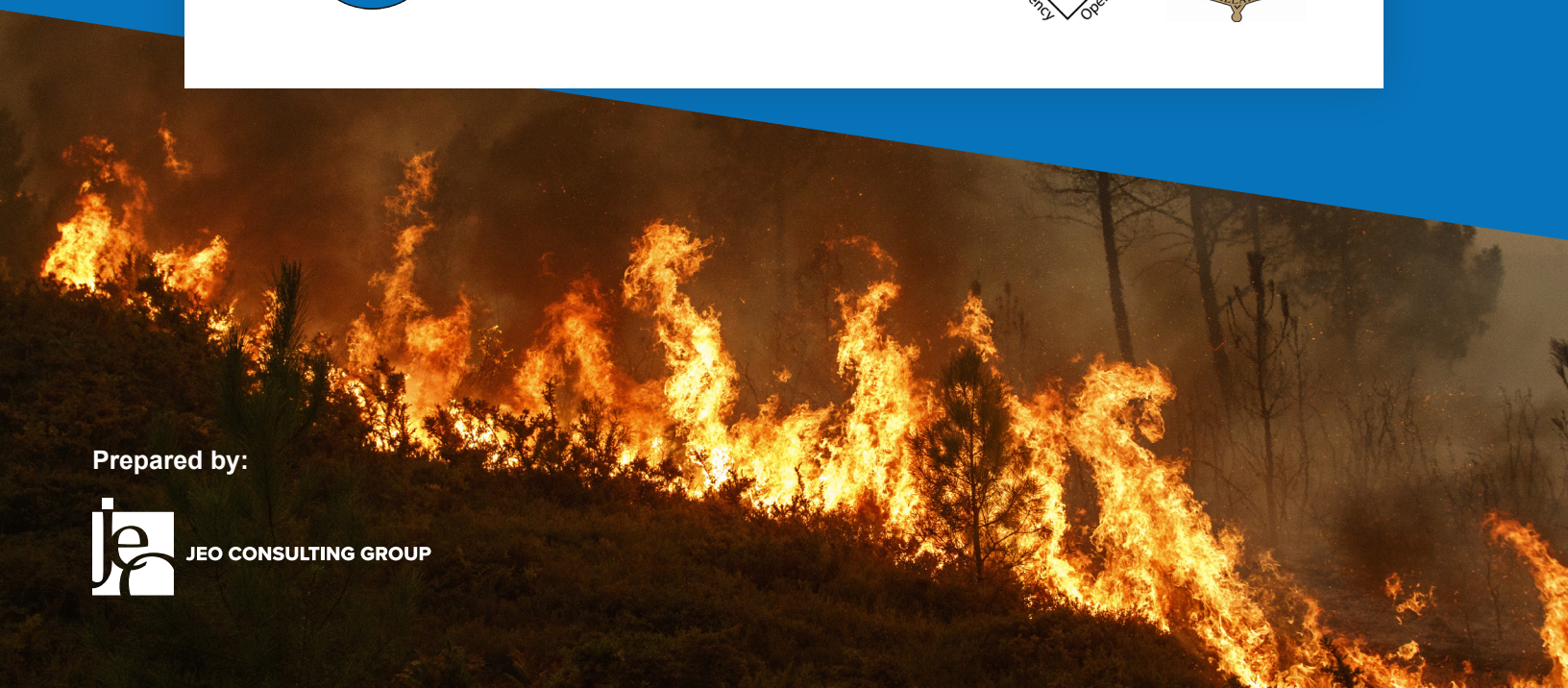
2022 Garfield County

Hazard Mitigation Plan Update

Garfield County

Garfield County Emergency Operations

Sheriff's Office Garfield County Vallario



Prepared by:

JEO CONSULTING GROUP

Contents

Table of Tables

Table of Figures

Acronyms

BLE – Base Level Engineering
BLM – Bureau of Land Management
BRIC – Building Resilient Infrastructure and Communities
CAIC – Colorado Avalanche Information Center
CDC – Center for Disease Control
CDOT – Colorado Department of Transportation
CDPHE – Colorado Deparmtent of Public Health and Environment
CERT – Community Emergency Response Teams
CFR – Code of Federal Regulations
CGS – Colorado Geological Survey
CIKR – Critical Infrastructure and Key Resources
COGCC – Colorado Oil and Gas Conservation Commission
CRS – Community Rating System
CRP – Conservation Reserve Program
CSFS – Colorado State Forest Service
CWCB – Colorado Water Conservation Board
CWPP – Community Wildfire Protection Plan
DFIRM – Digital Flood Insurance Rate Map
DHS – Department of Homeland Security
DHSEM – Division of Homeland Security and Emergency Management
DMA 2000 – Disaster Mitigation Act of 2000
DOLA – Department of Local Affairs
DWR – Division of Water Resources
EOP – Emergency Operations Plan
EPA – Environmental Protection Agency
FACE – Future Avoided Cost Explorer
FBI – Federal Bureau of Investigation
FEMA – Federal Emergency Management Agency
FIS – Flood Insurance Study
FMA – Flood Mitigation Act
FR – Federal Regulation
FSA – Farm Service Agency
GCS – Colorado Geological Survey
GIS – Geospatial Information Systems
HMA – Hazard Mitigation Act
HMGP – Hazard Mitigation Grant Program
HMP – Hazard Mitigation Plan
HSAS – Homeland Security Advisory System
HTS – Housing Technology and Standards
HUD – Department of Housing and Urban Development
IDD – Intellectual and Developmental Disabilities
JEO – JEO Consulting Group, Inc.
LGA – Liquid Gallons
LOMA – Letter of Map Amendment
LOMR – Letter of Map Revisions
MPH – Miles Per Hour
NCEI – National Center for Environmental Information
NDMC – National Drought Mitigation Center
NFIP – National Flood Insurance Program
NHMP – Natural Hazard Mitigation Plan
NIPP – National Infrastructure Protection Plan
NOAA – National Oceanic and Atmospheric Administration
NPI – Nonpharmaceutical Interventions
NRC – National Response Center
NTAS – National Terrorism Advisory System
NWS – National Weather Service
PHSMA – Pipeline and Hazardous materials Safety Administration
P.L. – Public Law
PDM – Pre-Disaster Mitigation
PDSI – Palmer Drought Severity Index
RFC – Roaring Fork Conservancy
SFHA – Special Flood Hazard Area
SHELDUS – Spatial HHazard Events and Losses Database
SSA – Sector-Specfic Agency
START – Study of Terrorism and Responses to Terrorism
USDA – United States Department of Agriculture
USFS – United States Forest Service
USGS – United States Geological Survey
WUI – Wildland Urban Interface

Executive Summary

Why develop a hazard mitigation plan?

Natural hazards impact the citizens, properties, environments, and economies of all communities. Wildfire, landslides, and severe winter storms have exposed Garfield County residents and businesses to the financial and emotional costs of recovery. The risk associated with natural and human-made hazards increases as more people move to vulnerable areas. The inevitability of natural hazards, and the growing population and activity within hazard-prone parts of the County create an urgent need to develop strategies, coordinate resources across jurisdictions, and increase public awareness. These efforts reduce risk and prevent loss from future natural hazard events.

It is impossible to predict exactly when disasters will occur or the extent to which they will affect a community. However, with careful planning and collaboration among public agencies, private sector organizations, and citizens within the community, it is possible to minimize the losses that can result from natural hazards. Mitigation plans assist communities to reduce risk by identifying resources, information, and strategies for risk reduction, while helping to guide and coordinate mitigation activities throughout the County.

This Garfield County Hazard Mitigation Plan (HMP) provides a set of actions to reduce risk from natural hazards through education and outreach programs, the development of partnerships, and implementation of preventative activities such as land use or watershed programs. It is a multi-jurisdictional plan that contains actions specific to Garfield County and to the communities and special districts (such as fire districts) within it.

The resources and information within the mitigation plan:

(1) Establish a foundation for coordination and collaboration among agencies and the public in Garfield County;
(2) Identify and prioritize future mitigation projects; and
(3) Meet qualifications for federal assistance programs.

The mitigation plan works in conjunction with other County plans with many of its actions implemented through other plans and policies, including the County Comprehensive Land Use Plan; County and jurisdictional building codes; or the Garfield County Continuity of Operations Plan. This mitigation plan is part of a suite of plans that together form a comprehensive emergency management framework for Garfield County. Those plans include a Continuity of Operations Plan, a Recovery Plan, a Comprehensive Risk Assessment, and Community Wildfire Protection Plans. Together, these plans will be implemented and maintained in a coordinated way.

Plan participants are listed in the following table and illustrated in the following planning area map.

Table 1: Participating Jurisdictions

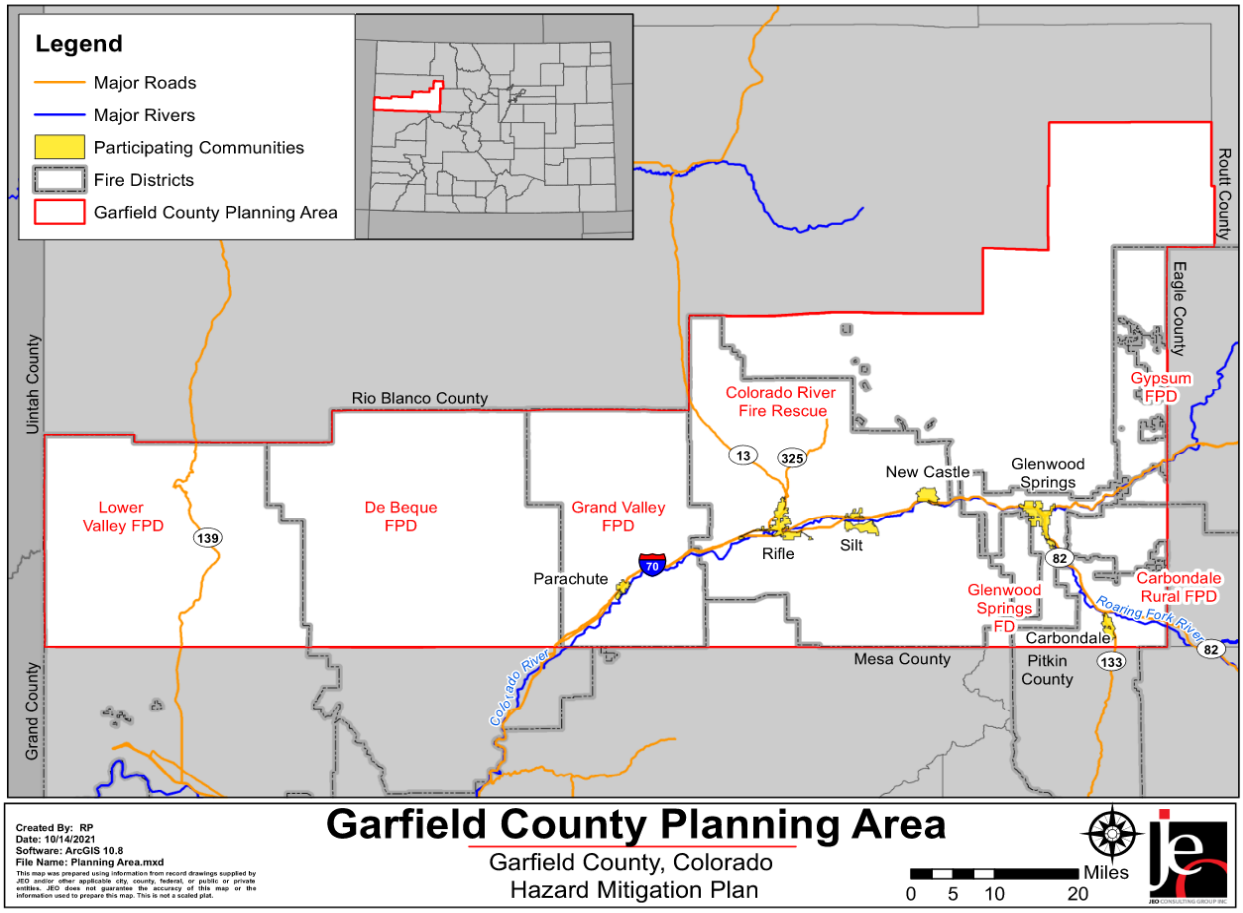
Plan Participants		
Garfield County	Town of Parachute	Colorado River Fire Rescue District
Town of Carbondale	City of Rifle	Glenwood Springs Fire Protection District
City of Glenwood Springs	Town of Silt	Grand Valley Fire Protection District

Plan Participants		
Town of New Castle	Carbondale and Rural Fire Protection District	

Lower Valley FPD, De Beque FPD, and Gypsum FPD do not have any infrastructure located in Garfield County and participate in other surrounding mitigation planning efforts.

This Hazard Mitigation Plan does not conflict with the Federal Land Policy and Management Act of 1976. Although maps within this plan show areas under the management of federal agencies, this plan does not change the management authority over those areas. Garfield County will continue to coordinate with federal agencies and other stakeholders that manage public lands to mitigate hazards within the County.

Figure 1: Map of Planning Area



Mission, Goals, and Actions

The Garfield County HMP provides a set of actions that aim to reduce the risks posed by hazards through education and outreach programs, the development of partnerships, and the implementation of mitigation activities through the County Development Code, Source Water Protection Plan, Community Wildfire Protection Plan, Emergency Operations Plan and 5-Year Plan. The actions described in the HMP are intended to be implemented through existing plans and programs within the County and its jurisdictions.

Mission
The mission of the Garfield County HMP is to reduce risk to life and property from hazard events.

