MADISON COUNTY, MONTANA
TOWN OF ENNIS, MONTANA
TOWN OF SHERIDAN, MONTANA
TOWN OF VIRGINIA CITY, MONTANA
PREDISASTER MITIGATION PLAN

2017 REVISION

DRAFT TOPICAL REPORT RSI-2705

PREPARED FOR
Beaverhead County, MT
City of Dillon, MT
Town of Lima, MT

MAY 2017

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PREPARED BY

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PREPARED FOR

Beaverhead County, MT

City of Dillon, MT

Town of Lima, MT

APRIL 2017

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EXECUTIVE SUMMARY

Disasters can strike at any time in any place. In many cases, actions can be taken before disasters strike to reduce or eliminate the negative impacts. These actions are called mitigation and often protect life, property, the economy, and other values. The Madison County Pre-Disaster Mitigation (PDM) Plan addresses 13 major hazards with respect to risk and vulnerabilities countywide, including the Towns of Ennis, Sheridan, Twin Bridges, and Virginia City. Through a collaborative planning process, the Madison County hazards were identified, researched, profiled, updated, and prioritized.

The major hazards (i.e., aircraft accident, disease and environmental contamination, drought, earthquake, flood, hazardous material release, severe weather, terrorism and civil unrest, transportation accident, urban fire, utility and energy failure, volcanic ashfall, and wildfire) are each profiled in terms of their hazard description, history, probability and magnitude, mapping, vulnerabilities, data limitations, and other factors. The vulnerabilities to critical facilities; critical infrastructure; structures; the population; economic, ecologic, historic, and social values; and future development are updated for each hazard.

Based on the probability and extent of potential impacts that were identified in the risk assessment, the prioritizations of hazards within Beaverhead County are displayed in Table ES-1. Note that individual jurisdictions have their own prioritizations based on the hazards and vulnerabilities specific to their locations but are generally similar to that of the county. Their priorities can be found in Section 4.14.

Table ES-1. Madison County Hazard Prioritizations

Level	Hazard
High Hazard	Earthquake Flood Wildfire Utility and Energy Failure
Moderate Hazard	Winter Weather Communicable Disease Hazardous Matieral Release Structure collapse Drought
Low Hazard	Terrorism and Civil Unrest Transportation Accident Volcano Landslide and Avalanche

The following goals are outlined in the plan's mitigation strategy, based on the results of the risk assessment:

- Goal 1: Encourage mitigation from multiple hazards through education and existing programs.
- Goal 2: Reduce loss of life, injuries, and property damage in the event of an earthquake.
- Goal 3: Reduce loss of life and prevent injury in the event of a hazardous material incident.
- Goal 4: Reduce or prevent loss of life and injuries and property damage in the event of flooding.
- Goal 5: Reduce losses from wildfires in the wildland urban interface.

- Goal 6: Minimize impacts from weather events such as severe thunderstorms and winter storms.

Associated with each of the goals are objectives and mitigation actions that range from adopting building codes to burying electric infrastructure to community education. The mitigation projects are prioritized based on cost, staff time, feasibility, population benefit, property benefit, values benefit, project maintenance, and the probability and impact of the hazards being mitigated. An implementation plan outlines the suggested course of action, given the limited resources available to Madison County and the jurisdictions. The Madison County Local Emergency Planning Committee is responsible for implementing and maintaining the plan. Other recommended activities, such as integrating this plan into a variety of county, city, and town plans, regulations, and documents, will further the goals of hazard mitigation in Madison County.

The Madison County plan exceeds the requirements of a local hazard mitigation plan as outlined in the Interim Final Rule published in the Federal Register on February 26, 2002, at Title 44 of the Code of Federal Regulations, Part 201 as part of the Disaster Mitigation Act of 2000 (DMA 2000). This plan has been approved by the Federal Emergency Management Agency (FEMA) as a hazard mitigation plan; therefore, the county and towns may be eligible for federal mitigation funds. This plan serves as a guide for understanding the major hazards that face Madison County and the jurisdictions and provides a strategy for preventing or reducing some of the impacts.

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1.0 INTRODUCTION

Emergency management is typically divided into four interrelated actions: mitigation, preparedness, response, and recovery. This plan will focus on the mitigation phase only. Mitigation actions involve lasting, often permanent, reduction of, exposure to, probability of, or potential loss from hazard events. These actions tend to focus on where and how to build. Examples include: zoning and building code requirements for building or rebuilding in high hazard areas, floodplain buyouts, and analyses of hazard-related data. Mitigation also can involve educating businesses and the public on simple measures they can take to reduce loss and injury, like fastening bookshelves, water heaters, and file cabinets to walls to keep them from falling during earthquakes.

Cost-effective mitigation measures are the key to reducing disaster losses in the long term. In hazard-prone areas, mitigation can break the cycle of having to rebuild and rebuild again with every recurrence of floods, wildfires, earthquakes, or other hazards. Where there is a willingness to mitigate, opportunities can be found. Ongoing efforts might include: educating the private sector about what it can do to mitigate at home and at work; reaching out to planning, zoning, and development agencies to ensure that hazard conditions are considered in comprehensive plans, construction permits, building codes, design approvals, etc., and creating inventories of existing structures and their vulnerabilities, to aid mitigation planning. Planning is also needed to take advantage of mitigation opportunities in the aftermath of an emergency or disaster when hazard awareness is high, funds are possibly available, and disruption of the status quo makes it possible to rethink design and location of some facilities and infrastructure. Attention to mitigation opportunities can make safer communities.

The Madison County Pre-Disaster Mitigation (PDM) Plan (the plan) is a combined effort of Madison County; the Madison County Local Emergency Planning Committee; Madison County Disaster and Emergency Services; the Towns of Ennis, Sheridan, Twin Bridges, and Virginia City; and the public.

1.1 PURPOSE

Madison County and the Towns of Ennis, Sheridan, Twin Bridges, and Virginia City recognize that hazards, both natural and human-caused, threaten their communities. Rather than wait until disaster strikes, the jurisdictions can take proactive measures to prevent losses and lessen the impact from these hazards. Actions taken to reduce or eliminate the long-term risk from hazards are defined as mitigation. Disaster mitigation is an investment that can save lives and money.

The purpose of this PDM plan is to:

- Serve as a consolidated, comprehensive source of hazard information.
- Educate the communities, including government leaders and the public, on their vulnerabilities.
- Fulfill federal, state, and local hazard mitigation planning responsibilities.
- Prioritize and promote cost-effective mitigation solutions.
- Support requests for grant funding.
- Encourage long-term community sustainability.

Effective mitigation planning promotes a broader understanding of the hazards threatening the communities and provides a clearer vision and competitive edge for future mitigation grant funding. By integrating mitigation concepts into local thinking, the communities will find many more opportunities for disaster resistance beyond grant funding. For example, the consideration of disaster mitigation when designing subdivisions may include multiple access points or removal of drinking water wells from the floodplain that will provide greater disaster resistance, reduce future expenses and contribute to community sustainability.

The plan's intent is to assist the communities in making financial decisions for mitigation projects and clarify actions that could be taken through additional funding. Through an effective and inclusive planning process, communities will become more aware of their hazards and will take a proactive approach to disaster prevention and mitigation.

1.2 AUTHORITIES

The Disaster Mitigation Act (DMA) of 2000 amends the Robert T. Stafford Disaster Relief and Emergency Assistance Act by adding a new section, Section 322 – Mitigation Planning. The requirements of such are outlined in the Interim Final Rule published in the Federal Register on February 26, 2002 at 44 CFR Part 201, with some additional amendments. This legislation requires all local governments to have an approved hazard mitigation plan in place by November 1, 2004 to be eligible to receive Hazard Mitigation Grant Program (HMGP) and other types of disaster and mitigation funding.

Madison County and the Towns of Ennis, Sheridan, Twin Bridges, and Virginia City have adopted this Pre-Disaster Mitigation Plan by resolution (see Appendix L for copies of the resolutions). These governing bodies have the authority to promote mitigation activities in their jurisdictions.

This plan is developed, promulgated, and maintained pursuant to the following state and federal statutes and regulations:

- Code of Federal Regulations Title 44, Part 201, 205, and 206.
- Public Law 106-390, Disaster Mitigation Act of 2000.
- Public Law 93-288, The Disaster Relief Act of 1974, as amended by Public Law 100-707, the Robert T. Stafford Disaster Relief and Emergency Assistance Act.
- Public Law 96-342, Improved Civil Defense 1980.
- Public Law 99-499, Superfund Amendment and Re-authorization Act (SARA) of 1986, Title III, Emergency Planning Community Right-to-Know Act (EPCRA), Title 42, Chapter 116.
- Public Law 920, Federal Civil Defense Act of 1950, as amended.
- Public Law 105-19, Volunteer Protection Act of 1997.
- Response to Hazardous Materials Incidents, Title 10, Chapter 3, Part 12 MCA.

1.3 ACKNOWLEDGEMENTS

Madison County is located in southwest Montana, as shown in Figure 1-1, with an area of approximately 3,587 square miles. Madison County is bounded by Silver Bow and Jefferson Counties on the north, Gallatin County on the east, Beaverhead County on the southwest, and a small portion of Idaho on the

south. The Town of Virginia City is the county seat and other incorporated communities include the Towns of Ennis, Sheridan, and Twin Bridges. Figure 1-2 shows the general features in the county. The Madison and Ruby Valleys, within Madison County, are surrounded by several mountain ranges and are marked by pristine rivers, creeks, and streams. The Madison River flows from Quake Lake in southern Madison County north past Ennis into neighboring Gallatin County, forming the Madison Valley. The Ruby River starts high in the Snowcrest Mountain Range and flows north to Twin Bridges where it comes together with the Beaverhead and Big Hole Rivers to form the Jefferson River. Mountain ranges within Madison County include the Tobacco Root, Snowcrest, Gravelly, Ruby, and Madison Ranges. Elevations range from about 4,300 feet in the valleys to over 11,300 feet in the mountains.

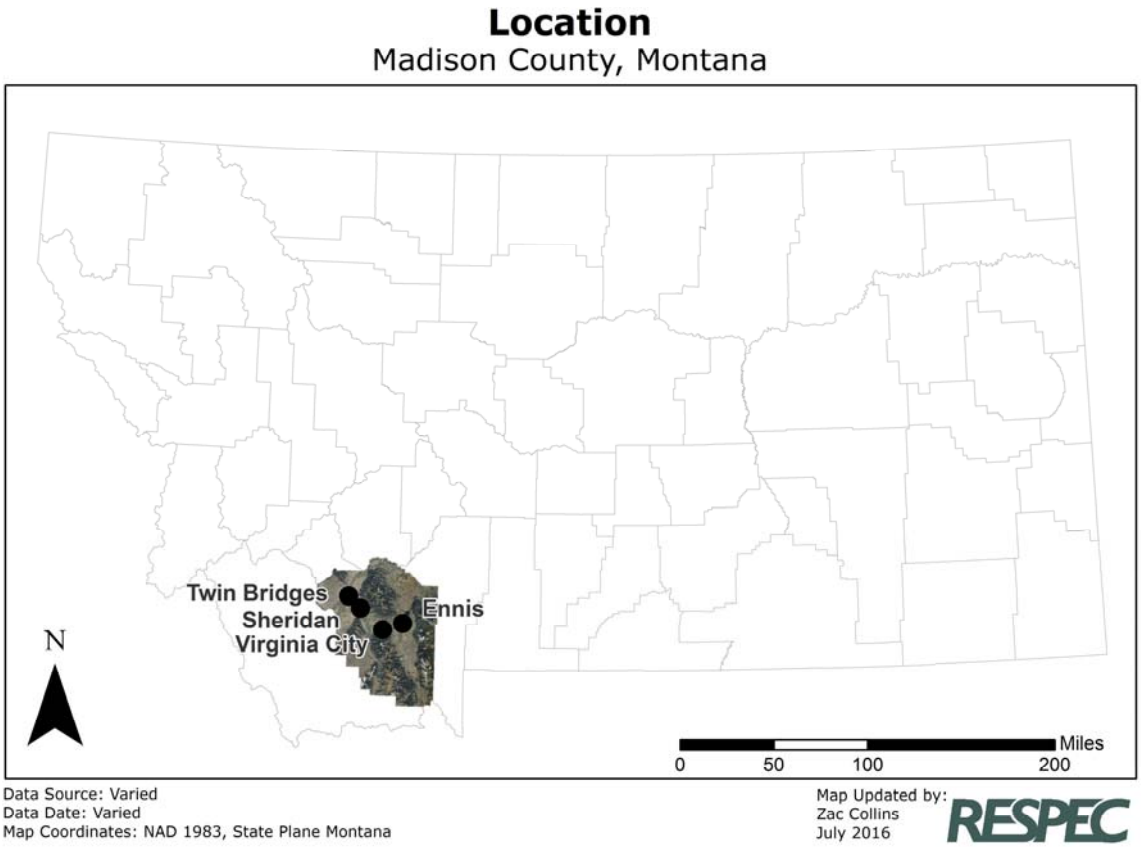
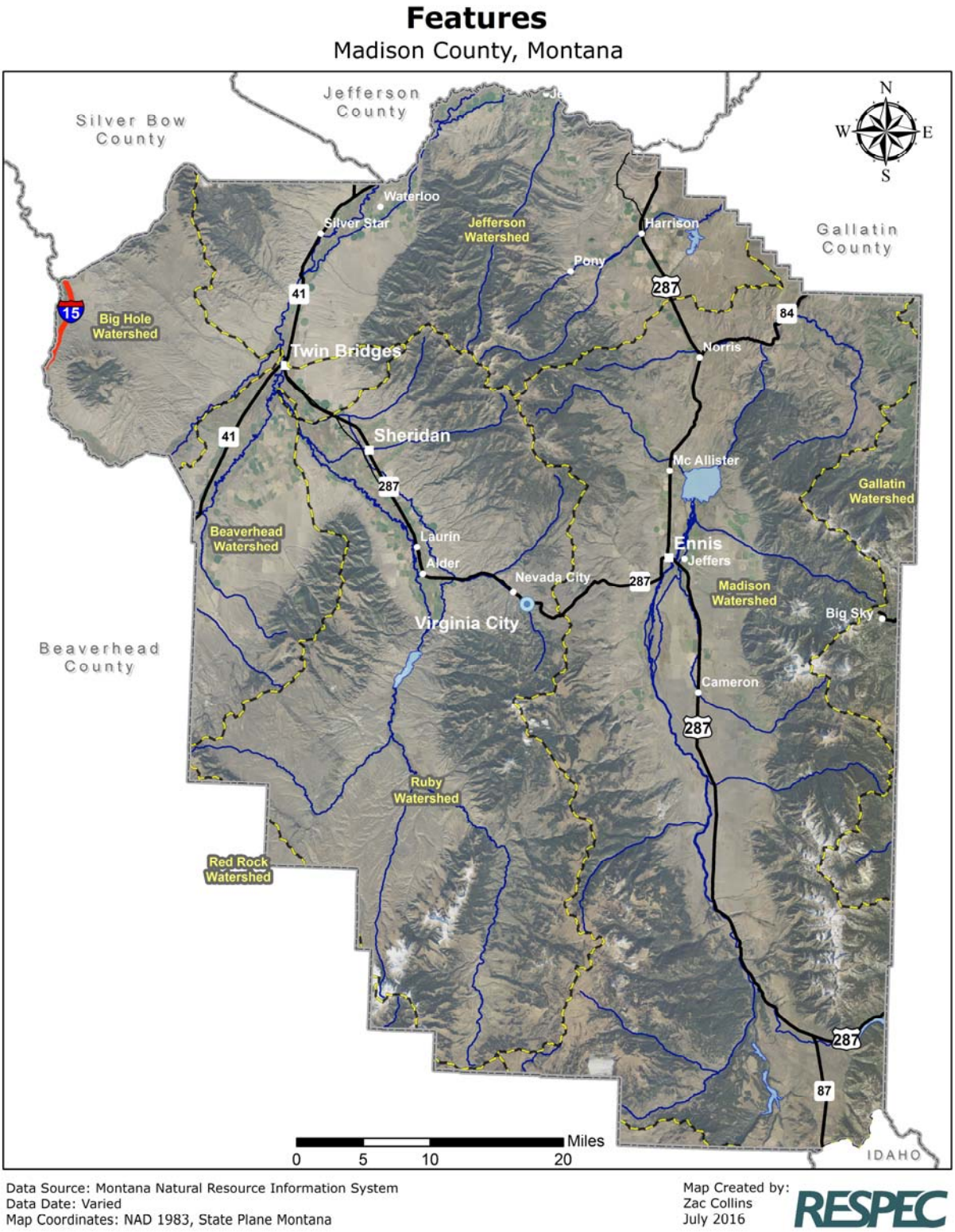


Figure 1-1. Need Caption. Also, the logo needs to be updated on this.

Table 1-1 details the climate statistics recorded by the National Weather Service (NWS) at the Virginia City weather station. Climate data from Twin Bridges (western Madison County), the Norris Madison pump house (eastern Madison County), and Hebgen Dam (just southeast of Madison County) show the variations in climate.

1.4 PLAN SCOPE AND ORGANIZATION

The Madison County PDM Plan is organized into sections that describe the planning process (Chapter 2.0), assets and community inventory (Chapter 3.0), risk assessment/hazard profiles (Chapter 4), mitigation strategies (Chapter 5.0), and plan maintenance (Chapter 6.0). Appendices containing supporting information are included at the end of the plan.



Data Source: Montana Natural Resource Information System
Data Date: Varied
Map Coordinates: NAD 1983, State Plane Montana

Map Created by:
Zac Collins
July 2016

Figure 1-2. Need a Caption. Also the logo should be updated.

This plan, particularly the risk assessment section, outlines each hazard in detail and how it may affect Madison County and the Towns of Ennis, Sheridan, Twin Bridges, and Virginia City. The mitigation strategy outlines long-term solutions to possibly prevent or reduce future damages. Additional hazards may exist that were not apparent to local government or participants through the development of this plan, and certainly, disasters can occur in unexpected ways. Although any and all hazards cannot be fully mitigated, this plan will help the communities understand the hazards better and become more disaster resistant.

Table 1-1. Madison County Climate Statistics [Western Regional Climate Center, 2009]

	Virginia City 1893–2012	Twin Bridges 1950–2012	Norris Madison Pump High School 1907–2012	Hebgen Dam 1948-2012
Annual Average Maximum Daily Temperature	54.9F	58.3°F	58°F	49.2F
Annual Average Minimum Daily Temperature	29.5°F	27.9°F	35.4°F	23.6°F
Annual Average Total Precipitation	14.95 inches	9.62 inches	17.45 inches	28.39 inches
Annual Average Total Snowfall	64.8 inches	9.1 inches	54 inches	207.4 inches
Highest Temperature Recorded	103°F July 25, 1919	101°F July 12, 2002	102°F August 12, 1940	96°F June 13, 2002
Lowest Temperature Recorded	–40°F January 19, 1963	–39°F January 26, 1957	–36°F February 9, 1933	–45°F January 10, 1962
Annual Average Number of Days Dropping Below Freezing	200 days	212 days	146.8 days	231.7 days
Annual Average Number of Days Staying Below Freezing	48 days	34.4 days	34.2 days	97.1 days
Annual Average Number of Days Reaching 90°F or Higher	4.9 days	14.2 days	17.6 days	.8 days
Highest Annual Precipitation	21.25 inches 1962	15.64 inches 1983	25.21 inches 1959	39.57 inches 1982
Lowest Annual Precipitation	9.05 inches 1934	5.33 inches 1974	11.25 inches 2001	18.74 inches 1988
1-Day Maximum Precipitation	1.88 inches July, 9, 1968	1.80 inches June 10, 1969	5.04 inches May 24, 1909	2.15 inches September 15, 1966
Highest Annual Snowfall	103.2 inches 1984	22.6 inches 1952	98.5 inches 1924	381.0 inches 1975

2.0 PLANNING PROCESS AND METHODOLOGIES

Mitigation planning is a community effort and takes time and expertise. For Madison County and the Towns of Ennis, Sheridan, Twin Bridges, and Virgina City, an effective hazard mitigation plan requires input from a variety of stakeholders, including elected officials, first responders, emergency management, healthcare providers, public works, road officials, state and federal agencies, businesses, non-profit organizations, academia, and the public. After a disaster, many of these stakeholders will be overwhelmed with recovery responsibilities. Therefore, planning for mitigation and involving as many stakeholders as possible before a disaster strikes will make mitigation activities easier after a disaster and may even prevent the disaster in the first place.

2.1 INITIAL PLANNING PROCESS

With the enactment of the Disaster Mitigation Act of 2000, The Local Emergency Planning Committee (LEPC) evolved into an all-hazard planning organization. The legislation required each jurisdiction to develop a PDM plan. PDM Committees became subcommittees of the LEPC or the LEPC took on these additional duties. While the Disaster Mitigation Act of 2000 specifically addresses the requirement to plan for the mitigation of natural disasters, it is generally accepted that the most prudent course of action is for the LEPC to also plan for the mitigation of human-caused disasters, while still maintaining its original intended purpose with regard to hazardous material incidents mitigation.

With the events of September 11, 2001, and the attack on the World Trade Center in New York City by terrorists, the LEPC was thrust into yet a new role. The LEPC is now responsible to plan for mitigation, response, and recovery efforts related to the possible eventuality of chemical, biological, nuclear/radiological, and conventional weapons of mass destruction (WMDs). The ability of the local government to prevent and respond decisively to terrorist attacks against our citizens is one of the most challenging priorities facing our nation today.

The Madison County LEPC was formed on May 21, 2002. At that time, the decision was made that the LEPC would also serve as the PDM Committee.

Members of the LEPC represent a solid cross section of the population of Madison County and the areas of the county. Agencies represented by members of the LEPC include the Madison County Commission, Madison County Planning Department, Madison County Sheriff's Office, Madison County Disaster and Emergency Services, Madison County Grant Writer, Madison County Health Department, Harrison Volunteer Fire Department, Town of Ennis, Ennis Ambulance Service, Virginia City Volunteer Fire Department, Town of Virginia City, Sheridan Volunteer Fire Department, Town of Sheridan, Twin Bridges Volunteer Fire Department, Town of Twin Bridges, Twin Bridges Public Works Department, and Twin Bridges School District. In addition, the participation of numerous other groups and interested individuals was invited and encouraged by the LEPC. These groups include the Vigilante Rural Electric Cooperative, the Three Rivers Telephone Cooperative, community service organizations, and other interested emergency services personnel as well as members of the general public.

The development of the Madison County Pre-Disaster Mitigation Plan followed a 10-step process with its basis in community planning. While not a requirement, adhering to this process ensured a thorough planning effort. The 10-steps included:

1. Get organized to prepare the plan.
2. Plan for public involvement.
3. Coordinate with other agencies.
4. Identify the hazard(s).
5. Assess the risk.
6. Set planning goals.
7. Review possible activities.
8. Draft an action plan.
9. Adopt the plan.
10. Implement, evaluate, and revise.

2.2 PLAN UPDATE PROCESS

Approaching the required 5-year plan update, Madison County applied for and received a Pre-Disaster Mitigation (PDM) grant to update its plan in 2015. With the funding, a consultant was hired to facilitate the plan update for Beaverhead County and Madison County. Respec based in Bozeman, Montana with experience in hazard mitigation and emergency management, coordinated the planning process in partnership with the county, city, and town. The contract was managed by Madison County for the two county area with the Beaverhead County Disaster and Emergency Services Coordinator acting as the key point-of-contact for the county.

The 2017 Plan update builds on the original 2004 plan and the updated 2009 plan with revised data for each of the defined risks and an updated and reprioritized list of goals and actions for each of these risks. These risks were discussed by Local Emergency Planning Committee (LEPC) as well as the local DES coordinator Dustin Tetrault. Hazus 3.1 as well as other GIS data was used to provide updated maps as well as data.

The plan update process consisted of the following basic steps:

1. Initial review of the existing plan by the contractor.
2. A proposed outline for the updated plan was developed.
3. An initial public meeting was held to solicit comment on the existing plan during a LEPC meeting to discuss what changes and accomplishments have taken place in the county and the jurisdictions over the past five years, and to brainstorm ideas (new hazards, mitigation strategies) for the updated version. Stakeholders were given the opportunity to review the updated draft sections and were asked to provide comments, including any new ideas for the mitigation strategy.
4. The Mitigation Strategy and remaining sections were updated.
5. Stakeholders were asked to review the draft plan and provide comments.

6. Public meetings (advertised through invitations, press releases, and a newspaper ad) were held in each of the jurisdictions to update the community on the newly revised plan and to solicit comments on the update.
7. Following the public comment period, any comments received were incorporated and the final plan was sent to the state and FEMA for review.
8. Jurisdictions adopted the updated plan, either before or immediately after state and FEMA conditional approval.

2.2.1 COMMUNITY CHANGES

A driving force in updating this type of plan is the changes that have occurred in the community over the past five years. Perhaps the biggest change in Madison County has been the residential and associated commercial growth. Since the communities do not have building codes or permit systems, the exact number of new developments is difficult to determine. However, over 1,000 new buildable lots were created over the past five years through land divisions (subdivision or family transfer) in the county. The recent economic slowdown has reduced this activity, but growth still continues [Madison County, 2009].

A few relatively minor disasters have occurred in the county over the past 5 years, but nothing that has led to big changes in communities or policies.

2.2.2 PLAN CHANGES

Another driving force in updating the plan was the updates to information and requirements of these plans provided by the federal government. In order to continue to comply with federal requirements, additions and changes to the plan needed to be made. These types of changes were proposed and made by the contractor and reviewed by the communities. Other changes were proposed by community members and made where applicable. Data, methods, and information used in the initial plan were reviewed by the contractor and changes were made if updated information existed. Other items, such as mitigation actions and plan maintenance procedures, were reviewed by local individuals and changes were made as needed. A greater emphasis was placed on hazard mitigation as well as a more in-depth look at drought as a hazard.

The 5-year update of the plan featured updates to all sections to improve readability, usability, and methodologies. Specifically, the following major changes were part of the plan's update:

- Updated the executive summary.
- The planning process was updated to include the five-year revision.
- New hazards were identified, others were modified, and one was removed.
- Updated Geographic Information System (GIS) mapping was added.
- Sections specific to critical facilities and infrastructure, the population, structures, and economic, ecologic, historic, and social values were added.
- Evaluations of current land use, new development, and future development were added and updated.

- The risk assessment methodology was modified to evaluate hazards on the structure scale to better estimate losses.
- Ranking of hazards updated based on evaluated risk and probability.
- Mitigation goals and strategies continued to be focused on mitigation and less on preparedness and response.
- New mitigation strategies and concepts were added and those completed or no longer relevant were removed.
- New appendices were added as needed.

2.2.3 JURISDICTION PARTICIPATION

This plan includes the following jurisdictions:

- Madison County
- Town of Ennis
- Town of Sheridan
- Town of Twin Bridges
- Town of Virginia City

Note that the jurisdictions listed above are all of the incorporated jurisdictions in Madison County. Other communities such as Alder, Big Sky, and Harrison are not incorporated nor do they have governing bodies and are under the jurisdiction of Madison County.

Each jurisdiction participated in a variety of ways depending on the resources available in the community. Madison County applied for, received, and managed the funding for the plan update. Representatives from several county offices were active in all aspects of the plan's update. The towns participated in the plan's update by sending representatives to public meetings, discussing elements of the plan at the public meetings and with the contractor, providing information and comments to the contractor when requested, hosting public meetings, and reviewing the draft plan. All of the jurisdictions adopted the plan through resolution upon completion.

2.2.4 PUBLIC PARTICIPATION

LEPC meetings were held on November 19, 2015, and January 28, 2016. The completed draft was posted from July 30 through September 15, 2009. Each jurisdiction also had a hard copy available. Comments could be made via the mail, phone, or email. Any comments received were reviewed and integrated where applicable. Comments were readily accepted throughout the planning process.

Since county commission and town council meetings are also open, public meetings, the discussions and subsequent adoption of the plan by the governing bodies were additional opportunities for public comment. The jurisdictions advertised these meetings using their usual public notification procedures, typically by posting meeting agendas and newspaper notices.

2.2.5 INCORPORATION OF EXISTING INFORMATION

Information from existing plans, studies, reports, and technical information related to hazards, mitigation, and community planning was gathered by RESPEC by contacting individuals throughout the planning process and reviewing the 2004 and 2009 plans Many national and state plans, reports, and studies provided background information. Mapping for and updating of the plan was done by RESPEC based on information collected from a wide variety of sources, including the 2004 and 2009 plans and subject matter experts. The information was organized into a clear, usable, and maintainable format for the county that also ensured the federal regulations regarding hazard mitigation plans were met.

The Madison County PDM plan is a living, expandable document that will have new information added and changes made as needed. The plan's purpose is to improve disaster resistance through projects and programs, and therefore, opportunities for changes and public involvement will exist as disasters occur and mitigation continues. Details on the plan's maintenance and continued public involvement are further outlined in Chapter 6.0.

Table 2-1. Existing Local Plans and Documents Incorporated

Plan/Report/Study Name	Plan/Document Date
Clark Canyon Dam and Reservoir Emergency Action Plan	September 2016
Hebgen Development Emergency Action Plan	2016
Madison County Code of the West	2005
Madison County Comprehensive Plan	1999
Madison County Emergency Operation Plan	Living Document
Madison County Growth Policy	May 2013
Madison County Housing Needs Assessment and Five Year Housing Plan	2006
Madison County Community Wildfire Protection Plan	August 2013
Madison County Subdivision Regulations	June 1 2015
Madison Development Emergency Action Plan	December 15, 2014
Madison Valley Ranchlands Group's Growth Management Action Plan for the Madison Valley	Spring 2007
Montana Department of Natural Resources and Conservation Emergency Operations Plan	March 2008
Ruby Dam Emergency Action Plan	2016
Willow Creek Dam Emergency Action Plan	February 2015

2.3 RISK ASSESSMENT METHODOLOGIES

A key step in preventing disaster losses in Madison County and the incorporated jurisdictions is developing a comprehensive understanding of the hazards that pose risks to the communities. The following terms [Federal Emergency Management Agency, 2001] can be found throughout this plan:

Hazard: a source of danger
Risk: possibility of loss or injury
Vulnerability: open to attack or damage

This all-hazard risk assessment and mitigation strategy serves as an initial source of hazard information for those in Madison County. Other plans may be referenced and remain vital hazard documents, but each hazard has its own profile in this plan. As more data becomes available and disasters occur, the

individual hazard profiles and mitigation strategies can be expanded or new hazards added. This risk assessment identifies and describes the hazards that threaten the communities and determines the values at risk from those hazards. The risk assessment is the cornerstone of the mitigation strategy and provides the basis for many of the mitigation goals, objectives, and potential projects.

The *assets and community inventory* section includes elements such as critical facilities, critical infrastructure, population, structures, economic values, ecologic values, historic values, social values, current land uses, new development, and future development potential. The list of critical facilities and infrastructure were carried over from the 2004 plan version. Additional elements were included during the plan update based on contractor research.

Each hazard or group of related hazards has its own *hazard profile*. A stand-alone hazard profile allows for the comprehensive analysis of each hazard from many different aspects. Each hazard profile contains a *description* of the hazard containing information from specific hazard experts and a record of the hazard *history* compiled from a wide variety of databases and sources.

Using the local historical occurrence, or more specific documentation if available, a *probability* was determined. In most cases, the number of years recorded was divided by the number of occurrences, resulting in a simple past-determined recurrence interval. If the hazard lacked a definitive historical record, the probability was assessed qualitatively based on regional history or other contributing factors. The *magnitude* or extent of the hazard describes a realistic approximation of the worst case scenario. This qualitative approximation is based on past occurrences in the county or in nearby counties. If the past occurrence was not an accurate representation, general knowledge of the hazard was used to approximate the types of impacts that could be expected from a low-frequency, high magnitude event of that hazard.

Mapping of the hazards, where spatial differences exist, allows for hazard analyses by geographic location. Some hazards, such as riverine flooding, can have varying levels of risk based on location (i.e. near the river versus far away from the river). Other hazards, such as winter storms or drought, cover larger geographic areas and the delineation of hazard areas is not typically available or useful on the county scale.

C*ritical facilities* were mapped using data provided by Madison and Gallatin Counties. The mapping of the facilities allowed for the comparison of building locations to the hazard areas where such hazards are spatially recognized. Base maps depicting the critical facility locations were compared to available hazard layers to show the proximity of the facilities to the hazard areas. Given the nature of critical facilities, the functional losses and costs for alternate arrangements typically extend beyond the structural and contents losses. These types of losses can be inferred based on the use and function of the facility.

Critical infrastructure for services such as electricity, heating fuels, telephone, water, sewer, and transportation systems was assessed in a narrative format using history and a general understanding of such systems to determine what infrastructure losses may occur. Basic mapping exists of the road networks in the county. These layers were additionally compared to the hazard areas. Most of the

other types of infrastructure do not have digital mapping or were withheld by the managing company for security reasons.

Structures were mapped and analyzed in a way similar to that of the critical facilities. Data showing the locations of most structures countywide was provided by Madison and Gallatin Counties. This GIS mapping allowed for the comparison of building locations to the mapped hazard areas. Using this technique, an approximate number of structures in the various hazard areas can be determined. The value of structures in the hazard areas was determined using Montana Department of Revenue Computer Assisted Mass Appraisal System (CAMA) data that contains the taxable building value of each parcel in the county. The structure points provided by the counties were matched with the closest taxable building values. For some hazards, the total dollar exposure was multiplied by a damage factor since many hazard events will not result in a complete loss of all structures. These estimates are general in nature, and therefore, should only be used for planning purposes. The approximations, however, are based on current hazard and exposure data. HAZUS-3.1, a loss estimation software program developed by the Federal Emergency Management Agency (FEMA), approximated losses from earthquakes and floods to structures. Where GIS mapping was unavailable or not useful, estimations and plausible scenarios were used to quantify potential structure losses.

Population impacts were qualitatively assessed based on the number of structures estimated to be in the hazard area. Given 6,931 housing units based on 2011-2015 American Community survey and the population of 7,691 based on the 2010 Censuc, an estimate of 1.1 people per structure was derived. Depending on the time of year, population concentrations are likely much greater due to non-resident populations. Other factors used in evaluating the population impacts include the ability of people to escape from the incident without casualty and the degree of warning that could be expected for the event. In general, the loss of life and possible injuries are difficult to determine and depend on the time of day, day of the week, time of year, extent of the damage, and other hazard specific conditions.

Qualitative methodologies, such as comparisons to previous disasters, occurrences in nearby communities, and plausible scenarios, helped determine the potential losses to *economic, ecologic, historic, and social values*. In many cases, a dollar figure cannot be placed on values, particularly those that cannot be replaced. Therefore, these types of losses were quantified through narrative descriptions and provide some background on what may occur during a disaster.

The assessment on the impact to *future development* is based on the mechanisms currently in place to limit or regulate development in hazardous areas. Some hazards can be mitigated during development, others cannot. The impacts were assessed through a narrative on how future development could be impacted by the hazard based on current regulations.

Many unknown variables limit the ability to quantitatively assess all aspects of a hazard with high accuracy. Therefore, *data limitations* provide a framework for identifying the missing or variable information. These limitations were determined by hazard through the risk assessment process. In some cases, the limitations may be resolved through research or data collection. If a limitation can be reasonably resolved through a mitigation project, the resolution is included as a potential action in the mitigation strategy. O*ther factors* were determined based on an evaluation of past events and a general understanding of the hazard characteristics. This basic listing of secondary hazards provides a

link between the hazard profiles and identifies additional hazards that may compound the impacts of the primary event (i.e. poor air quality because of smoke during a wildland fire).

At the end of the risk assessment, the *summary* brings together data from each of the hazards to show comparisons and ultimately rank the hazards by jurisdiction. The overall hazard rating is determined using qualitative rankings of the probability of future occurrences and likely impacts when compared to other hazards.

Because of the inherent errors possible in any disaster risk assessment, the results of the risk assessment should only be used for planning purposes and in developing projects to mitigate potential losses.

2.4 HAZARD IDENTIFICATION

Hazards are continuously being identified and modified to reflect the needs of the communities. In 2004, thirteen hazards were initially identified, and the top five hazards (earthquakes, hazardous materials, communication issues, wildfire, bio-terrorism/epidemic/health) as selected by meeting attendees, were chosen for the risk assessment. During additional research, the flooding hazard was added.

In 2016, all hazards were included and others were identified. New hazards identified social terrorism in the form of an active shooter

Table 2-2 shows the hazards, jurisdictions, and how and why they were identified. The level of detail for each hazard correlates to the relative risk of each hazard and is limited by the amount of data available. As new hazards are identified, they can be added to the hazard list, profiled, and mitigated.

Table 2-2. Madison County Hazards for All Jurisdictions (Page 1 of 2)

Hazard Profile	How Identified	Why Identified
Communicable Disease (including human, animal, and plant diseases)	/ Centers for Disease Control and Prevention / Montana Department of Livestock / Pandemic studies / US Department of Agriculture / World Health Organization	/ Global disease threat / History of pandemics / Dependence on agricultural economy
Drought	/ National Drought Mitigation Center / National Climatic Data Center / National Weather Service / US Department of Agriculture	/ History of droughts / Importance of agriculture to the local economy / Numerous USDA disaster declarations
Earthquake	/ US Geological Survey / Montana Bureau of Mines and Geology / HAZUS-MH / National Earthquake Hazards Reduction Program	/ History of strong earthquakes, including damages / Faults located throughout the county
Flood (including riverine, flash, ice jam, and urban floods and dam failure)	/ National Climatic Data Center, HAZUS-MH, National Weather Service, US Army Corps of Engineers, FEMA, US Geological Survey	/ History of riverine, ice jam, and flash floods, Several dams throughout the county and in neighboring counties, including several high hazard dams
Hazardous Material Release	/ US Department of Transportation Emergency Response Guidebook, National Response Center, Environmental Protection Agency	/ Regular truck traffic transport goods through the county
Landslide and Avalanche (Madison County Virginia City)	/ US Geological Survey, Montana Disaster and Emergency Services	/ Potential for landslides due to varied terrain, History of fatal avalanches
Severe Thunderstorm and Strong Wind (including tornadoes, hail, downbursts, lightning, and strong winds)	/ National Climatic Data Center, Storm Prediction Center, National Weather Service	/ History of tornadoes, severe thunderstorms, and strong winds, including damages
Structure Collapse	/ Montana Department of Transportation, Community input	/ Potential for structure collapses, especially with older buildings and bridges
Terrorism and Civil Unrest	/ Federal Bureau of Investigation, Memorial for the Prevention of Terrorism, Southern Poverty Law Center	/ National indications and foreign threats of future terrorist attacks, Potential for school violence and other domestic attacks
Transportation Accident (including aircraft, railroad, and motor vehicle accidents)	/ National Transportation Safety Board, Montana Highway Patrol, Federal Railroad Administration	/ History of small transportation accidents, Potential for larger transportation accidents causing mass casualties
Volcano	/ US Geological Survey, Cascades Volcano Observatory	/ History of volcanic ashfall, Proximity to active geologic areas

Table 2-2. Madison County Hazards for All Jurisdictions (Page 2 of 2)

Hazard Profile	How Identified	Why Identified
Wildfire	/ Madison County Strategic Wildland Fire Plan, Montana Department of Natural Resources and Conservation, US Forest Service, Farm Service Agency	/ Local history of wildfires, Government lands and Conservation Reserve Program lands within the county, Numerous areas of wildland urban interface
Winter Weather (including blizzards, heavy snow, ice storms, and extreme cold)	/ National Climatic Data Center, National Weather Service	/ History of severe winter storms

3.0 ASSETS AND COMMUNITY INVENTORY

In addition to identifying and understanding the hazards of the area, an important aspect of mitigation planning is contemplating the effects that such hazards may have on the communities. To thoroughly consider the effects, the assets and values at risk must be identified. Examples of community assets include the population, critical facilities, businesses, residences, critical infrastructure, natural resources, historic places, and the economy. The following sections identify the specific assets and community inventory.

3.1 CRITICAL FACILITIES AND INFRASTRUCTURE

Critical facilities and infrastructure protect the safety of the population, the continuity of government, or the values of the community. In many cases, critical facilities fulfill important public safety, emergency response, and/or disaster recovery functions. In other cases, the critical facility may protect a vulnerable population, such as a school or elder care facility. Examples of critical facilities include: 911 emergency call centers, emergency operations centers, police and fire stations, public works facilities, sewer and water facilities, hospitals, jails, schools, essential businesses, shelters, and public services buildings.

Utilities such as electricity, heating fuel, telephone, water, and sewer rely on established infrastructure to provide services. The providers of these services use a variety of systems to ensure consistent service in the county. Each of these services is important to daily life in Beaverhead County and, in some cases, is critical to protecting life and property. The transportation network is another example of important infrastructure and relies on bridges and road/rail segments.

Critical facilities and infrastructure were initially identified throughout the planning process for the 2004 and 2009 plans and then reviewed and updated in 2016.

3.1.1 CRITICAL FACILITIES

Table 3-1. Local Government and Emergency Facilities (Page 1 of x)

Table 3-2.. State and Federal Government Facilities(Page 1 of x)

Table 3-3. Vulnerable Populations (Page 1 of X)

Inerable Populations (continued) WHERE ARE THESE TABLES??

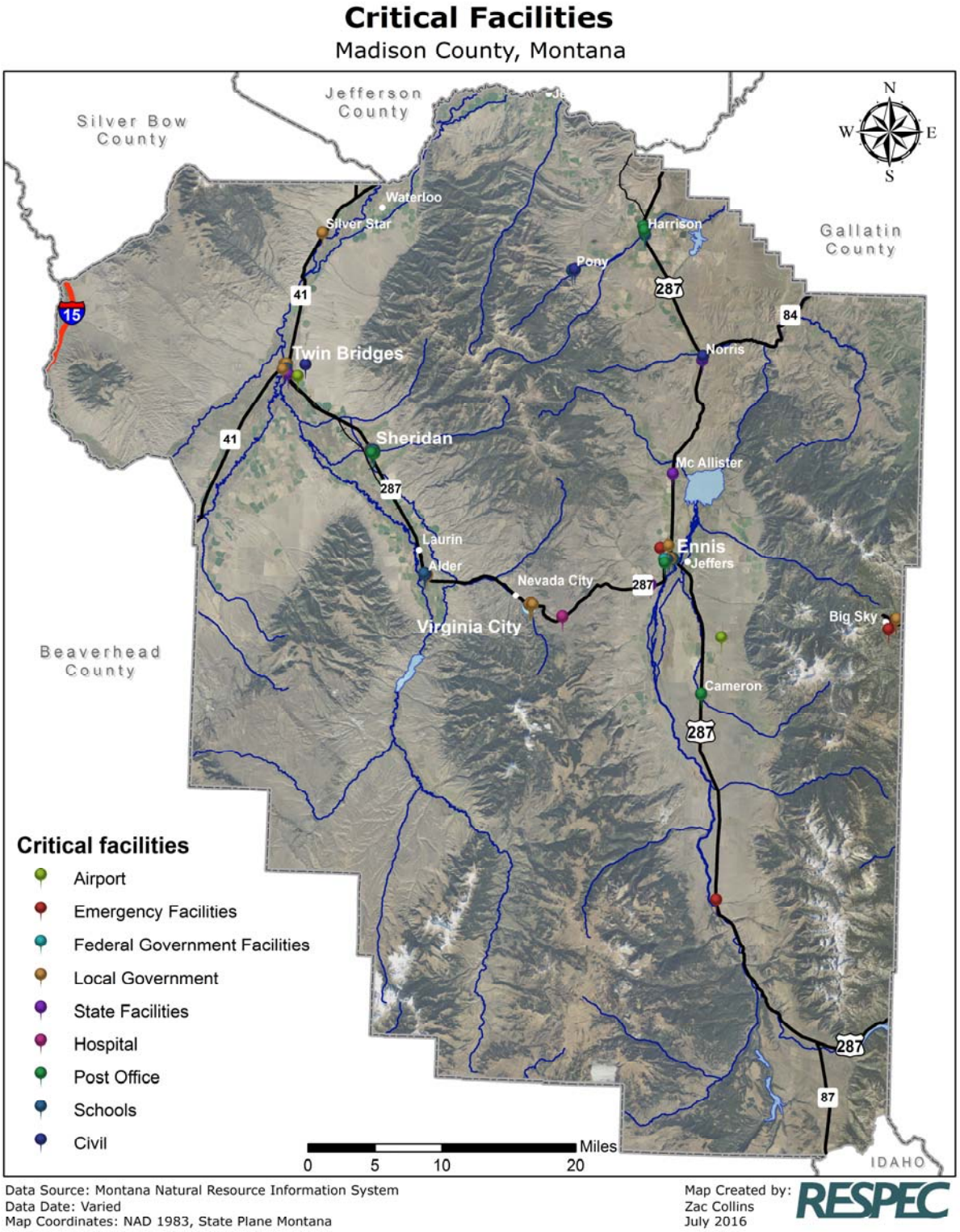


Figure 3-1. Need Captions on Figures.

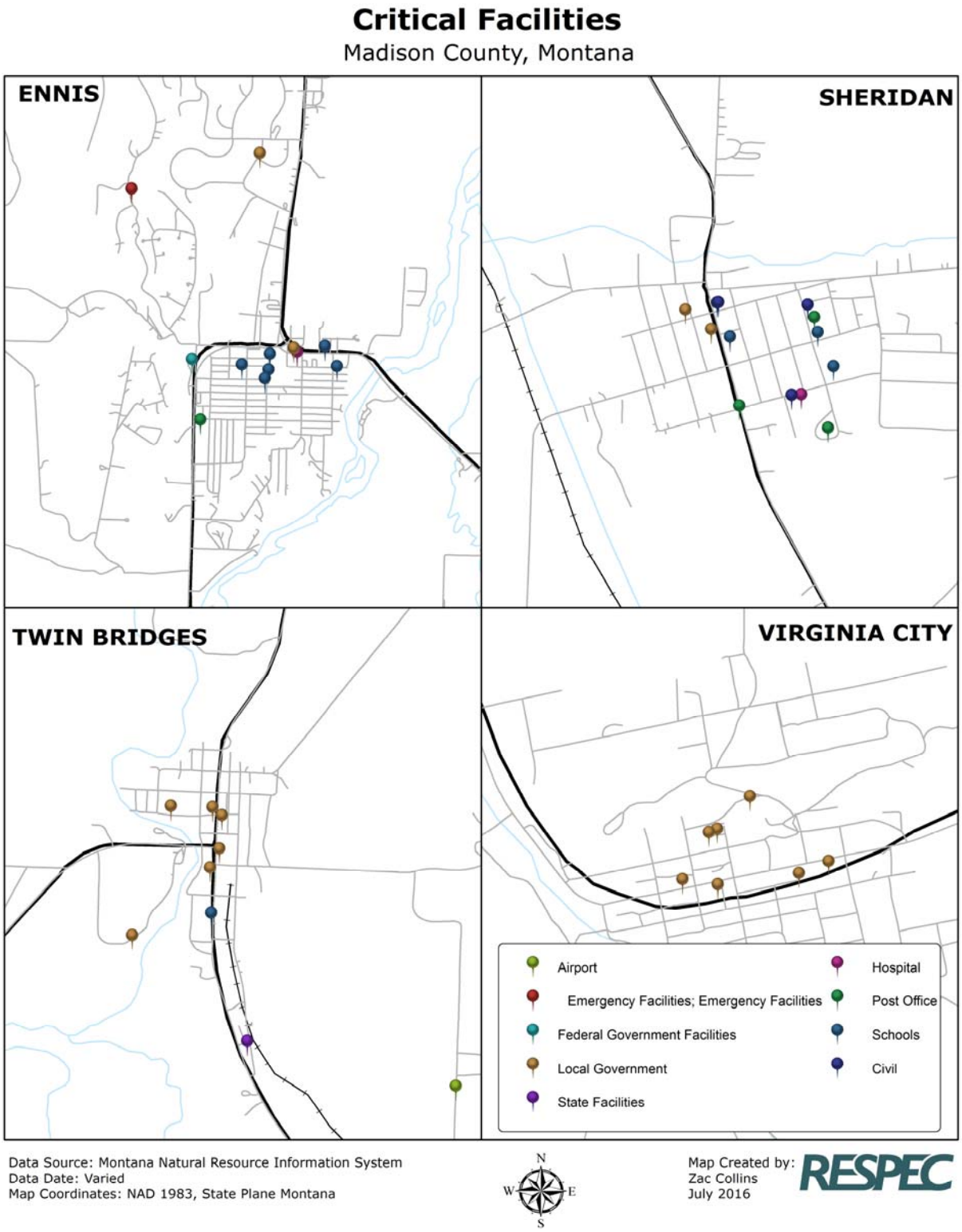


Figure 3-2. Need Captions on Figures.

3.1.2 CRITICAL INFRASTRUCTURE

Need an Introductory statement.

3.1.2.1 ELECTRICITY

Electricity runs lights, computers, medical equipment, water pumps, heating system fans, refrigerators, freezers, televisions, and many other types of equipment. Electric providers in Madison County include Vigilante Electric Cooperative, headquartered in Dillon, Montana, and NorthWestern Energy, headquartered in Sioux Falls, South Dakota. Much of the electric service is run through overhead lines. These lines are supported by poles and have key components such as transformers and substations.

3.1.2.2 HEATING FUEL

During the cold winter months, the heating of homes and businesses is a necessity. The primary heating fuel used in Madison County is propane. Overall, a variety of fuels are used as shown in Table 3-4. Most systems ultimately require electricity to run their thermostats and blowers.

