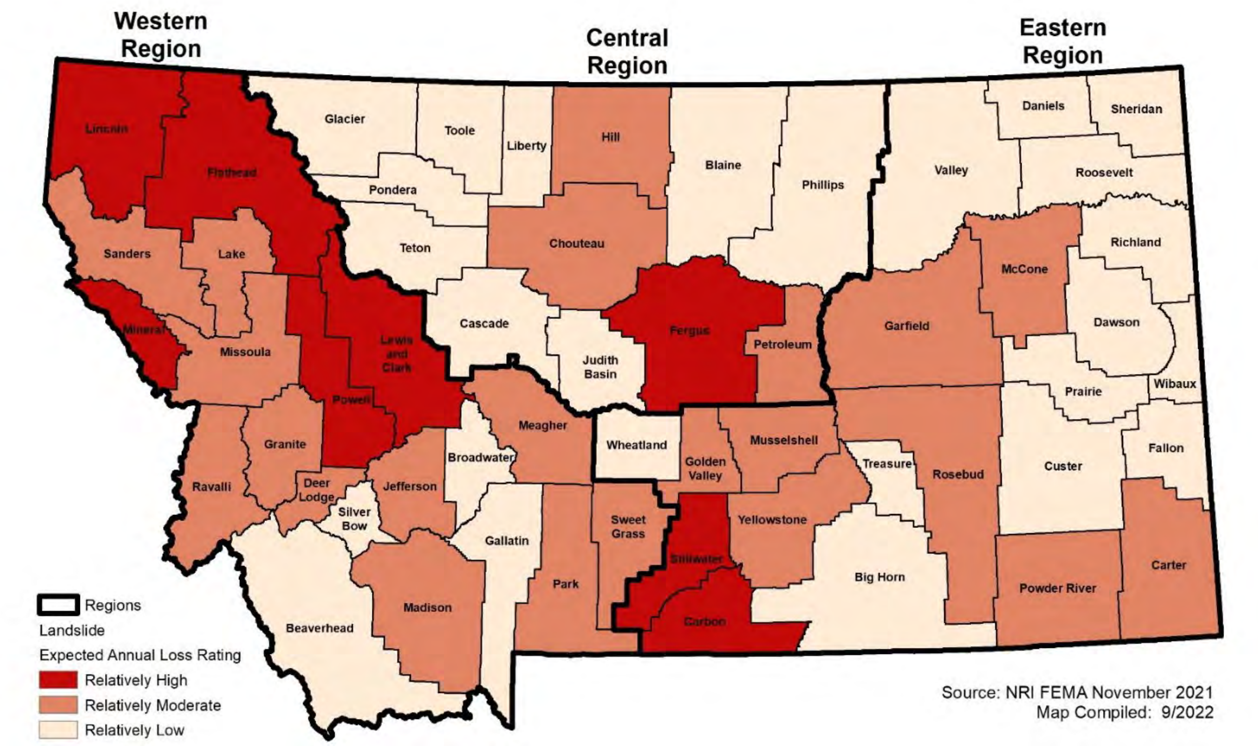
People exposed to landslide hazards are most at risk to death or injury from these hazards. This includes not only people residing in areas prone to landslides but also outdoor recreationists and travelers in the Region. There have been no recorded deaths or injuries due to landslides in Montana, so the likelihood of this in the future is minimal, but still possible. Landslides typically result in property damage, not risk to human life. However, injuries could occur to those traveling in a vehicle where rockfall has a higher confidence of occurring.

Property

Landslides directly damage engineered structures 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 Western Region several counties, Lincoln, Flathead, Powell, Mineral, and Lewis & Clark Counties, have an EAL rating due to landslides of relatively high. This is then followed by Sanders, Lake, Ravalli, Granite, Anaconda-Deer Lodge, Jefferson, Meagher, Madison, Park, and Sweet Grass Counties with a relatively moderate estimation of annualized losses due to landslide damages. The other three counties in the Western Region have an EAL of relatively low damages due to landslide hazards. The risk for each county in the Western Region is detailed in Figure 4-48.

Figure 4-48 NRI Expected Annual Loss Rating Montana Statewide



Critical Facilities and Lifelines

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. 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. Large detours could result for periods of time while roads are cleared and repaired.

Extension, bending, and compression caused by ground deformation can break lifelines. Failure of any component along the lifeline can result in failure to deliver service over a large region. Once broken, transmission of the commodity through the lifeline ceases, which can have catastrophic repercussions down the line: loss of power to critical facilities such as hospitals, impaired disposal of sewage, contamination of water supplies, disruption of all forms of transportation, release of flammable fuels, and so on. Therefore, the overall impact of lifeline failures, including secondary failure of systems that depend on lifelines, can be much greater than the impact of individual building failures.

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. Also, tourism can be interrupted as well.

Historic and Cultural Resources

In general, historic structures would likely have similar levels of vulnerability to landslide as all other property types. The biggest impact would likely be on older properties such as wooden or masonry buildings.

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 Western Region has a much higher risk for landslides and other geological hazards in comparison to the entire State of Montana. The mountainous terrain, steep hillsides, and narrow valleys commonly found throughout the Western Region makes processes such as landslides and debris flows more likely. As counties such as Flathead, Lewis & Clark, and Ravalli see sustained large growth in population and housing units the exposure to this hazard could increase as well unless careful consideration of landslide hazards is included in land use decisions. Steps to mitigate these risks should be taken as the Western Montana Region accommodates future growth, such as mapping of hazard areas, adoption and enforcement of engineering and building codes for soil hazards, and ordinances to limit development on steep slopes.

4.2.10.8 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 Lincoln, Flathead, Powell, Mineral, and Lewis & Clark Counties, have an EAL rating due to landslides of relatively high. Sanders, Lake, Ravalli, Granite, Anaconda-Deer Lodge, Jefferson, Meagher, Madison, Park, and Sweet Grass 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 and often alternate routes can result in long detours.
- Large earthquakes, particularly in the rugged mountainous terrain of Western Montana, can trigger numerous and massive landslides.
- Related Hazards: Earthquake, Floods, Severe Summer Weather, Wildland and Rangeland Fire.

Table 4-38 Risk Summary Table: Landslide

Jurisdiction	Overall Significance	Additional Jurisdictions	Jurisdictional Differences?
Western Region	Low	N/A	N/A

Jurisdiction	Overall Significance	Additional Jurisdictions	Jurisdictional Differences?
Anaconda-Deer Lodge	Low	N/A	N/A
Beaverhead	Low	City of Dillon, Town of Lima	N/A
Broadwater	Medium	City of Townsend	N/A
Butte-Silver Bow	Low	Town of Walkerville	N/A
CSKT	High	N/A	N/A
Flathead	Medium	Columbia Falls, Kalispell, Whitefish	Flathead has the greatest expected annual frequency. Estimated annual losses are also expected to be high in Flathead County
Granite	Low	Towns of Drummond and Philipsburg	None
Jefferson	Low	City of Boulder, Town of Whitehall	None
Lake	Medium	City of Polson, City of Ronan, Town of St. Ignatius	Risk and likelihood for future events is generally moderate in Lake County
Lewis and Clark	Medium	City of Helena, City of East Helena	Estimated annual losses are expected to be high in Lewis & Clark County
Lincoln	Low	City of Libby, City of Troy, Town of Eureka	Estimated annual losses are expected to be high in Lincoln County, as is the general RIs
Madison	Low	Town of Ennis, Town of Sheridan, Town Virginia City	None
Meagher	Low	City of White Sulphur Springs	N/A
Mineral	Medium	N/A	Estimated annual losses are expected to be high in Mineral County, as is the general RIs
Park	Low	City of Livingston, Town of Clyde Park	None
Powell	Medium	City of Deer Lodge	Estimated annual losses are expected to be high in Powell County
Ravalli	Medium	City of Hamilton, Town of Darby, Town of Stevensville	Ravalli has seen the highest recorded number of suspected previous landslides
Sanders	Low	City of Thompson Fall, Town of Plains, Town of Hot Springs	None
Sweet Grass	Low	City of Big Timber	N/A

4.2.11 Severe Summer Weather

4.2.11.1 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 "Heat Index" is a measure of the effect of the combined elements on the body. 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 death by overworking the human body. Extreme Heat often results in the highest number of annual deaths among all weather-related hazards.

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. 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 Western Region.

Heavy Rain

Heavy rain is typically associated with thunderstorm conditions and can result in flash flooding. The reviewed history of heavy rain events in the Western 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 further the accumulation of flash flooding. It is rarely reported in Montana that flash floods cause an accumulation of water in structures in the planning area.

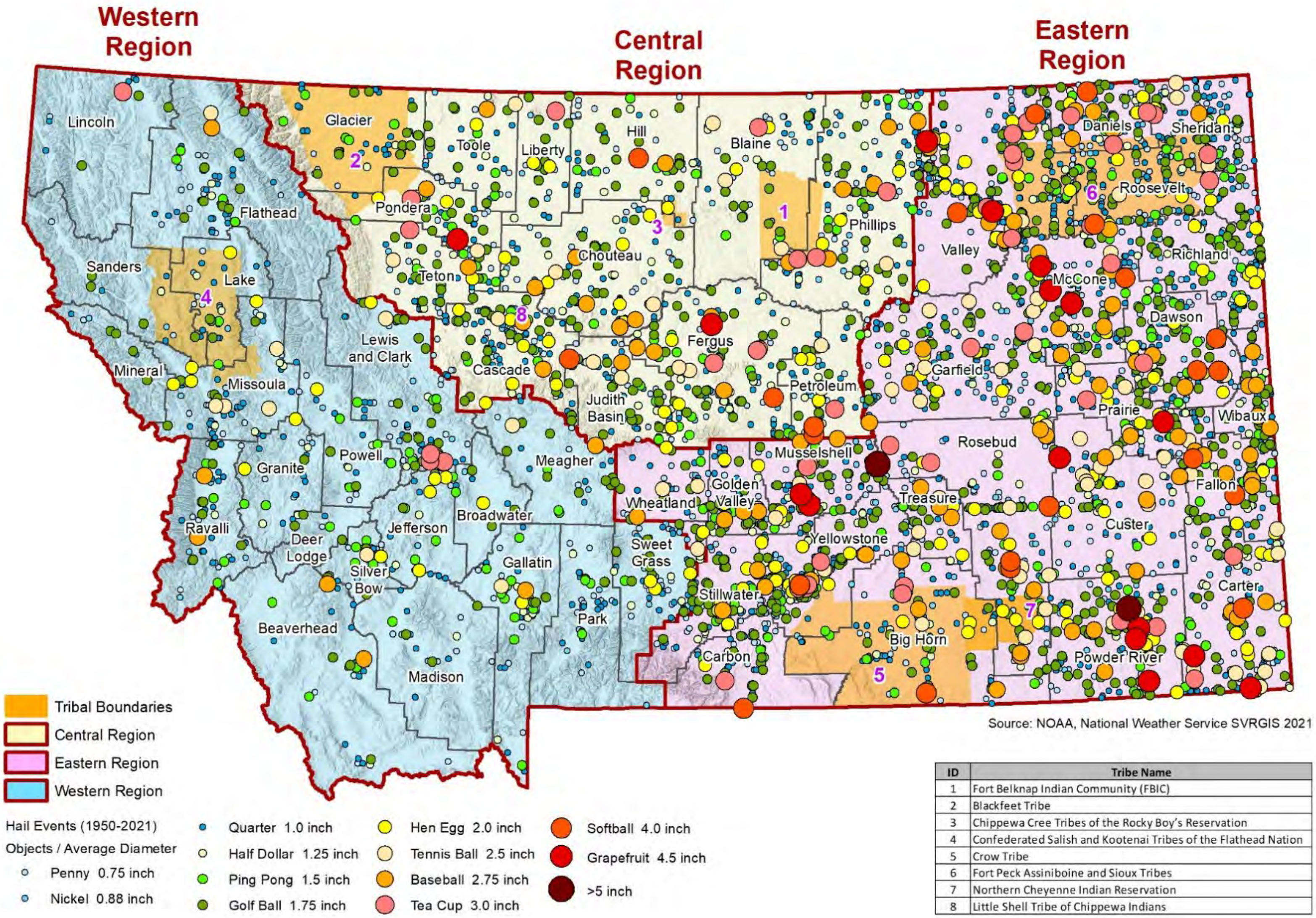
Lightning

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 flash of light usually occurs within the clouds or between the clouds and the ground. Lightning's electrical charge and intense heat can electrocute on contact, split trees, ignite fires, and cause electrical failures. A visible electrical discharge produced by a thunderstorm. The discharge may 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.

4.2.11.2 Geographical Area Affected

The geographic extent of summer weather is **Extensive**. The entire Western 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 4-49 below displays the weather history in the State of Montana.

Figure 4-49 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

4.2.11.3 Past Occurrences

The NCEI database was used to gather information on historic severe summer weather events in the Western 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 Confederated Salish and Kootenai Tribes of the Flathead Nation is 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 Western Region. Only lightning events have resulted in casualties. Excessive heat events had no reported damages in the NCEI dataset.

Table 4-39 Summary of Historic Summer Weather Events

	Deaths	Injuries	Property Loss	Crop Loss	Days with Events	Total Events
Excessive Heat	0	0	$0	$0	4	9
Hail	0	0	$2,394,100	$210,100	368	897
Heavy Rain	0	0	$42,000	$0	51	110
Lightning	1	12	$492,000	$0	16	17
Total	1	12	$2,928,100	$210,100	439	1,033

Source: NCEI

There are variations in losses and frequency of hazards across the Western Region. According to the NCEI database, the counties of Sweet Grass, Lewis and Clark, and Flathead experienced significantly more hail events than the rest of the planning area. Lewis and Clark County also experienced the greatest number of reported heavy rain events in the planning area, followed by Beaverhead County. Seven counties have reported previous lightning events. The only county with documented excessive heat events is Flathead County. Table 4-40 and Figure 4-50 display the summary of total severe weather events by county.

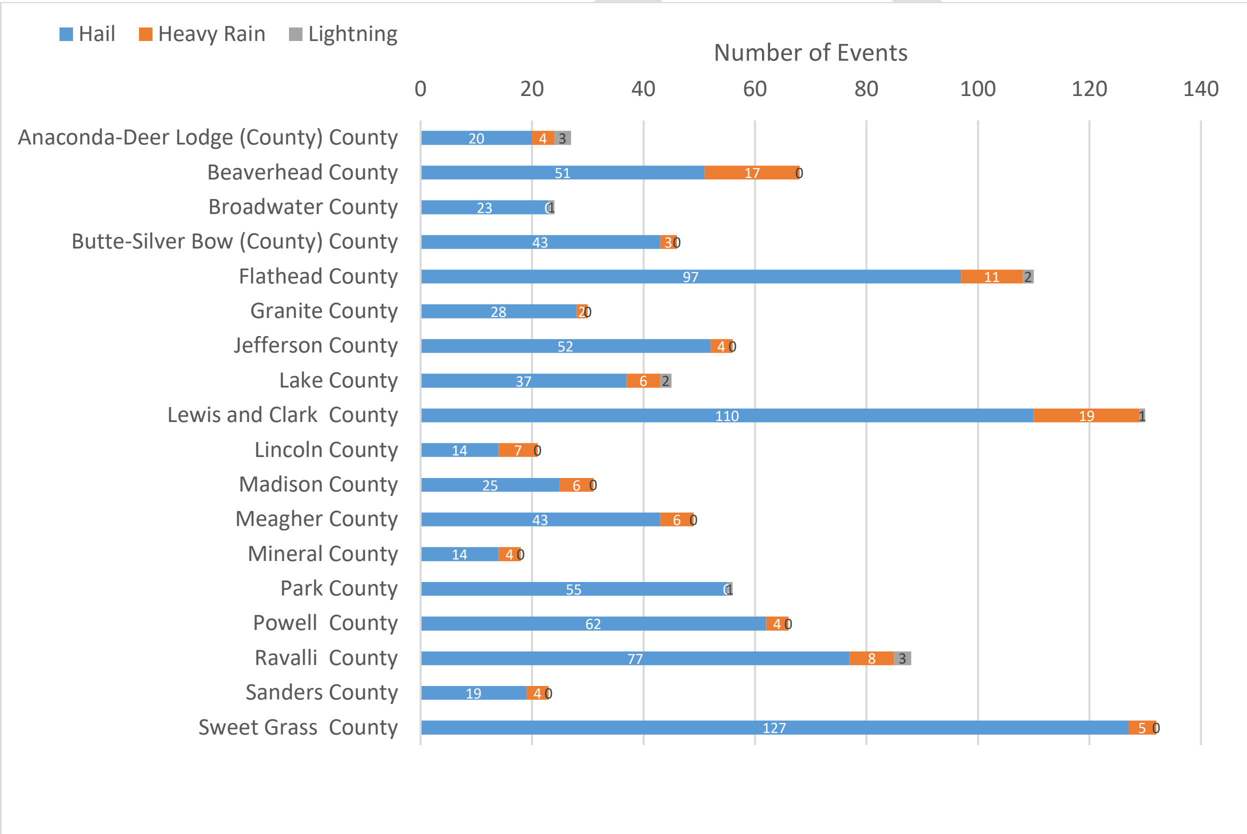
Table 4-40 Summary of Severe Summer Weather Events by County in the Western Region

	Excessive Heat	Hail	Heavy Rain	Lightning
Anaconda-Deer Lodge	0	20	4	3
Beaverhead	0	51	17	0
Broadwater	0	23	0	1
Butte-Silver Bow	0	43	3	0
Flathead	1	97	11	2
Granite	0	28	2	0
Jefferson	0	52	4	0
Lake	0	37	6	2
Lewis and Clark	0	110	19	1

	Excessive Heat	Hail	Heavy Rain	Lightning
Lincoln	0	14	7	0
Madison	0	25	6	0
Meagher	0	43	6	0
Mineral	0	14	4	0
Park	0	55	0	1
Powell	0	62	4	0
Ravalli	0	77	8	3
Sanders	0	19	4	0
Sweet Grass	0	127	5	0
Total	**1**	**897**	**110**	**13**

Source: NCEI

Figure 4-50 Summary of Severe Summer Weather Events by County in the Western Region



Source: NCEI, Chart by WSP

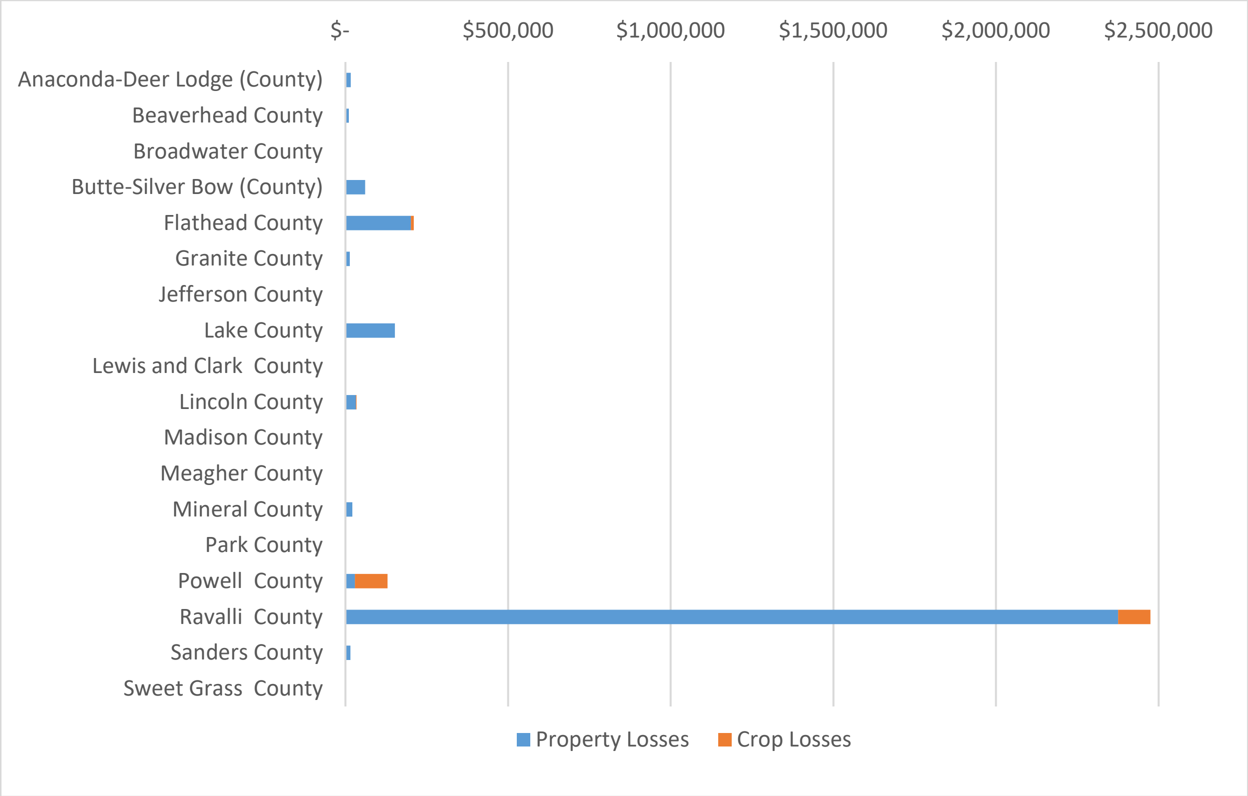
There are also variations between counties in the Western Region in terms of losses from severe summer weather events. A summary of losses reported by the NCEI dataset by county is displayed in Table 4-41 and Figure 4-51. Based on this data, Ravalli County has experienced the greatest property loss. Ravalli and Powell Counties have experienced the greatest crop loss from severe summer weather events. All crop losses and the majority of the property losses are due to hail events in the Western Region. There have also been 12 reported injuries due to lightning in the Western Region, and one death due to lightning in Broadwater County.

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

	Deaths	Injuries	Prop. Loss	Crop Loss
Anaconda-Deer Lodge	0	3	$16,000	-
Beaverhead	0	0	$10,000	-
Broadwater	1	0	-	-
Butte-Silver Bow	0	0	$60,500	-
Flathead	0	0	$201,600	$8,600
Granite	0	0	$13,000	-
Jefferson	0	0	-	-
Lake	0	0	$152,000	-
Lewis and Clark	1	5	$2,000	-
Lincoln	0	0	$32,500	$1,500
Madison	0	0	-	-
Meagher	0	0	-	-
Mineral	0	0	$21,000	-
Park	0	3	-	-
Powell	0	0	$29,500	$100,000
Ravalli	0	1	$2,375,000	$100,000
Sanders	0	0	$15,000	-
Sweet Grass	0	0	-	-
Total	**1**	**12**	$2,928,100	$210,100

Source: NCEI

Figure 4-51 Summary of Severe Summer Weather Events by County in the Western Region



Source: NCEI, Graph by WSP

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

- August 4, 2002 (Ravalli County): Supercell thunderstorm formed over the Bitterroot Valley near Hamilton and moved north through the valley, impacting the communities of Stevensville to Florence. Extensive damage to property and crops was caused by large hail up to golf ball size, and strong winds in the Stevensville area. Property damage was $2 million and crop damage was $100,000. State snowplows had to be called out to clear several miles of Highway 93 from Stevensville turnoff north towards Florence. Houses, garages, and farm outbuildings were damaged by falling trees, flying debris, hail, and wind. The hail stripped trees bare, smashed windows, dented cars, bruised and cut horses as well as blew fruit off trees.
- August 3, 2003 (Lewis and Clark County): Five people were injured by a lightning bolt; one adult suffered serious bruising and trauma.
- September 9, 2005 (Anaconda-Deer Lodge): Three high school golfers were struck by lightning at a golf tournament at the Anaconda Country Club. One boy was not breathing and had no pulse prior to CPR, and he spent a few days in the hospital. The other two golfers were not seriously injured.
- May 18, 2007 (Broadwater County): Lightning event associated with a cold front killed a man who was in a boat fishing on Canyon Ferry Reservoir.
- July 26, 2011 (Park County): Scattered thunderstorms moved across southern Park County during the late afternoon hours of Tuesday July 26, resulting in three people injured to different degrees.
- July 17, 2013 (Flathead County): A mid-level southwest 50 knot jet combined with high moisture and very warm temperatures provided the prime environment for strong supercells. These cells brought both severe wind and hail. The hail event resulted in $100,000 of property damage.

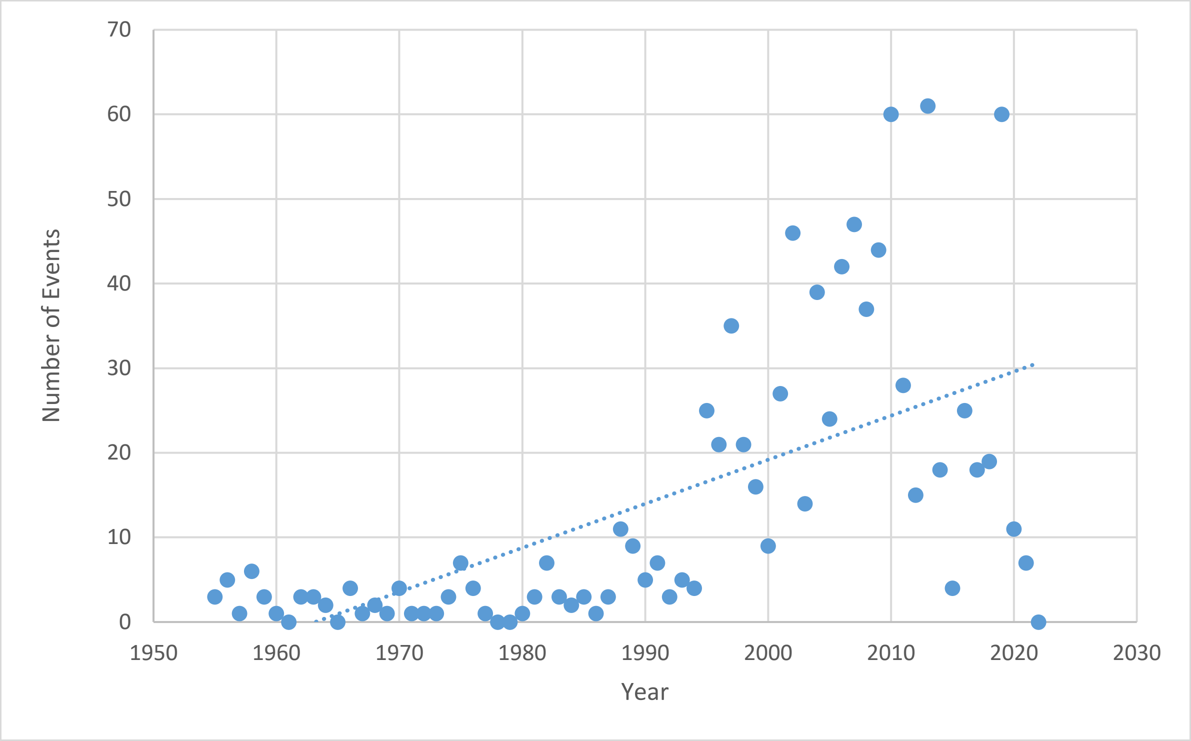
4.2.11.4 Frequency/Likelihood of Occurrence

The frequency of severe summer weather events in the Western Region is ranked as **Highly Likely** All counties in the planning area are likely to experience a severe summer hazard yearly. Since 1955, 1,033 severe summer weather events over 439 days have been recorded in the Western Region. As discussed above, there are variations in frequency and severity of damage from severe summer weather across the Western Region. The counties of Beaverhead, Park, and Sweet Grass were rated as a few counties in Montana with the highest exposure to severe weather in the 2018 State HMP. As shown above in the NCEI data demonstrated, Flathead, Lewis and Clark, and Sweet Grass Counties experience a higher frequency of reported events than the rest of the Counties in the Western Region.

A total of 897 hail events on 368 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 Western Region, all counties are likely to experience at least one hail event per year. Counties such as Broadwater and Granite averages less than one extreme hail event per year, while some counties, such as Sweet Grass and Lewis and Clark Counties, average more than one and sometimes two hail events per year. Figure 4-52 displays the trend of hail events by year in the Western Region, showing a generally increasing trend in the frequency of hail events from 1955 to 2021.

While all counties in the Western 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, Anaconda-Deer Lodge County and Ravalli County most frequently experience damaging lightning events, while many 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.

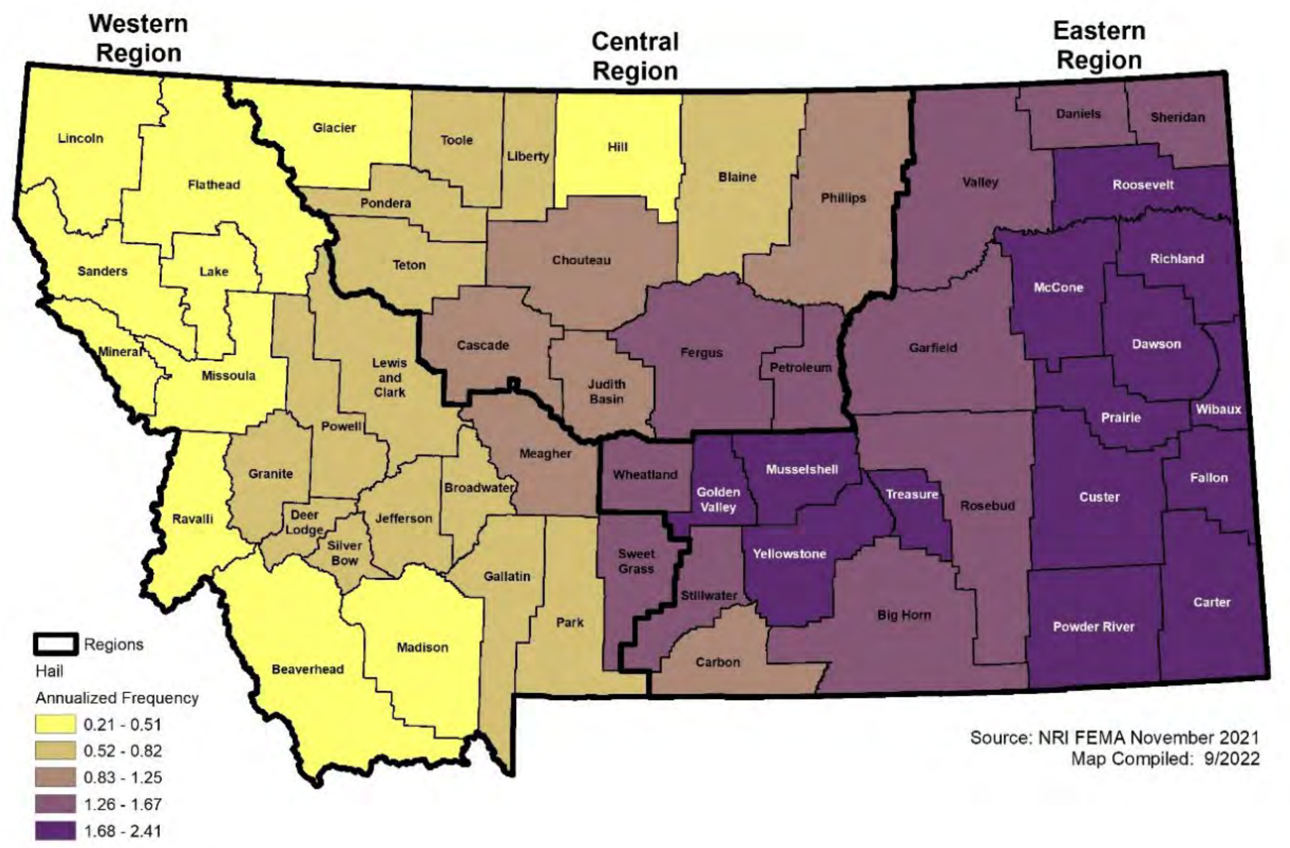
Figure 4-52 Hail Events by Year in the Western Region (1955-2021)



Source: NCEI, Chart by WSP

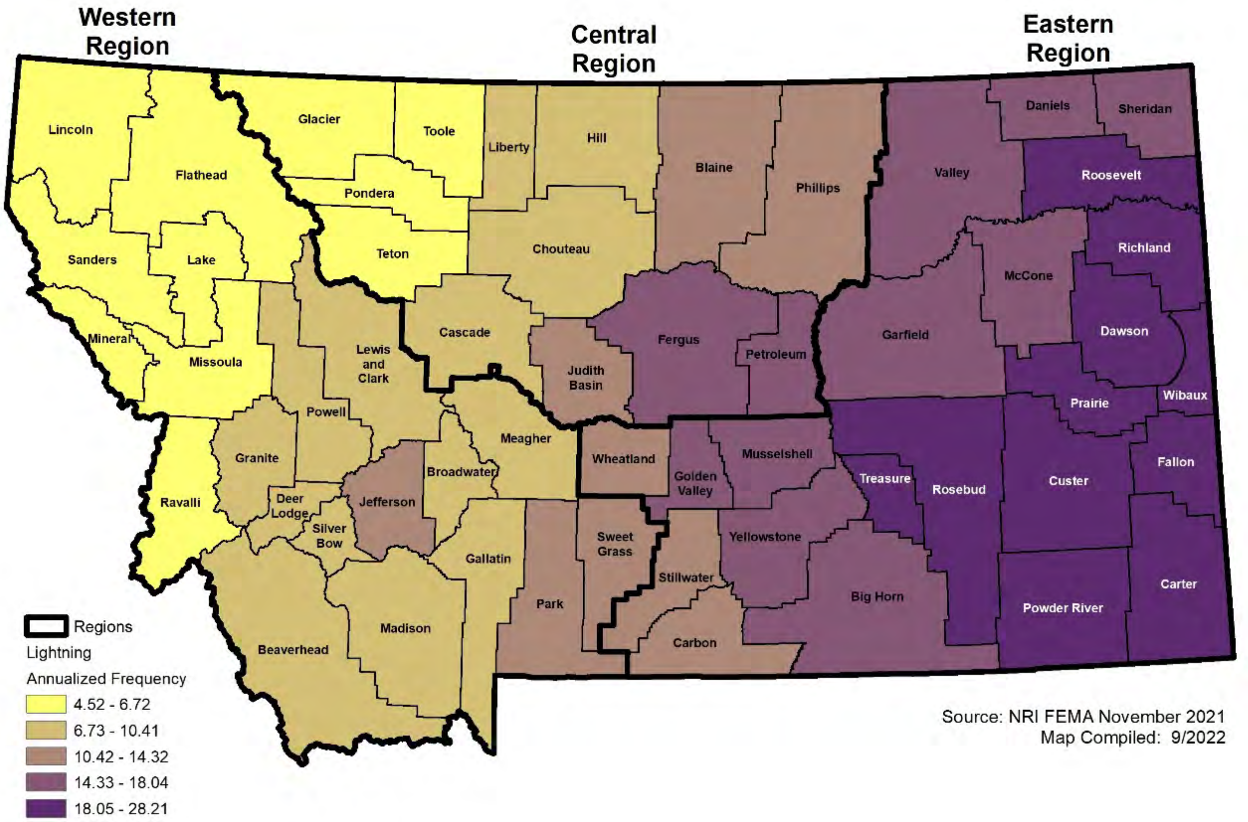
The figures below depict annualized frequency of hail and lightning at a county level based on the NRI. The mapping shows a trend towards increased likelihood in the southeastern portions of the Region.

Figure 4-53 NRI Annualized Frequency of Hail Events by County



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

Figure 4-54 NRI Annualized Frequency of Lightning Events by County



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

4.2.11.5 Climate Change Considerations

The frequency of severe weather events has increased steadily over the last century. According to the 2018 State of Montana Hazard Mitigation Plan, the number of weather-related disasters during the 1990s was four times that of the 1950s and cost 14 times as much in economic losses. Historical data shows that the probability of severe weather events increases in a warmer climate. There has been a sizable upward trend in the number of storms causing large financial and other losses. Climate change presents a challenge for risk management associated with severe weather.

Moreover, according to the 2018 State of Montana Hazard Mitigation Plan, Montana has seen an uptick in average temperature of about 2 degrees F in the last 50 years, while precipitation has stayed largely the same. At the same time, temperatures at the extremes – the absolute coldest and absolute warmest temperatures of the year have shifted upwards by about 10 degrees for the absolute low, with more days falling into the hotter extreme as well. These are observations supported by scientists who received a Nobel Prize in Physics.

In addition, the 2018 State of Montana Hazard Mitigation Plan also mentions that projected changes in summer and fall precipitation are small; however, the number of days with heavy precipitation is expected to increase by mid-century. The HMPC noted that for Flathead County, an increase in the number of days with severe summer weather could be a significant issue, while new buildings are constructed with AC, it is common for residents living in older buildings to not have AC due to the usually mild summers.

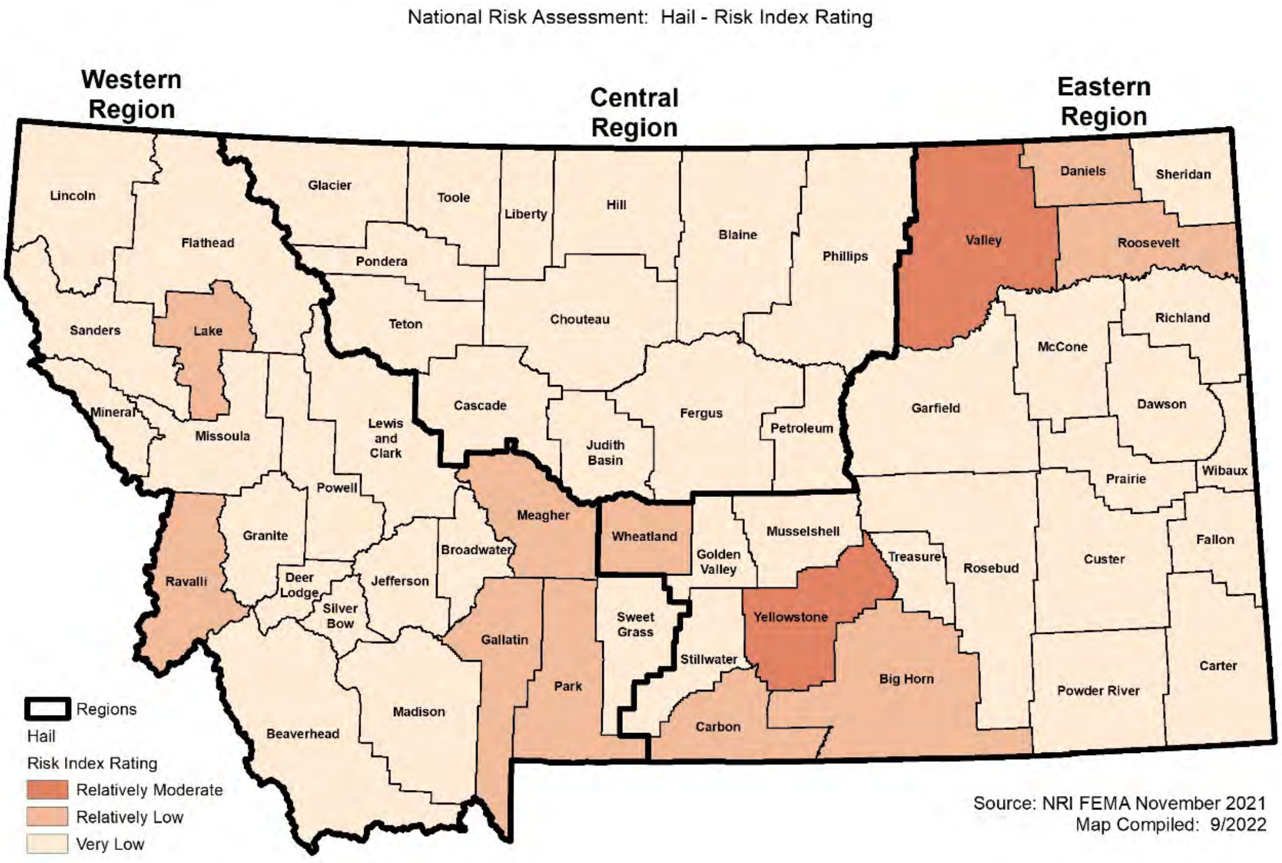
4.2.11.6 Potential Magnitude and Severity

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 Western Region; therefore, severity of summer weather is ranked as **Critical** for the Western 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 Western Region alone, one fatality, 12 injuries, $2,928,100 in property damages and $210,100 crop damages have been recorded since 1955.

4.2.11.7 Vulnerability Assessment

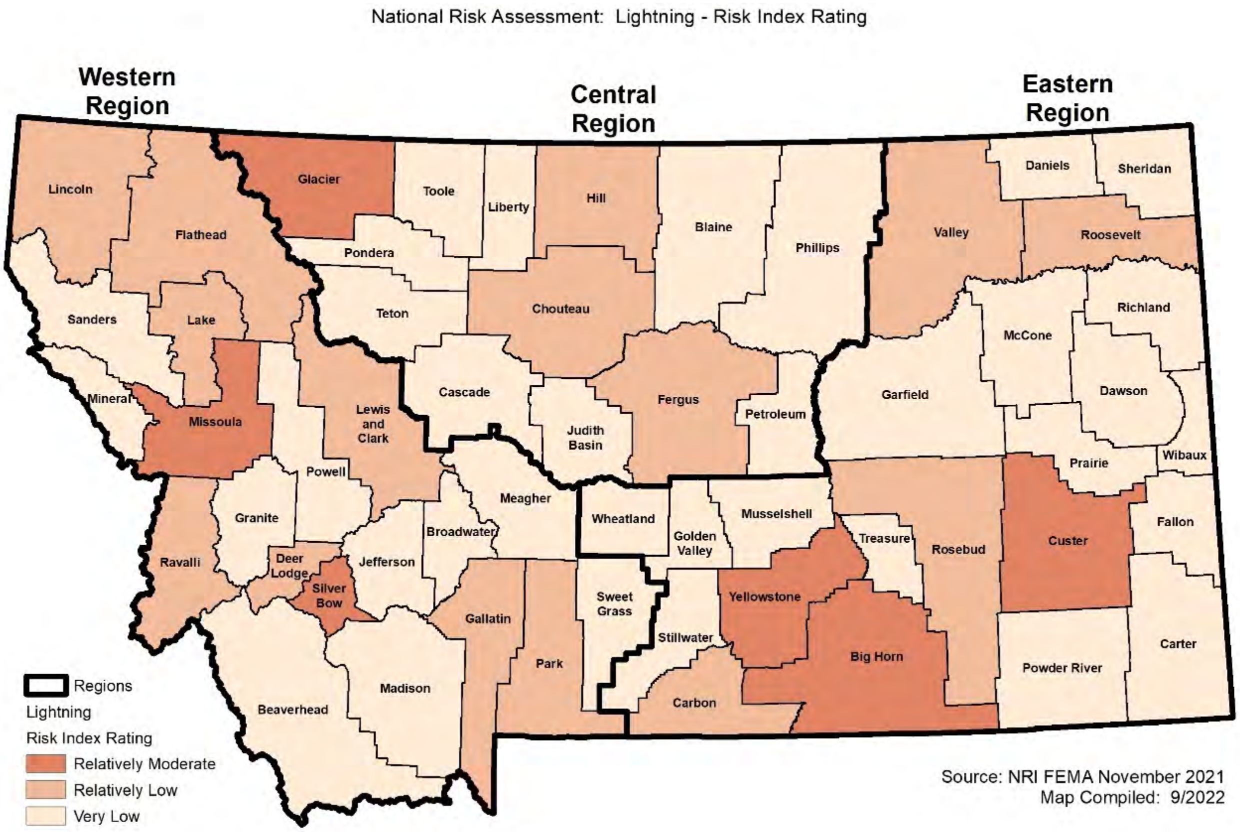
The figures below illustrate the relative RIs rating to hail and lightning events for Montana counties based on data in the NRI. The RI calculation takes into account various factors, including the EALes from these events, social vulnerability, and community resilience in each county across Montana. Most counties in the Region have a relatively low to moderate rating; none have a high or very high RI rating.