Goals
This Hazard Mitigation Plan's goals describe the overall direction that Garfield County agencies, organizations, and citizens can take toward mitigating risk from natural hazards. They were updated from the goals identified in the past 2017 Plan and are similar to the goals included in the State of Colorado Natural Hazard Mitigation Plan. The Planning Team felt that this alignment with the State Plan would increase opportunities for collaboration during implementation.

- Goal 1: Reduce the loss of life and personal injuries from natural and human-made hazard events
- Goal 2: Reduce damage to community lifelines
- Goal 3: Reduce public costs of disaster response and recovery
- Goal 4: Minimize economic losses
- Goal 5: Reduce damage to personal property

Mitigation Actions
There are a wide variety of strategies that can be used to reduce the impacts of hazards for the residents of the planning area as well as the built environment. *Section Five: Mitigation Strategy* shows the mitigation actions chosen by Garfield County to prevent future losses. Actions selected by each participating jurisdiction can be found *Section Seven: Participant Sections*.

Summary of Changes
Several changes were made to the 2017 Natural Hazard Mitigation Plan and planning process, including:

- Minor changes to clarify language in HMP goals;
- Reprioritization to hazard tier to align with local priorities. Drought and Public Health Emergency added as new Tier I hazards, Hazardous Soils moved to a Tier II hazard;
- Expansion on hazard assessments to address growing concerns in the planning area, specifically for Public Health Emergency and Terrorism;
- An online public engagement and meeting schedule to accommodate the novel Coronavirus-19 pandemic;
- Reorganization and evaluation of critical facilities for the county to align with Federal Emergency Management Agency (FEMA) Community Lifelines;
- The review, inclusion, and/or removal of mitigation actions and strategies as applicable for each jurisdiction; and,
- Added and expanded on community commitments to maintain the plan between five year updates.

This update also works to unify the various planning mechanisms in place throughout the participating communities (i.e. comprehensive plans, local emergency operation plans, zoning ordinances, building codes, etc.) to ensure that the goals and objectives identified in those planning mechanisms are consistent with the goals and strategies included in this plan. These changes and efforts were made throughout the planning process to address evolving priorities from FEMA Region IIIV and the State of Colorado.

THIS PAGE INTENTIONALLY BLANK

Section One: Introduction

Hazard Mitigation Planning

Hazard events are inevitable, it is just a matter of when they happen and what jurisdictions have done to prepare against the potential impacts. Hazard mitigation reduces risk and is a socially and economically responsible action to prevent long-term risks from natural and man-made hazard events.

Natural hazards, such as severe winter storms, severe winds, flooding, drought, earthquakes, and wildfires are a part of the world around us. Their occurrence is natural and inevitable, and there is little that can be done to control their force and intensity. Man-made hazards are a product of society and can occur with significant impacts to communities. Man-made hazards include hazardous material spills and terrorism. All jurisdictions participating in this planning process are vulnerable to a wide range of natural and man-made hazards that threaten the safety of residents, have the potential to damage or destroy both public and private property, cause environmental degradation, and disrupt the local economy and overall quality of life.

Garfield County prepared this Multi-Jurisdictional Hazard Mitigation Plan in an effort to reduce impacts from natural and man-made hazards and to better protect the people and property of the region from the effects of hazards. This plan demonstrates the communities' commitment to reducing risks from hazards and serves as a tool to help decision makers establish mitigation activities and resources. This plan was developed to ensure Garfield County and participating jurisdictions are eligible for federal mitigation funding programs and to accomplish the following objectives:

- Minimize the disruption to each jurisdiction following a disaster
- Establish actions to reduce or eliminate future damages to efficiently recover from disasters
- Investigate, review, and implement activities or actions to ensure disaster-related hazards are addressed by the most efficient and appropriate solutions
- Educate citizens about potential hazards
- Facilitate development and implementation of hazard mitigation management activities to ensure sustainable communities

Disaster Mitigation Act of 2000

The U.S. Congress passed the Disaster Mitigation Act 2000 (DMA) to amend the Robert T. Stafford Disaster Relief and Emergency Assistance Act[1]. Section 322 of the DMA 2000 requires that state and local governments develop, adopt, and routinely update a hazard mitigation plan to remain eligible for pre- and post-disaster mitigation funding.[2] These funds include the Hazard Mitigation Grant Program (HMGP)[3], Flood Mitigation Assistance (FMA)[4], and the newly released Building Resilient Infrastructure and Communities (BRIC)[5]. BRIC replaced the Pre-Disaster

[1] Federal Emergency Management Agency, Public Law 106-390. 2000. "Disaster Mitigation Act of 2000." Last modified September 26, 2013. https://www.fema.gov/media-library/assets/documents/4596.

[2] Federal Emergency Management Agency. June 2007. "Robert T. Stafford Disaster Relief and Emergency Assistance Act, as amended, and Related Authorities." Federal Emergency Management Agency 592: 22. Sec. 322. Mitigation Planning (42 U.S.C. 5165). https://www.fema.gov/pdf/about/stafford_act.pdf.

[3] Federal Emergency Management Agency. "Hazard Mitigation Grant Program." Last modified July 8, 2017. https://www.fema.gov/hazard-mitigation-grantprogram.

[4] Federal Emergency Management Agency. "Flood Mitigation Assistance Grant Program." Last modified July 11, 2017. https://www.fema.gov/flood-mitigationassistance-grant-program.

[5] Federal Emergency Management Agency. "Building Resilient Infrastructure and Communities." Last modified September 8, 2020. https://www.fema.gov/grants/mitigation/building-resilient-infrastructure-communities.

Mitigation (PDM) Program in 2020. The Federal Emergency Management Agency (FEMA) administers these programs under the Department of Homeland Security (DHS).[6]

This plan was developed in accordance with current state and federal rules and regulations governing local hazard mitigation plans. The plan shall be monitored and updated on a routine basis to maintain compliance with the legislation – Section 322, Mitigation Planning, of the Robert T. Stafford Disaster Relief and Emergency Assistance Act, as enacted by Section 104 of the DMA 2000 (P.L. 106-390)[7] and by FEMA's Final Rule (FR)[8] published in the Federal Register on November 30, 2007, at 44 Code of Federal Regulations (CFR) Part 201.

Hazard Mitigation Assistance

On June 1, 2009, FEMA initiated the Hazard Mitigation Assistance (HMA) program integration, which aligned certain policies and timelines of the various mitigation programs. These HMA programs present a critical opportunity to minimize the risk to individuals and property from hazards while simultaneously reducing the reliance on federal disaster funds.[9]

Each HMA program was authorized by separate legislative action, and as such, each program differs slightly in scope and intent.

- **HMGP:** this program provides funds to states, territories, Indian tribal governments, local governments, and other eligible participants following a presidential disaster declaration. The DMA 2000 authorizes up to seven percent of HMGP funds available to a state after a disaster to be used for the development of state, tribal, and local mitigation plans.
- **FMA:** this program provides grant funds to implement projects such as acquisition or elevation of flood-prone homes. Jurisdictions must be participating communities in the National Flood Insurance Program (NFIP) to qualify.
- **BRIC:** this program is replacing the Pre-Disaster Mitigation Program and provides funds on an annual allocation basis to local jurisdictions for implementing programs and projects to improve resiliency and local capacity before disaster events.

Plan Financing and Preparation

In regard to plan financing and preparation, in general, Garfield County is the "sub-applicant" that is the eligible entity that submits a sub-application for FEMA assistance to the "Applicant." The "Applicant," in this case is the State of Colorado. If HMA funding is awarded, the sub-applicant becomes the "sub-recipient" and is responsible for managing the sub-grant and complying with program requirements and other applicable federal, state, territorial, tribal, and local laws and regulation.

6 Federal Emergency Management Agency. "Hazard Mitigation Assistance." Last modified March 29, 2017. https://www.fema.gov/hazard-mitigation-assistance.
7 Federal Emergency Management Agency: Federal Register. 2002. "Section 104 of Disaster Mitigation Act 2000: 44 CFR Parts 201 and 206: Hazard Mitigation Planning and Hazard Mitigation Grant Programs; Interim Final Rule." https://www.fema.gov/pdf/help/fr02-4321.pdf.
8 Federal Emergency Management Agency: Federal Register. 2002 "44 CFR Parts 201 and 206: Hazard Mitigation Planning and Hazard Mitigation Grant Programs; Interim Final Rule." https://www.fema.gov/pdf/help/fr02-4321.pdf.
9 Federal Emergency Management Agency. "Hazard Mitigation Assistance." Last modified March 29, 2017. https://www.fema.gov/hazard-mitigation-assistance.

Section Two: Planning Process

Introduction

The process utilized to develop a hazard mitigation plan is often as important as the final planning document. For this plan update, Garfield County adapted the four-step hazard mitigation planning process outlined by FEMA to fit the needs of the participating jurisdictions. The following pages will outline: how the Regional Planning Team was established; the function of the Regional Planning Team; key project meetings and community representatives; outreach efforts; plan review and adoption; and ongoing plan maintenance.

Multi-Jurisdictional Approach

According to FEMA, "A multi-jurisdictional hazard mitigation plan is a plan jointly prepared by more than one jurisdiction." The term 'jurisdiction' means 'local government.' Title 44 Part 201, Mitigation Planning in the CFR, defines a 'local government' as "any county, municipality, city, town, township, public authority, school district, special district, intrastate district, council of governments, regional or interstate government entity, or agency or instrumentality of a local government; any Indian tribe or authorized tribal organization, any rural community, unincorporated town or village, or other public entity." For the purposes of this plan, a 'taxing authority' was utilized as the qualifier for jurisdictional participation.

FEMA recommends the multi-jurisdictional approach under the DMA 2000 for the following reasons:

- It provides a comprehensive approach to the mitigation of hazards that affect multiple jurisdictions;
- It allows economies of scale by leveraging individual capabilities and sharing cost and resources;
- It avoids duplication of efforts; and
- It imposes an external discipline on the process.

Garfield County utilized the multi-jurisdiction planning process recommended by FEMA (Local Mitigation Plan Review Guide[10], Local Mitigation Planning Handbook[11], and Mitigation Ideas: A Resource for Reducing Risk to Natural Hazards[12]) to develop this plan.

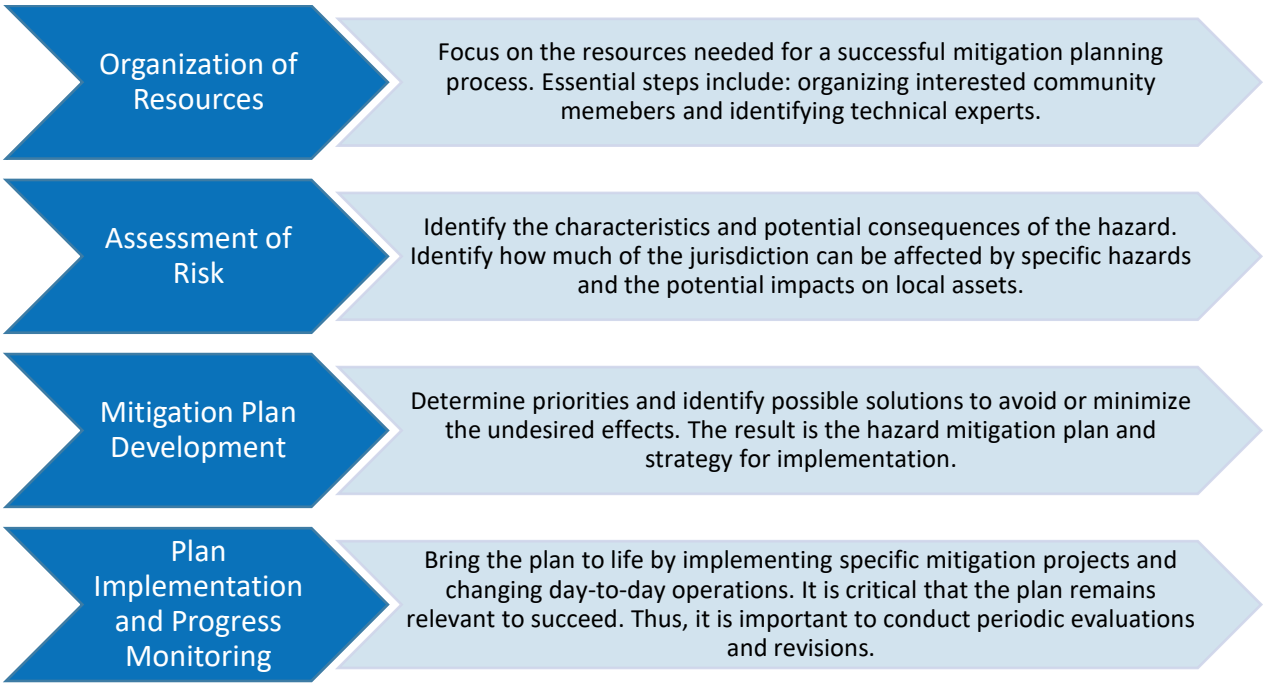
Hazard Mitigation Planning Process

The hazard mitigation planning process as outlined by FEMA has four general steps which are detailed in the figure below. The mitigation planning process is rarely a linear process. It's common that ideas developed during the initial assessment of risks may need revision later in the process, or that additional information may be identified while developing the mitigation plan or during the implementation of the plan that results in new goals or additional risk assessments. The four-step approach is described in the figure below.

[10] Federal Emergency Management Agency. 2011. "Local Mitigation Plan Review Guide." https://www.fema.gov/media-library-data/20130726-1809-25045-7498/plan_review_guide_final_9_30_11.pdf

[11] Federal Emergency Management Agency. 2013. "Local Mitigation Planning Handbook." https://www.fema.gov/media-library-data/20130726-1910-25045-9160/fema_local_mitigation_handbook.pdf.