Table 3-4. US Census Housing Data on House Heating Fuel [Montana Census and Economic Information Center, 2015]

	Madison County (TOTAL)	Town of Ennis	Town of Sheridan	Town of Twin Bridges	Town of Virginia City
Utility Gas	388	8	180	82	0
Bottled, Tank, or LP Gas	1,306	217	4	2	59
Electricity	670	95	51	19	9
Fuel Oil, Kerosene	46	5	0	0	1
Coal or Coke	1	0	0	0	0
Wood	867	28	51	27	24
Solar Energy	10	0	0	0	0
Other Fuel	62	8	0	1	2
No Fuel Used	19	0	0	0	0

Natural gas in portions of Madison County is provided by NorthWestern Energy through underground pipeline infrastructure. Buildings heated with propane and fuel oil typically have a nearby tank that is refilled regularly by a local vendor. The vendor uses a truck to transport the propane/oil to the users. Therefore, the vendors rely on accessibility to the communities and rural residents via the road network. Should any areas become isolated due to poor road conditions, the vendor may not be able to access the tanks to refill them.

3.1.2.3 TELEPHONE

Local telephone services in the county are provided by 3RiversTelephone. Similar to electric infrastructure, telephone can be run through overhead or underground lines. Much of the telephone infrastructure in Madison County lies within the road right-of-ways.

3.1.2.4 WATER AND SEWER

Municipal water and sewer systems exist within the incorporated communities and in some unincorporated communities in the county, such as Big Sky. The water systems typically consist of groundwater wells or pumps from a body of water. The sewer systems generally have treatment plants

and/or lagoons. Both water and sewer use underground pipes to service customers. County residents outside of the water and sewer districts rely on individual well and septic systems.

3.1.2.5 TRANSPORTATION

The transportation infrastructure within Madison County includes the road, rail, and air networks. The primary road transportation routes in Madison County are a small section of Interstate 15, US Highway 287, and Montana Highways 41, 84, 87, and 287. Madison County has an estimated 1,250 miles of county road. Roadway reconstruction costs depend on the length of the road to be reconstructed and whether the existing road has an asphalt driving surface. In general, 200 linear feet of roadway reconstruction is assumed for each bridge replaced to account for transitions into and out of the bridge.

Montana Rail Link operates two railroad branch lines through the county, both connecting to a line north of Madison County, one to Twin Bridges and the other to Harrison. The railroad transports goods and raw materials along this line.

Madison County has two small airports serving private, charter, and/or government aircraft, Ennis -Big Sky Airport (EKS),), and Twin Bridges Airport (7S1). The closest commercial service airports are in Bozeman and Butte.

3.2 POPULATION AND STRUCTURES

The citizens, visitors, and their property are at all risk from various disasters. In essentially all incidents, the top priority is the protection of life and property.

Table 3-5. Population Statistics [Montana Census and Economic Information Center, 2016]

Location	July 1, 2010 Estimated Population	Change Since 2000 Census
Madison County (TOTAL)	7,924	+498
Town of Ennis	884	–129
Town of Sheridan	677	–22
Town of Twin Bridges	394	–30
Town of Virginia City	199	+58

Like critical and special needs facilities, structures such as residences and businesses are also vulnerable to hazards. Tables 3-6 and 3-7 detail some of the housing statistics.

The total value of residential structures in Madison County can be estimated as shown in Table 3-7. Census values were estimated by multiplying the number of housing units (6,931 units) by the median unit value ($237,800). Data from the Montana Department of Revenue Computer Assisted Mass Appraisal System (CAMA) can be also used to show the estimated building value. This database lists for each parcel of land the associated taxable land and building market values. The CAMA data for Madison County has 5,704 parcels listed with a building value greater than zero. Table 3-7 contains the sum of the building values listed in the CAMA data. In comparison, the FEMA's HAZUS-MH loss estimation software gives the building stock in Madison County a replacement value of $537 million for

4,024 buildings. Figure 3-3 shows the locations of structures with values based on the closest CAMA parcel with a building value greater than $0.

Table 3-6. Housing and Business Census Data [Montana Census and Economic Information Center, 2016]

	Madison County (Total)	Town of Ennis	Town of Sheridan	Town of Twin Bridges	Town of Virginia City
Number of Housing Units	6,931	503	379	162	165
Median Value of Specified Owner-Occupied Housing Units	$237,800	$192,500	$171,400	$117,400	$174,000
Number of Mobile Homes	531	93	56	50	6
Lacking Complete Plumbing Facilities	48	8	0	0	0
Lacking Complete Kitchen Facilities	44	8	0	1	0
No Telephone Service	33	0	2	2	1

Table 3-7. Structure Ages Based on US Census Data [Montana Census and Economic Information Center, 2016]

	Madison County (Total)	%	Town of Ennis	%	Town of Sheridan	%	Town of Twin Bridges	%	Town of Virginia City	%
Total housing units	6,931		503		379		162		165	
Built 2014 or later	1	0.00	0	0.00	0	0.00	0	0.00	1	0.60
Built 2010 to 2013	31	0.40	0	0.00	0	0.00	0	0.00	0	0.00
Built 2000 to 2009	2,200	31.70	103	20.50	30	7.90	9	5.60	14	8.50
Built 1990 to 1999	1,357	19.60	80	15.90	59	15.60	9	5.60	24	14.50
Built 1980 to 1989	823	11.90	95	18.90	56	14.80	39	24.10	12	7.30
Built 1970 to 1979	940	13.60	92	18.30	9	2.40	28	17.30	12	7.30
Built 1960 to 1969	213	3.10	21	4.20	34	9.00	10	6.20	6	3.60
Built 1950 to 1959	244	3.50	33	6.60	3	0.80	3	1.90	5	3.00
Built 1940 to 1949	149	2.10	14	2.80	45	11.90	10	6.20	1	0.60
Built 1939 or Earlier	973	14.00	65	12.90	143	37.70	54	33.30	90	54.50

Table 3-8. Estimated Value of Residential Structures [Montana Census and Economic Information Center, 2016; Montana Department of Revenue, 2017]

Jurisdiction	Census Estimated Value ($)	CAMA Estimated Building Value ($)	HAZUS-MH Residential Building Replacement Value ($)
Madison County, total	$1,648,191,800	$2,172,883,510	$1,310,318,000
Town of Ennis	$96,827,500	$218,294,096	not applicable
Town of Sheridan	$64,960,600	$105,520,773	not applicable
Town of Twin Bridges	$19,018,800	$60,399,224	not applicable
Town of Virginia City	$28,710,000	$19,313,815	not applicable

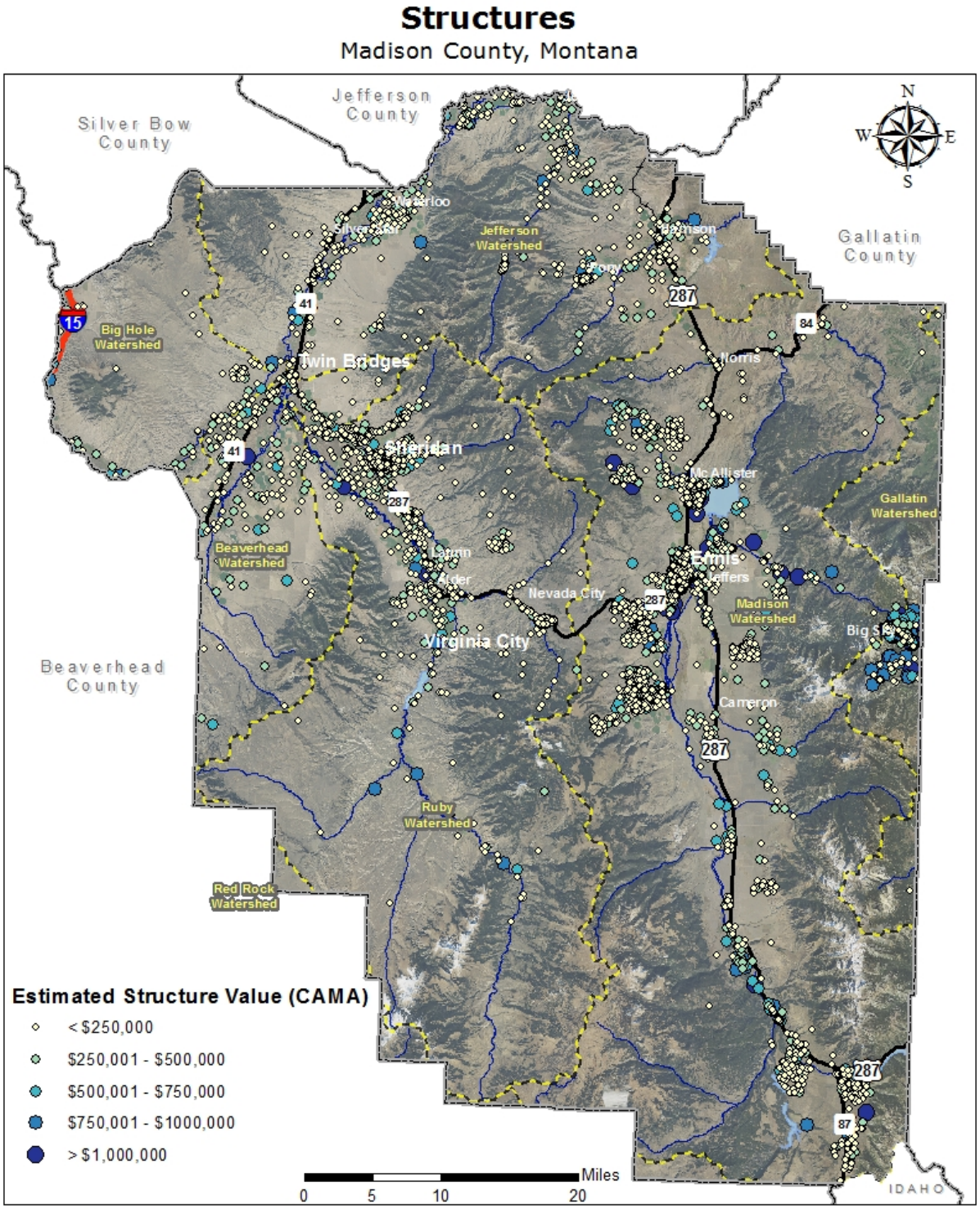


Figure 3-3. Need Captions.

3.3 ECONOMIC, ECOLOGIC, HISTORIC, AND SOCIAL VALUES

Madison County is a rural county with an abundance of natural resources and scenic beauty. Surrounded by mountain ranges, and within close proximity of Yellowstone National Park, the county's economy depends on tourism and recreation, as well as agriculture and mining. As of 2012, the county's largest non-government employer was the A.M. Wells, Inc, (Madison County Growth Plan, 2012) this should be updated

Disasters of any magnitude can threaten the fragile economies and well-being of residents. The following list some of the basic economic statistics [US Census Bureau, 2009]:

- Median household income (2015): $46,250
- Persons below poverty (2015): 6.4%
- Total number of companies/firms (2015): 1,438

The ten top private employers (excluding railroad and government) in the county include the following [Madison County Growth Policy, 2012

- A.M. Welles, Inc. 500-999 Employees
- Big Sky Resort 250- Employees
- CP of Bozeman 5 -
- First Madison Valley Bank
- Madison Foods 50- 99 Employees
- Madison Valley Hospital 50-99 Employees
- Moonlight Basin Ranch 50-99 Employees
- R L Winston 50-99 Employees
- Ruby Valley Hospital 20-49 Employees
- Yellowstone Club 250-499 Employees
- Yellowstone Mine - 20-49 Employees
- YMC Public Safety & Privacy Inc. 20-49 Employees

Based on data from the US Census of Agriculture in 2012, Madison County had:

- Number of farms: 571 farms
- Acres in farmland: 1,085,291 acres
- Total market value of agricultural products sold: $81,254,000
  - Market value of livestock, poultry, and their products sold: $53,980,000 (66%)
  - Market value of crop sales, and their products sold: $27,275,000 (34%)
- Number of cattle and calves: 74,683
- Number of sheep and lambs: 3,557

Primary crops (based on number of farms): Forage-land used for all hay and haylage, grass silage, and greenchop, Wheat for grain, all, Spring wheat for grain, Barley for grain, Winter wheat for grain heat for grain [US Department of Agriculture, 2012)

The ecologic, historic, and social values of Madison County each tie in to the quality of life for residents and visitors. Without these values, lives and property may not be threatened, but the way of life and connections to history and the environment could be disrupted. These values can have deep emotional meaning and investment.

Historic values capture a piece of history and maintain a point in time. Historic values can include sites, buildings, documents, and other pieces that preserve times past and have value to people. Madison County has 17 resources listed in the National Register of Historic Places. (National Park Service, 2016 Motana Territory, and is considered a National Historic Landmark. The county also has several ghost towns.

Social values often cannot be quantified but are an important aspect of quality of life and interpersonal relationships. Examples of social values in Madison County may include gatherings to promote community building, personal achievement, freedom from tyranny, the ability to communicate with others, pride in making the world a better place, and friendships. The realm of social values is only limited by the human imagination and usually relates to how a person feels. Disasters, both natural and human-caused, can disrupt important social activities and sometimes have lasting effects on society.

3.4 CURRENT LAND USE

Madison County has varied land use but is primarily rural with most of the land use devoted to agriculture, undeveloped areas, and government ownership. Small communities and individual homes and farms are interspersed. Growth is occurring throughout the county. Conservation easements have been widely used in Madison County, especially the Madison Valley, as a tool for voluntary land conservation and preservation of natural resources, productive agricultural lands, and wildlife habitat. Figure 3-4 shows the federal, state, and local government ownership in the county.

3.5 NEW DEVELOPMENT

Madison County experienced a 11% population increase between 2000 and 2010. From 2010 to 2016, the population of the county was estimated to have increased by 3 percent. Ennis had population increase of 3.4 percent from 2010 to 2016 [Montana Census and Economic Information Center, 2016] It is estimated that 15 percent of the private land with in Madison County has been subdivided with nearly 63 percent of parcels considered available for development [Madison County Growth Policy, 2013]. Many new residences have been built in numerous subdivisions, the majority located in the Madison Valley around Ennis, the Ruby Valley around Sheridan and Twin Bridges, in the Big Sky area, and in northern Madison County near Whitehall. The five guiding principles for new growth for Madison County according to the Madison County Growth Policy [2012] are:

- **Guiding Principle #1.** Locate new development close to existing services and communities. Requires attention to both locational considerations and service system capabilities.
- **Guiding Principle #2.** Protect our river corridors Requires attention to environmental, public health and safety, recreation, and aesthetic concerns.
- **Guiding Principle #3.** Preserve our most productive agricultural lands Requires attention to economic, environmental, and cultural issues.

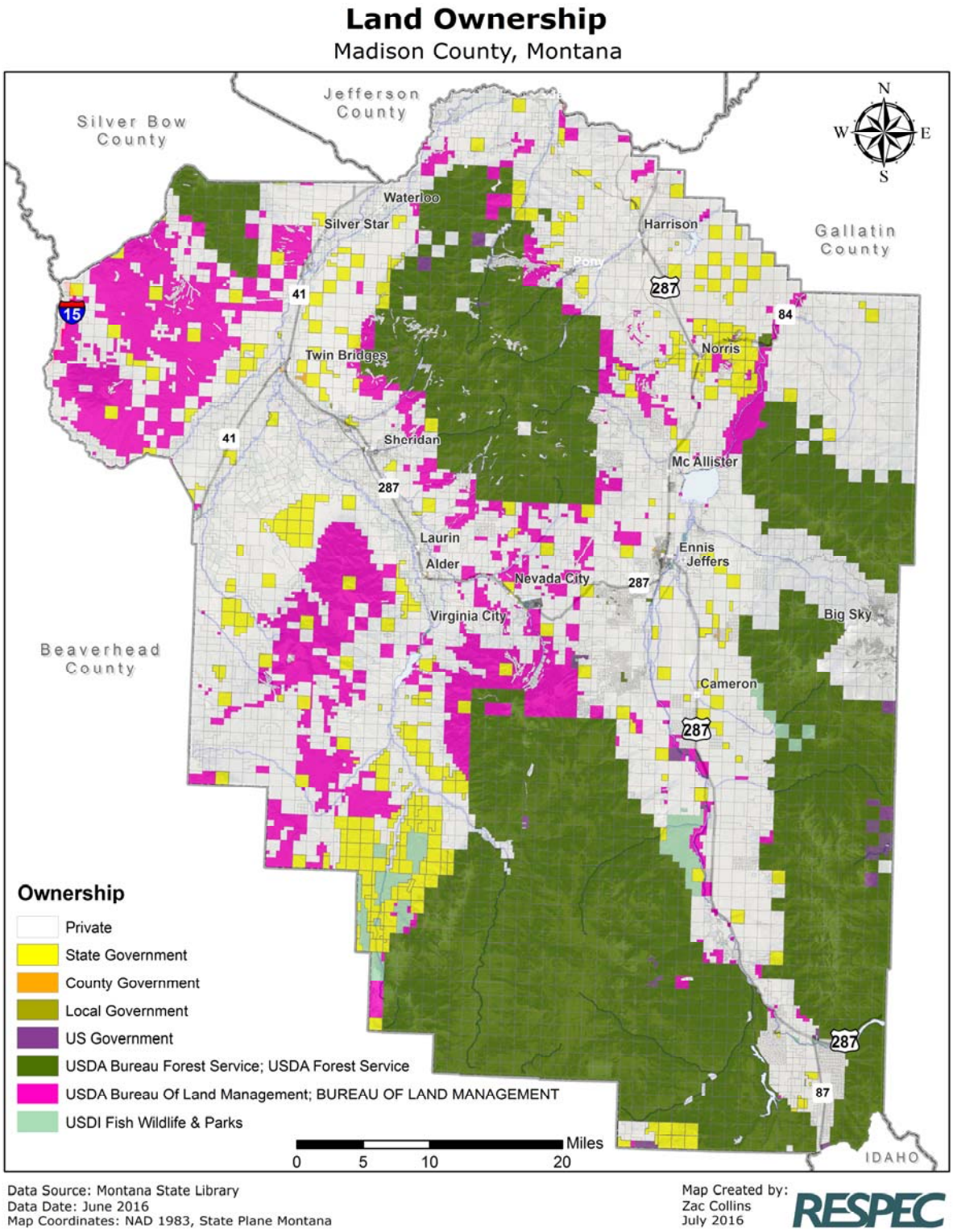


Figure 3-4. Need Caption.

- **Guiding Principle #4.** New development should pay its own way. Requires attention to fiscal and equity issues of concern to many County taxpayers and officials.
- **Guiding Principle #5.** Respect private property rights. A reminder that Madison County officials will be cognizant of, and abide by, state and federal constitutional law as it pertains to private property rights. Consideration of this principle, however, will be balanced by consideration of the public interest, generally defined as the public health, safety, and welfare.

Table 3-9. Recent Land Division Activity (Tracts Less Than 160 Acres) [Madison County Grownt Policy, 2012]

Time Period	No. of Preliminary Plats and Family Transfers Approved	Lots, Condo Units, and RV Spaces Created	Acres Divided
FY 2004-2005			
By Subdivision	6	241	1,035
By Family Transfer	18	18	-
FY 2005-2006			
By Subdivision	11	217	1,427
By Family Transfer	28	28	-
FY 2006-2007			
By Subdivision	20	207	1,205
By Family Transfer	28	28	-
FY 2007-2008			
By Subdivision	9	591	4,516
By Family Transfer	24	24	-
FY 2008 - 2009			
By Subdivision	6	116	1,120
By Family Transfer	8	21	298
FY 2009-2010			
By Subdivision	7	71	357
By Family Transfer	6	21	387
FY 2010-2011			
By Subdivision	3	8	87
By Family Transfer	5	13	158
FY 2011-2012			
By Subdivision	3	38	77
By Family Transfer	9	19	527

Table 3-10. Madison County Conservation Easements [Montana Natural Heritage Program, 2016]

Easement Holder	Acres
Montana Land Reliance	129,242
The Nature Conservancy	88,653
US Forest Service	11,166
Montana Fish, Wildlife and Parks	9,745
Rocky Mountain Elk Foundation	8,883
Ducks Unlimited	4,179
Gallatin Valley Land Trust	2,439
US Fish and Wildlife Service	2,322
The Bighorn Institute 1,443	1,443
US Department of Agriculture 875	875
County Total	258,947

3.6 FUTURE DEVELOPMENT

Existing land uses and the review processes and regulations for new development play important roles in disaster mitigation. Often, smart development is an inexpensive and effective way to reduce the impact of future disasters on the community. The following mechanisms are used by the jurisdictions to guide future development.

3.6.1 GROWTH POLICIES

Madison County and the incorporated jurisdictions have growth policies, as required by state law. These policies do not provide regulatory authority but rather outline the future of growth in the jurisdictions. Regulatory authorities such as subdivision regulations and zoning are then guided by the growth policies. These growth policies are essentially the new version of comprehensive plans.

The Madison County Growth Policy, derived from the Comprehensive Plan, has the purpose of guiding elected officials in land use, economic development, and capital investment decisions. The plan is organized around five guiding principles, including one to protect the river corridors. Objectives include developing landowner-supported, neighborhood-specific strategies for land utilization, keep development out of the floodplain and riparian areas, and locate and design developments to be safe from natural disasters. Policies listed in the plan include requirements for water supplies, adequate roadways, reducing wildfire risk, and protecting riparian areas. Strategies listed in the plan include subdivision regulation updates, landowner initiated zoning, and floodplain mapping [Madison County Growth Policy, 2012].

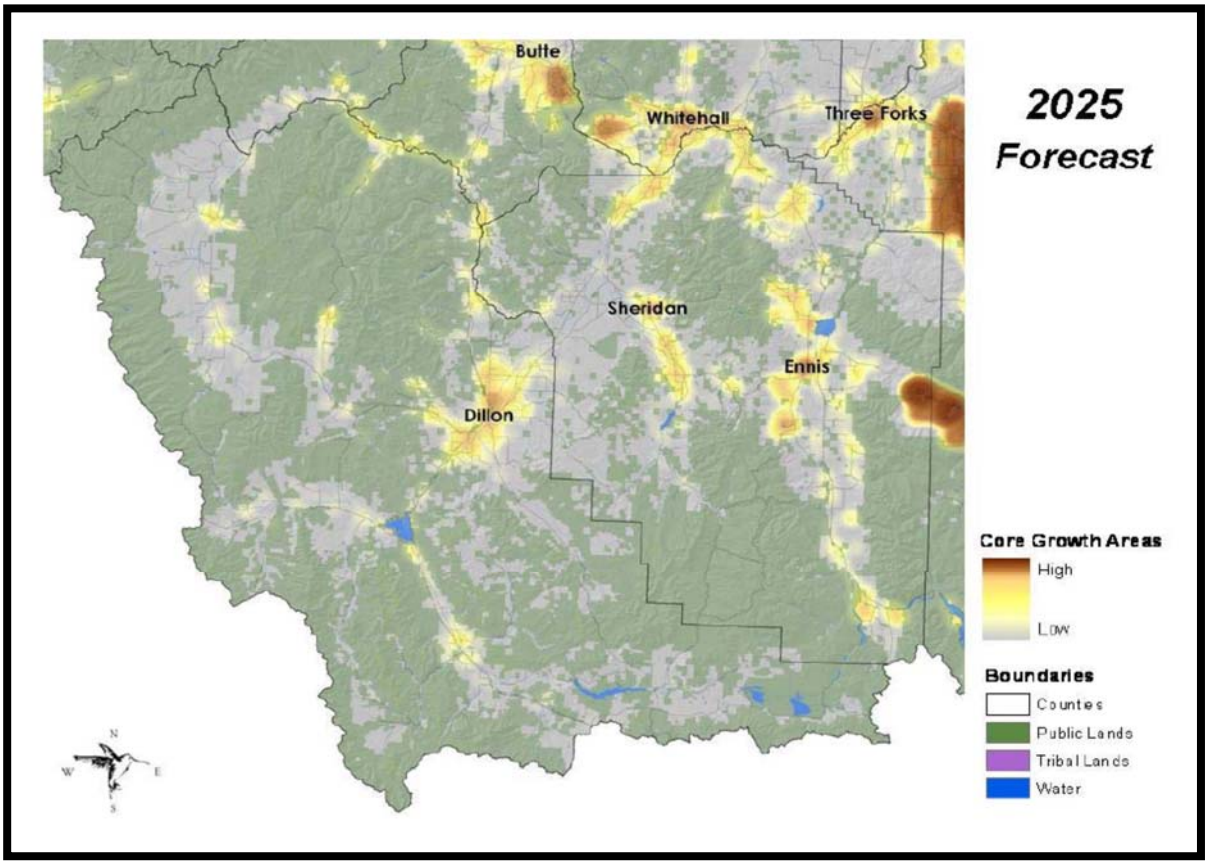


Figure 3-5. Areas of Projected Growth Between 2005–2025.

3.6.2 SUBDIVISION REGULATIONS

The Subdivision Regulations apply to all divisions of land in which one or more parcels are 160 acres or less, with some exemptions. Purposes of the regulations include the following:

- Promote the public health, safety, and general welfare by regulating the subdivision of land
- The avoidance of danger of injury to health, safety, or welfare by reason of natural hazard or the lack of water, drainage, access, transportation, or other public services

Lands considered unsuitable for development include areas of natural and human-caused hazards, floodways, other waterways, and riparian areas. Subdivisions may be required to have covenants to address public health and safety issues such as mowing to reduce wildfires. All subdivisions are urged to follow the design and development standards of the Urban Wildland Interface Code prepared by the International Fire Code Institute. Emergency access roads may be required and have their own set of standards. Emergency services may provide the governing body with recommendations for the subdivision (e.g., fire protection standards, water supplies, ingress/egress, and defensible space). Geological assessments are required for most lands to be subdivided. Minimum setbacks along waterbodies include 500 feet from the ordinary high water mark on the Madison River; 150 feet from the Big Hole, Jefferson, Ruby, Beaverhead, and South Boulder Rivers; and 100 feet from other waterways. The County floodplain ordinance requires new construction to be elevated above the 100-year floodplain. The Town of Ennis has adopted Madison County's Subdivision Regulations.

3.6.2.1 ZONING

The municipalities in Madison County have zoning regulations. These regulations generally guide land use for the towns and include designations for areas such as agricultural, residential, commercial, and floodplains.

4.0 RISK ASSESSMENT/HAZARD PROFILES

4.1 COMMUNICABLE DISEASE

4.1.1 DESCRIPTION

Diseases affect humans, animals, and plants continuously. Each species has its own natural immune system to ward off most diseases. The causes and significance of diseases vary. Of significance in the disaster prevention realm are communicable diseases with the potential for high infection rates in humans or those which might necessitate the destruction of livestock or crops. Such diseases can devastate human populations and the economy.

Disease transmission may occur naturally or intentionally, as in the case of bioterrorism, and infect populations rapidly with little notice. New diseases regularly emerge or mutate. Known diseases, such as influenza, can be particularly severe in any given season. Terrorism experts also theorize the possibility of attacks using biological agents.

4.1.1.1 HUMAN DISEASE

Human epidemics may lead to quarantines, large-scale medical needs, and mass fatalities. Typically, the elderly, young children, and those with suppressed immune systems are at greatest risk from communicable diseases. The following biologic agents are considered the highest bioterrorism threats (Category A) because of their ease of dissemination or person-to-person transmission, high mortality rate with potential for major public health impacts, potential for public panic and social disruption, and the necessity for special public health preparedness [Centers for Disease Control and Prevention, 2016]:

- Anthrax
- Botulism
- Plague
- Tularemia
- Viral Hemorrhagic Fevers

In addition to global disease and bioterrorism concerns, naturally occurring diseases can threaten communities. Natural illnesses of particular concern, among others, include:

- Food-bourne illnesses, such as E. coli and Salmonella
- Influenza
- Meningitis
- Pertussis/Whooping Cough
- Measles
- Norwalk Virus
- Severe Acute Respiratory Syndrome (SARS)

These diseases can infect populations rapidly, particularly through groups of people in close proximity such as schools, assisted living facilities, and workplaces.

Well developed surveillance and epidemiologic capacity is the foundation on which health departments detect, evaluate, and mitigate disease and bioterrorism impacts. Complementing the need for accurate and timely case reports is the need for expertise to analyze the information properly. Epidemiologic expertise is critical to judging whether the incident involves biological or chemical agents or is a consequence of a natural phenomenon, an accident, or terrorism. Extraordinary measures are not necessary to develop a comprehensive terrorism health surveillance and epidemiologic network. Initiating partnerships and developing new or pre-existing data links have always been components of public health systems while using current technology to promote timely disease identification and reporting.

Madison County Public Health Department possesses the legal authority to receive reports and investigate unusual illness clusters. The health care system lacks the capabilities needed to effectively handle large numbers of victims.

4.1.1.2 ANIMAL DISEASE

Madison County is an agricultural and ranching community. Animal diseases, particularly those that infect livestock, can distress the agricultural community. Such diseases could lead to food shortages and negative economic impacts, depending on the animals infected and the geographic extent of the disease. Diseases or conditions requiring state and federal reporting and quarantine include [Montana Department of Livestock, 2015]:

- Acute swine erysipelas
- African horse sickness
- African swine fever
- Avian influenza (High pathogenic (Zoonotic disease) or Low pathogenic)
- Bovine babesiosis
- Bovine spongiform encephalopathy (Zoonotic disease)
- Brucellosis (Brucella abortus, B. melitenses, B. suis, B. canis) (Zoonotic disease)
- Cattle fever tick (Boophilus annulatus, B. microplus)
- Chronic wasting disease
- Classical swine fever (Hog cholera)
- Contagious bovine pleuropneumonia (Mycoplasma mycoides mycoides)
- Contagious equine metritis
- Dourine (Trypanosoma equiperdum)
- Equine encephalomyelitis (EEE, WEE, VEE) (Zoonotic disease)
- Equine infectious anemia
- Equine piroplasmosis
- Exotic Newcastle disease (Zoonotic disease)

- Foot and mouth disease
- Fowl typhoid (Salmonella gallinarum)
- Glanders (Burkholderia mallei) (Zoonotic disease)
- Heartwater (Cowdria ruminantium)
- Japanese encephalitis (Zoonotic disease)
- Lumpy skin disease
- Malignant catarrhal fever
- Mange (Psoroptes ovis, Sarcoptes scabiei [Zoonotic disease] or Chorioptes sp.) (only Psoroptes mange is quarantinable)
- Nairobi sheep disease
- New and Old World Screwworm
- Nipah virus encephalitis (Zoonotic disease)
- Peste des petits ruminants
- Porcine Epidemic Diarrhea PEDv (Zoonotic disease)
- Pseudorabies (Aujeszky's disease)
- Rabbit hemorrhagic disease
- Rift Valley fever*
- Rinderpest
- Scrapie
- Sheep pox and goat pox
- Surra (Trypanosoma evansi)
- Swine influenza (H1N1)
- Swine vesicular disease
- Trypanosomosis (Tse-tse borne)
- Tuberculosis (Mycobacteriumbovis) (Zoonotic disease)
- Vesicular exanthema
- Vesicular stomatitis
- Viral hemorrhagic septicemia

Diseases or conditions requiring state reporting and quarantine include:

- Anthrax*
- Bluetongue
- Contagious agalactia (Mycoplasma spp)
- Contagious caprine
- Pleuropneumonia
- Contagious foot rot

- Crimean Congo hemorrhagic fever
- Equine viral arteritis
- Equine rhinopneumonitis, neurologic form (EHV-1)
- Ovine pediculosis
- Plague* (Yersinia pestis)
- Pullorum disease
- (S. pullorum)
- Q-Fever* (Coxiella burnettii)
- Rabies*
- Theileriosis
- Trichomonosis
- Tularemia*
- West Nile virus*.

4.1.1.3 PLANT DISEASE

Many plant and crop diseases exist. Of most concern are those diseases that spread rapidly and cause widespread economic losses. The specific diseases that could cause plant epidemics depend on the species. Of particular concern in Madison County would be those diseases that affect forage/hay, barley, wheat, oats, or potatoes. Although not categorized as a disease, new pests and weeds introduced could have similar impacts.

4.1.2 HISTORY

Fortunately, Madison County has not experienced any significant disease outbreaks within its population in recent years. Approximately three human influenza pandemics have occurred over the past 100 years, one severely affecting the United States. Following World War I, the Spanish influenza pandemic of 1918 killed 20-40 million people worldwide, including 675,000 Americans [Billings, 1997]. In the State of Montana, the Spanish influenza caused 9.9 deaths per 1,000 people from 1918-1919 [Brainerd, 2002]

4.1.2.1 DOCUMENTED DISEASES IN BEAVERHEAD COUNTY

In addition to global disease and bioterrorism concerns, naturally occurring diseases can threaten communities. Table 4-1 lists the cases in the last 10 years.

4.1.3 PROBABILITY AND MAGNITUDE

Quantifying the probability of a human epidemic affecting Madison County presents challenges due to a limited history of outbreaks. Medical advances over the past 50 years prevent many disease outbreaks, yet the potential still remains. Much of the county is in a rural setting, and therefore, is somewhat isolated from the rapid spread of global diseases. Madison County, however, is a popular tourist destination and has a substantial transient population. Travelers that pass through the county after being exposed to a disease could potentially start an epidemic. Lacking the resources of larger population areas, any exposure to one of these diseases could quickly overwhelm county public health capabilities.

Table 4-1. need Captions

Madison	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	Grand Total
Grand Total by year	11	12	13	25	19	18	21	27	35	29	210
Anaplasma phagocytophilum									1		1
Campylobacteriosis	1	3	1	15	3	4	2	2	8	7	46
Chlamydia	3	3	7	5	4	6	14	9	7	7	65
Coccidioidomycosis										1	1
Cryptosporidiosis					3		1			1	5
Giardiasis		2						2	1	1	6
Gonorrhea	1		1					1	3	2	8
Haemophilus influenzae, invasive						1					1
Hemolytic uremic synd,postdiarrheal								1			1
Hepatitis B virus infection, Chronic									1		1
Hepatitis B, acute									1		1
Hepatitis C Virus Infection, chronic or resolved	2	2	1	5	6	3	1	8	3	5	36
Influenza, hospitalization								2	3	2	7
Legionellosis			1			1					2
Lyme disease		1	1						1		3
Malaria			1								1
Mumps								1			1
Pertussis							1				1
Salmonellosis	2				1	1	1	1	1	1	8
Shiga toxin-producing Escherichia coli (STEC)							1		2	1	4
Shigellosis					1						1
Streptococcus pneumoniae, invasive	1					1				1	3
Tuberculosis					1						1
Varicella Chickenpox	1	1				1			3		6

Note that the lack of data for a disease represents the fact that an occurrence did not exist in the last 10 years. Totals for 2016 are year-to-date as of December 5, 2016. Influenza hospitalizations do not include all of the flu cases, only those hospitalized [montana Department of Public Health and Human Services, 2016].

Table 4-2. Madison County Communicable Disease Declared Disasters and Emergencies

Declaration	Year	Additional Information	Casualties	Damages/Assistance
None				

Animal and plant disease outbreaks are even harder to predict. Most global livestock diseases have been confined to specific countries due to strict import regulations. Any plant disease outbreaks have been relatively easily contained.

The magnitude of a communicable disease outbreak varies from every day disease occurrences to widespread infection. During the 1918 Influenza Pandemic, infection rates approached 28% in the United States. (Billings, 1997) Other pandemics produced infections rates as high as 35% of the total population. (World Health Organization, 2009) Such a pandemic affecting Madison County represents a severe magnitude event. Almost any highly contagious, incapacitating disease that enters the regional population could overwhelm local health resources. Similarly, any rapidly spreading bioterrorism event for which little vaccination or containment capability exists is a high magnitude event.

Overall Communicable Disease Probability: Moderate

4.1.4 MAPPING

The communicable disease hazard is uniform across the county, and therefore, mapping does not enhance this hazard profile.

4.1.5 VULNERABILITIES

4.1.5.1 CRITICAL FACILITIES

In some instances, the accessibility and functionality of critical facilities can be compromised by communicable diseases until the facility is decontaminated or the threat has passed. With the loss of function of facilities supporting emergency response, delays in emergency services could result. Additionally, with a significant human disease outbreak, resources such as ambulance services and the hospitals could quickly become overwhelmed.

Should a building become contaminated by some disease agent, clean up costs and the loss of use of the buildings could result. Such costs could be significant. For example, the cleanup of anthrax in several congressional offices on Capitol Hill in September and October of 2001 cost the Environmental Protection Agency about $27 million. (US General Accounting Office, 2003) For this reason, all critical facilities are assumed to be at some risk from communicable disease.

Diseases can spread quickly in facilities housing vulnerable populations such as schools and elderly housing. Often these facilities, as well as the hospitals and medical clinics, are the first places where diseases are identified and treated.

Possible losses to critical facilities include:

- Critical functional losses
- Clean-up costs

Expected Communicable Disease Impact to Critical Facilities: Low-Moderate

4.1.5.2 CRITICAL INFRASTRUCTURE

In most cases, infrastructure would not be affected by communicable disease. Scenarios that would affect infrastructure include the contamination of the water supplies and diseases that require special provisions in the treatment of wastewater. Should an epidemic necessitate a quarantine or incapacitate a significant portion of the population, support of and physical repairs to infrastructure may be delayed, and services may be disrupted for a time due to limitations in getting affected employees to work.

Possible losses to infrastructure include:

- Functional losses because of a low workforce

Expected Communicable Disease Impact to Critical Infrastructure: Low-Moderate

4.1.5.3 STRUCTURES

The structural integrities of buildings are not generally threatened by communicable disease. Similar to critical facilities, should a structure become contaminated, clean-up costs could be expensive.

Possible losses to structures include:

- Clean-up costs

Expected Communicable Disease Impact to Structures: Low

4.1.5.4 POPULATION

Perhaps the most significant impact from communicable disease is to the population. Disease can spread rapidly through schools, universities, health facilities, and communities. The entire county population of 7,691 plus non-residents is at risk for contracting a communicable disease. The number of infections and fatalities in the communities would depend on the transmission and mortality rates.

Using a general estimate of 35 percent for the infection rate and a mortality rate (once infected) of 20%, as can be the case in an influenza pandemic, approximately 2,691 residents of Madison County would be infected with about 540 fatal infections. This estimate is somewhat extreme, but uses plausible infection and mortality rates.

As with any disease, age and other health conditions can be a contributing factor. The ability to control the spread of disease depends on the virulence of the disease, the time lapse before the onset of symptoms, the movement of the population, and the warning time involved. Vaccinations, anti-virals, quarantines, and other protective measures may also prevent the spread and impact of the disease. Besides human diseases, animal and plant diseases could negatively affect agriculture and limit food supplies.

Expected Communicable Disease Impact to the Population: High

4.1.5.5 ECONOMIC, ECOLOGIC, HISTORIC, AND SOCIAL VALUES

Possible economic losses according to the US Department of Agriculture [2012] include:

- Service industry losses during human quarantines and limited travel
- Business disruption losses due to a lack of workers and customers during human outbreaks

- Direct agricultural losses during animal or plant disease outbreaks
  - Madison County had 571 farms and 1,085,291 acres in farmland with annual sales totaling over $81 million in 2012.
  - Madison County had 74,683 head of cattle and calves, 3,557 head of sheep and lambs in 2012.

Possible ecologic losses include:

- Eradication of certain species

Possible social losses include:

- Emotional impacts related to mass fatalities
- Disruption of social activities during quarantines
- Fear of contracting diseases

Expected Communicable Disease Impact to the Values: Moderate-High

4.1.5.6 FUTURE DEVELOPMENT

Structures built as a result of new development would have little impact on the communicable disease vulnerabilities, unless in the rare case, the new structures were part of a lab dealing with biological agents. New residents and population add to the number of people threatened in Madison County, but the location of such population increases would probably not matter.

Expected Communicable Disease Impact to Future Development: Low

4.1.6 DATA LIMITATIONS AND OTHER FACTORS

The data limitations related to the communicable disease hazard include:

- Uncertainties related to how and when a disease will spread through a population
- The emergence of new, unstudied diseases

Other hazards often related to communicable disease include:

- Other disasters that result in the loss or contamination of potable water or sewer services
- Food contamination due to long-term power outages
- Mold, mildew, and other toxins from flooding

4.2 DROUGHT

4.2.1 DESCRIPTION

A drought is an extended period of unusually dry weather. Drought is a special type of disaster because its occurrence does not require evacuation of an area nor does it constitute an immediate threat to life or property. People are not suddenly rendered homeless or without food and clothing. The primary impact of a drought is economic hardship, but it does, in the end, resemble other types of disasters in that victims can be deprived of their livelihoods, and communities can suffer economic decline.

The following is an excerpt from the National Drought Mitigation Center [2009]:
Drought is an insidious hazard of nature. Although it has scores of definitions, it originates from a deficiency of precipitation over an extended period of time, usually a season or more. This deficiency results in a water shortage for some activity, group, or environmental sector. Drought should be considered relative to some long-term average condition of balance between precipitation and evapotranspiration (i.e., evaporation + transpiration) in a particular area, a condition often perceived as "normal." It is also related to the timing (i.e., principal season of occurrence, delays in the start of the rainy season, occurrence of rains in relation to principal crop growth stages) and the effectiveness (i.e., rainfall intensity, number of rainfall events) of the rains. Other climatic factors such as high temperature, high wind, and low relative humidity are often associated with it in many regions of the world and can significantly aggravate its severity.
Droughts can range from minor to severe, short-term to long-term with a variety of determining factors such as precipitation, soil moisture, and river levels. A minor, short-term drought can slip by unnoticed while a long-term severe drought can impact the agricultural economy, natural resources, and even public water supplies. Monitoring of drought conditions occurs nationally, and various indices, such as the Palmer Index, indicate the level of drought.

4.2.2 WARNINGS, WATCHES, AND ADVISORIES

Sometimes related to drought, the National Weather Service [2006] issues the following products:

- **Blowing Dust Advisory:** Blowing dust advisories are issued for widespread or localized blowing dust reducing visibilities to less than a mile but greater than ¼ mile with sustained winds of 25 mph or greater.
- **Dust Storm Warning:** Dust storm warnings are issued when widespread or localized blowing dust reduces visibilities to less than ¼ mile with sustained winds of 25 mph or greater.
- **Heat Advisory:** A heat advisory is issued when conditions are favorable for heat index values reaching 105 or greater for three days or more.
- **Heat Warning:** A heat warning is issued when high temperatures are expected to be over 105°F and low temperatures are expected to be over 80°F for three days or more.

4.2.3 HISTORY

Paleoclimate studies show extreme periods of drought hundreds of years ago in the northern Great Plains including 200-370 A.D., 700-850 A.D., and 1000-1200 A.D. Compared to these periods over the past 2,000 years, the droughts since 1200 A.D. have been relatively wet and minor [Laird et al., 1996]. Droughts cannot be defined with certainty as extremely dry periods often alternate with wetter than normal periods.

1930s: The 1930s Dust Bowl remains the most highly publicized of past droughts in Montana. This nationwide drought produced erosion problems in the creation of dust storms throughout Montana.

1950s: Montana had a period of reduced rainfall; however, Madison County did not suffer as severely as those counties in the eastern and central portions of the state.

1960s: Montana saw another drought episode in 1961. By the end of June, 17 counties had requested federal disaster designations due to a lack of moisture, higher than normal temperatures, and

grasshopper infestation. Small grain crops died before maturing, and range grass and dryland hay crops were deteriorating rapidly. Livestock water supplies were at critical levels. In July of 1961, the State's Crop and Livestock Reporting Service called it the worst drought since the 1930s. In 1966, the entire state experienced another episode of drought.

1970s: Over 250,000 acres of Montana farmland was damaged by winds in the western and southern part of state over a 7-month period in 1977. Excessive tillage and inadequate crop cover during years of little moisture caused exaggerated soil damage. In June of 1977, Montana officials worked with officials from Washington, Idaho, and Oregon on the Northwest Utility Coordination Committee to lessen the potential for hydroelectricity shortages. On June 23, Governor Judge ordered a 10 percent electric use reduction in state and county governments.

1980s: Drought-related economic losses in Montana in 1980 were estimated to be $380 million. Drought continued to plague the state in 1985, and all 56 counties received disaster declarations. The continued lack of moisture in 1985 resulted in a wheat crop that was the smallest in 45 years. Grain farmers received more in government deficiency payments and insurance money than they did for their crops. For a typical 2,500 acre Montana farm/ranch, the operator lost more than $100,000 in equity over the course of that year. The state's agriculture industry lost nearly $3 billion in equity. The extended effects of this drought included the loss of thousands of off-farm jobs and the closing of many implement dealerships and Production Credit Associations.

1990s: Drought emergencies were declared in a number of Montana counties with 83 percent of the state reported under drought conditions by mid-August 1994. Impacts included stress to stream fisheries (low water levels, high temperatures), reduced crop yields, and wildfires.

2000s: Severe drought and persistent heat caused significant losses to agriculture and related industries. The US Department of Agriculture issued Natural Disaster Determinations for drought for the entire state of Montana for the years 2000, 2001, 2002, and 2003. This designation entitled counties to low interest loans for producers, small business administration loans, and an Internal Revenue Service provision deferring capital gains. February 2005 was a particularly dry month; it was the driest February on record across the State of Montana [Montana Disaster and Emergency Services, 2015].

The Federal Emergency Management Agency's ability to use the President's Disaster Fund for drought relief to state and local interests is very limited in scope. However the US Department of Agriculture frequently declares agricultural disasters because of drought.

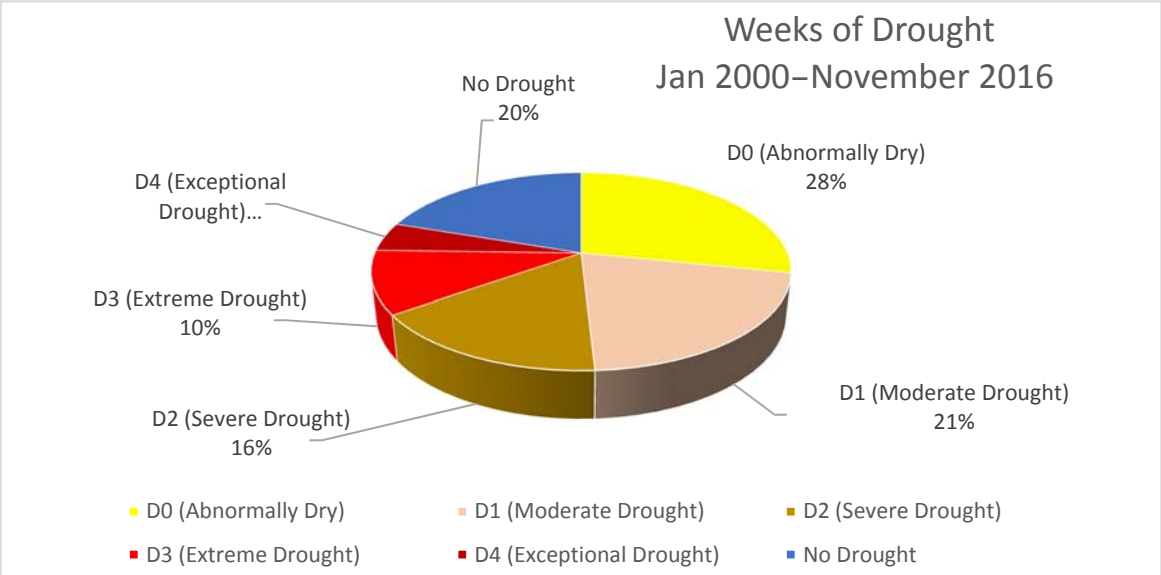


Figure 4-1. Drought Monitor by including the National Drought Mitigation Center (NDMC), the U.S. Department of Agriculture (USDA) and the National Oceanic and Atmospheric Association (NOAA). 2016

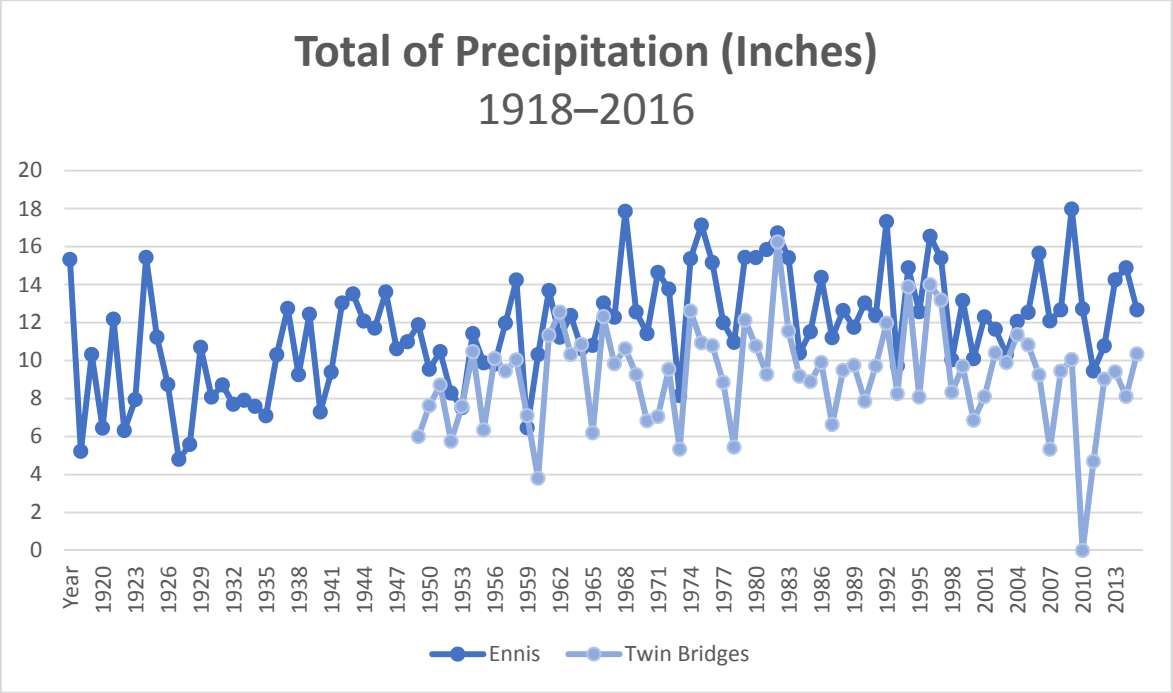


Figure 4-2. Need Captions.