Figure 4-55 NRI Risk Index Rating for Hail



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

Figure 4-56 NRI Risk Index Rating for Lightning



People

According to the Center for Disease Control (CDC), extreme heat is one of the leading causes of weather-related deaths in the United States. In the absence of shelter, any summer storm can pose a threat to people stuck outside. Although all people may be affected by the health-related impacts of severe summer weather, the elderly, young children, and people with weakened immune systems are often the most susceptible. Additionally, residents living in dense urban areas are disproportionately impacted by heat due to the "heat island effect", where city buildings and roads absorb more heat than vegetation and therefore cities are at a higher risk of extreme temperatures. Hail can cause serious injuries to unprotected people. Similarly, outdoor enthusiasts and workers are most vulnerable to lightning strikes. Individuals without proper air conditioning or shelter, especially members of the population who are 65 years and older, are most vulnerable to extreme heat events due to the stress that long-term high temperatures put on the body. Heavy rain will generally not cause injuries but could pose a threat to commuters if the event results in flash flooding.

Property

All outdoor property is equally at risk of severe summer weather events. Roofs, windows, and cars are frequently reported as receiving damage in a hail event. One of the most significant damaging property events from severe summer weather events occurred when a severe hail event significantly damaged houses, garages, vehicles, and farms in Ravalli County. Estimated damages reached $2,100,000. Fire due to lightning strikes has also been known to cause property damage in the Western Region. Reported events have happened in Anaconda-Deer Lodge County, Lake County, and Ravalli County. There were four reported instances of lightning damaging houses and stores. While there are no reported property damages from excessive heat, heat can expand metal and cause infrastructural defects. Heavy rain that results in flash flooding or standing water can cause significant damage to a foundation of a home. The NCEI database shows previous occurrences of heavy rain events during which secondary hazards including flooding and landslide hazards happened, resulting in properties such as houses being flooded and damaged.

Critical Facilities and Lifelines

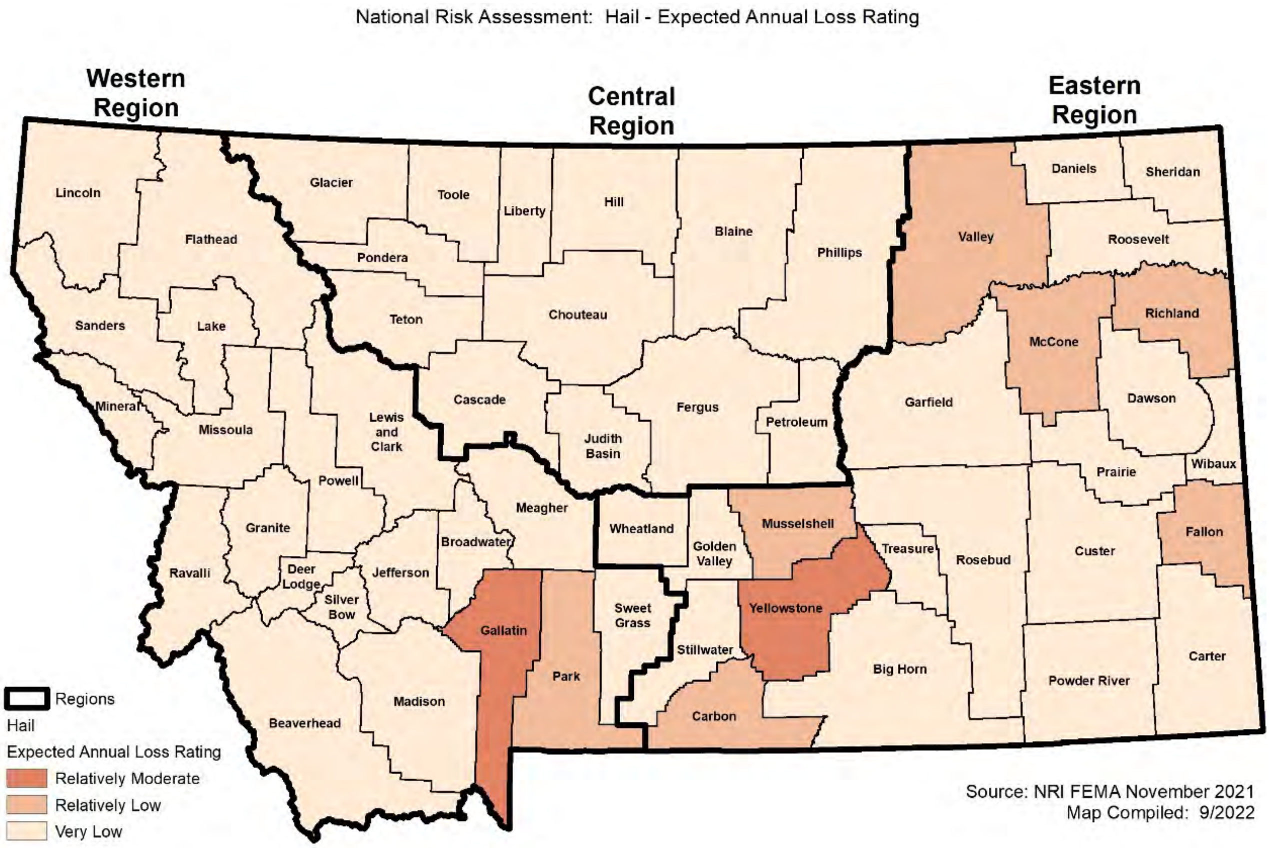
All infrastructure and critical facilities are equally at risk since severe storms indiscriminately affect the entire planning area. Extreme heat can cause infrastructural defects when structures are made of materials that expand under extreme heat, such as wood and metal. Roads have been known to crack under extreme heat conditions. It is also possible for power transformers to detonate and cause fires, as well as general failures within the electric system due to sagging power lines that can result in blackouts. Hail and heavy rain can also accumulate along highways and prevent commuters and emergency responders from traveling quickly and safely.

Economy

As seen from the NCEI dataset, severe summer storms can result in significant economic losses, particularly hail. Losses can be seen when severe storm events cause direct damage to property or crops, but indirect losses can be a result of these storms as well. The 2018 State of Montana Hazard Mitigation Plan notes that increasing extreme temperature events will impact tourism in the future and reduce revenue from tourists. Businesses will need to close, and commuters will be unable to drive to work due to flash flooding or extreme hail events. These will result in disruption in local economies.

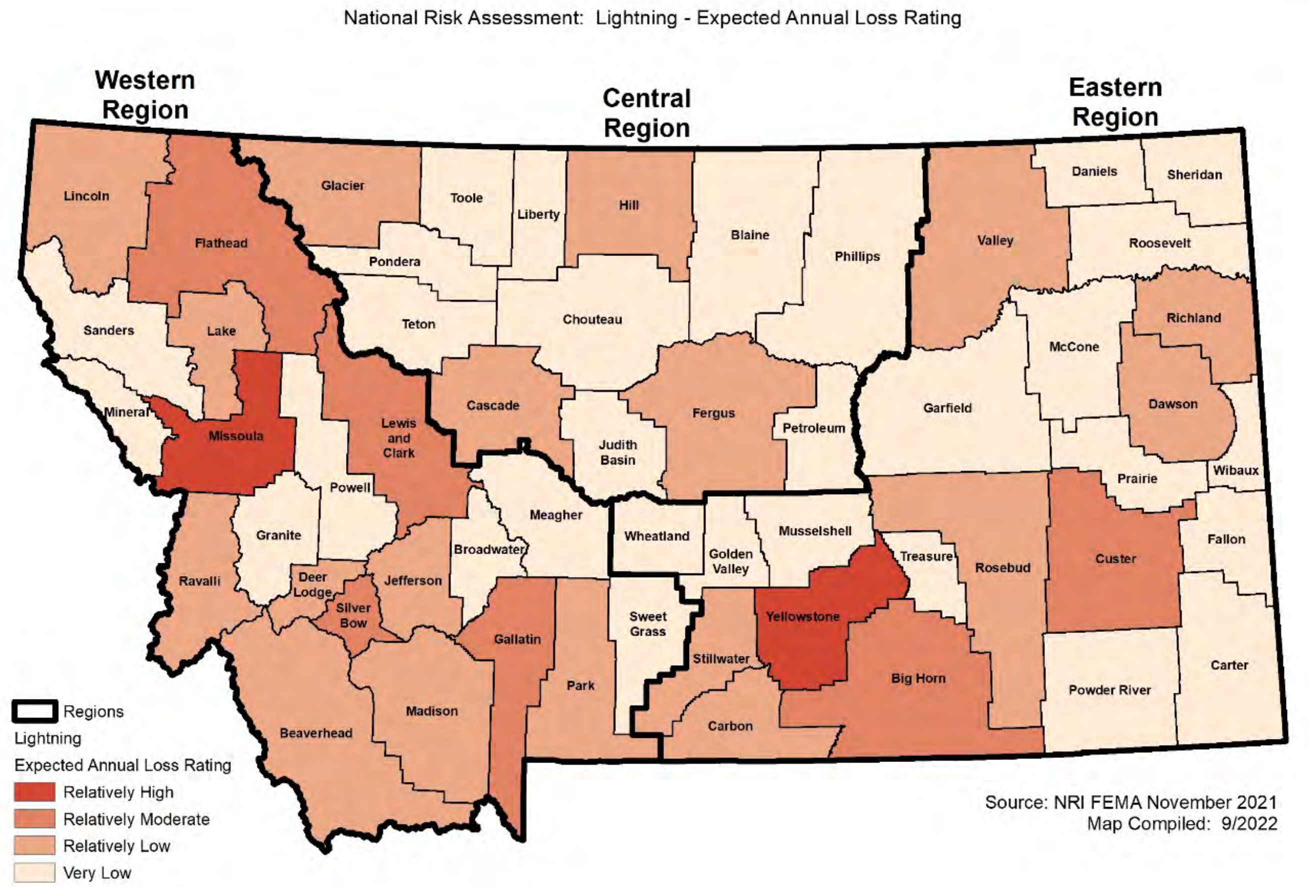
The figures below illustrate the relative risk of EAL rating due to hail and lightning for Montana counties based on data in the NRI. For hail, all counties except Gallatin County in the Region have a very low or low EAL rating. Gallatin County has a relatively moderate EAL rating. For lightning, Missoula County has a relatively high rating, and Flathead, Lewis and Clark, Silver Bow and Gallatin Counties have a relatively moderate rating. Missoula County, however, is not included in the planning area. All other counties are rated as relatively low or very low. The EAL calculation considers agriculture value exposed to hail and lightning, annualized frequency for hail and lightning, and historical losses.

Figure 4-57 NRI Hail Expected Annual Loss Rating



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

Figure 4-58 NRI Lightning Expected Annual Loss Rating



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

Historic and Cultural Resources

Historic and cultural resources are equally as exposed to severe weather events as any other infrastructure. Buildings in poor condition or that are not built to code are more likely to experience damage from severe weather events.

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 Powell and Ravalli Counties. Lightning has also been documented to strike trees and cause fires, which can impact vegetation and crops.

Development Trends Related to Hazards and Risk

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. Additionally, as temperatures continue to rise and city infrastructure is developed, there is an increasing threat of heat-related illness to people living in urban areas. Incorporating green spaces in urban areas and using building materials that are more reflective or lighter in color are some ways to mitigate the impacts of urban heat islands.

4.2.11.8 Risk Summary

- The hazard significance of severe summer weather (excessive heat, hail, heavy rain, and lightning) in the Western Region is ranked as **Medium.**
- The entire Western Region can be impacted by severe summer weather; therefore, the geographic extent is rated as **Extensive.**
- The NCEI dataset recorded 439 days of severe summer weather events in the Western Region over the course of 67 years, from 1955 to March 2022. This averages roughly 6.6 days with events per year; therefore, the probability of future occurrence is ranked as **Highly Likely.**
- The NCEI data recorded one death, 12 injuries, \$2,928,100 in property damages, and \$210,100 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 pre-existing 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 Western 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?
Western Region	Medium	N/A	None
Anaconda-Deer Lodge	Medium	Anaconda - Deer Lodge City	None
Beaverhead	Medium	City of Dillon, Town of Lima	None
Broadwater	High	City of Townsend	None
Butte-Silver Bow	Medium	Butte-Silver Bow City, Town of Walkerville	None
CSKT	Medium	Confederated Salish and Kooteani Tribes of the Flathead Reservation	None
Flathead	Medium	Columbia Falls, Kalispell, Whitefish	None
Granite	Medium	Towns of Drummond and Philipsburg	None
Jefferson	Medium	City of Boulder, Town of Whitehall	None
Lake	Medium	City of Polson, City of Ronan, Town of St. Ignatius	None
Lewis and Clark	High	City of Helena, City of East Helena	None
Lincoln	Medium	City of Libby, City of Troy, Town of Eureka	None

Jurisdiction	Overall Significance	Additional Jurisdictions	Jurisdictional Differences?
Madison	Medium	Town of Ennis, Town of Sheridan, Town Virginia City	None
Meagher	Medium	City of White Sulphur Springs	None
Mineral	Medium	N/A	None
Park	Medium	City of Livingston, Town of Clyde Park	None
Powell	Medium	City of Deer Lodge	None
Ravalli	Medium	City of Hamilton, Town of Darby, Town of Stevensville	None
Sanders	Medium	City of Thompson Fall, Town of Plains, Town of Hot Springs	None
Sweet Grass	Medium	City of Big Timber	None

4.2.12 Severe Winter Weather

4.2.12.1 Hazard/Problem Description

According to the Montana State Hazard Mitigation Plan 2018 Update, 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, hurricanes, 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 NWS 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.
- 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.

4.2.12.2 Geographical Area Affected

All counties in the Montana Western 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. Extremely low temperatures are also common in jurisdictions located at high elevations in the Rocky Mountain.

4.2.12.3 Past Occurrences

The NCEI database was used to gather information on historic severe summer weather events in the Western 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 Confederated Salish and Kootenai Tribes of the Flathead Nation is 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 severe winter weather events from 1996 to March of 2022. The specific hazards selected for severe winter weather consist of blizzard, cold/wind child, heavy snow, ice storm, winter storm, and winter weather events.

Table 4-43 summarizes the data from NCEI. It is important to note that 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, heavy snow is the most frequently occurring type of severe weather in the Western Region. Winter storms are the most damaging yet second most frequently occurring type of severe winter weather event in the Western Region. All these different types of severe winter weather events have resulted in documented property losses. All these events resulted in a total of 15 deaths and 19 injuries in the Western Region.

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

	Deaths	Injuries	Property Loss	Days with Events	Total Events
Blizzard	1	0	$460,000	33	64
Cold/Wind Chill	2	0	$1,400	61	117
Heavy Snow	2	4	$1,597,000	610	1,301
Ice Storm	2	0	$30,000	7	10
Winter Storm	4	1	$5,515,000	409	1,110
Winter Weather	4	14	$5,000	143	267
Total	15	19	$7,608,400	1,263	2,869

Source: NCEI

There are variations in losses and frequency of hazards across the Western 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. Table 4-44 and Figure 4-59 display a list of the total number of severe winter weather events by zone. It is possible to see the variation between zones, with the Lower Clark Fork Region having the most significant number of events.

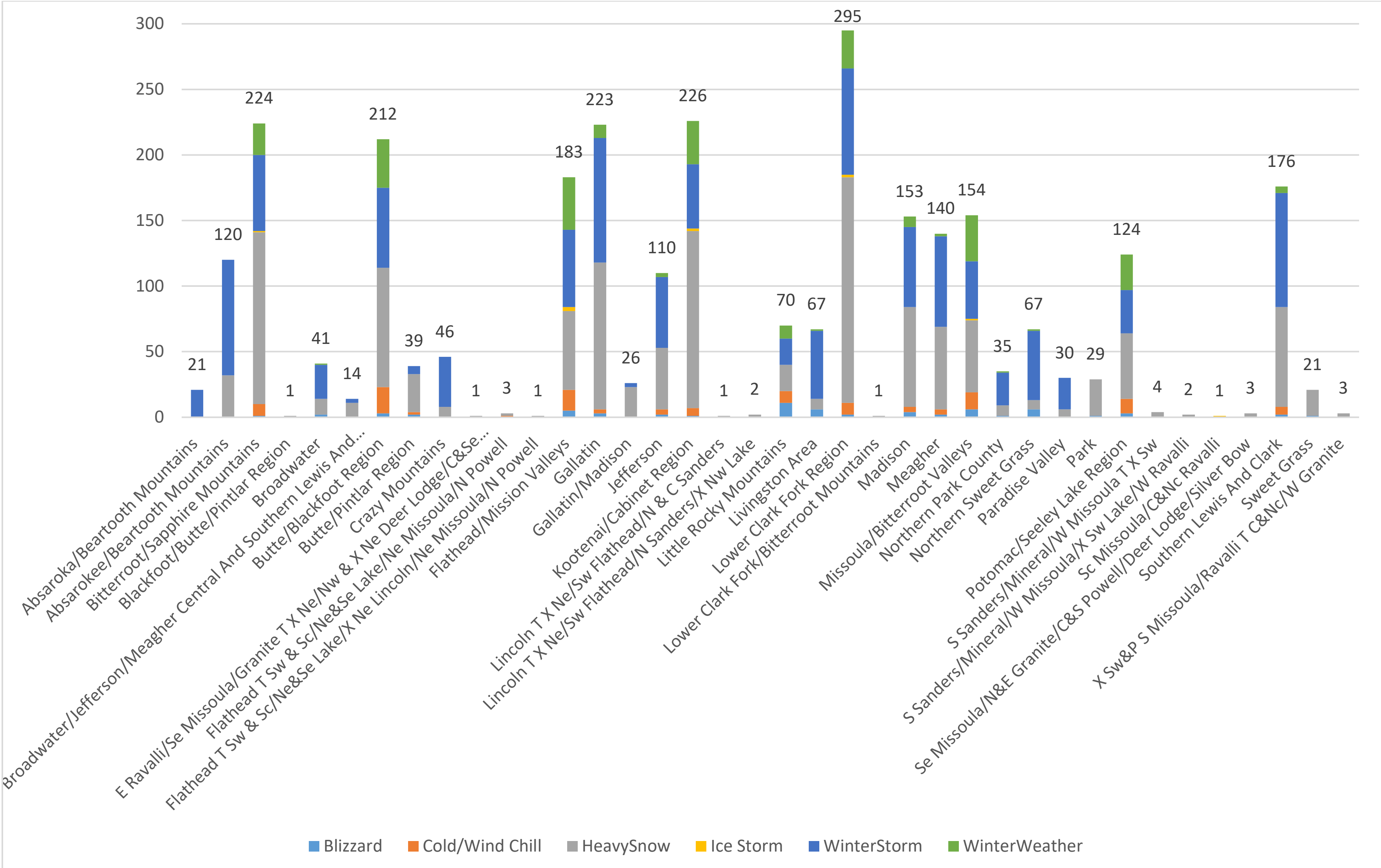
Table 4-44 Summary of Severe Winter Weather Events by Zone in the Western Region

	Blizzard	Cold/Wind Chill*	Heavy Snow	Ice Storm	Winter Storm	Winter Weather	Total
ABSAROKA / BEARTOOTH MOUNTAINS (ZONE)	0	0	0	0	21	0	21
ABSAROKEE / BEARTOOTH MOUNTAINS (ZONE)	0	0	32	0	88	0	120
BITTERROOT / SAPPHIRE MOUNTAINS (ZONE)	1	9	131	1	58	24	224
BLACKFOOT/BUTTE/PINTLAR REGION (ZONE)	0	0	1	0	0	0	1
BROADWATER (ZONE)	2	0	12	0	26	1	41
BROADWATER/JEFFERSON/MEAGHER CENTRAL AND SOUTHERN LEWIS AND CLARK (ZONE)	0	0	11	0	3	0	14
BUTTE / BLACKFOOT REGION (ZONE)	3	20	91	0	61	37	212
BUTTE / PINTLAR REGION (ZONE)	2	2	29	0	6	0	39
CRAZY MOUNTAINS (ZONE)	0	0	8	0	38	0	46
E RAVALLI/SE MISSOULA/GRANITE T X NE/NW & X NE DEER LODGE/C&SE & X SW POWELL/ X N SILVER BOW (ZONE)	0	0	1	0	0	0	1
FLATHEAD T SW & SC/NE&SE LAKE/NE MISSOULA/N POWELL (ZONE)	0	1	2	0	0	0	3
FLATHEAD T SW & SC/NE&SE LAKE/X NE LINCOLN/NE MISSOULA/N POWELL (ZONE)	0	0	1	0	0	0	1
FLATHEAD/MISSION VALLEYS (ZONE)	5	16	60	3	59	40	183
GALLATIN (ZONE)	3	3	112	0	95	10	223
GALLATIN/MADISON (ZONE)	0	0	23	0	3	0	26
JEFFERSON (ZONE)	2	4	47	0	54	3	110
KOOTENAI/CABINET REGION (ZONE)	1	6	135	2	49	33	226

	Blizzard	Cold/Wind Chill*	Heavy Snow	Ice Storm	Winter Storm	Winter Weather	Total
LINCOLN T X NE/SW FLATHEAD/N & C SANDERS (ZONE)	0	0	1	0	0	0	1
LINCOLN T X NE/SW FLATHEAD/N SANDERS/X NW LAKE (ZONE)	0	0	2	0	0	0	2
LITTLE ROCKY MOUNTAINS (ZONE)	11	9	20	0	20	10	70
LIVINGSTON AREA (ZONE)	6	0	8	0	52	1	67
LOWER CLARK FORK REGION (ZONE)	2	9	172	2	81	29	295
LOWER CLARK FORK/BITTERROOT MOUNTAINS (ZONE)	0	0	1	0	0	0	1
MADISON (ZONE)	4	4	76	0	61	8	153
MEAGHER (ZONE)	2	4	63	0	69	2	140
MISSOULA/BITTERROOT VALLEYS (ZONE)	6	13	55	1	44	35	154
NORTHERN PARK COUNTY (ZONE)	1	0	8	0	25	1	35
NORTHERN SWEET GRASS (ZONE)	6	0	7	0	53	1	67
PARADISE VALLEY (ZONE)	0	0	6	0	24	0	30
PARK (ZONE)	1	0	28	0	0	0	29
POTOMAC / SEELEY LAKE REGION (ZONE)	3	11	50	0	33	27	124
S SANDERS/MINERAL/W MISSOULA T X SW (ZONE)	0	0	4	0	0	0	4
S SANDERS/MINERAL/W MISSOULA/X SW LAKE/W RAVALLI (ZONE)	0	0	2	0	0	0	2
SC MISSOULA/C&NC RAVALLI (ZONE)	0	0	0	1	0	0	1
SE MISSOULA/N&E GRANITE/C&S POWELL/DEER LODGE/SILVER BOW (ZONE)	0	0	3	0	0	0	3
SOUTHERN LEWIS AND CLARK (ZONE)	2	6	76	0	87	5	176
SWEET GRASS (ZONE)	1	0	20	0	0	0	21
X SW&P S MISSOULA/RAVALLI T C&NC/W GRANITE (ZONE)	0	0	3	0	0	0	3
Total	64	117	1,301	10	1,110	267	2,869

*This category includes both cold/wind chill events and extreme cold/wind events recorded in the NCEI database.
Source: NCEI

Figure 4-59 Summary of Severe Winter Weather Events by Zone in the Western Region



Source: NCEI, Chart by WSP

The NCEI dataset reported $7,608,400 in total property losses in the Western Region since 1996. Only heavy snow events had reported crop damage of $3,800 in the Region. 12 zones accounted for the over $7.6 million in property damages. Table 4-45 below summarizes property loss by zone in the Western Region.

Table 4-45 Summary of Property Losses from Winter Weather Events by Zone in the Western Region

Zone	Total Property Damage ($)
BITTERROOT / SAPPHIRE MOUNTAINS (ZONE)	3,000
BUTTE / BLACKFOOT REGION (ZONE)	113,500
BUTTE / PINTLAR REGION (ZONE)	85,000
FLATHEAD T SW & SC/NE&SE LAKE/X NE LINCOLN/NE MISSOULA/N POWELL (ZONE)	200,000
FLATHEAD/MISSION VALLEYS (ZONE)	5,431,400
GALLATIN (ZONE)	354,000
GALLATIN/MADISON (ZONE)	10,000
KOOTENAI/CABINET REGION (ZONE)	13,000
LITTLE ROCKY MOUNTAINS (ZONE)	260,000
LOWER CLARK FORK REGION (ZONE)	66,000
MISSOULA / BITTERROOT VALLEYS (ZONE)	1,055,000
POTOMAC / SEELEY LAKE REGION (ZONE)	17,500
Total	7,608,400

Source: NCEI

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

November 18, 1996: Record heavy snow event with wind, followed with areas of freezing rain throughout Western Montana. Two deaths occurred with this storm. A 39-year-old woman died near Troy in Lincoln County, when her car skidded on ice and collided with another car. Another woman died near Thompson Falls in Sanders County when her car rolled into a ditch. Superior in Mineral County declared a state of emergency when the storm caused severe power outages, with the area without power for 40 hours. As many as 13,000 people were without power on 11/19/96 south and west of Missoula as snow, ice and freezing rain caused trees to snap onto power lines and poles or caused lines to short-circuit. Ice also downed a 100,000-volt transmission line near Superior. Numerous roads were closed throughout the area with some schools also closed.

June 4, 2001: A late spring storm brought significant rain and snow to both west central and southwest Montana. As temperatures cooled after nightfall, the lower valleys began to see the rain change to snow. The 0.7 inches of snow measured at the NWS office in Missoula was a new record snowfall for the month of June, and only the second time in the past 100 years that measurable snow has been recorded in June. However, this paled in comparison to the 4 to 8 inches of snow that fell in the City of Missoula by the early morning hours of the 4th, with countless tree limbs down and widespread power outages reported by daybreak. Many streets in Missoula were closed due to the fallen debris, and the city was declared a disaster area by the mayor that afternoon. Many other locations throughout Missoula, Granite, Powell, and Silver

Bow Counties faced similar problems, with portions of Highway 83 closed and emergency travel on Interstate 90 and U.S. Highway 12. This event resulted in $750,000 property damage.

June 4, 2001: 14 inches of snowfall was reported by spotter at the Montana State University campus in Bozeman. Numerous tree limbs and power lines were downed across town by the weight of the wet snow while automobile damage also occurred due to the falling tree limbs. Damage cost estimate based on a report in the newspaper stating that a total of $354, 000 in damage was done by snowstorm to the Bozeman area, including the City of Bozeman, Montana State University, Bozeman Public Schools, and Park Electric Cooperative.

January 7, 2004: Freezing rain turned to moderate snow over Flathead County causing numerous car accidents throughout the county from very slick roads. One fatality and six injuries were reported from automobile accidents to due icy roads.

December 12, 2008: Snowfall was estimated to be anywhere from 3 to 7 inches. The main impact came from strong east to northeast winds measured at sustained 20 mph gusting up to 40 mph. Visibility down to near zero was reported in many locations due to the blowing snow. Many area roads were closed, including Highway 35 between Polson and the junction with S-206 where many trees were blown down onto the road from strong winds. One person was killed on this road when a tree blew onto his vehicle. Two other vehicles were also damaged from falling trees. This event also resulted $200,000 of property damage.

November 24, 2015: Trained spotters reported between 3 to 5.8 inches of snow in Kalispell during the day, with drifts up to a foot and a half deep. Winds at the Glacier Park International Airport ASOS gusted to around 40 mph during the morning and afternoon, peaking at 41 mph in the late morning. Roads became very slick by the afternoon. Local law enforcement reported that snow and wind had caused over 60 vehicle accidents or slide-offs in the Flathead Valley. This event resulted in $120,000 of property damage.

February 8, 2018: Severe driving conditions occurred in the Flathead and Mission valleys the evening of the 8th through the morning of the 9th due to snow and blowing snow. A peak wind gust of 56 mph occurred at Glacier Park International Airport at 4:46 pm on the 8th during the evening commute with minor power outages also noted. This event resulted in $5 million of property damage.

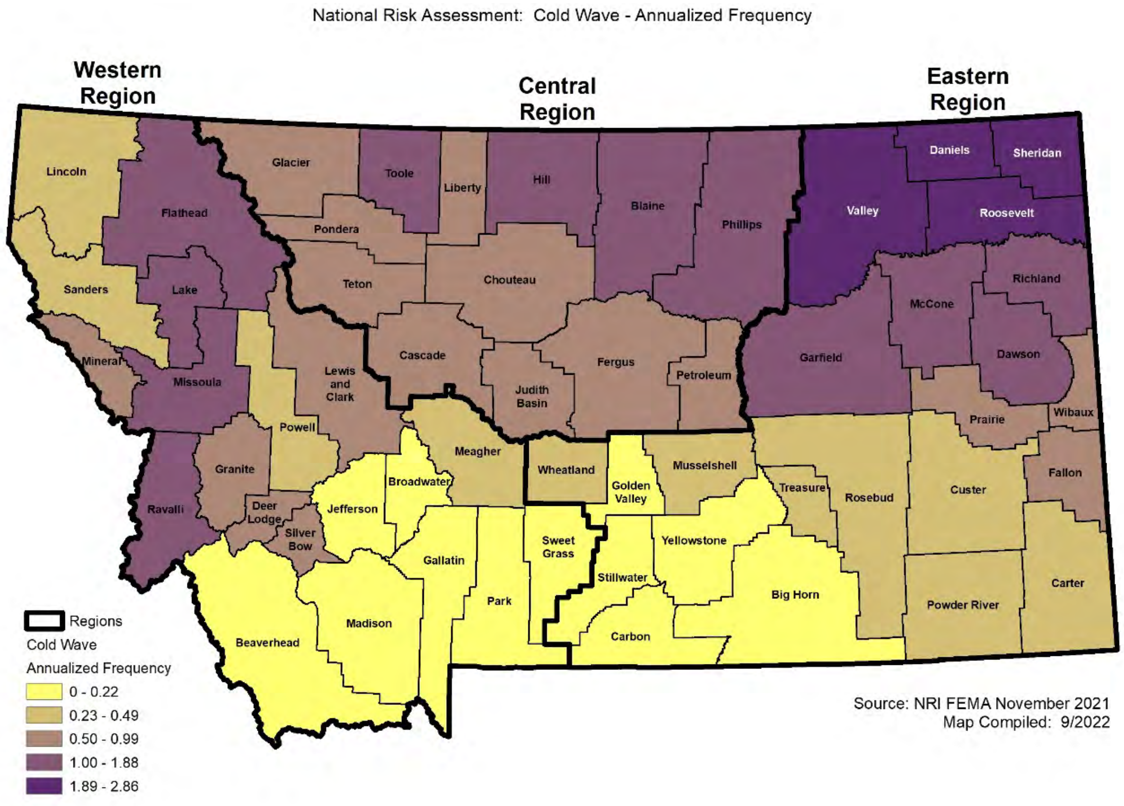
April 28, 2019: Late Sunday morning April 28th, two fishing boats capsized on Upper Holter Lake in Southern Lewis and Clark County. The accident resulted in one fatality and sent five others to the hospital. Winter weather conditions may have played a role in the crash. Snow with gusty winds over 30 mph were reported in the area that morning.

4.2.12.4 Frequency/Likelihood of Occurrence

The frequency of severe winter weather in the Western 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 1,263 days with severe weather events over 26 years, which averages to nearly 39 days a year with severe winter weather events in the Western 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 4-60 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 central parts of the Region, particularly Flathead, Lake, Missoula, and Ravalli Counties.

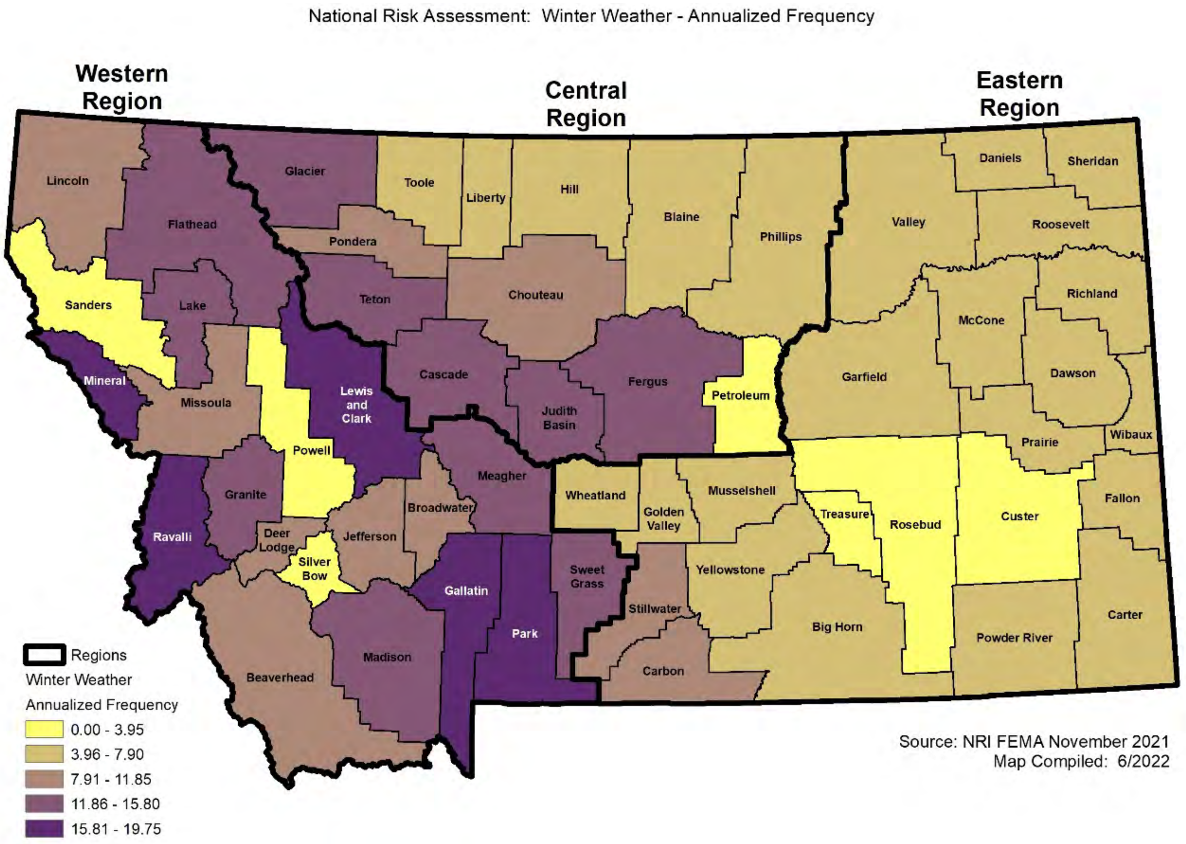
Figure 4-60 NRI Annualized Frequency of Cold Events by County



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

The figure 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, eastern, and southeastern regions, particularly Mineral, Ravalli, Lewis and Clark, Gallatin, and Park Counties.

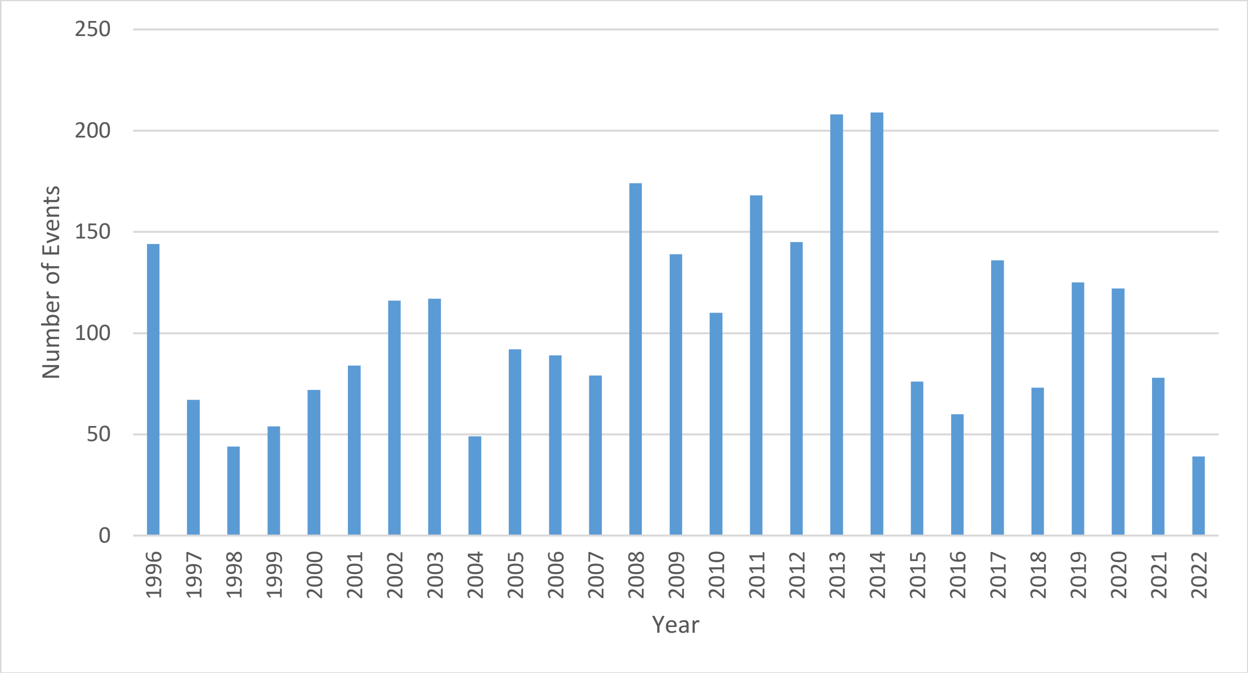
Figure 4-61 NRI Annualized Frequency of Winter Weather Events by County



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

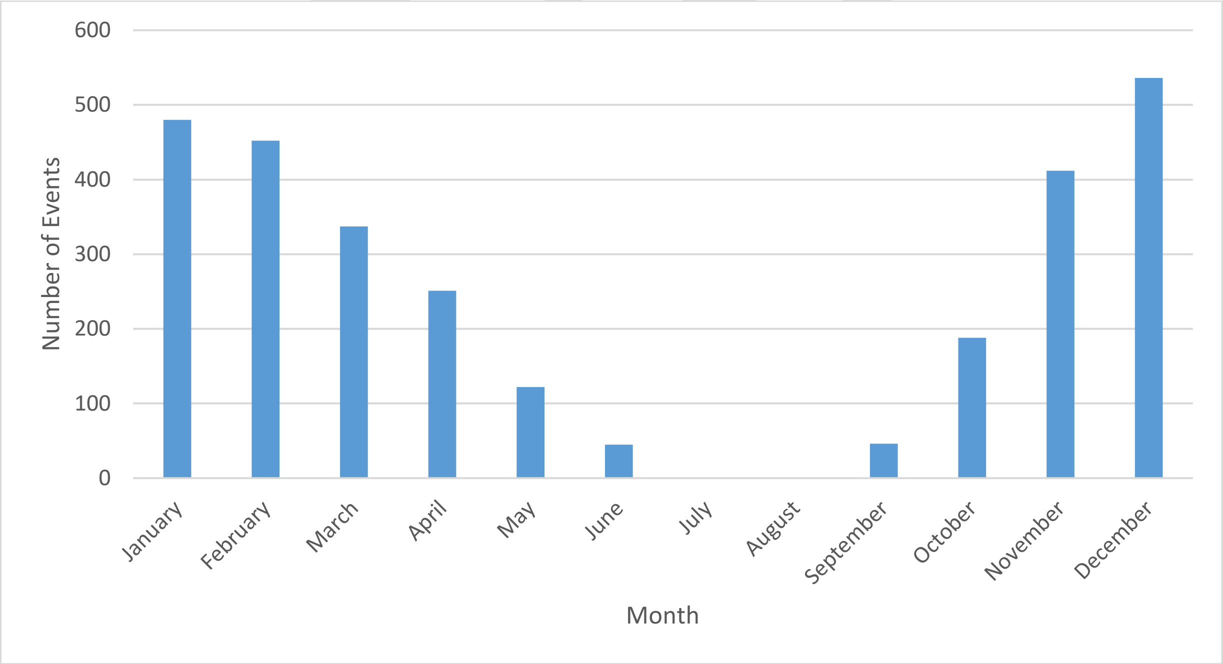
Figure 4-62 displays the yearly trend of severe winter weather event from 1996 to March of 2022 and Figure 4-63 displays the monthly trend of severe winter weather events in the Western Region. There is evident variation in the frequency of events between years in the Region. While most events occur from November to March, severe winter weather has been recorded in the Region from September to June.