[12] Federal Emergency Management Agency. 2013. "Mitigation Ideas: A Resource for Reducing Risk to Natural Hazards." https://www.fema.gov/media-librarydata/20130726-1904-25045-0186/fema_mitigation_ideas_final508.pdf.



Organization of Resources

Plan Update Schedule

JEO Consulting Group, INC. (JEO) was contracted in January 2017 to guide and facilitate the planning process and assemble the Multi-Jurisdictional Hazard Mitigation Plan. The first activity in the development process for the Garfield County HMP update was coordination of efforts with local, state, and federal agencies and organizations. The State of Colorado Division of Homeland Security and Emergency Management (DHSEM) became involved in the planning process. Garfield County and JEO worked together to identify elected officials and key stakeholders to lead the planning effort.

County Planning Team Establishment

At the beginning of the planning process, the County Planning Team was established to guide the planning process; review the 2017 HMP and discuss planning process changes or plan requirements; and serve as the liaison between the county, state, and consultant to local participating jurisdictions. The following table provides a list of County Planning Team Members who attended the Kick-off Meeting and/or participated in this plan update process.

Table 2: Garfield County Regional Planning Team

Name	Title	Jurisdiction
Chris Bornholdt	Emergency Manager	Garfield County
Chad Whiting	Sergeant – Emergency Operations Sheriff's Office	Garfield County
Glenn Hartmann	Senior Planner	Garfield County
Wyatt Keesbery	Road and Bridges	Garfield County
Levy Burris	Sheriff's Office	Garfield County
Philip Berry	Planning Manager	Garfield County
Andrea Grygo	GIS Analyst	Garfield County
Renelle Lott	Chief Communications Officer	Garfield County

Name	Title	Jurisdiction
Joshua Williams	Environmental Health Manager	Garfield County
Mark Thompson*	Mitigation Planning Specialist	DHSEM
Phil Luebbert*	Project Manager	JEO Consulting Group, Inc.
Brooke Seachord*	Project Coordinator	JEO Consulting Group, Inc.

**Served as a consultant or advisory role*

A project Kick-off meeting was held on July 15, 2021 to discuss an overview of the planning process between JEO staff and the County Planning Team. Discussion at this meeting included responsibilities for the planning teams, participation requirements for eligible jurisdictions, review and updates to plan goals, identify hazards for risk assessment, identify potential plan participants or key stakeholders, public engagement and outreach strategies, and general schedule for the planning process. The following table lists attendees from the Kick-off Meeting.

Table 3: Garfield County Kick-off Meeting Attendees

Name	Title	Jurisdiction
Chris Bornholdt	Emergency Manager	Garfield County
Chad Whiting	Sergeant – Emergency Operations Sheriff's Office	Garfield County
Glenn Hartmann	Senior Planner	Garfield County
Wyatt Keesbery	Road and Bridges	Garfield County
Levy Burris	Sheriff's Office	Garfield County
Philip Berry	Planning Manager	Garfield County
Andrea Grygo	GIS Analyst	Garfield County
Renelle Lott	Chief Communications Officer	Garfield County
Joshua Williams	Environmental Health Manager	Garfield County
Mark Thompson	Mitigation Planning Specialist	DHSEM
Phil Luebbert*	Project Manager	JEO Consulting Group, Inc.
Brooke Seachord*	Project Coordinator	JEO Consulting Group, Inc.

Public Involvement and Outreach

Citizens and stakeholder groups throughout Garfield County contributed to the development of this plan. An online survey was developed and shared on the county's website, community websites, and via email in multiple email distribution lists. In addition to the general public the survey was also sent to key stakeholders. Survey results and stakeholder comments were shared with County staff and the local planning teams then incorporated within the plan as appropriate. Survey results and public comments mainly focused on hazard prioritization and risk identification. See *Appendix B* for Survey Results.

Figure 2: Open House

Source: JEO Photo, 2016

The public was also give the opportunity to comment on the draft plan. The final draft document was posted on the County's website, which provided a specific comment form for those interested in providing comments (https://www.garfield-county.com/emergency-management/email-hmp/).

Table 4: Outreach Activity Summary

Action	Intent
Project Website	Garfield County Emergency Management developed and shared relevant HMP related information through a project website (https://www.garfield-county.com/emergency-management/natural-hazard-mitigation-plan/). The website will remain available for public use following plan completion with a copy of the current HMP and comment box to solicit any additional comments and feedback to utilize in future updates.
Project Announcement	A Project Announcement letter was sent to all neighboring jurisdictions and eligible participants to inform them of the planning process.
Press Release	Sent to local media outlets to announce the plan and its purpose.
Project Flyer	Flyers were posted about the HMP update and how to become involved.
One-on-one Correspondence	Phone calls, emails, and word-of-mouth were used to share information about HMP meetings and requested information.
Public Survey	An online survey was developed and posted on the Garfield County website to receive feedback from the general public.
Videos	Videos were developed and posted on the County's website to aid in public engagement. These videos described the hazard mitigation plan, the planning process, and described how the public could become involved.

Notified Neighboring Jurisdictions and Stakeholders

Neighboring stakeholders and communities were notified of the Garfield County HMP update process and invited to participate in the planning process. The following table lists the neighboring communities or entities notified of the planning process. Letters and emails were sent to stakeholders at their respective jurisdictions and disseminated appropriately in August 2021.

Table 5: Notified Jurisdictions

Notified Jurisdictions	
Rio Blanco County, CO	Garfield County Oil and Gas Division
Routt County, CO	Garfield County School District 16
Eagle County, CO	Garfield County Sheriff
Pitkin County, CO	Garfield School District No RE-2
Mesa County, CO	Glenwood Springs Area Chamber of Commerce
Uintah County, UT	Grand River Hospital and Medical Center
Grand County, UT	Holy Cross Energy
Battlement Mesa Service Association	Middle Colorado Watershed Council
Black Hills Energy	Rifle Garfield County Airport
Bureau of Land Management	Rifle Regional Economic Development
Carbondale Chamber of commerce	Roaring Fork Conservancy
Colorado Avalanche Information Center	Roaring Fork Schools
Colorado Department of Agriculture	Roaring Fork Transportation Authority
Colorado Department of Public Health and Environment	Roaring Fork Water and Sanitation District

Notified Jurisdictions	
Colorado Department of Transportation	US Fish and Wildlife (Grand Junction Fish and Wildlife Conservation Office)
Colorado Division of Natural Resources	US Forest Service
Colorado Geological Survey	Valley View Hospital
Colorado Mountain College	Western Garfield County Chamber of Commerce
Colorado Parks and Wildlife	White River National Forest Office
Colorado River Water Conservation District	Xcel Energy
Colorado Water Conservation Board	

Public Survey

As a method to engage the public and receive more local input on local risks and concerns in the county, a public survey was developed by Garfield County for both the Hazard Mitigation Plan and adjacent Community Wildfire Protection Plan updates. This analysis provides a summary of responses from the HMP specific survey. The goal of the survey was to capture local concerns, priorities, and ideas.

EMERGENCY MANAGEMENT

Garfield County hazard mitigation plan underway

OCTOBER 7, 2021

GARFIELD COUNTY, CO – Garfield County is currently updating its regional multi-jurisdictional Hazard Mitigation Plan (HMP) for 2022. HMPs are a requirement of the Disaster Mitigation Act of 2000, administered by the Federal Emergency Management Agency (FEMA). Once a community, county, or district is part of an approved plan, it becomes eligible for up to...

More info

As identified by the County's local planning team members, finding effective ways to engage the public and gain feedback can be a challenging component of the HMP process. HMPs are a complex planning tool that address issues that community members may be unaware of, and identifies potential impacts that people may not have dealt with. In addition, the HMP showcases numerous solutions to natural and human-caused hazards--and ways to get involved--that are unfamiliar to readers. Because of these plan functions, it is critical to successfully engage the public.

A public engagement survey was developed through SurveyMonkey. Social media posts were created and shared by Garfield County which linked to the project survey. The survey was also sent directly to all planning officials engaged throughout the HMP process who were also encouraged to share the survey with their teams, departments, and local stakeholders.

Figure 3: Garfield County HMP Survey on Website

Social media posts were created and shared by the project sponsor and planning team members which included a link to the project survey. Questions about prior knowledge of hazard types, local impacts, local priorities, completed household mitigation actions, and what community members would like to see done locally were asked through the survey. In total, 85 survey responses were collected. Specific areas represented in the survey are listed in the table below.

Table 6: Survey Results - Question 1

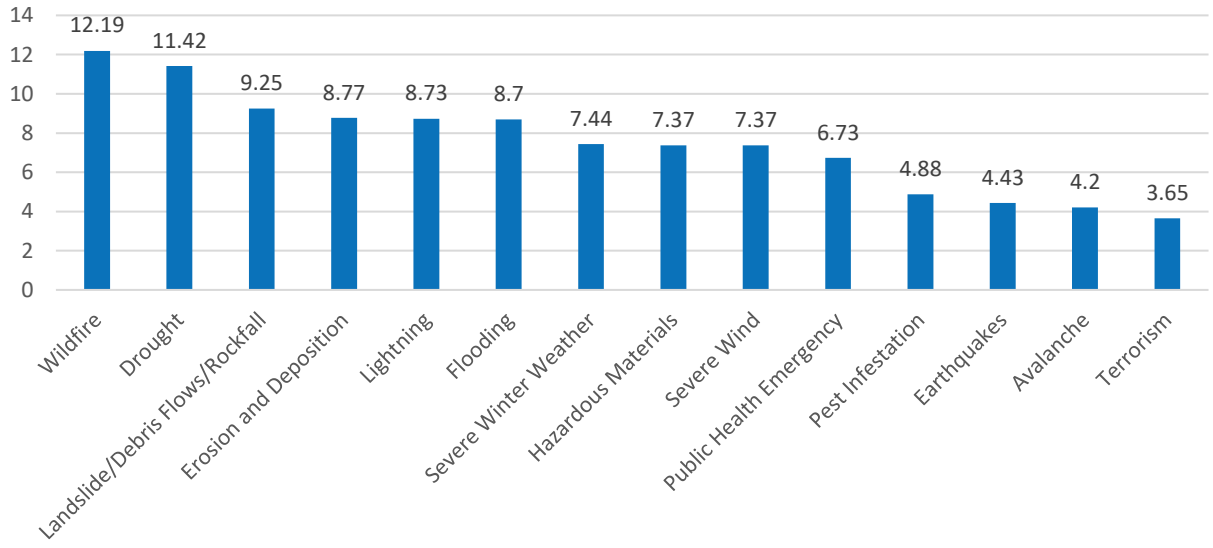
Represented Area	Number of Responses	Percentage
Battlement Mesa	6	7.1%
Carbondale	1	1.2%
Garfield County (general)	17	20.0%
Glenwood Springs	7	8.2%
New Castle	7	8.2%

Represented Area	Number of Responses	Percentage
Parachute	6	7.1%
Rifle	30	35.3%
Rio Blanco County	1	1.2%
Silt	6	7.1%
Other (Canyon Creek, Elk Springs, Grass Valley, Sweetwater Creek)	4	4.7%

The first questions in the survey asked residents about their local perception of damaging hazard types. Responses were weighted according to the total number of respondents and ranking. Overall Wildfire was identified as the hazard of top concern for the public while Terrorism was identified as the least damaging.

Question 2: Please rank these natural hazards from which you think would cause the greatest harm to people and property in your community to least harm or damage.

Figure 4: Survey Responses – Question 2



Each of the identified hazards has specific concerns or values to the public. The survey asked for follow up information regarding the reasoning behind hazard ranking in Question 1. The following list provides a summary of key responses.

Question 3: Why did you choose these hazards? Why do they cause the greatest concern to you? How have these hazards impacted you/your home/your community?

- Past experience – many respondents ranked hazard events they had personally experienced or seen in the region as a higher concern
- Subsequent impacts – Hazard types which have compounding impacts are of greater concern. Examples include drought, lightning, and wildfire or flooding and landslides.

- Location – Different hazards were of greater concern to residents depending if they lived in a community or in the more rural areas of the county.
- Climate change – changes in both local weather patterns and overarching snowpack raise concerns for future severity of hazard events
- Limited transportation – key concern for many residents were blocked transportation corridors from landslides, storm debris, and/or hazardous material spills.

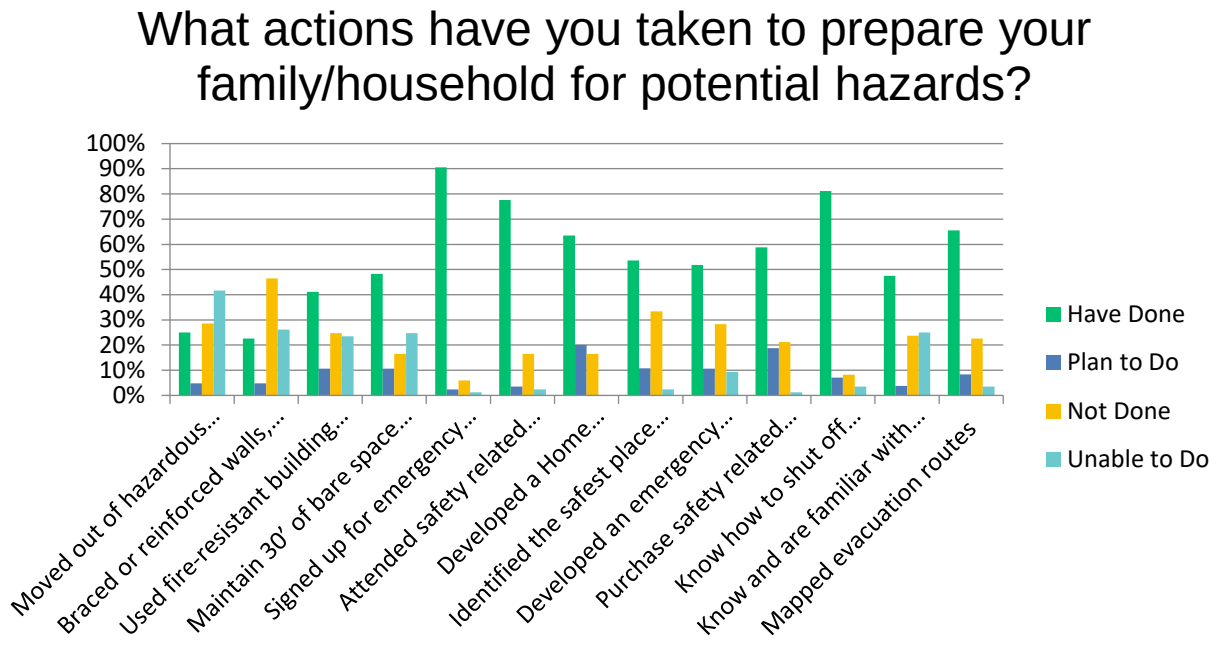
Respondents were also asked about some common household mitigation actions which they may have done or not. The most commonly done actions included signing up for emergency alerts, being aware on how to shut off utilities, and attended safety related training or certifications.