Table 4-3 Madison County Drought Declared Disasters and Emergencies

Declaration	Year	Additional Information	Casualties	Damages/Assistance
None				

4.2.4 PROBABILITY AND MAGNITUDE

The National Oceanic and Atmospheric Administration Paleoclimatology Program studies drought by analyzing records from tree rings, lake and dune sediments, archaeological remains, historical documents, and other environmental indicators to obtain a broader picture of the frequency of droughts in the United States. According to their research, "...paleoclimatic data suggest that droughts as severe as the 1950s drought have occurred in central North America several times a century over the past 300-400 years, and thus we should expect (and plan for) similar droughts in the future. The paleoclimatic record also indicates that droughts of a much greater duration than any in the 20th century have occurred in parts of North America as recently as 500 years ago." Based on this research, the 1950s drought situation could be expected approximately once every 50 years or a 20 percent chance every 10 years. An extreme drought, worse than the 1930s Dust Bowl, has an approximate probability of occurring once every 500 years or a 2 percent chance of occurring each decade [National Oceanic and Atmospheric Administration, 2003].

A 500-year drought with a magnitude similar to that of the 1930s that destroys the agricultural economy and leads to wildfires is an example of a high magnitude event. The Palmer Index, an index used by the Climate Prediction Center to measure long-term drought, has frequently had southwest Montana in the extreme drought category over the past several years.

Overall Drought Probability: Moderate-High

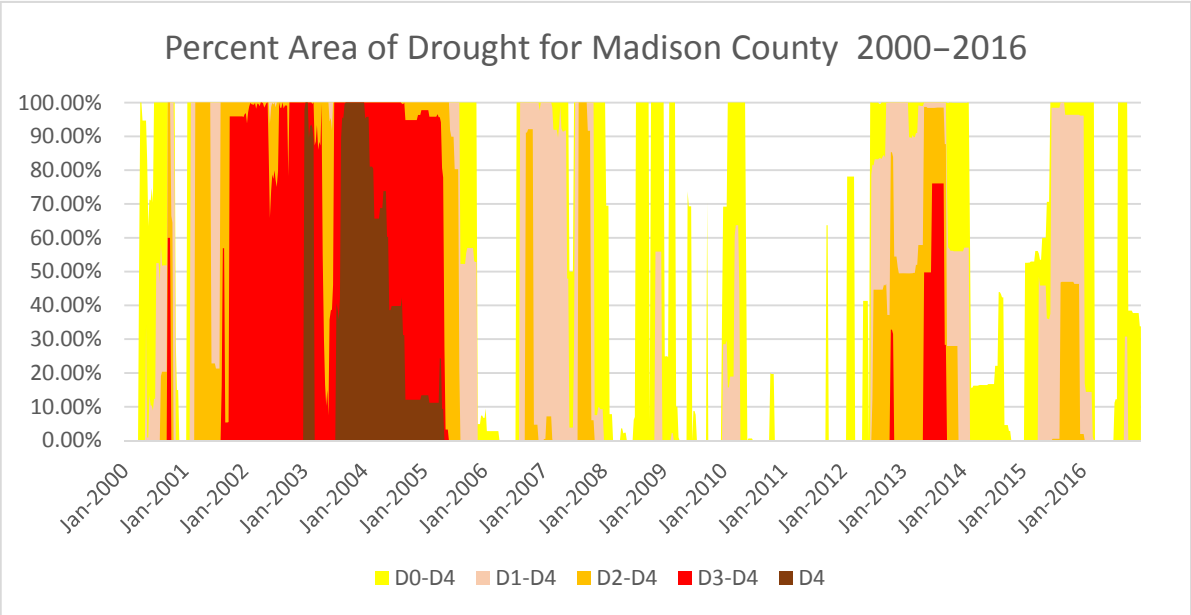


Figure 4-3. Need Caption and Callout. Drought Monitor by including the National Drought Mitigation Center [2016]. Overall Drought Probability: Moderate-High Drought Monitor by including the National Drought Mitigation Center [2016].

4.2.5 MAPPING

Drought is usually a regional hazard that is not enhanced by county-level mapping. All county areas are assumed to have the same risk level. Mapping of the current drought status is published by the US Drought Monitor each Thursday online (*http://drought.unl.edu/dm*).

4.2.6 VULNERABILITIES

4.2.6.1 CRITICAL FACILITIES

Drought typically does not have a direct impact on structures.

Possible losses/impacts to critical facilities include:

- Loss of critical function because of low water supplies

Expected Drought Impact to Critical Facilities: Low

4.2.6.2 CRITICAL INFRASTRUCTURE

Severe droughts can negatively affect drinking water supplies. Should a public water system be affected, the losses could total into the millions of dollars if outside water is shipped in. Private wells could also dry up.

Possible losses to infrastructure include:

- Loss of potable water

Expected Drought Impact to Critical Infrastructure: Low-Moderate

4.2.6.3 STRUCTURES

Drought typically does not have a direct impact on structures.

Possible losses/impacts to structures include:

- Loss of function because of low water supplies

Expected Drought Impact to Structures: Low

4.2.6.4 POPULATION

Drought evolves slowly over time and the population typically has ample time to prepare for its effects. Should a drought affect the water available for public water systems or individual wells, the availability of clean drinking water could be compromised. This situation would require emergency actions and could possibly overwhelm the local government and financial resources.

Possible impacts to the population include:

- Casualties because of a lack of clean drinking water or food

Expected Drought Impact to the Population: Low-Moderate

4.2.6.5 ECONOMIC, ECOLOGIC, HISTORIC, AND SOCIAL VALUES

Possible economic losses according to the US Department of Agriculture [2002] include:

- Significant agricultural losses from damaged crops and reduced livestock feed.
  - Madison County had 513 farms and 1,028,781 acres in farmland with annual sales totaling over $37 million in 2002.
  - Madison County had 70,892 head of cattle and calves, 4,803 head of sheep and lambs, and 544 head of poultry in 2002.
- Business interruptions

On August 19, 2016, Montana's Department of Fish, Wildlife and ParksFWP (FWP) Department established a temporary emergency closure on a large section of the Yellowstone River. This temporary closure affected the Yellowstone River and its tributaries between Yellowstone National Park boundaries near Gardiner, Montana, approximately 183 miles downriver to Laurel, Montana. The closure applied to all water- based recreation uses on the affected area. It is believed that tThe temporary closure cost Park County between an estimated $360,000 and $524,000. The major rivers used by guides and outfitters in Beaverhead County include, the Beaverhead River and the Big Hole River. If an event of the same nature took place on the rivers of Beaverhead County, there would be similar tolls would be taken on the livelihood of locals as well as long- lasting effects for future use of the rivers.

Possible ecologic losses include:

- Loss of fish and waterfowl populations
- Loss of wildlife food and water supplies
- Potential Loss of Fish populations.

Table 4-4. Outfitter Angling Pressure Estimates 2013 Angling Year for Madison County Area Drainages

	Totals		Resident		Nonresident	
	Pressure	Trips	Pressure	Trips	Pressure	Trips
Big Hole River						
Undesig	194	2	194	2		
Lake	4712	51	3097	33	1615	18
Stream	96109	1130	48677	592	47432	538
Total:	101016	1183	51968	627	49047	556
Madison River						
Lake	67,079	702	30,903	311	36,176	391
Stream	207,306	2,201	63,218	639	144,088	1,562
Total:	274,385	2,903	94,121	950	180,264	1,953
Ruby River						
Lake	11,043	96	9,238	81	1,805	15
Stream	15,783	170	6,807	68	8,976	102
Total:	26,826	266	16,045	149	10,781	117

Tests results on whitefish collected from the main stem of the Yellowstone show that the reason for the fish kill was Proliferative Kidney Disease. With the loss of fish on the Yellowstone River numbering in the high thousands, drought can have a devastating effect on populations of whitefish and trout. One Yellowstone Cutthroat found was also tested positive for the disease. The disease is caused by a microscopic parasite known to exist in Canada, the United StatesUS and Europe, which. The disease has been documented before in two isolated locations in Montana during the past 20 years. The latest outbreaks that have been found have happened in the Pacific Northwest and Idaho. Other causes for this out break are higher -than- average water temperatures, lower -than- average stream flows, and recreational stressors.

As experts continue to identify the potential ramifications of changing climatic conditions, disturbances such as those contributing to the closure (e.g., low flows and elevated water temperatures) may increase in frequency and severity. Such a prospective warrants additional attention to the economic impacts of closures or other management actions taken to preserve the resource. Thus, as the summer fishing and floating seasons come to a close at the end of September, and the river is incrementally opened back up by FWP, ITRR aims to follow up this preliminary report with a more in-depth study of the economic impacts of the closure. The goal of a follow- up investigation would be to not only more precisely quantify the impact to fishing and rafting based businesses during the closure period based on the actions of travelers, but also shed light on the future potential impacts of parasitic outbreaks and any lasting residual effects of this event. Residual effects are potentially positive and negative. Potentially positive effects stem from the containment of the outbreak to a limited set of rivers, while negative effects may continue if visitor willingness or desire to recreate in the affected areas declines [Economic Contributions of the Yellowstone River to Park County, Montana, 2016].

With populations of whitefish and trout in all of the Beaverhead County area drainages, an outbreak of any kind that will harm native and non-native fish populations will be detrimental to both economic and ecologic markers with in the county.

Possible social losses include:

- Water rationing and conservation resulting in less than ideal lawns and gardens
- Water-related recreational activities may be limited

Expected Drought Impact to the Values: Moderate-High

4.2.6.6 FUTURE DEVELOPMENT

Future development's greatest impact on the drought hazard would possibly be to ground water resources. New water and sewer systems or significant well and septic sites could use up more of the water available, particularly during periods of drought. Fortunately, public water systems are monitored by the Montana Department of Environmental Quality, but individual wells and septic systems are not as strictly regulated. Therefore, future development could have an impact on the drought vulnerabilities.

Expected Drought Impact to Future Development: Low-Moderate

4.2.7 DATA LIMITATIONS AND OTHER FACTORS

The data limitations related to the drought hazard include:

- Difficulties in pinpointing the start and end of drought periods
- Limitations in quantifying economic losses from drought
- Lack of a publicly available database listing historical USDA drought declarations and the associated losses

Other hazards often related to drought include:

- Wildfires
- Strong winds
- Extreme heat

Flash flooding (dry soils are not as permeable to water and heavy rains run off faster)

4.3 EARTHQUAKE

4.3.1 DESCRIPTION

One of the most frightening and destructive phenomena of nature is a severe earthquake and its terrible aftereffects. An earthquake is the sudden movement of the Earth, caused by the abrupt release of strain that has accumulated over a long time. For hundreds of millions of years, the forces of plate tectonics have shaped the Earth's surface. Huge plates slowly move over, under, and past each other. Sometimes the movement is gradual. At other times, the plates are locked together, unable to release the accumulating energy. When the accumulated energy grows strong enough, the plates break free, thus, producing an earthquake [US Geological Survey, 1997].

Most of the earthquake activity in Montana occurs along the Intermountain Seismic and Centennial Tectonic Belts in western Montana as shown in Figure 4-4. Madison County lies near the junction of these two regions and is within close proximity to Yellowstone National Park, an active geologic area.

Earthquakes occur along faults, which are fractures or fracture zones in the earth across which relative motion may occur. The energy released radiates outward from the source, or focus, as a series of waves and is known as an earthquake. The primary hazards of earthquakes are ground breaking, as the rocks slide past one another, and ground shaking, by seismic waves. Secondary earthquake hazards result from the distortion of the surface materials such as water, soil, or structures. The hazard of ground breaking is confined to a single fault or a narrow zone of multiple faults. Within the fault zone, which is generally less than a half mile wide, most structures can be destroyed and utilities can be disrupted. In the case of a moderate, small, or deep earthquake, ground breaking may not occur at all.

Ground shaking may affect areas hundreds of miles from the epicenter. Ground shaking may trigger the failure of snow (avalanche) or earth materials (landslide). Ground shaking can also change the mechanical properties of some fine grained, saturated soils, whereupon they liquefy and act as a fluid (liquefaction). The dramatic reduction in bearing strength of such soils can cause buried utilities to rupture and otherwise undamaged buildings to collapse.

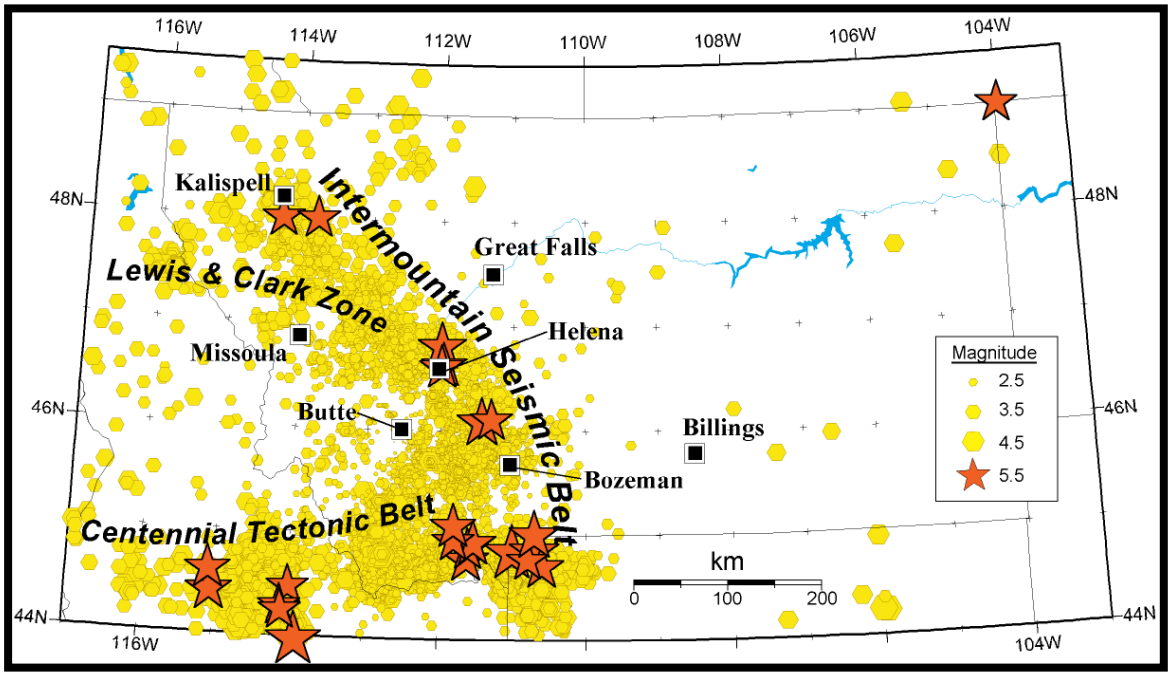


Figure 4-4. Intermountain Seismic Belt in Montana.

The major form of damage from most earthquakes is damage to construction. Bridges are particularly vulnerable to collapse, and dam failure may generate major downstream flooding. Buildings vary in susceptibility, dependent upon construction and the types of soils on which they are built. Fires caused by ruptured gas mains may also destroy structures.

The damage caused by both ground breaking and ground shaking can lead to the paralysis of the local infrastructure: police, fire, medical, and governmental services. As with many catastrophes, the worst hazard to the survivors is their own shock and inability to respond to the necessity for prompt, effective action.

Geologists primarily measure earthquake severity in two ways: by magnitude and by intensity. Magnitude is based on the area of the fault plane and the amount of slip. The intensity is based on how strong the shock is felt and the degree of damage at a given location. The most commonly used scales are the Richter magnitude scale, moment magnitude scale, and modified Mercalli intensity scale. (National Earthquake Hazards Reduction Program, 2009)

The modified Mercalli intensity scale is the method most commonly used in the United States for measuring earthquake intensity. This twelve tier scale ranks observed effects from I, felt only under especially favorable circumstances, to XII, total damage.

The magnitude of an earthquake is most commonly measured through the use of the Richter magnitude scale. Earthquake magnitudes describe the subject on an absolute, not arithmetic, scale. An earthquake of magnitude 8, for example, is ten times stronger than a magnitude 7 earthquake, 100 times stronger than a magnitude 6 earthquake, and so on.

Earthquakes most commonly occur in the same place as prior earthquakes, that is, along active faults. The term active is often interpreted by non-scientists as meaning active during historical time (the last 100 years). Active faults are most commonly indicated by micro-seismicity (earthquakes so small they can only be detected by instruments) and by the presence of scarps. Scarps are steep, linear slopes, up to 65 feet high, showing offset of the ground surface. Scarps are commonly found along the base of mountain ranges, and are prominent in the Madison and Yellowstone Valleys.

The earthquake sub-committee conducted extensive study on the location of earthquake faults and scarps and the location of prior earthquakes in Madison County. This study was conducted with the assistance of the Montana Bureau of Mines and Geology, Montana Tech, and University of Montana. The Madison Valley makes up the eastern half of Madison County with the south end of the valley within 10 miles of Hebgen Lake, an active fault area. Faults and scarps in the Madison Valley are, starting at the south end of the valley proceeding north, the Madison Fault, the Graben Scarp, the Wolf Creek Scarp, the Indian Creek Scarp, the Bear Creek Scarp, the Burger Creek Scarp, and the Jack Creek Scarp. The western half of the county has several major faults systems. These are located near the Towns of Sheridan and Twin Bridges. One fault system runs directly through the community of Alder.

4.3.2 HISTORY

The historic earthquakes of Montana are among the largest recorded on the continental United States. Madison County has been the site of and near many of those earthquakes. Below are the earthquakes that have affected Madison County over the past 100 years.

Clarkston Valley Earthquake, June 27, 1925. *Richter magnitude 6.6, modified Mercalli intensity VIII, 8 miles north of Three Forks*. Most of the damage from this earthquake occurred in Gallatin County, however, intensities in Madison County likely reached VI and VII on the modified Mercalli scale. Newspaper reports indicate damages occurred at a grocery store in Norris and the schoolhouse and courthouse in Virginia City; county prisoners were taken to another building. Very minor damages were reported at Twin Bridges. An automobile accident was reported on the Virginia City hill. The sparse population of the area contributed to relatively low losses. Aftershocks continued for several months.

Helena Earthquake, February 29, 1928. *Richter magnitude approximately 5.5, modified Mercalli intensity IV, at Helena.* The earthquake was very noticeable but caused very little damage in Madison County.

Lombard Earthquake, February 15, 1929. *Richter magnitude 5.6, modified Mercalli intensity V, 20 miles north of Manhattan*. The earthquake was felt over a wide area but no damages were reported in Madison County.

Helena Earthquakes, October 12-31, 1935. – *Richter magnitude 6.3, modified Mercalli intensity VIII, 15 miles north of Helena*. Most of the damages from the series of earthquakes, about $4 million, occurred in the Helena area. Four people were killed by falling debris near Helena.

Virginia City Earthquake, November 23, 1947. *Richter magnitude 6.3, modified Mercalli intensity VIII, 25 miles west-northwest of West Yellowstone*. Chimneys fell, twisted, or cracked in several towns in

Madison County, including Alder, Cameron, Ennis, Laurin, and Virginia City. New springs formed in several areas, and creeks became muddy. Huge rocks rolled down the mountainside. Plaster was shaken off walls and ceilings and a number of window panes shattered. At the County Courthouse, 13 window panes were broken, plaster cracked or fell in several rooms, and chimneys were slightly damaged. At Virginia City Hall, the front wall cracked, chimneys were damaged, and bricks were shaken out of the belfry, landing on the sidewalk. Plastered walls in the Masonic temple and the Virginia City school were slightly damaged. Brick, masonry, and concrete structures sustained considerable damage. The earthquake was also felt in parts of Idaho, Washington, and Wyoming.

Hebgen Lake Earthquake, August 17, 1959. *Richter magnitude 7.5, modified Mercalli intensity X, 15 miles north of West Yellowstone*. The epicenter of this earthquake was located in southeastern Madison County. This is the strongest earthquake to have occurred in the Northern Rockies since 1876.

This earthquake caused 28 fatalities and about $11 million in damage to highways and timber. The earthquake caused extensive fault scarps, subsidence and uplift, a massive landslide, and a seiche in Hebgen Lake. The most spectacular and disastrous effect of the earthquake was the huge avalanche of rock, soil, and trees that cascaded from the steep south wall of the Madison River Canyon. This slide formed a barrier that blocked the gorge and stopped the flow of the Madison River, and within a few weeks, created a lake almost 174 feet deep. The volume of material that blocked the Madison River below Hebgen Dam was estimated at 36–43 million yards. Most of the 28 deaths were caused by rockslides that covered the Rock Creek public campground on the Madison River, about 6 miles below Hebgen Dam.

New fault scarps as high as 20 feet formed near Hebgen Lake. The major fault scarps formed along preexisting normal faults northeast of Hebgen Lake. Subsidence occurred over much of an area that was about 15 miles north-south and about twice as long east-west. As a result of the faulting near Hebgen Lake, the bedrock beneath the lake was permanently warped, causing the lake floor to drop and generate a seiche. Maximum subsidence was 22 feet in Hebgen Lake Basin. Approximately 50 square miles subsided more than 10 feet, and about 200 square miles subsided more than 1 foot. The earth-fill Hebgen Dam sustained significant cracks in its concrete core and spillway, but it continued to be an effective structure.

Many summer houses in the Hebgen Lake area were damaged; houses and cabins shifted off their foundations, chimneys fell, and pipelines broke. Most small-unit masonry structures and wooden buildings along the major fault scarps survived with little damage when subjected only to vibratory forces. Roadways were cracked and shifted extensively, and much timber was destroyed. Highway damage near Hebgen Lake was due to landslides slumping vertically and flowing laterally beneath pavements and bridges, which caused severe cracks and destruction. Three of the five reinforced bridges in the epicentral area also sustained significant damage.

On the basis of vibration damage (and excluding geologic effects), damage to buildings along the fault zone was singularly unspectacular (intensity VIII at places, intensity VII generally). Minor damage occurred throughout southern Montana. Aftershocks continued for several months.

Following the earthquake, the US Forest Service established the Madison River Canyon earthquake area to preserve the earthquake features and provide for public use and safety. The visitor center includes a visible-recording seismograph and a memorial marker to those whose lives were lost during the earthquake. Although the scene of large-scale destruction and tragedy, the locality is of great scientific and general interest because it provides a dramatic example of mountain-building and earth-shaping processes.

A

B

Figure 4-5. (A) Damaged and Collapsed Buildings at the Blarneystone Ranch Near Hebgen Lake. Photograph by I.J. Witkind [US Geological Survey, 2009a]. (B) Landslide and slumping damage to State Highway 287 along the shore of Hebgen Lake. Photograph by J.R. Stacy [US Geological Survey, 2009a].

Yellowstone Earthquake, June 30, 1975. *Richter magnitude 6.1, modified Mercalli intensity VII, 5 miles east-northeast of Norris Junction, WY.* No damages, except some park road closures, were reported with this earthquake.

Dillon Earthquake, July 25, 2005. *Richter magnitude 5.6, modified Mercalli intensity VI, 10 miles north of Dillon.* This earthquake knocked items off of shelves throughout the region and cracked masonry in Dillon. Minor damages occurred in Silver Star and Twin Bridges.

Sheridan Earthquake May 8, 2007. *Richter magnitude 4.5, modified Mercalli intensity V, 9 miles northeast of Sheridan.* An apartment building in Sheridan was damaged and bricks were knocked off the facades in town.

(US Geological Survey, 2016a, University of Utah, 2009)

Table 4-5. Madison County Earthquake Declared Disasters and Emergencies

Declaration	Year	Additional Information	Casualties	Damages/Assistance
None				

4.3.3 PROBABILITY AND MAGNITUDE

Southwest Montana has a high probability of future earthquakes, although, damaging earthquakes are somewhat harder to predict. Earthquake experts use probabilities when determining the seismicity of an area. Peak horizontal acceleration is the maximum horizontal acceleration experienced by a particle during the course of the earthquake motion. When acceleration acts on a physical body, the body experiences the acceleration as a force. Gravity is a commonly known force of nature, and therefore, the units of acceleration are measured in terms of g, the acceleration due to gravity. At 10 percent g, pre-1940 dwellings (17 percent of total housing units) are likely to perform poorly and pre-1975 (approximately 24 percent of total housing units) dwellings are likely to have some vulnerability to earthquake shaking [US Geological Survey, 2008].

The peak ground acceleration with a 10 percent probability of exceedance in 50 years in Madison County ranges from 9 percent g to 30 percent g. To make sense of these values, at 9.2 percent g, the earthquake is felt by all with many frightened. Some heavy furniture is moved with a few instances of fallen plaster. Damage is considered slight. At 18 percent g, damage is negligible in buildings of good design and construction, slight to moderate in well-built ordinary structures, and considerable in poorly-built or badly designed structures. Some chimneys may be broken, and the shaking is noticed by people driving cars. At 34 percent g, damage is slight in specially designed structures, considerable in ordinary substantial buildings with partial collapse, and great in poorly built structures. Chimneys and walls may fall and heavy furniture is overturned [Qamar, 2008].

In all of western Montana, an event of magnitude greater than 5.0 can be expected every 1.5 years, a magnitude of 6.0 or greater is expected every ten years, and a magnitude 7.0 or greater is expected every 77 years. The highest recurrence rate of large earthquakes in Montana occurs in the Hebgen Lake-Yellowstone Region, followed by Helena and Three Forks. The Hebgen Lake Region is located near the southeast corner of Madison County. Three Forks is less than 10 miles from the county line on the northeast corner of the county. Helena is just 40 miles north of Madison County.

Madison County has experienced strong earthquakes of magnitude 7 or greater causing significant damage and fatalities. Another earthquake of this magnitude could cause similar losses and is considered a high magnitude event.

Overall Earthquake Probability: Low-Moderate

4.3.4 MAPPING

As discussed in the probability section, structural engineers often use peak horizontal acceleration as a guide for seismically designing structures. Map 4.3.4A shows the earthquake peak horizontal acceleration that has a 10 percent probability of exceedance in 50 years. The map also shows the known fault areas.

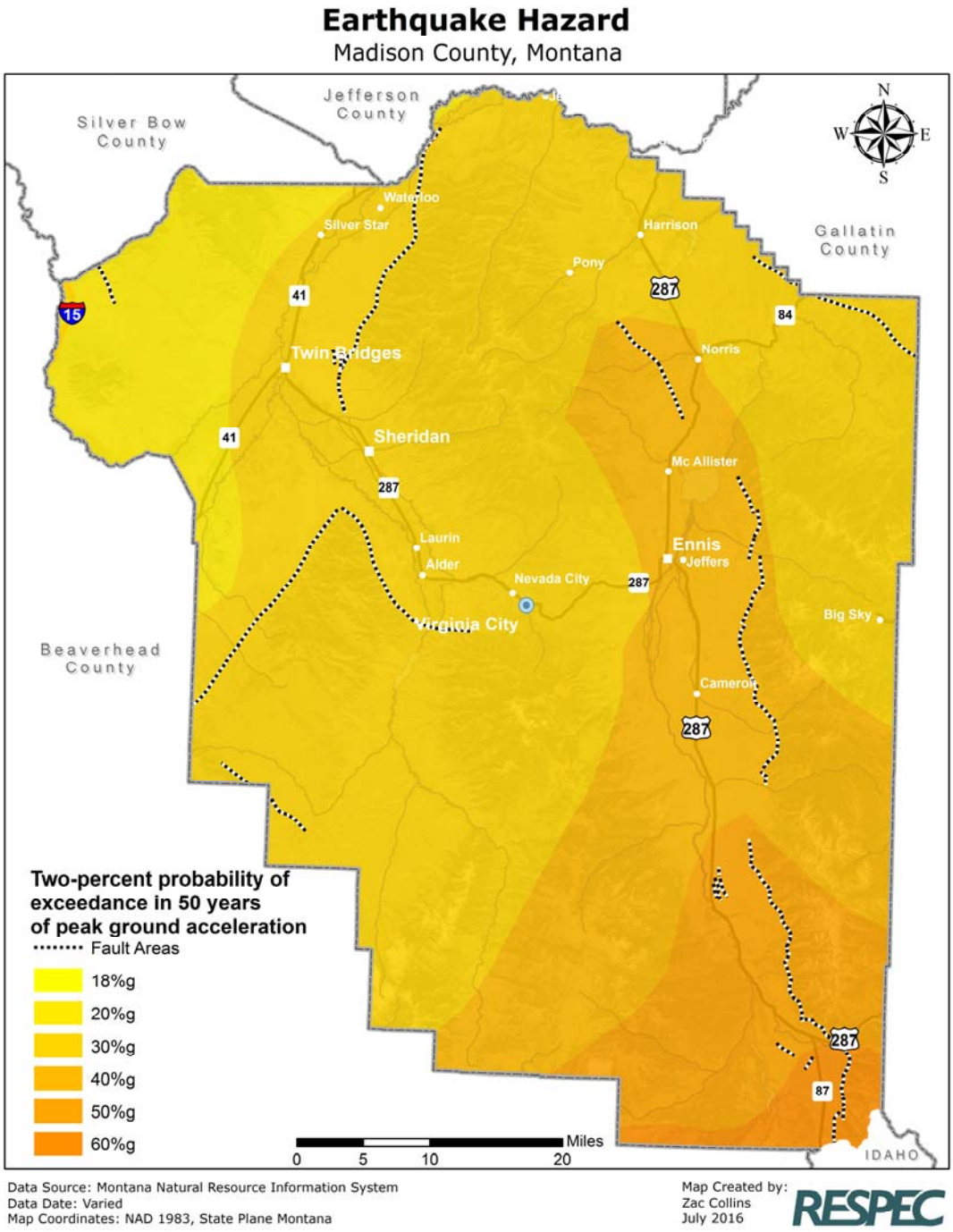


Figure 4-6. Need Caption and Callout.

4.3.5 VULNERABILITIES

All of Madison County is vulnerable to the threat of earthquakes, as the county lies within one of the most geologically active areas in the United States. With the continued increase in population of the county and a median housing value of $104,500, damage to residential property alone will be in the millions of dollars. This estimate does not take into account the cost of deaths and injuries or the value of critical structures and infrastructure.

General losses from earthquakes can be estimated using HAZUS-MH, a loss estimation model developed by the Federal Emergency Management Agency. This model uses national datasets and hazard information to estimate the earthquake losses from a particular event at the census tract or county level. Although the default data and methods provided with the model contain many generalizations that could lead to inaccuracies, the model provides a ballpark estimate of what earthquake losses may occur and the magnitude of such. A structural engineer can make specific determinations on individual structures.

One scenario was run through the model. The model used a 500-year probabilistic hazard with a 7.0 moment magnitude. Details on the results follow.

4.3.5.1 CRITICAL FACILITIES

Certainly, all critical facilities identified in this plan are not included in the national databases used by HAZUS-MH. The facilities included in the model were assigned a probability of at least slight damage given the 500-year, 7.0 moment magnitude scenario as follows:

Table 4-6. Need Caption and Callout

		No. of Facilities		
Classification	Total	Damage > 50%	Damage > 50%	> 50% on day
Hospitals	2	0	0	2
Schools	13	0	0	13
Police Stations	1	0	0	1
Fire Stations	3			3

The HAZUS-MH scenario also estimates that Madison County has a total of 17 hospital beds. On the day of the earthquake, only 11 beds are estimated to be available to existing patients and the injured. By one week, the number of beds increases to 16 beds.

Fire stations in Sheridan and Twin Bridges are of masonry construction. The town halls for both communities are located within the same fire station buildings. Water and sewer systems in both communities could suffer profound damage, possibly eliminating service to the population. The Ruby Valley Hospital, the only medical facility within 34 miles, and the Tobacco Root Care Center, the nursing home in Sheridan, are of masonry construction.

The Madison County Courthouse located in Virginia City was constructed in 1872 and is of masonry and stone construction. This building houses most of the county government offices, including the

Sheriff's Office in the basement. The 911 Center, and the Emergency Operations Center have moved to 7 placer loop next to the Emergency Services office.

The Ennis Town Hall, Police Department, and Ambulance Service are located in a building that was built in the 1950s of masonry construction. This building suffered damage in the 1959 Hebgen Lake Earthquake. An earthquake in the Ennis area of the magnitude of the Hebgen Lake Earthquake would devastate the community. Water and sewer lines have already suffered damages from several of the minor earthquakes in the area. In addition to the Town Hall, the Madison Valley Hospital, Madison Valley Manor, Ennis High School, and Ennis Elementary School are also vulnerable to damage.

Possible losses/impacts to critical facilities include:

- Structural damages
- Content losses
- Loss of critical function

Expected Earthquake Impact to Critical Facilities: Moderate-High

4.3.5.2 CRITICAL INFRASTRUCTURE

The HAZUS database contains 204 miles of highway, 73 bridges, and 480 miles of pipeline valued at over $1,511,000,000 in Madison County. Infrastructure, as quantified in the default HAZUS-MH database, suffers significant damages during the 500-year, 7.0 moment magnitude earthquake. Table 4-7 shows the estimated economic losses and damages by type.

Table 4-7. HAZUS-MH Estimated Infrastructure Losses

Infrastructure System	Economic Losses	Damages
Highway	$800 thousand	1 bridge suffer at least moderate damage
Airport	$4.1 million	
Potable Water	$130 thousand	28 leaks 7breaks
Waste Water	$900 thousand	20 leaks 5 breaks
Natural Gas	$300 thousand	6 leaks 1 breaks

Possible losses to infrastructure include:

- Loss of potable water
- Sewer line breaks
- Gas line breaks
- Electric outages
- Damages to roads, bridges, and runways

Expected Earthquake Impact to Critical Infrastructure: Moderate-High

4.3.5.3 STRUCTURES

Using the same HAZUS-MH methodology as the critical and special needs facilities, the building stock in Madison County was tested through the 500-year, 7.0 moment magnitude probabilistic model. The results estimated that 23 structures would have complete damage, 137 structures would have extensive damage, 626 structures would have moderate damage, 1,805 would have slight damage, and 3,701 would have no damage. The building losses are broken into two groups: direct building losses and business interruption losses. The direct building losses are the projected costs to repair or replace the damage caused to the building and its contents. The business interruption losses are the projected losses related to the inability to operate a business due to the damage sustained during the earthquake. Business interruption losses also include the temporary living expenses for those who are displaced from their homes due to the earthquake. HAZUS-MH estimates the building-related income economic losses countywide would be $10.38 million, and the building-related income economic losses countywide would be $65.49 million. As with any loss estimate, large errors may be present and estimations should only be used for planning purposes.

Over 75 percent of the buildings in Madison County are pre-seismic code structures or recent constructions not built to seismic code. This includes all county and city government buildings. Although seismic codes are not part of the 2013 Growth Policy, new County construction such as the new Administration offices in Vergina City are up to seismic code. While the vast majority of the residential buildings are of wood frame construction, many have masonry chimneys.

Possible losses/impacts to structures include:

- Structural damage
- Content losses
- Loss of function/habitability

Expected Earthquake Impact to Structures: Moderate-High

4.3.5.4 POPULATION

Assuming the 500-year, 7.0 moment magnitude probabilistic earthquake occurred at 2pm, the following casualties are estimated by HAZUS-MH:

- 1 fatality
- 2 injuries requiring hospitalization but not life threatening
- 11 injuries requiring medical attention but not hospitalization.

Most of the casualties occurred in commercial structures.

Expected Earthquake Impact to the Population: Moderate

4.3.5.5 ECONOMIC, ECOLOGIC, HISTORIC, AND SOCIAL VALUES

Possible economic losses include:

- Physical and functional damages to businesses.

Possible historic losses include:

- Structural losses, especially in older, unreinforced masonry and/or poorly constructed buildings
- Content losses

Possible social losses include:

- Fear of aftershocks
- Emotional impacts from casualties
- Cancellation of activities

Expected Earthquake Impact to the Values: Moderate-High

4.3.5.6 FUTURE DEVELOPMENT

Madison County, Ennis, Sheridan, Twin Bridges, and Virginia City do not have residential building codes, except for electric and plumbing codes required by the state. Most new construction is generally of decent quality. Structures built to current codes have a lower chance of suffering damages in a strong earthquake. Without code adoption and enforcement, future development is at risk from earthquake damages.

Expected Earthquake Impact to Future Development: Moderate-High

4.3.6 DATA LIMITATIONS AND OTHER FACTORS

The data limitations related to the earthquake hazard include:

- Estimating the probability and possible damages associated with this low frequency, high impact hazard
- Lack of improved digital data for use in the HAZUS module
- Lack of individual facility assessments by a structural engineer

Other hazards often related to earthquake include:

- Dam failures
- Hazardous material releases
- Landslides

4.4 FLOOD

Including Riverine, Flash, Ice Jam, and Urban Floods and Dam Failure

4.4.1 DESCRIPTION

A flood is a natural event for rivers and streams and occurs when a normally dry area is inundated with water. Excess water from snowmelt and rainfall accumulates and overflows onto the banks and adjacent floodplains. Floodplains are lowlands, adjacent to rivers and lakes that are subject to recurring floods. Flash floods, usually resulting from heavy rains or rapid snowmelt, can flood areas not typically

subject to flooding, including urban areas. Extreme cold temperatures can cause streams and rivers to freeze, causing ice jams and creating flood conditions.

Flooding occurs when the amount of water arriving on land (from rainfall, snowmelt, surface flow, or flow in watercourses) exceeds the capacity of the land to discharge that water (by infiltration, surface flow, piped drainage, or surface watercourse). It can occur on any level or near level areas of land, but the main concern is with areas adjacent to watercourses - the floodplain. It is difficult to determine the precise limits of floodplains, as floods with similar probability can arise from different combinations of events and result in different levels of impact. Importantly, a major component of a healthy river system (fish and wildlife, good water quality, erosion control, sediment transport, etc.) is related to the river's ability to access its floodplain on a periodic basis.

Hundreds of significant floods occur in the United States each year and kill an average of about 100 people annually. Flooding is one of the most deadly hazards nationwide and in Montana. Most injuries and deaths occur when people are swept away by flood currents, and most property damage results from inundation by sediment-laden water. Fast-moving water can wash buildings off their foundations and sweep vehicles downstream. Pipelines, bridges, and other infrastructure can be damaged when high water combines with flood debris. Basement flooding can cause extensive damage.

4.4.1.1 RIVERINE FLOOD

Riverine flooding originates from a body of water, typically a river, creek, or stream, as water levels rise onto normally dry land. Flooding on the rivers generally occurs during the spring. Smaller streams are more susceptible to flooding in the summer with peak flows resulting from thunderstorms.

4.4.1.2 IDENTIFICATION AND MAPPING

The riverine hazard areas may be mapped as part of the National Flood Insurance Program (NFIP). Under this program, an area is broken into zones to depict the level of flood hazard. Most commonly, the areas within the 100-year floodplain are considered the greatest risk. The 100-year floodplain has a 1% chance of exceedance in any given year. Over a 100-year period, a flood of this magnitude or greater has a 63.5% chance of occurring. Structures in the 100-year floodplain are five times more likely to be damaged by flood than a major fire [Federal Emergency Management Agency, 2009a]. Locations outside the 100-year floodplain may also experience flood conditions during greater magnitude floods, localized events, or along unmapped creeks, streams, and ditches.

The Flood Insurance Rate Maps (FIRMs) depicting flood-prone areas of the Town of Ennis were last officially updated on November 19, 1986 and for the Town of Twin Bridges on July 3, 1986. Preliminary mapping was completed for the Town of Ennis and is dated May 27, 2009, but this mapping is not considered official yet. Unincorporated areas of Madison County, the Town of Sheridan, and the Town of Virginia City are not mapped. None of the jurisdictions have a completed Flood Insurance Study; the Town of Ennis has a draft version. In 2005, the Big Hole Planning Group (a four-county group) developed 100-year flood inundation potential mapping and channel migration zone delineation for the Big Hole River.

The primary waterbodies in Madison County include the Madison River, Ruby River, Big Hole River, Jefferson River, and several creeks, streams, and lakes. Ennis, along the Madison River, is at risk for

riverine flooding. Twin Bridges in located in a lowland area along the Beaverhead River, just downstream of the confluence of the Beaverhead River and the Ruby River, and just upstream of the confluence of the Beaverhead River (now containing the water of the Ruby River) and the Big Hole River. The Beaverhead and Big Hole Rivers come together to form the Jefferson River. In high water years when the snowpack melts late or too fast, Twin Bridges often experiences flooding.

4.4.1.3 FLOODPLAIN MANAGEMENT

The floodplain in the Town of Ennis and the Town of Twin Bridges is managed through floodplain ordinances. Both towns participate in the National Flood Insurance Program (NFIP) and have a designated floodplain administrator that issues and reviews permits for development in the floodplain. In unincorporated areas of Madison County, the floodplain is not mapped, but the county does have a floodplain ordinance and uses setbacks from rivers and creeks. In the Towns of Sheridan and Virginia City, the floodplain is not managed since flood hazard areas have not been formally identified. No changes in NFIP participation have occurred in Madison County or the incorporated jurisdictions since the last plan update.

In 2011 the Montana DNRC instigated new floodplain mapping for 116 miles of the Big Hole River. After draft maps were completed by Respec and public meetings held in 2013, The DNRC issued a Final Order on January 13, 2015, to adopt the reports and maps. Local and county floodplain management regulations have been updated with the new floodplain maps as well as the data form the report. The link below is the DNRC web page for the study as well as the location to find the DNRC Big Hole Floodplain Study Final Order and the products of the study.
http://dnrc.mt.gov/divisions/water/operations/floodplain-management/big-hole-floodplain-study-products

4.4.1.4 FLOOD INSURANCE

Residents of Madison County and the jurisdictions have the opportunity to purchase flood insurance through the National Flood Insurance Program. Currently, 38 policies are in force in Madison County, including nine in Ennis and three in Twin Bridges [Montana DNRC, 2016]. Madison County does not have any National Flood Insurance Program repetitive loss properties as of January 31, 2009 [Federal Emergency Management Agency, 2015].

Because of relatively long intervals between major events, complacency on the part of residents, as well as officials charged with minimizing flooding hazards and risks and protecting public investment in infrastructure, is a concern. The highest risk for riverine flooding appears to be during the months of May and June, during snowmelt runoff sometimes increased by high rainfall. The very large drainage areas of the rivers of Madison County, emphasized by the fact that they are the headwaters of the Missouri River, creates a high potential for movement of large volumes of water over short periods of time.

Stream and river channels have been straightened, deepened, widened, lined, reshaped, and routed through pipes and culverts with profound effects on the stability and integrity of natural systems. Traditional engineered designs were primarily implemented in response to public requests for protection from floods, as more communities, farms, homes, and infrastructure were located on the floodplain. These encroachments, in turn, caused river adjustments and increased the perceived need

for additional hard engineering controls. This further changed the natural function and value of many rivers. Societal values have changed and new challenges exist, including restoring natural stability and functions of rivers, and initiation of efforts to avoid problematic encroachment into floodplains and floodways of rivers and streams [Rosgen, 1996].

4.4.1.5 FLASH FLOOD

Flash floods can occur anywhere when a large volume of water falls or melts over a short time period, usually from slow moving thunderstorms or rapid snowmelt. Because of the localized nature of flash floods, clear definitions of hazard areas do not exist. These types of floods often occur rapidly with significant impacts. Rapidly moving water, only a few inches deep, can lift people off their feet, and only a depth of a foot or two, is needed to sweep cars away. Most flood deaths result from flash floods. Many areas of Madison County contain mountainous terrain, and therefore, are more prone to flash flooding. Steep mountain drainages in many watersheds create conditions where flash flooding and rapid runoff of spring snowmelt and high precipitation can result in flooding, even though floodplains in these streams and creeks may be narrow or non-existent. High, unpredictable stream flows and intense periods of runoff may result in conditions that are life threatening for those that live in close proximity to mountain streams and drainages.

4.4.1.6 ICE JAM FLOOD

An ice jam is a stationary accumulation of ice that restricts flow. Ice jams can cause considerable increases in upstream water levels, while at the same time downstream water levels may drop. Types of ice jams include freezeup jams, breakup jams, or combinations of both. When an ice jam releases, the effects downstream can be similar to that of a flash flood or dam failure. Ice jam flooding generally occurs in the late winter or spring.

Ice jams along the Madison River have diverted the flow into Ennis and upon break-up, the flow of the river can divert into yet another direction. Ice jams in the Twin Bridges area are also common.

4.4.1.7 URBAN FLOOD

Urban flooding is the result of development and the ground's decreased ability to absorb excess water without adequate drainage systems in place. Typically, this type of flooding occurs when land uses change from fields or woodlands to roads and parking lots. Urbanization increases runoff two to six times more than natural terrain [National Oceanic and Atmospheric Administration, 1992]. The flooding of developed areas may occur when the amount of water generated from rainfall and runoff exceeds a storm water system's capability to remove it.

4.4.1.8 DAM FAILURE

Although not particularly likely, seismic activity, poor maintenance, overwhelming flow conditions, and terrorist activities can all lead to the catastrophic failure of a dam. The result is the rush of water contained by the dam downstream at a rapid pace. The structural integrity of a dam depends on its design, maintenance, and ambient conditions. The potential for dam failure and catastrophic downstream impacts cannot be overlooked in an area subject to earthquakes and intense spring snowmelt and runoff events. Dams exist in a variety of shapes, sizes, and materials; uses include recreation, flood control, irrigation, water supply, and hydroelectricity. Should a dam fail, the consequences can be devastating or minimal depending on the dam's characteristics and regional attributes. Most dams are classified based on the potential hazard to life and property should the dam

suddenly fail. Note the hazard rating is not an indicator of the condition of the dam or its probability of failure. Definitions as presented by the Federal Emergency Management Agency [2004a] are as follows:

- **Low Hazard Potential.** Dams assigned the low hazard potential classification are those where failure or misoperation results in no probable loss of human life and low economic and/or environmental losses. Losses are principally limited to the owner's property.
- **Significant Hazard Potential:** Dams assigned the significant hazard potential classification are those dams where failure or misoperation results in no probable loss of human life but can cause economic loss, environment 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.
- **High Hazard Potential:** Dams assigned the high hazard potential classification are those where failure or misoperation will probably cause loss of human life.

According to the National Inventory of Dams database, Madison County has 34 dams – 8 high hazard, 7 significant hazard, and 19 low hazard. In 2016 the Montana DNRC worked with FEMA and Gannett Flemming Inc to produce the Dam Owner Emergency Intervention Toolbox (2016).

This Dam Emergency Intervention Toolbox was developed to provide owners of dams throughout the United States with the necessary information and tools to identify and remedy unsafe conditions which may develop. In addition to presenting identification techniques and intervention actions that may be performed to prevent or delay an incident resulting from an observed unusual dam condition, the toolbox includes background information on embankment dams, inspection guidelines, and recordation practices for monitoring procedures. User-input sections of the toolbox support the text and allow for site-specific recommendations. Figure 1: Map of Dams across the United States Source: National Inventory of Dams Dam Owner Emergency Intervention Toolbox Page 2 for all dams with an Emergency Action Plan (EAP), this Dam Emergency Intervention Toolbox and the EAP should be considered companion documents for responding to emergency events. While this document contains general guidance responding to emergency conditions at dams, EAPs contain information for coordination with local emergency responders during emergency circumstances.

Table 4-8 shows the high and significant hazard dams in Madison County [US Army Corps of Engineers, 2009]. The Clark Canyon Dam in neighboring Beaverhead County and the Hebgen Dam in neighboring Gallatin County could also impact Madison County.

Table 4-8. Dams in Madison County [US Army Corps of Engineers, 2016]

Name	Owner	River	Hazard
Albro Dam	Warren T Albro	Potosi Creek	Significant
Bell Lake Dam	J M Ferrell & Rice Ranch	Fork Of South Willow Creek	Low
Big Sky Dam	Big Sky Of Montana Inc	Middle Fork West Fork Gallatin River	High
Cataract Creek Dam	State Of Montana, D.N.R.C., W.R.D.	Cataract Creek	High
Cedar Lake Dam	Stalcup Jeffers & Vujovich	Cedar Creek	Low
Cosmic Nick Dam	East Bench Unit	Spring Creek	Low
Durham Dam	Massar Cattle Company	Tr-Indian Creek	Low
East Axolotl Lake Dam	Union Bank And Trust	Tr-Moran Creek	Low
Hacker Dam	Richard L Henderson	Moore Creek	Low
Hagl Dam	Zabel	North Meadow Creek	Significant
Hemund Dam	George Armstrong Jr	Dogtown Sewer	Significant
Hill Dam	W.E. Banks And Sons	North Fork Indian Creek	Low
Jackson Dam	Jackson Reservoir Assoc.	North Fork Wisconsin Creek	Significant
Klatt Dam	Wall Creek Grazing Association	Fork Wall Creek	Low
Lakeshore (Crystal Lake) Dam	Lakeshore Dam Association	Wisconsin Creek	Low
Lower Branham Dam	Three Creeks Water Company	North Fork Mill Creek	Low
Lower Mason (Marsh) Dam	Larry G & M Carrol Young	Cataract Creek	Significant
Mad Chant Dam	Heart L Ranch Company	McHessor Creek	Low
Middle Axoloil Lake #2 Dam	Union Bank And Trust	Tr-Moran Creek	Low
Middle Axolotl Lake #1 Dam	Union Bank And Trust	Tr-Moran Creek	Low
Middle Hollowtop Dam	James J. Griffits	North Willow Creek	Significant
No Man Dam	Jp & E Branger	No Man Creek	Low
Noble Dam	Noble Reservoir Assoc.	Noble Fork Wisconsin Creek	Significant
Norwegin Creek Dam	Barry L Rice	Norwegian Placer Gulch	Significant
Rillito Lark Dam	Beaver Dam Ranch Partners	Leonard Creek	Low
Ruby Dam	State Of Montana, D.N.R.C., W.R.D.	Ruby River	High
South Meadow Creek Dam	South Meadow Creek Dam Inc	South Meadow Creek	High
Sunrise Dam	Sunrise Reservoir Assoc.	Wisconsin Creek	Low
Upper Mason (Gem) Dam	Larry G & M Carrol Young	Cataract Creek	Significant
Willow Creek Dam	State of Montana, D.N.R.C., W.R.D.	Willow Creek	High

4.4.1.9 WARNINGS, WATCHES, AND ADVISORIES

The National Weather Service issues flood warnings, watches, and advisories when flood conditions are forecast. The following products may be issued [National Weather Service, 2006]:

- **Flood Watch:** Flood watches inform the public of conditions which may cause gradual flooding within the next 36 hours, but the flooding is neither certain nor imminent.