Figure 4-62 Yearly Trend of Winter Weather Events in the Western Region (1996-2022)



Source: NCEI, Chart by WSP

Figure 4-63 Monthly Trend of Winter Weather Events in the Western Region (1996-2022)



Source: NCEI, Chart by WSP

4.2.12.5 Climate Change Considerations

The 2018 Montana State Hazard Mitigation Plan states that the frequency of severe weather events has increased steadily over the last century. The number of weather-related disasters during the 1990s was four times that of the 1950s and cost 14 times as much in economic losses. Historical data shows that the probability of severe weather events increases in a warmer climate. There has been a sizable upward trend in the number of storms causing large financial and other losses. Climate change presents a challenge for risk management associated with severe weather.

Moreover, according to the 2018 State of Montana Hazard Mitigation Plan, Montana has seen an uptick in the State's average temperature of about 2 degrees F in the last 50 years, while precipitation has stayed largely the same. At the same time, temperatures at the extremes – the absolute coldest and absolute warmest temperatures of the year have shifted upwards by about 10 degrees for the absolute low, with more days falling into the hotter extreme as well. These are observations supported by scientists who received a Nobel Prize in Physics.

Changing extremes in precipitation are projected across all seasons, including higher likelihood of both increasing heavy rain and snow events. Winter and spring precipitation is projected to increase in the northern states of the Great Plains, relative to the 1971-2000 average. Winter storms have increased in frequency and intensity since the 1950s, and their tracks have shifted northward over the U.S. Projected changes in summer and fall precipitation are small, however, the number of days with heavy precipitation is expected to increase by mid-century. An increase in moisture in snow can also lead to an increase in property damage due to the weight of the snow on structures.

4.2.12.6 Potential Magnitude and Severity

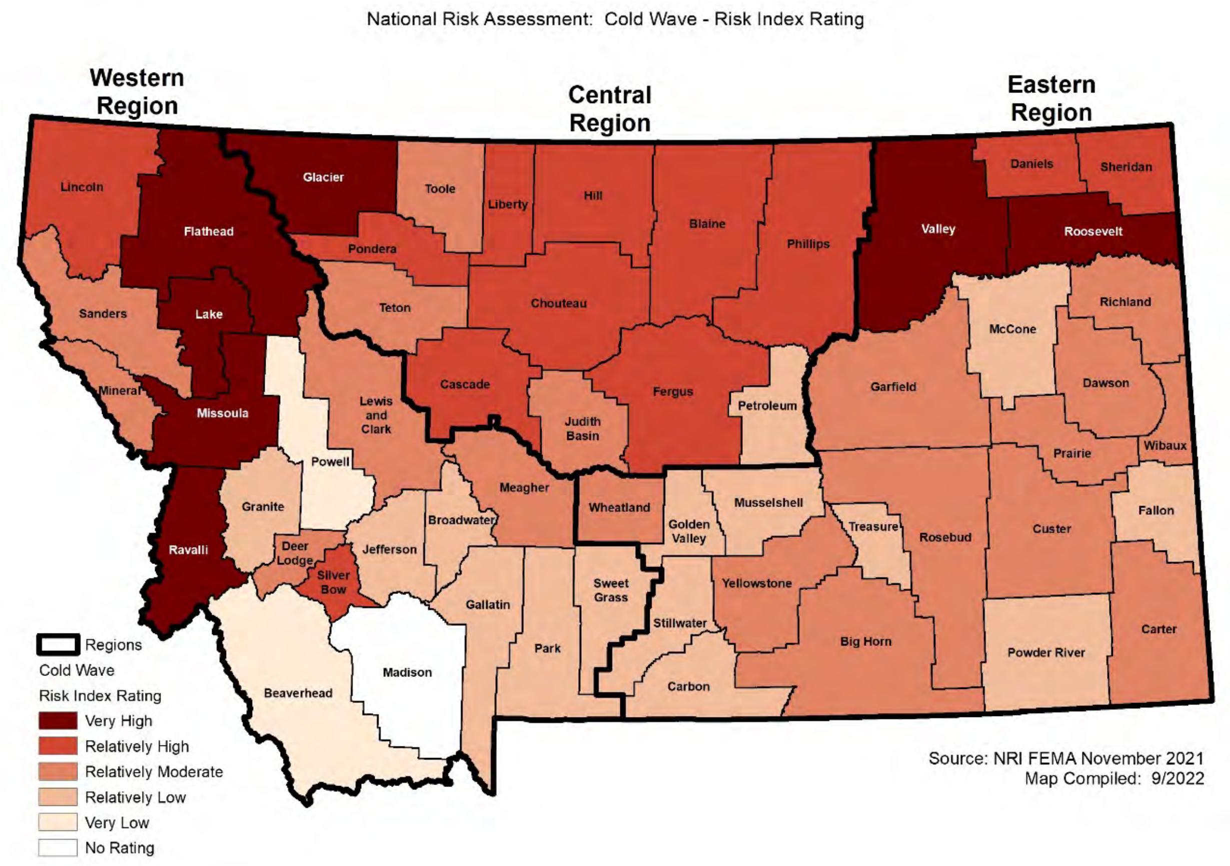
The 2018 Montana State Hazard Mitigation Plan explains that the magnitude of severe weather is measured by the severity of the event and the resulting damage. Winter storms are generally slow in developing and advance notice often lessens their effects on the population. Severe winter weather that results 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 Western 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 July 7, 2001, a disaster declaration was issued in the Western Region due to severe winter storms. In the Western Region, the NCEI reported 15 deaths, 19 injuries, and $7.6 million in property losses; therefore, the magnitude of severe winter weather is ranked as **Critical**.

4.2.12.7 Vulnerability Assessment

The figure below illustrates the relative RIs rating due to cold for Montana counties based on data in the NRI. The NRI calculation considers various factors, including the EALes from these events, social vulnerability, and community resilience in each county across Montana. Quite a few counties in the Region have a very high rating. Powell and Beaverhead Counties have a rating of very low. A few counties in the central and southeastern portions of the Region also have a rating of relatively low.

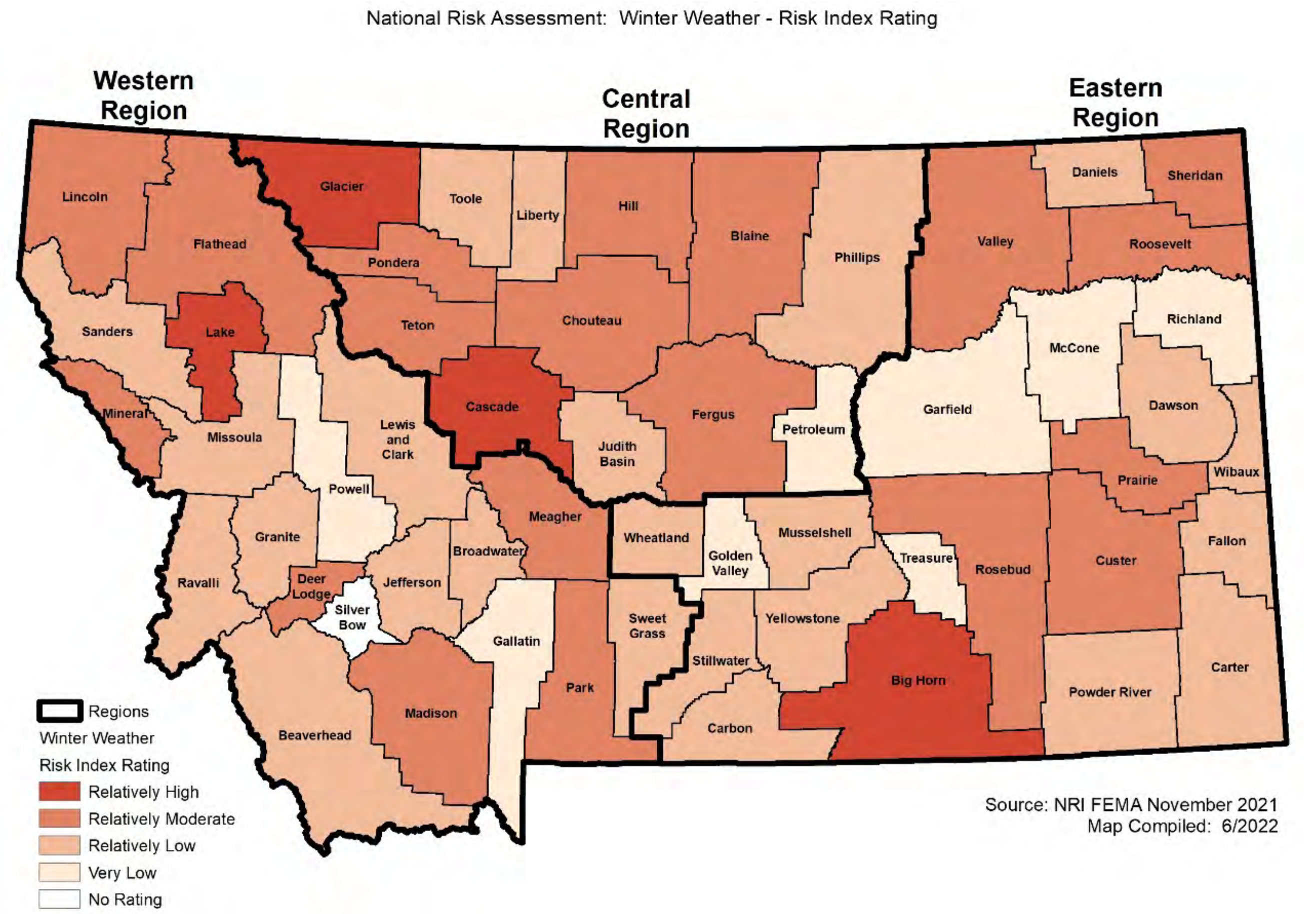
Figure 4-64 NRI Risk Index Rating for Cold



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

The figure below illustrates the relative RIs rating due to winter weather for Montana counties based on data in the NRI. Most counties in the Region have a relatively low to moderate rating. Lake County is rated as relatively high. Powell and Gallatin Counties are rated as very low.

Figure 4-65 NRI Risk Index Rating for Winter Weather



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

People

Major problems typically only occur during record snowfalls and extended periods of below-zero temperatures. Initial consequences include threats to vulnerable populations from utility interruption, freezing pipes, and snow removal costs. 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 15 deaths and 19 injuries due to severe winter weather events.

Property

All outdoor property is vulnerable 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 Western Region were primarily due to downed powerlines and poles that resulted in widespread blackouts, as well as damages to cars from traffic accidents.

Critical Facilities and Lifelines

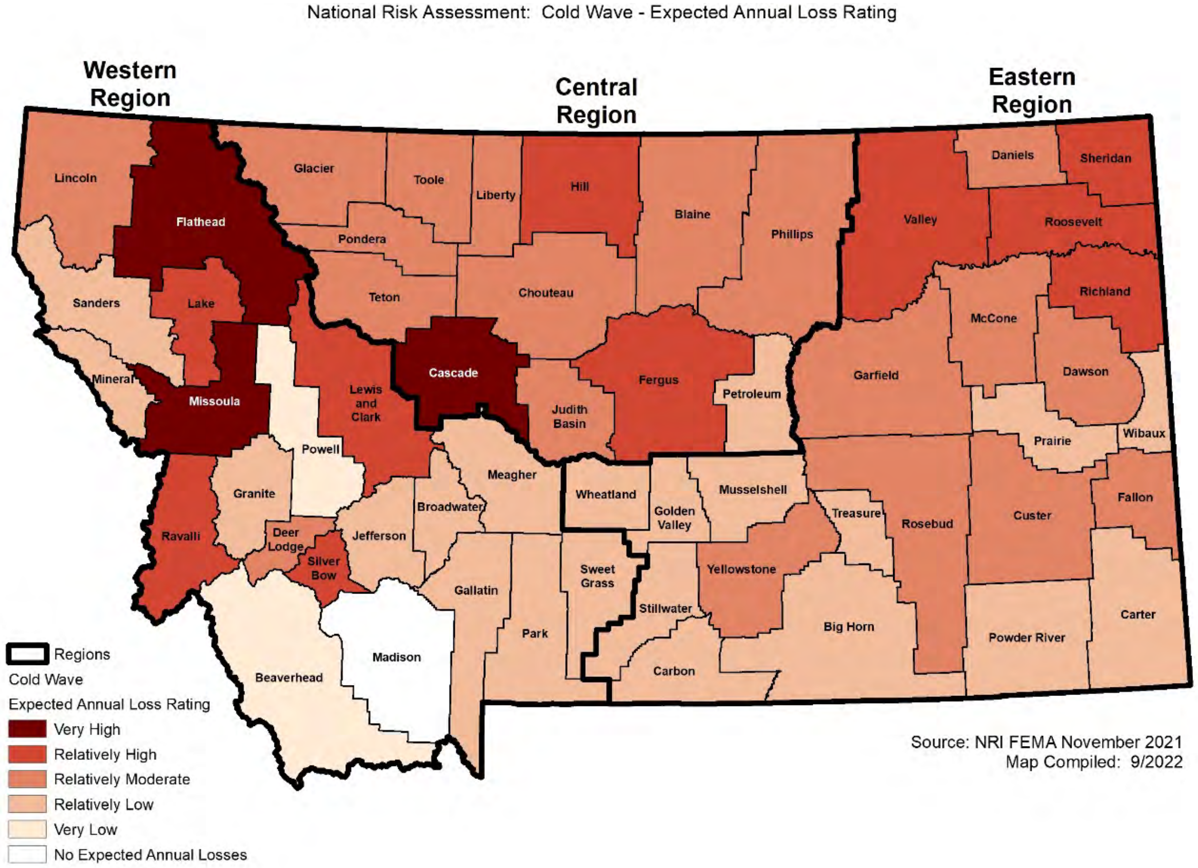
Winter weather can impact roads, decrease the speeds of vehicles, and create traffic jams. Blowing or drifting snow and ice can make it difficult for commuters to get to work and for emergency responders to reach areas in need. Overall, winter weather makes it difficult and dangerous for travel of any kind, which can lead to the isolation of groups of people who are vulnerable and stranded commuters. Additionally, the accumulation of snow and ice on powerlines can cause damages that result in power loss. A power outage in the winter months is increasingly dangerous during periods of extremely cold temperatures and wind chill. Moreover, according to NCEI database, Glacier Park International Airport was impacted by severe winter weather events several times. Future similar events may continue to impact the airport, causing flight delays or even airport shutdown.

Economy

Economic losses can result from business interruptions due to poor road conditions and/or power outages. Additionally, losses could result from damages due to power lines and roofs from the accumulation of heavy snow and ice. The NCEI reported over $7.6 million in property losses and $3,800 in crop losses in the Western Region. It is important to note that the NCEI database may not be able to capture the entire crop losses caused by severe winter events.

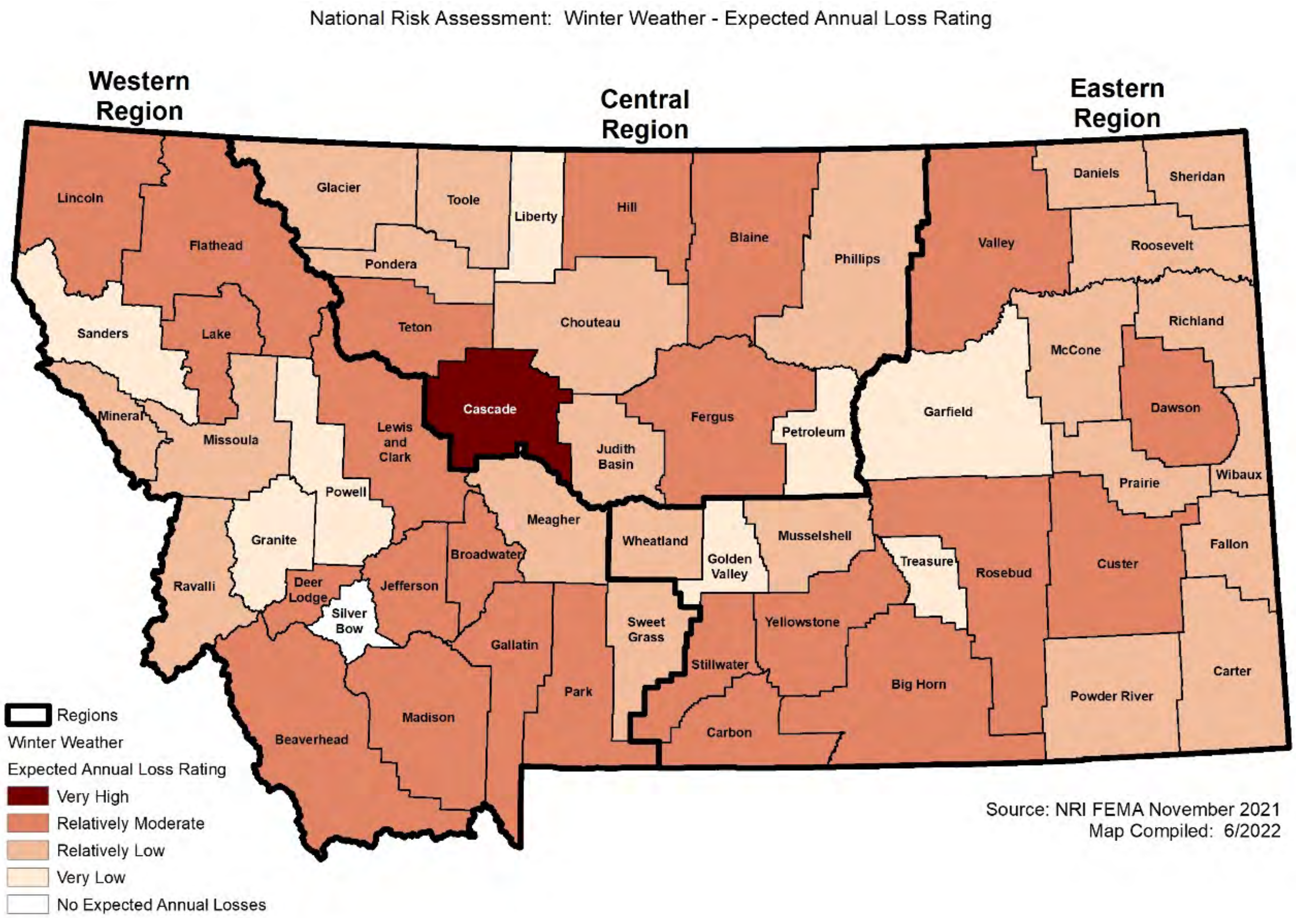
The figures below illustrate the relative risk of EAL rating due to cold waves and winter weather for Montana counties based on data in the NRI. For cold waves, Flathead and Missoula Counties are rated as very high. A few counties surrounding the center of the Region are also rated as relatively high. The rest of counties are rated as relatively moderate/low and very low. For winter weather, most counties are rated as relatively moderate. Counties of Sanders, Powell and Granite are rated as very low, and Madison is rated as no expected losses. The EAL calculation considers agriculture value exposed, annualized frequency of events, and historical loses.

Figure 4-66 NRI Expected Annual Loss Rating from Cold Waves



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

Figure 4-67 NRI Expected Annual Loss Rating from Winter Weather



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

Historic and Cultural Resources

Like general property, heavy snow and ice could cause damages to historic buildings, especially those that are in poor condition or not built to code. Historic buildings are less likely to be built with proper insulation to protect property and people inside from extreme cold temperatures and wind chill.

Natural Resources

Trees, landscaping, and crops can be damaged due to prolonged periods of extreme cold weather and the accumulation of snow and ice. Trees that break due to the weight of snow and ice have also been reported in the NCEI dataset.

Development Trends Related to Hazards and Risk

The 2018 Montana State Hazard Mitigation Plan reports that Montana snow is generally dry and snow loads do not threaten roof collapse in most areas. However, the northwestern portion of the State where snow contains greater moisture content should consider building regulations that require a stricter design standard for flat roofs to ensure they can support maximum snow loads. The State of Montana has adopted the 2012 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.

4.2.12.8 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 1,263 days with severe weather events over 26 years, which averages to nearly 49 days a year with severe winter weather events in the Western Region; therefore, the future occurrence is rated as **Highly Likely.**
- The NCEI reported 15 deaths, 19 injuries, and $7,608,400 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. Much 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 4-46 Risk Summary Table: Severe Winter Weather

Jurisdiction	Overall Significance	Additional Jurisdictions	Jurisdictional Differences?
Western Region	Medium	N/A	
Anaconda-Deer Lodge	Medium	Anaconda - Deer Lodge City	
Beaverhead	Medium	City of Dillon, Town of Lima	
Broadwater	Medium	City of Townsend	
Butte-Silver Bow	Medium/High	Butte-Silver Bow City, Town of Walkerville	
CSKT	Medium	Confederated Salish and Kooteani Tribes of the Flathead Reservation	
Flathead	Medium/High	Columbia Falls, Kalispell, Whitefish	
Granite	Medium	Towns of Drummond and Philipsburg	
Jefferson	Medium	City of Boulder, Town of Whitehall	
Lake	Medium	City of Polson, City of Ronan, Town of St. Ignatius	

Jurisdiction	Overall Significance	Additional Jurisdictions	Jurisdictional Differences?
Lewis and Clark	Low	City of Helena, City of East Helena	
Lincoln	Medium	City of Libby, City of Troy, Town of Eureka	
Madison	Medium	Town of Ennis, Town of Sheridan, Town Virginia City	
Meagher	Medium	City of White Sulphur Springs	
Mineral	Medium	N/A	
Park	Medium	City of Livingston, Town of Clyde Park	
Powell	Medium	City of Deer Lodge	
Ravalli	Medium	City of Hamilton, Town of Darby, Town of Stevensville	
Sanders	Medium	City of Thompson Fall, Town of Plains, Town of Hot Springs	
Sweet Grass	Medium	City of Big Timber	

4.2.13 Human Conflict

4.2.13.1 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 U.S. 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 U.S. soil since 1970.

Incidents involving weapons of mass destruction (WMDs) are a special subset of terrorism and mass violence incidents. Such incidents may involve 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' effects.

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. Typically, active shooters are not interested in taking hostages or attaining material gain, and frequently are not even interested in their own survival. 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 U.S. 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).

4.2.13.2 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 the reported terrorist attack and civil unrest events in the Western Region have been concentrated to 14 major cities in the Region listed below, 10 of which are participating in the planning process. Therefore, geographic extent of these events is rated as **Limited**.

Butte-Silver Bow County

- Butte

Flathead County

- Columbia Falls
- Kalispell

- Whitefish

Lake County
- Alree

Lewis and Clark County
- Helena

Lincoln County
- Eureka
- Libby

Park County
- Livingston

Ravalli County
- Hamilton

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 Western Montana. Like terrorist attacks, active shooter incidents most 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.

Civil unrest, such as protests and demonstrations, can also occur anywhere. The 2020 George Floyd protests occurred in cities across the United States and even extended to other counties across the world. Highly populated cities are more likely to see large protests that can turn violent and result in property damage and death. Protests can also be localized to a single city or organization.

4.2.13.3 Past Occurrences

Terrorism

The GTD catalogues more than 200,000 domestic and international terrorist attacks from 1970 to 2020. Table 4-47 displays a list of the GTD reported seven events that have occurred in the State of Montana since 1970. Of the seven terrorist attack events reported in Montana, three occurred in the Western Region planning area in Flathead and Lewis and Clark Counties. These events are listed in the table below:

Table 4-47 Terrorist Attacks in the State of Montana 1970-2020

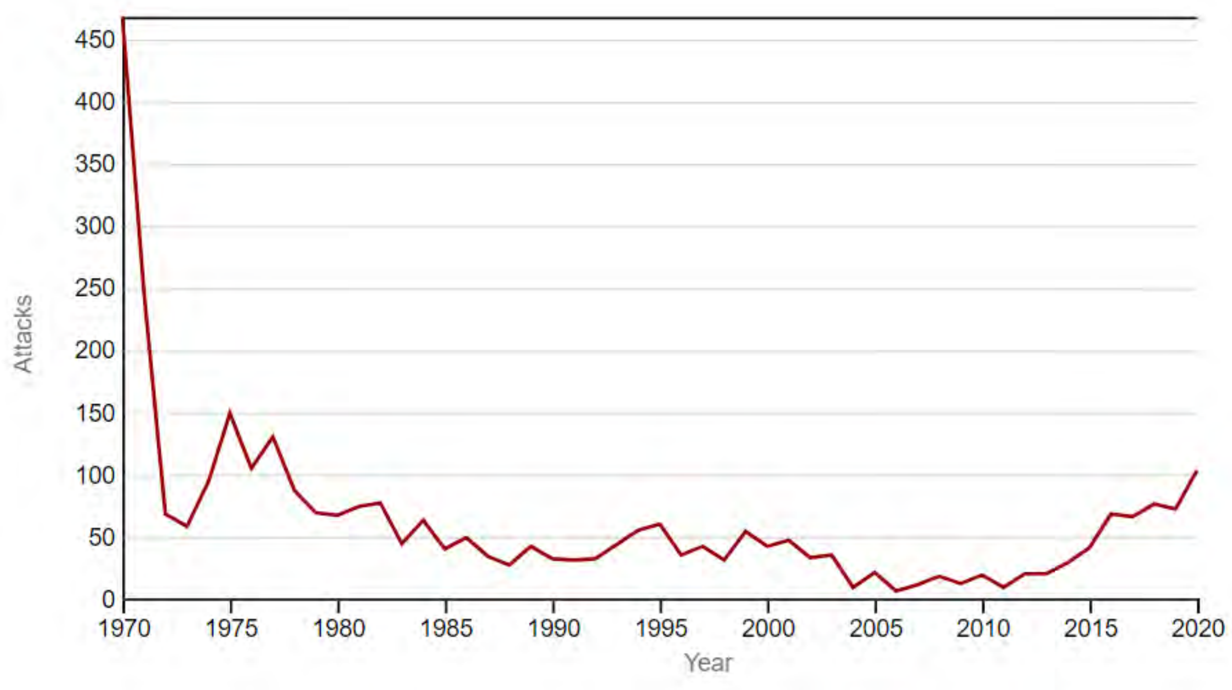
Date	City	County	Perpetrator Group	Fatalities	Injuries	Target Type
2017-05-16	Three Forks	Gallatin	Anti-Police extremists	2	5	Police
1997-04-02	Bozeman	Gallatin	Anti-Abortion extremists	0	0	Abortion Related
1994-10-11	Kalispell	Flathead	Anti-Abortion extremists	0	0	Abortion Related
1994-01-00	Helena	Lewis and Clark	Anti-Abortion extremists	0	0	Abortion Related

Date	City	County	Perpetrator Group	Fatalities	Injuries	Target Type
1992-01-18	Helena	Lewis and Clark	Anti-Abortion extremists	0	0	Abortion Related
1987-04-19	Missoula	Missoula	Aryan Nation (suspected)	0	0	Police
1970-03-15	Billings	Yellowstone (Eastern Region)	Unknown	0	0	Police

Source: GTD 1970-2020

As shown in Figure 4-68, 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 4-68 Terrorist Attacks on U.S. Soil, 1970-2020



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

The increase in attacks over the last decade 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 U.S. since 1994, with sharp growth over the last 10-15 years. Figure 4-69 shows the increase in domestic terrorist attacks from 1994-2021 broken down by the ideology of the attacker. As shown in the chart, the rise in domestic terrorist attacks since 2015 has been largely driven by violent far-right groups.

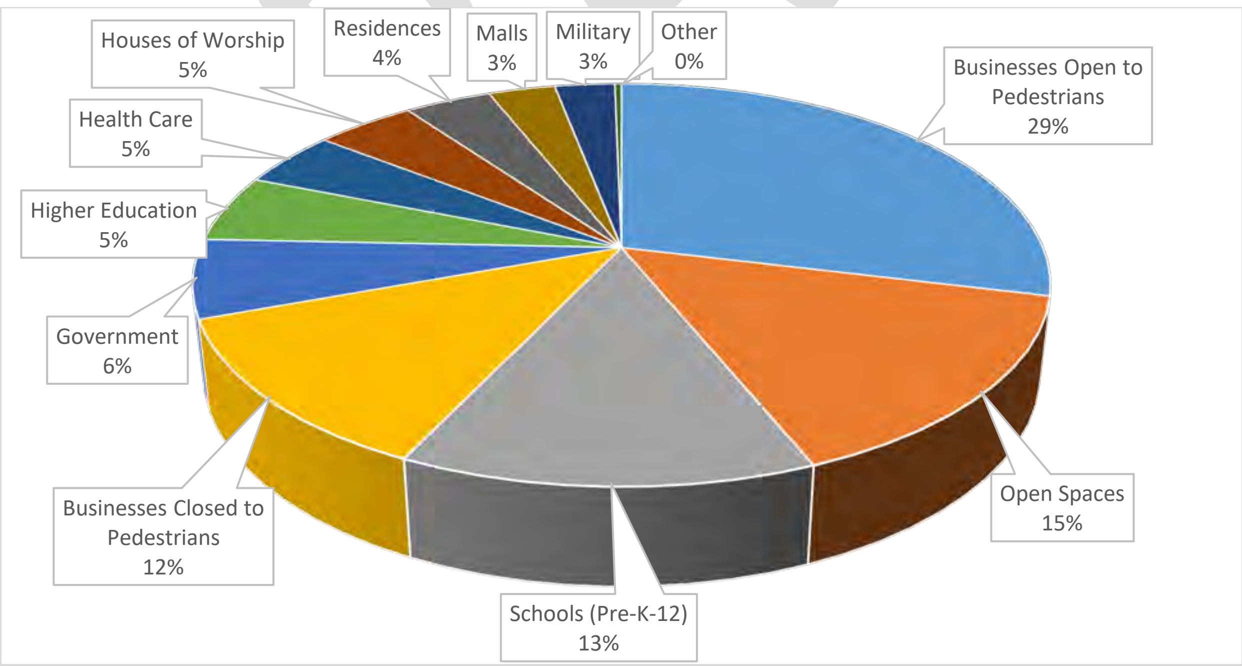
Figure 4-69 Domestic Terrorist Attacks in the U.S., 1994-2021

Source: Center for Strategic and International Studies

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

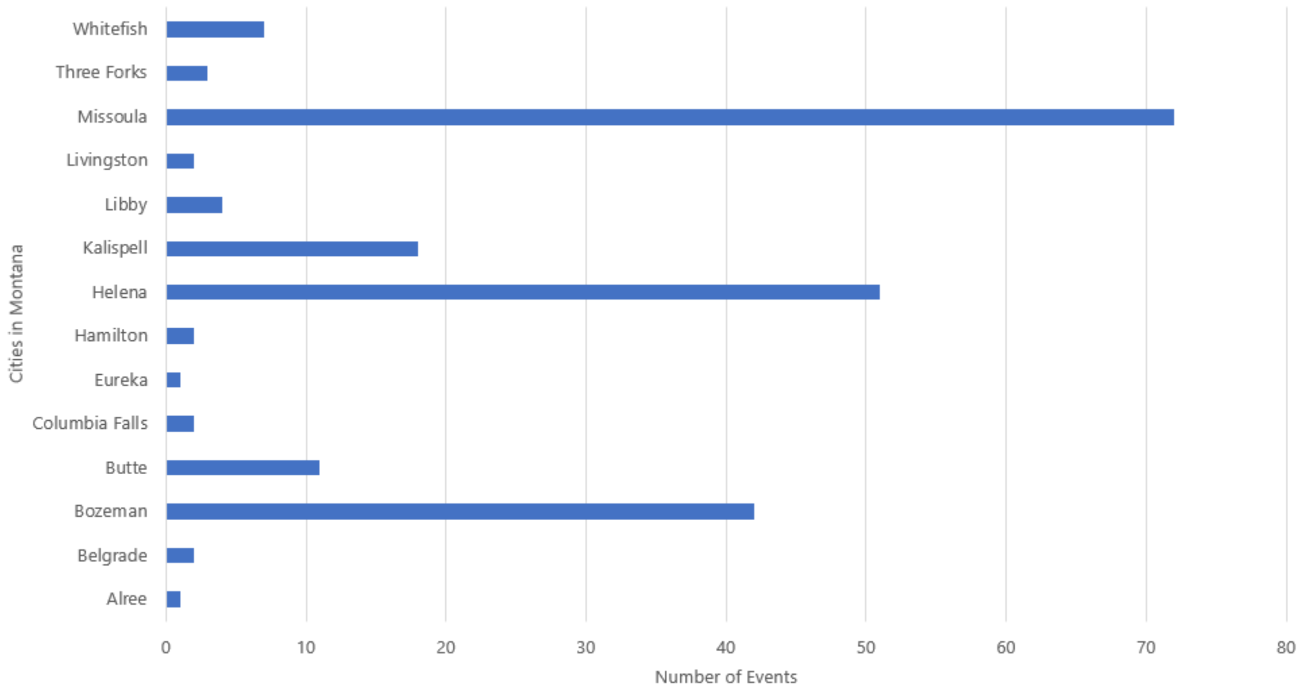


Source: FBI report Active Shooter Incidents, 20-Year Review 2000-2019

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. Of the Western Region counties participating in this plan, the City of Helena in Lewis and Clarke County and the City of Kalispell in Flathead County have experienced the greatest number of protest events. Figure 4-71 below displays the number of documented protest events by city in the Western Region. Count Love reported a total of 59,620 attendees in the Western Montana protest events.

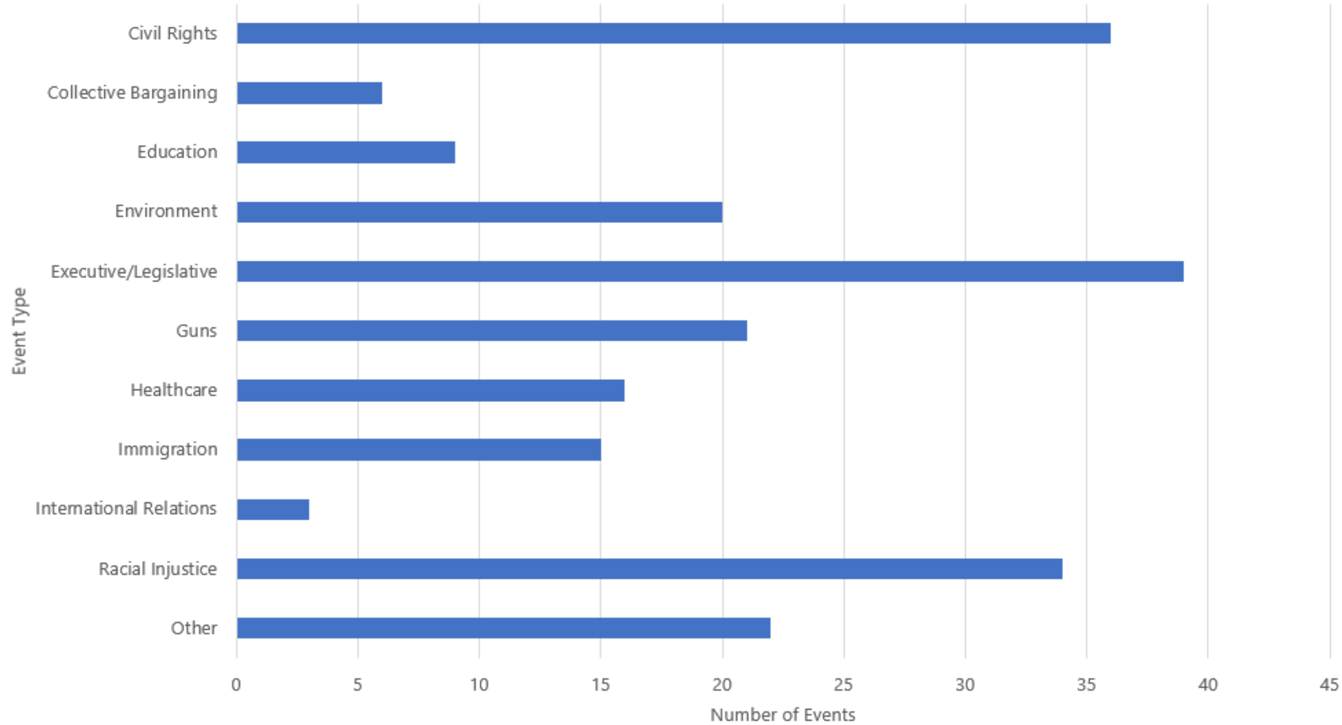
Figure 4-71 Protests in the Western Region by City, Jan. 2017 – Jan. 2021



Source: https://countlove.org/

The dataset also reported on the types of protest events. Figure 4-72 indicates that executive/legislative protests are the most common type of protest in the Western Region. Executive and legislative protests include the March for Truth, a nationwide protest calling for an investigation into President Trumps campaign administration and Russia, Tax Day, Supreme Court Nomination, and Town Hall protests. Civil rights protests, such as Women's March, Pride, Anti-Abortion, and Anti-LGBTQ protests were the second most common type of protest in the Western Region, with racial injustice protests as a close third. Gun protests encompass both gun-rights/second amendment protection protests and gun regulation protests. Other protest events include protests for Animal Welfare, Custody, Jewish Community, Local Development, March for Science, State Budget, Tobacco Tax, Unsolved Murder, Veterans Affairs.

Figure 4-72 Protests in the Western Region by Event Type, Jan. 2017 – Jan. 2021



Source: https://countlove.org/

4.2.13.4 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, six of which took place in the Western Region. The FBI recorded 434 active shooter incidents from 2000-2021 in the United States, 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, 221 protest events were recorded in the Western Region of Montana. This averages out to about 55 protests per year in the Western Region, however, these protests are generally peaceful, and no deaths or injuries were reported due to protests in the Western Region. Based on these past events, the likelihood of these events is **Likely**.

4.2.13.5 Climate Change Considerations

Climate change has the potential to impact terrorism and civil unrest in the future. Extreme weather has been known to worsen social tensions, poverty, and hunger. Social instability and global conflict brought on by climate change could result in an increase in the number of both domestic and international terrorist attacks and civil unrest. While it is unlikely that climate change will have a significant impact on human conflict in the Western Region of Montana, if conditions continue to worsen, it is possible in the future.

4.2.13.6 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 is often much worse than the direct impacts and can continue to affect a community for years. Thus, the overall significance of this hazard is **Critical**.

Terrorism

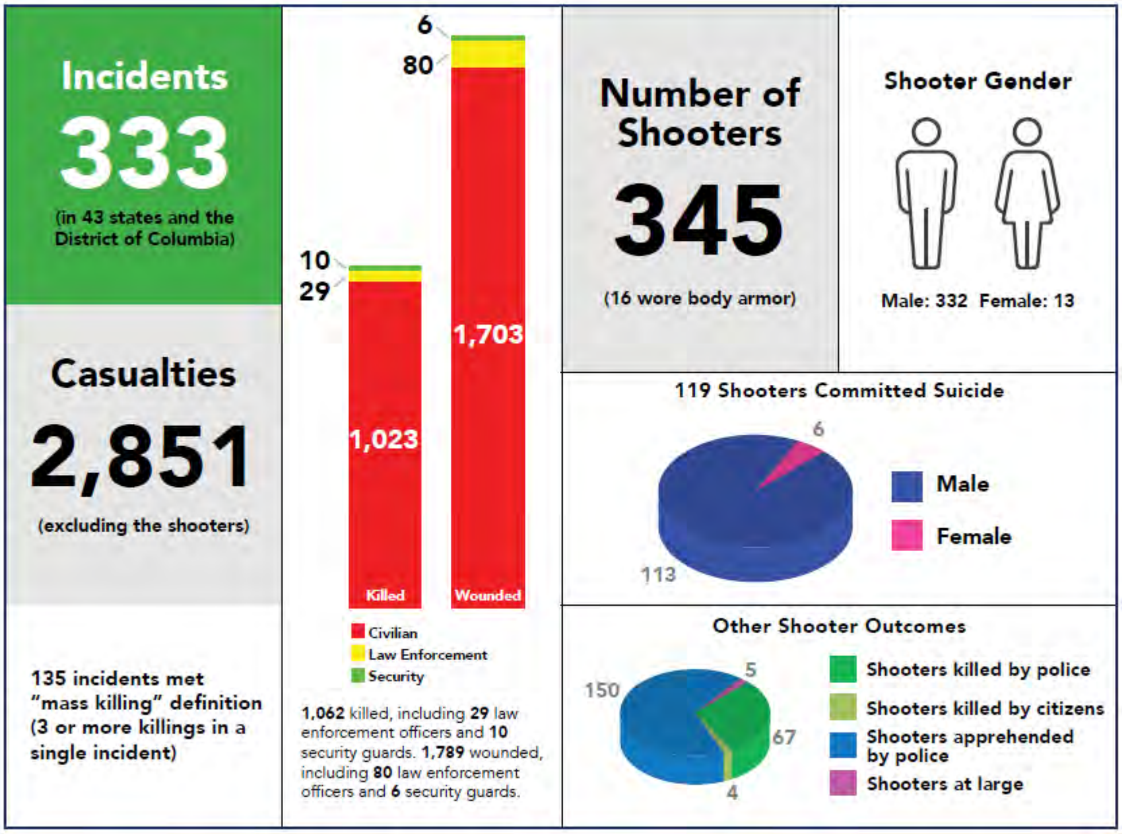
The GTD catalogues more than 200,000 terrorist attacks between 1970 and 2020 (the most recent year the GTD has analyzed). Those incidents averaged roughly one fatality and five injuries per incident. However, this data is to a large extent skewed by a handful of deadly attacks. These five attacks account for 64% of the fatalities and 87% of the injuries from terrorist attacks in the U.S.:

- 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 U.S. 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 4-73 summarizes the outcomes of 333 active shooter incidents in the U.S. 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.

Figure 4-73 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.

4.2.13.7 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%.

Historic and Cultural Resources

Terrorists have been known to target sites with historic or cultural significance. Civil unrest and protests also frequently 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.

4.2.13.8 Risk Summary

In summary, the human conflict hazard has an 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.

- There were no recorded incidents of active shooters in the Western Region, however, there were three terrorist attacks since 1970 in the planning area and 221 recorded civil unrest cases across the Region from 2017-2020; therefore, the ranking of frequency for human conflict is rated as **Likely**.
- 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 Western Region have been limited to 14 major cities in the Region, 10 of which are in the planning area; therefore, geographic extent of these events is rated as **Limited**.
- Impacts on people from human conflict include injury and death, as well as psychology damage from being in an incident.
- 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.