Question 4: What actions have you taken to prepare your family/household for potential hazards.

Table 7: Survey Responses – Question 4

	Have Done	Plan to Do	Not Done	Unable to Do
Moved out of hazardous areas (floodplain, wildfire prone areas, or near major highways)	25.00% (21)	4.76% (4)	28.57% (24)	41.67% (35)
Braced or reinforced walls, foundations, chimneys, or utilities	22.62% (19)	4.76% (4)	46.43% (39)	26.19% (22)
Used fire-resistant building or roof materials	41.18% (35)	10.59% (9)	24.71% (21)	23.53% (20)
Maintain 30’ of bare space around homes or buildings	48.24% (41	10.59% (9)	16.47% (14)	24.71% (21)
Signed up for emergency alerts from your county emergency management agency	90.59% (77)	2.35% (2)	5.88% (5)	1.18% (1)
Attended safety related training and certifications (CERT, First Aid, CPR, etc.)	77.65% (66)	3.53% (3)	16.47% (14)	2.35% (2)
Developed a Home Emergency Plan that describes what you will do during a natural disaster	63.53% (54)	20.00% (17)	16.47% (14)	0.00% 0
Identified the safest place to be in your home/work during an earthquake	53.57% (45)	10.71% (9)	33.33% (28)	2.38% (2)
Developed an emergency plan for pets during disasters	51.76% (44)	10.59% (9)	28.24% (24)	9.41% (8)
Purchase safety related equipment (weather radios, go-packs, emergency supply kits)	58.82% (50)	18.82% (16)	21.18% (18)	1.18% (1)
Know how to shut off utilities	81.18% (69)	7.06% (6)	8.24% (7)	3.53% (3)
Know and are familiar with school and/or childcare's emergency procedures	47.50%	3.75%	23.75%	25.00%
Mapped evacuation routes	65.48%	8.33%	22.62%	3.57%

Figure 5: Survey Results - Question 4



While some mitigation actions can be taken on easily by a homeowner, other strategies to reduce risk require additional resources or support. The following question was asked to help identify which resources or incentives would best serve Garfield County. The top incentives identified by the public included reduced costs on insurance premiums, funding assistance to accomplish projects, and reduced property or other taxes.

Question 5: If available, which of the following incentives would help to encourage you to retrofit your home to reduce the possible impacts of hazards?

Figure 6: Survey Responses - Question 5

Answer Choices	Responses	
Discounted insurance premiums	65.48%	55
Funding assistance (grant or other sources)	63.10%	53
Reduced property tax/other tax incentives	60.71%	51
Partial rebate for out-of-pocket expenses	59.52%	50
Assistance with installation	45.24%	38
Building permit fee waiver	39.29%	33
Roster of certified contractors	23.81%	20
Other (please specify)	11.90%	10

The “Other” category included provided an opportunity for residents to add additional comments or suggestions for incentives or actions to take. Six of the ten responses in the other category regarded housing and noted they rent their current place of living which limits their ability to conduct improvements.

The following two questions asked respondents about their preferred or best ways to share information or communicate with the public both during an event and for general information.

Question 6: What are the best ways for you to receive information about hazards as they are occurring?

Question 7: What are the best ways for you to receive information about hazards and the threat they may pose to your household and property?

The majority of respondents indicated the best way to share information during a disaster is through emergency text alerts (92.8% of respondents), social media posts (51.8% of respondents), and community website and social media updates (48.2% of respondents). Similarly, the majority of respondents preferred to learn about hazards and mitigation strategies in general through social media posts (63.1% of respondents) and community or county websites and social media posts (59.5% and 52.9% of respondents respectively).

Local planning team members specifically noted the need to share emergency alerts in both English and Spanish across the county.

Figure 7: Survey Results - Question 6

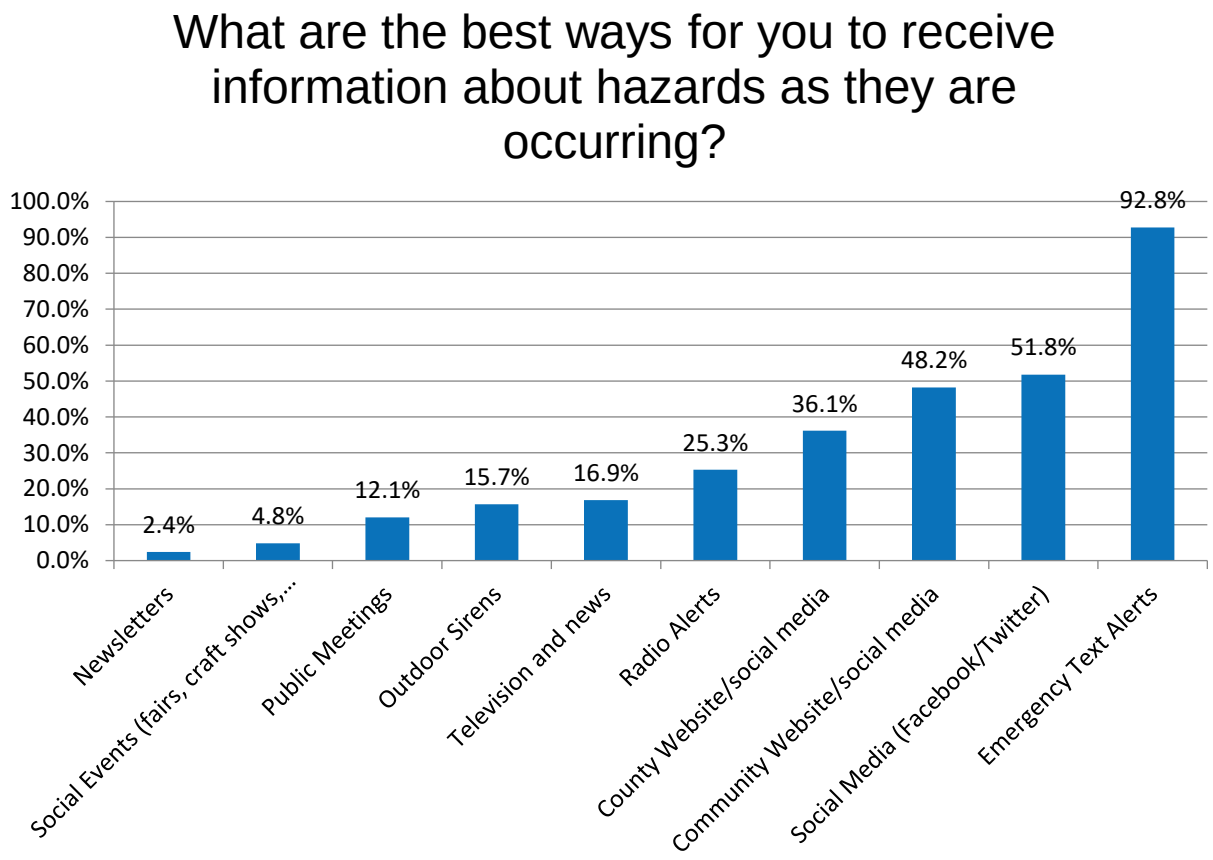
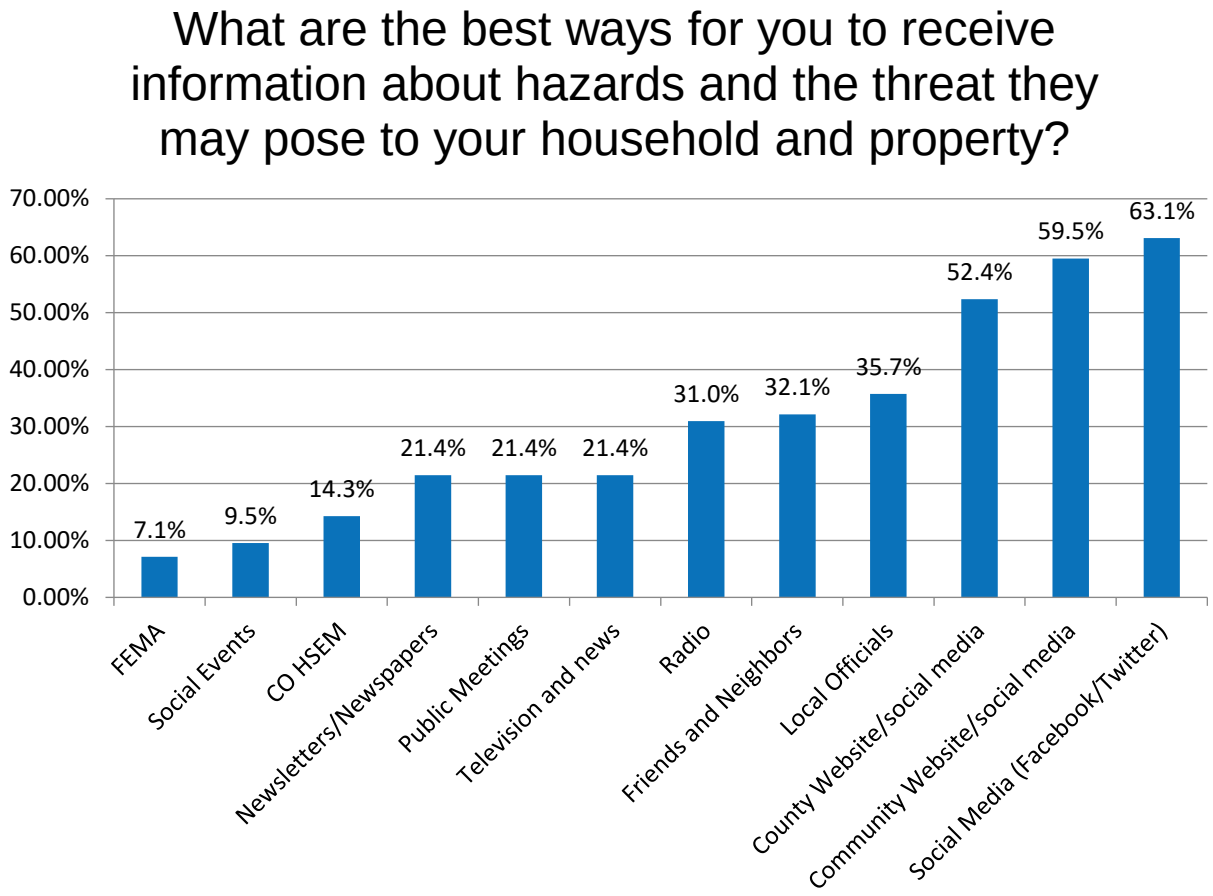


Figure 8: Survey Results - Question 7



Oftentimes implemented mitigation actions are prioritized based upon need to mitigate risk, cost effectiveness, feasibility, and public support. To help identify overall local support for types of mitigation projects, respondents were asked to rank from very important to not important mitigation action end goals.

Question 8: Preparing for a disaster can take many forms. How important is it to mitigate potential hazard risk to the following?

Table 8: Survey Results - Question 8

	Protecting people	Protecting private property	Protecting community assets (parks, community buildings)	Protecting critical facilities (hospitals, fire/police stations, utilities)	Preventing development in hazardous areas (example - flood prone areas)
Very Important	78 (91.8%)	35 (41.2%)	19 (22.4%)	75 (88.2%)	46 (54.1%)
Somewhat Important	5 (5.9%)	32 (37.7%)	36 (42.4%)	8 (9.4%)	25 (29.4%)
Neutral	2 (2.4%)	15 (17.7%)	26 (30.6%)	2 (2.4%	11 (12.9%)
Somewhat Not Important	0 (0%)	3 (3.5%	4 (4.7%)	0 (0%)	2 (2.4%)
Not Important	0 (0%)	1 (1.2%)	0 (0%)	0 (0%)	1 (1.2%)
	Protecting natural environments	Protecting historical/cultural landmarks	Increasing cooperation between emergency response agencies and the public	Improving notification and weather alert communication systems	Improving emergency response capabilities (fire/police/emergency management equipment and training)
Very Important	43 (50.6%)	28 (32.9%)	69 (81.2%)	57 (67.1%	70 (82.4%)
Somewhat Important	31 (36.5%)	40 (47.1%)	11 (12.9%)	21 (24.7%)	10 (11.8%)
Neutral	10 (11.8%)	14 (16.5%)	5 (5.88%)	6 (7.1%)	3 (3.5%)
Somewhat Not Important	1 (1.2%)	2. (2.4%)	0 (0%)	0 (0%)	2 (2.4%)
Not Important	0 (0%)	0 (0%)	0 (0%)	1 (1.2%)	0 (0%)

Participant Involvement

Participants play a key role in the following: reviewing goals and objectives; identification of hazards; providing a record of historical disaster occurrences and localized impacts; identification and prioritization of potential mitigation projects and strategies; and, the development of annual review procedures. Participating jurisdictions were required to meet with members of the Planning Team to discuss plan components. Meetings were scheduled with each jurisdiction within their community. Jurisdictions were encouraged to invite local representatives and staff to provide insights during the planning process.