- **Flood Warning:** Flood warnings are issued when flooding is expected to occur more than 6 hours after the causative event.
- **Flood Advisory:** Flood advisories are issued when main stem river flows are elevated and flooding of low-lying areas is possible.
- **Small Stream Flood Advisory:** Small stream flood advisories are issued when small streams are rising and flooding of low-lying areas or ponding of water in urban areas are possible.
- **Flash Flood Watch:** Flash flood watches inform the public of conditions which may cause short duration, intense flooding from heavy precipitation, snow melt, dam failure, or ice jams within the next 36 hours, but the flooding is neither certain nor imminent.
- **Flash Flood Warning:** Flash flood warnings are issued when flooding is imminent during short term events requiring immediate action. Flash flooding occurs when the water level rises rapidly to inundation within 6 hours of a causative event (i.e. heavy precipitation, snow melt, dam failure, or ice jams).

4.4.2 HISTORY

Outside of anecdotal information, some photographic documentation, and sparse newspaper articles, little specific information exists to document the recent historic (mid-1800s to present) extent of flooding or to document damage and damage costs. A summary of news accounts reports generally on recorded flooding events from 1876–1956 in the Ruby, Beaverhead, Big Hole, and Jefferson watersheds. During the 81 year time period, eight flood events were recorded: 1876, 1908, two in 1915, 1927, 1937, 1955, and 1956. All events occurred in May or June, when the month of flood was available [Holbert, 1958]. Ground and aerial photography and flow data are available from the US Geological Survey (USGS), the Natural Resources Conservation Service (NRCS), and the Madison County Sanitarian's Office documenting flooding events along the Big Hole River in June 1972, along the Ruby River in 1984, and along the Big Hole, Jefferson, and Madison Rivers in June 1997.

The following information was written by Mayor Howard S. Holbert on August 23, 1958:
Flood damage seems to have been just one of the hazards of life in Montana according to newspapers. Reporting was done by local correspondents, who did not always seem to think that a normal occurrence like high water was newsworthy, unless the water overflowed into the streets or pastures. Old timers tell of when the area from the Beaverhead River west to the Big Hole was all under water nearly every spring. The mail was brought in by a swimming horse.
Even in exceptional flood years, all the newspapers did not report the floods. A cross check between papers for the same year shows that one paper would carry a story while the other would ignore the matter altogether.

Until the State Highway was built in Twin Bridges, there were two sloughs running through the town. This permitted overflows from the Beaverhead during high water to run harmlessly away. These sloughs have been filled and houses built on them and during high water or ice jams the river now has no place to go except over its bank, with subsequent flooding of the houses adjoining the river banks.
Spring high water has become less important than formerly. Heavy use for irrigation reduces the flow and the Beaverhead at Twin Bridges becomes very low. However, this year (1958) there have been fairly heavy rains. During these rains the ranchers do not irrigate so the River goes up and during the

week of June 18th to 25th the Beaverhead was bank full. If there had been a late spring, with heavy snows in the hills and heavy rains there would have been flooding.

This concludes the information we have been able to compile. Future years with heavy snow and high temperatures in November and December, followed by a quick drop in temperature will probably duplicate the ice jams and floods of 1955 and 1956.

4.4.3 PROBABILITY AND MAGNITUDE

Floodplain mapping through the National Flood Insurance Program geographically demonstrates the 100-year riverine flood probability. The 100-year floodplain has a 1% probability of being exceeded in any given year. Only those areas that are mapped have geographic depictions of their flood probabilities. For other areas, estimated probabilities can be based on the historical occurrence.

For flood, the 500-year events typically represent the worst-case scenarios. Detailed mapping of the 500-year hazard areas do not exist for Madison County. Such an event would likely cause significant problems. Damages to structures, infrastructure, and the economy could be expected in areas that have never flooded in recorded history. With only 36 flood insurance policies in force in Madison County, 6 in Ennis, 2 in Twin Bridges, and none in Sheridan or Virginia City as of January ,2017, many property owners will not have many options for financial recovery from floods since most homeowners' insurance policies do not cover flood damages. (Federal Emergency Management Agency, 2017)

Overall Flood Probability: Moderate-High
Except the Town of Ennis: Moderate
Except the Towns of Sheridan and Virginia City: Low-Moderate

4.4.4 MAPPING

Typically, as part of the National Flood Insurance Program (NFIP) assessment, the Federal Emergency Management Agency (FEMA) conducts a Flood Insurance Study (FIS) to identify the community's risk levels. The Flood Insurance Study includes statistical data for river flows, rainfall, topographic surveys, and hydrologic and hydraulic analyses. After examining the FIS data, FEMA creates Flood Insurance Rate Maps (FIRMs) delineating the different areas of flood risk. Land areas that are at high risk for flooding are called Special Flood Hazard Areas (SFHAs), or floodplains. Madison County and the jurisdictions do not have digital floodplain mapping. Parts of Ennis and Twin Bridges have paper maps available showing the hazard areas.

Table 4-9. Flood Events in Madison County (Page 1 of 2)

Date	Type	Impacts
May 1875	Riverine	"The water in the Jefferson River was high and the Ruby River was higher than usual."
June 1876	Riverine	"The Ruby River was higher than for several years, and in many places in the Ruby Valley, the bottom land resembled a little sea." "The high water of last week washed out the smelter and wheel at Iron Rod. The bridge over Pipestone Creek near Whitehall was carried away. Extra high water in Alder Creek and other creeks. Much snow on peaks and mountains." "This is not a good spring for bridges. Many have been washed out and more damaged. The Stinkingwater (Ruby), Beaverhead and Big Hole overflowed their banks. The Territorial Grange, which met in Sheridan, was not fully represented because of high water."
June 1908	Riverine	"Heavy rains throughout Montana cause disaster. Heavy rain and snow for 30 days. Heavy damage to crops, bridges out, and all three railroads were tied up due to washouts. The farmers residing near Twin Bridges were the heaviest losers in Madison County, with losses of grain crops and live stock." "The high water situation in the vicinity of Twin Bridges has not improved during the last week. Recent reports from there are to the effect that the Beaverhead River is higher than it has ever been known to be. Near the Point of Rocks on the Dillon Road the river is out of its banks and covers a stretch of country two miles wide. Low land crops under water for two weeks are ruined."
June 1913	Riverine	Jefferson River near Silver Star reached 9 feet.
May 1915	Riverine	"Rained continuously for 48 hours and let down estimated 2 inches. Heavy rains all during May. Rivers out of banks."
June 1915	Riverine	"High water washed away approach to Big Hole bridge and threatened to wash out bridge, but county crews saved it with teams. All roads nearly impassable because of rain."
June 1927	Dam Failure	Jefferson River near Silver Star reached 10 feet due to the failure of the Pattengail Dam on the Wise River during a spring snowmelt event. The high flows combined with the reservoir flows causing considerable damage to structures and bridges in Wise River and downstream. Four people were killed. "Montana Power Dam at Wise River broke. The resulting high water ran down Bridge Street in Twin Bridges. Yards, basements and houses flooded. The Fair Grounds were under water. Most ranches between Twin Bridges and Dillon were flooded and under water. The Bird and Balkovetz ranch dwellings near Pennington Bridge were in three feet of water."
June 1937	Flash	"Severe storm June 23rd. High wind and cloudbursts. Roads washed out. Wind blew Tom Novich house three feet off foundation. Eighteen inches of water on roads near Twin Bridges for a time."
February 1955	Ice Jam	Madison River near Cameron recorded a gage height of 8.37 feet due to backwater.
February 1956	Ice Jam	Madison River near Cameron recorded a gage height of 8.11 feet due to backwater.
February 1957	Ice Jam	Madison River near Cameron recorded a gage height of 8.69 feet due to backwater.
January 1962	Ice Jam	Madison River near Cameron recorded a gage height of 8.83 feet due to backwater.
June 1972	Riverine	Big Hole River
May - June 1984	Riverine	Ruby River near Alder (below reservoir) reached 8.52 feet. Ruby River near Alder (above reservoir) reached 6.24 feet. Beaverhead River near Twin Bridges reached 7.88 feet, the height of record for the site.
1995	Ice Jam	Debris caught in a culvert caused ice jamming and flooding Ennis along Moores Creek.

Table 4-6. Flood Events in Madison County (Page 2 of 2)

Date	Type	Impacts
June 1997	Riverine	Flooding along the Big Hole, Jefferson, and Madison Rivers caused damage to buildings, agricultural operations, and infrastructure such as bridges and roads along and across the rivers.
May 30 – June 5, 2003	Riverine	Snowmelt brought the Big Hole and Jefferson Rivers over their banks. Lowland pastures were flooded, and rural roadways and a few homes were threatened.
January 8, 2009	Ice Jam	An ice jam on the Ruby River just south of Twin Bridges (upstream of the Seyler Lane Bridge) caused minor flooding of low-lying areas. Pasture land and a few outbuildings were affected.
January 11, 2011	Ice Jam	Ice jamming on the Madison River flooded Highway 287 from the town of Ennis to Odell Creek.
June 7, 2011	Heavy Rain/ Snow Melt	Rain and snowmelt. Presidential Disaster Declaration for Montana made on 6/17/11
July 1, 2011	Heavy Rain/ Snow Melt	Rapid snowmelt caused flooding on area streams and creeks across Madison county. Original start date was 06/30/11 and flooding continued through the first week of July
December 27, 2016	Ice Jam	Emergency management reported an ice jam on the Madison River causing flooding near Ennis. The flooding was occurring along portions of the Madison River and Odell Creek. Water was covering the US-287 bridge near Ennis, at mile marker 48.2.
March 15, 2017	Flash Flood	Virginia City. Warm temperatures caused rapid snowmelt and a large amount of runoff into Daylight Creek in Virginia City flooding 3 roads including Highway 287. The water flooded the streets within an hour of first report and receded within 24 hours.

Sources: Holbert, 1958; US Soil Conservation Service, 1986; National Climatic Data Center, 2009; US Geological Survey, 2016; Federal Emergency Management Agency, no date; Newspaper excerpts from The Madisonian, Sheridan Enterprise, and Madison County Monitor.

Table 4-10. Madison County Flood Declared Disasters and Emergencies [Montana Disaster and Emergency Services, 2016]

Declaration	Year	Additional Information	Casualties	Damages/Assistance
FEMA-1996-DR	2011	18 counties designated for public assistance, Madison County plus 29 other counties Individual assistance + Public assistance, 1 county designated as individual assistance		Total $6,708,117.08- IA $41,980,729.04 -PA
FEMA-1183-DR-MT	1997	Madison County, plus 20 other counties and 1 reservation		$7,696,015 PA[(a)]
ST-84-2 (state)	1984	Madison County		$191,245 state share $27,860 local share

(a) Figures are for all Montana counties/reservations included in the declaration.

In 2005, GIS mapping of the 100-year flood inundation area was developed for the Big Hole River by DTM Consulting and Applied Geomorphology located in Bozeman, Montana. In 2014 the DNRC contracted approximate level floodplain analysis for 117 miles of the Big Hole River. This analysis was the final phase in conducting a NFIP approximate level floodplain study for most of the entire length of the Big Hole River. Floodplain mapping was performed using ESRI ArcMap 10.0 in conjunction with Atkins' aforementioned proprietary floodplain mapping tool RASGEO. Using RASGEO, the results of the

modeled 1- and 0.2- percent-annual-chance events were used to create a DEM of the respective water surface profiles. RASGEO then intersects the water surface DEMs with the 5-m DEM to delineate the boundaries of the respective floodplains. While creating the final floodplain shapefiles, the majority of islands found within the floodplains of the 1- and 0.2-percent-annual-chance events were removed. All island areas that were deemed higher than the adjacent 1- and 0.2-percent-annual-chance water surface profile that were less than one acre in size were removed using ArcMap 10.0. Any backwater areas that extended through multiple cross sections were also modified to represent the elevation associated at the point which the backwater initiates from the main channel. These adjustments provide a slight variance in the mapped widths versus the top widths described by the HEC-RAS model. A model and mapped top width check was performed where discrepancies are documented, included as Appendix C. Note that larger islands and islands relating to residences or roadway embankments were left as originally mapped [Big Hole River Approximate Level Floodplain Study Hydraulic Analysis and Floodplain Mapping, 2014].

Alternatively, FEMA's HAZUS-MH Flood Module software uses sophisticated GIS technology to show the estimated flood hazard areas. A 500-year analysis was conducted for Madison County along the Madison, Ruby, Beaverhead, and Jefferson Rivers using default HAZUS-MH data. Figure 4-7 shows the hazard areas along the Big Hole, Beaverhead, and Jefferson Rivers.

The dam inundation maps for the hazardous dams in and near Madison County are available in paper format and can be found in the Madison County Sheriff's office, as well as the State DES office in Helena, Montana.

4.4.5 VULNERABILITES

Riverine flood losses were estimated by comparing the Big Hole River and HAZUS-MH 500-year estimated floodplains to countywide structure and infrastructure data. In addition, essentially any structure or infrastructure in the county or the jurisdictions could experience flash flood damages; these damages all depend on exactly where the heavy rain or snowmelt occurs.

The type of property damage caused by flood events depends on the depth and velocity of the floodwaters. Faster moving floodwaters can wash buildings off their foundations and sweep cars downstream. Extensive damage can be caused by basement flooding. Most flood damage is caused by water saturating materials susceptible to loss such as wood, insulation, wallboard, fabric, furnishings, floor coverings, and appliances.

FEMA's Benefit-Cost Analysis Module determines damage percentages for various building types. Table 4-11 shows the estimated percentages of building and contents losses from flooding at depths of 1 foot, 3 feet, and 6 feet.

Areas that are particularly vulnerable to flooding are the Waterloo area in the north end of the county, rural areas around Twin Bridges, rural areas around Ennis, and all areas along the Madison River, Ruby River, Beaverhead River, Big Hole River, and Mill Creek which runs through Sheridan.

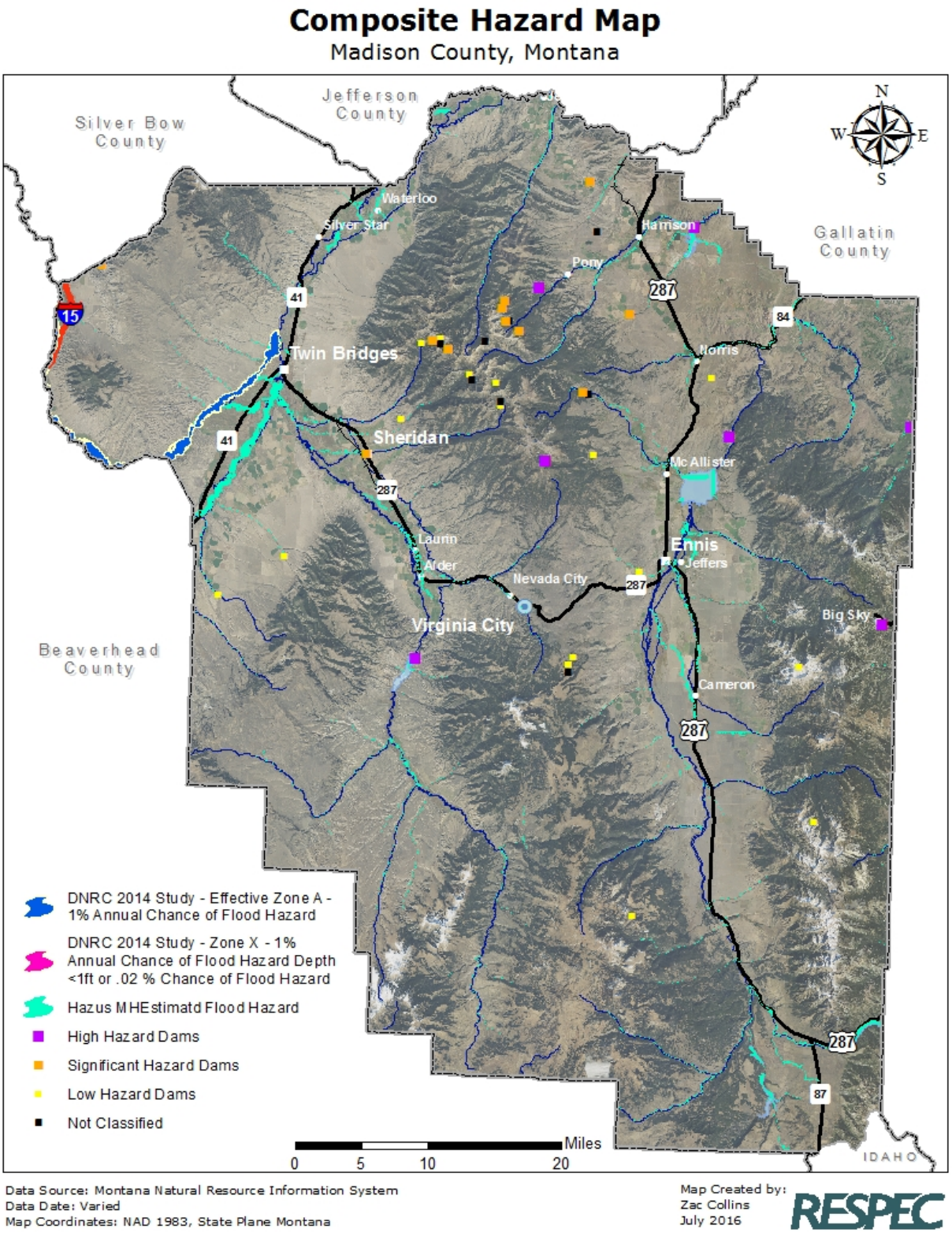


Figure 4-7. Need Caption.

Table 4-11. Flood Building and Contents Loss Estimation Percentages

Structure Type		Flood Depth		
		1 foot	3 feet	6 feet
RES1, One Story With No Basement	Building Damage (%)	23	40	59
	Content Damage (%)	26	44	64
RES1, Two Story With No Basement	Building Damage (%)	12	18	24
	Content Damage (%)	11	23	39
RES1, One story With Basement[(a)]	Building Damage (%)	32	46	65
	Content Damage (%)	19	25	32
RES1, Two story With Basement	Building Damage (%)	21	29	44
	Content Damage (%)	18	29	42
RES2,- Manufactured Housing	Building Damage (%)	44	73	81
	Content Damage (%)	27	64	78

(a) By default, Hazus now uses the damage functions from the FEMA Benefit Cost Analysis tool which may greatly increase loss estimates for these specific building types than versions of Hazus before Hazus 3.0 [Federal Emergency Management Agency, 2016]

4.4.5.1 CRITICAL FACILITIES

Data included with HAZUS-MH has a few of the critical facilities, but does not include all of them. During the 500-year event one hospital was determined to have moderate damage. In total, HAZUS projected a loss of just over 1 million dollars. While this estimate is encouraging, comparing the more detailed database of critical facilities to the estimated flood hazard areas and dam inundation areas shows that some facilities are vulnerable to floods;. None of the critical facilities lie within the effective DNRC 2014 study or Willow Creek Dam inundation area. Losses from flash floods are always possible to essentially any facility.

Possible losses to critical facilities include:

- Structural losses
- Contents losses
- Vehicle losses
- Critical functional losses
- Critical data losses

Expected Flood Impact to Critical Facilities: Moderate
Except the Towns of Ennis, Sheridan, and Virginia City: Low-Moderate

4.4.5.2 CRITICAL INFRASTRUCTURE

Critical infrastructure is often threatened by floods. The most common losses are to roads, bridges, water systems, and sewer systems. Clark Canyon Dam threatens a large portion of Montana Highway 41.

Possible losses to critical infrastructure include:

- Road, bridge, and culvert losses
- Water and sewer system losses
- Contaminated wells
- Blocked, flooded roads
- Electric service disruptions
- Railroad losses
- Telephone service disruptions.

Expected Flood Impact to Critical Infrastructure: Moderate-High
Except the Towns of Ennis, Sheridan, and Virginia City: Moderate

4.4.5.3 STRUCTURES

Structure data for Madison County was compared to the various flood hazard areas. Table 4-12 shows the results using data generated by HAZUS-MH and the DNRC 2014 Big Hole River Study. HAZUS-MH runs were used to estimate damages to structures for 500-year floods along the Beaverhead and Jefferson Rivers using census block data.

In a similar fashion to the critical facilities, the local structure database was compared to the 2014 DNRC Big Hole River 100/500year flood hazard areas and HAZUS-MH calculated100 / 500-year flood hazard areas. Table 4-13 shows the estimated number of structures within the hazard areas and their associated building values.

Table 4-12. Estimated Year Flood Exposure [Big Hole River Study 100 yr and 500 yr; 2015 Hazus 3.1, 2016]

Study Area	Estimated Number of Structures in the Flood Hazard Area	Estimated Total Building Value ($)
100 Yr County (HAZUS-MH)	204	36,719,575
500 Yr County (HAZUS-MH)	65	9,222,293
Big Hole River Study (DNRC) 100 Yr	29	7,822,844
Big Hole River Study (DNRC) 500 Yr	1	117,270

Table 4-13. Dam Failure Exposure in Madison County [Northwestern Energy, 2016]

Dam Inundation Area	Estimated Number of Structures in the Dam Inundation Area	Estimated Total Building Value ($)
Hebgen Dam	509	100,865,175
Madison Dam	1	3,170

Madison County does not have any National Flood Insurance Program repetitive loss properties as of January 31, 2016. A repetitive loss property is defined as "any insurable building for which two or more

claims of more than $1,000 were paid by the National Flood Insurance Program (NFIP) within any rolling ten-year period, since 1978" [Federal Emergency Management Agency, 2016].

Regular homeowners' insurance typically does not cover flood losses. Therefore, to financially protect their properties, owners must purchase flood insurance. Table 4-14 shows the flood insurance statistics for Madison County.

Possible losses to structures include:

- Structural losses
- Contents losses
- Vehicle losses
- Displacement losses

To minimize the loss of structures in a flooding event, the proper sizing of culverts for future construction will offer the water the ability to flow with in the structures network to remove water from areas of low elevation. Existing culverts can be maintained regularly to insure that when needed they will perform correctly.

Expected Flood Impact to Structures: Moderate
Except the Towns of Ennis, Sheridan, and Virginia City: Low-Moderate

Table 4-14. National Flood Insurance Program Statistics [FEMA. 2017]

Location	Policies	Insurance In-Force ($)	Total Loss Payments 1978–November 2008 ($)
Madison County unincorporated areas	36	11,618,300	13,023
Town of Ennis	6	1,407,600	0
Town of Sheridan	0	0	0
Town of Twin Bridges	2	560,000	13,068
Town of Virginia City	0	0	0

4.4.5.4 POPULATION

Slow-rising riverine floods usually have a fair amount of warning time and allow people to evacuate from the hazard areas. Based on the history involving rescues of people and animals, the entire population has not historically heeded or received warnings. Flash floods may not have lengthy lead times. Heavy rains can quickly inundate areas not typically prone to flooding and roads can washout and become a hazard to vehicle occupants. Normally dry channels may fill up with rushing waters. Throughout the United States, an average of 127 people die each year from floods, based on the 30-year average, which compares to 73 deaths by lighting, 68 by tornadoes, and 16 from hurricanes within the same time period [National Weather Service, 2017a].

Expected Flood Impact to the Population: Moderate
Except the Town of Sheridan: Low-Moderate

4.4.5.5 ECONOMIC, ECOLOGIC, HISTORIC, AND SOCIAL VALUES

Possible economic losses include:

- Agriculture losses due to reduced profits, damaged crops, killed livestock, or delays in planting
- Transportation delays due to road infrastructure losses or closures
- Business interruptions and physical losses

Possible ecologic losses include:

- Flooding typically benefits riparian areas, but ecologic losses could occur if toxins were released into the flood waters

Possible historic losses include:

- Structural, contents, and physical losses to historic properties from flood waters

Possible social losses include:

- Cancelled activities due to road infrastructure losses or damaged properties
- Emotional impacts from long term evacuations and property losses

Expected Flood Impact to the Values: Moderate-High
Except the Towns of Ennis, Sheridan, and Virginia City: Moderate

4.4.5.6 FUTURE DEVELOPMENT

The Towns of Ennis and Twin Bridges participate in the National Flood Insurance Program and have ordinances regulating development in and around floodplain areas. All other areas of the county are not mapped. Madison County uses setbacks in unincorporated parts of the county. New development in unmapped areas or outside the setbacks could potentially occur in areas prone to flooding and increase vulnerabilities and potential losses, however, most of the current land use regulations require the consideration of flood hazards during the development review process. Madison reviewed and updated the county Floodplain Hazard Management Regulations in January of 2017

Subdivisions within the Regulated Flood Hazard Areas, including new or expansion of existing manufactured home parks, must be designed to meet the following criteria [Madison County Floodplain Hazard Management Regulations, 2017]:

1. The Base Flood Elevations (BFE) and boundary of the Regulated Flood Hazard area must be determined and considered during lot layout and building location design
2. Locations for future structures and development must be reasonably safe from flooding Adequate surface water drainage must be provided to reduce exposure to flood hazards;
3. Public utilities and facilities such as sewer, gas, electrical and water systems must be located and constructed to minimize or eliminate flood damage
4. Access to developed areas must be designed to be at least two feet above base flood elevation
5. Floodplain permits must be obtained according to these regulations before development occurs that is within the Regulated Flood Hazard Area.

Floodplains are an important consideration in the review of proposed subdivisions. Flooding is considered a hazard that can preclude subdivision development. Review by the Floodplain Management Section of the Montana Department of Natural Resource and Conservation may be required, and compliance with the Madison County Floodplain Management Ordinance is required. Recognition is made of the fact that unsuitable floodplain development can pose a threat the health, safety, and welfare of existing and future residents.

Expected Flood Impact to Future Development: Moderate

4.4.6 DATA LIMITATIONS AND OTHER FACTORS

The data limitations related to the flood hazard include:

- Quantifying all of the losses that occur during major floods, especially when some are covered by insurance and others are not
- Lack of detailed floodplain mapping in many areas

Other hazards often related to flood include:

- Hazardous material release
- Winter storms that produce heavy snow
- Severe thunderstorms with heavy rain

4.5 HAZARDOUS MATERIAL RELEASE

4.5.1 DESCRIPTION

A hazardous material release is the contamination of the environment (i.e. air, water, soil) by any material that because of its quantity, concentration, physical characteristics, or chemical characteristics threatens human, animal, or plant health, the environment, or property. The term "hazardous materials" refers generally to hazardous substances, such as petroleum, natural gas, synthetic gas, acutely toxic chemicals, and other toxic chemicals. The term "extremely hazardous substances" is used to refer to those chemicals that could cause serious health effects following short-term exposure from accidental releases. The US Environmental Protection Agency lists over 300 extremely hazardous substances for which emergency planning is required [US Environmental Protection Agency, 2009]

An accidental or intentional release of materials could produce a health hazard to those in the area, downwind, and/or downstream with immediate, prolonged, and/or delayed effects. The spread of the material may additionally be defined by weather conditions and topography of the area. A hazardous material release can come from a fixed facility, via its transportation, or intentionally in the case of terrorism. Even nuclear fallout from an upwind nuclear power plant is possible.

Reports of spills and releases of hazardous materials are increasingly commonplace. Thousands of new chemicals are developed each year. Citizens of Madison County are concerned about accidents (highway incidents, warehouse fires, train derailments, and shipping accidents) happening in Madison County. As evident by the results of the public meetings, many people in Madison County consider hazardous materials incidents to be one of the most significant threats facing the county.

Madison County has no major fixed hazardous material facilities with the exception of gas and propane storage facilities. The largest in the county is the 270,000 gallons of jet fuel at the airports as well as the sulfuric acid that is stored in the batteries for multiple cell towers in the county. These cell towers fall under state tier II reporting for hazardous materials required by the Federal Emergency Planning and Community Right to Know Act) (EPCRA) regulations Another concern of most involved participants in the pre-disaster mitigation planning process is an accident involving hazardous material in transit through Madison County. The most likely locations for a transportation-related hazardous material release are along the interstates and federal and state highways. The roadways in Madison County include a small section of Interstate 15, Interstate 90 in nearby Jefferson County, US Highway 287, and Montana Highways 41, 84, 87, and 287. Other areas of concern are those areas near the Montana Rail Link branch lines in and around the northern part of the county.

A hazardous material release within Madison County could immediately overwhelm the response capability of the emergency services in Madison County. Madison County does not have a local hazardous material response capability.

Worst case scenarios include those releases in one of the more densely population centers in Madison County. Both Twin Bridges and Ennis have major transportation routes going through the town, and in both cases, carriers must come to a complete stop at a "T" intersection.

A commercial carrier transporting hazardous materials north along Montana Highway 41 must stop at the intersection of Montana Highway 41 and Montana Highway 287 in downtown Twin Bridges. If the carrier fails to stop or fails to negotiate this turn, the accident and subsequent hazardous material release could directly impact the downtown business district of Twin Bridges. Buildings potentially damaged include the Ruby Valley National Bank, U.S. Post Office, Blue Anchor Bar, Blue Anchor Cafe, NAPA Store, Headwater Reality, McAlear Pharmacy, and grocery stores. This area is also located less than two blocks from the Twin Bridges High School and the Twin Bridges Elementary School.

A commercial carrier transporting hazardous materials south along US Highway 287 must stop at the intersection of US Highway 287 and Montana Highway 287 in Ennis. If the carrier fails to stop or fails to negotiate this turn, it could crash into the Ennis Elementary School grounds. A hazardous material release at this location could impact the Ennis Elementary School, the Ennis High School, the Madison Valley Manor (a nursing home), the Madison Valley Hospital and Clinic, the Ennis Community Children's School, and the Town Pump gas station.

4.5.1.1 WARNINGS, WATCHES, AND ADVISORIES

Warnings in Madison County and the Towns of Ennis, Sheridan, Twin Bridges, and Virginia City may occur for a variety of reasons, including, but not limited to, bioterrorism, communicable disease, dam failure, flood, hazardous material release, hazardous weather, terrorism, civil unrest, volcano, wildfire, or any other hazard that leads to a situation requiring protective actions by the public. Warnings are most often issued for weather events.

As technology improves, the number of methods to disseminate warnings effectively is increasing. The options currently available to Madison County include:

- Emergency Alert System (EAS)

- Reverse calling
- Warning siren in Ennis
- Public address systems / Loud speakers
- Door-to-door/Face-to-face notifications

In many cases, a combination of methods may be most effective.
Source Madison County Emergency Operations Plan, 2017; National Weather Service, 2016

4.5.2 HISTORY

Based on information from the National Response Center database, Table 4-15 lists the hazardous material incidents for Madison County. Note this database likely does not contain all incidents, only those responses reported to federal officials.

Table 4-15. Hazardous Material Releases from 1990-2007 [National Response Center, 2016]

Date	Location	Material	Cause/Impacts
March 8, 1990	Madison Dam	Governor Oil 15 gallons	Power house pipeline rupture.
November 14, 1991	Ennis Lake	Diesel Motor Oil	Roadway gave way causing a forklift to go into the water.
July 3, 1995	Sheridan, ¼ mile S	Anhydrous Ammonia 34 gallons	Temperature fluctuations caused seepage from vapor valve on a nurse tank.
December 18, 1996	Ennis Lake	Hydraulic Oil 3 gallons	Spilled during maintenance of a hydraulic cylinder on a head gate.
August 12, 1998	Madison Dam	Hydraulic Oil 1 gallon	The oil seal on the dam's screen rake failed.
March 12, 2002	North Meadow Creek, McAllister	Unknown Oily Sheen	Sheen found on the creek.
May 21, 2002	Big Sky	Photo Processing Chemicals	Chemicals were being poured down the sink drain.
January 21, 2003	Cameron, 6 miles S	Transmission Oil 71 gallons	Hose broke on production drill.
January 20, 2004	Madison Dam	Hydraulic Fluid, Vegetable Based, 1 cup	Spill of fluid when performing maintenance.
January 26, 2004	Cameron	Transmission Fluid 55 gallons	Frozen valve on a production drill.
March 9, 2004	Cameron	Hydraulic Oil 40 gallons	High pressure in the hydraulic tank of a drill.
January 14, 2005	Big Sky	Diesel 50 gallons	A stump ruptured the fuel tank of a snow cat.
May 10, 2007	Treasure Mines	Hydraulic Oil 50 gallons	Equipment failure on a loader.
August 30, 2010	Madison Hydroelectric	Hydraulic Oil	Spill Of 25-50 Gallons Of Hydraulic Oil. Caused By Falling Rock
November 19, 2015	Private Residence (Alder)	Unknown	Dumping Of An Unknown Material Into The Ground In A Residential Community By A Private Enterprise.

Table 4-16. Madison County Hazardous Material Release Declared Disasters and Emergencies

Declaration	Location	Date	Magnitude	Casualties	Damages
None					

4.5.3 PROBABILITY AND MAGNITUDE

Since 1990, 15 reports of hazardous material incidents have been documented. Based on this history, a hazardous material release can be expected about every 1-2 years in Madison County. The frequency of relatively minor hazardous material releases is likely much greater as not all incidents get recorded in the national database.

Although only hazardous material releases with limited damages have occurred in Madison County in the past, the potential exists for a release with human and property impacts. A serious, yet plausible, scenario includes the release and explosion of a substance such as fuel or propane, particularly in the vicinity of the primary highways. Affected areas from these types of releases could extend as far away as 1 mile downwind. The greatest magnitude events include those that occur within close proximity to a populated area.

Overall Hazardous Material Release Probability: Moderate
Except the Towns of Ennis and Twin Bridges: Moderate-High

4.5.4 MAPPING

A hazardous material release can occur anywhere. Buffer zones around the primary hazardous materials transportation routes show the areas that would most likely be affected by a transportation-related hazardous material incident. Table 4-17 shows the evacuation radii for a few common hazardous materials. This list is generalized for planning purposes and is certainly not all-inclusive. Emergency responders should rely on other sources for more detailed information.

Table 4-17. Evacuation Radii for Hazardous Material Releases [US Department of Transportation, 2016]

Material	Potential Hazard	Initial Isolation	Evacuation
Anhydrous Ammonia	Corrosive, Toxic	1 mile	1 mile
Diesel Fuel/Gasoline	Highly Flammable	150 feet	1,000 feet
Ammonium Nitrate Fertilizers	Oxidizer	150 feet (liquids) 75 feet (solids)	Up to .5 miles
Propane	Extremely Flammable	330 feet	Up to 1 mile

4.5.5 VULNERABILITIES

The buffers around the highways shown in Map 4.6.4B represent those areas with an enhanced risk from a hazardous materials release based on their proximity to regular hazardous materials transportation routes and infrastructure. Along the highways, buffer zones of 150 feet, 330 feet, ½ mile, and 1 mile were established based on the initial isolation and evacuation radii for diesel fuel/gasoline and propane releases, as shown in Table 4.5.4A. For the railroad, the buffers were 500 feet and 1.4 miles for anhydrous ammonia. Note that the actual evacuation zones are highly dependent on factors such as

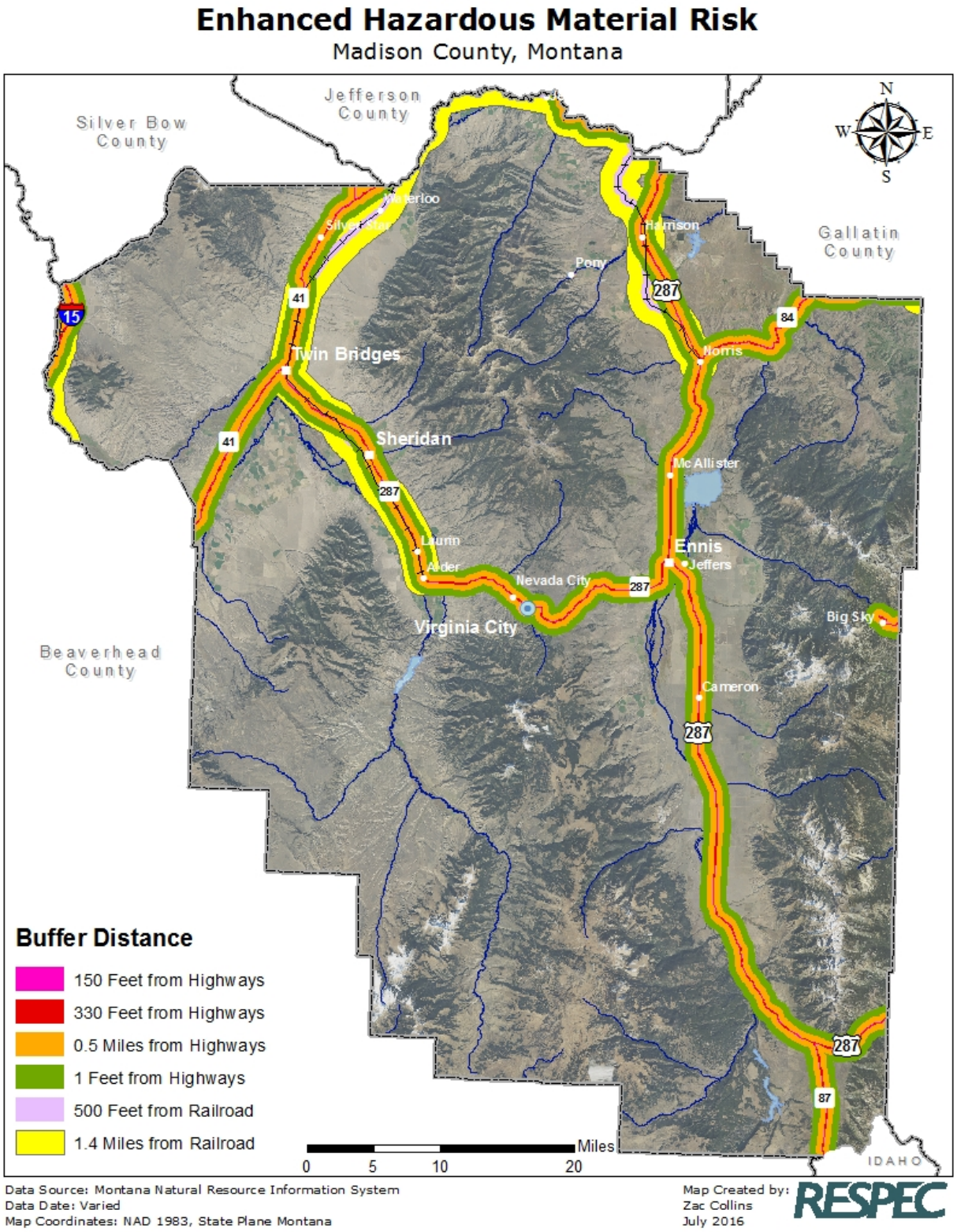


Figure 4-8. Need Caption and Callout.

wind speed, wind direction, material released, and quantity released. Like most other hazards, in an actual event, the entire risk area likely won't be affected, but a small section surrounding the spill location may.

4.5.5.1 CRITICAL FACILITIES

Based on these buffer zones, the highest risk critical facilities can be identified. Should a hazardous material release affect one of the critical facilities, the level of emergency services available could be reduced. A release near a special needs facility may present unique evacuation challenges. Of the 136 mapped critical facilities in Madison County, 103 are within ¼ mile, 11 are within ½ mile, 19 are within on mile, and 3 are further than a mile.

Possible losses to critical facilities include:

- Critical functional losses
- Contamination
- Structural and contents losses, if an explosion is present

Expected Hazardous Material Release Impact to Critical Facilities: Low-Moderate

4.5.5.2 CRITICAL INFRASTRUCTURE

Most hazardous material releases do not usually have an effect on infrastructure, particularly underground infrastructure. Some critical infrastructure uses hazardous materials to operate such as chlorine for water treatment and PCBs for electric transformers. Similarly, the contamination of the water supply may be treated like a hazardous material release. Propane, oil, and natural gas, necessary fuels for heating, can also be hazardous if released during their delivery due to their explosive potential. Transportation may be limited if a key roadway or railway is blocked by an incident.

Possible losses to critical infrastructure include:

- Contamination
- Blocked roadways
- Physical losses, if an explosion is present

Expected Hazardous Material Release Impact to Critical Infrastructure: Low

4.5.5.3 STRUCTURES

Comparing the structure databases to the buffer zones, Table 4-18 shows the estimated number of structures within the high hazard areas.

Table 4-18. Structure Vulnerabilities to Hazardous Material Releases

Within the Buffer Zone	Estimated Total Number of Structures
<150 feet	375
150 - 330 feet	483
330 - ½ mile	1,894
½ mile - 1 mile	713
> 1 mile	2,239

Fortunately, unless an explosion is present with the release, structures are typically not damaged in a hazardous materials release.

Possible losses to structures include:

- Inaccessibility
- Contamination
- Structural and contents losses, if an explosion is present

Expected Hazardous Material Release Impact to Structures: Low-Moderate

4.5.5.4 POPULATION

The population impacts are often greater than the structural impacts during a hazardous material release. Depending on the material, the health impacts to humans can be long and short term. A release in Madison County could threaten the population. Table 4.5.5B shows the estimated population within each of the buffer zones. These estimates are based on 2.1 people per structure. Greater population concentrations may be found in communities, special needs facilities, and businesses. Generally, an incident will affect only a subset of the total population at risk.

Table 4-19. Population Vulnerabilities to Hazardous Material Releases [US Census Bureau, 2009–2013]

Within Buffer Zone	Estimated Total Number of Structures	Estimated Population
<150 feet	375 structures	788 people
150 - 330 feet	483 structures	1014 people
330 feet - ½ mile	1,894 structures	3977 people
½ mile - 1 mile	713 structures	1497 people
> 1 mile	2,239 structures	4702 people

In a hazardous material release, 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 evacuate, depending on the weather conditions, material released, and public notification.

Expected Hazardous Material Release Impact to the Population: Moderate-High
Except the Towns of Ennis and Twin Bridges: High

4.5.5.5 ECONOMIC, ECOLOGIC, HISTORIC, AND SOCIAL VALUES

Possible economic losses include:

- Business closures and associated business disruption losses

Possible ecologic losses include:

- Loss of wildlife
- Habitat damage
- Reduced air and water quality

Possible social losses include:

- Cancelled activities
- Emotional impacts of significant population losses and illnesses

Expected Hazardous Material Release Impact to the Values: Moderate

4.5.5.6 FUTURE DEVELOPMENT

Madison County and the surrounding areas are rich in natural resources and the continued development of industries related to these natural resources is a distinct possibility. New development may increase the number of people and facilities exposed to hazardous material releases.

Expected Hazardous Material Release Impact to Future Development: Low-Moderate

4.5.6 DATA LIMITATIONS AND OTHER FACTORS

The data limitations related to the hazardous material release hazard include:

- Estimating what substances and the quantity that may be released in any given location
- Lack of a study with the numbers and types of hazardous materials being hauled on the highways in the county

Other hazards often related to hazardous material releases include:

- Transportation accident
- Flood
- Strong wind
- Tornado
- Wildfire
- Structure collapse
- Winter storm
- Earthquake
- Terrorism

4.6 LANDSLIDE AND AVALANCHE

4.6.1 DESCRIPTION

Landslides and avalanches are similar in nature such that both occur when a material on the surface of the earth cannot be supported any longer and gives way to gravity. In the case of an avalanche, the substance is snow, and for a landslide, the substance is mud, rock, or other geologic material. Both can occur rapidly with little warning.

4.6.1.1 LANDSLIDE

A landslide is the movement of rock, soil, artificial fill, or a combination thereof on a slope in a downward or outward direction. The primary causes of landslides are slope saturation by water from intense rainfall, snowmelt, or changes in ground-water levels on primarily steep slopes, earthen dams, and the banks of lakes, reservoirs, canals, and rivers. (US Geological Survey, 2004) Other causative factors

include steepening of slopes by erosion or construction, alternate freezing or thawing, earthquake shaking, volcanic eruptions, and the loss of vegetation from construction or wildfires. The saturation or destabilization of a slope allows the material to succumb to the forces of gravity or ground movement.

Many different types of landslides exist: slides, falls, topples, flows, and lateral spreads. Slides involve the mass movement of material from a distinct zone of weakness separating the slide material from the more stable underlying material. The primary types of slides are rotational slides and translational slides. Falls occur when materials, mostly rocks and boulders, fall abruptly from a steep slope or cliff. Falls are strongly influenced by gravity, mechanical weathering, and the presence of interstitial water. Topples are similar to falls, yet they pivot around a connection point at the base of the material and are most often caused by gravity or fluids in the cracks of the rocks. Flows typically have a higher percentage of water material embedded in them and behave more like a liquid than other types of landslides. The five primary categories of flows are: debris flows, debris avalanches, earthflows, mudflows, and creeps. Lateral spreads usually occur on gentle slope or flat surfaces when liquefaction occurs and leads to fractures on the surface. Complex landslides involve any combination of these types [US Geological Survey, 2004].

Landslides are typically associated with mountainous regions, but they can also occur in areas of low relief. In these areas, the landslides are often the result of cut-and-fill failures (from roadway and building excavations), river bluff failures, lateral spreading, or mine collapse [US Geological Survey, 2004].

4.6.1.2 AVALANCHE

When snow accumulations on a slope cannot be supported any longer, the snow support structure may break and fall creating an avalanche. The subsequent rush of unsupported snow can bury and move things in its path. The majority of avalanches do not cause any damage; occasionally however, people and property may fall in their paths.

> *An avalanche is a mass of loosened snow, ice, and/or earth suddenly and swiftly sliding down a mountain. Avalanches occur throughout the mountains of Montana and, to a limited extent, elsewhere in the state. Avalanche hazards most-directly threaten winter recreationists and communication and transportation networks in mountainous regions. Two of Montana's ski areas, Bridger Bowl and Big Sky, are respectively the second and fourth most avalanche-prone ski resorts in the entire United States.*
>
> *The avalanche hazard is more localized in mountain regions. Avalanche-prone areas are well known; avalanche chutes identify where they will likely occur again. Where communities have built or developments have encroached into steep mountainous terrain, the vulnerability increases. Most of the exposure to the population is in winter recreation areas.*
>
> *The complex interaction of weather and terrain factors contributes to the location, size, and timing of avalanches. In the absence of detailed scientific observation, any accumulation of snow on a slope steeper than 20 degrees should be considered a potential avalanche hazard.*
>
> *The most certain sign of avalanche hazard is avalanche activity. Usually when one slope is hazardous, many of the nearby slopes are also hazardous. The historical record shows numerous cases where rescue parties searching for avalanche victims themselves become victims of the same avalanche cycle.* Source: Montana DES, 2016

Over the last 10 avalanche seasons an average of 27.8 people died in avalanches each winter in the United States. The Montana average is 4.2 persons per year over the same 10 year period. To date, the State of Montana has had 111 deaths relating to avalanches since 1951. Almost every fatal accident is investigated and reported. There is no way to determine the number of people caught or buried in avalanches each year because most non-fatal avalanche incidents are not reported.

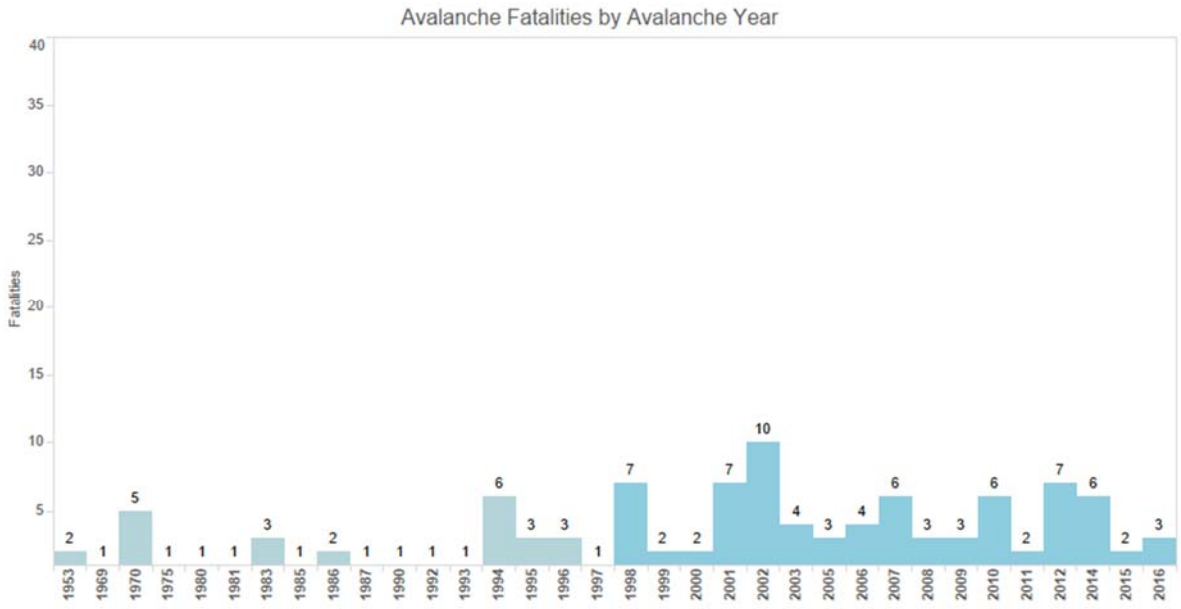


Figure 4-9. Need Caption and Callout [Colorado Avalanche Information Center, US Avalanche Accident reports Montana, 2016].