- Of the 14 major cities in the Western Region that have been reported to experience human conflict events, the City of Missoula (not participating in this plan) had the greatest frequency of events. In the planning area, the City of Helena and the City of Kalispell experienced the greatest number of events when compared to other cities in the planning area. This is likely due to both cities having a large population and the City of Helena being the capital city of Montana.
- Related Hazards: Cyber-attack.

Table 4-48 Risk Summary Table: Human Conflict

Jurisdiction	Overall Significance	Additional Jurisdictions	Jurisdictional Differences?
Western Region	Medium	N/A	N/A
Anaconda-Deer Lodge	Medium	N/A	N/A
Beaverhead	Medium	City of Dillon, Town of Lima	None
Broadwater	Medium	City of Townsend	N/A
Butte-Silver Bow	Medium	Town of Walkerville	N/A
CSKT	Medium	N/A	N/A
Flathead	Medium	Columbia Falls, Kalispell, Whitefish	While all three jurisdictions have experienced protest events, Kalispell has seen the greatest frequency of events and a terrorist attack event
Granite	Medium	Towns of Drummond and Philipsburg	None
Jefferson	Medium	City of Boulder, Town of Whitehall	None
Lake	Medium	City of Polson, City of Ronan, Town of St. Ignatius	None, the only protest event in the County occurred in Arlee
Lewis and Clark	Medium	City of Helena, City of East Helena	The City of Helena has seen historic protest and terrorist attack events, while East Helena has not
Lincoln	Medium	City of Libby, City of Troy, Town of Eureka	Libby and Eureka have documented historic protest events, but not the City of Troy
Madison	Medium	Town of Ennis, Town of Sheridan, Town Virginia City	None
Meagher	Medium	City of White Sulphur Springs	N/A
Mineral	Medium	N/A	N/A
Park	Medium	City of Livingston, Town of Clyde Park	The City of Livingston has documented historic protest events, but the Clyde Park has not
Powell	Medium	City of Deer Lodge	N/A
Ravalli	Low	City of Hamilton, Town of Darby, Town of Stevensville	The City of Hamilton has experienced historic protest events
Sanders	Medium	City of Thompson Fall, Town of Plains, Town of Hot Springs	None
Sweet Grass	Medium	City of Big Timber	N/A

*Rocky Boy's Reservation

4.2.14 Tornadoes & Windstorms

4.2.14.1 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 NWS defines high winds as sustained wind speeds of 40 mph or greater lasting for one hour or longer, or winds of 58 mph or greater for any duration. Windstorms are often produced by supercell 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 Western Region. Despite these differences, the wind speeds and associated impacts from these winds are comparable.

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. A comparison of the Fujita and EF scales and wind speeds is summarized in Table 4-49. 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 4-49 describes the EF-scale ratings versus the previous Fujita Scale used prior to 2007 (NOAA 2007).

Table 4-49 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)	EF Number	3-second gusts (mph)
0	40-72	45-78	0	65-85	0	65-85
1	73-112	79-117	1	86-109	1	86-110
2	113-157	118-161	2	110-137	2	111-135
3	158-207	162-209	3	138-167	3	136-165
4	208-260	210-261	4	168-199	4	166-200
5	261-318	262-317	5	200-234	5	Over 200

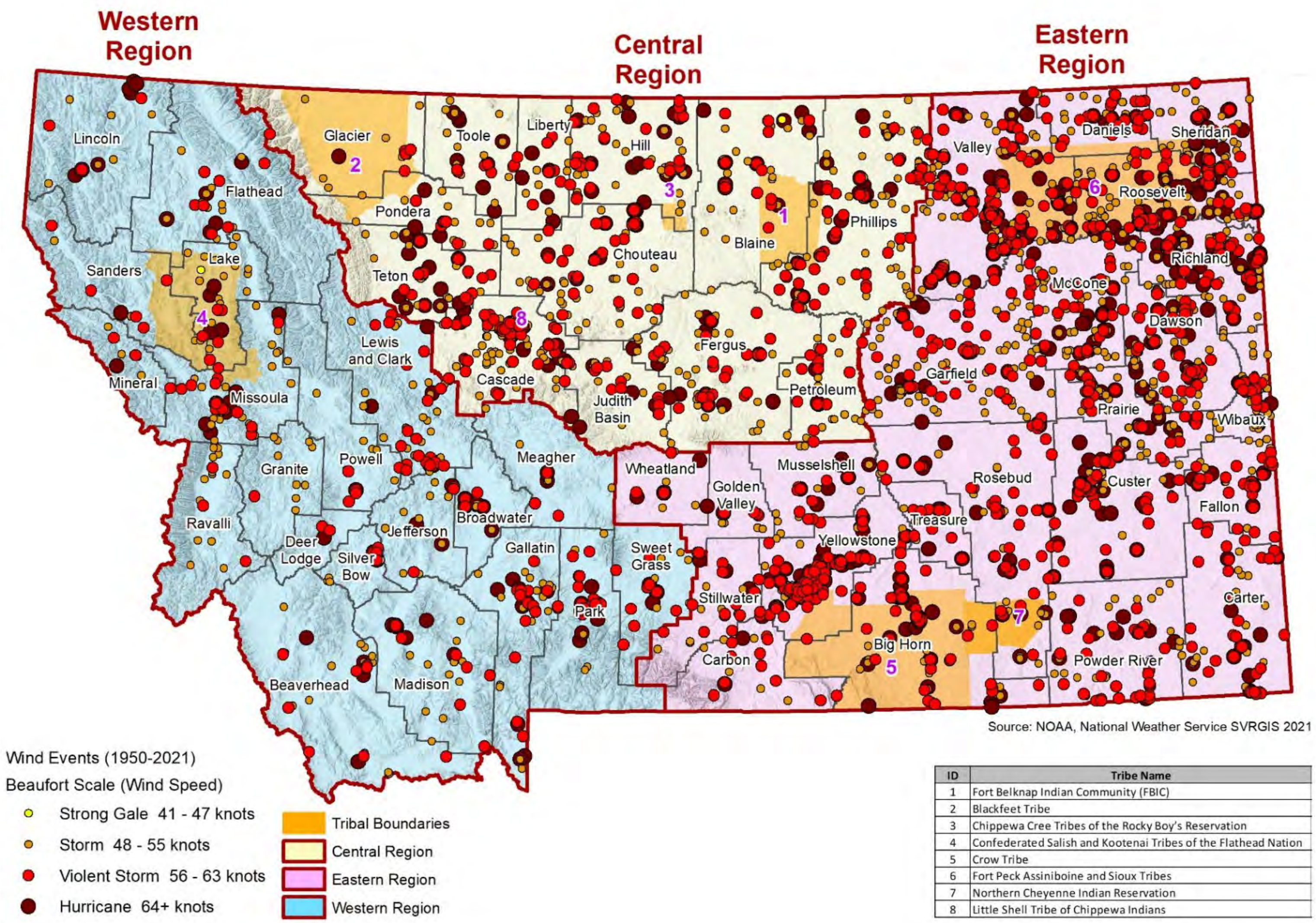
Notes:
EF = Enhanced Fujita; F = Fujita; mph = Miles per Hour

4.2.14.2 Geographical Area Affected

The spatial extent rating for both tornadoes and wind hazards is **Extensive**. Windstorms and tornadoes can occur anywhere in the Western Region. The rural, unpopulated areas of the Region 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 Western Region.

Figure 4-50 and Figure 4-51 display the historic wind and tornado events in the State of Montana by region.

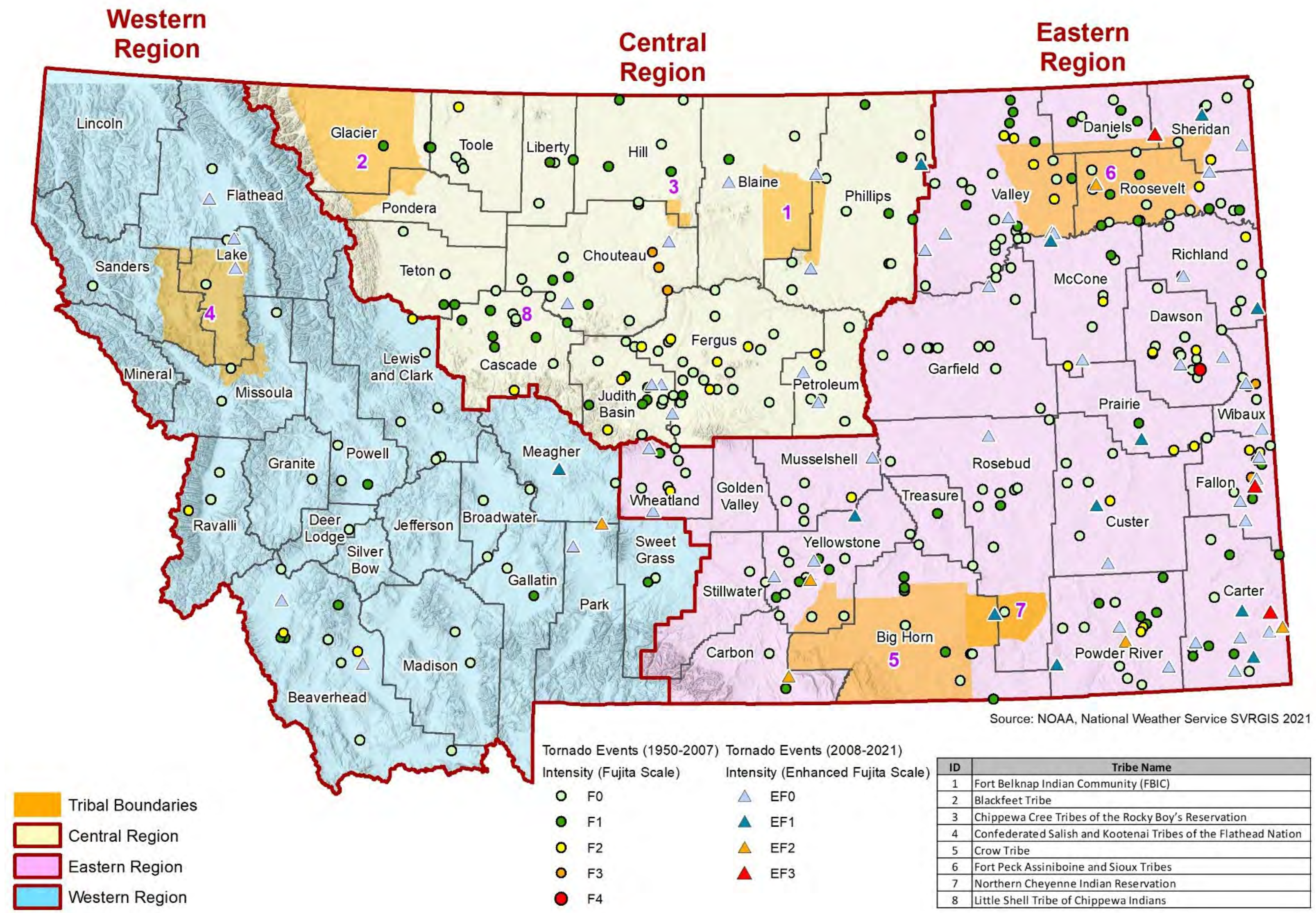
Figure 4-74 Wind Events in Montana by Region 1955-2021



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

Source: NOAA

Figure 4-75 Past Tornado Events in Montana by Region (1950-2021)



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

4.2.14.3 Past Occurrences

The NCEI database was used to gather information on historic severe summer weather events in the Western 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 Confederated Salish and Kootenai Tribes of the Flathead Nation is 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 2,218 windstorm events on 1,038 days and 42 tornado events on 41 days. A summary of these events is captured in Figure 4-50. In total, over $17 million was lost in property damages and almost $340,000 in crop losses. Two fatalities and 28 injuries were also reported in the Western 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 4-50 Summary of Losses by Hazard in the Western Region

	Deaths	Injuries	Property Loss	Crop Loss	Days with Events	Total Events
High Wind	1	9	$4,597,200	$216,900	621	1,478
Strong Wind	0	0	$2,431,350	$86,900	45	75
Thunderstorm Wind	1	18	$7,654,000	$36,000	412	728
Tornadoes	0	1	$2,931,060	$0	41	42
Total	2	28	$17,613,610	$339,800	1,119	2,323

Source: NCEI

The NCEI dataset reports variation in the frequency of events across the Western Region. High winds are the most common type of windstorm event, and the Southern Rocky Mountain Front Zone experiences the highest frequency of these events. The Southern Lewis and Clark Zone and Madison Zone also experience a high frequency of wind events in comparison to the other zones in the planning area. Table 4-51 and Figure 4-76 below display a summary of high wind and strong wind events by zone.

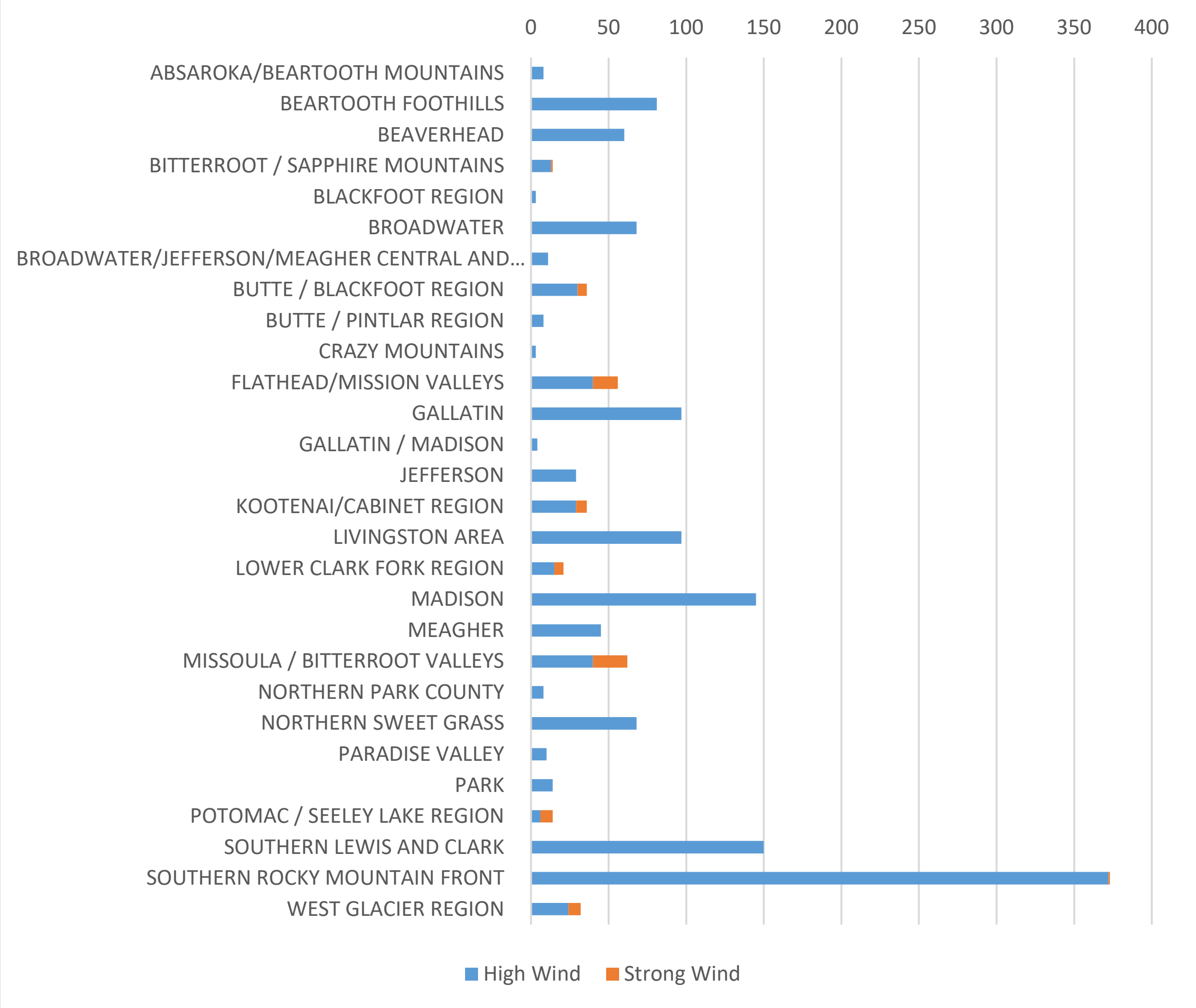
Table 4-51 Total High Wind and Strong Wind Events by Zone (1996 to 2022)

	High Wind	Strong Wind	Total
ABSAROKA / BEARTOOTH MOUNTAINS	3	0	**3**
ABSAROKEE / BEARTOOTH MOUNTAINS	5	0	**5**
BEARTOOTH FOOTHILLS	81	0	**81**
BEAVERHEAD	60	0	**60**
BITTERROOT / SAPPHIRE MOUNTAINS	13	1	**14**
BLACKFOOT REGION	3	0	**3**
BROADWATER	68	0	**68**
BROADWATER / JEFFERSON / MEAGHER / WESTERN AND SOUTHERN LEWIS AND CLARK	9	0	**9**

	High Wind	Strong Wind	Total
BROADWATER/JEFFERSON/MEAGHER WESTERN AND SOUTHERN LEWIS AND CLARK	2	0	**2**
BUTTE / BLACKFOOT REGION	30	6	**36**
BUTTE / PINTLAR REGION	8	0	**8**
CRAZY MOUNTAINS	3	0	**3**
FLATHEAD/MISSION VALLEYS	40	16	**56**
GALLATIN	97	0	**97**
GALLATIN / MADISON	4	0	**4**
JEFFERSON	29	0	**29**
KOOTENAI/CABINET REGION	29	7	**36**
LIVINGSTON AREA	97	0	**97**
LOWER CLARK FORK REGION	15	6	**21**
MADISON	145	0	**145**
MEAGHER	45	0	**45**
MISSOULA / BITTERROOT VALLEYS	40	22	**62**
NORTHERN PARK COUNTY	8	0	**8**
NORTHERN SWEET GRASS	68	0	**68**
PARADISE VALLEY	10	0	**10**
PARK	14	0	**14**
POTOMAC / SEELEY LAKE REGION	6	8	**14**
SOUTHERN LEWIS AND CLARK	150	0	**150**
SOUTHERN ROCKY MOUNTAIN FRONT	372	1	**373**
WEST GLACIER REGION	24	8	**32**
Total	1,478	75	**1,553**

Source: NCEI

Figure 4-76 Total High Wind and Strong Wind Events by Zone (1996 to 2022)



Source: NCEI, Chart by WSP

Like high wind and strong wind, there are variations between counties in the Western Region regarding thunderstorm wind and tornado events. Park County experienced the greatest number of thunderstorm wind events and Beaverhead County experienced the greatest number of tornado events. In total, there were 728 thunderstorm wind events since 1955 and 42 tornado events since 1950 in the Western Region. Table 4-52 displays a summary of these events.

Table 4-52 Total High Wind and Strong Wind Events by Zone

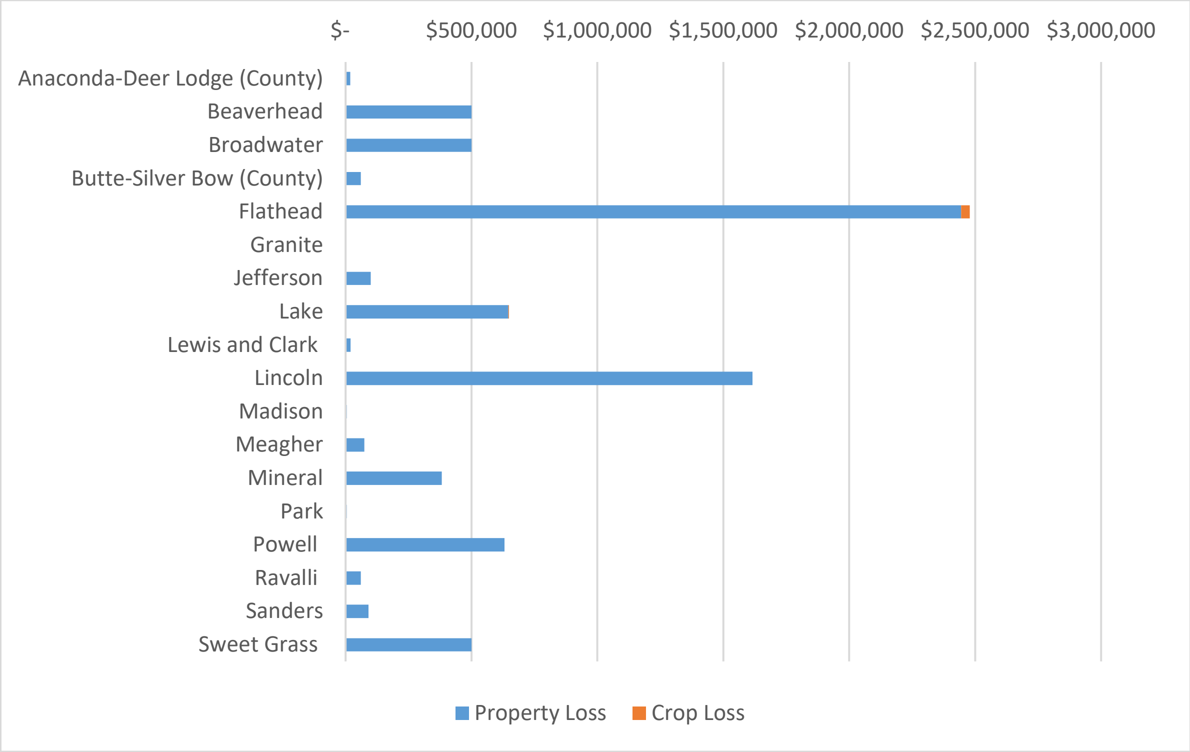
	Thunderstorm Wind	Tornadoes
BEAVERHEAD CO.	66	12
BROADWATER CO.	30	1
DEER LODGE CO.	10	1
FLATHEAD CO.	62	4

	Thunderstorm Wind	Tornadoes
GRANITE CO.	14	2
JEFFERSON CO.	25	0
LAKE CO.	43	3
LEWIS AND CLARK CO.	84	4
LINCOLN CO.	36	0
MADISON CO.	31	2
MEAGHER CO.	20	3
MINERAL CO.	16	0
PARK CO.	144	2
POWELL CO.	24	2
RAVALLI CO.	44	3
SANDERS CO.	24	1
SILVER BOW CO.	25	0
SWEET GRASS CO.	30	2
Total	728	42

Source: NCEI

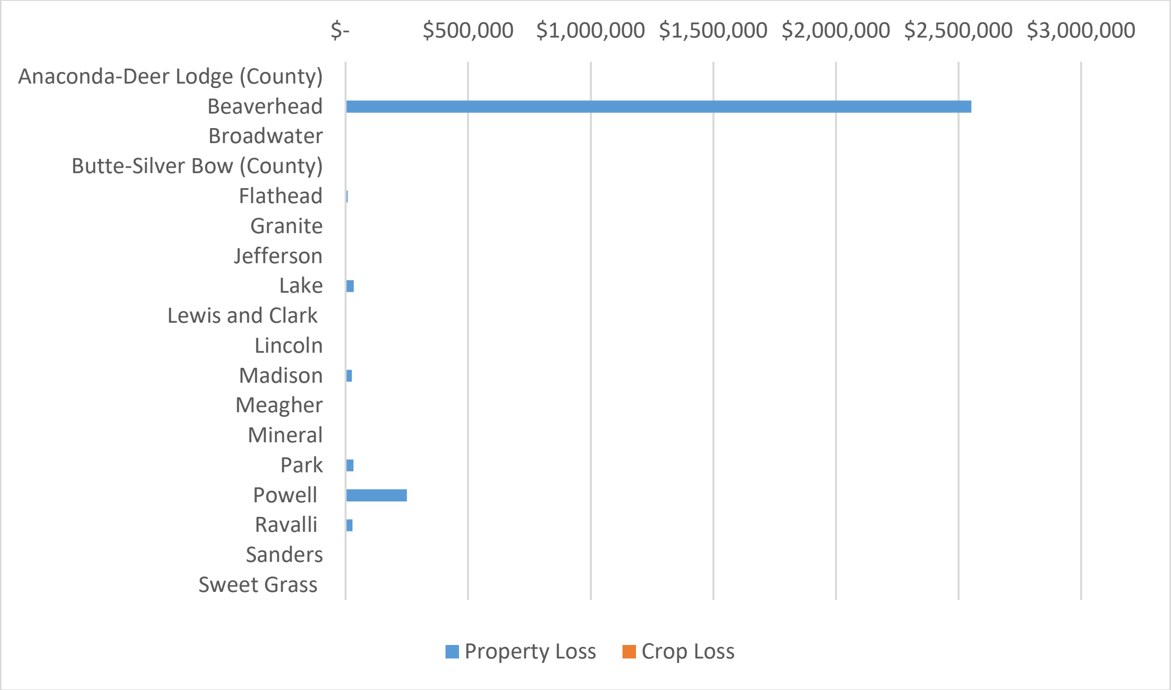
Figure 4-77 and Figure 4-78 display crop and property losses by county from tornado and thunderstorm wind events. According to the dataset, Flathead and Lincoln Counties experienced the highest property loss resulted from thunderstorm wind events. Beaverhead County experienced the highest property loss resulted from tornado events.

Figure 4-77 Total Losses from Thunderstorm Wind by County



Source: NCEI, Chart by WSP

Figure 4-78 Total Losses from Tornadoes by County



Source: NCEI, Chart by WSP

The NCEI reported details on significant events in the Western Region:

- **June 6, 1976:** A tornado event happened in Beaverhead County. The event resulted in $2.5 million of property damage.
- **July 2, 2010:** At approximately 3:45pm to about 3:52pm, a supercell thunderstorm produced a tornado with surrounding microburst damage. This occurred about 15 miles northeast of Wilsall over the foothills of the Crazy Mountains in Park County. Thousands of trees were damaged, including large trees that were uprooted or snapped off at the base. Trees as large as three to four feet in diameter were uprooted and/or snapped. EF-2 scale damage with estimated wind speeds up to 120 mph was determined with this tornado. According to NCEI, this event resulted in 32,500 of property damage.
- **July 21, 1997:** This event majorly impacted the City of Libby in Lincoln County. Microburst from a thunderstorm caused widespread damage. Wind gusts estimated at least 80 mph caused 2 injuries as trees fell on houses and through to people inside. Trees and power poles were also snapped off or uprooted. Almost every street in the town was blocked by fallen trees. Marble sized hail also fell. Damage to the public sector included blocked roads, damages to the city water system and system as well as an elementary school. Loss to the private sector included damaged homes and vehicles. The Red Cross estimated 20 homes with major damage and 70 with minor damage within the City of Libby city limits. Four insurance companies estimated damage to be at $1.5 million.
- **May 31, 2020:** This event impacted Flathead County. Widespread high winds were reported as a line of thunderstorms, in the form of a squall line, moved north-northeastward across the Region. While wind gusts of 50 to 60 miles per hour were common, a person from the public in Kila reported a measured peak wind gust of 78 miles per hour, and the ASOS at Glacier Park International Airport recorded a peak wind gust of 69 miles per hour. Numerous trees were either snapped in half or uprooted, which resulted in over 200 power outages and 37,000 customers without power. Several houses and vehicles were destroyed as trees fell onto them. Highway 2 and Montana Highway 83 were both covered by fallen trees for a time. This event resulted in $450,000 and caused one injury.

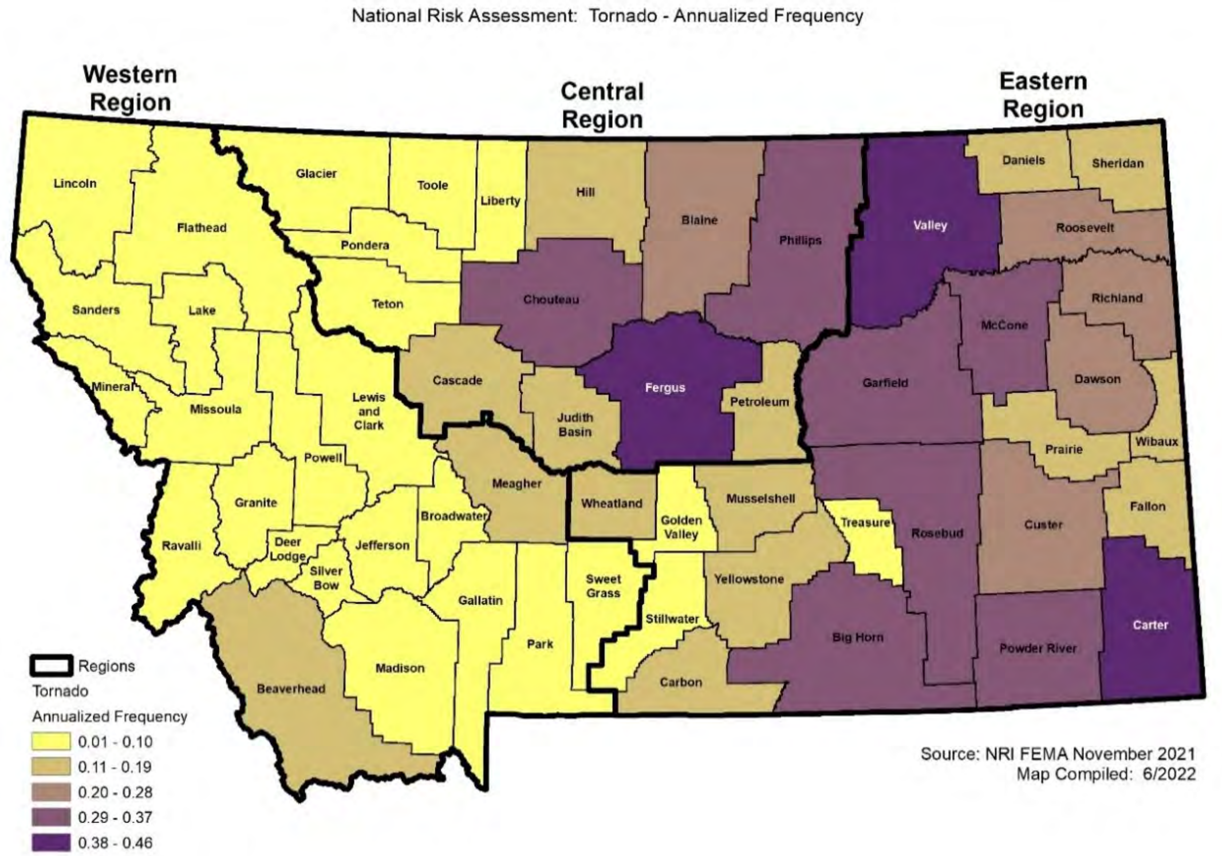
4.2.14.4 Frequency/Likelihood of Occurrence

According to the NCEI dataset, there has been 2,323 total recorded severe windstorm and tornado events on 1,119 days over the past 72 years in the Western Region; therefore, there is an average of nearly 16 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 every 1.7 years. Park County has the most documented reports of tornado events. The highest number of wind events occur along the Rocky Mountain Front, according to the 2018 Montana State Hazard Mitigation Plan. As shown by the NCEI dataset, the Southern Rocky Mountain Front Zone has the most recorded high wind and strong wind events.

The figure below depicts annualized frequency of tornado events at a county level based on the NRI. The mapping shows most counties in the Region have a low frequency of tornado events. Beaverhead and Meagher Counties have a slightly higher frequency.

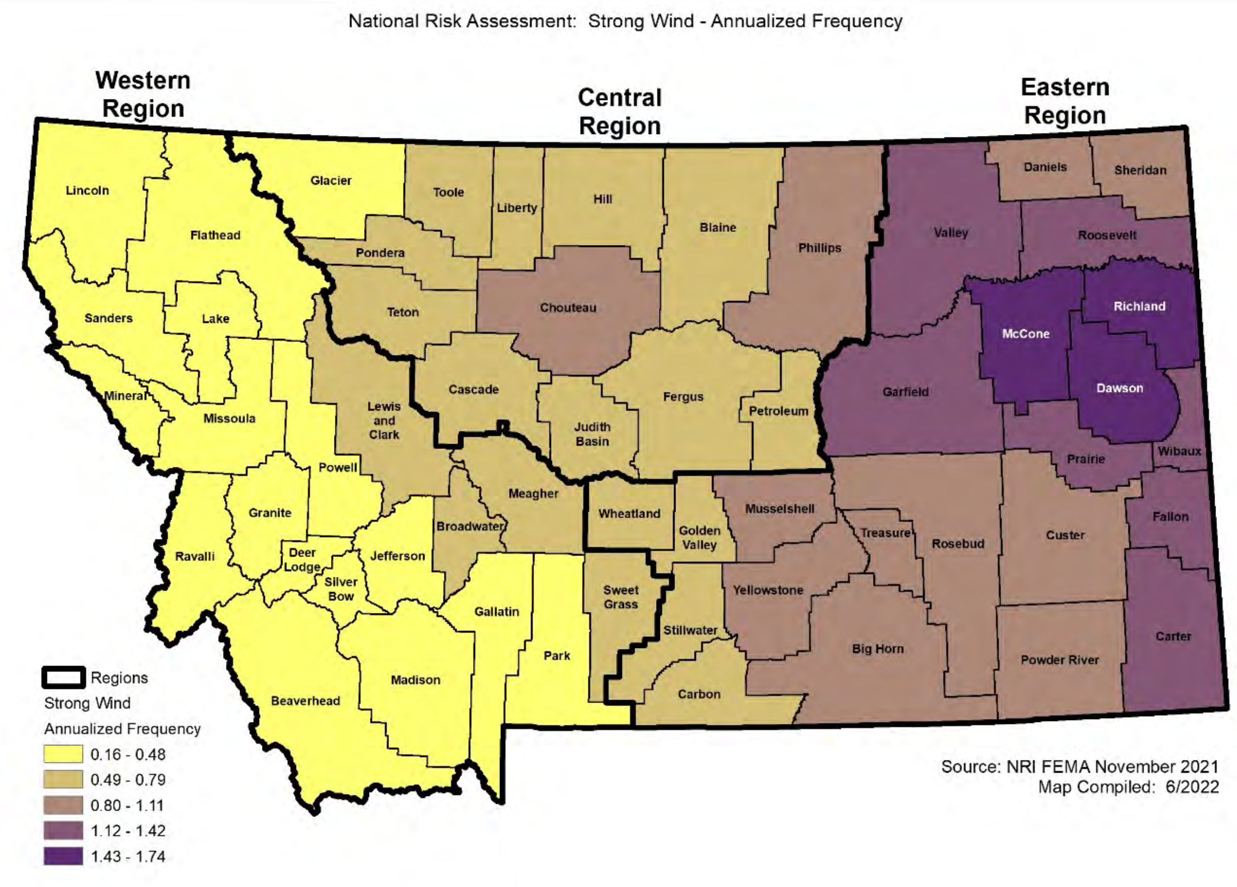
Figure 4-79 Annualized Frequency of Tornado Events by County



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

The figure below depicts annualized frequency of strong wind events at a county level based on the NRI. The mapping shows most counties in the Region have a low frequency of tornado events. Lewis and Clark, and Broadwater Counties have a slightly higher frequency.

Figure 4-80 Annualized Frequency of Strong Wind Events by County



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

4.2.14.5 Climate Change Considerations

According to the Montana State Hazard Mitigation Plan 2018, population exposure and vulnerability to severe weather are likely to increase because of climate change. Severe weather events may occur more frequently, which would lead to increased exposure and vulnerability. Although all people may be affected by the health-related impacts of climate change, the elderly, young children, and people with weakened immune systems are often the most susceptible.

Ongoing research compiled in the recent climate assessment has resulted in different conclusions on the effect of climate change on wind regimes. The August 2021 IPCC report argues that in most places, wind speeds will be drastically reduced because of climate change, whereas in 2019, Scientific American reported that winds across the world were speeding up. The Maine Monitor suggests that a lack of wind can increase wildfire risks and aggravate drought. Unusual wind patterns combined with other climate change issues, such as hotter water temperatures, can also cause problems. At this time, these changing factors are not well understood and are still being incorporated into state and regional research and risk analysis. Hopefully, soon, scientists will be able to find a solution for the rapidly changing wind patterns (Garrison 2022).

For other types of extreme weather events, such as tornadoes and severe thunderstorms, more research is also needed to understand how climate change will affect them. These events occur over much smaller scales, which makes observations and modeling more challenging. Projecting the future influence of climate change on these events can also be complicated by the fact that some of the risk factors for these events may increase with climate change, while others may decrease, like the complexity of predicting future wind patterns, which is mentioned above. Even though some studies predict that climate change could provide the opportunity for more severe thunderstorms to form, this does not necessarily mean that more tornadoes will occur, given that only about 20% of supercell thunderstorms produce tornadoes. The fourth National Climate Assessment summarizes the complicated relationship between tornadoes and climate change: "…extreme weather, such as tornadoes, are also exhibiting changes which may be linked to climate change, but scientific understanding isn't detailed enough to project direction and magnitude of future change." ("Tornadoes And Climate Change" 2022)

4.2.14.6 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, over $17.6 million was recorded in property damages, almost $340,000 in crop losses, 28 injuries and two fatalities have been recorded in the Western 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.

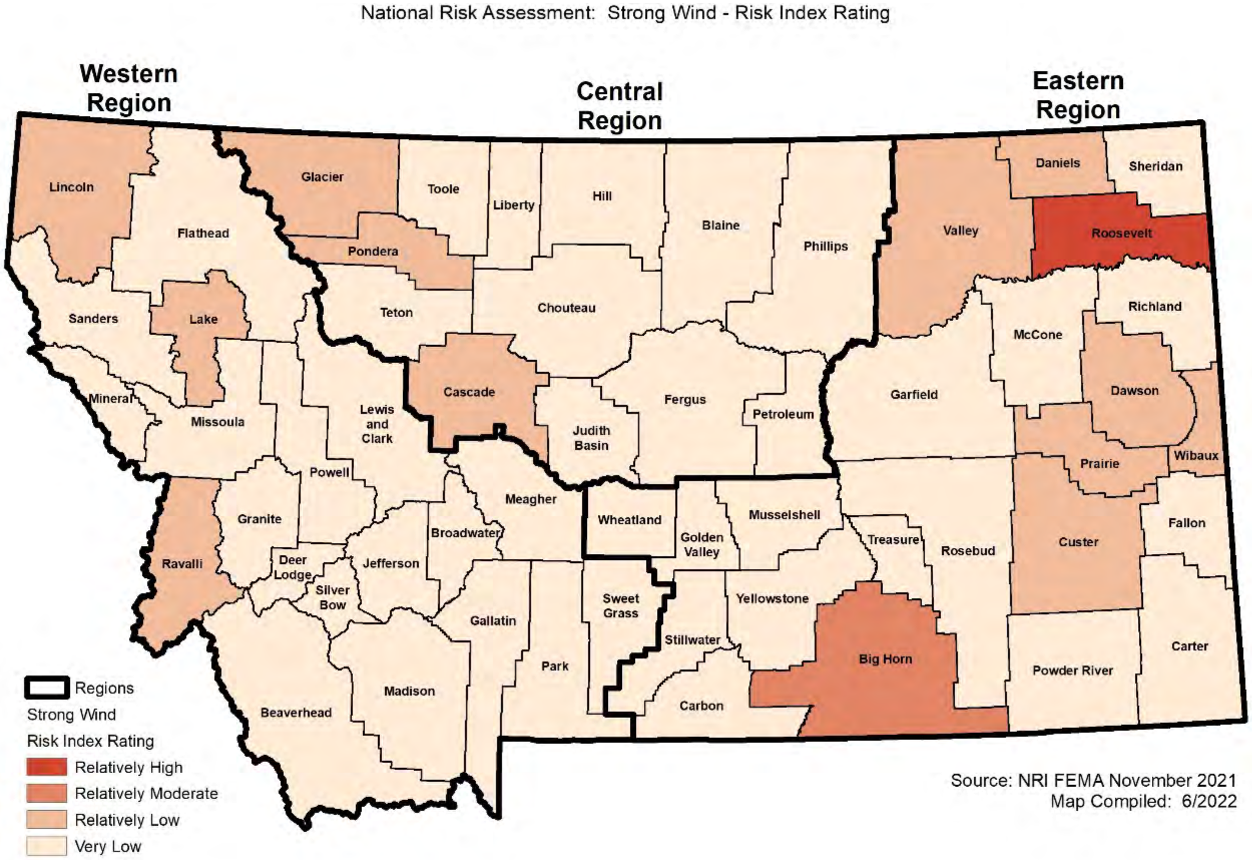
Overall, windstorm or tornado impacts in Western Region would likely be **critical**. While wind occurs rather frequently in the area, most events cause little to no damage. The impact on quality of life or critical facilities and functions in the affected area would be minimal. Injuries or deaths are possible due to wind-thrown trees in the backcountry or from other blown debris.

4.2.14.7 Vulnerability Assessment

The figure below illustrates the relative RIs rating due to strong wind and tornadoes in Montana counties based on data in the NRI. The NRI calculation considers various factors, including the EALes, social vulnerability, and community resilience in each county across Montana. Most counties in the Region have a relatively low to moderate rating for both strong wind and tornadoes; none have a high or very high RI rating.