The county held jurisdiction specific one-on-one meetings to discuss local hazards of top concern and their impacts to property and communities. These meetings were held virtually. Items of discussion at these one-on-one meetings included: demographic changes in the community; an overview of local capabilities; community lifelines (in relation to critical facility updates for the 2022 HMP); evaluation and descriptions of hazards of top concern; updates to old and identification of new mitigation strategies to reduce risk.

Local planning teams were asked to ensure all information included in the draft plan was up-to-date and accurate and were also asked to share the plan materials with other jurisdiction staff and elected representatives. The following table lists attendees at each jurisdictional meeting.

Table 9: Garfield County One-on-One Meeting Attendees, August 23

Name	Title	Jurisdiction
Chris Bornholdt	Emergency Manager	Garfield County
Chad Whiting	Sergeant – Emergency Operations Sheriff's Office	Garfield County
Glenn Hartmann	Senior Planner	Garfield County
Levy Burris	Sheriff's Office	Garfield County
Philip Berry	Planning Manager	Garfield County
Andrea Grygo	GIS Analyst	Garfield County
Drew Petersen		State of Colorado
Phil Luebbert*	Project Manager	JEO Consulting Group, Inc.
Brooke Seachord*	Project Coordinator	JEO Consulting Group, Inc.

In addition to the County Planning Team, each participating jurisdiction had a local planning team which guided plan development for their specific community and local interests. These local planning teams were primarily comprised of community officials, emergency responders, and the county sponsor. One-on-one meetings were held with each of the local community Planning Teams. At these meetings, jurisdictional representatives (i.e. the local planning teams) reviewed the hazards included in the 2017 Colorado Natural Hazard Mitigation Plan (NHMP)[13] to conduct further risk and vulnerability assessments based on these hazards' previous occurrence and the communities' exposure to the various hazards (for a complete list of hazards reviewed see *Section Four: Risk Assessment*).

The intent of these meetings was to familiarize the local planning teams with an overview of the work to be completed over the plan update process, and discuss the responsibilities of being a participant.. This was an opportunity to gather input on the identification of hazards, records of historical occurrences, changes to local demographics and capabilities (refer to *Appendices B*

[13] Division of Homeland Security and Emergency Management & Colorado Department of Public Safety. 2013. "Colorado Natural Hazards Mitigation Plan." https://www.colorado.gov/pacific/mars/2013-natural-hazard-mitigation-plan.

and *C).* In addition to the primary data collection objectives for the workshop, representatives also identified critical facilities, and reviewed preliminary participant sections.

The following table lists the dates and attendees to each of the community one-on-one meetings.

Table 10: Garfield County One-on-One Meeting Attendees

Name	Title	Jurisdiction
Town of Glenwood Springs – September 29, 2021; 1:30pm MT Virtual Meeting		
Joseph Deras	Police Chief	Glenwood Springs
Doug Gerrald	Battalion Chief/EMS Coordinator	Glenwood Springs
Gary Tillotson	Fire Chief	Glenwood Springs
Greg Bak	Fire Marshall	Glenwood Springs
Hannah Klausman	Assistant Director – Community Development	Glenwood Springs
Terri Partch	City Engineer	Glenwood Springs
Chad Whiting	Sergeant – Emergency Operations Sheriff's Office	Garfield County
Phil Luebbert	Project Manager	JEO Consulting Group
Brooke Seachord	Project Coordinator	JEO Consulting Group
Town of New Castle – September 30, 2021; 11:00am MT Virtual Meeting		
Rochelle Firth	Assistant Town Administrator, Public Information Officer	New Castle
John Wenzel	Public Works Director	New Castle
Melody Harrison	Town Clerk	New Castle
David Reynolds	Town Administrator	New Castle
Chad Whiting	Sergeant – Emergency Operations Sheriff's Office	Garfield County
Anthony Pagni	Police Chief	New Castle
Phil Luebbert	Project Manager	JEO Consulting Group
Brooke Seachord	Project Coordinator	JEO Consulting Group
Town of Parachute – September 30, 2021; 1:00pm MT Virtual Meeting		
Stuart McArthur	Town Manager	Parachute
Brandon Burke	Assistant Town Manager	Parachute
Phil Luebbert	Project Manager	JEO Consulting Group
Brooke Seachord	Project Coordinator	JEO Consulting Group
Town of Rifle – October 6, 2021; 10:00am MT Virtual Meeting		
Tom Whitmore	Parks and Recreation Director	Rifle
Tommy Klein	City Manager and Police Chief	Rifle
Chad Whiting	Sergeant – Emergency Operations Sheriff's Office	Garfield County
Mike Cooper	Police Lieutenant	Rifle
Robert Burns	Utilities Director	Rifle
Brian Prunty	Public Works Director	Rifle

Name	Title	Jurisdiction
Craig Spaulding	City Engineer	Rifle
Patrick Waller	Planning Director	Rifle
Mike Kuper	Police Officer	Rifle
Phil Luebbert	Project Manager	JEO Consulting Group
Brooke Seachord	Project Coordinator	JEO Consulting Group
Town of Silt – October 7, 2021: 2:00pm MT Virtual Meeting		
Jeff Layman	Town Administrator	Silt
Trey Fonner	Public Works Director	Silt
Chad Whiting	Sergeant – Emergency Operations Sheriff's Office	Garfield County
Phil Luebbert	Project Manager	JEO Consulting Group
Brooke Seachord	Project Coordinator	JEO Consulting Group
Town of Carbondale – October 13, 2021: 10:00am MT Virtual Meeting		
John Leybourne	Mayor	Carbondale
Kirk Wilson	Chief of Police	Carbondale
Mark O'Meara	Utility Director	Carbondale
Phil Luebbert	Project Manager	JEO Consulting Group
Carbondale and Rural Fire Protection District – October 25, 2021: 1:00pm MT Virtual Meeting		
Bill Gavette	Fire Marshall	Carbondale and Rural FPD
Mike Wagner	Deputy Chief of Operations	Carbondale and Rural FPD
Chad Whiting	Sergeant – Emergency Operations Sheriff's Office	Garfield County Sheriff's Dept
Paul Herr	Prevention Specialist	Carbondale and Rural FPD
Phil Luebbert	Project Manager	JEO Consulting Group
Brooke Seachord	Project Coordinator	JEO Consulting Group
Grand Valley Rural Fire Protection District – October 25, 2021: 10:00am MT Virtual Meeting		
David Blair	Fire Chief	Grand Valley Rural FPD
Chris Jackson	Deputy Fire Chief	Grand Valley Rural FPD
Chad Whiting	Sergeant – Emergency Operations Sheriff's Office	Garfield County Sheriff's Dept.
Phil Luebbert	Project Manager	JEO Consulting Group
Brooke Seachord	Project Coordinator	JEO Consulting Group
Glenwood Springs Fire Protection District – October 25, 2021: 2:00pm MT Virtual Meeting		
Doug Gerrald	Battalion Chief/EMS Coordinator	Glenwood Springs FPD
Greg Bak	Fire Marshall	Glenwood Springs FPD
Gary Tillotson	Fire Chief	Glenwood Springs FPD
Phil Luebbert	Project Manager	JEO Consulting Group
Brooke Seachord	Project Coordinator	JEO Consulting Group
Colorado River Fire Protection District – November 2, 2021; 10:00am MT Virtual Meeting		
Orrin Moon	Fire Marshall	CRFR
Phil Luebbert	Project Manager	JEO Consulting Group

Name	Title	Jurisdiction
Brooke Seachord	Project Coordinator	JEO Consulting Group

Plan Implementation and Progress Monitoring

This Hazard Mitigation Plan must be a living document. To ensure this, the plan must be monitored, evaluated, and updated on a five-year or less cycle. This includes incorporating the mitigation plan into county and local comprehensive or capital improvement plans as they stand or are developed. *Section Six: Plan Implementation and Maintenance* describes the system that jurisdictions participating in the Garfield County HMP have established to monitor the plan; provides a description of how, when, and by whom the HMP process and mitigation actions will be evaluated; presents the criteria used to evaluate the plan; and explains how the plan will be maintained and updated.

Public Review

Once the draft of the HMP was completed, a public review period was opened to allow for participants and community members at large to review the plan and provide comments and changes, if any at that time. The public review period was open from March 28, 2022 through April 25, 2022. Participating jurisdictions were emailed and mailed a letter notifying them of this public review period as well as an electronic copy of the plan. The HMP was also made available on the County website for download. Comments and changes that were received were incorporated into the plan. Examples of these revisions included:

- New Castle – updates to critical facilities and medical facilities. General grammatical and name revisions for planning team members.
- Section Four: Avalanche – revisions to historical occurrences and description of past events.

Plan Adoption

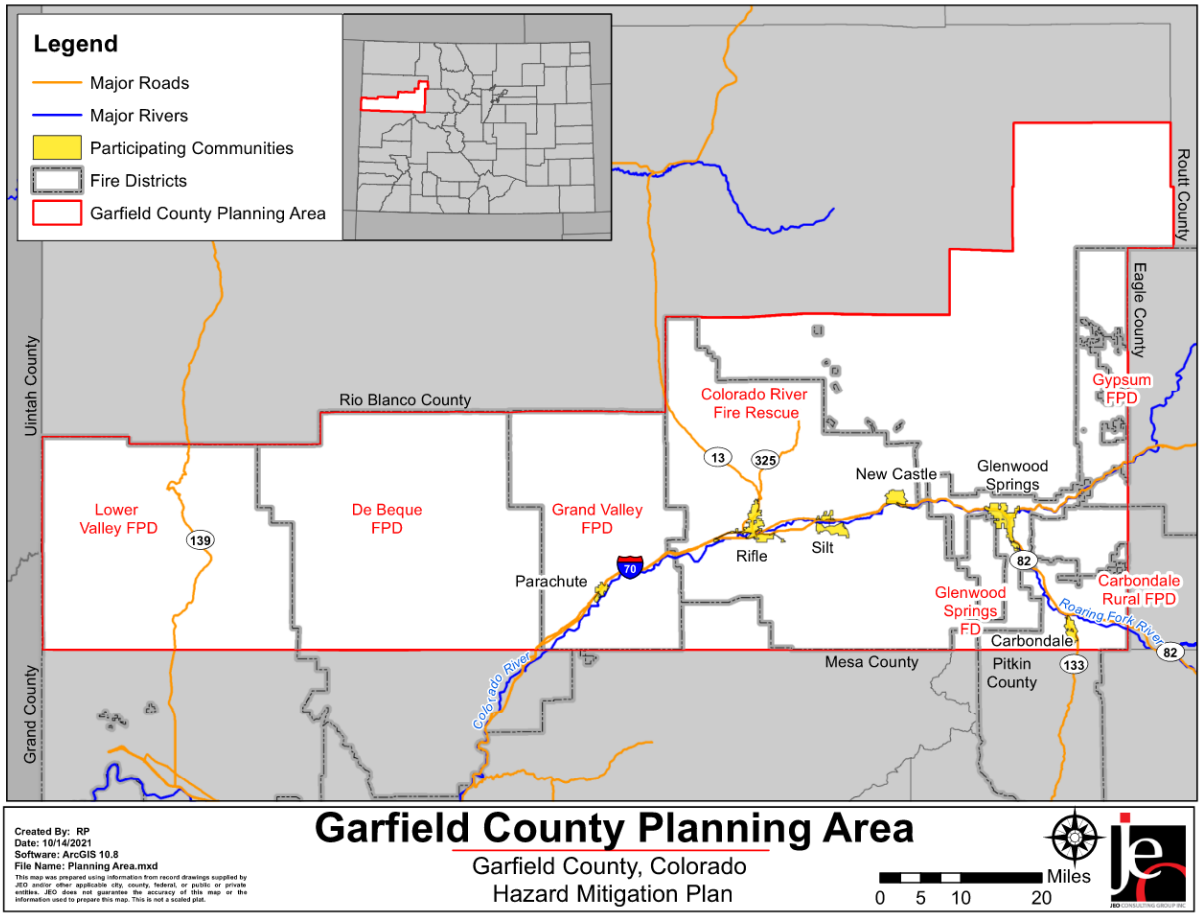
Based on FEMA requirements, this multi-jurisdictional hazard mitigation plan must be formally adopted by each participant's governing body through the approval of an *Adoption Resolution.* The approval creates 'individual ownership' of the plan by each participating entity. Formal adoption provides evidence of a participant's full commitment to implement the plan's goals, objectives, and action items. A copy of the resolution draft submitted to participating jurisdiction is located in Appendix A. Copies of adoption resolutions may be requested from the State Hazard Mitigation Officer.

HMPs need to be living documents. Once adopted, participants are responsible for implementing and updating the plan as described in their individual profile. Those who participated directly in the planning process would be logical champions for updating the plan. In addition, the plan will need to be reviewed and updated as projects are completed and particularly after major events occur. Additionally, HMPs should be integrated into other planning mechanism as they are reviewed and updated. This includes county and local comprehensive or emergency action plans as applicable.

Section Three: Planning Area Profile

This section provides a brief overview of the factors that make Garfield County unique, with a focus on the assets that the County wants to protect from the effects of natural disasters. They are described here in overview and the risk assessment provides details about how these assets overlap with geographic features within the County.