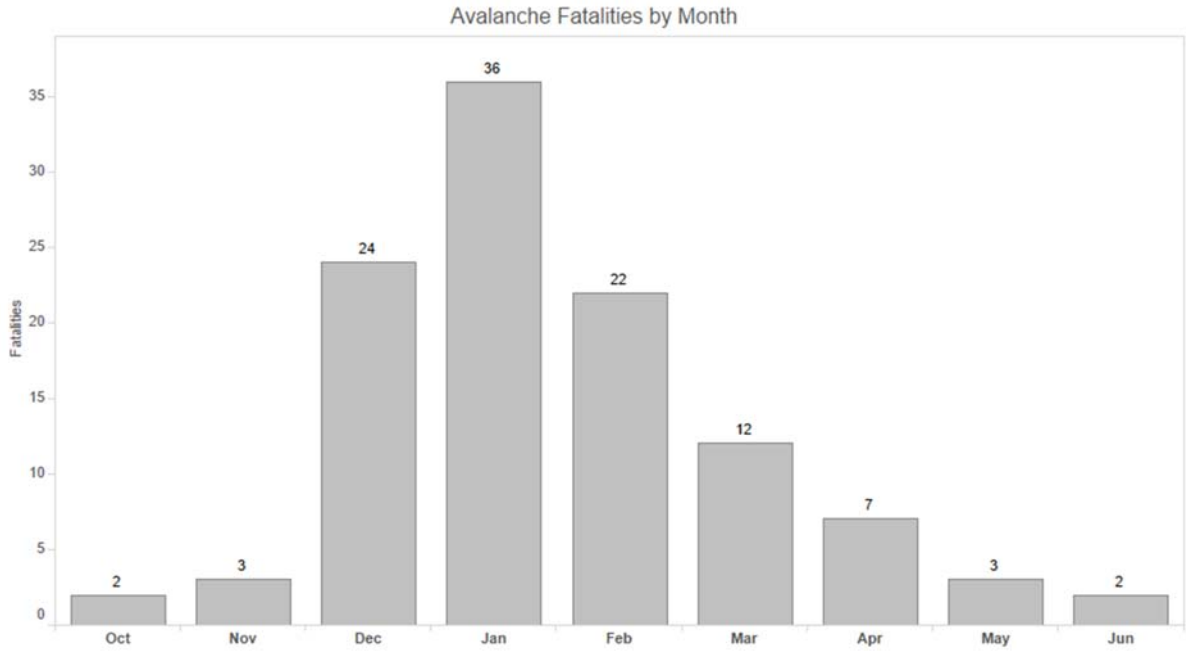


Figure 4-10. Need Caption and Callout [Colorado Avalanche Information Center, US Avalanche Accident reports Montana, 2016].

According to the Montana Disaster and Emergency Services [2009a] website, "If it is assumed that an accumulation of snow is possible anywhere in Montana, then we can evaluate the potential for hazard solely on the basis of terrain characteristics. The most important factor by far is terrain steepness. Wet snow avalanches can start on slopes of 20 degrees or less, but the optimum slope angle for avalanche starting zones is 25-45 degrees. Slopes steeper than 45 degrees will not normally retain enough snow to generate large avalanches, but they may produce small sluffs that trigger major avalanches on the slopes below. Therefore, all slopes of 20 degrees and greater should be considered as potential avalanche sites."

4.6.1.3 WARNINGS, WATCHES, AND ADVISORIES

Since the most destructive landslides are often related to heavy rains and flash flooding, the National Weather Service issues flash flood watches and warnings as described below. These types of alerts are likely during potentially significant landslides.

- **Flash Flood Watch:** Flash flood watches inform the public of conditions which may cause short duration, intense flooding from heavy precipitation, snow melt, dam failure, or ice jams within the next 36 hours, but the flooding is neither certain nor imminent.
- **Flash Flood Warning:** Flash flood warnings are issued when flooding is imminent during short term events requiring immediate action. Flash flooding occurs when the water level rises rapidly to inundation within 6 hours of a causative event (i.e. heavy precipitation, snow melt, dam failure, or ice jams).

Source: National Weather Service, 2006

Avalanche warnings may be issued by the National Weather Service in conjunction with the Gallatin National Forest Avalanche Center. This type of warning brings attention to severe avalanche dangers. Otherwise, during avalanche season, the Gallatin National Forest Avalanche Center issues detailed advisories outlining the avalanche hazards. The US Avalanche Danger Scale includes the following levels:

- **Extreme Avalanche Danger:** Avoid all avalanche terrain. Travel only on gentle slopes well away from areas affected by avalanches.
- **High Avalanche Danger:** Very dangerous conditions. Travel in avalanche terrain is not recommended. Extensive skill, experience, and local knowledge are essential.
- **Considerable Avalanche Danger:** Dangerous avalanche conditions. Use conservative decision making, careful route finding, and good travel habits. Training and experience are essential.
- **Moderate Avalanche Danger:** Dangerous avalanche conditions on some terrain features. Evaluate the snow and terrain carefully and use good travel habits.
- **Low Avalanche Danger:** Generally safe avalanche conditions. Watch for unstable snow on isolated terrain features.

Source: Utah Avalanche Center, 2009.

4.6.2 HISTORY

Landslides and avalanches occur seasonally in Madison County. None have made enough of an impact to result in a disaster declaration. The massive landslide triggered by the 1959 earthquake caused fatalities and property losses. See the earthquake hazard profile for more details. Avalanches have not led to large-scale disaster losses; however significant search and rescue resources are often needed for backcountry rescues and recoveries. Table 4.6.2A shows some of the more significant avalanches over the past 10.5 years.

Table 4-20. Fatal or Near Fatal Avalanches [Avalanche.org, 2016]

Location	Date	Impacts
MacAtee Basin south of Big Sky	1/23/1999	1 snowmobiler buried and rescued
Arasta Creek in Gravelly Range	3/6/1999	1 snowmobiler buried and rescued
Lone Mountain near Big Sky	11/26/1999	1 skier killed
Arasta Creek in Gravelly Range	1/26/2002	1 snowmobiler buried and rescued
Sphinx Mountain in Madison Range	10/30/2004	2 climbers killed
Beehive Basin near Big Sky	1/20/2008	1 skier killed
Black Butte area of Gravelly Range	1/17/2009	1 snowmobiler killed
Granite Peak Avalanche	10/31/2009	3 skiers caught
Lenin, Big Sky Ski Resort	12/13/2009	2 caught, 1 partially buried, no injuries
McAtee Basin Avalanche	4/14/2010	2 snowmobilers caught, 1 fully buried and killed
Beehive Basin Avalanche	2/16/2014	3 skiers caught, 2 partially buried, 1 injured
Chippewa Avalanche	2/26/2014	1 caught
Beehive Peak Avalanche Fatality	4/11/2015	1 caught, not buried, killed
Cedar Basin Avalanche Fatality	1/19/2016	1 skier caught, partially buried and killed

Table 4-21. Madison County Landslide and Avalanche Declared Disasters and Emergencies

Declaration	Year	Additional Information	Casualties	Damages/Assistance
None				

4.6.3 PROBABILITY AND MAGNITUDE

The actual probability of a major landslide affecting Madison County is difficult, if not impossible, to determine based on a limited history of major events. The probability, however, increases in key areas. In the vicinity of steep slopes, canyon bottoms, wildfire burn areas, and excavation sites, the probability increases. Also, near rivers, streams, and lakes, the probability of landslides along the shoreline from moving water increases the probability.

Madison County experiences numerous avalanches each year. Based on statistics from 1999-2016, someone is killed almost every 2 years (8 fatalities/17 years) in Madison County from avalanches.

For planning purposes, the greatest magnitude event from a landslide or avalanche would be an event that closes one of the major transportation routes in the county, destroys several homes, or claims several lives.

Overall Landslide and Avalanche Probability: Low-Moderate
Except the Towns of Ennis, Sheridan, and Twin Bridges: Low

4.6.4 MAPPING

Landslides and avalanches, because of their site specific nature, are difficult hazards to map. Only a geotechnical engineer, engineering geologist, or avalanche specialist can accurately assess the landslide or avalanche susceptibility of a particular location.

Excluding factors such as soil type, vegetation, snow stability, soil saturation, slope becomes an important factor in landslide and avalanche development. The following maps show the optimal slope for the development of landslides is slope > 50 percent and avalanches is 25–45 slope. Map 4.6.4A shows the areas of the county at greatest risk for landslides and Map 4.6.4.B shows the area of greatest risk for avalanches.

4.6.5 VULNERABILITIES

4.6.5.1 CRITICAL FACILITIES

The site-specific threat of landslides and avalanches to the critical facilities in Madison County can only be realistically determined by a geotechnical engineer or engineering geologist. More generally, those buildings on flat terrain, surrounded by other structures, likely have little vulnerability to landslides and avalanches. Similarly, buildings on steep slopes, at the bottom of hills, or in unstable soils likely have a higher vulnerability to landslides and avalanches. Based on the slope mapping, the Big Sky, Norris, Pony, and Virginia City critical facilities appear to have the greatest risk.

Possible losses to critical facilities include:

- Structural losses
- Content losses
- Critical functional losses

Expected Landslide and Avalanche Impact to Critical Facilities: Low

4.6.5.2 CRITICAL INFRASTRUCTURE

Critical infrastructure may be at risk from landslides and avalanche. The transportation network is likely the most vulnerable, particularly during periods of heavy rain, heavy snow, and snowmelt. Infrastructure such as power lines could be destroyed by a large landslide or avalanche, however, the historical record does not demonstrate this potential.

Possible losses to infrastructure include:

- Physical infrastructure losses
- Critical functional losses

Expected Landslide and Avalanche Impact to Critical Infrastructure: Low-Moderate
Except the Towns of Ennis, Sheridan, and Twin Bridges: Low

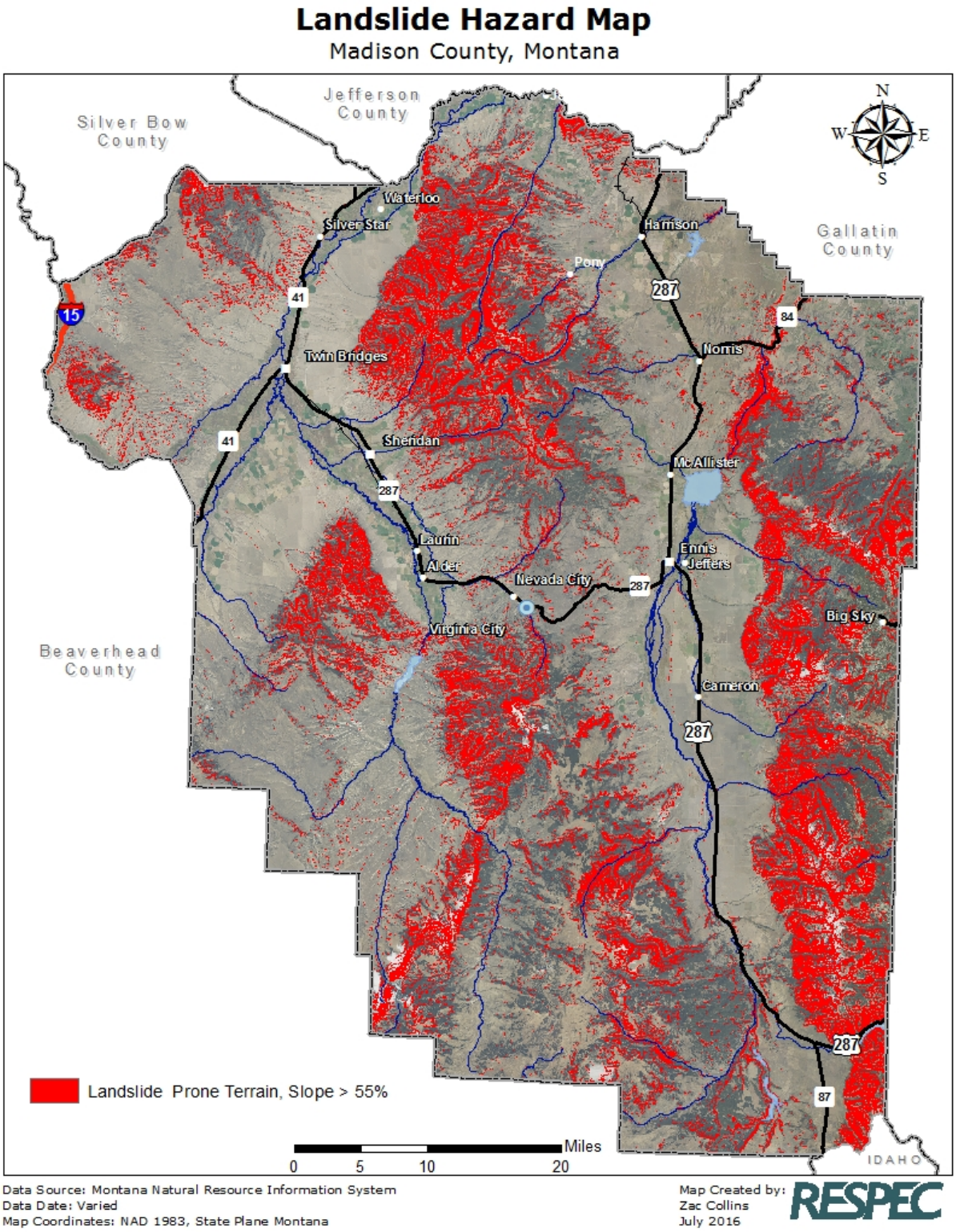


Figure 4-11. Need Caption.

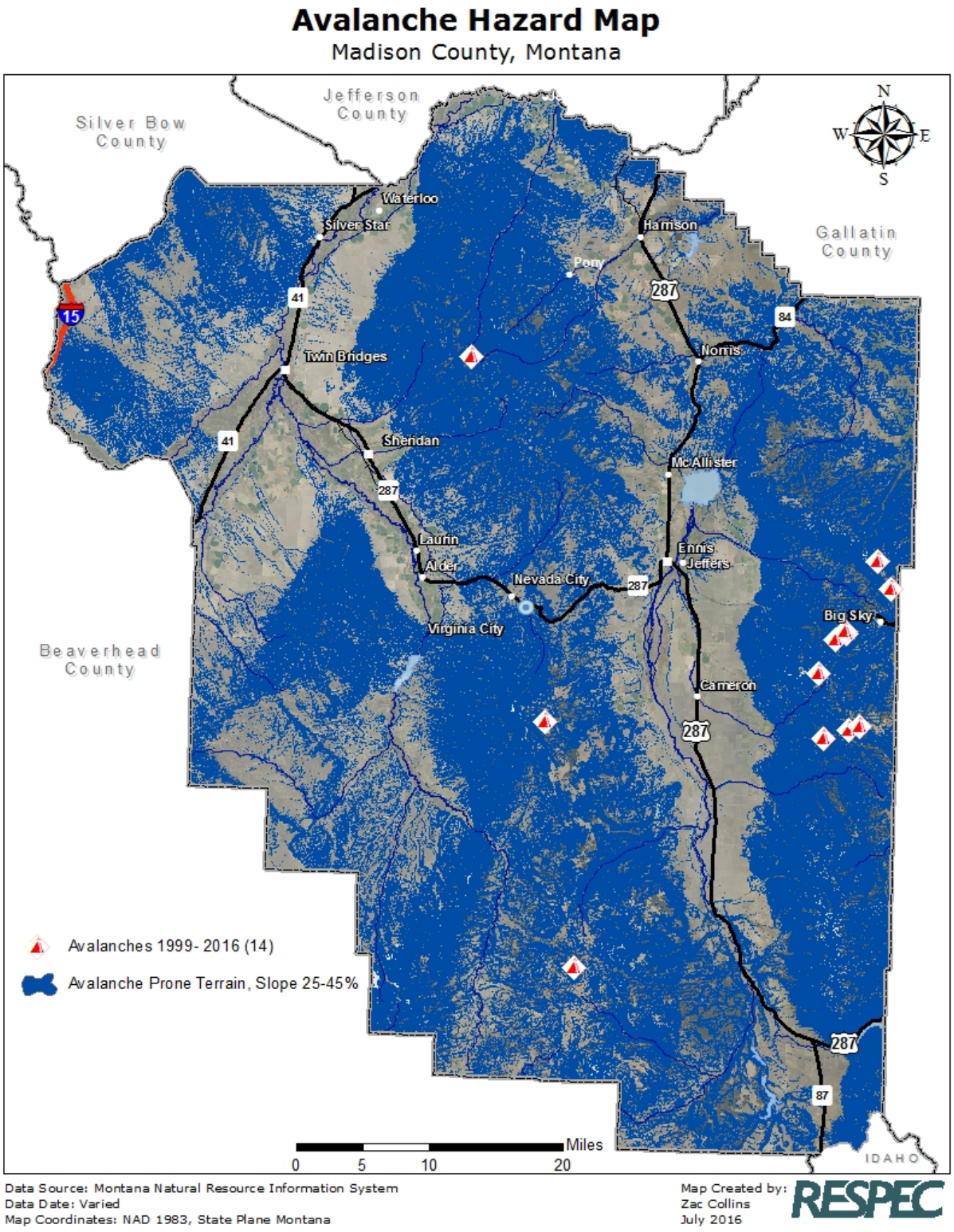


Figure 4-12. Need Caption.

4.6.5.3 STRUCTURES

The most probable areas for landslides are on steep slopes, at the bottom of hills, and in unstable soils. Without a detailed soils and slope map depicting the landslide potential, the number of structures at risk from landslides is unknown. Similarly, predicting avalanches requires an in-depth understanding of the snow surface and other factors. Fortunately, Madison County does not have any history of structures being destroyed by landslides and avalanches (other than the landslide triggered by an earthquake).

Possible losses to structures include:

- Structural losses
- Content losses

Expected Landslide and Avalanche Impact to Structures: Low

4.6.5.4 POPULATION

The primary threats to the population from landslides and avalanches are while driving and recreating. Landslide and avalanches can quickly bury and destroy road infrastructure, endangering those on the roadways. Additionally, the population could be threatened by a landslide or avalanche that damages an occupied structure. Most often, avalanches threaten those in the hazard areas such as snowmobilers, skiers, snowboarders, and climbers.

Expected Landslide and Avalanche Impact to the Population: Low-Moderate
Except the Towns of Ennis, Sheridan, and Twin Bridges: Low

4.6.5.5 ECONOMIC, ECOLOGIC, HISTORIC, AND SOCIAL VALUES

Possible economic losses include:

- Commerce losses due to closed roadways
- Timber losses in landslide and avalanche areas
- Tourism losses due to avalanche concerns

Expected Landslide and Avalanche Impact to the Values: Low

4.6.5.6 FUTURE DEVELOPMENT

Unless evaluated by a geotechnical engineer or similar professional, new development could occur in landslide and avalanche hazard areas. Some provisions are in place within the county subdivision regulations to restrict development in the hazardous areas. More specifically, lands unsuitable for subdivision include potential hazard areas from snow avalanches, rock falls, landslides, steep slopes in excess of 25 percent grade, subsidence, and slumping. (Madison County, 2015) These restrictions may prevent subdivisions in the most hazardous areas. Non-subdivision developments may still occur in some hazardous areas and others may have an unknown landslide or avalanche hazard at the time of evaluation.

Expected Landslide and Avalanche Impact to Future Development: Low-Moderate
Except the Towns of Ennis, Sheridan, and Twin Bridges: Low

4.6.6 DATA LIMITATIONS AND OTHER FACTORS

The data limitations related to the landslide and avalanche hazard include:

- Limited studies of the hazards for the area
- Site-specific nature of the hazards

Other hazards often related to landslides and avalanches include:

- Flooding
- Winter storms
- Strong wind
- Earthquakes
- Wildfires

4.7 SEVERE THUNDERSTORM AND STRONG WIND

Including Tornadoes, Hail, Downbursts, Lightning, and Strong Winds

4.7.1 DESCRIPTION

Thunderstorms develop across southwest Montana when moisture in the atmosphere rises, usually from a front with unstable atmospheric conditions, terrain uplift, or daytime ground heating, cools higher in the atmosphere, condensing into rain droplets or ice crystals. The cloud grows as these conditions continue and the atmospheric instability allows. Lightning can be produced, with or without rain, as a charge builds up in the cloud. With the right atmospheric conditions, updrafts and downdrafts form in the thunderstorm structure. Strong updrafts and downdrafts can produce hail, damaging downbursts, and even tornadoes.

The National Weather Service estimates that over 100,000 thunderstorms occur each year in the United States; approximately 10 percent of those storms are classified as severe. A severe thunderstorm is defined by the National Weather Service as a thunderstorm that produces wind gusts at or greater than 58 mph (50 kts), hail ¾ inch or larger in diameter, and/or tornadoes. These criteria represent thresholds where significant damages can occur. Strong winds and tornadoes can take down trees, damage structures, tip high profile vehicles, and create high velocity flying debris. Large hail can damage crops, dent vehicles, break windows, and injure or kill livestock, pets, and people.

4.7.1.1 TORNADOES

Tornadoes form when the right amount of shear is present in the atmosphere and causes the updraft and downdraft of a thunderstorm to rotate. A funnel cloud is the rotating column of air extending out of a cloud base, but not yet touching the ground. The funnel cloud does not become a tornado until it touches the ground. Once in contact with the surface, it can create great damage over a small area. In 1971, Dr. Theodore Fujita developed the Fujita tornado damage scale to categorize various levels of tornado damage. In 2006, enhancements to this scale resulted in more accurate categorizations of damage and the associated wind speeds. The Enhanced Fujita scale is shown in Figure 4-.

EF Rating	Wind Speeds	Expected Damage		
EF-0	65-85 mph	'Minor' damage: shingles blown off or parts of a roof peeled off, damage to gutters/siding, branches broken off trees, shallow rooted trees toppled.		
EF-1	86-110 mph	'Moderate' damage: more significant roof damage, windows broken, exterior doors damaged or lost, mobile homes overturned or badly damaged.		
EF-2	111-135 mph	'Considerable' damage: roofs torn off well constructed homes, homes shifted off their foundation, mobile homes completely destroyed, large trees snapped or uprooted, cars can be tossed.		
EF-3	136-165 mph	'Severe' damage: entire stories of well constructed homes destroyed, significant damage done to large buildings, homes with weak foundations can be blown away, trees begin to lose their bark.		
EF-4	166-200 mph	'Extreme' damage: Well constructed homes are leveled, cars are thrown significant distances, top story exterior walls of masonry buildings would likely collapse.		
EF-5	> 200 mph	'Massive/incredible' damage: Well constructed homes are swept away, steel-reinforced concrete structures are critically damaged, high-rise buildings sustain severe structural damage, trees are usually completely debarked, stripped of branches and snapped.		

Figure 4-13. Need Caption [Source: Storm Prediction Center, 2015a].

4.7.1.2 HAIL

Hail develops when a supercooled droplet collects a layer of ice and continues to grow, sustained by the updraft. Once the hail stone cannot be held up any longer by the updraft, it falls to the ground. Hail up to 1.75 inches in diameter, the size of golf balls, has been reported in Madison County. Nationally, hailstorms cause nearly $1 billion in property and crop damage annually, as peak activity coincides with peak agricultural seasons. Severe hailstorms also cause considerable damage to buildings and automobiles, but rarely result in loss of life.

4.7.1.3 DOWNBURSTS

Downburst winds, which can cause more widespread damage than a tornado, occur when air is carried into a storm's updraft, cools rapidly, and comes rushing to the ground. Cold air is denser than warm air, and therefore, wants to fall to the surface. On warm summer days, when the cold air can no longer be supported up by the storm's updraft, or an exceptional downdraft develops, the air crashes to the ground in the form of strong winds. These winds are forced horizontally when they reach the ground and can cause significant damage. These types of strong winds can also be referred to as straight-line winds. Downbursts with a diameter of less than 2.5 miles are called microbursts and those with a diameter of 2.5 miles or greater are called macrobursts. A derecho, or bow echo, is a series of

downbursts associated with a line of thunderstorms. This type of phenomenon can extend for hundreds of miles and contain wind speeds in excess of 100 mph.

4.7.1.4 LIGHTNING

Although not considered severe by National Weather Service definition, lightning and heavy rain can also accompany thunderstorms. Lightning develops when ice particles in a cloud move around, colliding with other particles. These collisions cause a separation of electrical charges. Positively charged ice particles rise to the top of the cloud and negatively charged ones fall to the middle and lower sections of the cloud. The negative charges at the base of the cloud attract positive charges at the surface of the Earth. Invisible to the human eye, the negatively charged area of the cloud sends a charge called a stepped leader toward the ground. Once it gets close enough, a channel develops between the cloud and the ground. Lightning is the electrical transfer through this channel. The channel rapidly heats to 50,000 degrees Fahrenheit and contains approximately 100 million electrical volts. The rapid expansion of the heated air causes thunder. (National Weather Service, 2009b)

4.7.1.5 STRONG WINDS

Strong winds can also occur outside of tornadoes and severe thunderstorms. These winds typically develop with strong pressure gradients and gusty frontal passages. The closer and stronger two systems (one high pressure, one low pressure) are, the stronger the pressure gradient, and therefore, the stronger the winds are.

4.7.1.6 WARNINGS, WATCHES, AND ADVISORIES

To protect people and property, the National Weather Service issues informational products alerting the public to varying degrees of hazardous weather. The following alerts from the National Weather Service [2015] and Storm Prediction Center [2015] may be issued for severe thunderstorm events:

- **Hazardous Weather Outlook:** Hazardous weather outlooks alert the public to the possibility for severe weather in the area from one to seven days in advance.
- **Severe Thunderstorm Watch:** Severe thunderstorm watches are issued by the Storm Prediction Center when conditions for severe thunderstorms appear favorable for an area over the next several hours. Watches are typically in effect for 4-6 hours.
- **Severe Thunderstorm Warning:** Severe thunderstorm warnings are issued when Doppler radar indicates or the public reports a thunderstorm with wind gusts of 58 mph or greater and/or hail ¾ inch or larger in diameter. The warning is usually valid for 30-60 minutes.
- **Tornado Watch:** Tornado watches are issued by the Storm Prediction Center when conditions for tornadoes appear especially favorable for an area over the next several hours. Watches are typically in effect for 4-6 hours.
- **Tornado Warning:** Tornado warnings are issued when Doppler radar indicates or the public reports a tornado. The warning is usually valid for 15-45 minutes.

The following alerts for nonthunderstorm high winds may be issued by the : The National Weather Service [2015]:

- **High Wind Watch:** A high wind watch is issued when conditions are favorable for non-thunderstorm sustained winds of 40 mph or greater or gusts of 58 mph or greater for a period of one hour or more, but the timing, location, and/or magnitude are still uncertain.

- **High Wind Warning:** High wind warnings are issued when non-thunderstorm sustained winds of 40 mph or greater or gusts of 58 mph or greater for a period of one hour or more are expected.

4.7.2 HISTORY

Reports of severe thunderstorms and tornadoes are collected from trained spotters by the National Weather Service (NWS) office in Great Falls. These records are archived by the National Climatic Data Center. Since official records can only indicate events that have been reported to the National Weather Service, events are often underreported in rural area and areas lacking trained spotters.

4.7.2.1 TORNADOES

Since 1950, 2 tornado events have been recorded in Madison County as shown in Table 4-22.

Table 4-22. Reported Tornadoes [National Climatic Data Center, 2016]

Location	Date	Magnitude	Impacts
Madison County	06/29/1992	F0	$25,000 estimated property damage.
Ennis Airport, 1 mile SW	06/29/1999	F0	

4.7.2.2 HAIL

Since 1950, 21 severe hail reports (3/4 inches or greater) have been recorded in Madison County as shown in Table 4-23.

4.7.2.3 DOWNBURSTS

Since 1994, 14 severe thunderstorm wind reports (55 mph or greater) have been recorded in Madison County. Table 4-24 lists the reports of 55 mph winds or greater or causing damages.

4.7.2.4 STRONG WINDS

Since 1994, 16 strong non-thunderstorm wind reports (58 mph or greater) have been recorded in Madison County. Table 4-25 lists the reports of 75 mph or greater or causing damages.

4.7.3 PROBABILITY AND MAGNITUDE

Generally, June, July, and August are the months when the probability of severe thunderstorms in Madison County is highest, but some have been recorded as early as May and as late as September. High wind events can occur during any time of year. Table 4-26 shows a summary of the severe thunderstorm and strong wind events.

Based on the historical record, the following can be expected on average:

- In an average 10 year period, 1 tornado.
- In an average year, 1 severe hail event.
- In an average year, 1 severe thunderstorm wind event.
- In an average year, 1 strong nonthunderstorm wind event.

Table 4-23. Severe Hail Reports [National Climatic Data Center, 2016]

Location	Date	Size	Impacts
Madison County	07/08/1968	0.75 inches	
Twin Bridges	09/07/1995	Unknown	
Virginia City	07/11/1998	1.75 inches	
Sheridan	08/13/1999	0.88 inches	
Virginia City	05/30/2002	1.00 inches	
Ennis	05/30/2002	0.75 inches	
Sheridan	08/04/2004	0.75 inches	
Norris	08/04/2004	0.75 inches	
Twin Bridges	07/09/2005	0.75 inches	
Sheridan, 10 miles N	06/07/2006	1.00 inches	
Virginia City, 2 miles W	08/18/2007	0.88 inches	30 windows damaged in Nevada City. Minor injuries to passengers in an open car train between Nevada City and Virginia City.
McAllister	08/18/2007	1.25 inches	
Sheridan, 6 miles SW	06/22/2008	0.75 inches	
Sheridan	07/22/2008	1.75 inches	Nearly every window on the south and west facing sides of the Sheridan High School and Elementary School were broken. Homes, vehicles, and crops suffered substantial damages.
Sheridan, 2 miles W	07/22/2008	0.88 inches	
Ennis	7/12/2009	1 inches	Severe thunderstorms developed over portions of North Central Montana. Hail the size of quarters and wind gusts in excess of 60 mph was reported.
Virginia City	6/30/2010	1.25 inches	A very unstable air mass over Southwest Montana produced numerous thunderstorms during the afternoon hours. Hail the size of baseballs was reported.
Alder	7/17/2013	1 inches	Convective activity developed early in the afternoon with thunderstorms rapidly developing over West and Southwest Montana in response to an upper trough moving across Northwest Montana into southern Alberta. Though jet streak energy supported the system, convective parameters were not overly impressive. Additionally, precipitable water values were very high across the CWA translating to heavy rain with some isolated to scattered severe storms.
Twin Bridges	8/1/2013	1.5 inches	As a trough pushed across the Pacific Northwest, an upper ridge flattened allowing southwest flow to develop and bring moisture to Central Montana. Showers and thunderstorms developed and moved across the plains of North-Central Montana during the afternoon and evening. Precipitation was enhanced by continued low level easterly up-slope flow. Over Southwest Montana, increased instability during the afternoon, coupled with the presence of a jet streak, resulted in scattered thunderstorm development with some storms becoming strong to severe.

Table 4-24. Severe Thunderstorm Wind Reports of 55 Miles Per Hour or Greater (and Other Select Events) [National Climatic Data Center, 2016]

Location	Date	Speed	Impacts
Silver Star	06/06/94	Unknown	$5,000 estimated property damage.
Ennis	08/07/95	68 mph	A light airplane crashed just short of the airport.
Ennis	05/29/96	63 mph	
Twin Bridges	08/18/00	75 mph	
Sheridan	08/21/02	75 mph	Several homes and trailers damaged.
Norris	07/15/06	61 mph	Power outages from falling tree limbs and downed lines.
Virginia City, 2 miles W	08/18/07	60 mph	A sign was blown through a windshield of a car, injuring the driver.
Ennis	05/20/08	58 mph	Severe thunderstorms developed over southwest Montana during the early evening hours of the 20th. Wind gusts in excess of 60 mph were reported.
Ennis	05/20/08	58 mph	Severe thunderstorms developed over southwest Montana during the early evening hours of the 20th. Wind gusts in excess of 60 mph were reported.
Ennis, 1 mile W	07/22/08	85 mph	Many trees and power lines were downed. A roof blew off a building in Ennis.
Sheridan	07/22/08	61 mph	A very unstable airmass allowed severe thunderstorms to develop over portions of Southwest Montana. Hail the size of golf balls and wind gusts in excess of 60 mph were reported in Beaverhead...Gallatin and Madison counties. Heavy rain also caused flash flooding in Beaverhead County.
Cameron	08/09/08	61 mph	A very unstable and moist airmass allowed severe thunderstorms to develop during the late afternoon and early evening hours. Hail the size of half dollars and wind gusts in excess of 60 mph were reported.
Twin Bridges	08/01/13	78 mph	As a trough pushed across the Pacific Northwest, an upper ridge flattened allowing southwest flow to develop and bring moisture to Central Montana. Showers and thunderstorms developed and moved across the plains of North-Central Montana during the afternoon and evening. Precipitation was enhanced by continued low level easterly up-slope flow. Over Southwest Montana, increased instability during the afternoon, coupled with the presence of a jet streak, resulted in scattered thunderstorm development with some storms becoming strong to severe.
Cameron	08/23/13	55 mph	Southwest flow continued to bring Pacific moisture into the area helping trigger afternoon showers and thunderstorms, primarily over higher terrain. Some storms moved out onto the plains and contained gusty, erratic winds and/or brief heavy rain. Precipitable water values ranged between 0.75 and 1 inch.

Table 4-25 Strong Nonthunderstorm Wind Reports of 75 Miles per Hour or Greater (and Other Select Events) [National Climatic Data Center, 2016]

Location	Date	Speed	Impacts
Ennis	12/30/1996	79 mph	
Twin Bridges	04/04/2000	69 mph	A roof was blown off a trailer. $10,000 estimated property damage.
Twin Bridges	04/04/2001	69 mph	Storage shed roof damaged. $1,000 estimated property damage.
Raynolds Pass	12/15/2006	65 mph	Power outages from downed power poles.
Norris	11/12-13/2007	76 mph	A strong Pacific weather system brought gusty winds to North Central Montana. Wind gusts in excess of 80 mph were reported
Cameron	02/22/2012	75 mph	A strong westerly flow aloft brought high winds to portions of Southwest and North Central Montana. Winds gusts in excess of 60 mph were reported.

Table 4-26. Madison County Severe Thunderstorm and Strong Wind Declared Disasters and Emergencies

Declaration	Year	Additional Information	Casualties	Damages/Assistance
None				

Table 4-27. Severe Thunderstorm and Strong Wind Events Historical Summary [National Climatic Data Center, 2016]

Event Type	Madison County
Reported Tornadoes	2 events (1992–2016) Highest Magnitude: F0 1 damaging event $25,000 property damage
Reported Severe Hail	21 events (1994–2016) Highest Magnitude: 1.75" 2 damaging events Unknown property damage
Reported Severe Thunderstorm Winds	17 events (1994–2016) Highest Magnitude: 85 mph 6 damaging events $5,000+ property damage
Reported Strong Non-Thunderstorm Winds	88 events (1994–2008) Highest Magnitude: 35 mph -79 mph 3 damaging events $26,000+ property damage

Reported severe thunderstorm and strong wind events over the past 15 years provide an acceptable framework for determining the magnitude of such storms that can be expected and should be planned for. For tornadoes, even though the maximum intensity that was reported in Madison County is an F0, stronger tornadoes can occur. The Federal Emergency Management Agency places this region in Zone II (160 mph) for structural wind design [Federal Emergency Management Agency, 2004b]. Large hail can damage structures, break windows, dent vehicles, ruin crops, and kill or injure people and livestock.

Non-tornadic, thunderstorm and non-thunderstorm winds over 100 mph should also be planned for. These types of winds can remove roofs, move mobile homes, topple trees, take down utility lines, and destroy poorly-built or weak structures.

Overall Severe Thunderstorm and Strong Wind Probability: Moderate-High

4.7.4 MAPPING

The science of meteorology and records of severe thunderstorms and strong winds are not quite sophisticated enough to identify what areas of the county are at greater risk for damages. Therefore, all areas of the county are assumed to have the same severe thunderstorm and strong wind risk countywide.

4.7.5 VULNERABILITIES

4.7.5.1 CRITICAL FACILITIES

Many of the critical facilities, although adequate for most events, may not be able to withstand 160 mph winds, as recommended by FEMA [FEMA, 2004b]. Most structures should be able to provide adequate protection from hail but the structures could suffer broken windows and dented exteriors.

The Storm Prediction Center has developed damage indicators to be used with the Enhanced Fujita Scale for different types of buildings. Some of the indicators for different building types are shown in Tables 4-28, 4-29, and 4-30.

Table 4-28. Institutional Buildings Storm Prediction Center, 2009a

Damage Description	Wind Speed Range (expected in parentheses)
Threshold of visible damage	59–88 mph (72 mph)
Loss of roof covering (<20%)	72–109 mph (86 mph)
Damage to penthouse roof and walls, loss of rooftop HVAC equipment	75–111 mph (92 mph)
Broken glass in windows or doors	78–115 mph (95 mph)
Uplift of lightweight roof deck and insulation, significant loss of roofing material (>20%)	95–136 mph (114 mph)
Façade components torn from structure	97–140 mph (118 mph)
Damage to curtain walls or other wall cladding	110–152 mph (131 mph)
Uplift of pre-cast concrete roof slabs	119–163 mph (142 mph)
Uplift of metal deck with concrete fill slab	118–170 mph (146 mph)
Collapse of some top story exterior walls	127–172 mph (148 mph)
Significant damage to building envelope	178–268 mph (210 mph)

Table 4-29. School Building (Junior or Senior High School) [Storm Prediction Center, 2009a]

Damage Description	Wind Speed Range (expected in parentheses)
Threshold of visible damage	55–83 mph (68 mph)
Loss of roof covering (<20%)	66–99 mph (79 mph)
Broken windows	71–106 mph (87 mph)
Exterior door failures	83–121 mph (101 mph)
Uplift of metal roof decking; significant loss of roofing material (>20%); loss of rooftop HVAC	85–119 mph (101 mph)
Damage to or loss of wall cladding	92–127 mph (108 mph)
Collapse of tall masonry walls at gym, cafeteria, or auditorium	94–136 mph (114 mph)
Uplift or collapse of light steel roof structure	108–148 mph (125 mph)
Collapse of exterior walls in top floor	121–153 mph (139 mph)
Most interior walls of top floor collapsed	133–186 mph (158 mph)
Total destruction of a large section of building envelope	163–224 mph (192 mph)

Table 4-30. Metal Building Systems [Storm Prediction Center, 2009a]

Damage Description	Wind Speed Range (expected in parentheses)
Threshold of visible damage	54–83 mph (67 mph)
Inward or outward collapsed of overhead doors	75–108 mph (89 mph)
Metal roof or wall panels pulled from the building	78–120 mph (95 mph)
Column anchorage failed	96–135 mph (117 mph)
Buckling of roof purlins	95–138 mph (118 mph)
Failure of X-braces in the lateral load resisting system	118–158 mph (138 mph)
Progressive collapse of rigid frames	120–168 mph (143 mph)
Total destruction of building	132–178 mph (155 mph)

Since the probability of a tornado or strong wind event is relatively the same across the county, the vulnerabilities to structures depend on the building types and their susceptibility to sustain damages in a wind or tornado event. Even if a structure performs well in the high winds, flying debris and falling trees may damage the building.

Possible losses to critical facilities include:

- Structural losses
- Contents losses
- Critical functional losses
- Critical data losses

Expected Severe Thunderstorm and Strong Wind Impact to Critical Facilities: Low-Moderate

4.7.5.2 CRITICAL INFRASTRUCTURE

Above ground infrastructure, namely overhead power lines, communications towers and lines, and structures, are very susceptible to severe thunderstorms and strong winds. High winds and falling trees can damage this type of infrastructure and disrupt services. Therefore, even an indirect hit by a tornado or strong winds could disrupt regional electricity and possibly telephone services. Table 4.7.5D shows the Enhanced Fujita Scale Damage Indicators for electric transmission lines.

Table 4-31. Electrical Transmission Lines [Storm Prediction Center, 2009a]

Damage Description	Wind Speed Range (expected in parentheses)
Threshold of visible damage	70-98 mph (83 mph)
Broken wood cross member	80-114 mph (99 mph)
Wood poles leaning	85-130 mph (108 mph)
Broken wood poles	98-142 mph (118 mph)
Broken or bent steel or concrete poles	115-149 mph (138 mph)
Collapsed metal truss towers	116-165 mph (141 mph)

Should an above ground facility such as a water treatment facility or a sewer lagoon be damaged, water and sewer services could also be disrupted. Debris may also block roadways making transportation and commerce difficult if not impossible.

Possible losses to critical infrastructure include:

- Electric power disruption
- Telephone service disruption
- Blocked roadways
- Damaged infrastructure components, such as sewer lift stations and treatment plants

Expected Severe Thunderstorm and Strong Wind Impact to Critical Infrastructure: Moderate

4.7.5.3 STRUCTURES

With the entire county at risk from severe thunderstorms and strong winds, estimates of damages are hard to determine. Realistically, an event involving a tornado or severe thunderstorm would most likely affect a small area. If that area were in a developed part of the county, roughly 10-20 homes could be damaged. Fifteen homes at a damage factor of 30% would result in roughly 1 million dollars in damages (15 homes x $237,800/home x 30% damage). Vehicles damaged by hail or falling debris would be additional losses to individuals, businesses, and government.

Tables 4.7.5E, 4.7.5F, and 4.7.5G show the damage indicators for various types of residential and ranch structures. In Madison County, 531 residences are mobile homes, including 93 in Ennis, 56 in Sheridan, 50 in Twin Bridges, and 6 in Virginia City. (Montana Census and Economic Information Center, 2016)

Table 4-32. One and Two Family Residences [Storm Prediction Center, 2009a]

Damage Description	Wind Speed Range (expected in parentheses)
Threshold of visible damage	53-80 mph (65 mph)
Loss of roof covering material (<20%), gutters, and/or awning; loss of vinyl or metal siding	63-97 mph (79 mph)
Broken glass in doors and windows	79-114 mph (96 mph)
Uplift of roof deck and loss of significant roof covering material (>20%); collapse of chimney; garage doors collapse inward; failure of porch or carport	81-116 mph (97 mph)
Entire house shifts off foundation	103-141 mph (121 mph)
Large sections of roof structure removed, most walls remain standing	104-142 mph (122 mph)
Top floor exterior walls collapsed	113-153 mph (132 mph)
Most interior walls of top story collapsed	128-173 mph (148 mph)
Most walls collapsed in bottom floor, except small interior rooms	127-178 mph (152 mph)
Total destruction of entire building	142-198 mph (170 mph)

Table 4-33. Single Wide Manufactured Homes [Storm Prediction Center, 2009a]

Damage Description	Wind Speed Range (expected in parentheses)
Threshold of visible damage	51-76 mph (61 mph)
Loss of shingles or partial uplift of one-piece metal roof covering	61-92 mph (74 mph)
Unit slides off block piers but remains upright	72-103 mph (87 mph)
Complete uplift of roof, most walls remain standing	73-112 mph (89 mph)
Unit rolls on its side or upside down, remains essentially intact	84-114 mph (98 mph)
Destruction of roof and walls leaving floor and undercarriage in place	87-123 mph (105 mph)
Unit rolls or vaults, roof and walls separate from floor and undercarriage	96-128 mph (109 mph)
Undercarriage separates from unit, rolls, tumbles, and is badly bent	101-136 mph (118 mph)
Complete destruction of unit, debris blown away	110-148 mph (127 mph)

Table 4-34 Small Barns and Farm Outbuildings [Storm Prediction Center, 2009a]

Damage Description	Wind Speed Range (expected in parentheses)
Threshold of visible damage	53-78 mph (62 mph)
Loss of wood or metal roof panels	61-91 mph (74 mph)
Collapse of doors	68-102 mph (83 mph)
Major loss of roof panels	78-110 mph (90 mph)
Uplift or collapse of roof structure	77-114 mph (93 mph)
Collapse of walls	81-119 mph (97 mph)
Overturning or sliding of entire structure	83-118 mph (99 mph)
Total destruction of building	94-131 mph (112 mph)

Possible losses to structures include:

- Structural losses
- Contents losses
- Vehicle losses
- Displacement losses

Expected Severe Thunderstorm and Strong Wind Impact to Structures: Moderate

4.7.5.4 POPULATION

Since structures are vulnerable to severe thunderstorms and strong winds, those people inside them are also at risk. The National Weather Service in Great Falls warns for tornadoes, severe thunderstorms, and high winds for Madison County. Meteorologists use a variety of tools such as Doppler radar and weather spotters to predict these hazardous events and issue warnings that are broadcast over NOAA Weather Radio and other media. NOAA weather radio transmitters are located in Bozeman, Dillon, and Butte, covering some northern parts of the county, and those with specially built receivers can be automatically alerted to weather hazards.

Some events have 15 minutes or more warning time and others have little to no warning. In 2016, the average national tornado warning lead time was 13 minutes. (National Weather Service, 2016c) Therefore, the population may have some lead time to take precautions, if they receive the warning. Generally, these warnings recommend that people move to a pre-designated shelter or a basement. If not available, interior rooms or hallways on the lowest floor away from windows or under a sturdy piece of furniture is recommended. Mobile homes, even if tied down, and automobiles are not safe places. With 531 mobile homes in Madison County, approximately 1,115 people are at enhanced risk from tornadoes and strong winds. Besides structure failure, wind-driven projectiles and shattered glass can injure or kill occupants. Lightning strikes can occur with little to no warning, causing injury or death to those in the area.

Expected Severe Thunderstorm and Strong Wind Impact to the Population: Moderate

4.7.5.5 ECONOMIC, ECOLOGIC, HISTORIC, AND SOCIAL VALUES

Possible economic losses include:

- Business closures and associated business disruption losses
- Crop and livestock losses
- Feed losses due to lightning sparked hay and field fires
- Commerce losses due to closed roads

Possible ecologic losses include:

- Damaged vegetation
- Soil erosion

Possible historic losses include:

- Structural and content losses of historic items

Possible social losses include:

- Cancelled activities
- Emotional impacts of significant population losses

Expected Severe Thunderstorm and Strong Wind Impact to the Values: Low-Moderate

4.7.5.6 FUTURE DEVELOPMENT

The severe thunderstorm and strong wind risk is assumed to be uniform countywide. Therefore, the location of development does not increase or reduce the risk necessarily. Madison County lacks building codes, and therefore new development might not be built to current standards for wind resistance. Generally, newer structures are built to withstand strong winds; mobile homes, however, continue to be the exception. Development and future population growth could possibly improve the television and radio technology available to residents; therefore improving the warning capabilities.

Expected Severe Thunderstorm and Strong Wind Impact to Future Development: Moderate

4.7.6 DATA LIMITATIONS AND OTHER FACTORS

The data limitations related to the severe thunderstorm and strong wind hazard include:

- Severe thunderstorms and strong winds are only recorded if observed and reported to the National Weather Service.
- The rural nature of the area leaves many areas without weather spotters.
- Only a limited number of weather observing stations are located in the county.
- Historic lightning data is expensive to purchase for analysis.

Other hazards often related to severe thunderstorms and strong winds include:

- Wildfire
- Flash flood
- Transportation accident
- Hazardous material release

4.8 STRUCTURE COLLAPSE

4.8.1 DESCRIPTION

Structure collapse occurs when the forces of gravity or other external forces overcome the structural integrity of a building or other important structure such as grandstands and bridges. The reasons for structure collapse can include poor construction, deterioration, extreme winds, gas explosions, structure fires, and heavy snow loads. Structure collapse can trap occupants and damage valuable property. Madison County has three areas of concern listed on the 2015 TRIP Montana Transportation Challenges Report as listed in Table xx below

Table 4-35. Need Caption and Callout

Area	Route	Description of challenge/deficiency
Beaverhead/Madison/Silver Bow	I-15	Several bridges have been identified along this section that require seismic upgrades in addition to interchange improvements near the intersection of I-90 and I-15
Gallatin/Madison/Broadwater	US-287	Deteriorating pavement near Ennis, horizontal/vertical curves and clear zones that do not meet current design standards create safety and Level of Services (LOS)issues.
Beaverhead/Madison	MT-41	Deteriorating pavement and bridge surfaces, safety improvements, vertical and horizontal realignments, and rock fall mitigation are needed to address congestion and reduced LOS.

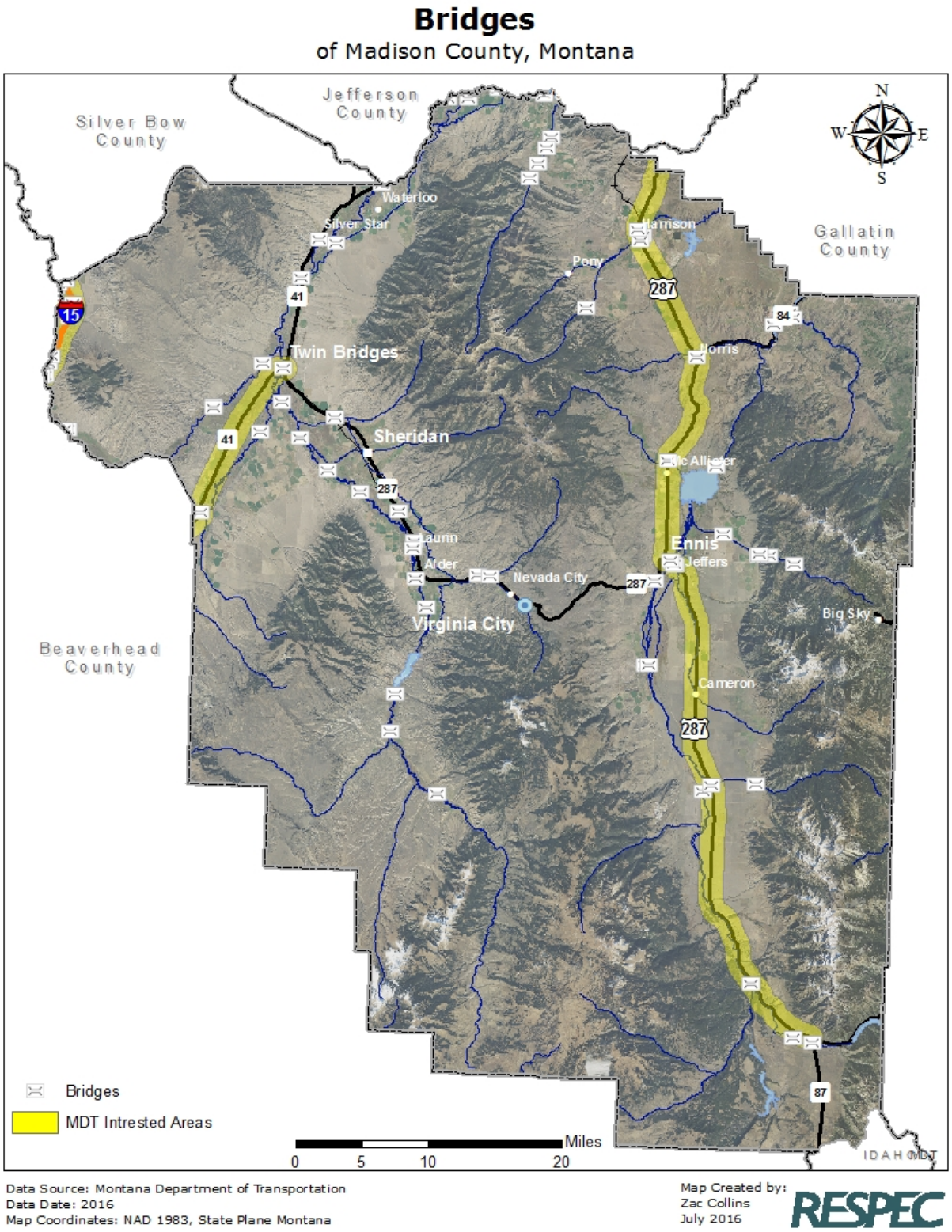


Figure 4-14. Need Caption and Callout.