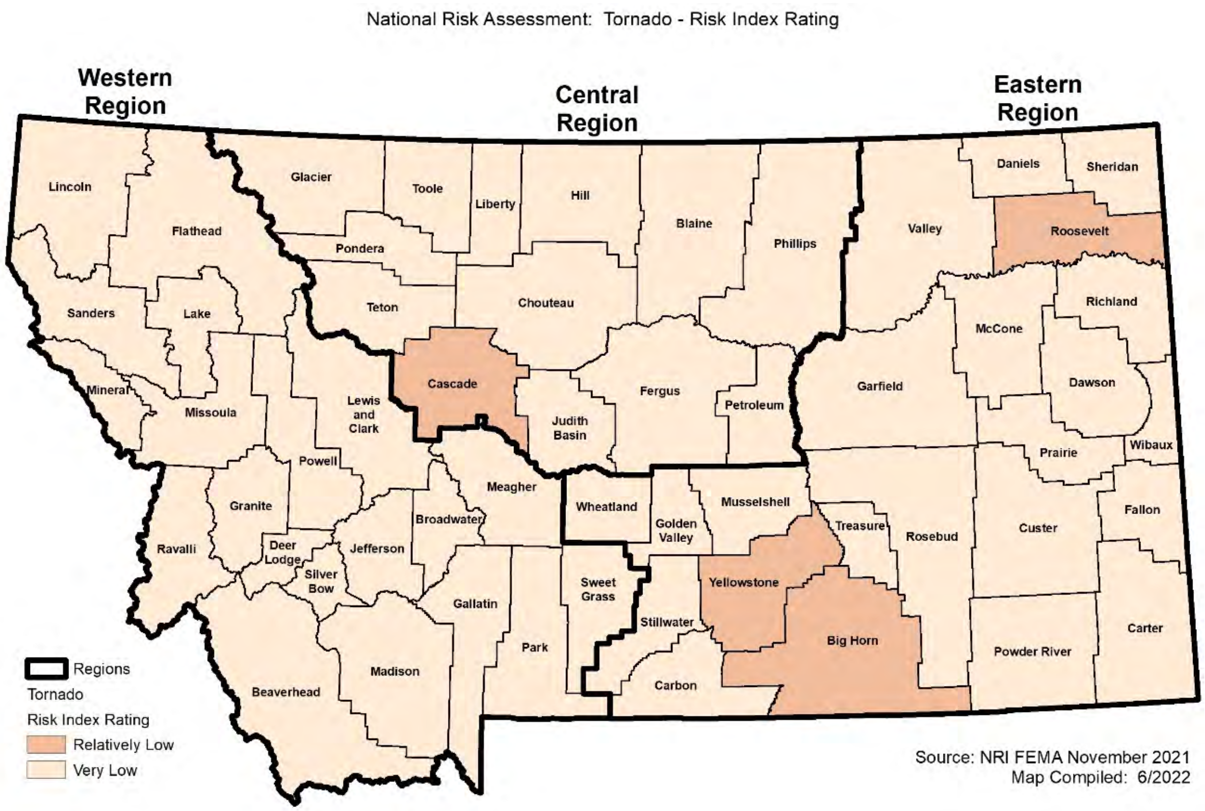
The figures below illustrate the relative risk of EAL rating due to strong wind and tornadoes for Montana counties based on data in the NRI. Most counties in the Region have a very low to relatively low rating; none have a moderate, high, or very high-risk EAL rating. The EAL calculation considers agriculture value exposed to hazards, annualized frequency, and historical losses.

Figure 4-81 NRI Risk Index Rating for Strong Wind



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

Figure 4-82 NRI Risk Index Rating for Tornadoes



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

People

The entire planning area is vulnerable to windstorm and tornadoes. Certain areas are more exposed due to geographic location and local weather patterns. Populations living at higher elevations with large stands of trees or power lines may be more susceptible to wind damage and black out. While tornadoes typically occur on flat plains, where conditions are most favorable for these events, tornadoes have been known to cross rivers and travel up mountains.

Vulnerable populations are the elderly, low-income or linguistically isolated populations, people with life-threatening illnesses, and residents living in areas that are isolated from major roads. Power outages due to severe wind or tornadoes can be life-threatening to those dependent on electricity for life support. These populations face isolation and exposure during thunderstorm wind, high wind, and tornado events and could suffer more secondary effects of the hazard.

Individuals caught in the path of a tornado who are unable to seek appropriate shelter are especially vulnerable. This may include individuals who are out in the open, in cars, or who do not have access to basements, cellars, or safe rooms. Hikers and climbers in the area may also be more vulnerable to severe weather events. Visitors to the area may not be aware of how quickly a thunderstorm can build in the mountains.

Property

All property is vulnerable during thunderstorm and high wind, but properties in poor condition or in particularly vulnerable locations may risk the most damage. Generally, the damage is minimal and goes unreported. Property located at higher elevations and on ridges may be more prone to wind damage. Property located under or near overhead lines or large trees may be damaged in the event of a collapse.

Like severe wind, all critical facilities and infrastructure are likely exposed to tornadoes. Older buildings in the planning area may be built to low code standards or none, making them more susceptible to severe wind and tornado events. Mobile homes are disproportionately at risk due to the design of homes. Tornadoes also often create flying debris which can cause damages to homes, vehicles, and landscape. In the Western Region, property damages due to wind and tornadoes totaled over $17.6 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

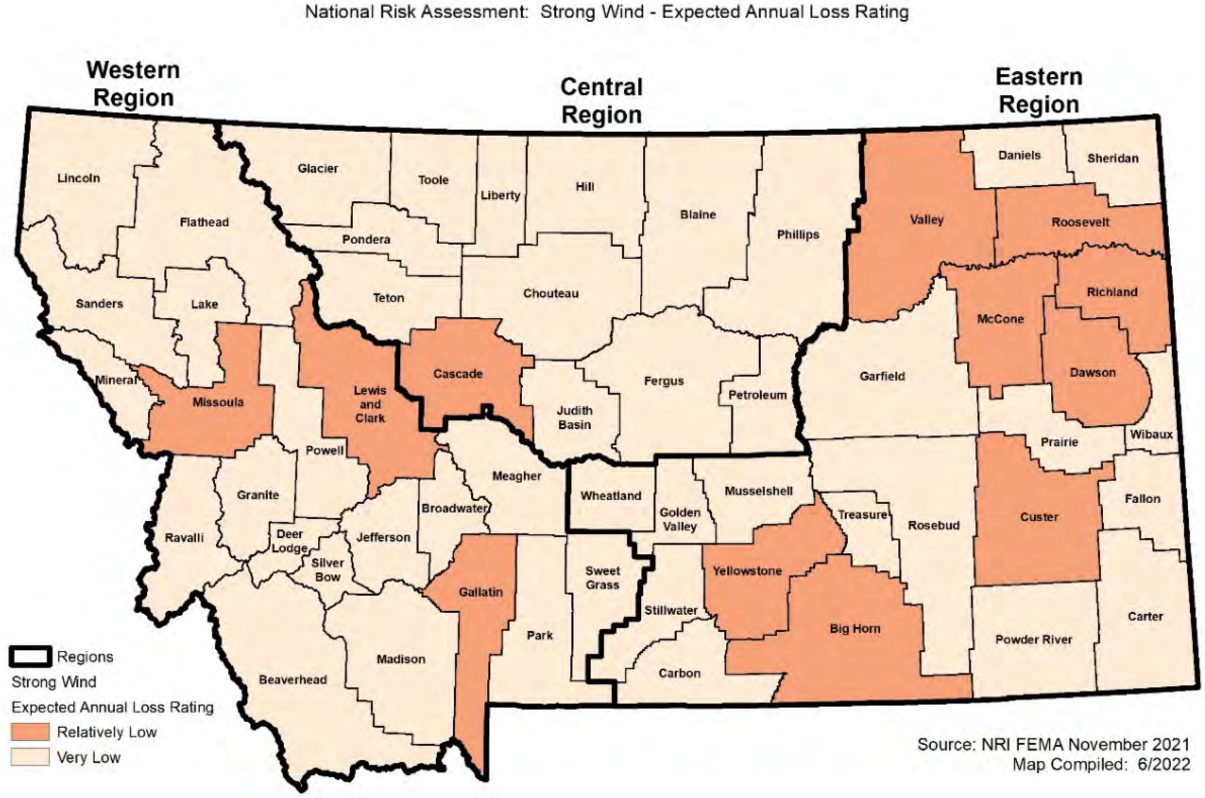
Incapacity and loss of roads are the primary transportation failures resulting from windstorms and tornadoes. These hazards can cause significant damage to trees and power lines, blocking roads with debris, incapacitating transportation, isolating population, and disrupting ingress and egress. Of particular concern are roads providing access to isolated areas and the elderly. The most common problems associated with these weather events are loss of utilities. Downed power lines can cause blackouts, leaving large areas isolated, which was reported several times in the NCEI dataset. Phone, water, and sewer systems may not function. Loss of electricity and phone connection would leave certain populations isolated because residents would be unable to call for assistance.

Economy

Loss of power and minimal damage following a tornado or severe windstorm event could cause disruptions to the local economy through forced temporary closures of businesses and preventing people from traveling to work. More severe events could result in significant economic disruption and hinder recovery through the forced extended or permanent closure of businesses damaged in the event. Additionally, events that cause significant property damage could negatively impact the local economy. Most financial losses due to wind and tornadoes are related to direct property damages as well as subsequent debris removal, response, and repair activities.

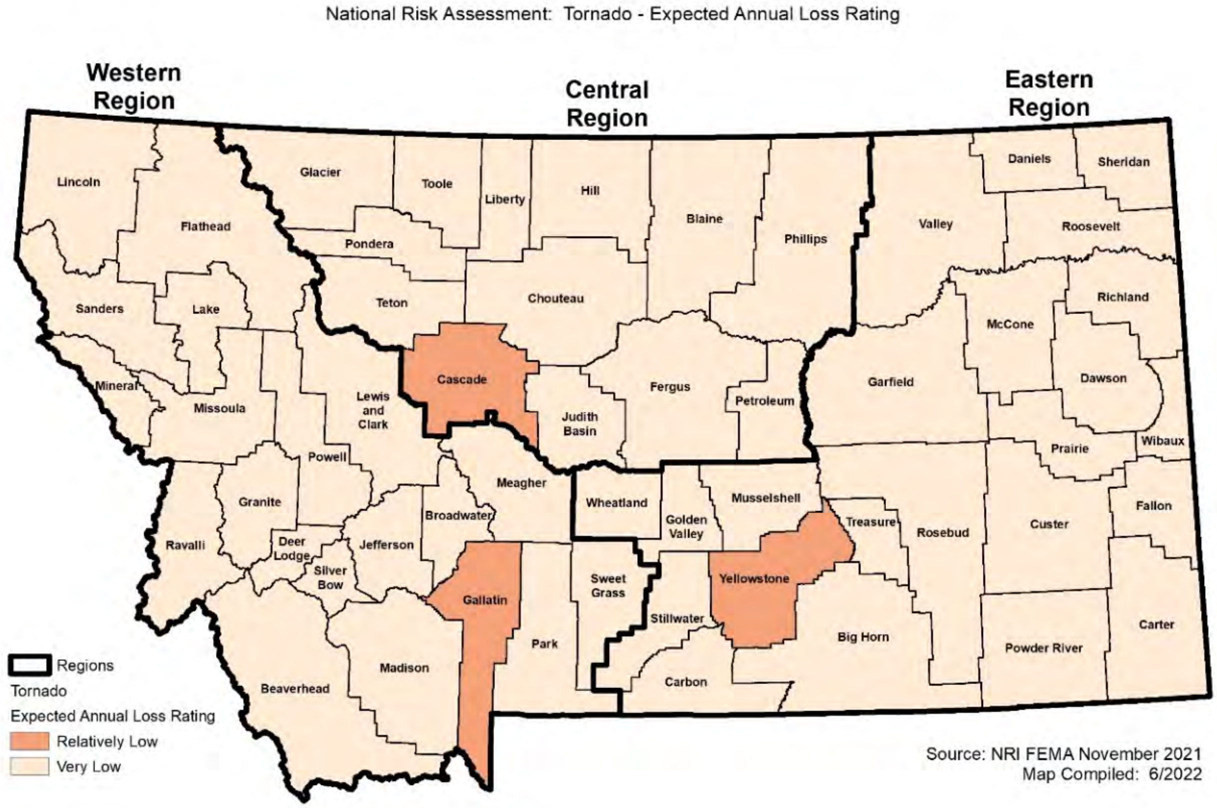
The figure below illustrates the relative risk of EAL rating due to strong wind and tornadoes for Montana counties based on data in the NRI. Most counties in the Region have a relatively low or very low rating; none has high or very high-risk EAL rating. The EAL calculation considers agriculture value exposed to these events, annualized frequency, and historical losses. The EAL rating is thus heavily based on agricultural impacts.

Figure 4-83 NRI Strong Wind Expected Annual Loss Rating



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

Figure 4-84 NRI Tornado Events Expected Annual Loss Rating



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

Historic and Cultural Resources

Historic and cultural resources are equally as exposed to tornado and windstorm events as any other infrastructure. As mentioned previously, historic infrastructure is less likely to be built to code and can be more vulnerable to damage during wind and tornado events.

Natural Resources

The environment is highly exposed to severe winds and tornadoes. Large swaths of tree blowdowns can occur, particularly in the beetle-killed forests prevalent in the State. Severe winds can trigger or spread wildfires under some conditions. Crops are also at risk of losses. The NCEI dataset reported almost $340,000 in crop losses from windstorm and tornado events in the Western Region.

Development Trends Related to Hazards and Risk

All future development will be exposed to severe winds and tornadoes. The ability to withstand impacts lies in sound land use practices and consistent enforcement of codes and regulations for new construction. Development regulations that require safe rooms, basements, or other structures that reduce risk to people would decrease vulnerability but may not be cost-effective given the relative infrequency of damaging tornadoes in the Western Region. The State of Montana has adopted the 2012 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.

4.2.14.8 Risk Summary

- Severe windstorms (high wind, strong wind, thunderstorm wind) and tornado events are rated as **Medium** overall significance for the Western Region.
- These events can impact anywhere in the planning region; therefore, the hazard extent is rated as **Extensive**.
- The NCEI data reported 1,119 days with severe weather events over 72 years, which averages to nearly 16 days a year with severe winter weather events in the Western Region; therefore, the future occurrence is rated as **Highly Likely.**
- The NCEI reported 2 deaths, 28 injuries, $17.6 million in property damages and almost $340,000 in crop 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 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 4-53 Risk Summary Table: Tornadoes and Windstorms

Jurisdiction	Overall Significance	Additional Jurisdictions	Jurisdictional Differences?
Western Region	Medium	N/A	
Anaconda-Deer Lodge	Low	Anaconda - Deer Lodge City	
Beaverhead	Medium	City of Dillon, Town of Lima	
Broadwater	Medium	City of Townsend	
Butte-Silver Bow	Low	Butte-Silver Bow City, Town of Walkerville	
CSKT	Medium	Confederated Salish and Kooteani Tribes of the Flathead Reservation	
Flathead	Medium	Columbia Falls, Kalispell, Whitefish	
Granite	Medium	Towns of Drummond and Philipsburg	
Jefferson	Medium	City of Boulder, Town of Whitehall	
Lake	Medium	City of Polson, City of Ronan, Town of St. Ignatius	
Lewis and Clark	Low/Medium	City of Helena, City of East Helena	
Lincoln	Medium	City of Libby, City of Troy, Town of Eureka	

Jurisdiction	Overall Significance	Additional Jurisdictions	Jurisdictional Differences?
Madison	Medium	Town of Ennis, Town of Sheridan, Town Virginia City	
Meagher	Medium	City of White Sulphur Springs	
Mineral	Medium	N/A	
Park	Medium	City of Livingston, Town of Clyde Park	
Powell	Medium	City of Deer Lodge	
Ravalli	Medium	City of Hamilton, Town of Darby, Town of Stevensville	
Sanders	Medium	City of Thompson Fall, Town of Plains, Town of Hot Springs	
Sweet Grass	Medium	City of Big Timber	

4.2.15 Transportation Accidents

4.2.15.1 Hazard/Problem Description

This hazard encompasses air transportation, highway transportation, waterway transportation, railway transportation, and wild animal vehicle collisions. 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 local 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. In fact, the driver's behavior and condition factors are the primary cause in an estimated 67 percent of highway crashes and a contributing factor in an estimated 95 percent of all crashes.

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. Deer are the most common wild animal involved in roadway transportation accidents in the United States and in the Western Region.

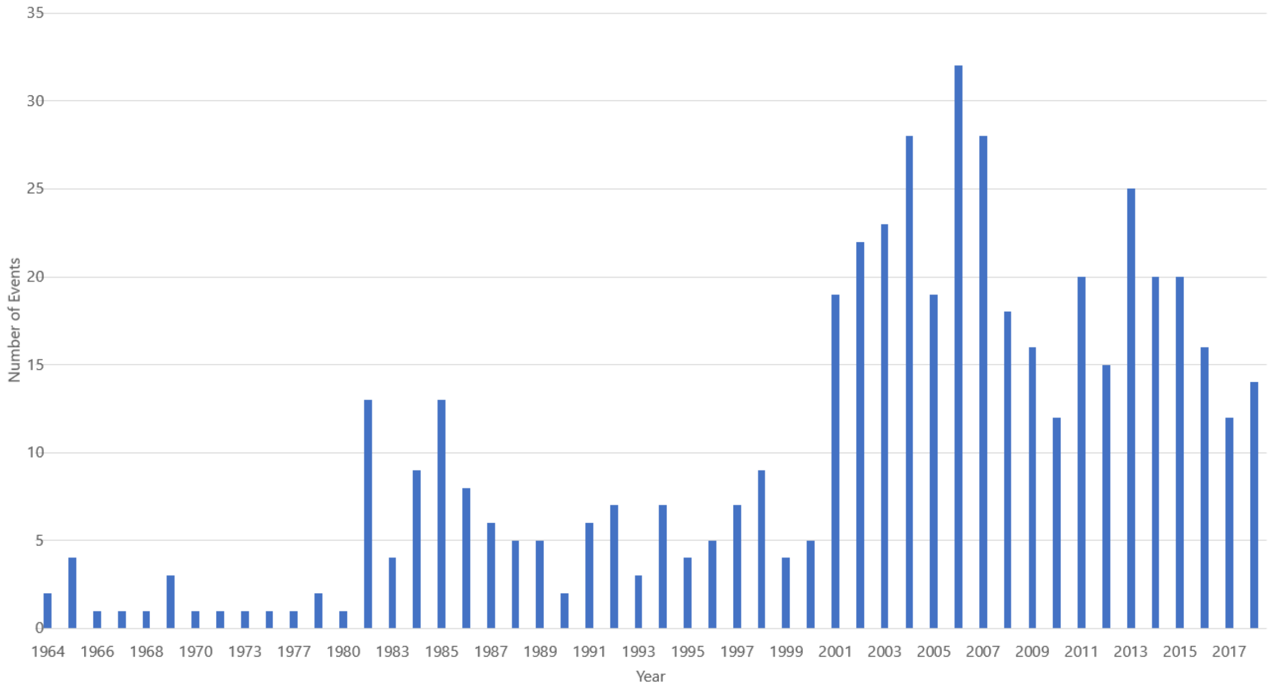
4.2.15.2 Geographical Area Affected

All counties in the Western Region are subject to transportation accidents. Due to transportation accidents typically occurring along roadways, waterways, or near airports, the significance rating for the geographic area affected in the Western Region is rated as **significant** (10-50% of planning area). Roads with frequently reported roadway transportation accidents in the Western Region include Interstates 15 and 90, and U.S. Route 2, U.S. Route 93, U.S. Route 287, and U.S. Route 12. The BNSF railway is the most significant railway running through the Western 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 Glacier Park International Airport in Kalispell, Helena Regional Airport in Helena, and the Dillon Airport in Dillon. However, documented aircraft crashes have happened across the planning area and are most frequently documented as being small civilian aircrafts.

4.2.15.3 Past Occurrences

Air Transportation Incidents
The National Transportation Safety Board reported 505 air transportation incidents statewide in Montana from 1964 to 2018. Figure 4-85 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 4-85 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 Western Region:

- October 2, 2022 - A plane crash occurred in Sanders County, located east of the Perma Bridge in the Flathead River. According to the report, upon further investigation it was determined that the plane struck power lines nearby leading to the crash. The pilot was the lone occupant of the plane and was killed in the incident.
- April 30, 2022 – Multiple area emergency response agencies converged on a property along Church Drive between Farm to Market Road and West Valley Drive in Flathead County after a yellow aircraft fell from the sky. Local officials said the two people aboard the single engine aircraft died in the crash.
- August 15, 2011 - A flight instructor and his student pilot sustained fatal injuries after a small aircraft crash in Sliver Bow County. The flight originated from Bert Mooney Airport in Butte. Witnesses traveling along I-90 reported seeing the aircraft spiraling and losing altitude before the crash, and investigations revealed that the aircraft struck terrain on a nearby mountain, resulting in the crash.

Highway Transportation Incidents

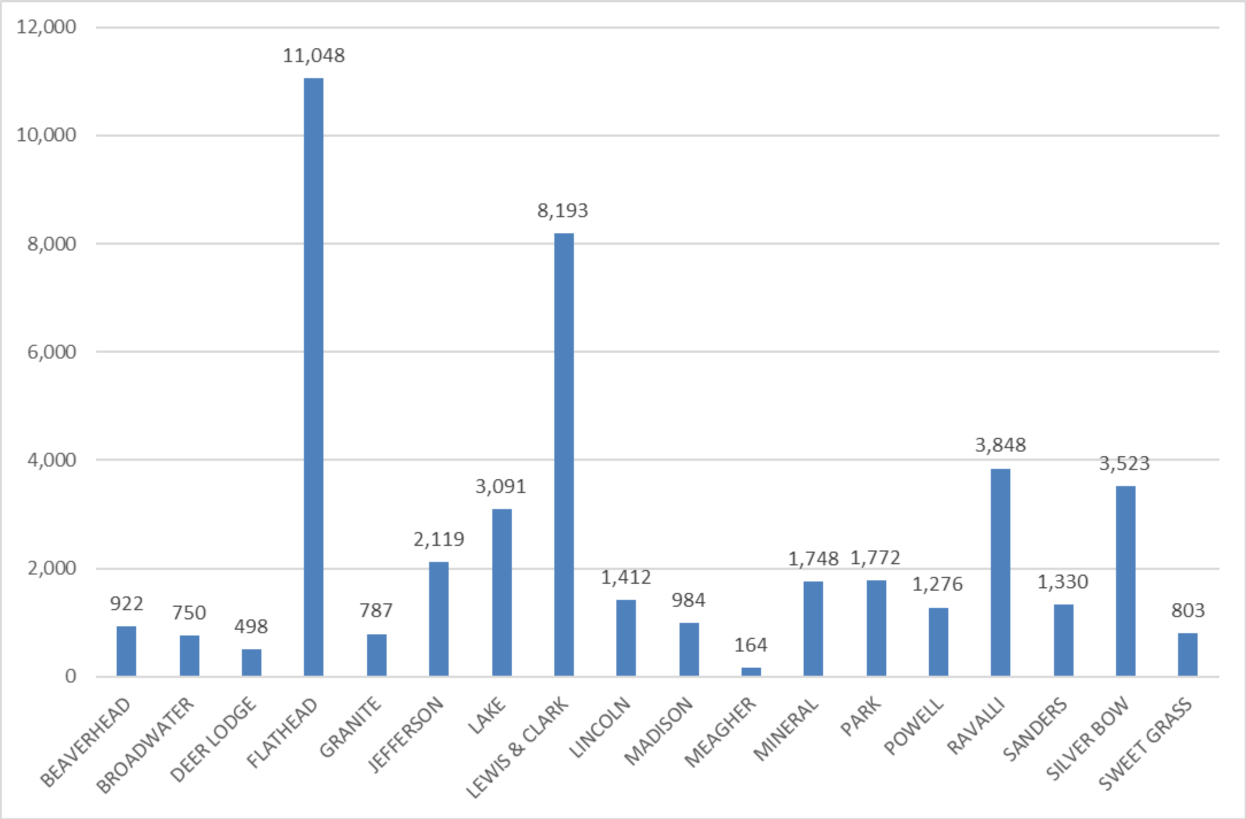
The MDT's Office of Traffic and Safety maintains traffic crash statistics and location maps by county. Table 4-54 and Figure 4-86 illustrate the trends of crashes by county in the Western Region between 2016 and 2020. This dataset was extracted from the MDT's Crash Database compiled for the purpose of safety enhancement of potential accident sites, hazardous roadway conditions, or railway-highway crossings. The dataset has reported 44,268 road transportation events over the course of 4 years across the counties in the Western Region. Flathead County had the greatest number of reported crash events, with a total of 11,048 reported events, far outpacing all other counties in the Region. The second highest number of crashes in this time period occurred in Lewis and Clark County with 8,193 incidents. These two counties alone account for approximately 43% of the total crashes recorded in the Region.

Table 4-54 Roadway Crash Statistics by County in the Western Region (2016-2020)

County	Number of Accidents (2016-2020)
Anaconda-Deer Lodge	498
Beaverhead	922
Broadwater	750
Butte-Silver Bow	3,523
Flathead	11,048
Granite	787
Jefferson	2,119
Lake	3,091
Lewis & Clark	8,193
Lincoln	1,412
Madison	984
Meagher	164
Mineral	1,748
Park	1,772
Powell	1,276
Ravalli	3,848
Sanders	1,330
Sweet Grass	803
Total	**44,268**

Source: MDT 2016-2020

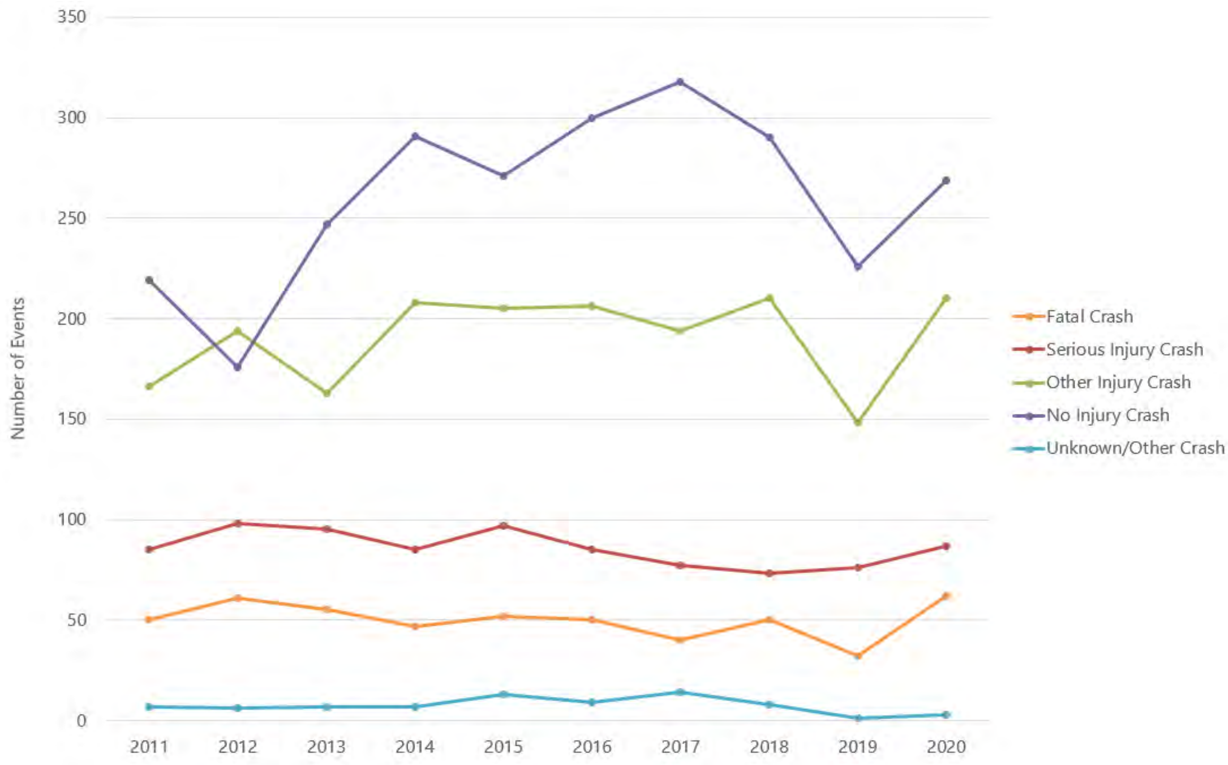
Figure 4-86 Roadway Crash Statistics by County in the Western Region (2016-2020)



Source: MDT *2016-2020*

The MDT (DoT) also reported crash severity from 2011-2020 for the entire State of Montana. Figure 4-87 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 4-87 Roadway Crash Severity in Montana (2011-2020)

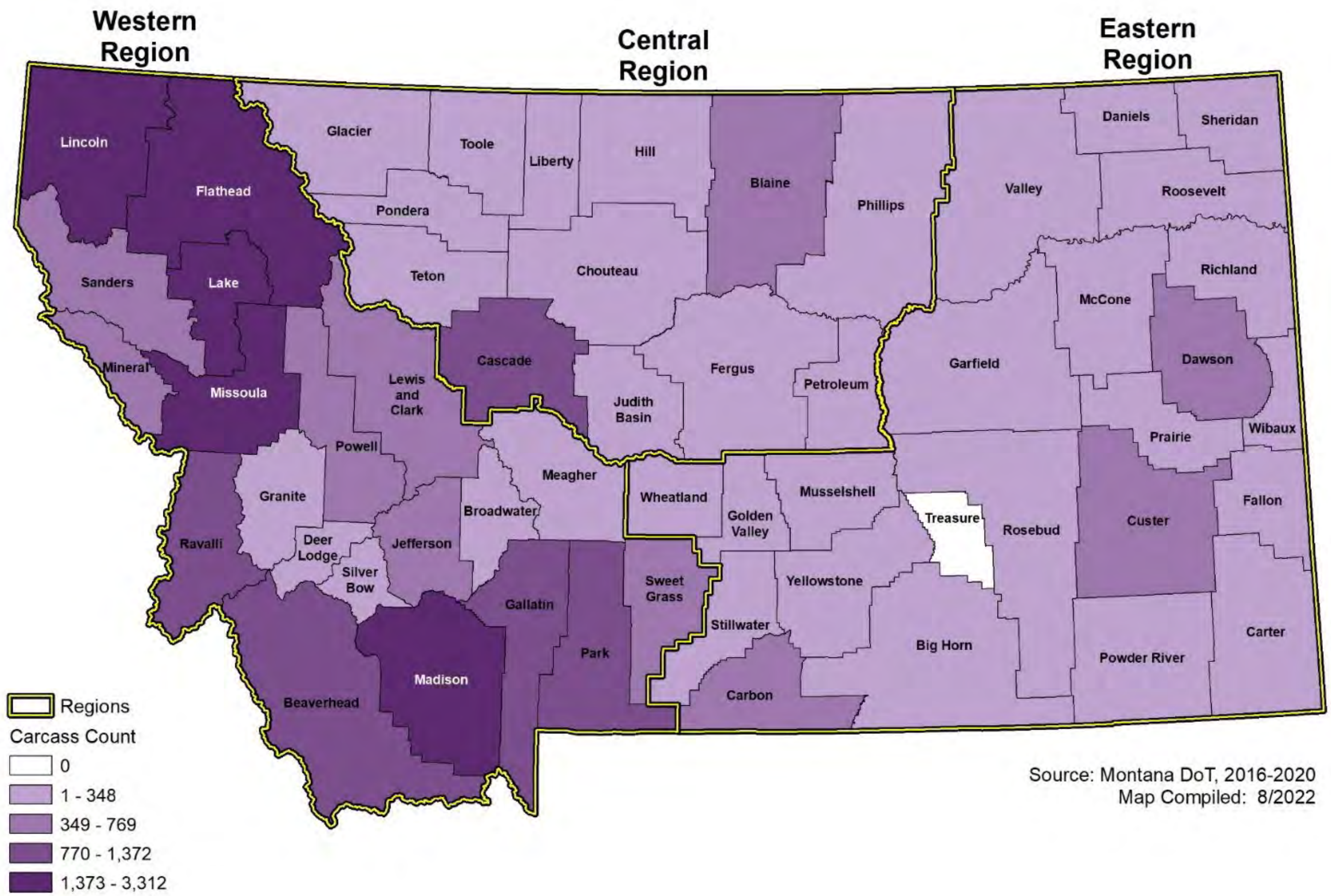


Source: MDT 2011-2020

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 28,585 wildlife car accidents from 2016-2020. Figure 4-88 displays the animal carcass data by county in Montana. The Western Region experiences consistently higher rates of wildlife car accidents than the rest of the State, with Flathead, Lake, Lincoln, Madison, and Missoula Counties seeing the greatest annual frequencies.

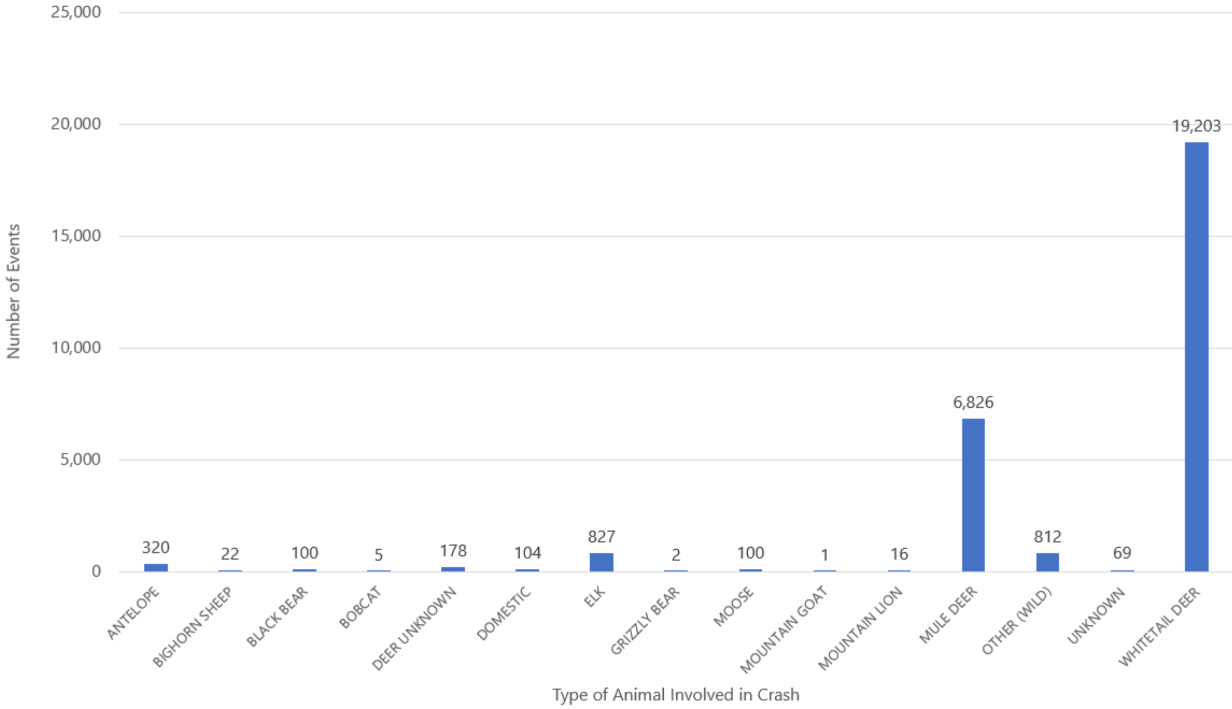
Figure 4-88 Wildlife Crash Statistics by County in Montana (2016-2020)



Source: Montana DoT, *Map by WSP*

Figure 4-89 displays a breakdown of the crashes by type of animal involved across the State of Montana. 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.

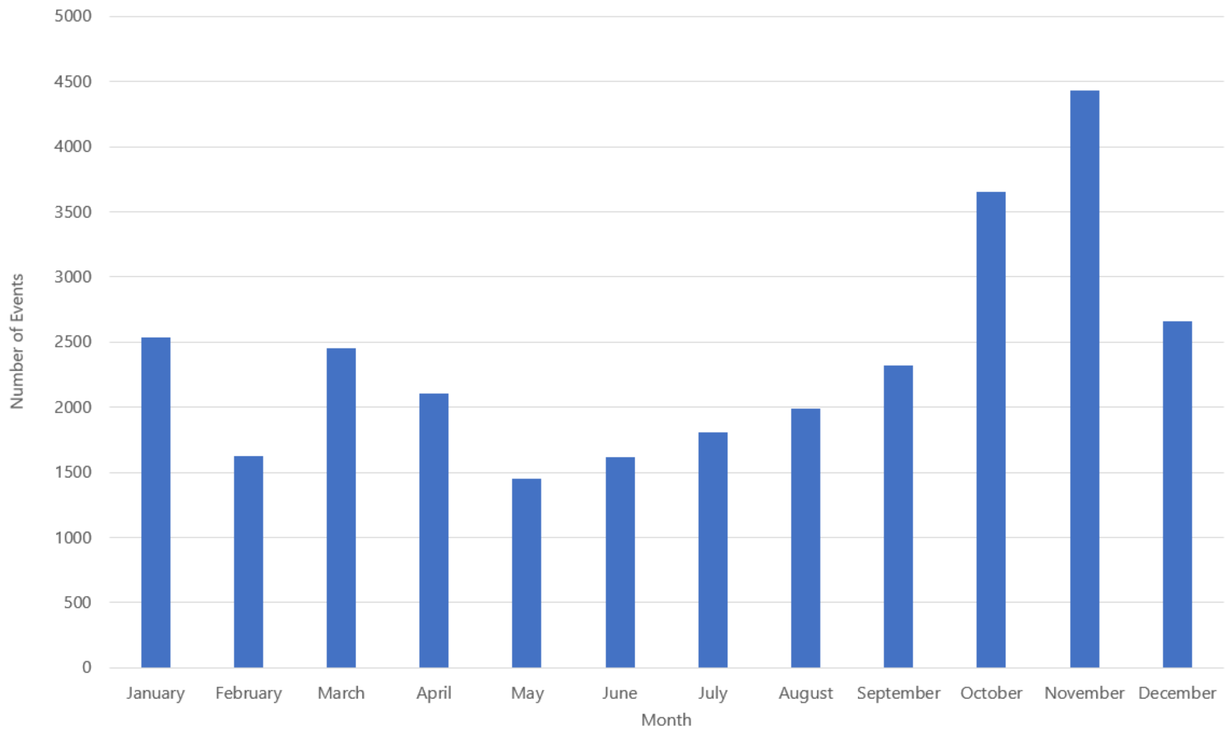
Figure 4-89 Wildlife Crash Statistics by Carcass Type in Montana (2016-2020)



Source: MDT 2016-2020

The Montana DoT also reported on the date that these wildlife accidents occurred. Figure 4-90 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.

Figure 4-90 Wildlife Crash Statistics by Month in Montana (2016-2020)



Source: MDT 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 and recreation. Several major rivers in the Western Region include the Flathead River, Bitterroot River, Missouri River, and Clark Fork River. Flathead Lake, Georgetown Lake, Lake Koocanusa, and Canyon Ferry Reservoir also provide space for outdoor recreation in the Western 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 4-55 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 4-55 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

4.2.15.4 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 Western 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 in recent years which may increase the statistical likelihood for an occurrence. The National Transportation Safety Board documented 505 aircraft accidents over 54 years, which averages over 9 aircraft accidents per year across the State. The trend of increasing numbers of people flying is likely to continue as will the crowdedness of airports and the skies above Montana.

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 increase, 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 the potential open 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 44,268 roadway traffic accidents from 2016 to 2020 in the Western Region, or an average of 11,067 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 7,163 accidents a year.

Many ponds, rivers, and lakes throughout the Region are used for recreation, including angling, boating, and swimming. The number of users of Montana lakes and rivers is increasing each year with increased tourism and population growth in the Region. 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.

4.2.15.5 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. Increasing temperatures due to climate change could therefore post threats to aircrafts.

4.2.15.6 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 4-56. Injuries and deaths are also impacts of transportation accidents. While transportation accidents are frequent in the Western Region, most accidents result in minor property injuries to vehicles involved; therefore, the magnitude ranking for transportation incidents in the Western Region is **Limited**.

Table 4-56 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

4.2.15.7 Vulnerability Assessment

People

All people are vulnerable to transportation accidents in the Western 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 significantly higher. This is also true before and after major gatherings such as sporting events, concerts, and conventions. Pedestrians and bystanders of the community are less vulnerable unless they are in the roadway. Any individual incident will have a direct impact on only a few people. Individuals involved in a transportation accident can have cuts, bruises, broken bones, loss of limbs, and death. It is also common for individuals involved in an accident to experience psychological effects from a severe accident.

Not all people are equally vulnerable to transportation incidents. A study by the Governors Highway Safety Association, An Analysis of Traffic Fatalities by Race and Ethnicity 2021, 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. At least one aircraft accident case documented in the Western Region damaged powerlines. Boating incidents can cause extensive damage to ships, bridges, and docks.

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 are 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

Transportation accidents to natural resources is 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 HAZMAT occurs.

Development Trends Related to Hazards and Risk

Increasing roadway infrastructure and the number of cars on the road will likely result in an increase in the number of transportation accidents in the Western 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.

4.2.15.8 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. First responder services may be delayed due to multi-car pileup 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.
- The frequency of transportation accidents is high across jurisdictions, but some counties such as Flathead, Lewis & Clark, Ravalli, and Butte-Silver Bow Counties are much more likely to experience greater losses due to larger populations and greater concentration of transportation systems.
- Related Hazards: Hazardous Materials Accident.

Table 4-57 Risk Summary Table: Transportation Accidents

Jurisdiction	Overall Significance	Additional Jurisdictions	Jurisdictional Differences?
Western Region	Low	NA	Major interstates, state highways and rail systems located throughout the study area. Several airports

Jurisdiction	Overall Significance	Additional Jurisdictions	Jurisdictional Differences?
			throughout the Region as well.
Anaconda-Deer Lodge County	Medium	NA	
Beaverhead County	Low	Dillon, Lima	
Broadwater County	Low	Townsend	
Butte-Silver Bow County	Medium	NA	Butte has a high concentration of transportation infrastructure, the convergence of I-15 and I-90, and Bert Mooney Airport. Larger population also makes higher likelihood.
CKST	Medium	NA	
Flathead County	Medium	Columbia Falls, Kalispell, Whitefish	Flathead County has the highest number of recorded traffic incidents in the Western Region. Kalispell is likelier to experience incidents due to larger population and traffic congestion.
Granite County	Low	Drummond, Philipsburg	
Jefferson County	Low	Boulder, Whitehall	
Lake County	Low	Polson, Ronan, St. Ignatius	
Lewis & Clark County	Medium	East Helena, Helena	Second highest number of recorded traffic incidents in the Western Region. Higher population in Helena makes likelihood for incidents higher.
Lincoln County	Low	Eureka, Libby, Rexford, Troy	
Madison County	Low	Ennis, Sheridan, Twin Bridges, Virginia City	
Meagher County	Low	White Sulphur Springs	
Mineral County	Medium	Alberton, Superior	
Park County	Low	Clyde Park, Livingston	
Powell County	Low	Deer Lodge	
Ravalli County	Medium	Darby, Hamilton, Pinesdale, Stevensville	
Sanders County	Medium	Hot Springs, Plains, Thompson Falls	
Sweet Grass County	Medium	Big Timber	

4.2.16 Volcanic Ash

4.2.16.1 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. Hazards include those related to volcanic activities such as: 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. 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 can result in significant hazards.