Figure 9: Planning Area



Environment and Geography

Garfield County is located in the northwest region of Colorado. Rio Blanco County borders Garfield County to the north. Routt and Eagle Counties form the eastern border. Pitkin and Mesa Counties lie to the south and the state of Utah (Grand and Uintah Counties) is the western boundary. The county seat and largest city is Glenwood Springs, Colorado, which is in the southeastern part of the County.

The County encompasses nearly 3,000 square miles, about 60 percent of which is federally owned.[14] The County is very geographically diverse: mountains, plateaus/mesas, canyons, the Colorado River, and the Roaring Fork rivers are the main geographical features. Mining, timber

[14] Garfield County, Colorado. "About Garfield County, Colorado." https://garfield-county.com/about-garfield-county/index.aspx .

harvesting and oil/gas extraction have somewhat altered the landscape of the County over time, as well as its vulnerability and risk to natural hazards.

Population and Demographics

According to the US Census Bureau estimates, the estimated population of Garfield County in 2019 was 59,055. At the time of this plan development, the U.S. 2020 census data was not available and is thus not included. The following table shows the population estimates from the U.S. Census Bureau for the county compared to the State of Colorado between 2000 and 2019.

Table 11: Population Change, 2000 to 2019

Jurisdiction	2000 Population	2010 Population	2019 Population (estimated)
Garfield County	43,791	54,761	59,055
State of Colorado	4,301,261	5,029,196	5,758,736

Source: U.S. Census Bureau

Table 12: Population Percentage by Cohort (2019)

Age	Planning Area	State of Colorado
<5	3,985 (6.7%)	327,302 (5.7%)
5 – 19	12,377 (21.0%)	1,076,153 (18.7%)
20 – 64	35,216 (59.7%)	3,509,903 (60.9%)
>64	7,477 (12.7%)	845,378 (14.6%)
Median Age	36.5	37.1

Source: U.S. Census Bureau

Between 2000 and 2019 the population of Garfield County increased by 25.8 percent, similar to the State growth rate of 25.3 percent.[15] In 2006, the Colorado State Demography Office projected that Garfield County's population would reach 146,271 by the year 2035, with a rapid increase in annual percentage change compared to most other counties in the State.[16] The county has experienced a steady increase in population, largely spurred by a growing natural gas extraction sector, tourism, and secondary homes. Approximately 49.0 percent of the population is female and 40.4 percent of the County's residents are either under the age of 20 or over 65 (27.7 percent and 12.7 percent respectively). The median age in the County is 36.5, making it a relatively young population.

Dependent children under 19 years old are one of the most vulnerable populations to disasters.[17] The majority of people in this age group do not have access to independent financial resources, transportation, or cellular telephones. They also lack practical knowledge necessary to respond appropriately during a disaster. As a result, this demographic group experiences increased vulnerability to the following list of hazards: high winds (especially daytime events during school year), wildfire, severe winter weather, water shortage created by drought, and hazardous material releases. Lack of awareness can at times be a concern for people in this age range as well as an inability to recognize and respond to environmental stimuli, which could lead to increased vulnerability to flooding (especially flash flooding) and wildfire.

[15] United States Census Bureau. "American FactFinder: Garfield County Colorado." [Data File: S0101: Age and Sex]. Accessed August 2021. https://data.census.gov/cedsci/.

[16] Office, Colorado State Demography. "Colorado Demography Homepage." Accessed August 2021. https://demography.dola.colorado.gov/ .

[17] Flanagan, Gregory, Hallisey, Heitgerd, & Lewis. 2011. "A Social Vulnerability Index for Disaster Management." Journal of Homeland Security and Emergency Management, 8(11): Article 3.

Despite this vulnerability, children are generally overlooked in disaster planning because the presence of a caretaker is assumed. With almost one third of the planning area's total population younger than 19, children are a key vulnerable group to address in the planning process. A significant portion of this subset are additionally children under the age of five, further exacerbating their vulnerability.

Schools house a high number of children within the planning area during the daytime hours of weekdays, as well as during special events on evenings and weekends. The following table identifies the various public school districts located within the county.

Table 13: Schools in Garfield County by District

School Name	Estimated Student Body
Roaring Fork RE-1 Student Body: 5,292	
Ambleside at Skylark School	Crystal River Elementary School
Basalt Elementary School	Glenwood Springs Elementary School
Basalt High School	Glenwood Springs High School
Basalt Middle School	Glenwood Springs Middle School
Blue Lake Preschool	Growing Years School
Bridges	Honey Tree
Campus Kids	Mount Sopris Montessori School
Carbondale Community Charter School	New Creation Preschool
Carbondale Middle School	Our School
Carbondale Rocky Mountain SER	Riverview School
Children's Mini College	Roaring Fork High School
Children's Rocky Mountain School Inc	Sopris Elementary School
CMC Start-Up Literacy Program	St Stephen Catholic School
Colorado Rocky Mountain School	Waldorf School on the Roaring Fork
Cornerstone Classical School	
Garfield Re-2 Student Body: 4,526	
Cactus Valley Elementary School	Highland Elementary School
Cactus Valley Elementary School	Highland Elementary School
Caring Kids Preschool	Kathryn Senor Elementary School
Caring Kids Preschool	Kathryn Senor Elementary School
Coal Ridge High School	Liberty Classical Academy
Coal Ridge High School	Liberty Classical Academy
Early Learners Center	Rifle High School
Early Learners Center	Rifle High School
Elk Creek Elementary	Rifle Middle School
Elk Creek Elementary	Rifle Middle School
Emmanuel Lutheran Preschool	Rifle Rocky Mountain SER
Emmanuel Lutheran Preschool	Rifle Rocky Mountain SER
Even Start	Riverside School
Even Start	Riverside School
Graham Mesa Elementary School	Wamsley Elementary School
Graham Mesa Elementary School	Wamsley Elementary School
Garfield 16 Student Body: 1,159	
Bea Underwood Elementary School	Grand Valley High School

School Name	Estimated Student Body
Bea Underwood Pre-School	Grand Valley Middle School
Grand Valley Center for Family Learning	Parachute Rocky Mountain SER

Source: Colorado Department of Education, 2020-2021

While natural hazards do not discriminate, the impacts -- in terms of loss and the ability to recover -- vary greatly, depending on demographic characteristics. The National Response Framework defines at-risk populations as "…populations whose members may have additional needs before, during, and after an incident in functional areas, including but not limited to: maintaining independence, communication, transportation, supervision, and medical care."[18] According to Peggy Stahl of FEMA's Preparedness, Training and Exercise Directorate, 80 percent of the disaster burden falls on the public, and women, children, minorities and the poor bear a disproportionate amount of this burden. The 2019 Census estimates noted that 8.6 percent of the County's residents were living below the poverty line. Residents below the poverty line may lack resources to prepare for, respond to, or recover from hazard events. Residents with limited economic resources will struggle to prioritize the implementation of mitigation measures over more immediate needs. Further, residents with limited economic resources are more likely to live in older, more vulnerable structures. These structures could be: mobile homes; located in the floodplain; located near know hazard sites (i.e. chemical storage areas); or older poorly maintained structures. Residents below the poverty line will be more vulnerable to all hazards within the planning area.

Similar to residents below the poverty line, racial minorities tend to have access to fewer financial and systemic resources that would enable them to implement hazard mitigation projects and to respond and recover from hazard events, including residence in standard housing and possession of financial stability. The planning area is primarily White alone, with little change in diversity since 2010. Small changes in racial inequity will likely not significantly affect the region's overall vulnerability to hazards.

Table 14: Racial Composition in Garfield County

Race	2010		2019		% Change
	Number	% of total	Number	% of total	
White alone	49,388	90%	50,055	86%	-4%
Black	404	1%	286	0%	-1%
American Indian & Alaskan Native	272	0%	400	1%	+1%
Asian	276	1%	532	1%	0%
Native Hawaiian & Other Pacific Islander	126	0%	30	0%	0%
Other Races	2,921	5%	5,843	10%	+5%
Two Or More Races	1,374	3%	1,131	2%	-1%
Total Population	**54,761**	**100%**	**59,055**	**100%**	**-**

Source: U.S. Census Bureau[19],[20]

The Center for Disease Control (CDC) has developed a Social Vulnerability Index to help public health officials and emergency responders identify communities at greater risk before, during, and after major hazardous events. The index evaluates 15 social factors and breaks down vulnerability

[18] United States Department of Homeland Security. June 2016. "National Response Framework Fourth Edition." https://www.fema.gov/media-librarydata/1572366339630-0e9278a0ede9ee129025182b4d0f818e/National_Response_Framework_4th_20191028.pdf .

[19] U.S. Census Bureau. 2019. "Race: 2018 ACS 5-year estimates." https://factfinder.census.gov/faces/nav/jsf/pages/searchresults.xhtml?refresh=t# .

[20] U.S. Census Bureau. 2019. "Race: 2010 ACS 5-year estimate." https://factfinder.census.gov/faces/nav/jsf/pages/searchresults.xhtml?refresh=t# .

into four domains: socioeconomic status; household composition and disability; minority status and language; housing and transportation. Several of these factors have been discussed in more depth earlier in this section. Garfield County's Social Vulnerability Index score was rated as 0.351 which translates to a low to moderate vulnerability level in 2018.

Land Use and Development

One unique characteristic of Garfield County is its urban/rural divide: the western area of the County is sparsely populated while the major population and economic activity centers are in the central section along the Colorado River / I-70 corridor. This development pattern results in an overall low density in the County, 19.9 people per square mile.

The Census Bureau estimates that the County has about 24,001 housing units with an 10.4 percent vacancy rate and 66.9 percent owner occupancy rate, putting Garfield County on par with Colorado rates (9.3 percent and 65.9 percent, respectively). Garfield County completed a Property Assessment Study in 2019 which noted Garfield County had a strong ranching and farming heritage, but all communities within the county have grown into bedroom communities for the expanding Aspen skiing economy.[21] It is worth noting that Pitkin County to the south of Garfield County has two primary skiing communities, Aspen and Snowmass Village, which are primary employment areas for Garfield County residents. Thus many residents who work in Pitkin County reside within Garfield County.

The 1990's residential development boom in Garfield County led to construction became a leading employment sector. The availability and affordability of housing spurred development and attracted residents from nearby counties such as Eagle and Pitkin.[22]

The vast majority of homes in the planning area were built between 2000 and 2009 (Figure 10). Housing age can serve as an indicator of risk, as structures built prior to building codes being developed may be more vulnerable. According to the Department of Housing and Urban Development (HUD), older homes are at greater risk of poor repair and dilapidation resulting in blighted or substandard properties. Residents living in these homes maybe at higher risk to the impacts of high winds, tornadoes, severe winter storms, and thunderstorms. While the State of Colorado has not adopted a standardized home building code, Garfield County adopted the 2015 International Building Code in July 2016.

[21] Wildrose Appraisal Incorporated. September 2019. "2019 Garfield County Property Assessment Study." https://www.garfield-county.com/assessor/filesgcco/sites/3/2019/11/2019-Garfield-County-Property-Assessment-Study.pdf.

[22] BBC Research & Consulting. June 2006. "Garfield County Land Values and Solutions Study." https://www.garfield-county.com/oil-gas/wp-content/uploads/sites/24/2019/08/2006-Land-Values-Study.pdf.