4.8.2 HISTORY

Madison County and the jurisdictions historically have not had any significant structure collapses.

Table 4-36. Madison County Structure Collapse Declared Disasters and Emergencies

Declaration	Location	Date	Magnitude	Casualties	Damages
None					

4.8.3 PROBABILITY AND MAGNITUDE

The probability of a structure collapse is difficult to determine given a lack of historical events. Older structures, structures with large span roofs, and structures not constructed to building code standards are more likely to collapse.

A realistic yet devastating structure collapse scenario is the complete and rapid destruction of an occupied building. In this scenario, little warning might exist for occupants and many could become trapped.

Overall Structure Collapse Probability: Low

4.8.4 MAPPING

Structure collapses are possible on any given structure. Therefore, the risk of structure collapse is countywide.

4.8.5 VULNERABILITIES

4.8.5.1 CRITICAL FACILITIES

Any building is vulnerable to structure collapse, including critical facilities. Structure collapses will likely result in total or nearly total structural losses. Using a general assumption, given improvements on construction methodologies over the years, the older the building or property, the more likely it is to succumb to a structural collapse. Flat roofs are also more susceptible to heavy snow loading and collapse.

Possible losses to critical facilities include:

- Structural losses
- Contents losses
- Functionality losses

Expected Structure Collapse Impact to Critical Facilities: Low-Moderate

4.8.5.2 CRITICAL INFRASTRUCTURE

Depending on the type of infrastructure, structure collapse could result in long-term disruptions while new arrangements for services are made. For example, collapse of a water treatment plant may leave communities without water for days or weeks. Bridge collapses could impact regional transportation.

Possible losses to critical infrastructure include:

- Loss of infrastructure services

Expected Structure Collapse Impact to Critical Infrastructure: Low-Moderate

4.8.5.3 STRUCTURES

Residential structures can be prone to structure collapses, but typically do not result in community-wide disasters. Therefore, the greatest impacts are from collapses that occur in downtown areas or at large businesses or civil buildings.

Possible losses to structures include:

- Structural losses
- Contents losses

Expected Structure Collapse Impact to Structures: Moderate

4.8.5.4 POPULATION

The population is at risk from structure collapses. Depending on the time and location, a major structure collapse could result in the loss of life either to building occupants or emergency responders. Should lives be lost, significant resources could be needed to manage the recovery.

Expected Structure Collapse Impact to the Population: Moderate
Economic, Ecologic, Historic, and Social Values

Possible economic losses include:

- Business losses and disruptions at the collapse site
- Income losses for displaced workers

Possible historic losses include:

- Historic structure and contents losses

Possible social losses include:

- Emotional impacts if a significant number of lives are lost
- Cancelled activities at the collapse site

Expected Structure Collapse Impact to the Values: Moderate

4.8.5.5 FUTURE DEVELOPMENT

Nationally, improvements have been made to building codes and standards to reduce the chances of a structure collapse. However none of the jurisdictions in Madison County have adopted these codes. Future development could certainly be vulnerable to structure collapse.

Expected Structure Collapse Impact to Future Development: Moderate

4.8.6 DATA LIMITATIONS AND OTHER FACTORS

The data limitations related to the structure collapse hazard include:

- Lack of an evaluation of important structures and their collapse potential

Other hazards often related to structure collapse include:

- Heavy snow
- Strong wind
- Terrorism and civil unrest
- Structure fires

4.9 TERRORISM AND CIVIL UNREST

4.9.1 DESCRIPTION

Terrorism and civil unrest are human-caused hazards that are intentional and often planned. Terrorism, both domestic and international, is a violent act done to try and influence government or the population of some political or social objective. Terrorist acts can come in many recognized forms or may be more subtle using untraditional methods. The primary recognized forms of terrorism are chemical, explosive, biological, radiological, and cyber; however, terrorism's only limitation is the human imagination.

Chemical terrorism is the use of chemical agents to poison, kill, or incapacitate the population or animals, destroy crops or natural resources, or deny access to certain areas. Chemical agents can be broken into five different categories: nerve agents, vesicants, cyanide, pulmonary agents, and incapacitating agents.

Terrorism using explosive and incendiary devices includes bombs and any other technique that creates an explosive, destructive effect. Bombs can take many forms from a car bomb to a mail bomb. They can be remotely detonated using a variety of devices or directly detonated in the case of a suicide bomb.

Bioterrorism is the use of biological agents, such as Anthrax, Ricin, and Smallpox, to infect the population, plants, or animals with disease.

Radiological terrorism involves the use of radiological dispersal devices or nuclear facilities to attack the population. Exposure to radiation can cause radiation sickness, long-term illness, and even death. Terrorism experts fear the use of explosive and radiological devices in the form of a "dirty bomb" to attack the population. A "dirty bomb" is a low-tech, easily assembled and transported device made up of simple explosives combined with a suitable radioactive agent.

Cyberterrorism is the attack or hijack of the information technology infrastructure that is critical to the US economy through financial networks, government systems, mass media, or other systems. Any cyber attack that creates national unrest or instability would be considered cyberterrorism.

Civil unrest and violence typically occur on a smaller scale than terrorism when large groups, organizations, or distraught individuals take action with potentially disastrous or disruptive results. Civil unrest can result following a disaster that creates panic in the community.

Most times, terrorist acts, both domestic and international, are driven by a terrorist group or hate organization. Occasionally, individuals, as was the case in the Oklahoma City bombing, perform independent acts. Usually, the perpetrators have an underlying belief that drives the act. Some of the types of groups that exist in Montana include the following:

- **Christian Identity:** This religion asserts that whites, not Jews, are the true Israelites favored by God in the Bible. For decades, Christian Identity has been one of the most influential ideologies for the white supremacist movement. (Southern Poverty Law Center, 2016)
- **Neo-Confederate:** Many groups celebrate traditional Southern culture and the Civil War's dramatic conflict between the Union and the Confederacy, but some groups go further and embrace racist attitudes towards blacks, and in some cases, white separatism. (Southern Poverty Law Center, 2016)
- **Neo-Nazi:** These groups share a hatred for Jews and a love for Adolf Hitler and Nazi Germany. While they also hate other minorities, homosexuals, and even sometimes Christians, they perceive "the Jew" as their cardinal enemy, and trace social problems to a Jewish conspiracy that supposedly controls governments, financial institutions, and the media. (Southern Poverty Law Center, 2016)

4.9.1.1 WARNINGS, WATCHES, AND ADVISORIES

When notified by a government official, the National Weather Service has the ability to send alert messages through the Emergency Alert System and over NOAA Weather Radio. Examples include the following:

- **Local Area Emergency Message:** This message defines an event that by itself does not pose a significant threat to public safety and/or property, but the event could escalate, contribute to other more serious events, or disrupt critical public safety services. Instructions, other than public protective actions, may be provided by authorized officials. Examples of when this message may be used include: utility disruptions, road closures, or a potential terrorist threat where the public is asked to remain alert.
- **Civil Emergency Message:** This message outlines a significant threat or threats to public safety and/or property that is imminent or in progress. The hazard is usually less specific or severe than those requiring a Civil Danger Warning.
- **Law Enforcement Warning:** This warning is issued for a bomb explosion, riot, or other criminal event. An authorized law enforcement agency may block roads, waterways, or facilities, evacuate or deny access to affected areas, and arrest violators or suspicious persons.
- **Radiological Hazard Warning:** This warning warns of the loss, discovery, or release of a radiological hazard such as the theft of a radiological isotope used for medical, seismic, or other purposes, discovery of radioactive materials, or a transportation accident involving nuclear weapons, nuclear fuel, or radioactive wastes. Authorized officials may recommend protective actions be taken if a radioactive hazard is discovered.
- **Civil Danger Warning:** This warning is issued when an event presents a danger to a significant civilian population. The message usually warns of a specific hazard and outlines specific protective actions such as evacuation or shelter in place.
- **Shelter In Place Warning:** This warning is issued when the public is recommended to shelter in place (go inside, close doors and windows, turn off air conditioning or heating systems, and turn on the radio or TV for more information). Examples include hazardous material releases or radioactive fallout.

Source: National Weather Service, 2006

4.9.2 HISTORY

Fortunately, Madison County has not been the location of a modern terrorism event. However on June 14, 2003, a drunken shooter killed one person and seriously injured six others outside an Ennis bar. This incident had a profound impact on the small community and is a recent example of local violence.

Significant terrorist acts occurring in Montana since 1950 include:

March 25-June 13, 1996: The Montana Freemen were in an 81 day standoff with federal law enforcement officials about 30 miles northwest of Jordan in Garfield County. Calling their ranch the Justus Township, they discounted federal, state, and county law and created their own currency. The standoff ended peacefully on June 13, 1996 when sixteen people at the ranch surrendered. Sources: National Memorial Institute for the Prevention of Terrorism, 2016

Table 4-37. Madison County Terrorism and Civil Unrest Declared Disasters and Emergencies [Montana Disaster and Emergency Services, 2016]

Declaration	Location	Date	Magnitude	Casualties	Damages
N/A	Statewide	January-February 1979	Activation of National Guard for State Institutions Strike	None	$1,393,714 State*
State EO 03-91	Statewide	April 1991	Activation of National Guard and Assistance Statewide for State Institutions Strike	None	Unknown
State EO 10-96	Statewide	April 23, 1996	Incident Response for Anniversary of Waco and Oklahoma City incidents	None	$4,368 State*
State EO 23-01	Statewide	September 11, 2001	Emergency Declaration following the World Trade Center and Pentagon terrorist attacks	None	Unknown
State EO 26-01	Statewide	September 28, 2001	National Guard activation to provide personnel for airport security	None	Unknown
State EO 26-2006	Statewide	September 28, 2001	Executive Order authorizing Incident Response authority in the State of Montana due to a Department of Correctiors prisoner escape froma prison transport vehicle within the City of Helena and Lewis & Clark County	None	Unknown
State EO 13-04	Statewide	September 2, 2004	Executive Order authorizing Incident Response authority in the State of Montana due to an escape of Department of Corrections convict in the City of Helena	None	Unknown

* Figures are statewide.

4.9.3 PROBABILITY AND MAGNITUDE

The probability of a terrorist or civil unrest event affecting Madison County directly is difficult to determine. The county is not considered a specific terrorist target nor is it an area at high risk for civil unrest. As with any area, a shooting by a disgruntled person, employee, or student is always possible. A large scale attack cannot be ruled out, and therefore, a small probability exists. Of greater probability is a terrorist attack that has an indirect effect on the county through its economy. The September 11th terrorist attacks in New York, Washington, and Pennsylvania had a significant impact on the national economy and required the activation of local resources. Another attack could have a similar effect. Such an attack in another part of the country has a greater probability than a direct attack within Madison County, but even the probability of such an attack elsewhere is unknown and is the subject of much debate.

An attack on the United States that collapses the economy or requires warfare and the drafting of soldiers is considered a high magnitude event. On a smaller but very significant scale would be an attack on a facility such as a school or business involving shooters, homemade bombs, or the taking of hostages. High schools across the country have struggled with similar events, and therefore, such an incident is possible, although not likely, in Madison County.

Overall Terrorism and Civil Unrest Probability: Low

4.9.4 MAPPING

Given the uncertainties associated with terrorism and civil unrest, uniform risk is assumed throughout the county.

4.9.5 VULNERABILITIES

4.9.5.1 CRITICAL FACILITIES

Critical facilities play prominent roles in Madison County. Often, terrorists target facilities that are highly important for government services and community stability. Threat data is not specific enough to identify what facilities are most vulnerable. Therefore, all critical facilities are considered to have the same risk countywide. Given the rural nature of the region, a major terrorist attack making a direct impact in Madison County is not expected. Perhaps the greatest threat to the communities is a disgruntled student, employee, or resident threatening others with violence, as was the case in June 2003. The extreme example of a bomb, depending on its size, could cause structural losses to a critical facility.

Possible losses to critical facilities include:

- Structural losses
- Contents losses
- Critical functional losses
- Critical data losses

Expected Terrorism and Civil Unrest Impact to Critical Facilities: Low-Moderate

4.9.5.2 CRITICAL INFRASTRUCTURE

Terrorism officials emphasize that potential targets include our nation's delicate infrastructure. Should an attack occur, Madison County could locally lose electricity, telephone, or internet services. More localized incidents could disrupt water or sewer services. Other attacks could limit fuel or propane supplies and affect transportation and heating capabilities.

Possible losses to critical infrastructure include:

- Electric power disruption
- Telephone service disruption
- Fuel shortages

Expected Terrorism and Civil Unrest Impact to Critical Infrastructure: Low-Moderate

4.9.5.3 STRUCTURES

Structure losses are possible from terrorism and civil unrest but are not likely. Looting, however, can be associated with these types of events. Therefore, this hazard places both the population and property at risk. Communities and places of public gathering are generally going to be the areas of greatest risk.

Possible losses to structures include:

- Structural losses
- Contents losses
- Vehicle losses
- Displacement losses

Expected Terrorism and Civil Unrest Impact to Structures: Low

4.9.5.4 POPULATION

The effects of terrorism and civil unrest are usually felt by the population. During times of unrest, the greatest risk is to human lives. Terrorists typically try to make a dramatic statement that will generate media interest. Attacking the population through a large loss of life is a common tactic. Depending on the type of attack, casualties could be light or involve much of the Madison County population.

Expected Terrorism and Civil Unrest Impact to the Population: Moderate-High

4.9.5.5 ECONOMIC, ECOLOGIC, HISTORIC, AND SOCIAL VALUES

Possible economic losses include:

- General national economic slowdowns
- Livestock losses through intentional disease spread
- Tourism losses during terrorism fears

Possible ecologic losses include:

- Environmental contamination

Possible social losses include:

- Cancelled activities
- Emotional impacts of significant population losses

- Loss of sense of security

Expected Terrorism and Civil Unrest Impact to the Values: Moderate

4.9.5.6 FUTURE DEVELOPMENT

Development should have little to no impact on the terrorism hazard, except for the increase in population and the associated increase in potential for life and property losses should an event occur.

Expected Terrorism and Civil Unrest Impact to Future Development: Low

4.9.6 DATA LIMITATIONS AND OTHER FACTORS

The data limitations related to the terrorism and civil unrest hazard include:

- Inability to quantify the probability and magnitude of an event
- General uncertainties related to terrorist attacks and civil unrest incidents

Other hazards often related to terrorism and civil unrest include:

- Any hazard that can be "imagined and created"
- Hazardous material release
- Dam failure
- Communicable disease
- Aircraft accident
- Wildfire

4.10 TRANSPORTATION ACCIDENT

Including Aircraft, Railroad, and Motor Vehicle Accidents

4.10.1 DESCRIPTION

A transportation accident, for the purposes of this plan, is any large-scale vehicular, railroad, or aircraft accident involving mass casualties. Mass casualties can be defined as an incident resulting in a large number of deaths and/or injuries that reaches a magnitude that overwhelms the ability of local resources to adequately respond.

Interstate, federal and state highways, county and town roadways, airports, and air traffic routes all pass through Madison County. Major roadways in the county include a small portion of Interstate 15, US Highway 287 and Montana Highways 41, 84, 87, and 287. Montana Highway 41 through Madison County and Twin Bridges is a popular interstate cut-off. Multi-vehicular accidents are many times related to weather, either obscuring the vision of drivers or hindering their control of a vehicle. Specific to the Towns of Sheridan and Virginia City, should a road blocking transportation accident occur during an evacuation, such as could be the case during a wildfire or hazardous material release, the evacuation could become impossible or significantly complicated due to the very limited road networks from those communities. This situation would put the communities at even greater risk of population losses from the initial hazard.

Montana Rail Link operates two railroad branch lines through the county, both connecting to a line north of Madison County, one to Twin Bridges and the other to Harrison. The railroad transports goods and raw materials along this line.

Madison County has two small airports serving private, charter, and/or government aircraft, Ennis -Big Sky Airport (EKS), and Twin Bridges Airport (7S1).Aviation accidents can occur for a multitude of reasons ranging from mechanical failure to poor weather conditions to intentional causes. The size of accidents also varies widely from single engine incidents to large commercial crashes. The location of the accident, such as a remote area versus a populated location, also plays an important role in the amount of destruction. Most aircraft accidents occur during takeoff or landing, and depending on the size of the aircraft, can be very serious events. It is also noted that Ennis airport has seen 34% or more increase in traffic yearly for the last 5 years. With growth on the rise in this area, the increased traffic at this airport will also increase. With the additional need for fuel storage and increased usage the chance or accidents also increases.

4.10.2HISTORY

The history of transportation accidents in Madison County consists primarily of small magnitude incidents, some with fatalities, but most with very little effect on the entire community. Traffic accidents along the roadways occur regularly, usually inconveniencing travelers, overwhelming local emergency resources, and occasionally causing delays. Table 4.10.2A shows the traffic fatalities in Madison County from 1980-2015

Table 4-38. Traffic Fatalities [Montana Highway Patrol, 2016]

Year	Number of Fatalities	Year	Number of Fatalities	Year	Number of Fatalities	Year	Number of Fatalities
1980	4	1990	4	2000	2	2010	3
1981	5	1991	1	2001	0	2011	9
1982	2	1992	0	2002	6	2012	5
1983	5	1993	3	2003	3	2013	4
1984	3	1994	1	2004	4	2014	4
1985	2	1995	8	2005	7	2015	4
1986	4	1996	3	2006	5		
1987	6	1997	5	2007	6		
1988	4	1998	1	2008	6		
1989	2	1999	3	2009	1		
WHERE'S THE OTHER YEARS???						Average	2.9

Over the past 31 years, Madison County has had one highway-rail incident which occurred in 1996 with no fatalities or injuries. (Federal Railroad Administration, 2016)

Table 4-39. Fatal Aircraft Accidents [National Transportation Safety Board, 2016]

Date	Location	Fatalities	Additional Information
10/23/1972	Near Ennis	2 fatalities	The pilot, not instrument rated, continued into obscured conditions and collided with terrain.
07/01/1979	Big Sky	2 fatalities	The plane crashed and caught fire when attempting to land in windy conditions.

Table 4-40. Madison County Transportation Accident Declared Disasters and Emergencies

Declaration	Location	Date	Magnitude	Casualties	Damages
None					

4.10.3 PROBABILITY AND MAGNITUDE

Lacking a history of transportation accidents resulting in mass casualties, the probability of such can only be theorized and expressed qualitatively. The probability is increased during winter storms, periods of poor visibility from snow, smoke, or dust, during holiday festivities with more instances of drinking and driving, and during times of increased traffic volume. Accidents with minor damage and injuries occur regularly. Serious, fatal accidents are less frequent but still occur.

Railroad accidents in Madison County have historically had very little impact on the communities. Over the past 20 years, only one railroad incident has occurred.

Aircraft accidents are documented carefully. Since 1964, 4 fatalities from aircraft accidents have occurred in Madison County. Based on these statistics over a 46-year period (1964-2009), a ten-year average can be derived. In an average ten-year period, about 1 aircraft fatality occurs. Although an incident involving a commercial passenger flight and mass casualties cannot be ruled out, the probability is considered lower.

Any mass casualty incident that overwhelms the emergency response resources within the county and neighboring counties, such as a bus or plane crash, represents a high magnitude event.

Overall Transportation Accident Probability: Moderate
Except the Towns of Sheridan and Virginia City: Low-Moderate

4.10.4 MAPPING

The Introduction section shows the major transportation routes within the county. Generally, those areas are at greater risk for a transportation accident, however, a mass casualty transportation accident cannot be ruled out anywhere in the county. Some risk exists countywide.

4.10.5 VULNERABILITIES

4.10.5.1 CRITICAL FACILITIES

Except in the very rare case of an aircraft, train, or vehicle crashing into a critical facility, the facilities should remain unaffected by a transportation accident. An accident involving a first response agency or blocking a primary transportation route could delay emergency services.

Possible losses to critical facilities include:

- Structural losses
- Contents losses
- Functionality losses
- Increased public safety calls

Expected Transportation Accident Impact to Critical Facilities: Low

4.10.5.2 CRITICAL INFRASTRUCTURE

In most cases, infrastructure remains unaffected during transportation accidents. The most likely impact would be the closure of a major roadway due to a vehicular accident, thus resulting in travel inconveniences and long detours. Theoretically, an aircraft or vehicle can take out power lines, telephone lines, or other important pieces of infrastructure resulting in service disruptions.

Possible losses to critical infrastructure include:

- Possible loss of infrastructure services and blocked roadways

Expected Transportation Accident Impact to Critical Infrastructure: Low
Except the Towns of Ennis and Twin Bridges: Low-Moderate

4.10.5.3 STRUCTURES

Like the critical facilities, except in the very rare case of an aircraft, train, or vehicle crashing into a structure, buildings should be unaffected by a transportation accident. For example, should structures be affected, damages could vary in the tens or hundreds of thousands of dollars depending on the structure or structures impacted. Should an accident occur in a developed area, structural losses in the neighborhood of $475,600 (2 homes x $237,800/average housing unit) could be expected. A large commercial jet crash could potentially destroy an entire segment of a populated area for a loss of roughly $2,378,000 (assuming approximately 10 structures were destroyed). The likelihood of such a high magnitude accident is extremely low.

Possible losses to structures include:

- Structural losses
- Contents losses

Expected Transportation Accident Impact to Structures: Low-Moderate

4.10.5.4 POPULATION

Of all the resources and values, transportation accidents pose the most common risk to the population. Accidents involving aircraft, trains, vans, or busses could have mass casualties. The magnitude of such

population impacts varies from the size of the aircraft, train, or vehicle to the number of vehicles involved. Anywhere from 2-200 people or more could be involved.

Expected Transportation Accident Impact to the Population: Moderate-High

4.10.5.5 ECONOMIC, ECOLOGIC, HISTORIC, AND SOCIAL VALUES

Possible economic losses include:

- Commerce losses due to closed roadways, railways, or airports

Possible social losses include:

- Emotional impacts due to mass casualties

Expected Transportation Accident Impact to the Values: Low-Moderate
Except the Towns of Ennis and Twin Bridges: Moderate

4.10.5.6 FUTURE DEVELOPMENT

Future development, particularly the associated increase in traffic, may increase the probability of a major transportation accident. With furture planning on expansions at both airports to facilitate larger aircraft and more traffic, the risk for an accident will go up, Ennis airport has seen 34% or more increase in traffic yearly over the last 5 years. This will lead to the need for more fule storage as well as a increase in flights in and out of the area.Otherwise, the specific locations of where development occurs, except for possibly in the immediate vicinity of the airports or the railroad, should not significantly affect the vulnerabilities from this hazard.

Expected Transportation Accident Impact to Future Development: Low

4.10.6 DATA LIMITATIONS AND OTHER FACTORS

The data limitations related to the transportation accident hazard include:

- Difficulties in predicting the location and magnitude of future accidents

Other hazards often related to transportation accidents include:

- Hazardous material release
- Severe weather
- Smoke
- Flood
- Terrorism

4.11VOLCANO

4.11.1 DESCRIPTION

Madison County does not have any known active volcanoes. However, the Yellowstone Caldera within Yellowstone National Park is about 50 miles away, and dense volcanic ash can travel hundreds of miles. The last non-hydrothermal eruption in the Yellowstone Caldera was thousands of years ago. Currently, the most active region in the continental United States is the Cascade Range to the west in Washington and Oregon, about 500 miles away. This region includes the volcanoes at Mount St. Helens, Mount Rainer, and Mount Hood. Madison County lies within reasonable range of ashfall from these volcanoes

under normal upper atmospheric wind and stability conditions. In addition to ashfall and other effects, large eruptions have been known to change weather patterns globally.

The Yellowstone Caldera, one of the world's largest active volcanic systems, has produced several giant volcanic eruptions in the past few million years, as well as many smaller eruptions and steam explosions. Although no eruptions of lava or volcanic ash have occurred for many thousands of years, future eruptions are likely. Over the next few hundred years, hazards will most likely be limited to ongoing geyser and hot-spring activity, occasional steam explosions, and moderate to large earthquakes. To better understand Yellowstone's volcano and earthquake hazards and to help protect the public, the US Geological Survey, the University of Utah, and Yellowstone National Park formed the Yellowstone Volcano Observatory, which continuously monitors activity in the region [(US Geological Survey, 2005].

If a large caldera-forming eruption were to occur at Yellowstone, its effects would be felt worldwide. Thick ash deposits would bury vast areas of the United States, and the injection of huge volumes of volcanic gases into the atmosphere could drastically affect global climate. Fortunately, the Yellowstone volcanic system shows no signs that it is headed toward such an eruption. The probability of a large caldera-forming eruption within the next few thousand years is exceedingly low. Any renewed volcanic activity at Yellowstone would most likely take the form of non-explosive lava eruptions [US Geological Survey, 2005].

The Cascade Region does not have the same caldera-forming potential as Yellowstone, but has been much more active in recent years. The volcanoes in this region can drop and have dropped measurable ash over Montana. Volcanic ashfall may not sound harmful hundreds of miles away, but depending on the volume of ash that falls, it can create problems. Ash in the air can affect those with respiratory sensitivities, reduce visibilities, and clog air intakes. Its corrosive properties can damage vehicles and other machinery. When wet, the ash becomes glue-like and hard to remove.

4.11.2HISTORY

On May 18, 1980, Mount St. Helens in the Cascade Range of Washington erupted, sending ash high into the atmosphere. Over the course of several days, the ash fell from the sky, primarily over eleven states, including Montana. Less than a half inch fell over Madison County but the ash on the ground was measurable, as shown in Figure 4.11.2A. The Montana Governor asked businesses to close and individuals with breathing problems to stay indoors until the threat was assessed. No reports of structure damage were received, and the health concerns lasted for a 3 day period.

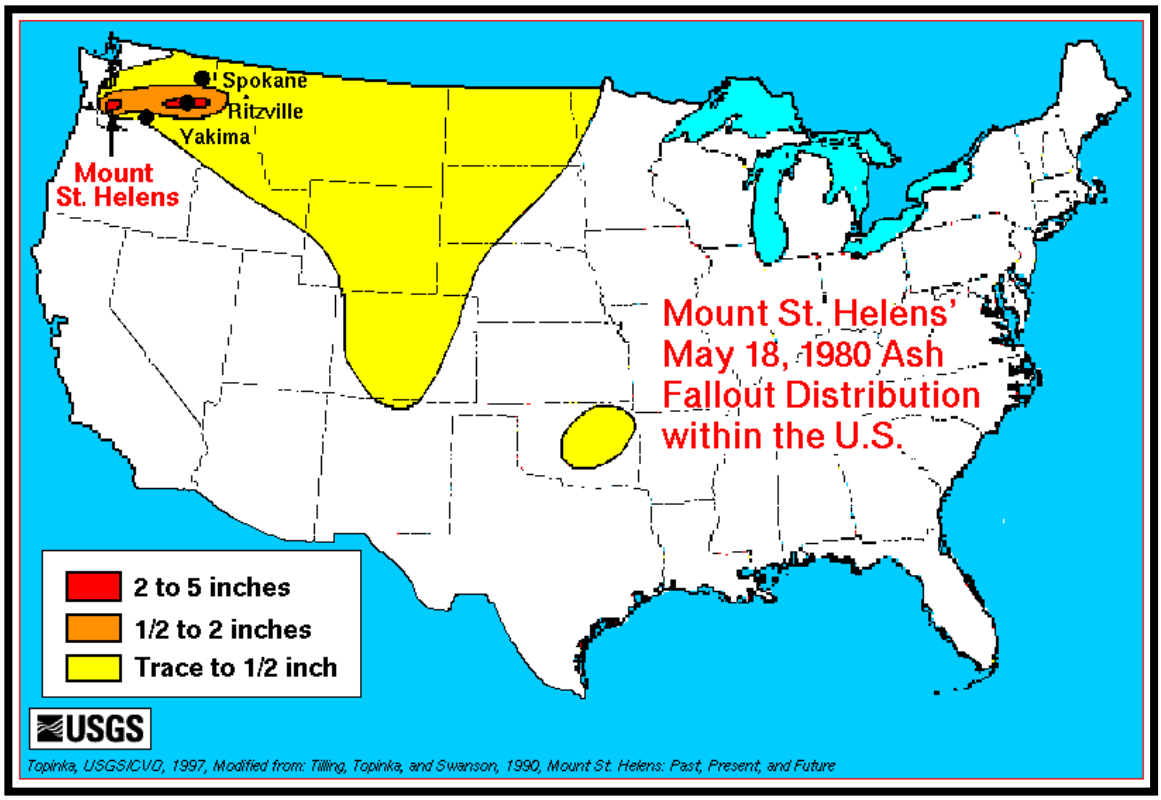


Figure 4-15 Generalized Map of United States Ashfall from Mount St. Helens [Cascades Volcano Observatory, 2006]

The Yellowstone region has produced three exceedingly large volcanic eruptions in the past 2.1 million years. In each of these cataclysmic events, enormous volumes of magma erupted at the surface and into the atmosphere as mixtures of red-hot pumice, volcanic ash (small, jagged fragments of volcanic glass and rock), and gas that spread as pyroclastic ("fire-broken") flows in all directions. Rapid withdrawal of such large volumes of magma from the subsurface then caused the ground to collapse, swallowing overlying mountains and creating broad cauldron-shaped volcanic depressions called "calderas." (US Geological Survey, 2005) Studies have shown that ash from each of these eruptions fell where Madison County now sits.

Table 4-41. Madison County Volcano Declared Disasters and Emergencies

Declaration	Year	Additional Information	Casualties	Damages/Assistance
None				

4.11.3 PROBABILITY AND MAGNITUDE

Volcanic eruptions are rare events when compared to other hazards. Scientists evaluate natural hazards by combining their knowledge of the frequency and the severity of hazardous events. In the Yellowstone region, damaging hydrothermal explosions and earthquakes can occur several times a century. Lava flows and small volcanic eruptions occur only rarely - none in the past 70,000 years. Massive caldera-forming eruptions, the most potentially devastating of Yellowstone's hazards, are extremely rare - only three have occurred in the past several million years. U.S. Geological Survey, University of Utah, and National Park Service scientists with the Yellowstone Volcano Observatory

(YVO) see no evidence that another such cataclysmic eruption will occur at Yellowstone in the foreseeable future. Recurrence intervals of these events are neither regular nor predictable. (US Geological Survey, 2005) Figure 4.11.3A shows the probability of the various events that can occur in Yellowstone National Park.

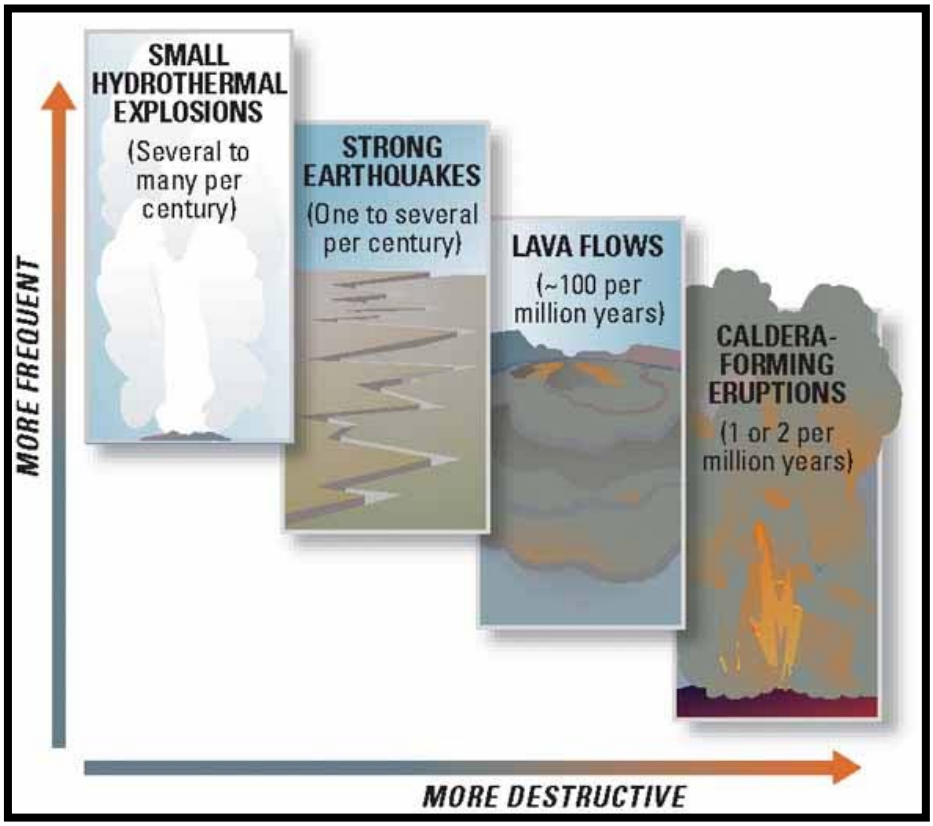


Figure 4-16. Recurrence Intervals for Geological Events in Yellowstone National Park [US Geological Survey, 2005]

The Cascade region, being more active, has a higher probability of eruptions over the next 100 years. Based on eruptions in the Cascade region over the past 4,000 years, the probability of an eruption is about 1.25% in any given year or approximately 1-2 eruptions per 100 years within the Cascade Range.

A large caldera-forming eruption of Yellowstone Park is always possible with devastating consequences for many communities across the United States. Given the extremely low probability of such an event, a more realistic magnitude over the next 500 years will be considered for planning purposes. A Cascade Range eruption that leaves an inch or more of ash over Madison County is a high magnitude volcanic ashfall event for this area. Such an event would not only affect the county, but many other communities throughout the region. Rainfall would additionally compound problems with the ash removal.

Overall Volcano Probability: Low

4.11.4 MAPPING

Following an eruption, the areas affected by ash will depend on the type of eruption, atmospheric stability, and wind conditions. Forecasts estimating the amount of ash will generally be issued at that time. Given the broad, regional nature of volcanic ashfall, Madison County is assumed to have the same risk countywide.

4.11.5 VULNERABILITIES

4.11.5.1 CRITICAL FACILITIES

Theoretically, large amounts of wet volcanic ash could weigh enough to bring down even strong roofs. A more likely problem is the removal of ash from building air intakes and vehicles. This removal takes time and care since volcanic dust is corrosive to metals. In most cases, critical facility clean-ups would be done by the building owner or facility maintenance. Additionally, emergency responders may look to alternatives to driving in ashfall given its corrosive properties and potential to damage vehicle engines. With the reduced visibilities and volcanic ash in the air, aircraft may not be able to fly to the affected area to provide medical or emergency supplies.

Possible losses to critical facilities include:

- Structural losses
- Contents losses
- Functionality losses
- Clean-up costs
- Increased public safety calls

Expected Volcano Impact to Critical Facilities: Low-Moderate

4.11.5.2 CRITICAL INFRASTRUCTURE

Since volcanic ash is corrosive, particularly when wet, above ground infrastructure such as power lines, telephone lines, and sewer lift stations may experience mechanical and connectivity problems. With only an inch or two of ash, however, such damages and disruptions would probably be relatively minor.

Possible losses to critical infrastructure include:

- Possible temporary loss of infrastructure services

Expected Volcano Impact to Critical Infrastructure: Low

4.11.5.3 STRUCTURES

Like the critical facilities, structures throughout the county are vulnerable to ashfall. The greatest challenge would most likely be the removal of the ash and not structural damages. Heavy ash does have the potential to clog air systems. Many residents would need guidance and assistance in removing ash from their personal property.

Possible losses to structures include:

- Structural losses

- Contents losses
- Clean-up costs

Expected Volcano Impact to Structures: Low-Moderate

4.11.5.4 POPULATION

Light ashfall does not usually significantly affect the general population, but those with respiratory sensitivities may experience additional problems. Ashfall conditions that exist for several days could lead to significant health problems even in the general population. Most communities recommend staying indoors, closing windows, and turning off air conditioners, thus minimizing the human exposure to the ash. Local officials would probably have some warning before the ash began to fall. Earthquakes would likely warn of any activity in the Yellowstone Caldera. The degree of population impacts will greatly vary, depending on the type of event.

Expected Volcano Impact to the Population: Moderate

Economic, Ecologic, Historic, and Social Values

Possible economic losses include:

- Losses to agriculture due to livestock health and feed and crop productivity issues
- Tourism losses due to minimized travel to the area

Possible ecologic losses include:

- Wildlife losses due to food shortages
- Fish and aquatic losses due to changes in water properties from the ash

Possible social losses include:

- Emotional impacts due to isolation in closed up buildings
- Cancelled activities during emergency travel only periods

Expected Volcano Impact to the Values: Low-Moderate

4.11.5.5 FUTURE DEVELOPMENT

Future development will have little to no effect on the volcano vulnerabilities. An increase in the population and number of structures would increase the exposure.

Expected Volcano Impact to Future Development: Low

4.11.6 DATA LIMITATIONS AND OTHER FACTORS

The data limitations related to the volcano hazard include:

- Difficulties in predicting future volcanic activity and the associated impacts due to the low frequency of eruptions.

Other hazards often related to volcanoes include:

- Earthquake

4.12 WILDFIRE

4.12.1 DESCRIPTION

A wildfire is an uncontrolled fire in a vegetated area. Wildfires are a natural part of the ecosystem. They have a purpose in nature and following years of fire suppression, many areas have built up fuels that can lead to larger, more intense fires. In Madison County, timber, shrubs, grasses, and rangeland make up the primary fuel sources. These fuels burn rapidly and readily when cured. These types of fires have the potential to destroy structures and natural resources while producing heavy amounts of smoke, particularly when spread by strong winds.

Any flame source can trigger a wildfire, but they are most often triggered by lightning. Once ignited, ambient conditions dictate whether the fire will spread or not. Moist, cool, and calm conditions or a lack of fuels will suppress the fire, whereas dry, warm, and windy conditions and dry fuels will contribute to fire spread. The terrain, accessibility, and capabilities of the fire agencies are also factors in the fire's growth potential. Problems with wildfire occur when combined with the human environment. People and structures near wildfires can be threatened unless adequately protected through evacuation, mitigation, or suppression.

Wildfire occurrence is weather dependent and highly variable from year to year. Fire season generally runs from March through November but wildfires can occur at any time of year. The light, flashy fuels and the heavy, fire-sustaining timber present in the region are capable of producing large, fast moving wildfires. The Beaverhead-Deerlodge National Forest and Lee Metcalf Wilderness regularly experience wildfires and the mixed fuels and rugged terrain of those areas make firefighting especially difficult. Timber areas, shrubs, native grasses, and non-irrigated lands in the remainder of the county also present wildfire hazards. The timber areas primarily contain Cool Dry Douglas Fir, Moist Douglas Fir, and Cool Habitat Types Lodgepole Pine. Sagebrush is fairly extensive throughout the rangelands in Madison County. (Madison County, 2003) Infestations of pine beetles have also created wide areas of dead timber throughout Madison County.

Madison County has large areas of government owned lands. The Beaverhead-Deerlodge National Forest is managed by the US Forest Service. Scattered across the county are large tracts of land managed by the US Bureau of Land Management and state government. This scattering of government and private ownership can present unique firefighting challenges and opportunities. Map 3.4A in the Current Land Use section shows the government land ownership in the county. Additionally, Madison County has Conservation Reserve Program (CRP) acres. The US Department of Agriculture (USDA) Farm Service Agency's Conservation Reserve Program (CRP) is a voluntary program available to agricultural producers to safeguard environmentally sensitive lands. Producers enrolled in CRP establish long-term, resource-conserving covers to improve the quality of water, control soil erosion, and enhance wildlife habitat. In return, the Farm Service Agency provides participants with rental payments and cost-share assistance. (Farm Service Agency, 2004) Although the CRP benefits the environment in many respects, CRP lands may increase the fuels available and therefore the wildfire

risk to nearby communities. As of 2016, Madison County had 3,203 acres participating in the CRP. This is a large reduction in acres in the last ten years, (Farm Service Agency, 2016)

Since fire suppression activities became common practice about 100 years ago, the natural cycle of frequent, low-intensity, surface fires was disrupted, and fuels, particularly in forested areas, have built up to hazardous levels. Those same habitats that would experience low-intensity fires now experience stand-replacing, high intensity fires. Changes to the ecosystem can have profound effects on the intensity and severity of wildland fires. To qualify the changes, fire ecologists use the term fire regime condition class. Fire regime condition classes measure the degree of departure from "natural" conditions. Table 4.12.1A shows the classes and definitions accepted by many agencies. Any work done to reduce a condition class or to maintain a condition class at Class I helps to lessen the intensity of future wildfires and increases the ability of firefighting agencies to control the fire.

Table 4-42. Fire Regime Condition Class [US Forest Service, 2016.]

Condition Class	Frequency	Severity	Severity Description
I	0–35 years	Low / Mixed	Generally low severity fires replacing less than 25% of the dominant overstory vegetation. Can include mixed-severity fires that replace up to 75% of the overstory.
II	0–35 years	Replacement	High severity fires replacing greater than 75% of the dominant overstory vegetation.
III	35–200 years	Mixed / Low	Generally mixed severity. Can also include low severity fires.
IV	35–200 years	Replacement	High severity fires.
V	200+ years	Replacement/ Any Severity	Generally replacement severity. Can include any severity type in this frequency range.

The following categories were used in the 2013 Madison County Community Wildfire Protection Plan to categorize potential areas by risk.

High Priority/Potential Areas: These are areas where wildland fire risk is the highest. Fire has the potential to cause major property damage or resource loss, major suppression costs, and could be a high risk to firefighters. Fire suppression actions could be aggressive and the acreage burned will likely be kept as small as possible within these areas. Prevention will also be emphasized to keep the numbers of person-caused ignitions to a minimum. These areas are characterized as those that are near National Forest or other public lands and have a slope and/or fuels favorable to intense wildfires. Consideration was also given to developed areas with poor transportation options (see Map 6.4A) and values at risk (see Section 3.4, Community Assets and Values).

Moderate Priority/Potential Areas: These are areas where wildland fire is undesirable. Like High Priority/Potential Areas, fuel conditions are hazardous, and fire suppression actions will be aggressive in order to keep fires small. Again, fire prevention will be emphasized in these areas. The fuels in the moderate areas are generally shrublands or grasslands, but agricultural and developed areas greater than five miles from a fire station are also included.

Low Priority/Potential Areas: These are areas where significant negative effects from wildfire are less likely. These areas are mostly agricultural and are within five miles of a fire station. Wildfires in these areas are usually relatively quickly and easily contained by local fire departments.

Source: Madison County Community Wildfire Protection Plan, 2013.

Hazard assessments were conducted in 2012 for the Madison County Community Wildfire Protection Plan. Each area was classified as follows, in order of severity:

High Hazard

- Sun Ranch West
- Elk Hills and South Meadow Creek Subdivisions
- Moonlight Basin Area
- South Boulder and Mammoth Area
- Shining Mountain and Virginia City Ranches Subdivisions
- Haypress Lake Area
- Madison River Ranches Subdivision
- Sundance Bench Ranches Subdivision
- Nevada City Area
- Washington Bar and North Meadow Creek Subdivisions
- Potosi Hot Springs Area
- Sundowner and Sunriser Subdivisions
- Big Sky Area
- Virginia City Area

Moderate Hazard

- Indian Creek Area
- Yellowstone Club Subdivision
- Highway 87 South to Idaho Line Area
- Rising Sun Mountain Estates Subdivision
- Lonesome Dove Subdivision
- Sphinx Mountain Subdivision
- Double M Ranch Subdivision
- Sportsmans Paradise Subdivision
- Lower Shining Mountain Subdivision
- South Ruby Area
- Pony Area
- Mustang Ranches Subdivision
- Air Park Shining Mountains Subdivision

- Melrose Road Area
- Silver Star Area
- Squaw Creek Tracts Subdivision
- Sturdivant Happy Acres Subdivision

Source: Madison County Community Wildfire Protection Plan, 2013.

4.12.1.1 WARNINGS, WATCHES, AND ADVISORIES

The National Weather Service issues several products to alert for significant wildfire potential or hazards. These include:

- **Fire Weather Watch:** A fire weather watch is issued when Red Flag conditions (see below) are expected in the next 24 to 72 hours.
- **Red Flag Warning:** A red flag warning is issued when Red Flag criteria are expected within the next 12 to 24 hours. A Red Flag event is defined as weather conditions that could sustain extensive wildfire activity and meet one or more of the following criteria in conjunction with "Very High" or "Extreme" fire danger:
  - Sustained surface winds, or frequent gusts, of 25 mph or higher
  - Unusually hot, dry conditions (relative humidities less than 20%)
  - Dry thunderstorm activity forecast during an extremely dry period
  - Anytime the forecaster foresees a change in weather that would result in a significant increase in fire danger. For example, very strong winds associated with a cold front even though the fire danger is below the "Very High" threshold.
- **Fire Warning:** A fire warning may be issued by local officials when a spreading wildfire or structure fire threatens a populated area. Information in the warning may include a call to evacuate areas in the fire's path as recommended by officials according to state law or local ordinance.
- **Dense Smoke Advisory:** Dense smoke advisories are issued when the widespread visibilities are expected at a ¼ mile or less for a few hours or more due to smoke.

Source: National Weather Service, 2006

4.12.2HISTORY

Madison County has a long history of wildfires ranging from small to large. Some have caused damages and others have not. The extent of damages often depends on the fire spread rate, the effectiveness of suppression and mitigation measures, and the property and infrastructure in the fire's path. The history of wildfires can be difficult to compile because of the various firefighting entities involved and a variety of recordkeeping measures over the years. Table 4.12.2A lists some of the more significant wildfires in Madison County.

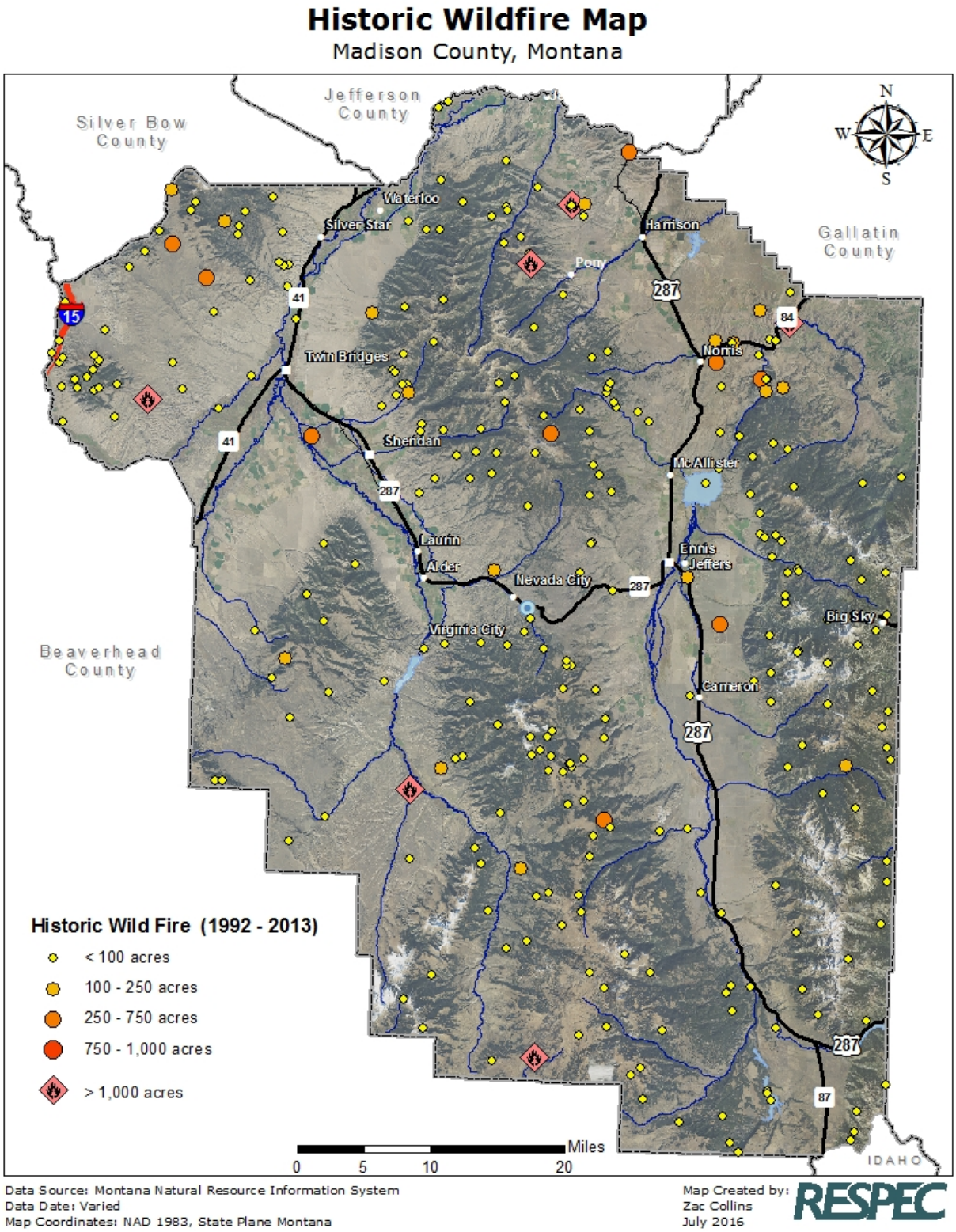


Figure 4-17. Need Caption and Callout.