According to the State of Montana Multi-Hazard Mitigation Plan, 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 known volcanic activity and did experience the effects of volcanic activity in 1980 during the eruption of Mount St. Helens in 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. According to the U.S. Geological Survey, there are 161 active or potentially active volcanoes in the United States.

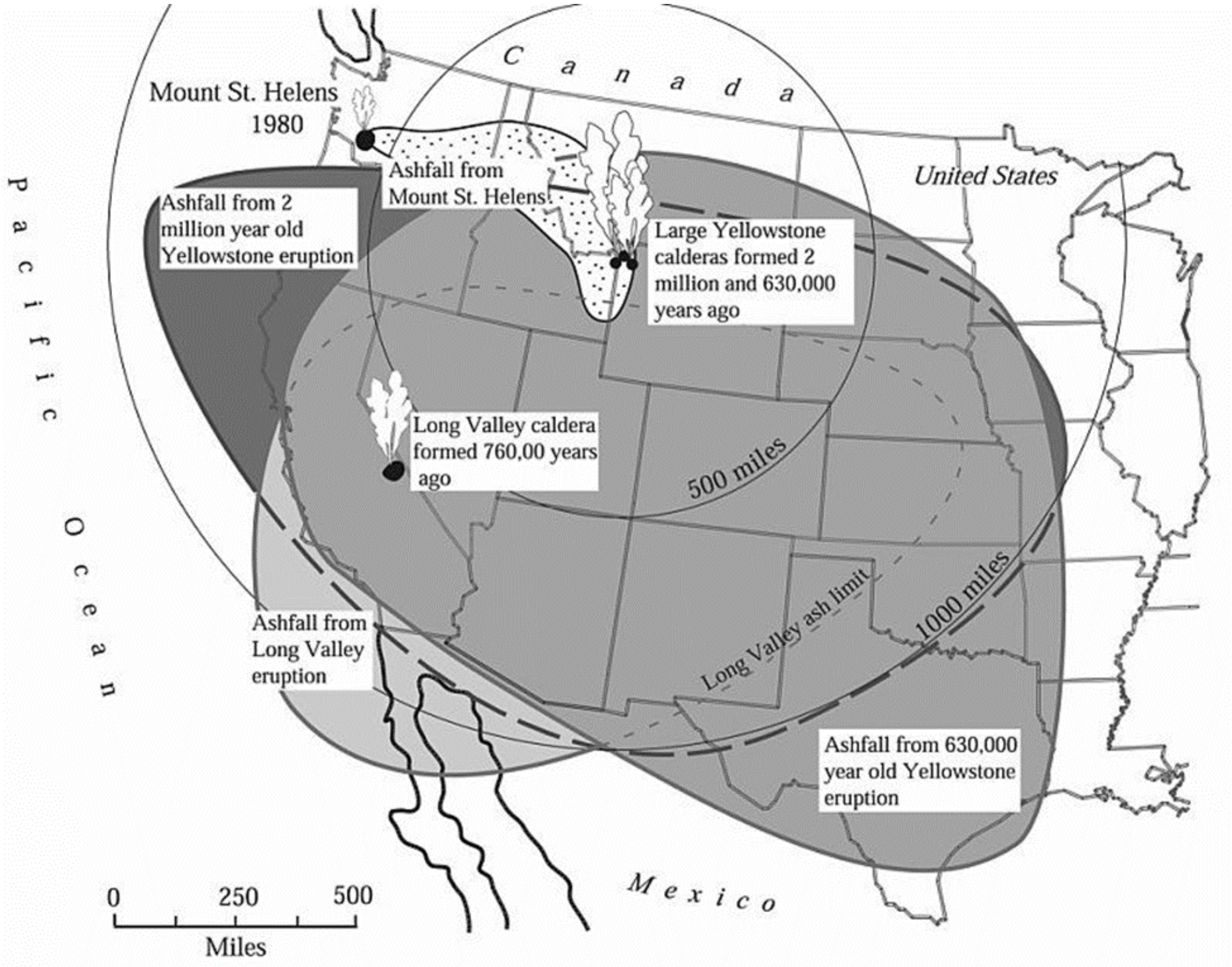
The two volcanic centers affecting Montana in recent geologic time are the Cascade Range of Washington, Oregon, and California, and the Yellowstone Caldera in Wyoming and Eastern Idaho. Historical trends suggest that eruptions in the Cascade Mountains are more likely to affect Montana than Yellowstone Caldera eruptions. The primary effect of a Cascade volcanic eruption in Montana would be ash fall.

According to the U.S. Geological Survey, Yellowstone National Park has been identified as a prominent hot spot for geologic activity. Studies dating back to the 1970's demonstrate that the ground level is in a constant state of flux. It has been determined that the Yellowstone Caldera floor is in near constant motion, with various regions moving in alternate directions on differing time scales. It is believed that these fluctuations are caused by seismic activity and the compounding effects of this activity, such as release of stored magma. Therefore, these measurable ground movements do not necessarily signal renewed volcanic activity in the area (Brantley et al., 2004).

4.2.16.2 Geographical Area Affected

The geographical extent of volcanic ash is **Extensive**. 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. All areas of the Western Region would be affected by a volcanic eruption of the Yellowstone Caldera. As shown in Figure 4-91 below, almost all of the State of Montana has been covered with volcanic ash at some point in the recent geologic history.

Figure 4-91 Areas of the United States Once Covered by Volcanic Ash from Major Eruptions



Source: USGS, 2000

4.2.16.3 Past Occurrences

The most recent occurrence of volcanic ash to impact Western Montana was fallout from the eruption of Mount St. Helens in 1980. Ash deposits were up to a fifth of an inch thick in the western part of the State and tapered to near zero toward the eastern part of the State. The 2018 State Hazard Mitigation Plan notes travel was restricted in Western Montana for over a week in part due to reduced visibility that resulted in closed roads and airports, as well as health risks posed to children, the elderly, and people with cardiac or respiratory conditions. It is estimated that the eruption cost between $15-20 million statewide (HMP, 2018).

Compared to previous volcanic events in the Cascades, the 1980 eruption of Mount St. Helens was not a large one. It was less than 1/100th of the estimated volcanic material ejection from the Mount Mazama eruption that formed Crater Lake (Foxworthy and Hill, 1982). Compacted ash deposits from the Mount Mazama eruption were measured to be 6 inches deep in Teton County, and although the eruption occurred approximately 7,700 years ago, ash layers can still be found in the geology of Western Montana (Nimlos, 1981).

Glacier Peak is another active volcano in the Cascade Range. While it has historically erupted every 500 to 2,000 years, the last volcanic event that affected Montana occurred about 13,000 years ago. A series of six eruptions occurred, with one eruption ejecting more than five times the amount of volcanic material than was discharged by Mount St. Helens (USGS Glacier Peak). Compacted ash deposits in Western Montana from the Glacier Peak eruption have been measured to be up to 1.2 inches in depth.

Volcano	Most Recent Eruption (Years Before Present)	Location Affected	Thickness of Ash
Glacier Peak	13,000	Western Montana	1.2 in. (compacted)
Crater Lake	7,700	Western Montana	Up to 6 in. (compacted)
Mount St. Helens	42	Entire Montana	Up to 0.2 in. (uncompacted)

Source: USGS; Foxworthy and Hill, *1982; Nimlos, 1981*

4.2.16.4 Frequency/Likelihood of Occurrence

Unlikely - Ashfall from a Cascade Volcano is the primary hazard to which the State may be vulnerable. Eruptions in the Cascades have occurred at an average rate of 1-2 events per century during the last 4,000 years, and future eruptions are certain. Seven volcanoes in the Cascades have erupted in the last 200 years (Dzurisin, Stauffer and Hendley II, 1997). The next eruption in the Cascades could affect hundreds of thousands of people. The effect in Western 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, and the most recent was about 600,000 years ago (Brantley, et al., 2004). 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 molten rock to erupt at the surface. According to Roadside Geology of Montana, 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). While ashfall would be far-reaching, evidence suggests that the most severe impact would be on the southern part of Montana.

4.2.16.5 Climate Change Considerations

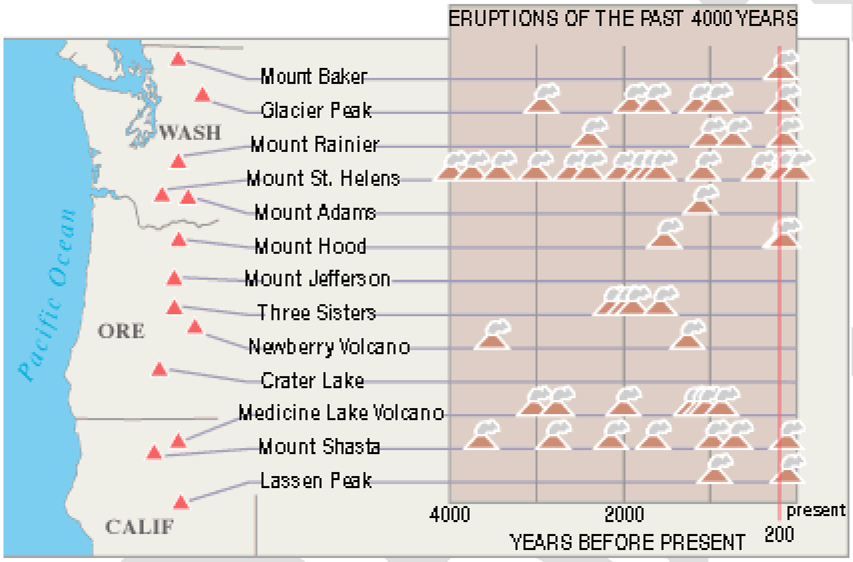
While most climate change considerations associated with hazards identified in this risk assessment pertain to how climate change might impact specific hazards, the considerations involved between climate change and volcanoes work the opposite way. While climate change is not expected to impact the size 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 atmospheric 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 Mount 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 the National Aeronautics and Space Administration (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 gases which would affect the global climate, as well as the nearby regions of Western Montana.

4.2.16.6 Potential Magnitude and Severity

Volcanic ash poses a unique hazard to Western Montana. According to Dzurisin et al., the volcanoes of the Cascade Range are very active and their proximity to the residents of the Pacific Northwest makes them some of the most hazardous volcanoes in the United States. While the greatest risks presented by the Cascade Range are posed by large eruptions, even small eruptions can have detrimental effects to the surrounding populations.

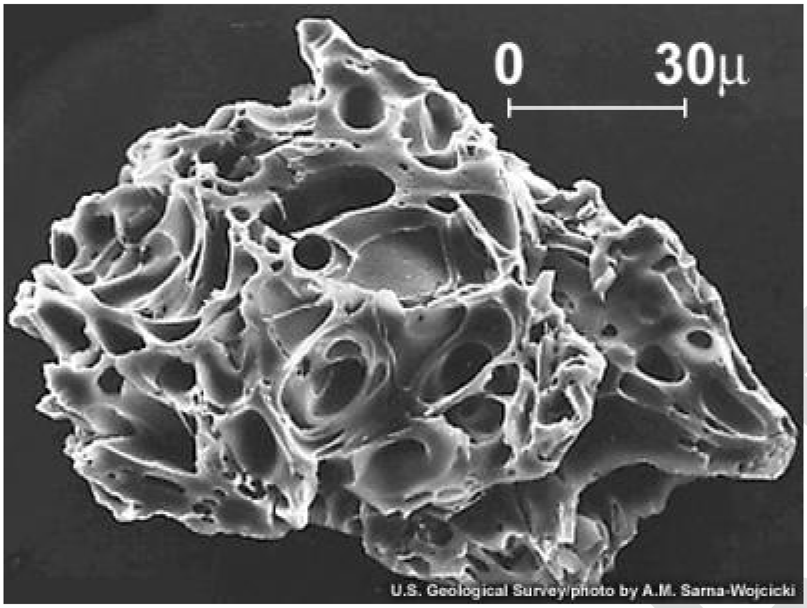
Figure 4-92 Past Eruptions of Cascade Volcanoes



Source: Dzurisin *et al., 1997*

Volcanic ash is composed of small, jagged pieces of minerals and volcanic glass. It is abrasive, corrosive, and does not dissolve in water. When it comes into contact with humans, it can cause irritation of the skin, eyes, and lungs. However, according to the USGS Volcanic Ashfall Working Group, volcanic ash is unlikely to have a direct impact on human health, except in cases where ash build up causes structural damage to buildings or leads to increased traffic accidents.

Figure 4-93 Microscopic View of Volcanic Ash



Source: Sarna-Wojcicki et al, 1981

Volcanic activity is also unique in its timing and duration. Unlike many natural hazards, such as earthquakes, tornadoes, or wildfires, which have a discrete beginning and end, volcanic activity can be a prolonged and fluid event. For example, the first warning signs of the impending eruption of Mount St. Helens is noted to be a 4.2 magnitude earthquake on March 20, 1980, a full week prior to the first eruption (Volcanic Ash Working Group, 2015). Intermittent bursts of ash and steam were ejected from the volcano from March 27th throughout April. The main explosion took place on May 18th, almost a full two months after initial warning signs. The volcano remained active, sporadically ejecting ash, gas, and pyroclastic flows, until January 3rd, 1981 (Harris, 2006).

The potential magnitude and severity of volcanic ash in Western Montana is limited. The most severe threat is to those in the immediate vicinity of active volcanoes. While the Cascade Range and the Yellowstone Caldera are both near to Western Montana, neither is close enough to pose a severe hazard without a major eruption. Scientists at the USGS Yellowstone Volcano Observatory do not expect Yellowstone to erupt soon. In fact, they are not certain it will erupt again (Yellowstone Volcano Observatory). There is only evidence of two eruptions from the Cascades, Mount Mazama and Mount St. Helens, leaving noticeable traces of ash in Montana. In the unlikely event another such eruption does occur, there should be sufficient warning time for preparation.

4.2.16.7 Vulnerability Assessment

People

Volcanic ash poses a public health risk to vulnerable populations, especially to children, the elderly, and individuals with cardiac and respiratory considerations. The U.S. Department of Health and Human Services (HHS) tracks Medicare beneficiaries who rely on electricity-depending medical equipment, such as ventilators, oxygen concentrator equipment, and implanted cardiac devices. According to HHS, there are 9,878 electricity dependent Medicare beneficiaries throughout the Western Region who rely on electricity to live independently in their homes. Many of these individuals will be vulnerable to effects of volcanic ash. The abrasiveness of the volcanic ash particles can scratch the surface of skin and eyes and in general cause discomfort and inflammation, in addition to difficulties breathing or death if too much ash is inhaled.

Property

Extensive cleanup efforts were required throughout Montana after the Mount Saint Helen eruption in 1980. Ashfall can impact both the interior and exterior of buildings. The interior of buildings can be contaminated with ash that builds up in air vents and filters. The exterior of buildings can have abrasive damage to roofs and gutters can be blocked with ash which could lead to secondary flooding issues. If a rain event was to occur post eruption, it can turn ash into heavy, cement-like sludge that can lead to the collapse of roofs and difficulty when cleaning up.

Critical Facilities and Lifelines

Critical facilities and infrastructure are most vulnerable to the effects of ashfall. Volcanic eruption with ashfall can cause electricity outages and issues with power supply. The air intakes for generators will also be vulnerable to airborne ash post eruption. Telephone and radio communications can also be interrupted and electronic components and short-circuits, especially high-voltage circuits and transformers, can fail due to ashfall.

Wastewater collection systems are also vulnerable 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 vulnerable to the impacts of ashfall. Roads, highways, and airport runways can become impassable due to the slippery ash and reduction of visibility. The abrasive volcanic ash can have damaging effects on aircraft, including melting the inside of engines and solidifying the turbine blades ultimately causing the engine to stall. According to Dzurisin et al., volcanic ash can cause damage to jet engines thousands of miles away. Ash can also lead to the failure of critical navigational and operational instruments.

Economy

In general, volcanic eruptions pose a risk to the tourism economy. Ashfall can disrupt travel into and out of all areas of the Region and create perilous conditions for residents, tourists, and nature alike. Ashfall can also lead to widespread power loss which could have lasting impacts on local businesses. The perception of risk after a volcanic event could lead to a downturn in visitors to the Region resulting in the need for the local communities to advertise that they are a safe place to visit. Massive impacts to the natural environment can also lead to widespread agricultural losses as well, resulting in far-reaching impacts to those related sectors of the economy.

Historic and Cultural Resources

The major vulnerability to volcanic activity in terms of cultural resources would be the recreational and tourism assets provided by the Region's natural environment. The natural landscape can be cataclysmically altered or destroyed by explosive volcanic eruptions. The Mt. St. Helens eruption permanently altered the landscape around the mountain, which was a popular tourism destination for many resorts and outdoor activities, not only damaging vegetation but physically altering the topography and waterways around the volcano. While this kind of explosive eruption occurring in the Western Region is unlikely, damage from heavy ashfall could also potentially destroy vegetation and the natural landscape.

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 that can result in decreased plant photosynthesis and poor pollination if flowers were damaged. Visual inspection of vegetation in a large area of the State of Washington impacted by the Mount St. Helens eruption showed three broad categories of plant damages: breakage due to the weight of ash, physiological changes such as decreased plant growth, and 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 4-58 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

As population increases in Western Montana and recreational usage continues to expand, more and more people and property are at risk from the effects of volcanic activity.

4.2.16.8 Risk Summary

Overall volcanic ash is considered a low significance hazard throughout the Western 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, region-wide manner.
- Related Hazards: Earthquake.

Table 4-59 Risk Summary Table: Volcanic Ash

Jurisdiction	Overall Significance	Additional Jurisdictions	Jurisdictional Differences?
Western Region	Low		
Anaconda-Deer Lodge	Low		None
Beaverhead	Low	City of Dillon Town of Lima	None
Broadwater	Low	City of Townsend	None
Butte-Silver Bow County	Low	City of Butte Town of Walkerville	None
Confederated Salish and Kootenai Tribes of the Flathead Reservation	Low	City of Columbia Falls City of Kalispell Town of Whitefish	None
Flathead	Low		None
Granite County	Low	Town of Drummond Town of Philipsburg	None
Jefferson	Low	City of Boulder Town of Whitehall	None
Lake	Low	City of Polson City of Ronan Town of St. Ignatius	None
Lewis and Clark	Low	City of Helena City of East Helena	None
Lincoln	Low	City of Libby City of Troy Town of Eureka Town of Rexford	None
Madison	Low	Town of Ennis Town of Sheridan Town of Twin Bridges Virginia City	None
Meagher	Low	City of White Sulphur Springs	None
Mineral	Low	Town of Superior Town of Alberton	None
Park	Low	City of Livingston Town of Clyde Park	None

Jurisdiction	Overall Significance	Additional Jurisdictions	Jurisdictional Differences?
Powell	Low	City of Deer Lodge	None
Ravalli	Low	City of Hamilton Town of Darby Town of Stevensville Town of Pinesdale	None
Sanders	Low	City of Thompson Fall Town of Plains Town of Hot Springs	None
Sweet Grass	Low	City of Big Timber	None

4.2.17 Wildland and Rangeland Fire

4.2.17.1 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" (NWCG 2012). Western Montana can be described as mostly rural and exhibits complex mountainous terrain, expansive forests, valley rangelands, and a complex and variable climate. Hot and dry summers typically follow cold and wet winters. As such, the Region's wildfire ecology is complex. Wildfire is an ongoing concern and considerable risk for the residents of Western Montana. Fires can occur at any time of the year in Western 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 (MT DNRC 2020a). 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 montane forest and rangeland ecosystems in Western 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, especially Western Montana's forests (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 2020a). Due to the complexity of the fire ecology exhibited by Western Montana's landscapes, wildfire risk and wildfire management vary drastically across the Region.

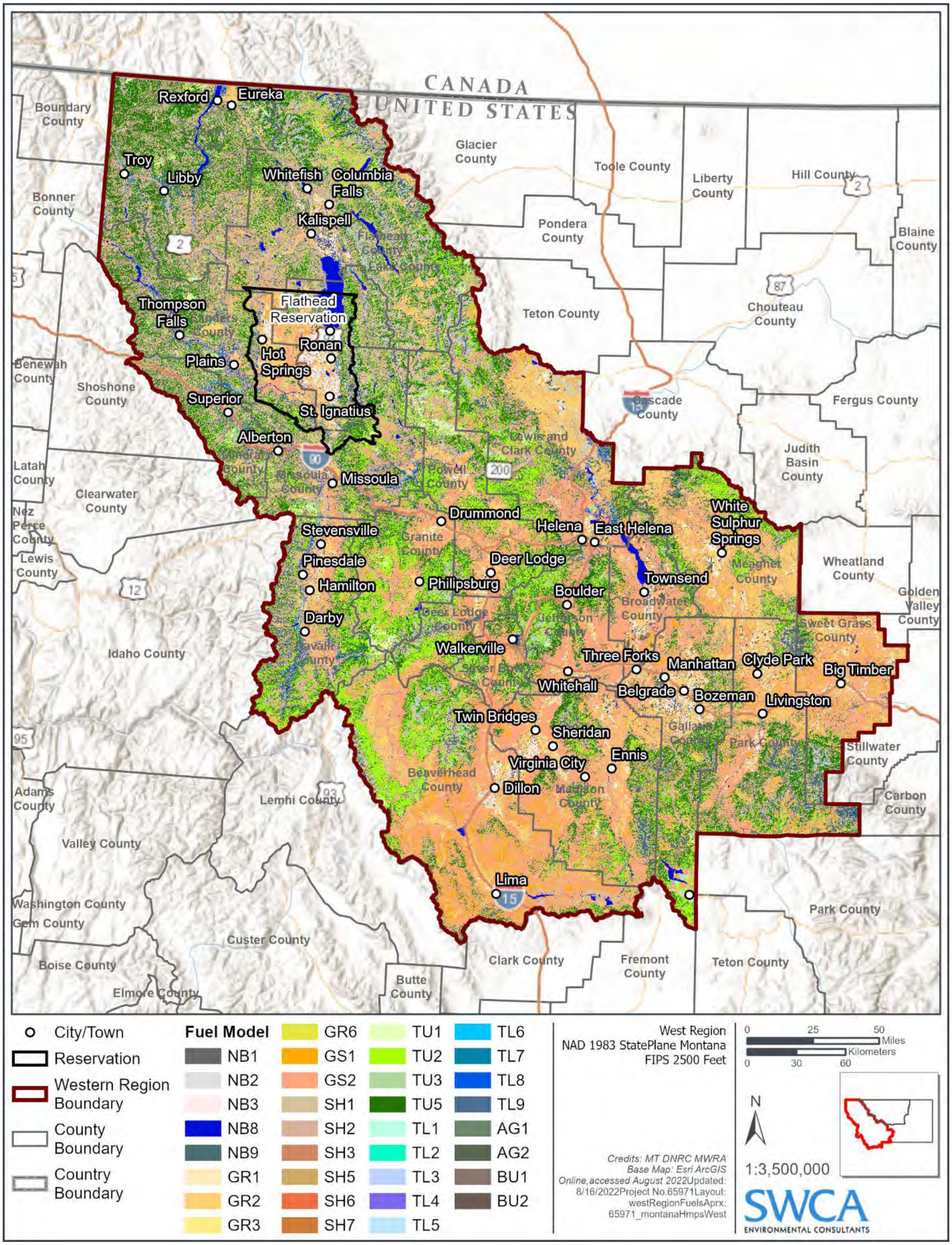
Generally, there are three major factors that predict wildfire behavior and predict a given area's potential to burn. These factors include fuel, topography, and weather.

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 types vary drastically throughout the Western Region. 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). Scott and Burgan's (2005) fire behavior fuel models were used to model fuels in Western Montana.

The northern portion of the Region is characterized by extensive tracts of forests which primarily exhibit TU5 (timber-understory) followed by TU2 fuels. TU5 fuels represent forests that have fuel beds with a high load of conifer litter and a shrub understory. Spread rate and flame length in TU5 fuels is usually moderate. Usually the cooler and/or wetter forests occupying the Western Montana are more likely to contain TU5 fuels. Common tree species characterizing the TU5 fuels can include subalpine fir (*Abies lasiocarpa*), Engelmann spruce (*Picea engelmannii*), lodgepole pine (*Pinus contorta*), and western larch (*Larix occidentalis*). Additionally, in the wetter and more temperate regions of Western Montana, species found in TU5 fuels can also include western red cedar (*Thuja plicata*) and western hemlock (*Tsuga heterophylla*). 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. TU2 fuels are more likely to occur in the southern portion of the Western Region, but they are also more commonly observed in the lower elevation forests of the montane regions. Species in TU2 forests typically consist of Douglas-fir (*Pseudotsuga menziesii*) and ponderosa pine (*Pinus ponderosa*).

There are also substantial expanses of rangelands in Western Montana. The primary fuel types in these rangelands are GS2 (grass-shrub) and GR2 (grass) fuels (Figure 4-94). GS2 fuels 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. Sagebrush (*Artemisia* sp.) systems occupy most of the GS2 fuels. GR2 fuels are characterized as lands with moderately coarse continuous grass with an average depth of about 1 foot. Wildfire spread rate is usually high and flame lengths are moderate. Bunchgrass grasslands occupy much of the GR2 fuels.

Figure 4-94 Wildfire Fuel Model of the Western Region



Source: MT DNRC 2022

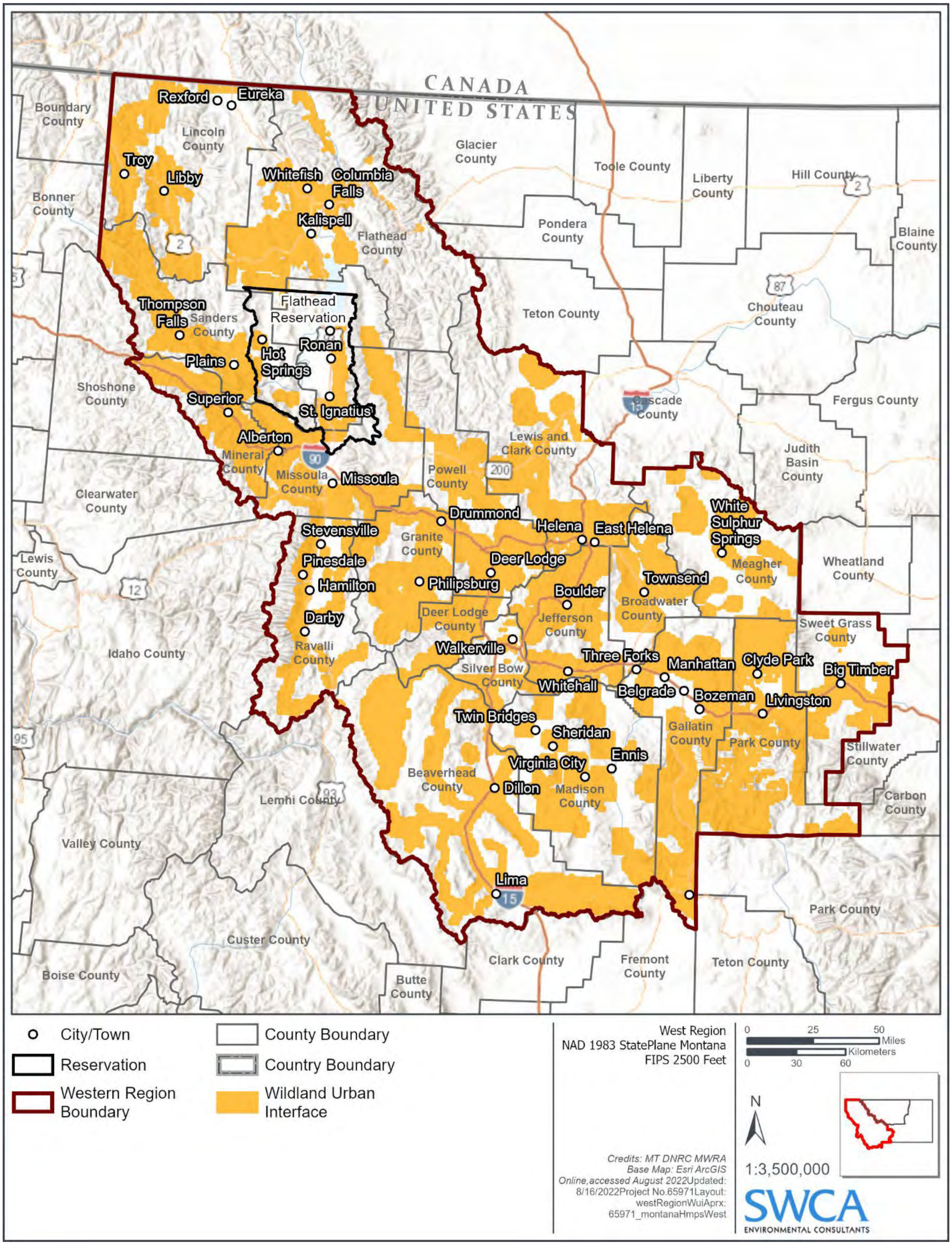
Topography: A region's topography is determined by slope and aspect. Normally, wildfire behavior, such as fire intensity and rate of spread, is more pronounced on steep slopes due to convective heat transfer (i.e., heat rising up the slope). South-facing slopes are typically drier due to receiving more 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 Western Montana Region's topography is diverse. It contains steep forested mountains, deep canyons, forested hills, valley rangelands, and flat farmlands.

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 Western Montana Region can vary drastically between low and high elevations, where the mountains receive more precipitation than the valleys. Additionally, the western areas of the Region generally receive more precipitation than the eastern portions (PRISM 2022). Specifically, the greater rangelands in and around Dillion and Livingston (Beaverhead and Park Counties, respectively) display the driest climates, while the montane forested regions around Troy and West Glacier (Lincoln and Flathead Counties, respectively) display the wettest climates.

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 4-95).

Wildfire risk is normally associated with the 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 Western 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). Increased development in Western Montana, especially around Missoula, Helena, Hamilton, Bozeman, and Whitefish, among others, is resulting in a greater portion of the Region falling within the WUI. Expansion of the WUI combined with increasing drought, high levels of fuel, and a higher likelihood of ignition is resulting in increased and considerable wildfire risk in the WUI.

Figure 4-95 Wildland Urban Interface Delineation



Source: MT DNRC 2020b

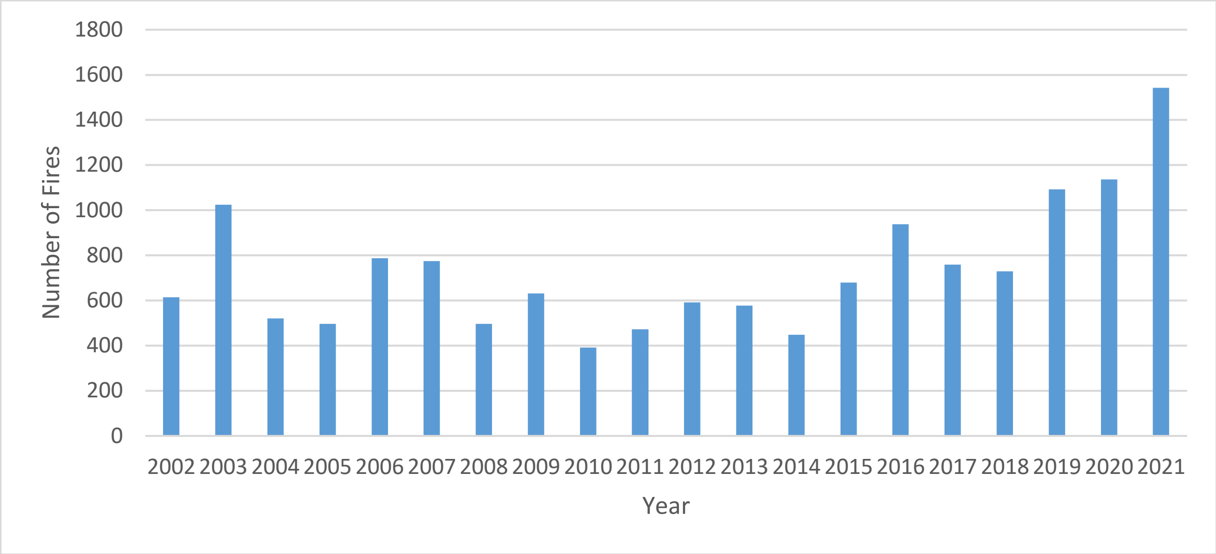
4.2.17.2 Geographical Area Affected

As depicted in the previous map of the WUI, wildfires can occur throughout the Region. The climate of the Western Montana Region varies from arid to semi-arid to mesic. All climates, combined with continuous loading of forest and rangelands fuels, make most 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 forested regions of Western Montana, especially the northern areas, have historically been most at-risk from wildfire; however, wildfires also occur in the rangelands. Rangeland fires are more likely to occur in the southern portion of the Project Area. As a whole, almost the entire Western Region is at-risk and/or susceptible to wildfire. Large tracts of land with agricultural crop cover in the Region are usually at less risk of wildfire. These can include, but are not limited to, the Flathead Valley, Gallatin Valley, and Beaverhead Valley.

4.2.17.3 Past Occurrences

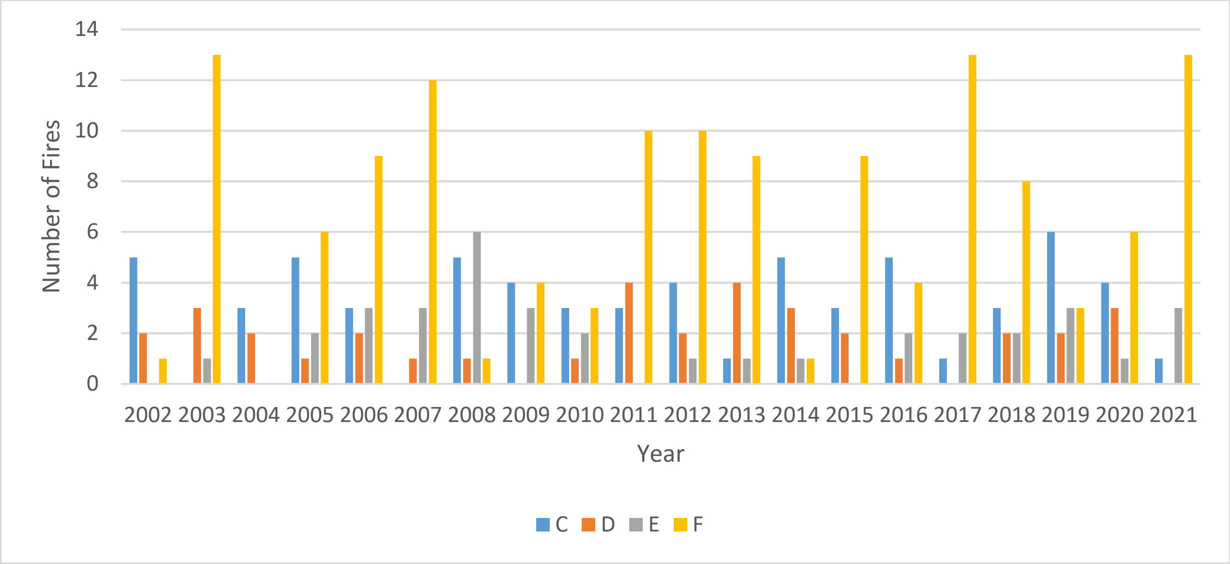
The Montana Wildfire Risk Assessment (MWRA) database, maintained by the Montana Department of Natural Resources and Conservation, includes perimeter GIS layers for recent wildfires throughout the State of Montana (MT DNRC 2022). According to the MWRA, wildfires in the Western Region occur on an annual basis and are usually contained early with little to no damage. Most wildfires are usually less than 1,000 acres; between 2002 and 2021 there have been 135 wildfires greater than 1,000 acres (Figure 4-96). Large fires (fires greater than 1,000 acres) and potentially destructive fires can occur in any year. There are no discernable trends in fire size over the last 20 years. Years where there are larger and more destructive fires (e.g., the 2003, 2007, 2017 and 2021 wildfire seasons) are correlated with drought conditions and/or warmer growing season temperatures. Generally, the vast majority of wildfires occurrences are small (less than 10 acres) and cause no meaningful damage. From 2002 to 2021 there were 14,704 fires that burned 10 acres or less (Figure 4-96); however, in the same time frame there have also been 271 fires greater than 10 acres with the majority of these (135 fires) being greater than 1,000 acres (Figure 4-97).

Figure 4-96 Number of Notable Wildfires in Western Montana by Year and size class A and B, 2002 to 2021



* Size Class: A = 0.25 acre or less; B = greater than 0.25 to 10 acres
Source: MT DNRC 2022

Figure 4-97 Number of Notable Wildfires in Western Montana by Year and size class C-F, 2002 to 2021

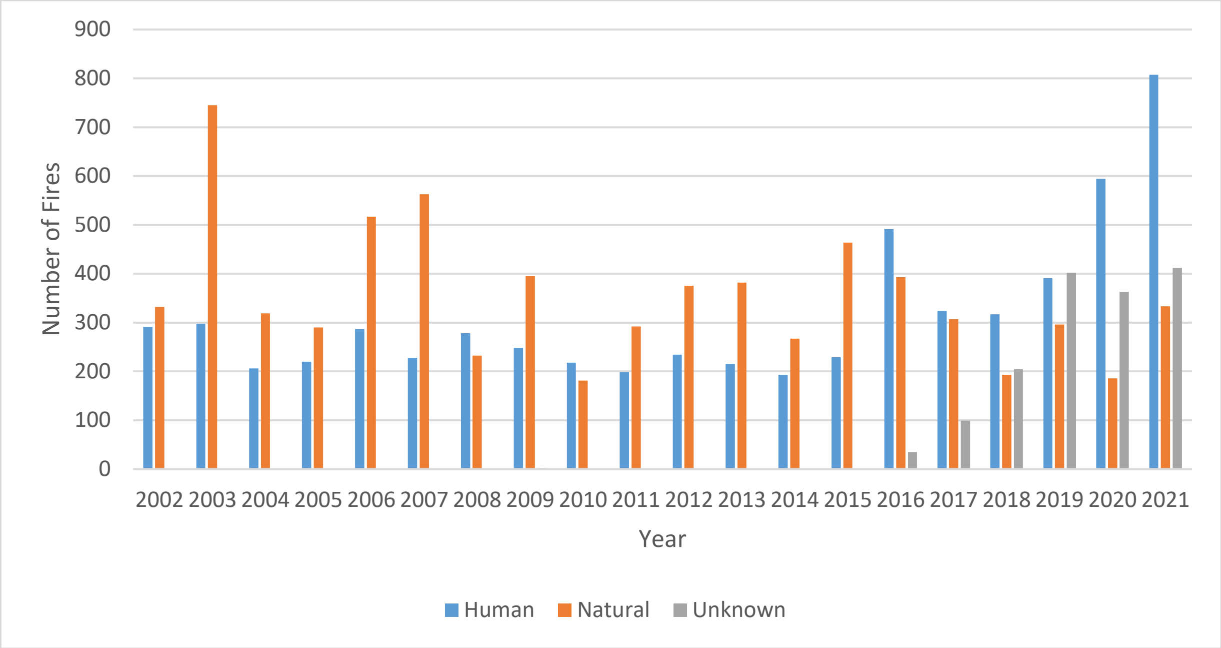


* Size Class: C = 10 to 100 acres; D = 100 to 300 acres; E = 300 to 1,000 acres; F = 1,000+ acres

Source: MT DNRC 2022

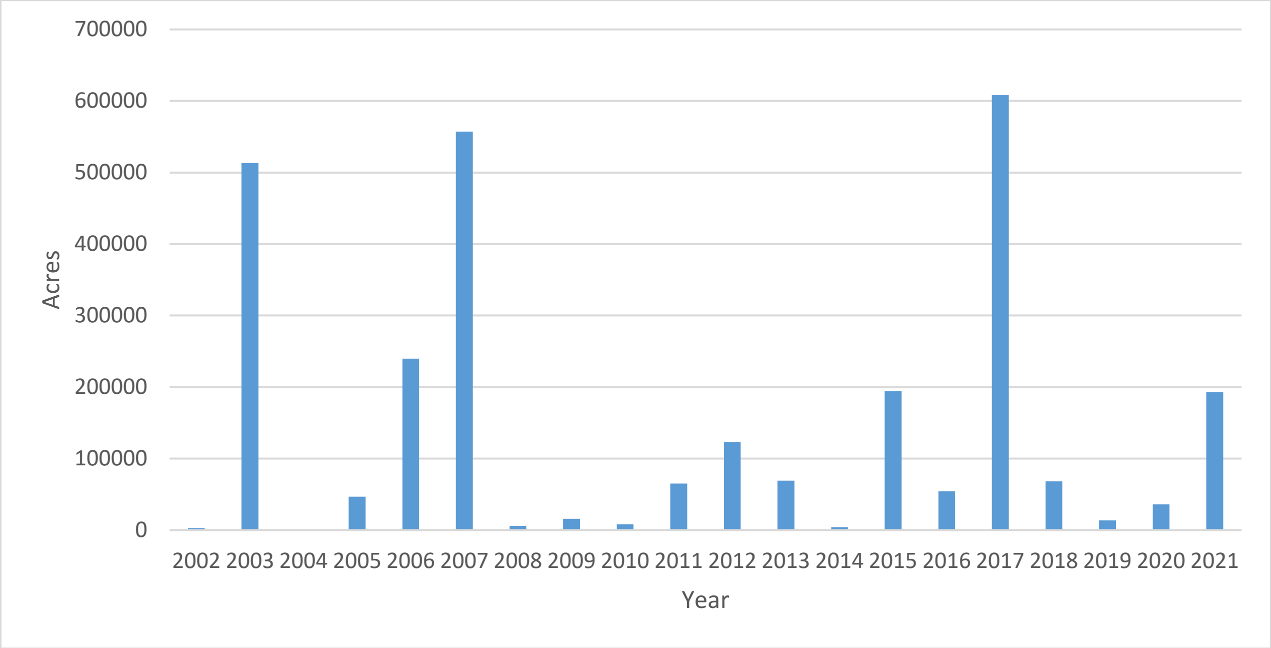
Natural wildfire occurrences (e.g., lightning ignitions) in the Region are common and particularly common in the northern portion of the Region where expansive tracts of montane forests occur. Human-caused wildfire occurrences are also common and are, generally, concentrated near the Region's municipalities (Figure 4-98). Land managers should take note that over the last decade there has been a consistent increase in the number of wildfires attributed to human causes. From 2016 to 2021 the number of human-caused wildfires outnumbered the number of natural caused wildfires. Figure 4-99 illustrates the total number of acres burned each year across the Region.