Figure 10: Housing Age in Garfield County

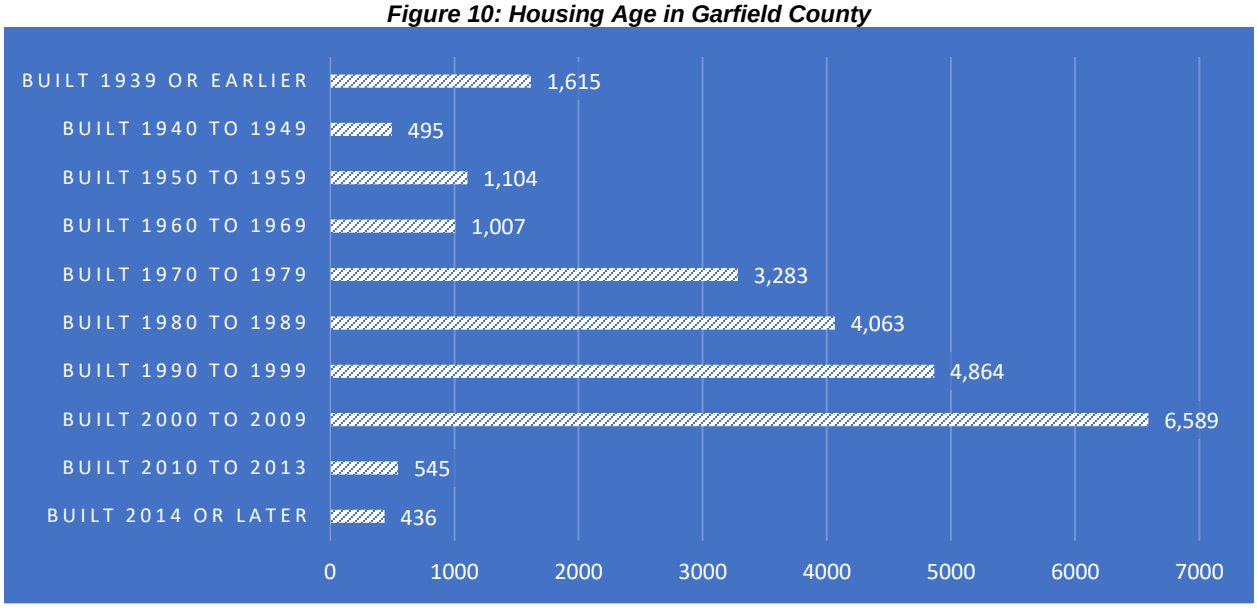


Figure 11: Land Cover in Garfield County

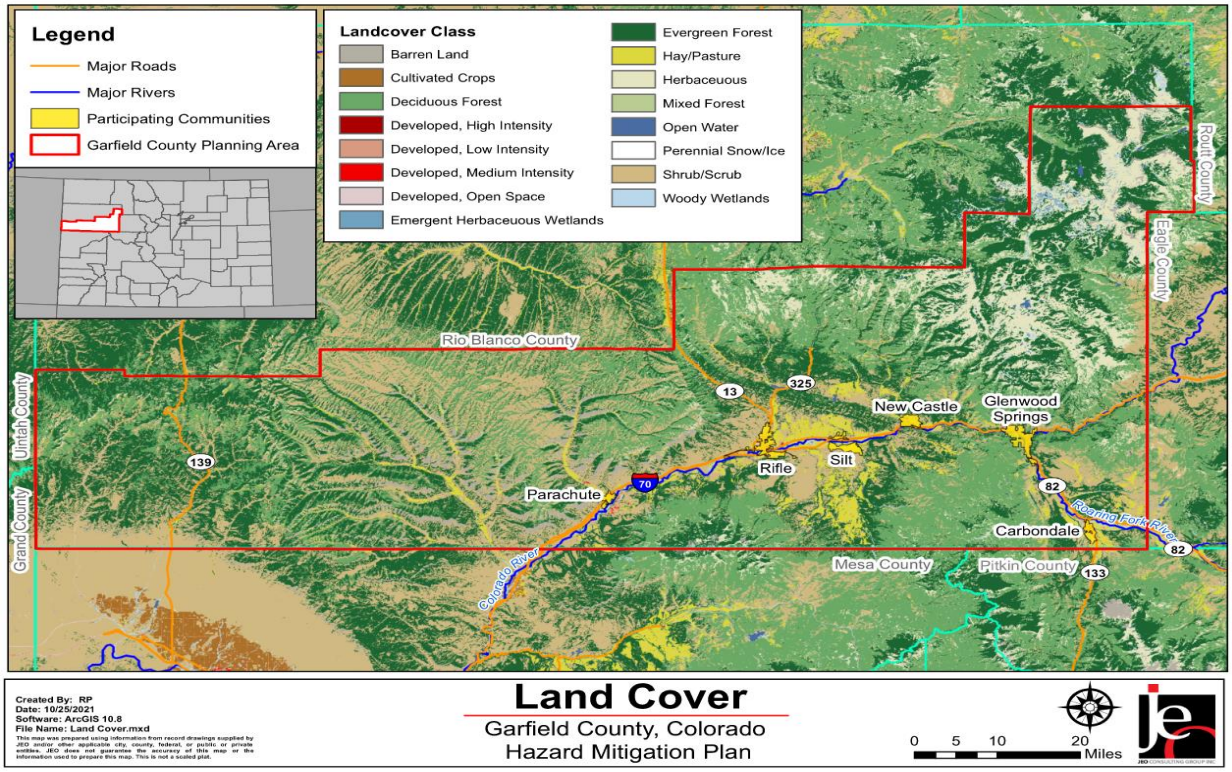
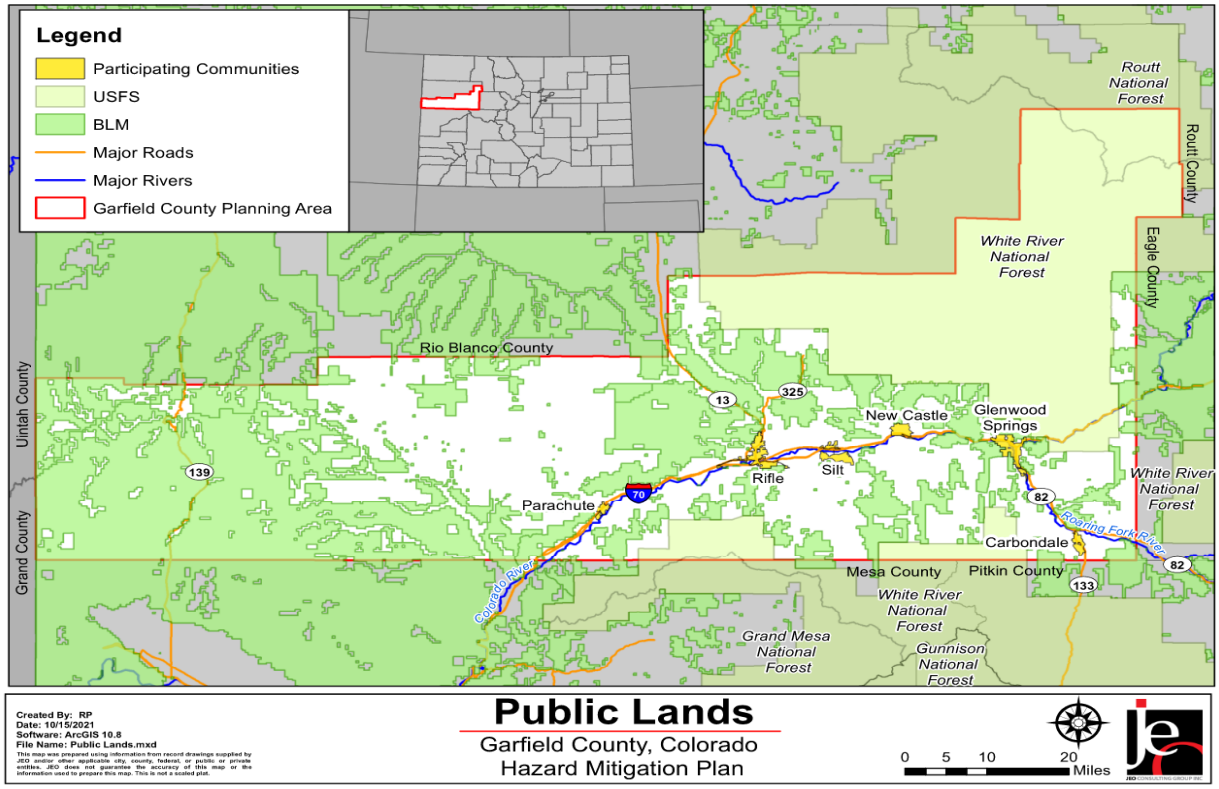


Figure 12: State Owned Land in Garfield County



Economy

The top industries in Garfield County are energy development, tourism, ranching, and farming. These economic characteristics of the County demonstrate the County's dependence on the land and natural resources.

The top employment sectors in the County in 2019 according to the U.S. Census Bureau were educational service and health care and social assistance (18.7 percent), construction (15.6 percent), arts, entertainment, recreation, accommodation and food (12.4 percent) and retail trade (11.1 percent).

A 2007 socio-economic assessment noted that steady unemployment between 1997 and 2005, even accounting for workforce growth, reflected a strong local economy.[23] The 2006 Land Values Study also identified three economic regions of the County roughly approximated as the western half (rural, sparsely populated, mostly public lands), the eastern/midsection of the County (I-70 Corridor through five municipalities supporting the majority of county residents and their needs) and the southeastern corner (geographically and, therefore, economically) aligned with the resort and recreation service sector of the region that is anchored by Aspen and Pitkin Counties. Impacts of a disaster event should also be considered in terms of their effect on individual income. Garfield County's median household income in 2019 was $75,937.

Transportation

I-70 runs through the southern part of the County, creating a population and economic corridor and providing a direct route to Denver (about 3 hours from Glenwood Springs). State Highway

[23] Redifer, J., Jouflas, G., Chase, T., & Morris, S. September 2007. "Socioeconomic Impacts of Growth." Mesa State College Natural Resource and Land Policy Institute.

139 runs north/south through the County's western section and State Highway 13 divides the County vertically. State Highway 82 runs from Glenwood springs through Carbondale and the southeastern corner of the County, connecting to Pitkin County and Aspen.

Garfield County is a corridor of commerce in western Colorado and hazardous materials are commonly transported through the County by truck and rail transport. Hazardous materials travels along Highways 139 and 13, and Interstate 70. Additionally, the Union Pacific Railroad operates rail lines along the Colorado River through the County. Mean travel time to work in 2019 was 32.3 minutes, suggesting that many residents travel to other communities for work, or live far from employment centers. Therefore, the County's Road system is critical to its economy.

Infrastructure and Critical Facilities

Critical facilities and infrastructure are vital to the continued delivery of key governmental and private services as well as recovery efforts. The loss of these services significantly impacts the public's ability to recover from a disaster event. Critical facilities were identified originally during the 2017 HMP and were reviewed during the 2022 HMP update. Critical facilities were identified to align with FEMA's Community Lifelines approach. These lifelines and their subcomponents include, but are not limited to:

- Safety and Security – law enforcement, fire services, search and rescue, government services, and community safety buildings
- Food, Water, & Shelter
- Health and Medical – medical care, patient movement, public health, fatality management, and medical supply chain
- Energy – power (grid) and fuel centers
- Communications – infrastructure, alerts/warnings/messages, 911 call centers, responder communications, and finance
- Transportation – highway/roadways, mass transit, railway, aviation
- Hazardous Materials – Tier II facilities and HAZMAT

Facilities that may cause secondary impacts if damaged, contaminated, or destroyed, such as hazardous materials storage sites, are also considered critical facilities. Community specific critical facilities are summarized and mapped in each jurisdiction's section of the plan. The main critical infrastructure in Garfield County is summarized below. Note that due to security concerns for some specific types of critical facilities, not all facilities are mapped.

The following table and figure provide a summary of the critical facilities for Garfield County and whether they are in known hazard areas. This does not constitute a comprehensive list of facilities. In some cases the local planning team choose not to map certain facilities from a security standpoint. Critical facilities should be reviewed and updated regularly by the local planning team during the annual review. See *Section Four: Risk Assessment* to view an in-depth discussion of Garfield County's risk to hazards.

As the majority of critical facilities are located within the WUI, risk to wildfire events was determined based on the Mean Fire Return Interval categories based on the following breakdown:

- High Risk – 0 to 5 years return interval
- Significant Risk – 5 to 10-year return interval
- Moderate Risk – 10 to 25-year return interval
- Low Risk – 25+ year return interval

Table 15: Safety and Security Lifelines

	Components	#	Critical Facility	Hazard Type Concerns and Notes
Safety and Security	Law Enforcement Security	1 - 2	Garfield County Sheriff Annex	Located in collapsible soil hazard area Significant Fire Risk
		3	Garfield County Criminal Justice Services	In Soils Concern area Significant Fire Risk
		4	Rifle Correctional Center	Localized flooding concerns Moderate Fire Risk
	Fire Service	5 - 7	Grand Valley Fire Protection District – Stations 31, 32, and 33	Station 32 located in Rifle Dam Inundation Area Stations 32 and 33 located in Ruedi Dam Inundation Area All stations located in collapsible soil hazard area All stations - Low Fire Risk
		8 - 13	Colorado River Fire Rescue	Located in Rifle Dam Inundation Area Located in Ruedi Dam Inundation Area Located in collapsible soil hazard area Moderate to Significant Fire Risk
		14 -16	Glenwood Springs Fire Rescue	Significant Fire Risk Located in Ruedi Dam Inundation Area Located in collapsible soil hazard area
		17 - 21	Carbondale and Rural Fire Protection District	Moderate Fire Risk Station 82 (#17) in Floodplain Located in collapsible soil hazard area
	Search and Rescue	22	Garfield County Search and Rescue	Located in collapsible soil hazard area Significant Fire Risk
	Government Service	23	Garfield County Administration	Located in Ruedi Dam Inundation Area Moderate Fire Risk
		24	Garfield County Clerk & Recorder Glenwood Springs	Moderate Fire Risk
		25	Garfield County Courthouse	Moderate Fire Risk
		-	Local Schools	Not mapped – Full list Table 13
	Community Safety	26	Garfield County Landfill	Moderate Fire Risk Located in collapsible soil hazard area
		27	South Canyon Municipal Landfill	Significant Fire Risk Landslides, Soils Located in collapsible soil hazard area
		28	Rifle Gap Dam	Flooding Dam Failure Located in collapsible soil hazard area Moderate Fire Risk

Table 16: Food, Water, and Shelter Lifelines

	Components	#	Critical Facility	Hazard Type Concerns and Notes
Food, Water, Shelter	Food	-	Grocery Stores	Not Mapped Blocked transportation routes
	Water	29	Wastewater Treatment Plant	Located in collapsible soil hazard area Moderate Fire Risk

		-	Drinking Water Utilities	Not mapped Landslides, Flooding
	Shelter*	-	-	-

**Specific shelter locations are not identified here. Shelter activation is determined based on the event occurring. Schools, community centers, or fairgrounds may be used as needed. Private agreements are in place between Garfield County and Red Cross.*