Table 4-43. Historic Wildfires (greater than 1,000 acres) [Montana Department of Natural Resources and Conservation, 2016; Rocky Mountain Research Station, 1999]

Name	Date	Size	Additional Information
Raynolds Pass Fire	1981	2,100 acres	31 miles south of Cameron
Sun Ranch Fire	8/25 – 8/29/1988	1,495 acres	7 miles southeast of Alder
Corral Creek Fire	8/29 – 9/18/1988	2,853 acres	4 miles southwest of Norris
Cameron Fire	1988	1,100 acres	19 miles south of Cameron
Snowcrest / Robb Fire	1994	1,033 acres	16 miles south of Alder
Antelope Creek Fire	9/30 – 10/10/1996	2,100 acres	4 miles southeast of Norris
Melrose	10/2/2011	2569 acres	West of Twin Bridges
Bear Trap 2	7/6/2012	15341 acres	In the Tobacco Root Mountains between the Communities of Mammoth and Pony
Pony	7/8/2012	5157 acres	East of Noris
Eureka	10/17/2013	6768 acres	In the Gravelly Range mainly north of Eureka Basin Rd
Blue Lake Fire	7/21/16	629 acres	Approximately 10 miles SW of Ennis, MT; 1 ½ miles south of the Axolotl Lake

Table 4-44. Madison County Wildfire Declared Disasters and Emergencies [FEMA, 2016]

Declaration	Year	Additional Information	Casualties	Damages/Assistance
FEMA-2110-FSA-MT FEMA-2111-FSA-MT	1994	Madison County, plus 12 other counties	Unknown	$2,904,088 PA*
FEMA-2318-FSA-MT	2000	Madison County, plus 1 other county	Unknown	$143,015 PA*
FEMA-1340-DR-MT	2000	Madison County, plus 47 other counties and 6 reservations	Unknown	$11,579,000 IA*

*Figures are for all Montana counties/reservations included in the declaration.

4.12.3 PROBABILITY AND MAGNITUDE

Wildfires are an annual occurrence in Madison County. The frequency and size of the wildfires depends on the ambient conditions and other factors. The probability of a damaging wildfire that burns uncontrollably despite firefighting efforts is difficult to assess. Generally, the summer months, particularly during droughts, create conditions favorable to wildfires. If the weather conditions and fuels allow, especially if the winds are strong, wildfires can grow rapidly with little warning. The probability of wildfires is slightly elevated during active ignition periods such as the Fourth of July holiday and before fire restrictions are in place.

The largest wildfire on record for Madison County is the Bear Trap 2 Fire that burned 15,341 acres. Wildfires of this magnitude are clearly possible and can be expected in the future. Based on a regional

history, wildfires burning tens of thousands of acres are possible. Of greater significance, however, is a wildfire that spreads into communities destroying structures and infrastructure, even if not large in size.

Overall Wildfire Probability: Moderate
Except the Towns of Ennis, Sheridan, and Twin Bridges: Low-Moderate

4.12.4 MAPPING

Wildfire potential is mapped in a variety of ways. Since many factors play into wildfire risk, components are often mapped individually. Vegetation type outlines the type of fuels available for wildfires. In the case of agriculture, the flammability depends on the crop and its condition at that point in the growing season. Grasslands and shrublands are not usually managed significantly and may contain a build-up of flashy fuels year round. Dense, evergreen, timber areas are usually at risk for crown fires. Map 4.12.4A shows the wildfire risk areas and the local structure data to show the areas at greatest risk from wildfires. The wildfire risk areas were created using the vegetation type. Areas within the general proximity of evergreen trees were categorized as “high” hazard. Areas within the general proximity of shrublands and prairie grasses were categorized as “moderate” hazard. All other areas were categorized as “low” hazard. These generalizations allow for planning estimations. The actual wildfire hazard for a particular structure can only be determined based on a site evaluation.

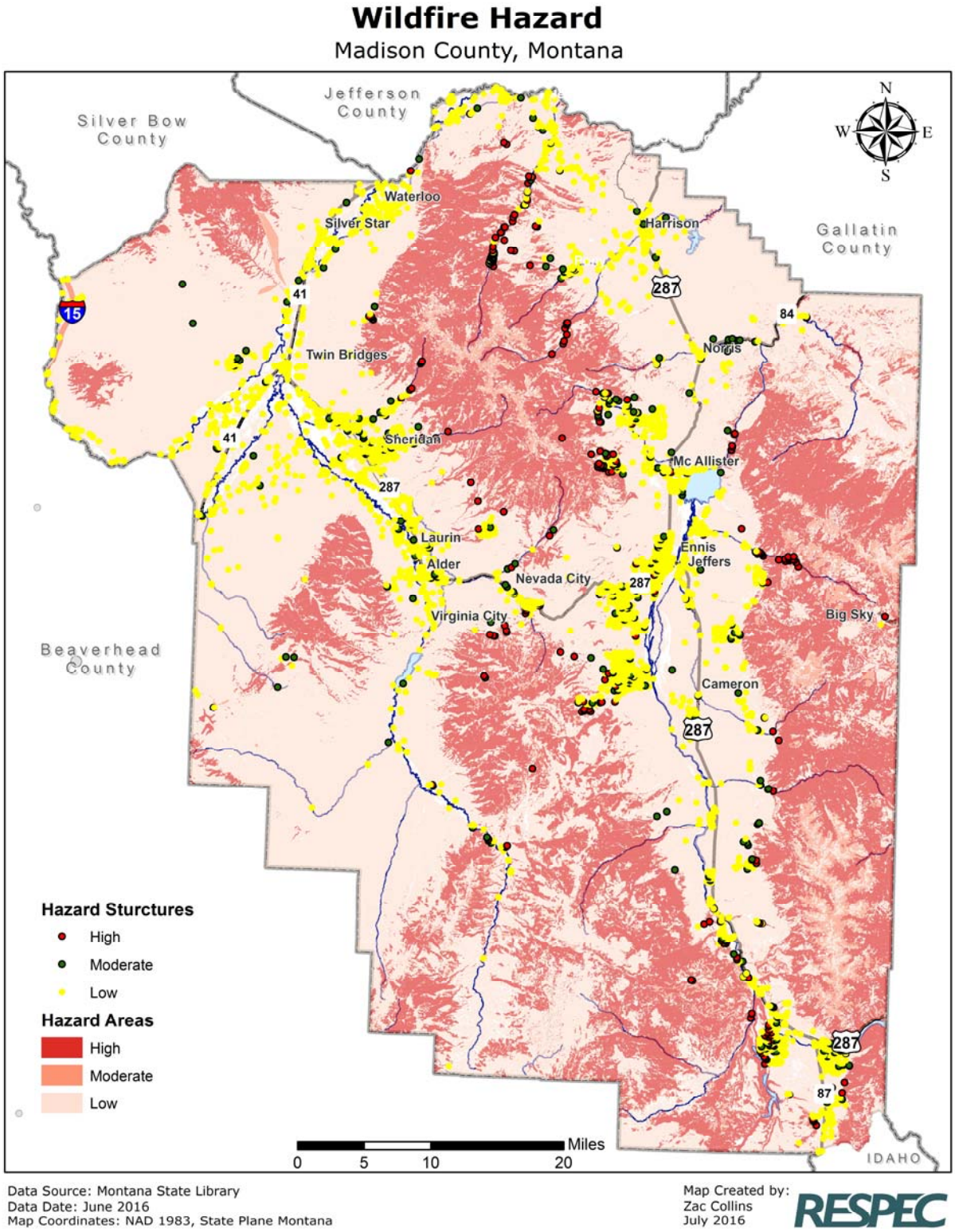


Figure 4-18. Need Caption and Callout.

4.12.5 VULNERABILITIES

Wildfires have the greatest potential to threaten structures lacking defensible space. Defensible space is a buffer zone between a structure and flammable fuels. Irrigation, mowed areas, fuels thinning, roads, and waterways can serve as buffers to wildfires in some cases. The threat to an individual structure can truly only be assessed on a case-by-case basis.

4.12.5.1 CRITICAL FACILITIES

Using the criteria that those structures in the general proximity of forested areas are at greatest risk for wildfire impacts and those in the shrublands and prairie areas are at moderate risk, Table 4.12.5A shows the critical facilities with high wildfire risk.

Table 4-45. Critical Facilities at High Wildfire Risk

Facility	Risk Area
Big Sky Sewer and Water District Office	High
Virgina City	High

Possible losses to critical facilities include:

- Structural losses
- Contents losses
- Critical functional losses
- Critical data losses

Expected Wildfire Impact to Critical Facilities: Moderate
Except the Towns of Ennis, Sheridan, and Twin Bridges: Low-Moderate

4.12.5.2 CRITICAL INFRASTRUCTURE

Often regional electric infrastructure passes through wildland and non-irrigated agricultural areas. In particular, the electric substations, transmission lines, and telephone lines are usually buffered by or overhang natural fuels. A wildfire could disrupt electricity or communications should this infrastructure be damaged. Propane tanks also become hazardous infrastructure when a wildfire threatens a structure.

Possible losses to infrastructure include:

- Electric power disruption
- Telephone service disruption
- Water shortages
- 911 Communication transmissions

Expected Wildfire Impact to Critical Infrastructure: Moderate
Except the Towns of Ennis: Low-Moderate

4.12.5.3 STRUCTURES

All residences, ranches, and businesses could potentially be threatened by wildfires. Comparing the estimated structure locations to the hazard areas, an estimated 133 structures with a total building

value exposure of $186,892,143 are at high risk from wildfires. An additional 31 structures with a total building value exposure of $10,442,584 are at moderate risk from wildfires.

A damage factor is rather difficult to determine because the losses will be highly dependent on the fire characteristics and its location. Not all areas in the high and moderate risk areas will be affected by one particular wildfire. However, structures in the fire perimeter could have a high loss rate. Given an assumption that 10% of the structures in the high hazard area could be lost in a probable wildfire, the structure losses from that fire would roughly total $18 million or about 13 structures. Because of the high value of structures in the Big Sky and Yellowstone Club areas, property losses could be higher in those areas and lower in other parts of the county. History has shown that personal property losses can be much greater than just that of residences. Outbuildings, fences, equipment, livestock, pastures, and crops are often additional losses.

Possible losses to structures include:

- Structural losses
- Contents losses
- Vehicle and equipment losses
- Displacement losses

Expected Wildfire Impact to Structures: High
Except the Towns of Sheridan and Virginia City: Moderate
Except the Towns of Ennis and Twin Bridges: Low-Moderate

4.12.5.4 POPULATION

Generally, the population at risk can evacuate before a wildfire moves into their area. Using the estimate of 164 structures in the high and moderate hazard areas, roughly 345 people in Madison County live with elevated wildfire risk. Occasionally when strong winds are in place, wildfires can move very rapidly and catch people by surprise, or people may just refuse to evacuate; fatalities and injuries are possible. In these types of situations, firefighters can also be at risk from rapidly moving wildfires. Many times, wildfire fatalities of the evacuating population occur when frantic drivers or poor visibilities due to smoke cause an accident.

Expected Wildfire Impact to the Population: Moderate

4.12.5.5 ECONOMIC, ECOLOGIC, HISTORIC, AND SOCIAL VALUES

Possible economic losses include:

- Crop and forage losses
- Livestock losses
- General agricultural economic losses, such as outbuildings, fencing, and equipment losses

Possible historic losses include:

- Structure and site losses, particularly in the historic Virginia City and Nevada City areas
- Contents losses, particularly in the historic Virginia City and Nevada City areas

Possible social losses include:

- Restricted recreational activities due to burn bans and closures

Expected Wildfire Impact to the Values: Moderate
Except the Towns of Ennis and Twin Bridges: Low-Moderate

4.12.5.6 FUTURE DEVELOPMENT

Remote, isolated, forested areas are becoming more popular places to live or to have a second home, as national trends show. Growth in these parts of Madison County is occurring. Regulating growth in these areas is a delicate balance between protecting private property rights and promoting public safety. Future development could have a negative impact on the wildfire vulnerabilities, putting more people and property in harm's way. Currently, Madison County does consider the wildfire risk when reviewing proposed subdivisions.

Expected Wildfire Impact to Future Development: Moderate-High
Except the Towns of Sheridan and Virginia City: Moderate
Except the Towns of Ennis and Twin Bridges: Low-Moderate

4.12.6 DATA LIMITATIONS AND OTHER FACTORS

The data limitations related to the wildfire hazard include:

- Lack of a comprehensive, multi-agency, historic wildfire digital database containing information on start location, cause, area burned, suppression costs, and damages
- Lack of mapping of Community Reserve Program lands

Other hazards often related to wildfire include:

- Drought
- Smoke
- Poor air conditions
- Aircraft accidents
- Thunderstorms
- Flash flood, in and around the burn area

4.13WINTER WEATHER

Including Blizzards, Heavy Snow, Ice Storms, and Extreme Cold

4.13.1 DESCRIPTION

Winters in Montana can be harsh, and Madison County is no exception. Winds, snow, and cold temperatures blast the region every winter. On average, the coldest month is January with average high temperatures in the lower 30's and average low temperatures in the lower teens. In Madison County, snow has fallen in all months except July. Given these facts, most people in the region expect winter conditions, and lifestyles are not disrupted by snow and cold. Exceptional winter storms, though, can and do cause problems for the communities, residents, and travelers. Examples of these types of storms include blizzards, heavy snow events, ice storms, and extended extreme cold temperatures.

4.13.1.1 BLIZZARDS

Blizzards, as defined by the National Weather Service, are a combination of sustained winds or frequent gusts of 35 mph or greater and visibilities of less than a quarter mile from falling or blowing snow for 3 hours or more. A blizzard, by definition, does not indicate heavy amounts of snow, although they can happen together. The falling or blowing snow usually creates large drifts from the strong winds. The reduced visibilities make travel, even on foot, particularly treacherous. The strong winds may also support dangerous wind chills.

4.13.1.2 HEAVY SNOW

Large quantities of snow may fall during winter storms. Six inches or more in 12 hours or eight inches or more in 24 hours constitutes conditions that may significantly hamper travel or create hazardous conditions. The National Weather Service issues warnings for such events. Smaller amounts can also make travel hazardous, but in most cases, only results in minor inconveniences. Heavy wet snow before the leaves fall from the trees in the fall or after the trees have leafed out in the spring may cause problems with broken tree branches and power outages.

4.13.1.3 ICE STORMS

Ice storms develop when a layer of warm (above freezing), moist air aloft coincides with a shallow cold (below freezing) pool of air at the surface. As snow falls into the warm layer of air, it melts to rain, and then freezes on contact when hitting the frozen ground or cold objects at the surface, creating a smooth layer of ice. This phenomenon is called freezing rain. Similarly, sleet occurs when the rain in the warm layer subsequently freezes into pellets while falling through a cold layer of air at or near the Earth's surface. Extended periods of freezing rain can lead to accumulations of ice on roadways, walkways, power lines, trees, and buildings. Almost any accumulation can make driving and walking hazardous. Thick accumulations can bring down trees and power lines.

4.13.1.4 EXTREME COLD

Extended periods of cold temperatures frequently occur throughout the winter months in Madison County. Heating systems compensate for the cold outside. Most people limit their time outside during extreme cold conditions, but common complaints usually include pipes freezing and cars refusing to start. On February 12, 1905, a temperature of -60°F was recorded at the Hebgen Dam near the Madison County line. When cold temperatures and wind combine, dangerous wind chills can develop.

Wind chill is how cold it "feels" and is based on the rate of heat loss on exposed skin from wind and cold. As the wind increases, it draws heat from the body, driving down skin temperature, and eventually, internal body temperature. Therefore, the wind makes it feel much colder than the actual temperature. For example, if the temperature is 0°F and the wind is blowing at 15 mph, the wind chill is -19°F. At this wind chill, exposed skin can freeze in 30 minutes. Wind chill does not affect inanimate objects. (National Weather Service, 2009d) Figure 4.13.1A shows the wind chill chart.

NWS Windchill Chart

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

Frostbite Times: 30 minutes, 10 minutes, 5 minutes

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

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

Effective 11/01/01

Figure 4-19. National Weather Service Wind Chill Chart [National Weather Service, 2009d]

4.13.1.5 WARNINGS, WATCHES, AND ADVISORIES

Winter weather related Warnings, Watches and Advisories are issued by your local National Weather Service office. Each office knows the local area and will issue Warnings, Watches or Advisories based on local criteria. For example, the amount of snow that triggers a "Winter Storm Warning" in the Montana is typically much higher than the amount needed to trigger a "Winter Storm Warning" in the Southeast

Warnings: Take Action!

- **Blizzard Warnings** are issued for frequent gusts greater than or equal to 35 mph accompanied by falling and/or blowing snow, frequently reducing visibility to less than 1/4 mile for three hours or more. A Blizzard Warning means severe winter weather conditions are expected or occurring. Falling and blowing snow with strong winds and poor visibilities are likely, leading to whiteout conditions making travel extremely difficult. Do not travel. If you must travel, have a winter survival kit with you. If you get stranded, stay with your vehicle and wait for help to arrive.
- **Winter Storm Warning**s are issued for a significant winter weather event including snow, ice, sleet or blowing snow or a combination of these hazards. Travel will become difficult or impossible in some situations. Delay your travel plans until conditions improve.
- **Ice Storm Warning**s are usually issued for ice accumulation of around 1/4 inch or more. This amount of ice accumulation will make travel dangerous or impossible and likely lead to snapped power lines and falling tree branches. Travel is strongly discouraged.
- **Wind Chill Warning** are issued for a combination of very cold air and strong winds that will create dangerously low wind chill values. This level of wind chill will result in frostbite and lead to hypothermia if precautions are not taken. Avoid going outdoors and wear warm protective clothing if you must venture outside. See the NWS Wind Chill Chart.
- **Lake Effect Snow Warnings** are issued when widespread or localized lake induced snow squalls or heavy showers are expected to produce significant snowfall accumulation. Lake effect snow usually develops in narrow bands and impacts a limited area. These bands can produce very heavy snow with sudden restrictions in visibility. Driving conditions may become hazardous at times.

Watches: Be Prepared

- **Blizzard Watches** are issued when there is a potential for falling and/or blowing snow with strong winds and extremely poor visibilities. This can lead to whiteout conditions and make travel very dangerous.
- **Winter Storm Watches** are issued when conditions are favorable for a significant winter storm event (heavy sleet, heavy snow, ice storm, heavy snow and blowing snow or a combination of events.)
- **Wind Chill Watches** are issued when there is the potential for a combination of extremely cold air and strong winds to create dangerously low wind chill values. See the NWS Wind Chill Chart.
- **Lake Effect Snow Watches** are issued when conditions are favorable for a lake effect snow event. A potential exists for heavy accumulation of lake effect snow. Travel and commerce may be significantly affected.

Advisories: Be Aware

Freezing Rain: Rain that freezes when it hits the ground; creating a coating of ice on roads, walkways, trees and power lines.

- **Sleet:** Rain that turns to ice pellets before reaching the ground. Sleet also causes moisture on roads to freeze and become slippery.
- **Wind Chill**: A measure of how cold people feel due to the combined effect of wind and cold temperatures; the Wind chill Index is based on the rate of heat loss from exposed skin. Both cold temperatures and wind remove heat from the body; as the wind speed increases during cold conditions, a body loses heat more quickly. Eventually, the internal body temperature also falls and hypothermia can develop. Animals also feel the effects of wind chill; but inanimate

objects, such as vehicles and buildings, do not. They will only cool to the actual air temperature, although much faster during windy conditions. Read how the Wind Chill Index was developed.

(National Weather Service, 2016)

4.13.2 HISTORY

Snow and cold are normal occurrences in Madison County throughout the late fall, winter, and early spring months. Summaries of the more significant events due to their extreme conditions or damages are shown in Table 4.13.2A. The National Climatic Data Center also lists several other lower impact types of common winter weather events.

Table 4-46. Significant Winter Weather Events [National Climatic Data Center, 2016]

Date	Type	Impacts
Dec. 24-25, 1996	Winter Storm	Blowing and drifting snow closed many roads.
Apr. 4-5, 1997	Winter Storm	Blowing and drifting snow closed many roads. Norris and Pony received 20 inches of new snow.
Oct. 16, 1998	Heavy Snow	Six to ten inches of snow during the early season storm snapped power lines.
Oct. 29-30, 2002	Winter Storm	Heavy and blowing and drifting snow led to emergency travel only on many roads.
Dec. 26-27, 2003	Winter Storm	Blowing and drifting snow closed many roads.
Mar. 27-28, 2007	Heavy Snow	Heavy, wet snow brought down power poles and caused numerous power outages.
Jun. 11, 2008	Heavy Snow	A June snowstorm downed numerous trees, toppled power poles, and caused many accidents.
Dec 13, 2008	Blizzard	Wind gusts to 45 mph, falling snow and visibilities less than one-quarter mile were reported at Silver City.
May 5, 2010	Winter Storm	Twenty-five inches of snow fell at Ennis 15NW (the Lower Twin SNOTEL site - elevation 7900 feet).
April 26, 2012	Winter Storm	Ten inches of snow fell at Cameron 15SSW (Clover Meadow SNOTEL site). Elevation 8600 feet.
Sep. 25, 2013	Heavy Snow	Heavy snow measuring 8.0 inches in 12 hours reported at the Albro Lake SNOTEL. Elevation 8300 feet.
Mar. 1, 2014	Extreme Cold/Wind Chill	Extreme wind chill of -40 degrees Fahrenheit reported 18 mi WNW of West Yellowstone, MT at the Raynolds Pass DOT sensor.
Dec. 17, 2016	Extreme Cold/Wind Chill	A strong arctic ridge of high pressure settled into the region from the Alberta and Saskatchewan prairies on Friday, December 16th and Saturday, December 17th. Appreciable winds and temperatures in the range of 0 to -30 degrees Fahrenheit yielded wind chills as low as the -40 to -55 degree range Friday night into Saturday morning.

Note: Events with over 6 inches of snow are common in the database, but no impacts were listed for these events.

Table 4-47. Madison County Winter Weather Declared Disasters and Emergencies

Declaration	Year	Additional Information	Casualties	Damages/Assistance
None				

4.13.3 PROBABILITY AND MAGNITUDE

Since 1996, 13 significant winter weather events have been noted in Madison County. Based on this historical occurrence, Madison County can expect a severe winter weather event every 2 years.

The severe blizzards and winter storms that result in the loss of life, extended road closures, long-term power outages, or significant isolation problems represent high magnitude winter weather events for Madison County. Blizzard conditions continuing for 2 or more days and blocked roadways or power outages for a week or more both represent extreme winter weather conditions that are possible. These types of events present significant transportation, sheltering, and logistical challenges.

Overall Winter Weather Probability: Moderate-High

4.13.4 MAPPING

The winter weather hazards, such as blizzards, heavy snow, ice storms, and extreme cold, usually occur on a regional scale; therefore, Madison County is assumed to have the same risk from the winter weather hazards countywide. Normally, the mountains receive more snow than the valleys but this is not always the case.

4.13.5 VULNERABILITIES

4.13.5.1 CRITICAL FACILITIES

The critical facilities themselves generally are not threatened by winter weather events. Heavy snow loads on roofs, particularly large span roofs, can cause roofs to leak or even collapse depending on their construction. Extremely cold temperatures may cause pipes to freeze and subsequently burst, causing water damage. Probably the greatest issue for critical facilities during significant winter weather is the inaccessibility of such facilities due to poor roadways, utility outages, or dangerous wind chills. First responders such as fire, law enforcement, and ambulance may have a difficult time responding during poor road conditions or may not be able to provide certain services during electric outages. Those facilities with back-up generators are better equipped to handle a winter storm situation should the power go out.

Possible losses to critical facilities include:

- Roof leaks and collapses
- Pipe ruptures and water damage
- Critical functional losses due to inaccessibility

Expected Winter Weather Impact to Critical Facilities: Low-Moderate

4.13.5.2 CRITICAL INFRASTRUCTURE

Winter weather does pose a threat to key infrastructure. Above ground power and telephone lines can be taken out by falling tree branches or thick ice accumulations. Following severe ice storms, power may take weeks to be restored. Water infrastructure may also be threatened by winter weather, particularly rapid freeze and thaw periods that cause underground water mains to burst. This could result in temporary disruptions of running water. The most difficult network to maintain is the road

infrastructure. During periods of heavy snow, ice, or blizzards, roads can quickly become impassable, stranding motorists and isolating communities. Long term road closures during an extended cold period may diminish and threaten propane and fuel supplies.

Possible losses to infrastructure include:

- Electric power disruption
- Telephone service disruption
- Water and fuel shortages
- Road closures

Expected Winter Weather Impact to Critical Infrastructure: Moderate-High

4.13.5.3 STRUCTURES

Most structures usually remain unaffected by winter weather with the primary exceptions being heavy snow loads, frozen pipes, or other utility failure. The most common incidents in winter weather conditions are motor vehicle accidents due to poor road conditions. These losses are usually covered by insurance.

Possible losses to structures include:

- Roof leaks and collapses
- Pipe ruptures and water damage
- Vehicle losses

Expected Winter Weather Impact to Structures: Low

4.13.5.4 POPULATION

The population of Madison County is most threatened by winter weather while driving or when electric service is lost. Transportation accidents are more common during poor road and visibility conditions and may result in injuries or death. In Madison County, about 670 people rely directly on electricity for heat, and although other primary fuel sources include natural gas (388) and propane (1,306), electricity is still needed to run the blowers and heating systems. Therefore, an extended power outage during winter may make many homes and offices unbearably cold. Additionally, during extended winter-time power outages, people often make the mistake of bringing portable generators inside or not venting them properly, leading to carbon monoxide poisoning. With poor road conditions, sheltering residents may present significant logistical challenges with getting people to heated facilities, feeding, and providing medical care. These situations, accompanied by stranded motorists that need to be rescued, represent significant threats to the population.

Expected Winter Weather Impact to the Population: Moderate

Economic, Ecologic, Historic, and Social Values

Possible economic losses include:

- Livestock losses

Possible historic losses include:

- Roof leaks and collapses

- Pipe ruptures and water damage

Possible social losses include:

- Cancelled school and other activities

Expected Winter Weather Impact to the Values: Moderate

4.13.5.5 FUTURE DEVELOPMENT

Future development should have little to no impact from winter weather. The most significant challenge may be, as homes go up in more remote parts of the county, accessing rural residents should sheltering or emergency services be needed in an extreme event. In addition, in those communities lacking building codes, structures with inadequate roof systems could theoretically be built.

Expected Winter Weather Impact to Future Development: Low-Moderate

4.13.6 DATA LIMITATIONS AND OTHER FACTORS

The data limitations related to the winter weather hazard include:

- Lack of a countywide, multi-agency, historic winter weather database containing information on the winter weather conditions (snow depth, temperature, wind, snowfall rates, water content, and duration) and the associated problems (number of accidents, conditions of roadways, and services needed).

Other hazards often related to winter weather include:

- Transportation accidents
- Hazardous material release
- Spring flood

4.14 RISK ASSESSMENT SUMMARY

The risk assessment represents an approximate history and estimated vulnerabilities to Madison County and the incorporated jurisdictions from the hazards identified. As with any assessment involving natural or human caused hazards, all potential events may not be represented here and an actual incident may occur in a vastly different way than described. This assessment, however, will be used, where possible, to minimize damages from these events in the future.

Every type of event is different, ranging from population to property to economic impacts. Incidents also have different probabilities and magnitudes even within hazards. For example, a light snowstorm will be different than a blizzard and a moderate flood will be different from both of those. Some hazards have estimates of dollar losses and population impacts whereas others are more qualitatively assessed based on the information available during the risk assessment process.

The hazards are prioritized using the best possible information on risks and vulnerabilities to provide guidance when selecting mitigation strategies. Generally, an evaluation of a specific mitigation activity will capture the benefits of such actions, including considering the probability of the hazard occurring and the disaster losses to be mitigated.

The following factors were considered when prioritizing the hazards:

- Probability or Frequency of a "Disastrous" Event
- Impact to Critical Facilities
- Impact to Critical Infrastructure
- Impact to Structures
- Impact to the Population
- Impact to Economic, Ecologic, Historic, and Social Values
- Impact to Future Development

For more information on these determinations, see the individual hazard profiles.

Table 4.14A provides a summary of the probabilities and impacts to the jurisdictions from each hazard. Based on this information, Table 4.14B shows the hazard prioritizations for Madison County as a whole while the Tables 4.14C through 4.14F are specific to the individual jurisdictions. Map 4.14G shows a composite hazard map.

Table 4-48. Hazard Ratings

Madison County	Probability	Critical Facilities	Critical Infrastructure	Structures	Population	Values	Future Development
COMMUNICABLE DISEASE	Moderate	Low-Moderate	Low-Moderate	Low	High	Moderate-High	Low
DROUGHT	Moderate-High	Low	Low-Moderate	Low	Low-Moderate	Moderate-High	Low-Moderate
EARTHQUAKE	Low-Moderate	Moderate-High	Moderate-High	Moderate-High	Moderate	Moderate-High	Moderate-High
FLOOD	Moderate-High	Moderate	Moderate-High	Moderate	Moderate	Moderate-High	Moderate
HAZARDOUS MATERIAL RELEASE	Moderate	Low-Moderate	Low	Low-Moderate	Moderate-High	Moderate	Low-Moderate
LANDSLIDE AND AVALANCHE	Low-Moderate	Low	Low-Moderate	Low	Low-Moderate	Low	Low-Moderate
SEVERE THUNDERSTORM AND STRONG WIND	Moderate-High	Low-Moderate	Moderate	Moderate	Moderate	Low-Moderate	Moderate
STRUCTURE COLLAPSE	Low	Low-Moderate	Low-Moderate	Moderate	Moderate	Moderate	Moderate
TERRORISM AND CIVIL UNREST	Low	Low-Moderate	Low-Moderate	Low	Moderate-High	Moderate	Low
TRANSPORTATION ACCIDENT	Low-Moderate	Low	Low	Low-Moderate	Moderate-High	Low-Moderate	Low
VOLCANO	Low	Low-Moderate	Low	Low-Moderate	Moderate	Low-Moderate	Low
WILDFIRE	Moderate	Moderate	Moderate	High	Moderate	Moderate	Moderate-High
WINTER WEATHER	Moderate-High	Low-Moderate	Moderate-High	Low	Moderate	Moderate	Low-Moderate
Ennis							
COMMUNICABLE DISEASE	Moderate	Low-Moderate	Low-Moderate	Low	High	Moderate-High	Low

DROUGHT	Moderate-High	Low	Low-Moderate	Low	Low-Moderate	Moderate-High	Low-Moderate
EARTHQUAKE	Low-Moderate	Moderate-High	Moderate-High	Moderate-High	Moderate	Moderate-High	Moderate-High
FLOOD	Moderate	Low-Moderate	Moderate	Low-Moderate	Moderate	Moderate	Moderate
HAZARDOUS MATERIAL RELEASE	Moderate-High	Low-Moderate	Low	Low-Moderate	High	Moderate-High	Low-Moderate
LANDSLIDE AND AVALANCHE	Low	Low	Low	Low	Low	Low	Low
SEVERE THUNDERSTORM AND STRONG WIND	Moderate-High	Low-Moderate	Moderate	Moderate	Moderate	Low-Moderate	Moderate
STRUCTURE COLLAPSE	Low	Low-Moderate	Low-Moderate	Moderate	Moderate	Moderate	Moderate
TERRORISM AND CIVIL UNREST	Low	Low-Moderate	Low-Moderate	Low	Moderate-High	Moderate	Low
TRANSPORTATION ACCIDENT	Low-Moderate	Low	Low	Low-Moderate	Moderate-High	Low-Moderate	Low
VOLCANO	Low	Low-Moderate	Low	Low-Moderate	Moderate	Low-Moderate	Low
WILDFIRE	Low-Moderate	Low-Moderate	Low-Moderate	Low-Moderate	Moderate	Low-Moderate	Low-Moderate
WINTER WEATHER	Moderate-High	Low-Moderate	Moderate-High	Low	Moderate	Moderate	Low-Moderate
Sheridan							
COMMUNICABLE DISEASE	Moderate	Low-Moderate	Low-Moderate	Low	High	Moderate-High	Low
DROUGHT	Moderate-High	Low	Low-Moderate	Low	Low-Moderate	Moderate-High	Low-Moderate
EARTHQUAKE	Low-Moderate	Moderate-High	Moderate-High	Moderate-High	Moderate	Moderate-High	Moderate-High
FLOOD	Low-Moderate	Low-Moderate	Moderate	Low-Moderate	Low-Moderate	Moderate	Moderate
HAZARDOUS MATERIAL RELEASE	Moderate	Low-Moderate	Low	Low-Moderate	Moderate-High	Moderate	Low-Moderate
LANDSLIDE AND AVALANCHE	Low	Low	Low	Low	Low	Low	Low
SEVERE THUNDERSTORM AND STRONG WIND	Moderate-High	Low-Moderate	Moderate	Moderate	Moderate	Low-Moderate	Moderate
STRUCTURE COLLAPSE	Low	Low-Moderate	Low-Moderate	Moderate	Moderate	Moderate	Moderate
TERRORISM AND CIVIL UNREST	Low	Low-Moderate	Low-Moderate	Low	Moderate-High	Moderate	Low
TRANSPORTATION ACCIDENT	Low-Moderate	Low	Low	Low-Moderate	Moderate-High	Low-Moderate	Low
VOLCANO	Low	Low-Moderate	Low	Low-Moderate	Moderate	Low-Moderate	Low
WILDFIRE	Low-Moderate	Low-Moderate	Moderate	Moderate	Moderate	Moderate	Moderate
WINTER WEATHER	Moderate-High	Low-Moderate	Moderate-High	Low	Moderate	Moderate	Low-Moderate
Twin Bridges							
COMMUNICABLE DISEASE	Moderate	Low-Moderate	Low-Moderate	Low	High	Moderate-High	Low

DROUGHT	Moderate-High	Low	Low-Moderate	Low	Low-Moderate	Moderate-High	Low-Moderate
EARTHQUAKE	Low-Moderate	Moderate-High	Moderate-High	Moderate-High	Moderate	Moderate-High	Moderate-High
FLOOD	Moderate-High	Moderate	Moderate-High	Moderate	Moderate	Moderate-High	Moderate
HAZARDOUS MATERIAL RELEASE	Moderate-High	Low-Moderate	Low	Low-Moderate	High	Moderate-High	Low-Moderate
LANDSLIDE AND AVALANCHE	Low	Low	Low	Low	Low	Low	Low
SEVERE THUNDERSTORM AND STRONG WIND	Moderate-High	Low-Moderate	Moderate	Moderate	Moderate	Low-Moderate	Moderate
STRUCTURE COLLAPSE	Low	Low-Moderate	Low-Moderate	Moderate	Moderate	Moderate	Moderate
TERRORISM AND CIVIL UNREST	Low	Low-Moderate	Low-Moderate	Low	Moderate-High	Moderate	Low
TRANSPORTATION ACCIDENT	Low-Moderate	Low	Low	Low-Moderate	Moderate-High	Low-Moderate	Low
VOLCANO	Low	Low-Moderate	Low	Low-Moderate	Moderate	Low-Moderate	Low
WILDFIRE	Low-Moderate	Low-Moderate	Moderate	Low-Moderate	Moderate	Low-Moderate	Low-Moderate
WINTER WEATHER	Moderate-High	Low-Moderate	Moderate-High	Low	Moderate	Moderate	Low-Moderate
Virginia City							
COMMUNICABLE DISEASE	Moderate	Low-Moderate	Low-Moderate	Low	High	Moderate-High	Low
DROUGHT	Moderate-High	Low	Low-Moderate	Low	Low-Moderate	Moderate-High	Low-Moderate
EARTHQUAKE	Low-Moderate	Moderate-High	Moderate-High	Moderate-High	Moderate	Moderate-High	Moderate-High
FLOOD	Low-Moderate	Low-Moderate	Moderate	Low-Moderate	Moderate	Moderate	Moderate
HAZARDOUS MATERIAL RELEASE	Moderate	Low-Moderate	Low	Low-Moderate	Moderate-High	Moderate	Low-Moderate
LANDSLIDE AND AVALANCHE	Low-Moderate	Low	Low-Moderate	Low	Low-Moderate	Low	Low-Moderate
SEVERE THUNDERSTORM AND STRONG WIND	Moderate-High	Low-Moderate	Moderate	Moderate	Moderate	Low-Moderate	Moderate
STRUCTURE COLLAPSE	Low	Low-Moderate	Low-Moderate	Moderate	Moderate	Moderate	Moderate
TERRORISM AND CIVIL UNREST	Low	Low-Moderate	Low-Moderate	Low	Moderate-High	Moderate	Low
TRANSPORTATION ACCIDENT	Low-Moderate	Low	Low	Low-Moderate	Moderate-High	Low-Moderate	Low
VOLCANO	Low	Low-Moderate	Low	Low-Moderate	Moderate	Low-Moderate	Low
WILDFIRE	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate
WINTER WEATHER	Moderate-High	Low-Moderate	Moderate-High	Low	Moderate	Moderate	Low-Moderate

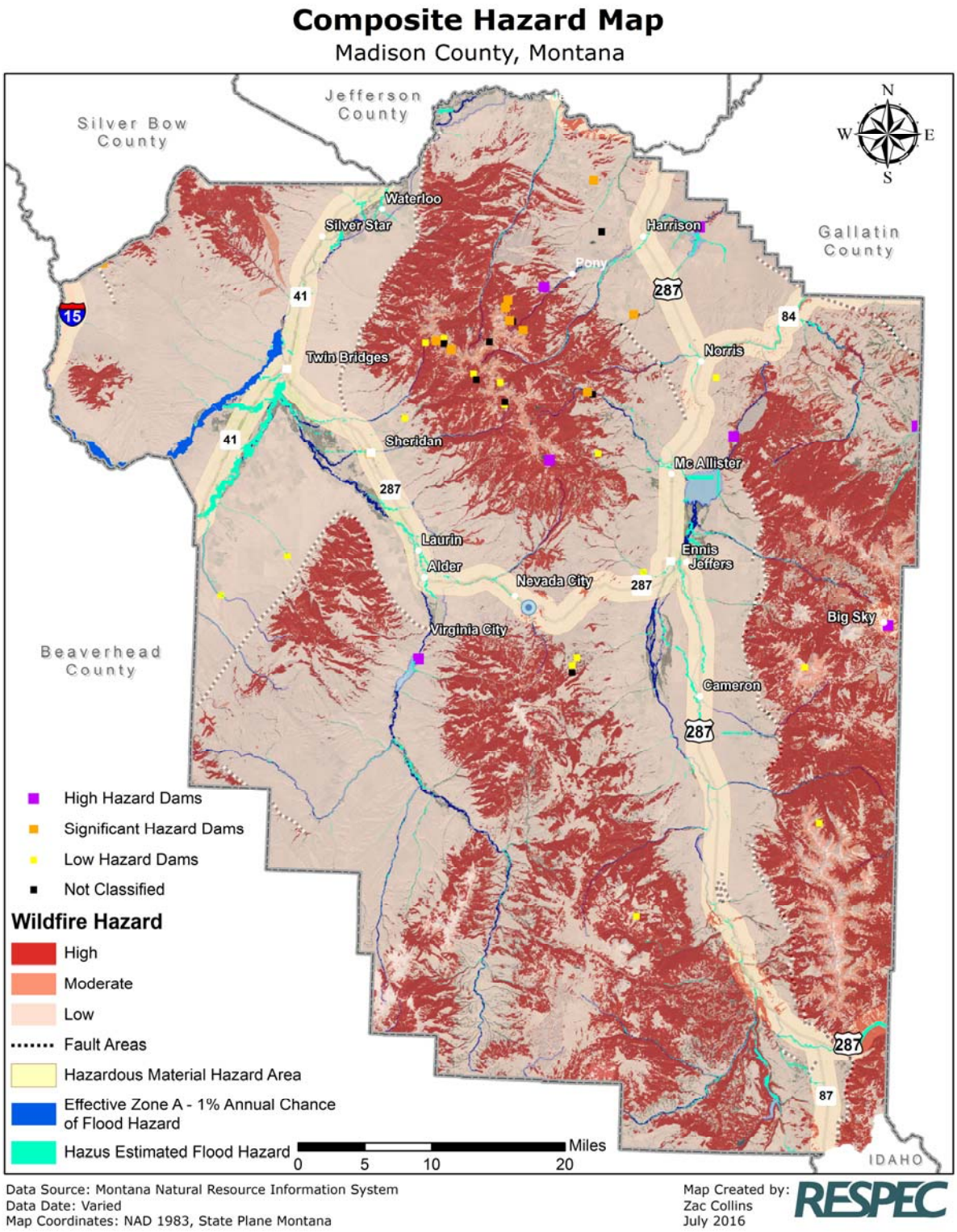


Figure 4-20. Need Caption and Callout.

5.0 MITIGATION STRATEGY

Hazard mitigation, as defined by the Disaster Mitigation Act of 2000, is any sustained action taken to reduce or eliminate the long-term risk to human life and property from hazards. Studies on hazard mitigation show that for each dollar spent on mitigation, society saves an average of four dollars in avoided future losses. (Multihazard Mitigation Council, 2005) Mitigation can take many different forms from construction projects to public education.

The development of a mitigation strategy allows Madison County and the Towns of Ennis, Sheridan, Twin Bridges, and Virginia City to create a vision for preventing future disasters, establish a common set of mitigation goals, prioritize actions, and evaluate the success of such actions. The mitigation strategy is based on the results of the risk assessment and recommendations by stakeholders and the public. The goals are broad, visionary, forward-looking statements that outline in general terms what the county and jurisdictions would like to accomplish. Goals are usually not measurable or fully attainable but rather ideals to which the county and communities should strive for as they develop and implement mitigation projects.

Rather than wait until a disaster occurs, Madison County and the Towns of Ennis, Sheridan, Twin Bridges, and Virginia City have developed this strategy to move in a more proactive direction for disaster prevention. All losses cannot be entirely mitigated, however, some actions can be taken, as funding and opportunities arise, that may reduce the impacts of disasters, thus, saving lives and property.

Initially, the mitigation strategies were developed based on input from the communities in public and LEPC meetings and focused on the priorities set by the citizens of Madison County. In 2015, initial mitigation goals and objectives were reviewed by the public, refined in public meetings during which suggestions from the attendees were incorporated, and also took into account recommendations from existing policies, plans, and studies. Many of the mitigation actions were carried over from the 2009 plan and new ones were developed based on direct input from stakeholders; the projects were then prioritized. More information on the changes to the mitigation strategy since 2009 can be found in Appendix J.

5.1 GOALS, OBJECTIVES, AND PROPOSED ACTIONS

The mitigation goals, objectives, and proposed actions for Madison County and Towns of Ennis, Sheridan, Twin Bridges, and Virginia City follow. Each of the actions specifies the jurisdiction or jurisdictions involved, the type of project, its priority, the responsible agencies and partners, resources needed, and the goal timeframe for completion.

For clarification and prioritization purposes, each action is categorized by its project type. The types of projects include:

- Supportive: Usually supportive projects are important components of all types of mitigation activities. For example, a coordinator or staff position is often critical to applying for and implementing mitigation grants.

- Educational/Informational: These projects typically do not mitigate a hazard directly, however, by educating the public or others, those individuals may then take their own mitigation actions. These types of projects may also be used by governing bodies and other authorities to make decisions or develop new policies or projects.
- Policy/Regulatory: Policies and regulations created, updated, or enforced by government entities can have powerful hazard mitigation impacts. Their benefits can often be difficult to measure. Conservation easements are an example of a land use change mechanism enforced by regulatory authorities.
- Property Protection: These actions often directly reduce future property losses through physical changes.
- Infrastructure Protection: These projects often physically reduce losses to critical infrastructure.
- Population Protection: Generally, population protection measures reduce the loss of life and injury by physically changing a threat to people or by prompting a person to take immediate action. For example, warning systems may alert people to imminent hazards.

Additional information on the priorities and goal timeframes can be found in the sections that follow.

5.1.1 GOAL 1: ENCOURAGE MITIGATION FROM MULTIPLE HAZARDS THROUGH EDUCATION AND EXISTING PROGRAMS.

Objective 1.1: Foster public and interagency cooperation to ensure effective implementation of mitigation activities.

5.1.1.1 ACTION 1.1.1: DES COORDINATOR POSITION

- Support the full-time Disaster and Emergency Service (DES) Coordinator and Deputy DES Coordinator positions and their mitigation efforts.

Jurisdiction(s): Madison County, Towns of Ennis, Sheridan, Twin Bridges, and Virginia City
Project Type: Supportive
Priority: High
Responsible Agencies and Partners: Local Elected Officials, All Other County and Town Departments
Resources Needed: None, as long as federal, state, and local funding of the position continues
Goal Timeframe: Ongoing: Already initiated and continuing

5.1.1.2 ACTION 1.1.2: PUBLIC EDUCATION

- Emphasize the importance of education and collaboration across jurisdictions and disciplines with public education topics such as, but not limited to:
  - 72-Hour Preparedness Kits
  - Purchase and use of NOAA Weather Radios
  - Firewise practices
  - School incident protocols
  - Evacuation protocols
  - Planning efforts at the state and local levels

Jurisdiction(s): Madison County, Towns of Ennis, Sheridan, Twin Bridges, and Virginia City
Project Type: Educational/Informational
Priority: High

Responsible Agencies and Partners: Disaster and Emergency Services, Schools, Fire Departments
Resources Needed: Staff time and expertise, some funding for materials
Goal Timeframe: Ongoing: Already initiated and continuing

5.1.1.3 ACTION 1.1.3: TOWN EMPLOYEE EDUCATION

- Educate town employees on mitigation practices and resources.

Jurisdiction(s): Towns of Ennis, Sheridan, Twin Bridges, and Virginia City
Project Type: Educational/Informational
Priority: High
Responsible Agencies and Partners: Local Elected Officials
Resources Needed: Staff time and expertise, some funding for materials
Goal Timeframe: Near Term: Initiated within Ongoing

5.1.1.4 ACTION 1.1.4: HEALTHCARE PROVIDER EDUCATION

- Educate healthcare providers on tracking and reporting signs and symptoms of biological agents and communicable diseases.

Jurisdiction(s): Madison County, Towns of Ennis, Sheridan, Twin Bridges, and Virginia City
Project Type: Educational/Informational
Priority: Low
Responsible Agencies and Partners: Health Department, Healthcare Providers
Resources Needed: Staff time and expertise, some funding for materials
Goal Timeframe: Long Term: Initiated within 7-10 years

5.1.1.5 ACTION 1.1.5: ADDRESS SIGNAGE

- Install metal, reflective address numbers along roadways at driveway entrances.

Jurisdiction(s): Madison County, Towns of Ennis, Sheridan, Twin Bridges, and Virginia City
Project Type: Educational/Informational
Priority: Low
Responsible Agencies and Partners: Disaster and Emergency Services, Fire Departments
Resources Needed: Staff time and expertise, some funding for materials
Goal Timeframe: Ongoing: Already initiated and continuing

Objective 1.2: Mitigate hazards during the construction of new development.

5.1.1.6 ACTION 1.2.1: GROWTH POLICY

- Update the countywide and town growth policies to encourage growth in low hazard areas and allow for the consideration of high hazard areas during subdivision reviews.

Jurisdiction(s): Madison County, Towns of Ennis, Sheridan, Twin Bridges, and Virginia City
Project Type: Policy/Regulatory
Priority: Medium
Responsible Agencies and Partners: Local Elected Officials, Planning Departments
Resources Needed: Staff time and expertise, political support

Goal Timeframe: Mid Term: Initiated within 3-6 years

5.1.1.7 ACTION 1.2.2: SUBDIVISION REGULATIONS

- Update countywide subdivision regulations to adopt higher minimum standards for subdivisions that improve their all-hazard disaster resistance.

Jurisdiction(s): Madison County
Project Type: Policy/Regulatory
Priority: High
Responsible Agencies and Partners: Local Elected Officials, Planning Department
Resources Needed: Staff time and expertise, political support
Goal Timeframe: Near Term: Initiated within 0-3 years

5.1.1.8 ACTION 1.2.3: BUILDING CODES

- Encourage all jurisdictions in the county to adopt the state's building codes.

Jurisdiction(s): Madison County, Towns of Ennis, Sheridan, Twin Bridges, and Virginia City
Project Type: Policy/Regulatory
Priority: Medium
Responsible Agencies and Partners: Local Elected Officials, Code Enforcement
Resources Needed: Staff time and expertise, political support, funding for personnel, training, and supplies for additional code enforcement
Goal Timeframe: Mid Term: Initiated within 3-6 years

5.1.1.9 ACTION 1.2.4: PERMIT SYSTEM

- Develop a simple permit system that allows the county to interact with and educate landowners when new development occurs.
- Create an informational packet that can be distributed with septic permits.

Jurisdiction(s): Madison County
Project Type: Educational/Informational
Priority: Medium
Responsible Agencies and Partners: Local Elected Officials, Planning Department, Sanitarian
Resources Needed: Staff time and expertise, some funding for materials
Goal Timeframe: Mid Term: Initiated within 3-6 years

Goal 2: Reduce loss of life, injuries, and property damage in the event of an earthquake.

Objective 2.1: Educate the populace on proactive measures regarding earthquake safety.