Figure 4-98 Number of Wildfires by Cause, 2002 to 2021



Source: MT DNRC 2022

Figure 4-99 Total Acres Burned per year in the Western Region, 2002 to 2021



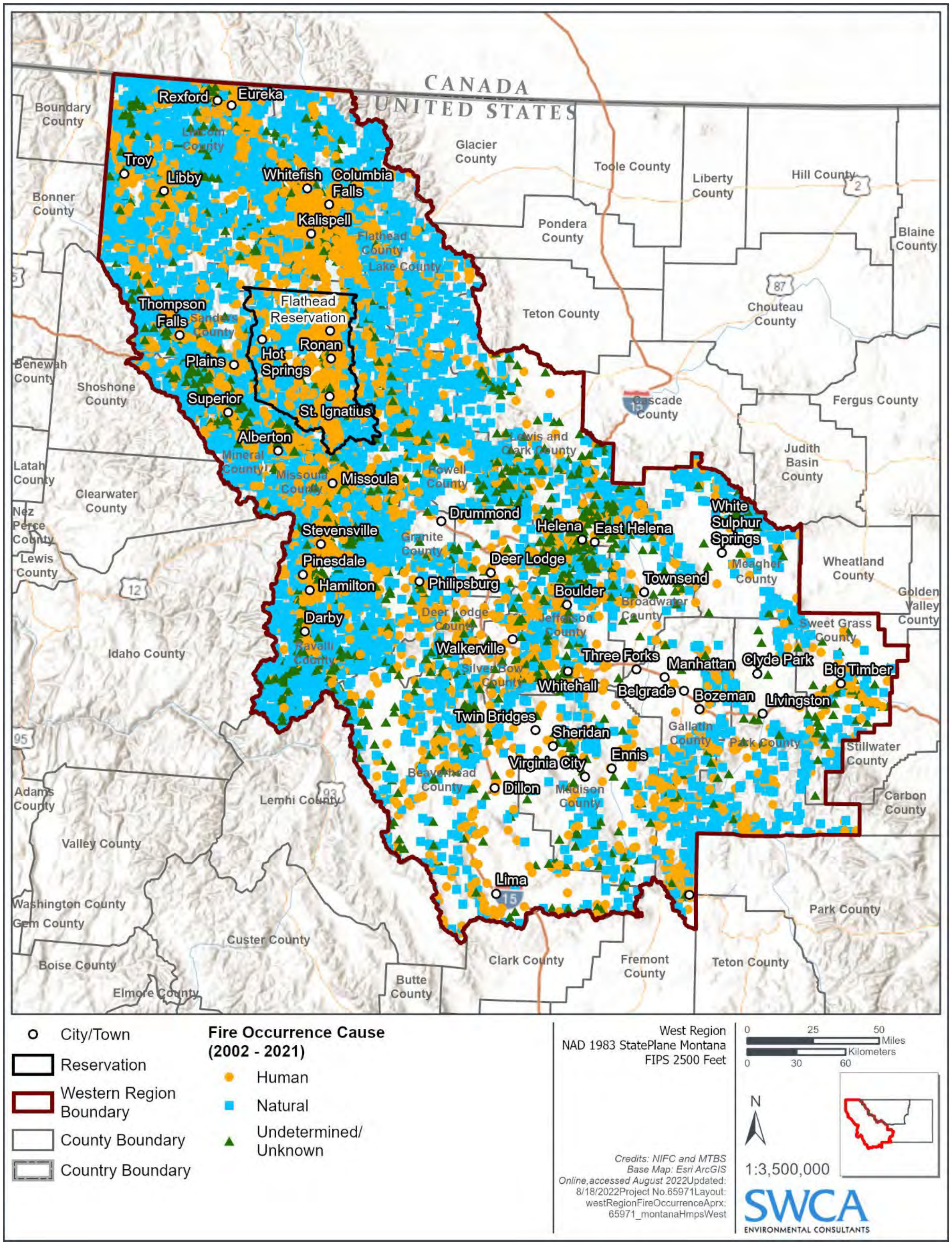
Source: MT DNRC 2022

Over the last 20 years, the larger fires in the Region have generally occurred in the forested areas. Notable fire incidents occurred in the Bob Marshall Wilderness Complex, the Glacier National Park Region, the Bitterroot Divide, and the Sapphire Mountains. In recent years, a more notable forest fire was the Rice Ridge wildfire of 2017 (Figure 4-102). This was a lightning caused wildfire that burned in the Lolo National Forest. The fire was located to the north and east of Seeley Lake, Montana and burned 160,193 acres. A FEMA Fire Management Assistance Declaration was declared for this fire. This fire threatened over 1,000 homes, required over 700 firefighting personnel, and caused significant degradation to regional air quality. In total, it cost 33.8 million dollars to fight this fire. It should be noted that 2017, a particularly hot and dry summer (PRISM 2022), was one of the most destructive and costly wildfire seasons in recent history. In the Western Region alone, wildfires burned over 600,000 acres of land. Additional notable wildfires that season in the Western Region included the Meyers Fire (62,034 acres), the Lolo Peak Fire complex (53,902 acres), the Sapphire Fire Complex (43,733 acres), and the Alice Creek Fire (29,252 acres) (MT DNRC 2022).

Other historic fires in the Region include the Yellowstone Fires of 1988 which affected Park and Gallatin Counties and had a broader economic impact. Also of note was the Great Fire of 1910 (also commonly referred to as the Big Blowup, the Big Burn, or the Devil's Broom fire) that burned three million acres in two days in August 20-21, 1910, in Northern Idaho and Western Montana. It killed 87 people, mostly firefighters, destroyed numerous manmade structures, including several entire towns, and burned more than three million acres of forest with an estimated billion dollars' worth of timber lost. It is believed to be the largest, although not the deadliest, forest fire in U.S. history (Wikipedia accessed 11-2022). The fire is often considered a catalyst in the development of early wildfire prevention and suppression strategies of the U.S. Forest Service.

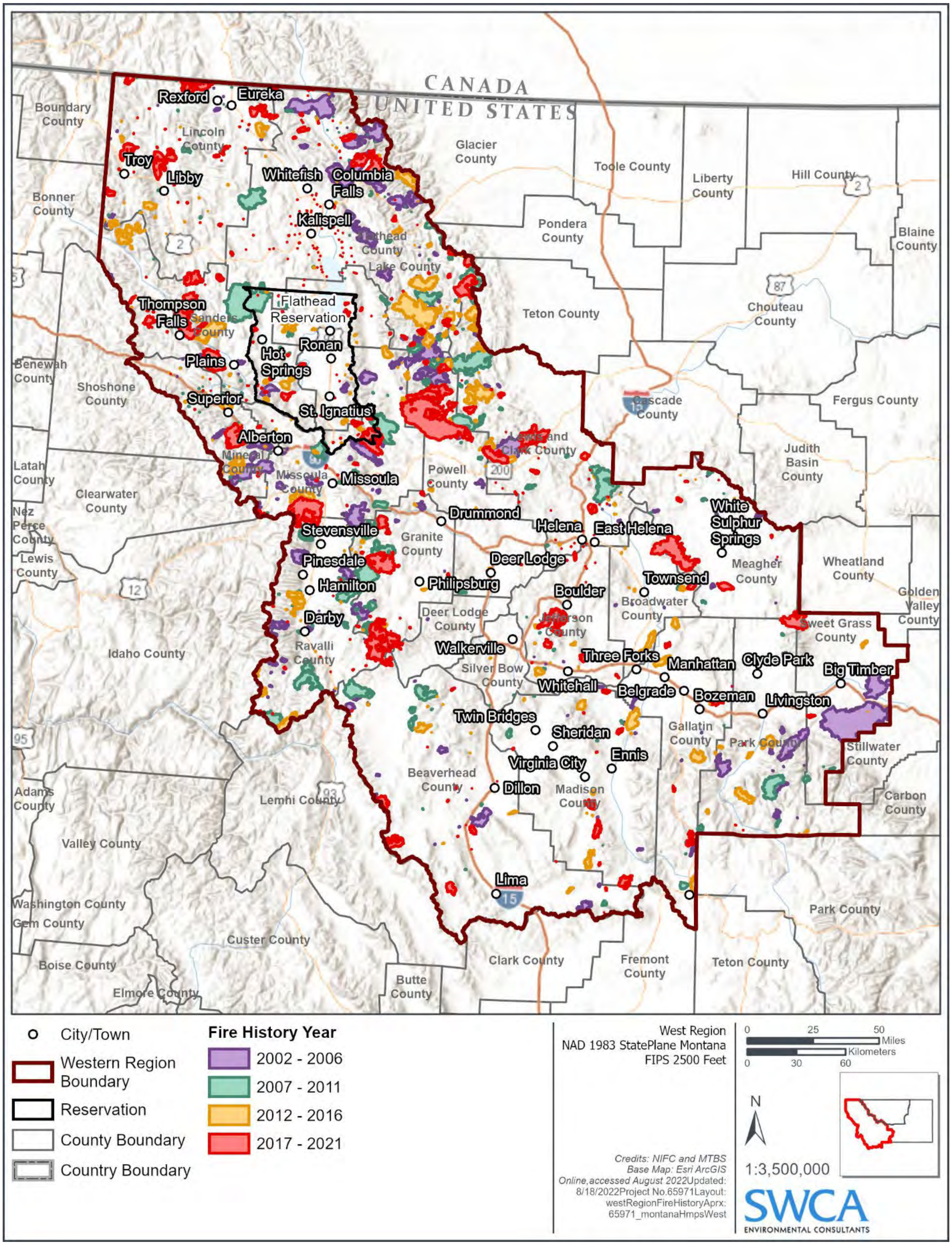
Rangeland wildfire can also occur in the Western Region. Rangeland fires can occur throughout the Region but are more likely to occur in the southern portions of the Region, where the majority of the rangelands are located. The largest rangeland fire in recent history was the large and destructive Derby Fire of 2006 (Figure 4-103). This fire occurred during drought conditions and burned 207,431 acres. Most of the burned acres were rangelands; however, large portions of forests also burned. This fire threatened Greycliff and Big Timber, MT. It destroyed 26 homes, and 20 outbuildings. The firefighting cost for this wildfire was estimated to be $22.5 million (Gallatin County Emergency Management 2016).

Figure 4-100 Fire Occurrence History of Western Montana, 2002 to 2021



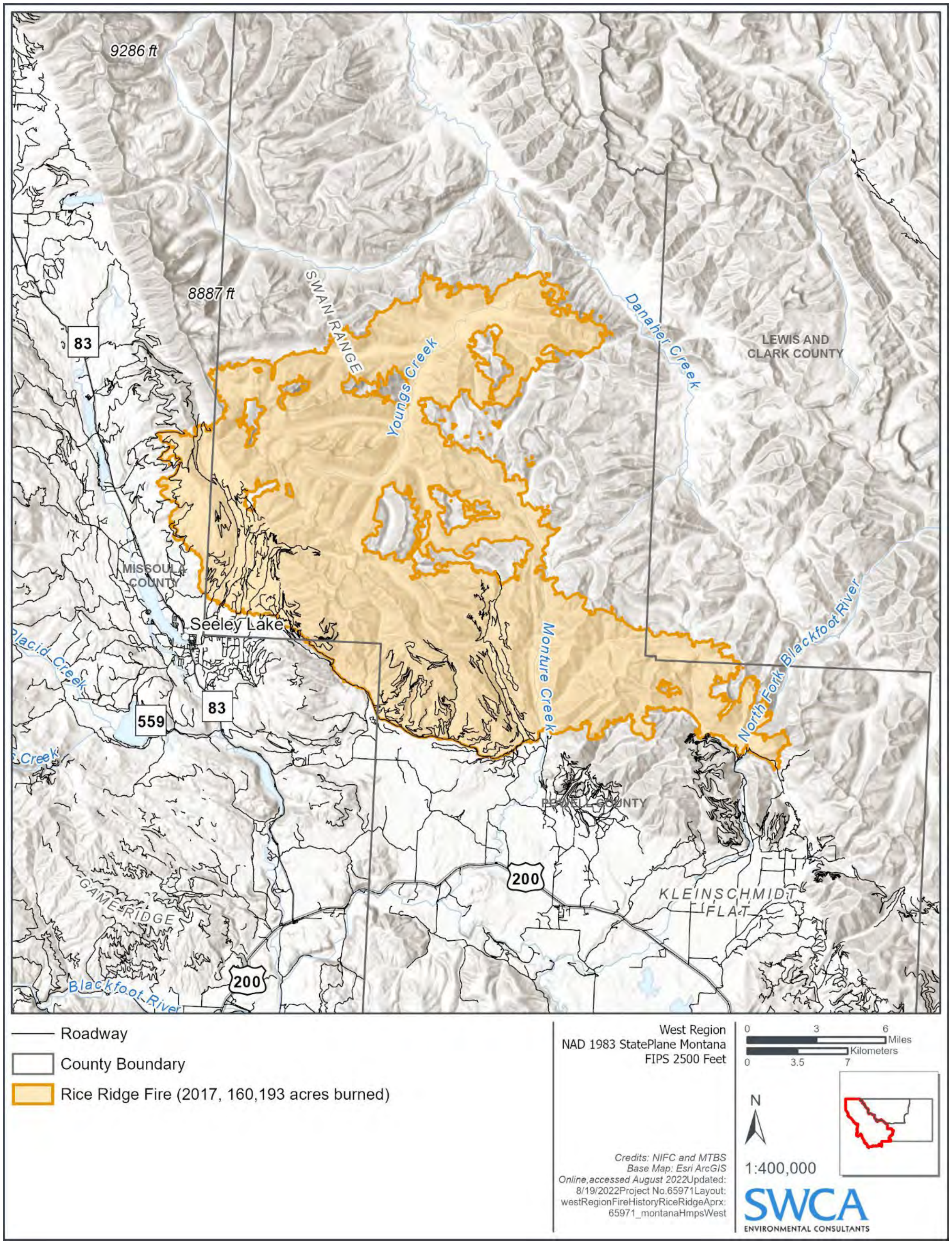
Source: MT DNRC 2022

Figure 4-101 Fire History of Western Montana – Fire Perimeters, 2002 to 2021



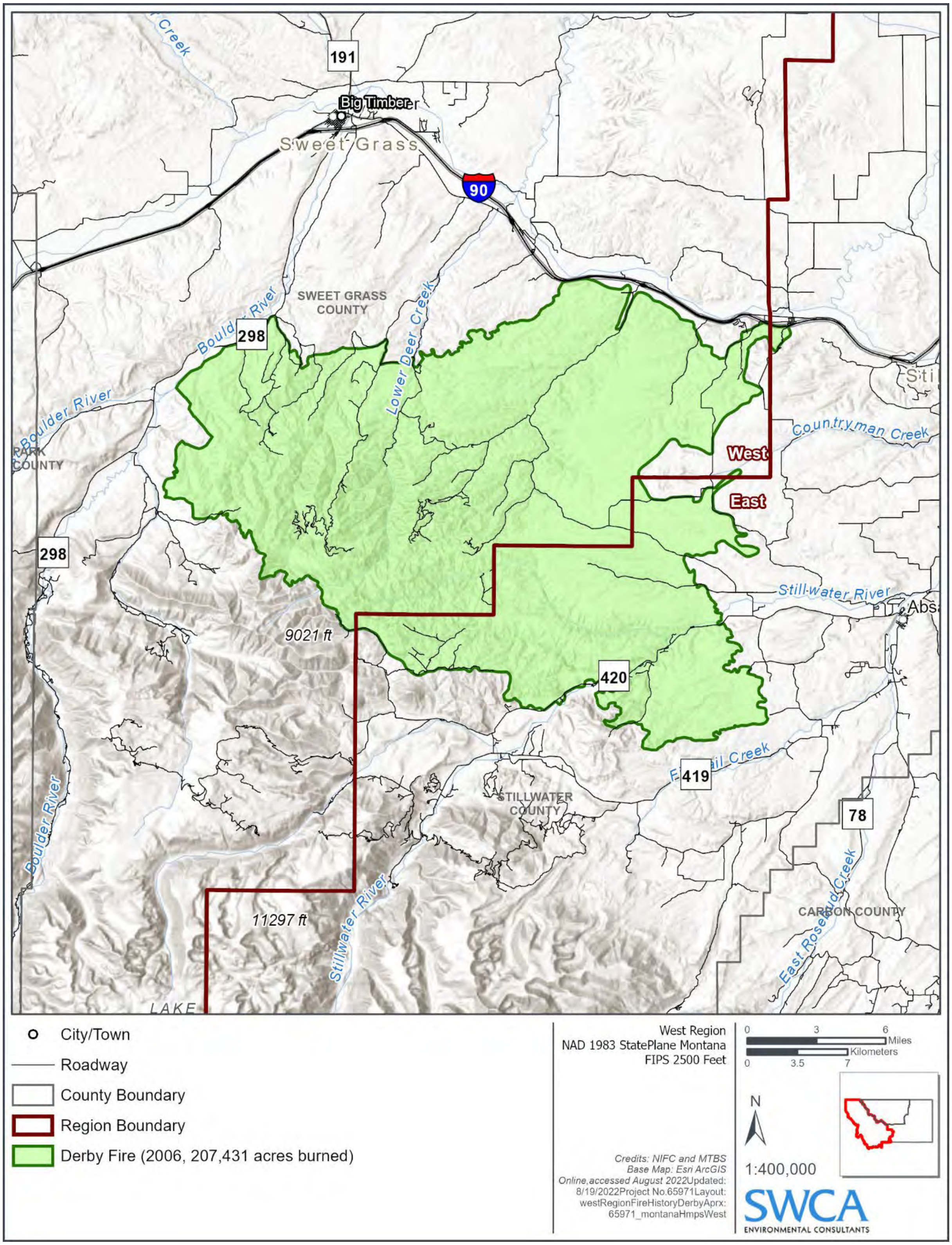
Source: MT DNRC 2022

Figure 4-102 Representative Large Forest Fire in the Western Region – Rice Ridge Fire of 2017



Source: MT DNRC 2022

Figure 4-103 Representative Large Rangeland Fire in the Western Region – 2006 Derby Fire



Source: MT DNRC 2022

4.2.17.4 Frequency/Likelihood of Occurrence

Wildfires occur every year throughout the Region and could occur in any county in any given year. Generally, the forested regions of the Western Region exhibit a high annual burn probability, usually greater than 1% annual burn probability. The forests of the Bitterroot and Sapphire Mountains exhibit the highest annual burn probabilities in the Region. The rangelands are less likely to experience wildfire. Rangelands typically display a 0.1 to 0.2% annual burn probability. The counties with a proportion of forested lands are usually more likely to experience wildfire and experience larger wildfires (see Table 4-60 for summary breakdown of wildfire statistics by county). Counties with a larger proportion of rangelands are less likely to experience wildfire (Table 4-60). While many rangeland wildfires in these counties can be small, it is very possible large rangeland fires can occur. 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 4-104 depicts the annualized frequency of wildfire at a county level based on the NRI. The mapping shows the greatest likelihood of occurrence in Ravalli County. Figure 4-105 below further details the burn probability for the Western Region at a more detailed level.

Figure 4-104 Annualized Frequency of Wildfire Events by County

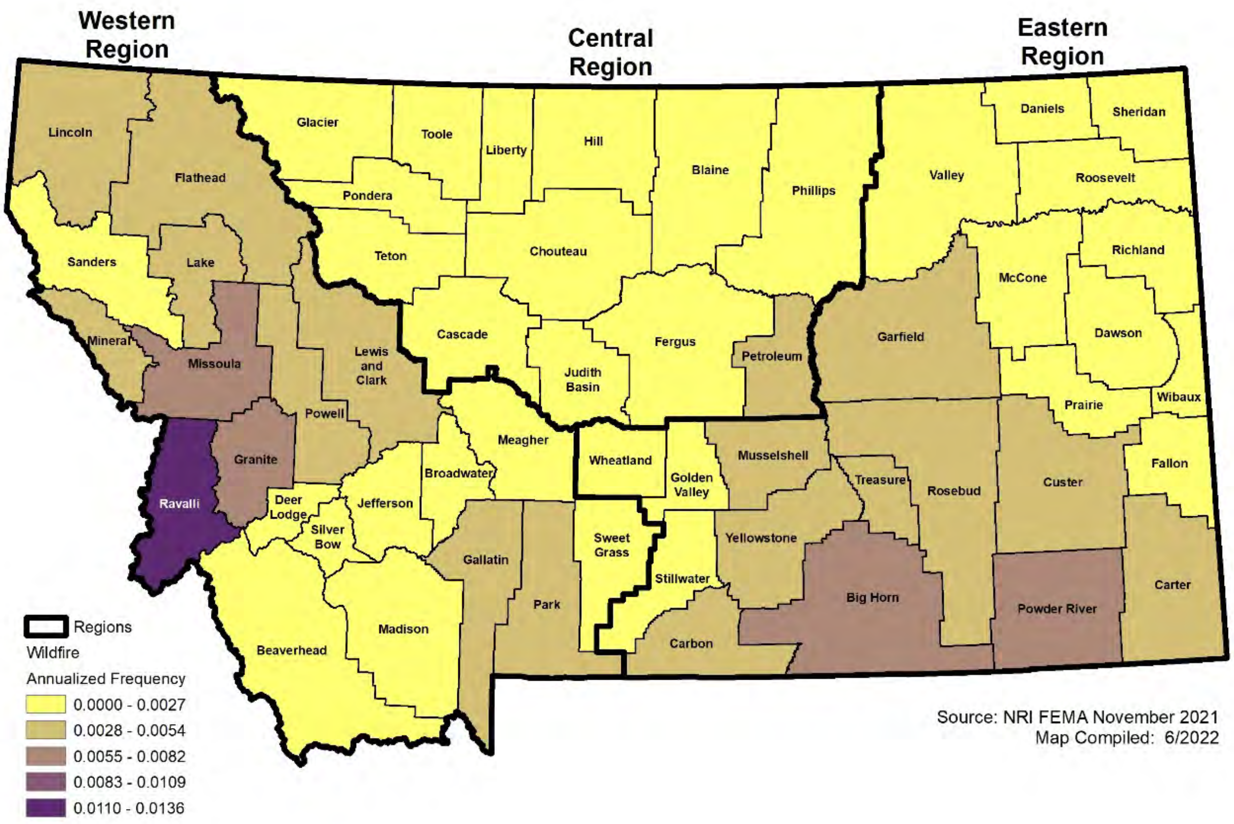
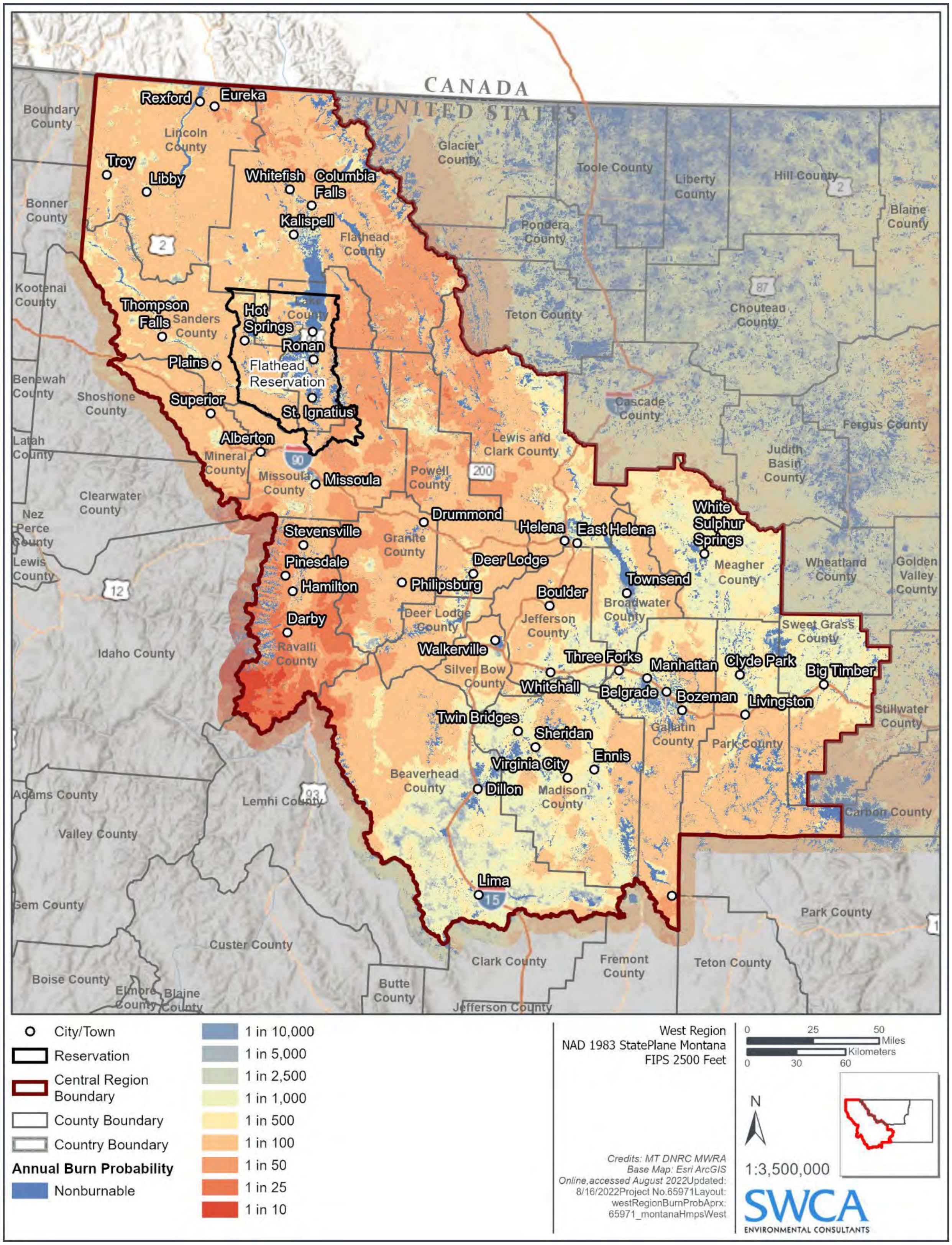


Figure 4-105 Western Montana Region Annual Burn Probability



Source: MT DNRC 2022

Table 4-60 Average Number of Wildfires per year for Western Region Counties, 2002-2021

County/Reservation	Annual Number of Wildfire Occurrences (average, includes all ignitions)	Annual Average Size of Total Acreage of Wildfires
Anaconda-Deer Lodge	6.35	50.95
Beaverhead	27.05	6,155.85
Broadwater	4.80	1,708.58
Butte-Silver Bow	9.15	3.43
CSKT	78.85	4,240.67
Flathead	99.75	26,463.52
Granite	24.80	9,258.83
Jefferson	29.75	1,912.82
Lake	62.30	592.64
Lewis and Clark	43.55	14,634.36
Lincoln	96.50	6,359.54
Madison	13.50	2,476.74
Meagher	12.00	2,488.03
Mineral	47.65	4,741.38
Park	12.75	5,862.52
Powell	25.30	13,359.57
Ravalli	86.95	8,997.27
Sanders	65.30	12,607.78
Sweet Grass	9.80	9,796.25
Total	**785.00**	**140,937.99**

Source: MT DNRC 2022

4.2.17.5 Climate Change Considerations

Annual average temperatures in the planning area, including daily minimums and maximums have risen 2.0 – 3.0ºF across the State between 1950 and 2015 (Whitlock et al 2017). Furthermore, Montana's growing season length has increased, as spring has come on earlier and fall freezes have occurred later. Between 1951 and 2010, Montana's growing season increased by 12 days. All regions of Montana are expected to experience warming in all seasons and under all future emissions scenarios. By 2050, Montana's average annual temperatures are expected to increase 4.5-6.0ºF. Additionally, the number of days where 90ºF will be exceeded will increase under future conditions. Finally, in Western Montana, there is expected to be increases in winter, spring, and fall precipitation, but decreases in summer precipitation, with substantial decreases in summer precipitation in the southern portion of Western Region (Whitlock et al 2017).

Taken together these climate change effects have contributed to increases in wildfire frequency and severity across the State and will exacerbate the future fire conditions across Western Montana. These climate impacts are also affecting forest and rangeland health. 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. Degraded forest health, significantly attributed to climate change, has already been linked with increased fire risk throughout large portions of Western Montana's forested regions (MT DNRC 202c). As climate change exacerbates disease outbreaks in Western Montana's forested areas, there will be an increased build up in hazardous fuels

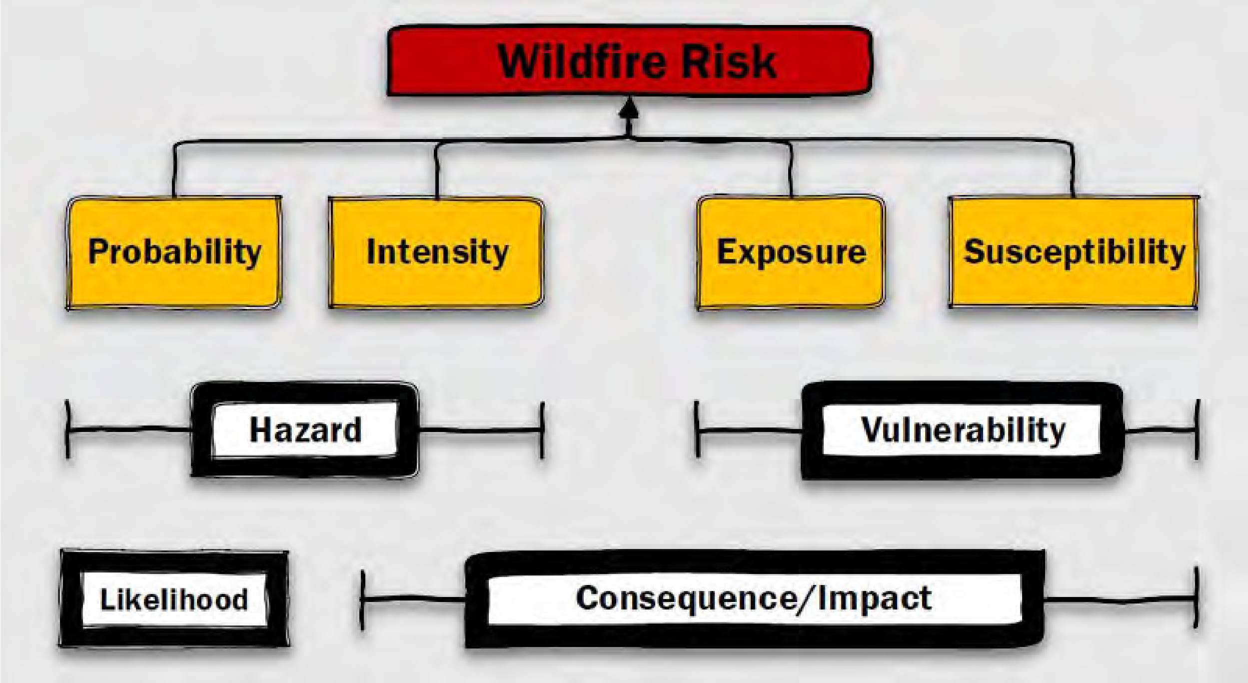
(Whitlock et al 2017). Additionally, climate change can result in an increase in invasive grass and weed abundance in grasslands and rangelands, which can contribute to increased wildfire risk in these systems (Whitlock et al 2017). Additionally, wetter winters and springs combined with hotter and drier summers will likely result in higher loading of dry fine fuels, which will also contribute to increased wildfire risk (Whitlock et al 2017). As the fire season increases there will be a higher likelihood of wildfires coinciding with high wind 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, a wildfire that occurred in the Central Region).

4.2.17.6 Potential Magnitude and Severity

Montana Wildfire Risk Assessment

The 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 statewide 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.

Figure 4-106 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 4-105).

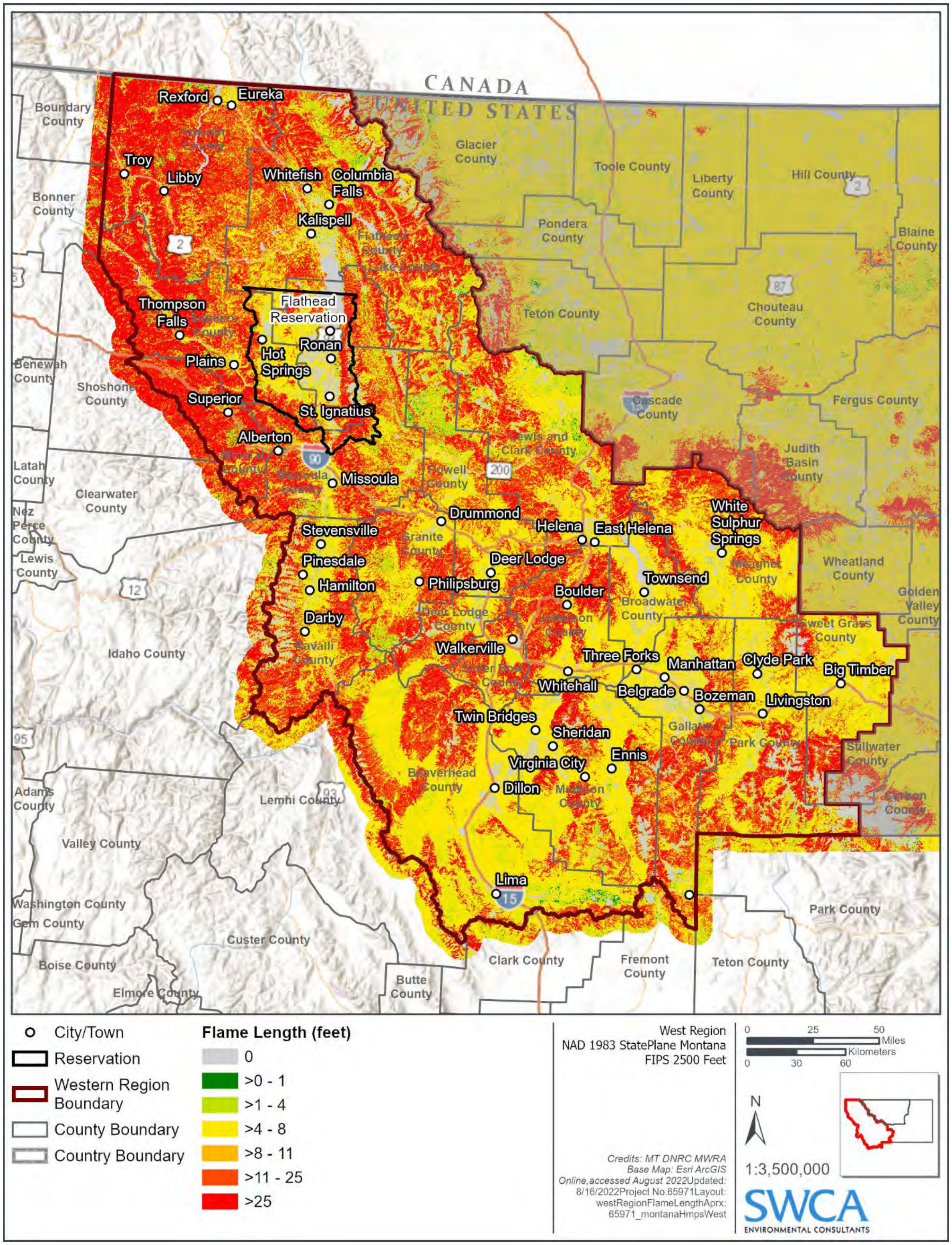
Wildfire intensity is a measure of the energy expected from a wildfire and is mainly determined by the topography and vegetative fuels of a landscape. Greater fuel loads (e.g., forests compared to grass lands), especially on steeper terrain, typically produce greater wildfire intensity. Wildfire intensity 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 4-107). More intense and taller fires are usually more difficult to control (Table 4-61).

Table 4-61 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 4-107 Western Montana Region Estimated Flame Length



Source: MT DNRC 2022

Vulnerability

Wildfire 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.

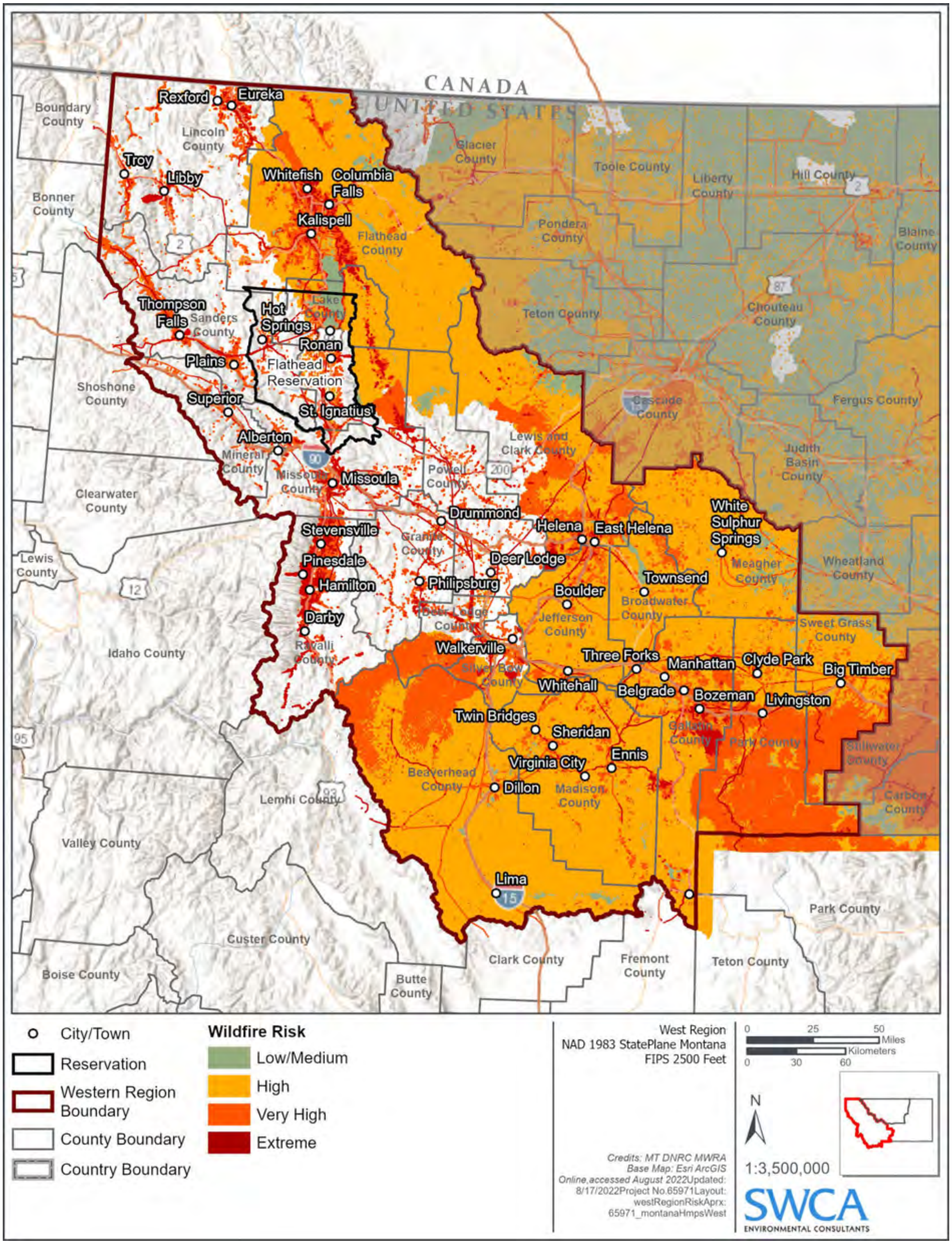
Wildfire exposure is the spatial coincidence of wildfire likelihood and intensity to homes and communities. Homes are exposed to wildfire if they are located where there is any chance wildfire could occur (i.e., burn probability is greater than zero). Communities can be directly exposed to wildfire from 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 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 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 4-108).

Figure 4-108 Western Region Wildfire Risk Summary as Determined by eNVC



*Blank areas have burnable fuels but no HVRAs have been mapped for the area (MT DNRC 2020c).
Source: MT DNRC 2022

The risk to highly valued resources and assets from wildfire varies from medium to extreme throughout the Region but the risk from wildfire to people and property is usually greatest within and near the inhabited areas (Figure 4-108) (i.e., see extreme risk ratings in inhabited areas). The municipalities most notably at risk from wildfire include most of the Bitterroot Valley, Whitefish, Thompson Falls, Missoula, Bozeman's suburban and exurban areas, Helena, Libby, and Eureka, among others. Across the Region, agricultural areas generally have low to medium risk from wildfire (e.g., agricultural areas near Townsend, MT), while the rangelands and forested areas are at high risk to very high risk from wildfire, respectively. Forests and rangelands in areas with more complex topography and/or drier climates generally have higher risk than forests and rangelands on flatter or less complex topography.