5.1.1.10 ACTION 2.1.1: EARTHQUAKE EDUCATIONAL BROCHURES

- Produce earthquake educational brochures to be distributed by the Madison County Sanitarian, the Madison County Planner, town halls, realtors, etc.

Jurisdiction(s): Madison County, Towns of Ennis, Sheridan, Twin Bridges, and Virginia City
Project Type: Educational/Informational
Priority: High

Responsible Agencies and Partners: Local Elected Officials, Disaster and Emergency Services, Planning Department, Sanitarian, Realtors
Resources Needed: Staff time and expertise, some funding for materials
Goal Timeframe: Near Term: Initiated within 0-3 years

5.1.1.11 ACTION 2.1.2: PROPOSED SUBDIVISION GEOLOGIC REVIEW

- Continue geologic reviews of proposed subdivisions.

Jurisdiction(s): Madison County
Project Type: Educational/Informational
Priority: High
Responsible Agencies and Partners: Planning Department, Developers
Resources Needed: Continued staff time and expertise
Goal Timeframe: Ongoing: Already initiated and continuing

5.1.1.12 ACTION 2.1.3: EXISTING SUBDIVISION GEOLOGIC REVIEW

- Initiate geologic reviews of existing subdivisions for educational purposes.

Jurisdiction(s): Madison County Towns of Ennis, Sheridan, Twin Bridges, and Virginia City
Project Type: Educational/Informational
Priority: High
Responsible Agencies and Partners: Disaster and Emergency Services
Resources Needed: Staff time and expertise, funding for professional services
Goal Timeframe: Near Term: Initiated within 0-3 years

5.1.1.13 ACTION 2.1.4: NEW HOMEBUILDER EARTHQUAKE EDUCATION

- Educate new homebuilders as to seismic building standards and earthquake fault locations.

Jurisdiction(s): Madison County, Towns of Ennis, Sheridan, Twin Bridges, and Virginia City
Project Type: Educational/Informational
Priority: High
Responsible Agencies and Partners: Disaster and Emergency Services, Developers
Resources Needed: Staff time and expertise, some funding for materials
Goal Timeframe: Near Term: Initiated within 0-3 years

Objective 2.2: Educate the public sector on earthquake mitigation measures.

5.1.1.14 ACTION 2.2.1: PUBLIC BUILDING SEISMIC RETROFITS

- Identify, recommend, and retrofit unsafe public buildings for seismic hazards.

Jurisdiction(s): Madison County, Towns of Ennis, Sheridan, Twin Bridges, and Virginia City
Project Type: Property Protection
Priority: High
Responsible Agencies and Partners: Local Elected Officials, Disaster and Emergency Services, Facility Administration
Resources Needed: Staff time and expertise, funding for professional services and implementation

Goal Timeframe: Near Term: Initiated within 0-3 years

5.1.1.15 ACTION 2.2.2: INFRASTRUCTURE SEISMIC IMPROVEMENTS

- Prioritize and make improvements to bring vulnerable infrastructure up to seismic code.

Jurisdiction(s): Madison County, Towns of Ennis, Sheridan, Twin Bridges, and Virginia City
Project Type: Infrastructure Protection
Priority: Medium
Responsible Agencies and Partners: Local Elected Officials, Disaster and Emergency Services, Public and Private Utility Managers
Resources Needed: Staff time and expertise, funding for professional services and implementation
Goal Timeframe: Mid Term: Initiated within 3-6 years

5.1.1.16 ACTION 2.2.3: FUTURE INFRASTRUCTURE SEISMIC REQUIREMENTS

- Require all future infrastructure to be earthquake resistant and built to seismic code.

Jurisdiction(s): Madison County, Towns of Ennis, Sheridan, Twin Bridges, and Virginia City
Project Type: Policy/Regulatory
Priority: High
Responsible Agencies and Partners: Local Elected Officials, Planning Department
Resources Needed: Staff time and expertise, political support
Goal Timeframe: Near Term: Initiated within 0-3 years

Goal 3: Reduce loss of life and prevent injury in the event of a hazardous material incident.

Objective 3.1: Undertake a program of public education and awareness of hazardous materials.

5.1.1.17 ACTION 3.1.1: HAZARDOUS MATERIAL STUDY

- Determine type and amount of hazardous materials moving through Madison County.

Jurisdiction(s): Madison County, Towns of Ennis, Sheridan, Twin Bridges, and Virginia City
Project Type: Educational/Informational
Priority: Medium
Responsible Agencies and Partners: Disaster and Emergency Services, Fire Departments
Resources Needed: Staff time and expertise
Goal Timeframe: Mid Term: Recently Completed/Ongoing

5.1.1.18 ACTION 3.1.2: HAZARDOUS MATERIAL EDUCATIONAL PUBLICATIONS

- Develop, produce, and distribute hazardous material educational publications.

Jurisdiction(s): Madison County, Towns of Ennis, Sheridan, Twin Bridges, and Virginia City
Project Type: Educational/Informational
Priority: Medium
Responsible Agencies and Partners: Disaster and Emergency Services, Fire Departments
Resources Needed: Staff time and expertise, some funding for materials
Goal Timeframe: Mid Term: Initiated within 3-6 years

5.1.1.19 ACTION 3.1.3: HAZARDOUS MATERIAL EARLY WARNING SYSTEM

- Develop an early warning system to alert affected populations of a hazardous material incident.
- Consider a siren in Ennis to be used for all hazards.
- Purchase highway signs and programming for the low band radio in Ennis.

Jurisdiction(s): Madison County, Towns of Ennis, Sheridan, Twin Bridges, and Virginia City
Project Type: Population Protection
Priority: Medium
Responsible Agencies and Partners: Disaster and Emergency Services, Fire Departments, Law Enforcement
Resources Needed: Staff time and expertise, funding for professional services and implementation
Goal Timeframe: Mid Term: Completed

Objective 3.2: Minimize the probability of and lessen the exposure to future hazardous material releases.

5.1.1.20 ACTION 3.2.1: PASSING LANES AND TRUCK ROUTES

- Add more passing lanes to allow safer passing of slower speed trucks transporting hazardous materials.
- Consider bypass truck routes around population centers.

Jurisdiction(s): Madison County, Towns of Ennis, Sheridan, Twin Bridges, and Virginia City
Project Type: Population Protection
Priority: Low
Responsible Agencies and Partners: Local Elected Officials, Montana Department of Transportation
Resources Needed: Staff time and expertise, funding for professional services and implementation
Goal Timeframe: Long Term: Initiated within 7-10 years

5.1.1.21 ACTION 3.2.2: CHAIN-UP AREA SIGNAGE

- Improve signage for chain-up areas during winter weather, especially the Norris Hill.
- Consider using light-emitting diode (LED) lights since poor visibilities are frequent during hazardous winter weather.

Jurisdiction(s): Madison County
Project Type: Population Protection
Priority: Medium
Responsible Agencies and Partners: Local Elected Officials, Montana Department of Transportation
Resources Needed: Staff time and expertise, funding for implementation
Goal Timeframe: Mid Term: Initiated within 3-6 years

Goal 4: Reduce or prevent loss of life and injuries and property damage in the event of flooding.

Objective 4.1: Improve flood hazard information and education.

5.1.1.22 ACTION 4.1.1: FLOODPLAIN MAPPING

- Conduct a floodplain (100-year flood) mapping project for Madison County consistent with FEMA mapping protocol.

Jurisdiction(s): Madison County, Towns of Ennis, Sheridan, Twin Bridges, and Virginia City

Project Type: Educational/Informational

Priority: Low

Responsible Agencies and Partners: Local Elected Officials, Floodplain Administrators

Resources Needed: Staff time and expertise, funding for professional services

Goal Timeframe: Long Term: Initiated within 7-10 years

5.1.1.23 ACTION 4.1.2: FLOODPLAIN STUDY

- Using floodplain maps, maps of current conditions, and all available historical information, identify and assess targets at risk, including dams.

Jurisdiction(s): Madison County, Towns of Ennis, Sheridan, Twin Bridges, and Virginia City
Project Type: Educational/Informational
Priority: Medium
Responsible Agencies and Partners: Local Elected Officials, Floodplain Administrators, Disaster and Emergency Services
Resources Needed: Staff time and expertise, funding for professional services
Goal Timeframe: Mid Term: Initiated within 3-6 years

5.1.1.24 ACTION 4.1.3: FLOOD PUBLIC EDUCATION

- Educate the public on the flood hazard and potential mitigation strategies.

Jurisdiction(s): Madison County, Towns of Ennis, Sheridan, Twin Bridges, and Virginia City
Project Type: Educational/Informational
Priority: High
Responsible Agencies and Partners: Local Elected Officials, Floodplain Administrators, Disaster and Emergency Services
Resources Needed: Staff time and expertise, some funding for materials
Goal Timeframe: Near Term: Initiated within 0-3 years

Objective 4.2: Reduce property and infrastructure losses from flood events.

5.1.1.25 ACTION 4.2.1: STRUCTURAL FLOOD MITIGATION

- Identify possible hazard mitigation efforts for targets at risk, including floodplain buyouts, floodplain conservation easements, zoning to limit building and rebuilding in high hazard areas, acquisition and/or relocation, and hardening, strengthening, or elevating structures at risk.

Jurisdiction(s): Madison County, Towns of Ennis, Sheridan, Twin Bridges, and Virginia City
Project Type: Property Protection
Priority: Medium
Responsible Agencies and Partners: Local Elected Officials, Floodplain Administrators, Disaster and Emergency Services, Planning Department
Resources Needed: Staff time and expertise, funding for professional services and implementation
Goal Timeframe: Mid Term: Initiated within 3-6 years

5.1.1.26 ACTION 4.2.2: ROAD, BRIDGE, AND CULVERT UPGRADES

- Upgrade roads, bridges, and culverts to support flood volumes.
- Install culverts in areas prone to washouts.

Jurisdiction(s): Madison County, Towns of Ennis, Sheridan, Twin Bridges, and Virginia City
Project Type: Infrastructure Protection
Priority: Medium
Responsible Agencies and Partners: Local Elected Officials, Road Departments, Disaster and Emergency Services

Resources Needed: Staff time and expertise, funding for professional services and implementation
Goal Timeframe: Mid Term: Initiated within 3-6 years

5.1.1.27 ACTION 4.2.3: FLOOD INSURANCE EDUCATION

- Educate property owners on the availability and importance of flood insurance.

Jurisdiction(s): Madison County, Towns of Ennis, Sheridan, Twin Bridges, and Virginia City
Project Type: Educational/Informational
Priority: Low
Responsible Agencies and Partners: Local Elected Officials, Floodplain Administrators, Disaster and Emergency Services
Resources Needed: Staff time and expertise, some funding for materials
Goal Timeframe: Long Term: Initiated within 7-10 years

5.1.1.28 ACTION 4.2.4: MOORES CREEK DIVERSION

- Research and implement a diversion for Moores Creek.

Jurisdiction(s): Madison County, Towns of Ennis
Project Type: Property Protection
Priority: High
Responsible Agencies and Partners: Local Elected Officials, Floodplain Administrators, Disaster and Emergency Services
Resources Needed: Staff time and expertise, funding for professional services and implementation
Goal Timeframe: Near Term: Initiated within 0-3 years

Objective 4.3: Reduce flood losses to future development.

5.1.1.29 ACTION 4.3.1: FLOOD ORDINANCES

- Continue to enforce flood ordinances in jurisdictions participating in the National Flood Insurance Program (NFIP).
- As new mapping occurs or flood hazard areas are identified, encourage new jurisdictions to join the NFIP and/or adopt flood ordinances.

Jurisdiction(s): Madison County, Towns of Ennis, Sheridan, Twin Bridges, and Virginia City
Project Type: Policy/Regulatory
Priority: High
Responsible Agencies and Partners: Local Elected Officials, Floodplain Administrators
Resources Needed: Staff time and expertise, political support, funding for professional services
Goal Timeframe: Near Term: Initiated within 0-3 years

Goal 5: Reduce losses from wildfires in the wildland urban interface.

Objective 5.1: Reduce risks in existing wildland urban interface areas.

5.1.1.30 ACTION 5.1.1: FIREWISE PROGRAM

- Develop Firewise Programs across the county.
- Conduct wildfire home site evaluations and homeowner and landowner education, including defensible space workshops.
- Encourage and provide funding for homeowners and landowners in the wildland urban interface to use fire-resistant materials and to create defensible space from wildfires around their homes and outbuildings using Firewise principles.

Jurisdiction(s): Madison County, Town of Virginia City
Project Type: Property Protection
Priority: Medium
Responsible Agencies and Partners: Fire Departments, Homeowners Associations, Landowners
Resources Needed: Staff time and expertise, funding for professional services and implementation
Goal Timeframe: Mid Term:Ongoing

5.1.1.31 ACTION 5.1.2: FUEL TREATMENTS

- Utilize various fuel treatments, such as prescribed burns, thinning, etc., to reduce fuels near homes and infrastructure.
- When feasible, use the fuels available to produce wood products.

Jurisdiction(s): Madison County, Town of Virginia City
Project Type: Property Protection
Priority: Medium
Responsible Agencies and Partners: Fire Departments, Homeowners Associations, US Forest Service, US Bureau of Land Management, Montana Department of Natural Resources and Conservation
Resources Needed: Staff time and expertise, political support, funding for professional services and implementation
Goal Timeframe: Mid Term: Ongoing

Objective 5.2: Minimize damage potential to future development.

5.1.1.32 ACTION 5.2.1: WUI STRUCTURE SITING REQUIREMENTS

- Require builders to site structures in locations that are the least prone to wildfire hazards in the wildland urban interface (WUI).

Jurisdiction(s): Madison County
Project Type: Policy/Regulatory
Priority: High
Responsible Agencies and Partners: Local Elected Officials, Planning Department, Fire Departments
Resources Needed: Staff time and expertise, political support
Goal Timeframe: Near Term: Initiated within 0-3 years

5.1.1.33 ACTION 5.2.2: INGRESS/EGRESS REQUIREMENTS

- Provide specific ingress/egress requirements for new development to allow access from hazard areas.

- Require homeowners' associations to keep the fuels reduced in right-of-ways and nearby areas.
- Ensure that road signs are fire resistant and easy to read in reduced visibilities.

Jurisdiction(s): Madison County
Project Type: Policy/Regulatory
Priority: High
Responsible Agencies and Partners: Local Elected Officials, Planning Department, Fire Departments, Road Department
Resources Needed: Staff time and expertise, political support
Goal Timeframe: Near Term: Ongoing

5.1.1.34 ACTION 5.2.3: CONSERVATION EASEMENTS

- Use conservation easements in high hazard wildfire areas as a dual purpose, to keep development from high hazard wildfire risk and to conserve wildland areas.

Jurisdiction(s): Madison County
Project Type: Policy/Regulatory
Priority: High
Responsible Agencies and Partners: Local Elected Officials, Planning Department, Private Conservation Entities
Resources Needed: Staff time and expertise, funding for easement purchases
Goal Timeframe: Ongoing: Already initiated and continuing

5.1.1.35 ACTION 5.2.4: WUI WATER REQUIREMENTS

- Require sufficient water supplies, such as dry hydrants and pressurized water systems, in wildland urban interface (WUI) developments.

Jurisdiction(s): Madison County
Project Type: Policy/Regulatory
Priority: Medium
Responsible Agencies and Partners: Local Elected Officials, Planning Department, Fire Departments
Resources Needed: Staff time and expertise, political support
Goal Timeframe: Mid Term: Initiated within 3-6 years

5.1.1.36 ACTION 5.2.5: COVENANT REQUIREMENTS

- Require provisions in community covenants for reducing fuels and/or mowing on vacant lots.

Jurisdiction(s): Madison County, Towns of Ennis, Sheridan, Twin Bridges, and Virginia City
Project Type: Policy/Regulatory
Priority: Medium
Responsible Agencies and Partners: Local Elected Officials, Planning Department, Fire Departments
Resources Needed: Staff time and expertise, political support
Goal Timeframe: Mid Term: Initiated within 3-6 years

Goal 6: Minimize impacts from weather events such as severe thunderstorms and winter storms.

Objective 6.1: Ensure the public can receive weather warnings.

5.1.1.37 ACTION 6.1.1: NOAA WEATHER RADIO REPEATER

- Install a NOAA Weather Radio repeater in the Lower Madison Valley.

Jurisdiction(s): Madison County, Town of Ennis
Project Type: Population Protection
Priority: Medium
Responsible Agencies and Partners: Local Elected Officials, Disaster and Emergency Services, National Weather Service
Resources Needed: Staff time and expertise, funding for professional services and implementation
Goal Timeframe: Mid Term: Initiated within 3-6 years

5.1.1.38 ACTION 6.1.2: STORM READY PROGRAM

- Participate in the National Weather Service's Storm Ready Program.

Jurisdiction(s): Madison County, Towns of Ennis, Sheridan, Twin Bridges, and Virginia City
Project Type: Population Protection
Priority: High
Responsible Agencies and Partners: Disaster and Emergency Services, National Weather Service
Resources Needed: Staff time and expertise
Goal Timeframe: Near Term: Compleated

Objective 6.2: Protect critical infrastructure from harsh weather conditions.

5.1.1.39 ACTION 6.2.1: ELECTRIC INFRASTRUCTURE PROTECTION

- Reduce the pole spans to strengthen the electric infrastructure.
- Bury electric lines.

Jurisdiction(s): Madison County, Towns of Ennis, Sheridan, Twin Bridges, and Virginia City
Project Type: Infrastructure Protection
Priority: High
Responsible Agencies and Partners: Local Elected Officials, Disaster and Emergency Services, Electric Companies
Resources Needed: Staff time and expertise, funding for professional services and implementation
Goal Timeframe: Near Term: Initiated within 0-3 years

5.1.1.40 ACTION 6.2.2: SNOW FENCES

Install snow fences (living or artificial) along critical roadways prone to drifting snow and strong winds.

Jurisdiction(s):	Madison County, Towns of Ennis, Sheridan, Twin Bridges, and Virginia City
Project Type:	Infrastructure Protection
Priority:	Medium

Responsible Agencies and Partners:	Local Elected Officials, Disaster and Emergency Services, Road Departments, Montana Department of Transportation
Resources Needed:	Staff time and expertise, funding for professional services and implementation
Goal Timeframe:	Initiated within 3-6 years

5.2 ACTION PRIORITIZATION

Each of the proposed projects has value; however, time and financial constraints do not permit all of the proposed actions to be implemented immediately. By prioritizing the actions, the most critical, cost effective projects can be achieved in the short term. The prioritization of the projects serves as a guide for choosing and funding projects. Depending on the funding sources, some actions may be best achieved outside the priorities established here.

To ensure that community goals and other factors are taken into account when prioritizing projects, a prioritization model that uses the following factors has been developed: cost, staff time, feasibility, population benefit, property benefit, values benefit, maintenance, and hazard rating. *Cost* considers the direct expenses associated with the project such as material and contractor expenses. *Staff time* evaluates the amount of time needed by a local government employee to complete or coordinate the project. *Feasibility* assesses the political, social, and/or environmental ramifications of the project and the likelihood such a project would proceed through permitting, public review processes, and/or private business implementation. The feasibility factor is essentially a summarization of FEMA's Social, Technical, Administrative, Political, Legal, Economic, and Environmental (STAPLEE) evaluation criteria as shown in Table 5.2A. *Population benefit* considers the possible prevention of deaths and injuries through the project's implementation. *Property benefit* estimates the reduction of property losses, including structures and infrastructure, from the hazard being mitigated. *Values benefit* considers the economic, ecologic, historic, and social benefits of the project. *Maintenance* rates the amount of work required to keep the mitigation measure effective and useful. The *hazard rating* is based on the results of the risk assessment and is a measure of the history, probability, magnitude, and vulnerabilities of the hazard.

Table 5-1. Federal Emergency Management Agency's STAPLEE Criteria [FEMA, 2003]

Criteria	Considerations
Social	Community Acceptance Effects on Segment of Population
Technical	Technical Feasibility Long-Term Solution Secondary Impacts
Administrative	Staffing Funding Allocated Maintenance/Operations
Political	Political Support Local Champion or Proponent Public Support

Legal	State Authority Local Authority Subjectivity to Legal Challenges
Economic	Benefit of Action Cost of Action Contribution to Economic Goals Outside Funding Requirement
Environmental	Effects on Land/Waterbodies Effects on Endangered Species Effects on Hazardous Material and Waste Sites Consistency with Community Environmental Goals Consistency with Federal Laws

Each of the factors was ranked qualitatively for each of the projects. The methods used to assign a category and the associated score can be generally defined as shown in Table 5.2B. The highest possible score is 30 for projects in which all factors are applicable. Some factors have a greater range than others, thus indicating a higher weighting. These weightings allow for appropriate prioritization of the project. More specifically, 11 of 30 points account for benefits (population benefit, property benefit, and values benefit), 11 of 30 points account for direct and indirect costs (cost, staff time, and maintenance), 5 of 30 points account for the hazard rating (incorporates hazard probability and impacts; see Section 4.14), and 3 of 30 points account for project feasibility.

The actions were prioritized by comparing the scores of actions of similar type. This method allows for more even prioritization of a variety of actions. When evaluating projects for grant applications, established cost-benefit analyses requiring detailed project-specific data should be used.

Table 5-2. Prioritization Criteria

Factor	Threshold	Rating	Score
Cost Range: 1-5	Little to no direct expenses	Low	5
	Less than $5,000	Low-Moderate	4
	$5,000-$25,000	Moderate	3
	$25,001-$100,000	Moderate-High	2
	Greater than $100,000	High	1
Staff Time Range: 1-3	Less than 10 hours of staff time	Low	3
	10-40 hours of staff time	Moderate	2
	Greater than 40 hours of staff time	High	1
Feasibility Range: 1-3	Positive support for the project	High	3
	Neutral support for the project	Moderate	2
	Negative support for the project	Low	1
Population Benefit Range: 1-4	Potential to reduce more than 20 casualties	Very High	4
	Potential to reduce 6–20 casualties	High	3
	Potential to reduce 1–5 casualties	Moderate	2
	No potential to reduce casualties	Low	1
Property Benefit Range: 1-4	Potential to reduce losses to more than 20 buildings or severe damages to infrastructure	Very High	4
	Potential to reduce losses to 6–20 buildings or substantial damages to infrastructure	High	3
	Potential to reduce losses to 1–5 buildings or slight damages to infrastructure	Moderate	2
	No potential to reduce property losses	Low	1
Values Benefit Range: 1-3	Provides significant benefits to economic, ecologic, historic, or social values	High	3
	Provides some benefits to economic, ecologic, historic, or social values	Moderate	2
	No or very little benefit to economic, ecologic, historic, or social values	Low	1
Maintenance Range: 1-3	Requires very little or no maintenance	Low	3
	Requires less than 10 hours per year	Moderate	2
	Requires more than 10 hours per year	High	1
Hazard Rating Range: 1-5	see Section 4.14	High	5
	see Section 4.14	Moderate	3
	see Section 4.14	Low	1

Table 5-3. Hazards and Development Mitigated by Each Proposed Project

Need Heading	Communicable Disease	Drought	Earthquake	Flood	Hazardous Material Release	Landslide and Avalanche	Severe Thunderstorm and	Structure Collapse	Terrorism and Civil Unrest	Transportation Accident	Volcano	Wildfire	Winter Weather	Existing Development	Future Development
Action 1.1.1: DES Coordinator Position	X	X	X	X	X	X	X	X	X	X	X	X	X		
Action 1.1.2: Public Education	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Action 1.1.3: Town Employee Education	X	X	X	X	X		X	X	X	X	X	X	X	X	X
Action 1.1.4: Healthcare Provider Education	X								X						
Action 1.1.5: Address Signage	X		X	X	X	X	X	X	X	X		X	X	X	
Action 1.2.1: Growth Policy		X	X	X	X	X				X		X			X
Action 1.2.2: Subdivision Regulations		X	X	X	X	X				X		X			X
Action 1.2.3: Building Codes			X	X			X	X	X			X	X		X
Action 1.2.4: Permit System		X	X	X		X	X	X	X			X	X		X
Action 2.1.1: Earthquake Educational Brochures			X											X	X
Action 2.1.2: Proposed Subdivision Geologic Review			X			X		X							X
Action 2.1.3: Existing Subdivision Geologic Review			X			X		X						X	
Action 2.1.4: New Homebuilder Earthquake Education			X					X							X
Action 2.2.1: Public Building Seismic Retrofits			X					X						X	
Action 2.2.2: Infrastructure Seismic Improvements			X											X	
Action 2.2.3: Future Infrastructure Seismic Requirements			X												X
Action 3.1.1: Hazardous Material Study					X										

Action 3.1.2: Hazardous Material Educational Publications					X										
Action 3.1.3: Hazardous Material Early Warning System				X	X		X		X		X	X			
Action 3.2.1: Passing Lanes and Truck Routes					X					X					
Action 3.2.2: Chain-Up Area Signage					X					X			X		
Action 4.1.1: Floodplain Mapping				X											X
Action 4.1.2: Floodplain Study				X										X	
Action 4.1.3: Flood Public Education				X										X	X
Action 4.2.1: Structural Flood Mitigation				X										X	
Action 4.2.2: Road, Bridge, and Culvert Upgrades				X						X				X	
Action 4.2.3: Flood Insurance Education				X										X	
Action 4.2.4: Moores Creek Diversion				X										X	X
Action 4.3.1: Flood Ordinances				X											X
Action 5.1.1: Firewise Program												X		X	X
Action 5.1.2: Fuel Treatments												X		X	
Action 5.2.1: WUI Structure Siting Requirements												X			X
Action 5.2.2: Ingress/Egress Requirements												X			X
Action 5.2.3: Conservation Easements												X			X
Action 5.2.4: WUI Water Requirements												X			X
Action 5.2.5: Covenant Requirements												X			X
Action 6.1.1: NOAA Weather Radio Repeater				X	X		X				X	X	X		
Action 6.1.2: Storm Ready Program				X			X						X		
Action 6.2.1: Electric Infrastructure Protection			X			X	X		X	X	X	X	X		
Action 6.2.2: Snow Fences		X											X		

Table 5-4. Mitigation Prioritization Scores

Heading	Cost	Staff Time	Feasibility	Population Benefit	Property Benefit	Values Benefit	Maintenance	Hazard Rating	TOTAL SCORE
Supportive									
Action 1.1.1: DES Coordinator Position	2	3	3	3	3	3	3	5	25
Educational/Informational									
Action 1.1.2: Public Education	4	2	2	4	3	2	2	5	24
Action 1.1.3: Town Employee Education	4	2	2	3	4	2	2	5	24
Action 1.1.5: Address Signage	3	1	2	3	2	2	2	5	20
Action 1.2.4: Permit System	4	1	2	3	3	2	2	5	22
Action 2.1.1: Earthquake Educational Brochures	4	2	2	4	3	2	2	5	24
Action 2.1.2: Proposed Subdivision Geologic Review	4	2	2	3	3	2	2	5	23
Action 2.1.3: Existing Subdivision Geologic Review	3	2	2	3	3	2	3	5	23
Action 2.1.4: New Homebuilder Earthquake Education	4	2	2	3	3	2	2	5	23
Action 1.1.4: Healthcare Provider Education	4	2	2	4	1	2	2	3	20
Action 3.1.1: Hazardous Material Study	4	2	3	3	1	2	2	5	22
Action 3.1.2: Hazardous Material Educational Publications	4	2	2	4	1	2	2	5	22
Action 4.1.1: Floodplain Mapping	2	2	2	3	3	2	2	5	21
Action 4.1.2: Floodplain Study	3	2	2	3	3	2	2	5	22
Action 4.1.3: Flood Public Education	4	2	2	4	3	2	2	5	24
Action 4.2.3: Flood Insurance Education	4	2	2	1	3	2	2	5	21
Policy/Regulatory									
Action 1.2.1: Growth Policy	5	2	2	2	2	2	2	5	22
Action 1.2.2: Subdivision Regulations	5	2	2	2	3	2	2	5	23
Action 1.2.3: Building Codes	3	1	2	4	4	2	1	5	22
Action 2.2.3: Future Infrastructure Seismic Requirements	5	2	2	2	3	2	2	5	23
Action 4.3.1: Flood Ordinances	5	2	2	2	3	2	2	5	23
Action 5.2.1: WUI Structure Siting Requirements	5	2	2	2	3	2	2	5	23
Action 5.2.2: Ingress/Egress Requirements	5	2	2	3	2	2	2	5	23
Action 5.2.3: Conservation Easements	3	2	3	2	4	3	2	5	24
Action 5.2.4: WUI Water Requirements	5	2	2	2	2	2	2	5	22
Action 5.2.5: Covenant Requirements	5	2	2	2	2	2	2	5	22

Table 5-5. Mitigation Prioritization Scores

Need Header	Cost	Staff Time	Feasibility	Population Benefit	Property Benefit	Values Benefit	Maintenance	Hazard Rating	TOTAL SCORE
Property Protection									
Action 2.2.1: Public Building Seismic Retrofits	2	2	3	4	3	2	3	5	24
Action 4.2.1: Structural Flood Mitigation	1	2	2	3	3	2	3	5	21
Action 4.2.4: Moores Creek Diversion	2	2	2	3	3	2	3	5	22
Action 5.1.1: Firewise Program	3	2	2	3	3	2	1	5	21
Action 5.1.2: Fuel Treatments	3	2	2	3	3	2	1	5	21
Infrastructure Protection									
Action 2.2.2: Infrastructure Seismic Improvements	1	2	2	2	3	2	3	5	20
Action 4.2.2: Road, Bridge, and Culvert Upgrades	2	2	2	2	3	2	2	5	20
Action 6.2.1: Electric Infrastructure Protection	1	3	2	2	3	3	2	5	21
Action 6.2.2: Snow Fences	3	2	2	2	2	2	2	5	20
Population Protection									
Action 3.1.3: Hazardous Material Early Warning System	3	2	2	4	1	2	2	5	21
Action 3.2.1: Passing Lanes and Truck Routes	1	2	2	3	1	2	3	5	19
Action 3.2.2: Chain-Up Area Signage	4	2	2	2	1	2	3	5	21
Action 6.1.1: NOAA Weather Radio Repeater	2	2	2	4	1	2	3	5	21
Action 6.1.2: Storm Ready Program	5	1	3	3	1	2	2	5	22

5.3 PROJECT IMPLEMENTATION

A critical component of any mitigation program is the implementation of the mitigation projects. Maintaining this Pre-Disaster Mitigation Plan has primarily been the responsibility of Madison County Emergency Management in coordination with other appropriate agencies. However, once a hazard has been identified for mitigation, Emergency Management generally steps back from the leadership role and assumes the role of team participant. The lead role in project development should then shift to the department or agency responsible for the project management.

Each proposed action was given a high, medium, or low prioritization based on the score received in Section 5.2 within each type of project. The proposed and prioritized projects are shown in Table 5.3A with the associated goal timeframes for the actions. The timeframes are defined as follows and are generally based on the nature of the project and its priority:

- Near Term: Initiated within 0-3 years
- Mid Term: Initiated within 3-6 years
- Long Term: Initiated within 7-10 years
- Ongoing: Already initiated and continuing

Some projects may be best achieved outside of the goal timeframes depending on the funding and staff resources available. Others may not be feasible in the goal timeframe due to financial, staff, or political limitations. This prioritized list, however, allows the county and jurisdictions to focus on the types of projects with the greatest benefits. Table 5.3B lists potential ideas for future mitigation grant cycles.

Table 5-6. Implementation Scheme for Mitigation Actions

Proposed Action	Jurisdiction(s)	Priority	Goal Timeframe
Supportive			
Action 1.1.1: DES Coordinator Position	All	High	Ongoing
Educational/Informational			
Action 1.1.2: Public Education	All	High	Ongoing
Action 1.1.3: Town Employee Education	Towns	High	Near Term
Action 2.1.1: Earthquake Educational Brochures	All	High	Near Term
Action 4.1.3: Flood Public Education	All	High	Near Term
Action 2.1.2: Proposed Subdivision Geologic Review	County	High	Ongoing
Action 2.1.3: Existing Subdivision Geologic Review	County	High	Near Term
Action 2.1.4: New Homebuilder Earthquake Education	All	High	Near Term
Action 1.2.4: Permit System	County	Medium	Mid Term
Action 3.1.1: Hazardous Material Study	All	Medium	Mid Term
Action 3.1.2: Hazardous Material Educational Publications	All	Medium	Mid Term
Action 4.1.2: Floodplain Study	All	Medium	Mid Term
Action 4.1.1: Floodplain Mapping	All	Low	Long Term
Action 4.2.3: Flood Insurance Education	All	Low	Long Term
Action 1.1.5: Address Signage	All	Low	Ongoing
Action 1.1.4: Healthcare Provider Education	All	Low	Long Term
Policy/Regulatory			
Action 5.2.3: Conservation Easements	County	High	Ongoing
Action 1.2.2: Subdivision Regulations	County	High	Near Term
Action 2.2.3: Future Infrastructure Seismic Requirements	All	High	Near Term
Action 4.3.1: Flood Ordinances	All	High	Near Term
Action 1.2.1: Growth Policy	All	Medium	Mid Term
Action 1.2.3: Building Codes	All	Medium	Mid Term
Action 5.2.4: WUI Water Requirements	County	Medium	Mid Term
Action 5.2.5: Covenant Requirements	All	Medium	Mid Term
Property Protection			
Action 2.2.1: Public Building Seismic Retrofits	All	High	Near Term
Action 4.2.4: Moores Creek Diversion	County, Ennis	High	Near Term
Action 4.2.1: Structural Flood Mitigation	All	Medium	Mid Term
Action 5.1.1: Firewise Program	County, Virginia City	Medium	Mid Term

Action 5.1.2: Fuel Treatments	County, Virginia City	Medium	Mid Term
Infrastructure Protection			
Action 6.2.1: Electric Infrastructure Protection	All	High	Near Term
Action 2.2.2: Infrastructure Seismic Improvements	All	Medium	Mid Term
Action 4.2.2: Road, Bridge, and Culvert Upgrades	All	Medium	Mid Term
Action 6.2.2: Snow Fences	All	Medium	Mid Term
Population Protection			
Action 6.1.2: Storm Ready Program	All	High	Near Term
Action 3.1.3: Hazardous Material Early Warning System	All	Medium	Mid Term
Action 3.2.2: Chain-Up Area Signage	County	Medium	Mid Term
Action 6.1.1: NOAA Weather Radio Repeater	County, Ennis	Medium	Mid Term
Action 3.2.1: Passing Lanes and Truck Routes	All	Low	Long Term

Table 5-7. Possible Mitigation Grant Funded Projects

Project Ideas	Potential Federal Funding Programs
Earthquake Study, Public Education Campaign, and Public Building Evaluations and Retrofits	PDM HMGP
Floodplain Mapping of New Areas and Updates of Existing Maps	Map Modernization
Moores Creek Diversion	PDM HMGP
Firewise Program and Fuel Reductions	National Fire Plan Hazardous Fuels Mitigation Program
Road, Bridge, and Culvert Upgrades in Flood Prone Areas	PDM HMGP
Floodplain Buyouts and Relocations	PDM HMGP

5.4 FUNDING SOURCES

Funding for mitigation projects exists from a multitude of sources. Some sources may be specifically designed for disaster mitigation activities, while others may have another overarching purpose that certain mitigation activities may qualify for. Most mitigation funding sources are recurring through legislation or government support. Some, however, may be from an isolated instance of financial support. Whenever possible, creative financing is encouraged. Often, additional funding sources are found through working with other agencies and businesses to identify common or complementary goals and objectives. Table 5.4A shows the programs that may be available to Madison County and the Towns of Ennis, Sheridan, Twin Bridges, and Virginia City. The traditional mitigation programs that are especially relevant for the county and communities are shown in bold.

Table 5-8. Mitigation Funding Sources

Name	Description	Managing Agencies

AmeriCorps	Provides funding for volunteers to serve communities, including disaster prevention.	/ Corporation for National & Community Service
Assistance to Firefighters Grants	Provides funding for fire prevention and safety activities and firefighting equipment.	/ Department of Homeland Security
Clean Water Act Section 319 Grants	Provides grants for a wide variety of activities related to nonpoint source pollution runoff mitigation.	/ US Environmental Protection Agency
Community Development Block Grant (CDBG)	Provides funding for sustainable community development, including disaster mitigation projects.	/ US Housing and Urban Development
Economic Development Administration (EDA) Grants and Investments	Invests and provides grants for community construction projects, including mitigation activities.	/ US Economic Development Administration
Emergency Watershed Protection	Provides funding and technical assistance for emergency measures such as floodplain easements in impaired watersheds.	/ US Natural Resources Conservation Service
Environmental Quality Incentives Program	Provides funding and technical assistance to farmers and ranchers to promote agricultural production and environmental quality as compatible goals.	/ US Natural Resources Conservation Service
Flood Mitigation Assistance Program (FMA)	Provides pre-disaster flood mitigation funding (with priority for repetitive flood loss properties under the National Flood Insurance Program).	/ Montana Department of Natural Resources and Conservation / FEMA – Region VIII
Hazard Mitigation Grant Program (HMGP)	Provides post-disaster mitigation funding.	/ Montana Disaster & Emergency Services / FEMA – Region VIII
Hazardous Fuels Mitigation Program	Provides funding for the reduction of hazardous wildfire fuels.	/ US Bureau of Land Management
Hazardous Materials Planning and Training Grants	Provides funding for planning and training for hazardous materials releases.	/ Montana Disaster & Emergency Services
Homeland Security Grants	Through multiple grants, provides funding for homeland security activities. Some projects can be considered mitigation.	/ Montana Disaster & Emergency Services / US Department of Justice / US Department of Homeland Security
Housing and Urban Development (HUD) Grants	Provides a number of grants related to safe housing initiatives.	/ US Housing and Urban Development
Individual Assistance (IA)	Following a disaster, funds can mitigate hazards when repairing individual and family homes.	/ Montana Disaster & Emergency Services / FEMA – Region VIII
Law Enforcement Support Office 1033 Program	Provides surplus military property to local law enforcement agencies.	/ Montana Public Safety Service Bureau
Map Modernization Program	Provides funding to establish or update floodplain mapping.	/ Montana Department of Natural Resources and Conservation / FEMA – Region VIII
National Fire Plan (NFP)	Provides funding for pre-disaster wildfire mitigation.	/ Montana Department of Natural Resources and Conservation / US Forest Service
National Wildlife Wetland Refuge System	Provides funding for the acquisition of lands into the federal wildlife refuge system.	/ US Fish and Wildlife Service
North American Wetland Conservation Fund	Provides funding for wetland conservation projects.	/ US Fish and Wildlife Service

Name	Description	Managing Agencies
NRCS Conservation Programs	Provides funding through a number of programs for the conservation of natural resources.	US Natural Resources Conservation Service
Partners for Fish and Wildlife	Provides financial and technical assistance to landowners for wetland restoration projects in "Focus Areas" of the state.	US Fish and Wildlife Service
PPL Montana Community Fund	Provides grants to Montana organizations in the areas of education, environment, and economic development.	PPL Montana
Pre-Disaster Mitigation (PDM) Grants	Provides grants through a competitive process for specific mitigation projects, including planning.	Montana Disaster & Emergency Services FEMA – Region VIII
Public Assistance (PA)	Following a disaster, funds can be used to mitigate hazards when repairing damages to public structures or infrastructure.	Montana Disaster & Emergency Services FEMA – Region VIII
Reclamation and Development Grants Program	Provides funding from the interest income of the Resource Indemnity Trust Fund to local governments for dam safety and other water related projects.	Montana Department of Natural Resources and Conservation
Renewable Resource Development Grant	Provides funding to protect, conserve, or develop renewable resources, including water.	Montana Department of Natural Resources and Conservation
Repetitive Flood Claims (RFC) Grant	Provides funding to reduce flood damages to insured properties that have had one or more claims to the NFIP.	Montana Department of Natural Resources and Conservation FEMA – Region VIII
Rural Development Grants	Provides grants and loans for infrastructure and public safety development and enhancement in rural areas.	US Department of Agriculture, Rural Development
Rural Fire Assistance (RFA) Grant	Funds fire mitigation activities in rural communities.	National Interagency Fire Center
SBA Pre-Disaster Mitigation Loan Program	Provides low-interest loans to small businesses for mitigation projects.	US Small Business Administration (SBA)

Table 5-9. Mitigation Funding Sources (continued)

Name	Description	Managing Agencies
Severe Repetitive Loss (SRL) Grant	Provides funding to reduce flood damages to residential insured properties that have had at least four claims to the NFIP.	Montana Department of Natural Resources and Conservation FEMA – Region VIII
Small Flood Control Projects	Authority of USACE to construct small flood control projects.	US Army Corps of Engineers (USACE)
Streambank and Shoreline Protection	Authority of USACE to construct streambank stabilization projects.	USACE
Wetland Program Development Grants (WPDGs)	Provides funding for studies related to water pollution prevention.	US Environmental Protection Agency

This list of potential funding sources is certainly not all inclusive. Many opportunities for mitigation funding exist both in the public and private sectors such as businesses, foundations, and philanthropic organizations.

5.5 EXISTING PLANNING MECHANISMS AND CAPABILITIES

Implementing mitigation projects requires cooperation and coordination between a variety of agencies, organizations, and the public. Most mitigation projects are time consuming and may require the attention of local officials with many other priorities. Incorporating mitigation ideas and information into existing planning mechanisms and programs is one way to use existing resources to achieve mitigation objectives.

Madison County and the Towns of Ennis, Sheridan, Twin Bridges, and Virginia City are in a unique position to perform disaster mitigation for future development. Much of the county has experienced growth over the past several years and the towns are seeing increases in the demand for services. Residential and commercial development has occurred at a rapid pace. Recent economic slowdowns may have tempered growth but also provides the opportunity to look at existing policies and regulations so that future development may be better protected.

Despite the growth in recent years, Madison County is still very much a rural area and has a relatively small tax base that limits the number of resources that can be devoted to mitigation, or even planning for that matter. County government consists of three county commissioners and staff. The towns each have a mayor and a town council. Emergency management is coordinated by one full-time position. The Madison County Planning Department has three staff – a planning director, planner, and secretary. Madison County also has a grant writer, an important position in the county for future mitigation activities.

These limited resources, although effective for a rural county, do not allow for many activities beyond the standard course of business; the time that can be devoted to disaster mitigation is limited. Madison County does have an active Local Emergency Planning Committee, with representatives from many agencies, which meets regularly to discuss emergency management and planning issues. In general, the county has only a few planning mechanisms and the towns have even fewer as most of the planning issues are handled by the local elected officials. Table 5.5A lists the existing local plans and development mechanisms.

Table 5-10 Existing Local Plans and Development Mechanisms

Plan Name	Date
Madison County Disaster and Emergency Plan	January 2006
Madison County Growth Policy	September 2006
Madison County Housing Needs Assessment and 5-Year Housing Plan	2006
Madison County Strategic Wildland Fire Plan	December 2003
Madison County Subdivision Regulations	September 2006
Town Municipal Codes	Varied

As the jurisdictions develop new plans and existing plans are updated, the new plans and updates will utilize the hazard information and actions identified in this mitigation plan for consideration and inclusion. Given that limited planning mechanisms exist in the county and jurisdictions, the information in this mitigation plan will be valuable for future planning efforts. Most of the integration of mitigation into existing plans will be done by the Madison County Planning Department, however, for more comprehensive integration, local officials and other departments will also need to consider mitigation when making decisions and updating codes, regulations, policies, and plans. Table 5.5B shows examples of projects and how they can be incorporated into existing and future planning documents. Note that some proposed mechanisms may not be feasible at this time or any time in the near future due to the staff, technical expertise, and financial resources need to implement the program.

Table 5-11. Incorporation into Existing and Future Plans

Existing or Anticipated Plan	Mitigation Strategies
Building Codes	/ Adopt and enforce the state building code. This activity will reduce the risks to future development from hazards such as earthquakes, tornadoes, strong winds, structure collapses, terrorism, volcanoes, and winter storms.
Capital Improvement Plans	/ When developed or updated, consider and include projects related to hazard mitigation, such as transportation and public utility infrastructure improvements, in the capital improvements schedule.
Madison County Disaster and Emergency Plan	/ Integrate the operational, response, training, and preparedness needs that are not directly tied to mitigation into the county's emergency operation plan.
Madison County Growth Policy	/ When updated, include elements of the risk assessment and mitigation strategy into the county's growth policy, considering sustainability and disaster resistance a top priority.
Madison County Housing Needs Assessment and Five Year Housing Plan	/ When updated, add the consideration of hazard vulnerability into future housing development. This consideration will add to the sustainability, and therefore affordability, of future housing.
Madison County Strategic Wildland Fire Plan	/ When updated, continue to emphasize mitigation activities in the strategy portion of the plan.
Madison County Subdivision Regulations	/ When updated, incorporate elements of the risk assessment and mitigation strategy into the county's subdivision regulations, considering sustainability and disaster resistance a top priority.
Municipal Codes / Ordinances / Zoning	/ Adopt ordinances that create disaster resistance such as fire reduction ordinances, flood ordinances, and open space zoning in hazard areas.

Note that some activities such as building codes and land use regulations are more easily implemented by some communities than others because of the community, planning, and enforcement resources available.

6.0 PLAN MAINTENANCE

An important aspect of any useable plan is the maintenance and upkeep of the document. To facilitate and ensure the plan will remain viable for Madison County and the incorporated jurisdictions for many years, the plan maintenance responsibilities lie with the Madison County Local Emergency Planning Committee (LEPC). This committee meets regularly and is responsible for coordinating emergency planning issues for the county and communities. Given the broad representation of agencies and jurisdictions, this committee is a good fit, has many members that participated in the initial plan development and update, and eliminates the need for an additional committee. All Local Emergency Planning Committee meetings are open to the public.

6.1 PLAN MONITORING

The plan will be monitored by the Madison County Local Emergency Planning Committee and mitigation progress will be discussed at each meeting, usually monthly. The status of projects will be reported on and new projects will be initiated during this time. Annually, a "Mitigation Year in Review" meeting will be conducted in January. At this meeting, a list of projects completed during the previous calendar year will be documented and put in Appendix K.

The LEPC will review the goals, objectives, and actions to determine if the actions for which funding exist are proceeding as planned. The LEPC will review any new risk information and modify the plan as indicated by the emergence of new vulnerabilities. Review of ongoing projects will be conducted to determine their status, their practicality, and which actions should be revised. If needed, site visits will be conducted.

6.2 PLAN EVALUATION

The evaluation of the plan will be conducted by the Madison County Local Emergency Planning Committee annually at the January Mitigation Year in Review meeting. At this meeting, the methods of implementing and maintaining the plan will be evaluated for successes and improvements. Changes to the implementation schedule or plan maintenance will be made as needed to ensure hazard mitigation activities continue. The evaluation will consider the following:

- changes in land development
- if the nature or magnitude of risks has changed
- if the goals and objectives address current and expected conditions
- the effectiveness of the program,
- if outcomes have occurred as expected
- if other agencies and partners have participated as originally planned,
- if current resources are adequate for implementing the pla,
- if other programs exist that may affect mitigation priorities.

New stakeholders and interested parties will be identified and invited to participate in the implementation process. The Madison County LEPC maintains a contact list of mitigation stakeholders.

Should a hazard event have occurred during the previous year in which a mitigation project was a factor, either positive or negative, a summary report, including avoided losses, will be written and included in Appendix K.

6.3 PLAN UPDATES

As disasters occur, projects are completed, and hazard information is improved, the Madison County Pre-Disaster Mitigation Plan will need to be updated. To remain an active and approved plan, an updated plan must be submitted to Montana Disaster and Emergency Services (DES) and the Federal Emergency Management Agency (FEMA) every five years. The next formal submission is required in 2022. To provide enough time for a full update before this plan expires, the following schedule is recommended:

- Pre-Disaster Mitigation Planning Grant Application Preparations: late 2020
- Pre-Disaster Mitigation Planning Grant Application: early 2021
- Contracting for Professional or Technical Services (if needed): June-August 2021
- Plan Reviews and Modifications: September 2021 – May 2022
- Montana DES and FEMA Reviews: June-July 2022
- Final Revisions and Adoption: August 2022
- Final Plan Approval: September 2022

To facilitate the update process, annual updates to the plan are recommended. Table 6-1 shows the schedule of plan updates.

Table 6-1. Schedule of Plan Updates

Plan Section	Post-Disaster	Annually	Every 5 Years
Introduction			X
Planning Process and Methodologies	X	X	X
Critical Facilities and Infrastructure			X
Population and Structures			X
Economic, Ecologic, Historic, and Social Values			X
Current Land Use			X
New Development		X	X
Future Development		X	X
Hazard Profiles	X	X	X
Risk Assessment Summary			X
Goals, Objectives, and Proposed Actions	X	X	X
Action Prioritization	X	X	X
Project Implementation	X	X	X
Funding Sources			X
Existing Planning Mechanisms and Capabilities	X	X	X
Plan Maintenance			X
Appendices	X	X	X

6.4 PUBLIC INVOLVEMENT

Madison County is dedicated to involving the public directly in the review and updates of the Pre-Disaster Mitigation Plan. A copy of the Pre-Disaster Mitigation Plan will be available for review at the Madison County Courthouse Commissioners' Office and town halls. The public is invited to attend all Local Emergency Planning Committee meetings and the annual January "Mitigation Year in Review" meeting to provide input and feedback. In an effort to solicit involvement, a press release will be distributed annually to The Madisonian newspaper prior to the "Mitigation Year in Review" meeting, encouraging the public to attend. Year round, written comments may also be submitted to the Local Emergency Planning Committee at:

Madison County LEPC
c/o Madison County Disaster and Emergency Services
PO Box 278
Virginia City, MT 59755

Received comments will be reviewed and integrated where applicable during the annual and five-year plan updates.

7.0 REFERENCES

APPENDIX A

APPENDIX TITLE

A. APPENDIX A APP H1 STYLE

A.1. SECOND LEVEL APPENDIX HEADING (APP H2 STYLE)