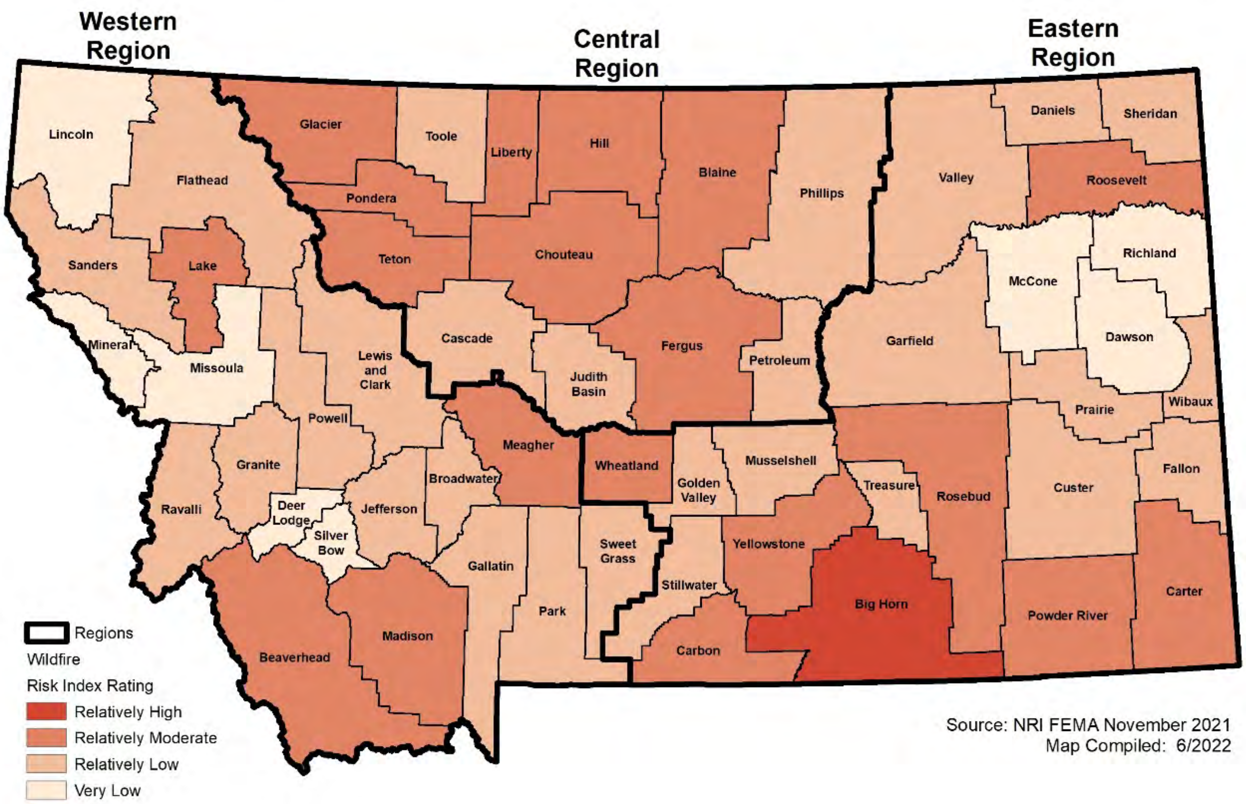
It is important to note, however, that most of the towns and municipalities throughout the Region have high to extreme risk from wildfire, regardless of the risk of surrounding landscape. This is because the expected net value change (eNVC) risk assessment model provides more weight in assessing detrimental changes (or expected losses) to structures and infrastructure than to wildlands or agricultural areas. Thus, HVRAs (typically structures or infrastructure) are given higher levels of weight (i.e., importance) in the model. The results of these expected losses are then summed by each pixel displayed in the map. Thus, areas (or pixels) with a high concentration of HVRAs (e.g., towns and municipalities) will display far greater risk to wildfire even if the likelihood of fire occurring on the surrounding landscape is low. Thus, the results of these eNVC risk assessment should be interpreted with caution. To summarize, the observed trends are mainly driven by risk to structures and infrastructure within the Region's towns and municipalities. Most of these structures/infrastructures are susceptible to fire (where they tend to be damaged if a wildfire occurs) and are exposed (located where there is a chance wildfire could occur), to some degree, to wildfire occurrence, which accounts for the high risk overall (Figure 4-108).

Generally, towns/municipalities surrounded by undeveloped forests and rangelands (i.e., landscapes with a higher probability of fire occurring and fire spreading) have higher levels of risk to wildfire than towns surrounded by more agricultural areas (however, agricultural fires can and do occur [see Denton fire of 2021] and these fires can have substantial economic impacts [Agricultural Climate Network 2021]). It is also important to note that the MWRA was developed by the MT DNRC at the statewide scale. Assessments at these scales may omit finer resolution, and more precise assessment of risk, as well as input by local subject matter experts. Many countywide or multi-county community wildlife protection plans (CWPPs) have been developed for counties covering the Western Region. For example, the 2020 Tri-County CWPP for Broadwater, Jefferson, and Lewis and Clark County provides a fine-scale local, wildfire risk assessment that incorporates recent wildfire effects, community input, and recent wildfire mitigation efforts (Tri-County CWPP 2020). In the event that a County has recently completed a CWPP with fine-scale risk assessment, land managers and fire responders should carefully consider if those locally derived assessments provide a more accurate, authoritative dataset for use in addressing and mitigating wildfire risk, than the statewide assessment.

4.2.17.7 Vulnerability Assessment

Figure 4-109 depicts the Risk Index rating for wildfire at a county level based on the NRI. The eastern and southeastern parts of the Region show a trend towards a relatively low rating, while the southern and north-central parts of the Region trend towards a relatively moderate rating.

Figure 4-109 Risk Index Rating for Wildfire by County



People

The most exposed population are those that are living within the WUI. The WUI in the Western 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 mental and physical health effects from fire.

A 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). Another 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). In Montana specifically, a study conducted on pulmonary function for community members living in Seeley Lake found that that lung function diminished significantly when exposed to extreme levels of smoke during the 2017 wildfire season (mostly due to the Rice Ridge Fire) and that lung function continued to decline even one year post fire (Orr et al 2022). In the Western U.S, 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 Western Montana will have larger and more frequent 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 U.S 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 was calculated, and then the census estimated household size for each county was multiplied by 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 Western Region counties, there are an estimated 16,572 residents exposed to high-risk wildfire areas, 242,745 residents exposed to very high-risk wildfire areas, and 251,898 residents exposed to Extreme risk wildfire areas, as summarized in Table 4-62 below.

Wildland fire fighters are also populations at risk from wildfire. Wildland fire fighting is an inherently dangerous profession where firefighters risk their health and lives while battling fires. During the 2017 Lolo Peak Complex, two wildland fire fighters were killed while battling the fire (Reuters, 2017). Wildland fire fighters are especially vulnerable to medium- and long-term health and safety risks associated with smoke and chemical inhalation and other conditions while firefighting, as well as immediate risks that may endanger their lives due to the fire environment.

Table 4-62 Population Within Wildfire Risk Areas

County	High-Risk Population	Very High-Risk Population	Extreme Risk Population
Anaconda-Deer Lodge	138	1,836	6,958
Beaverhead	1,444	4,736	614
Broadwater	1,308	3,710	214
Butte-Silver Bow	878	15,918	5,056
Flathead	1,177	54,714	49,027
Granite	36	1,471	3,514
Jefferson	1,365	8,369	3,763
Lake	1,092	14,804	9,909
Lewis & Clark	1,361	26,905	24,809
Lincoln	394	10,356	11,829
Madison	2,214	5,251	4,203
Meagher	257	1,301	1,140
Mineral	15	1,543	2,809
Park	657	6,914	2,003
Powell	135	1,732	3,448
Ravalli	46	9,213	30,712
Sanders	381	6,765	4,235
Sweet Grass	388	1,412	1,564
Total	**16,572**	**242,745**	**251,898**

Source: MSDI 2022, MWRA, US Census Bureau

Property

The potential impacts of wildfire on property include crop loss, timber 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 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 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 4-63 through Table 4-65 below summarizes the estimated exposed value of improvements in each wildfire risk category. The figures that follow summarize the data shown in the tables in graphs representing total improved parcels and the value of improvements at risk by County.

Table 4-63 Exposure and Value of Structures at High Risk to Wildfire by County

County	Improved Parcels	Improved Value	Content Value	Total Value	Loss Ratio
Anaconda-Deer Lodge	91	$16,879,244	$10,622,937	$27,502,181	2%
Beaverhead	1,030	$224,290,699	$147,702,695	$371,993,394	22%
Broadwater	809	$190,561,047	$111,542,331	$302,103,378	25%
Butte-Silver Bow	511	$241,293,188	$204,382,523	$445,675,711	3%
Flathead	654	$327,153,361	$233,083,626	$560,236,987	1%
Granite	18	$4,556,268	$3,400,659	$7,956,927	1%
Jefferson	664	$126,106,685	$78,967,813	$205,074,498	12%
Lake	533	$116,138,844	$77,650,402	$193,789,246	4%
Lewis and Clark	755	$264,504,766	$156,750,798	$421,255,564	3%
Lincoln	223	$47,301,937	$27,967,464	$75,269,401	2%
Madison	1,378	$1,271,056,383	$722,090,592	$1,993,146,975	21%
Meagher	228	$48,841,582	$39,906,031	$88,747,613	15%
Mineral	8	$1,765,276	$958,253	$2,723,529	0.3%
Park	538	$260,728,820	$189,786,880	$450,515,700	6%
Powell	91	$22,252,379	$13,766,860	$36,019,239	3%
Ravalli	27	$9,181,237	$5,447,324	$14,628,561	0.1%
Sanders	270	$47,820,415	$35,658,115	$83,478,530	4%
Sweet Grass	372	$107,428,827	$85,967,724	$193,396,551	19%
Total	**10,054**	**$4,421,648,466**	**$2,830,293,175**	**$7,251,941,641**	**4%**

Source: MSDI 2022, MWRA

Table 4-64 Exposure and Value of Structures at Very High Risk to Wildfire by County

County	Improved Parcels	Improved Value	Content Value	Total Value	Loss Ratio
Anaconda-Deer Lodge	988	$154,696,480	$81,687,695	$236,384,175	21%
Beaverhead	2,476	$425,854,983	$226,486,228	$652,341,211	52%
Broadwater	1,903	$350,420,549	$183,495,344	$533,915,893	60%
Butte-Silver Bow	8,258	$1,504,470,121	$847,041,977	$2,351,512,098	54%
Flathead	23,306	$7,273,646,655	$4,005,689,117	$11,279,335,772	50%
Granite	766	$164,599,464	$97,580,741	$262,180,205	30%
Jefferson	3,290	$796,755,560	$413,658,239	$1,210,413,799	58%
Lake	6,658	$1,695,481,672	$955,126,115	$2,650,607,787	50%
Lewis and Clark	11,882	$2,710,857,875	$1,483,605,654	$4,194,463,529	45%
Lincoln	5,062	$878,048,821	$497,210,940	$1,375,259,761	46%

County	Improved Parcels	Improved Value	Content Value	Total Value	Loss Ratio
Madison	2,572	$1,818,616,729	$944,935,629	$2,763,552,358	39%
Meagher	613	$83,235,462	$50,539,176	$133,774,638	39%
Mineral	844	$144,188,735	$86,896,888	$231,085,623	37%
Park	3,613	$1,338,610,640	$759,429,142	$2,098,039,782	42%
Powell	984	$249,839,507	$163,489,255	$413,328,762	31%
Ravalli	4,787	$1,450,607,195	$899,516,300	$2,350,123,495	25%
Sanders	3,747	$647,617,544	$384,519,281	$1,032,136,825	58%
Sweet Grass	658	$164,954,516	$97,126,001	$262,080,517	33%
Total	**111,555**	**$33,117,742,157**	**$18,259,961,765**	**$51,377,703,922**	**43%**

Source: MSDI 2022, MWRA

Table 4-65 Exposure and Value of Structures at Extreme Risk to Wildfire by County

County	Improved Parcels	Improved Value	Content Value	Total Value	Loss Ratio
Anaconda-Deer Lodge	277	$386,029,309	$199,023,794	$585,053,103	6%
Beaverhead	320	$40,669,267	$22,877,825	$63,547,092	7%
Broadwater	111	$13,039,203	$7,042,727	$20,081,930	3%
Butte-Silver Bow	2,575	$313,692,710	$164,372,132	$478,064,842	17%
Flathead	19,866	$5,541,787,546	$2,851,077,342	$8,392,864,888	43%
Granite	1,519	$217,228,561	$111,985,454	$329,214,015	59%
Jefferson	1,473	$273,083,764	$143,490,526	$416,574,290	26%
Lake	4,164	$958,311,351	$514,127,032	$1,472,438,383	31%
Lewis and Clark	10,806	$2,239,000,809	$1,180,186,156	$3,419,186,965	41%
Lincoln	5,348	$785,210,773	$435,947,785	$1,221,158,558	49%
Madison	2,033	$965,382,563	$496,756,440	$1,462,139,003	31%
Meagher	512	$56,523,960	$30,701,420	$87,225,380	33%
Mineral	1,329	$174,799,880	$95,121,565	$269,921,445	58%
Park	1,018	$326,676,571	$169,554,682	$496,231,253	12%
Powell	1,757	$223,405,244	$121,192,911	$344,598,155	55%
Ravalli	13,433	$3,122,609,560	$1,712,064,030	$4,834,673,590	70%
Sanders	2,051	$242,274,036	$131,851,490	$374,125,526	32%
Sweet Grass	683	$124,553,378	$70,133,348	$194,686,726	34%
Total	**106,667**	**$27,718,611,001**	**$14,685,160,037**	**$42,403,771,038**	**41%**

Source: MSDI 2022, MWRA

Figure 4-110 Total Improved Parcels in Wildfire Risk Areas by County

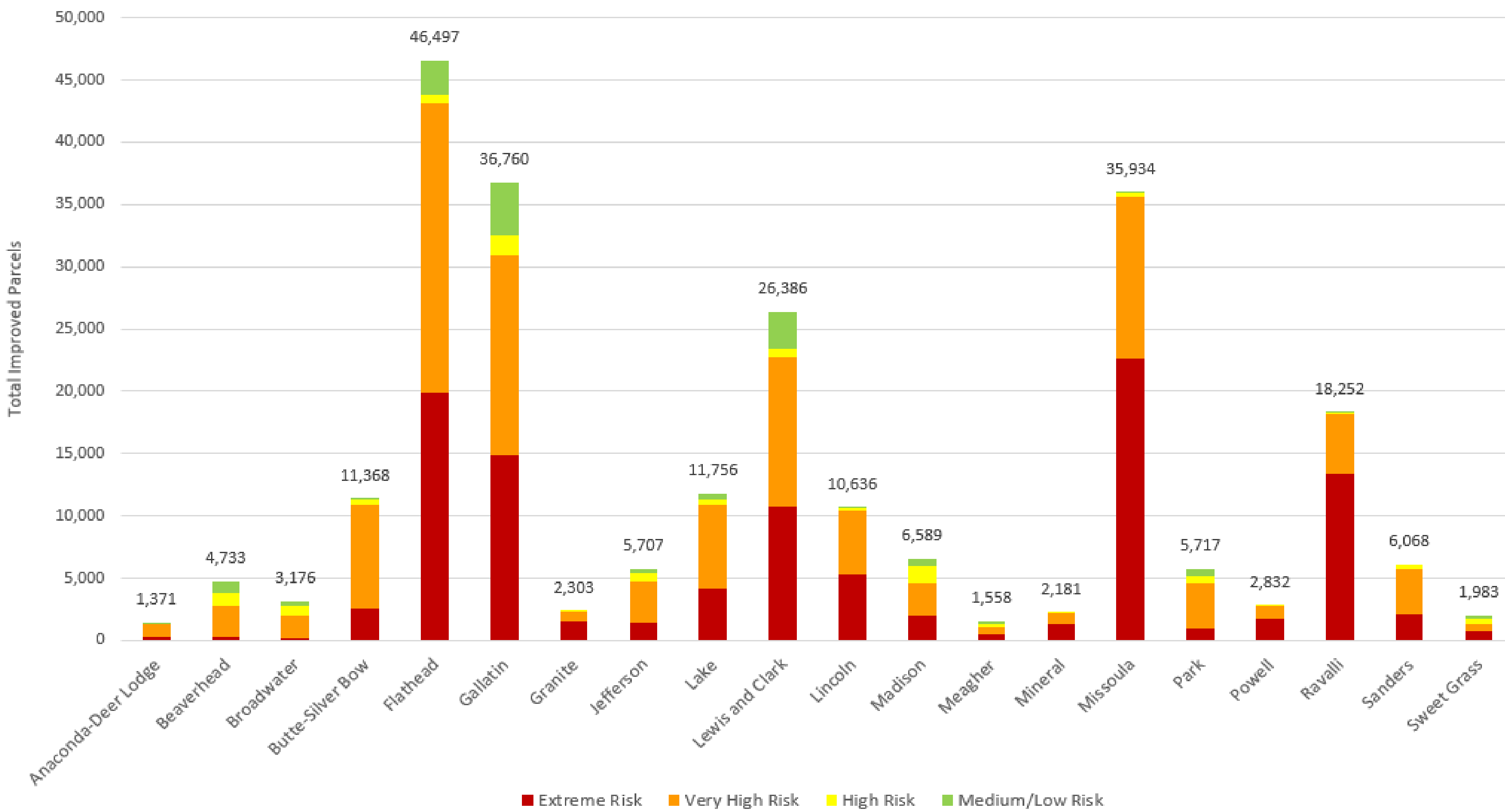


Figure 4-111 Total Improved Parcels (Values) in Wildfire Risk Areas by County

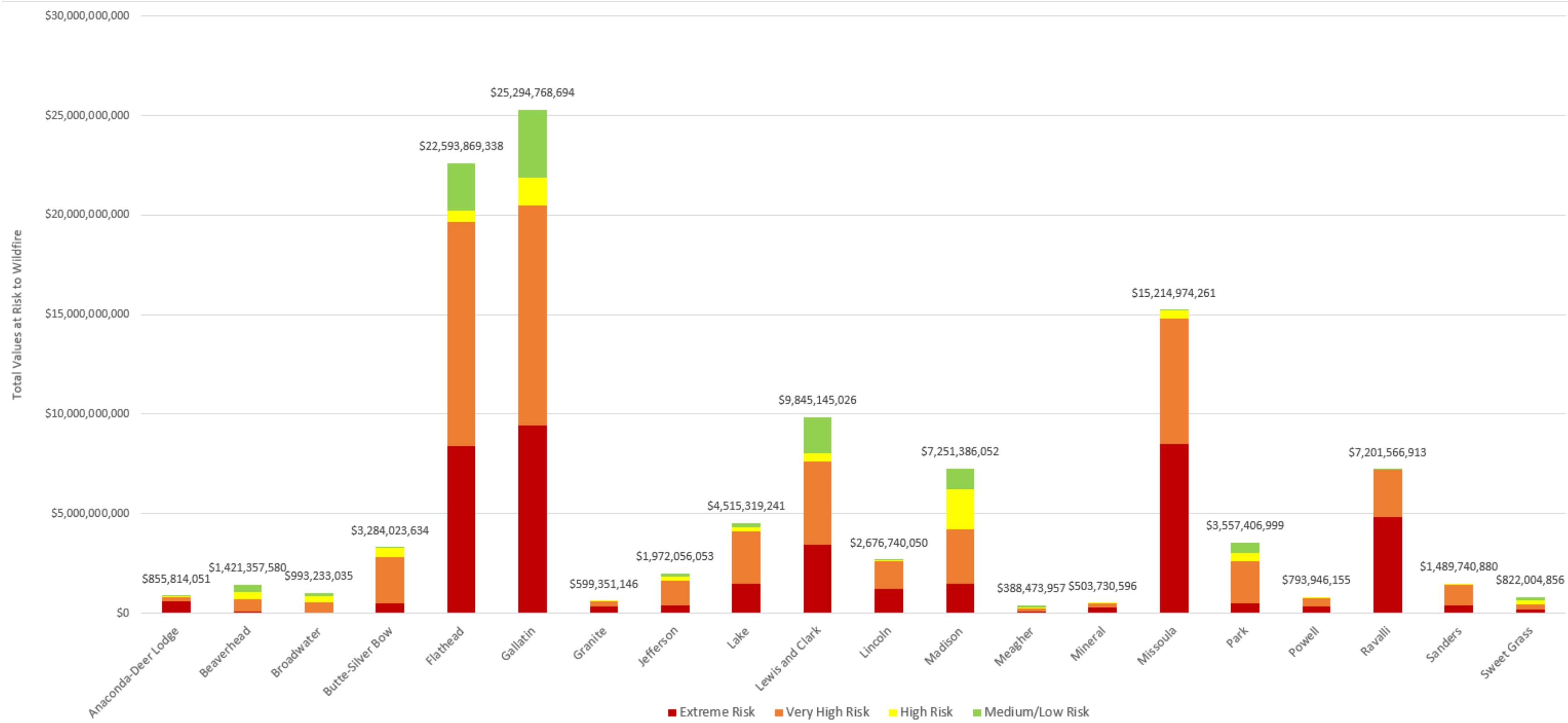
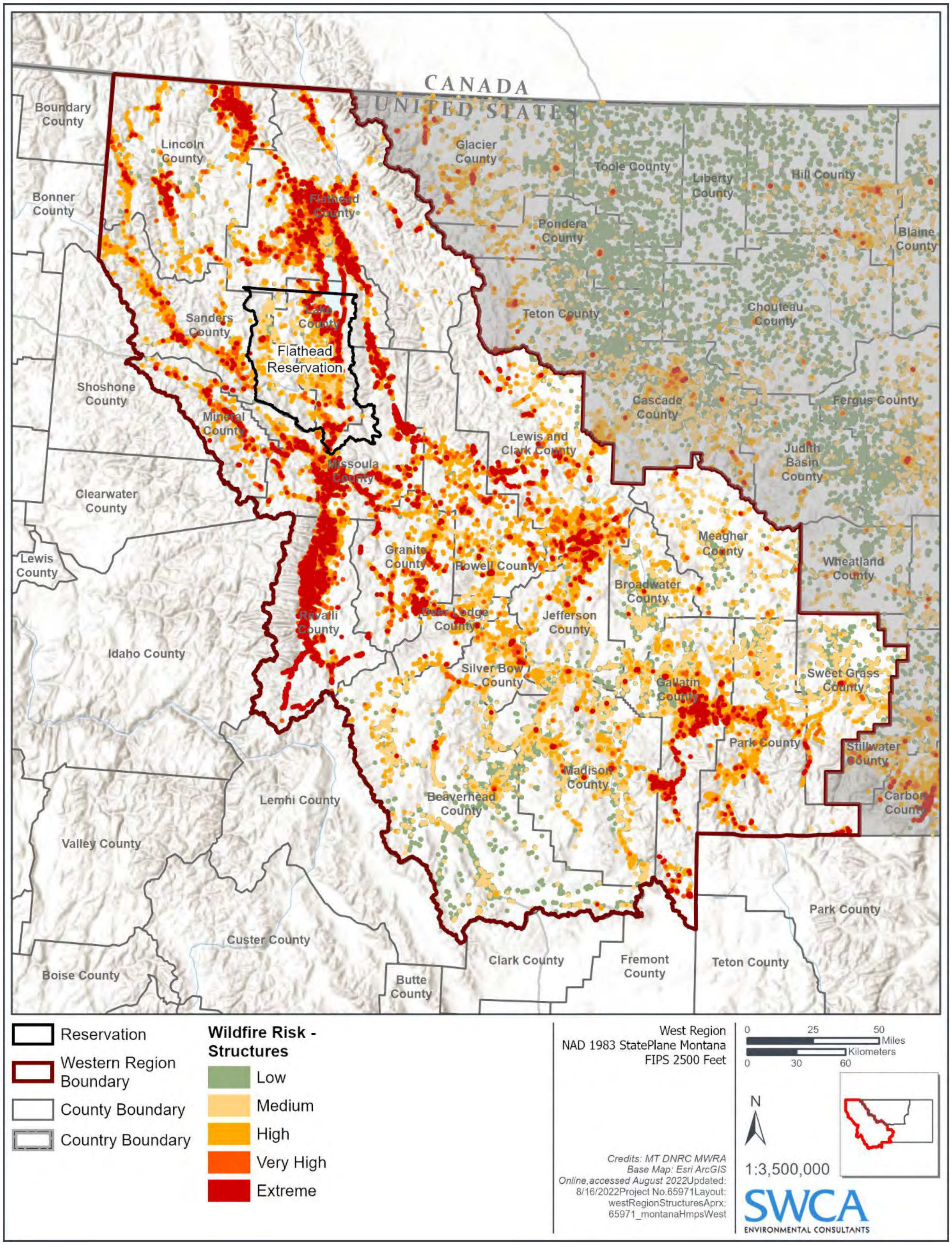


Figure 4-112 Wildfire Risk to Structures in the Western Region



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 MWRA data with critical facility data from HIFLD, Montana DES, and NBI. Summary tables of these results are shown below in Table 4-66 through Table 4-68, highlighting the type and number of facilities in each county that are located in high, very high, or extreme wildfire risk areas.

Table 4-66 Critical Facilities at Risk to Extreme Wildfire Hazards

County	Communications	Energy	Food, Water, Shelter	Hazardous Materials	Health and Medical	Safety and Security	Transportation	Total
Anaconda-Deer Lodge	25	3	2	2	2	11	8	**53**
Beaverhead	10	3	7	0	3	9	4	**36**
Broadwater	19	3	0	0	0	4	0	**26**
Butte-Silver Bow	34	15	1	0	0	5	1	**56**
Flathead	102	41	23	0	14	60	22	**262**
Granite	30	13	4	0	2	6	14	**69**
Jefferson	78	11	2	0	2	17	12	**122**
Lake	32	14	0	0	4	19	21	**90**
Lewis and Clark	90	9	15	1	3	38	27	**183**
Lincoln	38	13	7	1	5	34	18	**116**
Madison	20	12	1	0	4	14	12	**63**
Meagher	4	1	2	0	1	6	0	**14**
Mineral	19	9	5	0	1	16	35	**85**
Missoula/CSKT	0	0	0	0	0	0	2	**2**
Park	65	23	13	0	4	20	10	**135**
Powell	30	18	6	1	2	17	14	**88**
Ravalli	88	21	8	1	12	42	72	**244**
Sanders	40	12	7	0	6	22	6	**93**
Sweet Grass	11	5	6	1	1	5	2	**31**
Total	**735**	**226**	**109**	**7**	**66**	**345**	**280**	**1,768**

Source: HIFLD 2022, Montana DES, NBI, MWRA

Table 4-67 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
Anaconda-Deer Lodge	1	3	1	0	0	4	14	**23**
Beaverhead	25	12	9	1	1	7	34	**89**
Broadwater	10	8	1	0	0	4	8	**31**
Butte-Silver Bow	28	11	11	1	0	20	29	**100**
Flathead	57	17	29	4	5	57	100	**269**
Granite	1	0	0	0	0	1	27	**29**
Jefferson	4	0	0	1	1	12	48	**66**
Lake	12	10	5	0	2	25	49	**103**
Lewis and Clark	29	10	21	4	1	35	90	**190**
Lincoln	3	1	3	1	2	12	51	**73**
Madison	9	6	1	0	1	5	33	**55**
Meagher	2	4	0	0	0	3	13	**22**
Mineral	0	1	1	1	0	0	40	**43**
Missoula/CSKT	0	0	0	0	0	0	4	**4**
Park	27	5	9	0	1	9	55	**106**
Powell	4	0	1	0	0	5	44	**54**
Ravalli	28	1	1	2	0	1	44	**77**
Sanders	2	2	2	1	2	10	42	**61**
Sweet Grass	13	6	0	0	1	3	38	**61**
Total	**255**	**97**	**95**	**16**	**17**	**213**	**763**	**1,456**

Source: HIFLD 2022, Montana DES, NBI, MWRA

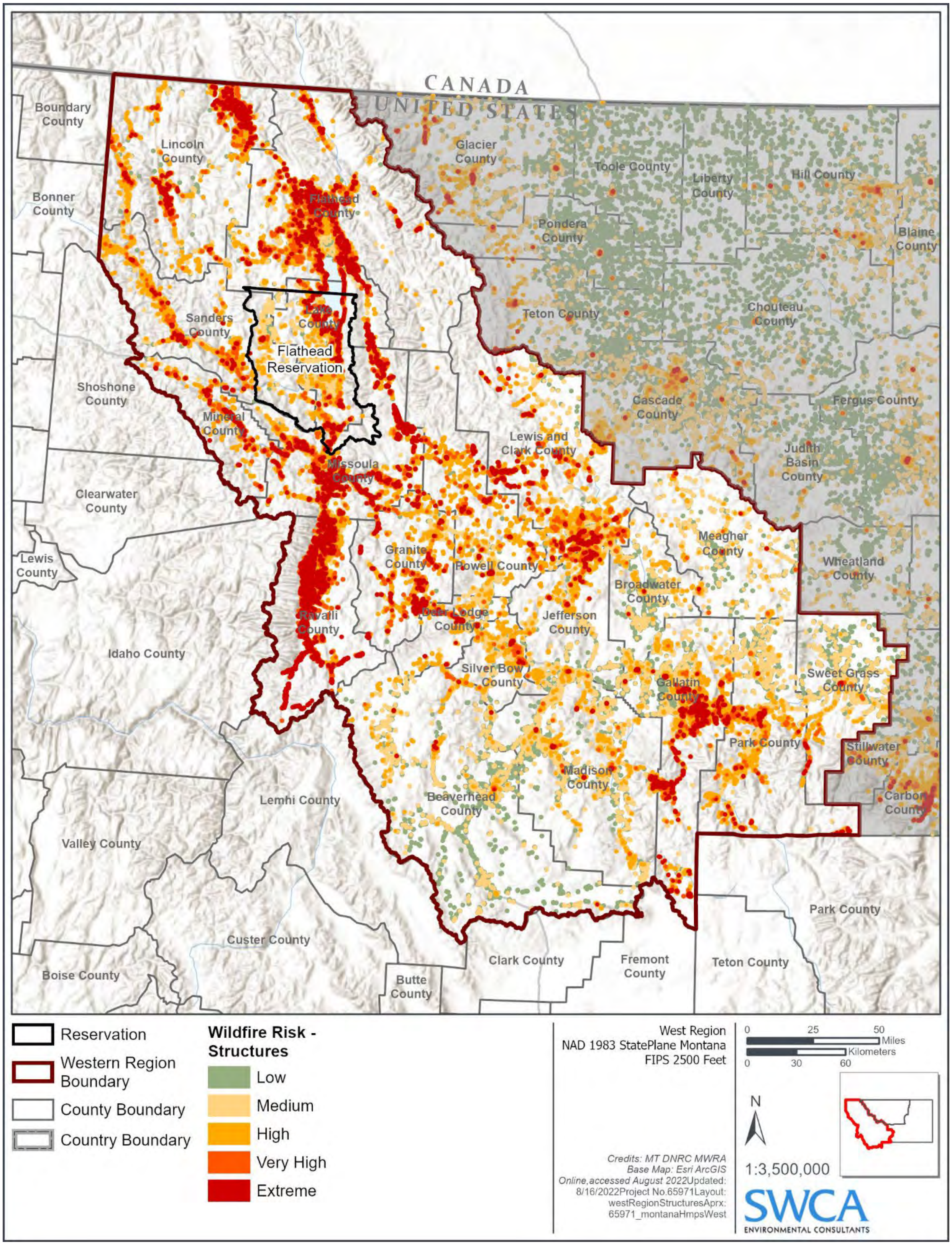
Table 4-68 Critical Facilities at Risk to High Wildfire Hazards

County	Communications	Energy	Food, Water, Shelter	Hazardous Materials	Health and Medical	Safety and Security	Transportation	Total
Anaconda-Deer Lodge	3	0	0	0	0	1	12	**16**
Beaverhead	2	2	1	0	0	1	98	**104**
Broadwater	3	0	2	2	0	1	22	**30**
Butte-Silver Bow	6	0	4	5	0	1	18	**34**
Flathead	4	0	4	2	0	2	47	**59**
Granite	5	0	0	0	0	0	3	**8**
Jefferson	3	2	1	2	0	0	29	**37**
Lake	0	0	1	0	0	3	26	**30**
Lewis and Clark	16	0	6	1	1	2	46	**72**
Lincoln	0	0	0	0	0	0	15	**15**
Madison	5	0	1	0	0	0	27	**33**
Meagher	0	0	0	0	0	0	26	**26**

County	Communications	Energy	Food, Water, Shelter	Hazardous Materials	Health and Medical	Safety and Security	Transportation	Total
Mineral	0	0	0	0	0	0	1	**1**
Missoula/CSKT	-	-	-	-	-	-	-	**-**
Park	7	0	0	0	0	0	27	**34**
Powell	1	1	1	0	0	0	9	**12**
Ravalli	0	0	0	0	0	0	1	**1**
Sanders	1	0	1	1	0	0	9	**12**
Sweet Grass	2	2	1	0	0	0	31	**36**
Total	**58**	**7**	**23**	**13**	**1**	**11**	**447**	**560**

Source: HIFLD 2022, Montana DES, NBI, MWRA

Figure 4-113 Wildfire Risk to Infrastructure in the Western Region



Source: MT DNRC 2022

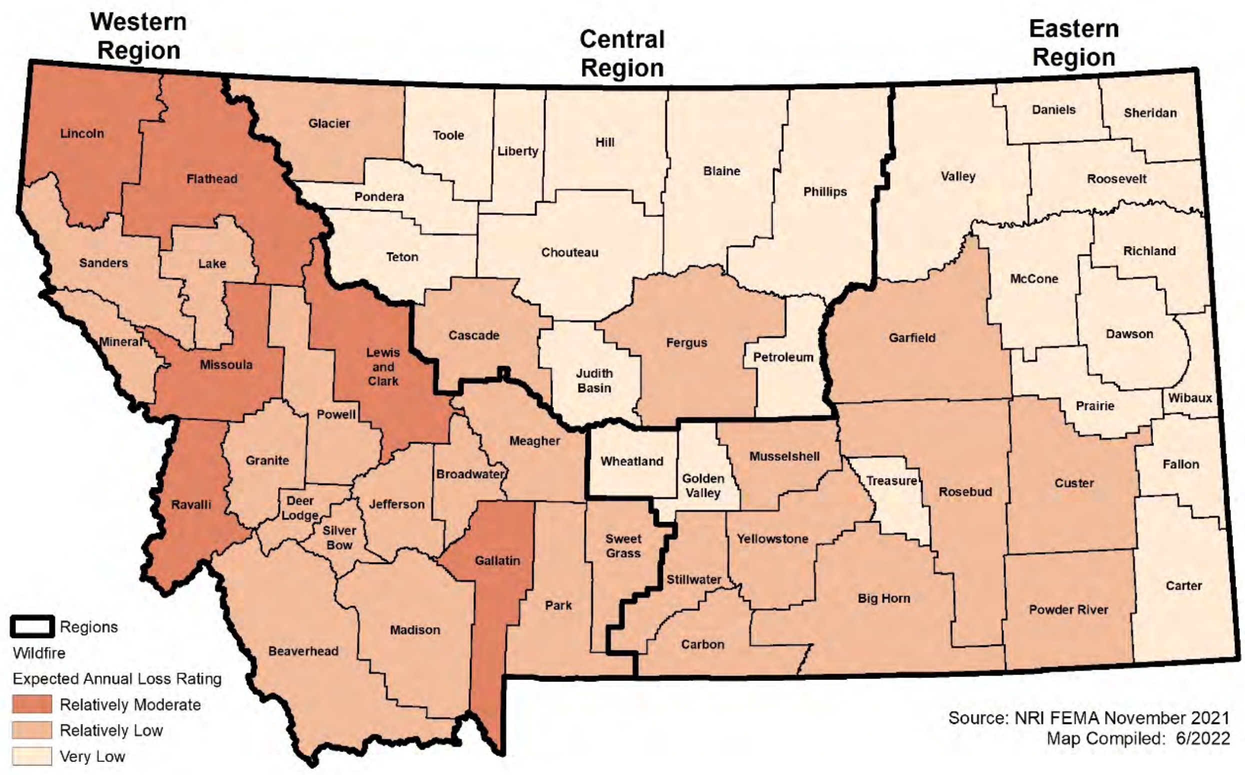
Economy

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 Western Region economy. Wildland fires can have a direct impact on the Region'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 Western 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 4-114 illustrates the relative risk of EAL rating due to wildfire. Many counties in the Western Region have relatively moderate risk, including Lincoln, Flathead, Lewis & Clark, and Ravalli counties.

Figure 4-114 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 Western 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 forest and rangeland systems of Western 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 U.S, watershed vulnerability to 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 western portion of Glacier National Park, the Bob Marshall-Scapegoat Wilderness complex, the Selway-Bitterroot Wilderness, the Mission Mountain Wilderness, the Cabinet Mountain Wilderness, Gallatin National Forest, Lolo National Forest, Kootenai National Forest, Flathead National Forest, Beaverhead-Deer lodge National Forest, and the Lewis and Clark National Forest, and Bureau of Land Management managed forests and 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 is an extremely valuable resource in Western Montana and occurs on publicly and privately managed land across much of the Western Region. In Montana, the forestry industry employs some 8,000 people, generates over 500 million dollars in wood sales, and produces approximately 500 million board feet (Montana Business Quarterly, 2018), with the majority of this industry occurring in the Western Region. Increasing wildfire conditions can halt timber sales (due to closures) and damage and potentially destroy harvestable trees, negatively impacting the timber industry. Western Montana is predicted to have larger and more severe forest fires in the coming years (MT DNRC 2020a). Historically, wildfires of all frequencies and severities occurred in the regions forests and were necessary for maintaining stand structure, native forest ecology, and landscape heterogeneity (MT DNRC 2020a). While wildfire activity is known to impact timber resources, it is important to note that timber extraction practices are also known to impact wildfire activity. Commercial thinning and commercial harvest, when done properly, can improve forest health, reduce wildfire risk (MT DNRC 2020a), and reduce wildfire severity (Ager et al 2007). However, it is important to note that logging does not always equate to wildfire risk reduction.

During the Cooney Ridge Fire of 2003 (within the Sapphire Mountains of Western Montana), heavily logged (e.g., clear-cut) privately managed lands displayed more severe wildfire impacts than publicly managed and less intensively logged landscapes (where the landscape exhibited more natural forested conditions) (Stone et al 2004). Across the fire impacted landscape, 98% of the privately managed lands (where the intensive logging was more likely to occur) experienced wildfire, with the majority experiencing high severity wildfire. On the other hand, only 79% of the publicly managed lands (where there was less intensive logging) experienced wildfire, with the majority of the burned areas only experiencing low and moderate severity wildfire. Leftover slash, remaining vegetation, high density tree plantations, growth of fine fuels, and lack of landscape heterogeneity were some of the conditions that contributed to the more extreme wildfire conditions on the privately managed lands. Similar patterns have been observed in other heavily logged areas in the Western U.S (see Zald and Dunn 2018; Odion et al 2004; and Bradley et al 2016). These examples highlight the complexity of the relationship between timber management and fire management. It is also important to note that the fire ecology exhibited by the diverse landscapes of Western Montana is complex and the interaction between forest management, fire ecology, and fire management is also complex. How timber and wildfire are managed should be regionally and ecologically specific and, ideally, should complement each other. Overall, timber management can and should be aligned with fire management, such that it allows forests, their natural fire regimes, and their dependent ecology to be restored and/or persist while concurrently minimizing wildfire risk to local communities and reducing the vulnerability of region's timber industry.

Public and privately managed rangelands across the Western 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 minimize risk to local ranchers.

Wildfire can also threaten the Region's farmlands. Currently, counties with a high proportion and concentration of farmlands are less vulnerable to wildfire. However, agricultural areas in the Region usually have an intermix of farmland and undeveloped rangelands and forests. 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). Additionally, indirect impacts from wildfire, primarily smoke impacts, can also negatively affect produce harvest, quality, and sales (AEI 2021), this is especially relevant for the Western Region's fruit industry. Overall, increasing wildfire conditions are making the Western Region's farmlands more vulnerable to wildfire.

Development Trends Related to Hazards and Risk

Throughout the Region there has been general increase in population. The counties and reservations with the most notable increase in population include Flathead County, Flathead Reservation, Gallatin County, Lewis and Clark County, and Missoula County. Trends across the State and the Western U.S have demonstrated that the WUI is a desirable location for development, even though it presents increased wildfire risk. Thus, there is a high likelihood for homes to be developed within the WUI in the Western Montana Region. Building future homes/structures in high-risk WUI areas places 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 to include ponds, 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 infrastructure currently situated in the WUI to prepare for potential increased risk from wildfire.

4.2.17.8 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 at which wildfire occurs in the Western Region is, generally, high with wildfire having a greater likelihood of occurrence in the forested regions.

- The counties with large areas of forests are likely to experience the most acres burned in any given year, while those counties with more rangeland are likely to experience fewer total acres burned.
- Socially vulnerable populations are likely to experience the worst effects of wildfire.
- The eNVC statewide risk assessment tends to skew risk toward populated areas; communities with Community Wildfire Protection Plans should refer to those plans for additional local-level risk analysis.
- Property, structures, and critical infrastructure is at moderate to extreme risk from wildland and rangeland fire 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 will be more likely and the detrimental impacts on human health and the built environment from wildfire will likely increase as the fire season becomes year-round.
- Related Hazards: Drought, Flooding, Severe Summer Weather (lightning).

Table 4-69 Risk Summary Table: Wildland and Rangeland Fire

Jurisdiction	Overall Significance	Additional Jurisdictions	Jurisdictional Differences?
Western Region	High	NA	Yes by county/tribe
Anaconda-Deer Lodge County	Medium	NA	NA
Beaverhead County	Medium	Dillon, Lima	None
Broadwater County	Medium	Townsend	None
Butte-Silver Bow County	Medium	NA	None
CSKT	Medium	NA	NA
Flathead County	High	Columbia Falls, Kalispell, Whitefish	Flathead county has the highest vulnerable population. Also has the highest burn probability in Region
Granite County	High	Drummond, Philipsburg	None; majority of property in extreme to high risk
Jefferson County	High	Boulder, Whitehall	None
Lake County	High	Polson, Ronan, St. Ignatius	None
Lewis & Clark County	High	East Helena, Helena	None
Lincoln County	High	Eureka, Libby, Rexford, Troy	Second highest burn probability in Region
Madison County	Medium	Ennis, Sheridan, Twin Bridges, Virginia City	None, Virginia City has historic structures
Meagher County	Medium	White Sulphur Springs	None
Mineral County	High	Alberton, Superior	None
Park County	Medium	Clyde Park, Livingston	None
Powell County	Medium	Deer Lodge	None

Jurisdiction	Overall Significance	Additional Jurisdictions	Jurisdictional Differences?
Ravalli County	High	Darby, Hamilton, Pinesdale, Stevensville	Ravalli County's expected loss ratio to extreme wildfire is 70%
Sanders County	High	Hot Springs, Plains, Thompson Falls	None
Sweet Grass County	Medium	Big Timber	None

*Based on feedback from HMPC