Table 17: Health and Medical Lifelines

	Components	#	Critical Facility	Hazard Type Concerns and Notes
Health and Medical	Medical Care	30	Valley View Hospital	Moderate Fire Risk
		31	Grand River Health Hospital & Grand River Primary Care	Located in collapsible soil hazard area Moderate Fire Risk
		32	Ascendigo Autism Services (IDD Facility)	Located in Ruedi Dam Inundation Area Significant Fire Risk
		33	Bookcliffs House (IDD Group Home)	Moderate Fire Risk
		34	Chateau at Rifle (Assisted Living Residence)	Moderate Fire Risk Located in collapsible soil hazard area
		35	CO State Veterans Nursing Home (Nursing Home)	Moderate Fire Risk
		36	Columbine House (IDD Group Home)	Moderate Fire Risk
		37	Glenwood Springs Healthcare (Nursing Home)	Located in collapsible soil hazard area Moderate Fire Risk
		38	Grand Avenue Group Home (IDD Group Home)	Located in collapsible soil hazard area Moderate Fire Risk
		39	Grand River Health Care Center (Nursing Home)	Moderate Fire Risk
		40	Grand River Health Clinic West (Rural Health Clinics)	Located in collapsible soil hazard area Moderate Fire Risk
		-	Here to There Home Health Care LLC (Home Care Agency)	Not mapped
		41	Heritage Park Assisted Living (Assisted Living Residence)	Significant Fire Risk
		42	Heritage Park Care Center (Nursing Home)	Significant Fire Risk
		43	Home Care and Hospice of the Valley (Home Care Agency)	Located in Ruedi Dam Inundation Area Located in collapsible soil hazard area Moderate Fire Risk
		44	Life Resources LLC (IDD Facility)	Moderate Fire Risk
		45	Mesa View (IDD Group Home)	Moderate Fire Risk

		46	Mesa Vista Assisted Living Residence (Assisted Living Residence)	Moderate Fire Risk Located in collapsible soil hazard area
		47	Mike's Place (IDD Facility)	Significant Fire Risk Located in Ruedi Dam Inundation Area
		48	Mountain Family Health Centers – Rifle (Federally Qualified Health Center)	Moderate Fire Risk Located in Rifle Dam Inundation Area Located in collapsible soil hazard area
		49	Mountain Valley Development Services (IDD Facility)	Moderate Fire Risk Located in collapsible soil hazard area
		50	Oakhurst House (IDD Group Home)	Moderate Fire Risk Located in collapsible soil hazard area
		51	Pitkin House (IDD Group Home)	Located in Ruedi Dam Inundation Area Located in collapsible soil hazard area Significant Fire Risk
		52	Pursuejoy LLC (IDD Facility)	Located in Floodplain Located in Rifle Dam Inundation Area Located in Ruedi Dam Inundation Area Moderate Fire Risk
		53	Renew Roaring Fork (Assisted Living Residence)	Located in Ruedi Dam Inundation Area Located in collapsible soil hazard area Moderate Fire Risk
		-	Roaring Fork Home Care (Home Care Agency)	Not mapped
		54	Sopris Home Care LLC (Home Care Agency)	Located in collapsible soil hazard area Significant Fire Risk
		55	Sopris House (IDD Group Home)	Located in collapsible soil hazard area Moderate Fire Risk
		56	Sopris Lodge at Carbondale (Assisted Living Residence)	Located in Ruedi Dam Inundation Area Significant Fire Risk
		57	Splendor Services (IDD Facility)	Located in Ruedi Dam Inundation Area Located in collapsible soil hazard area Moderate Fire Risk
		58	Vista House (IDD Group Home)	High Fire Risk

		59	Yampah House (IDD Group Home)	Located in collapsible soil hazard area Moderate Fire Risk
	Fatality Management	60	Garfield County Coroner's Office	Located in Ruedi Dam Inundation Area Moderate Fire Risk
	Public Health	61	Garfield County Public Health Dept	Moderate Fire Risk

**IDD – intellectual and developmental disabilities*

Table 18: Energy Lifelines

	Components	#	Critical Facility	Hazard Type Concerns and Notes
Energy	Power Grid	62	Shoshone Hydroelectric Facility	
		63	Holy Cross Energy	Infrastructure not mapped Located in collapsible soil hazard area Located in Ruedi Dam Inundation Area Moderate Fire Risk Located in Floodplain
		64	Xcel Energy	Infrastructure not mapped Located in collapsible soil hazard area Moderate Fire Risk Landslides
	Fuel	-	Gas/Fuel Stations	Not mapped Chemical Spills

Table 19: Communications Lifelines

	Components	#	Critical Facility	Hazard Type Concerns and Notes
Communications	Infrastructure	-	Cell Towers	Not mapped Moderate Fire Risk
	Alerts, Warnings, and Messages / 911 and Dispatch	65	Garfield County Emergency Communications Authority	Moderate Fire Risk

Table 20: Transportation Lifelines

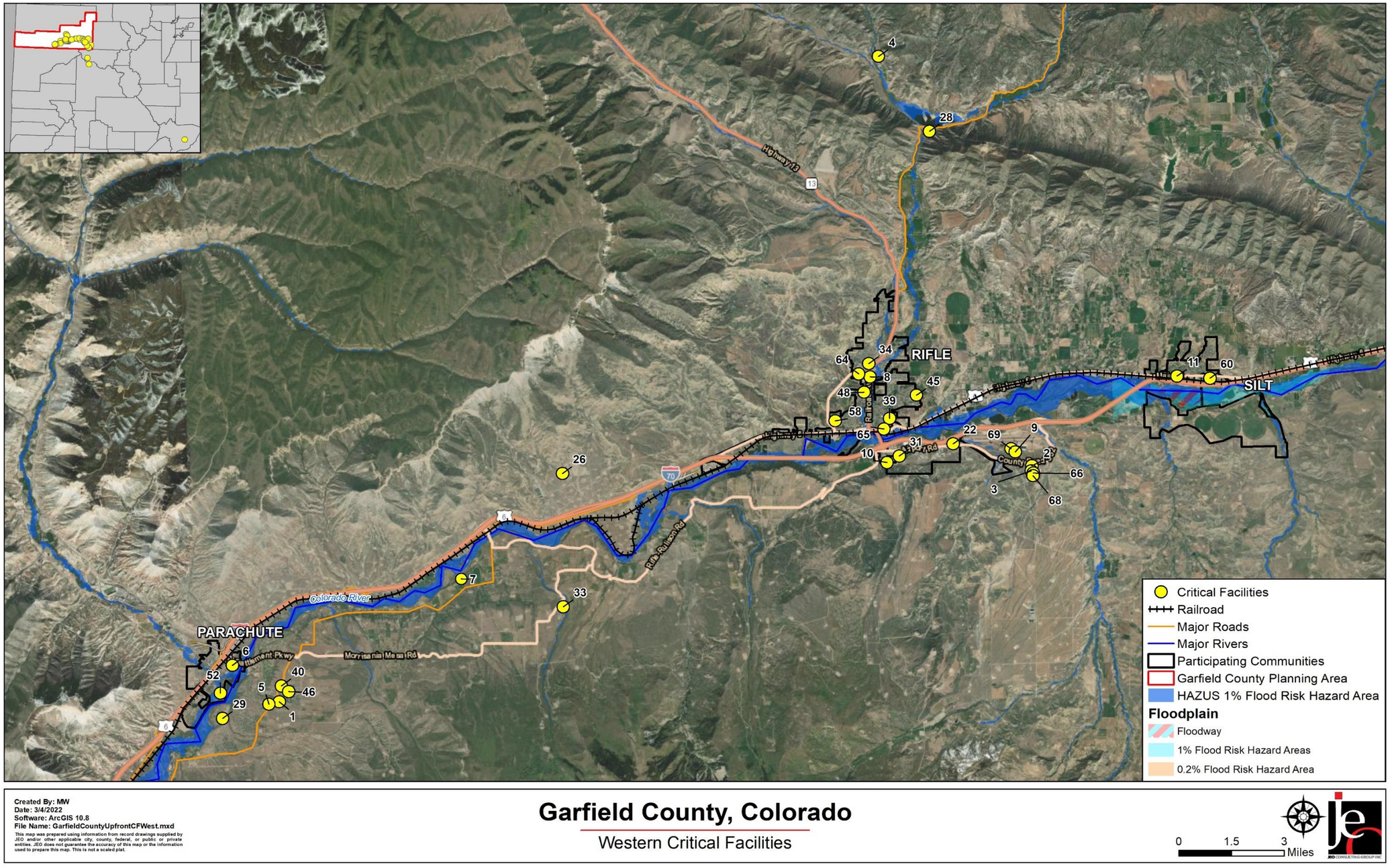
	Components	#	Critical Facility	Hazard Type Concerns and Notes
Transportation	Highway	-	Interstate 70	Not Mapped Landslides, Expansive Soils, Avalanche
		-	Colorado Highways 13, 6, 82, 133	Not mapped Landslides, Expansive Soils, Avalanche
		66	Garfield County Road & Bridge Administration – District 2-3 Facilities	Located in collapsible soil hazard area Moderate Fire Risk
		67	Garfield County Road and Bridge District 1 Facility	Located in collapsible soil hazard area Located in Ruedi Dam Inundation Area Significant Fire Risk
		68	Garfield County Road & Bridge Motor Pool	Moderate Fire Risk
	Aviation	69	Rifle Garfield County Airport	Located in collapsible soil hazard area Significant Fire Risk
	Railway	-	Denver and Rio Grande Western Railroad	Passenger and Freight trains Avalanche, Landslides, Flooding

Table 21: Hazardous Materials Lifelines

	Components	#	Critical Facility	Hazard Type Concerns and Notes
Hazardous Materials	Facilities	-	Tier II Facilities throughout county – not mapped	Not mapped Hazardous Material Release Some facilities in floodplain and moderate fire risk areas
	HAZMAT, Pollutants, Contaminants	-	Sites not mapped – HAZMAT response team from Grand Junction	Not mapped Hazardous Material Release; Blocked transportation routes Some facilities in floodplain and moderate fire risk areas

THIS PAGE INTENTIONALLY BLANK

Figure 13: Critical Facilities (Western Portion of County)



Created By: MW
Date: 3/4/2022
Software: ArcGIS 10.8
File Name: GarfieldCountyUpfrontCFWest.mxd

This map was prepared using information from record drawings supplied by JEO and/or other applicable city, county, federal, or public or private entities. JEO does not guarantee the accuracy of this map or the information used to prepare this map. This is not a scaled plat.

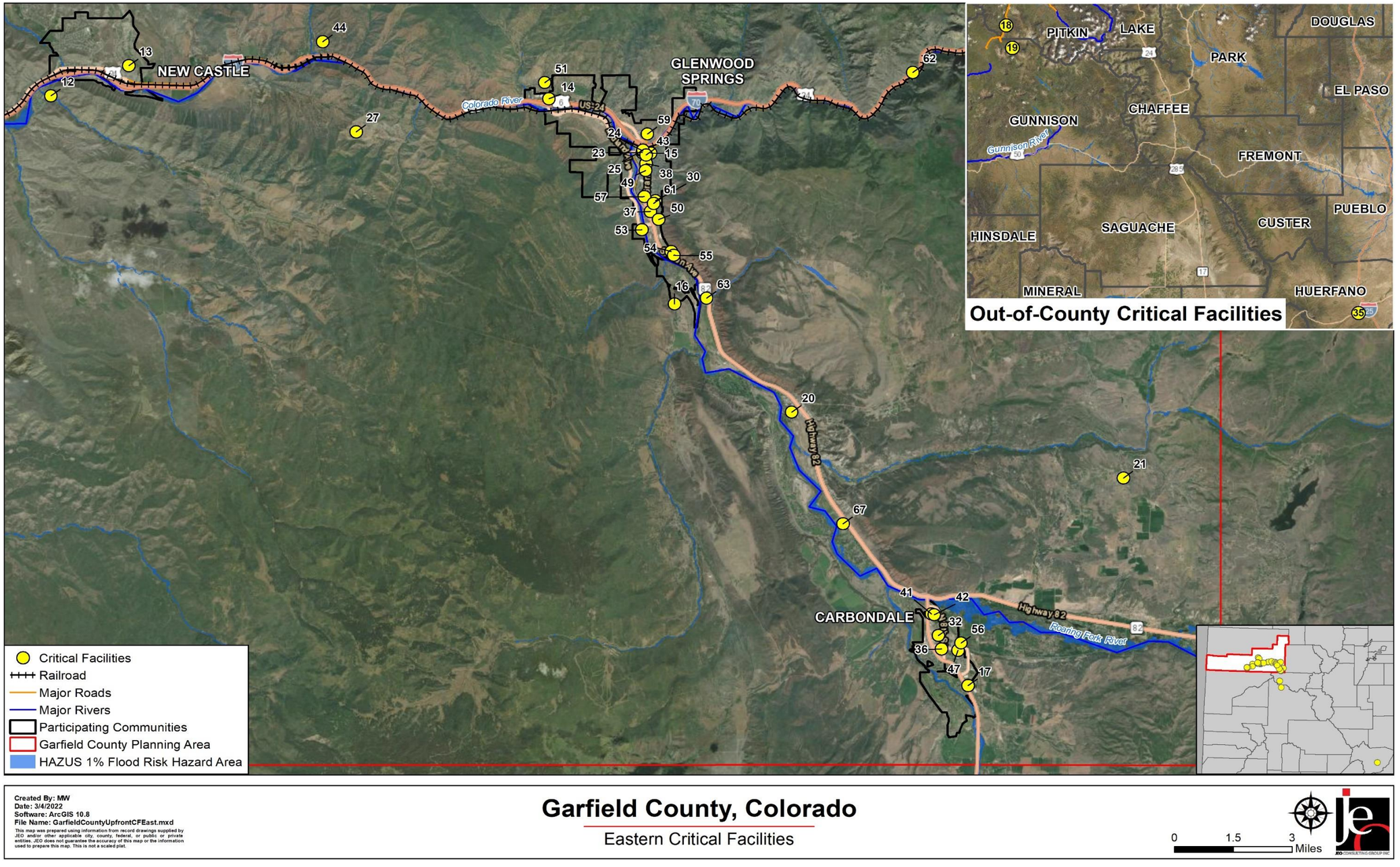
Garfield County, Colorado

Western Critical Facilities

0 1.5 3 Miles

THIS PAGE INTENTIONALLY BLANK

Figure 14: Critical Facilities (Eastern Portion of County)



THIS PAGE INTENTIONALLY BLANK

Cultural and Historic Assets

The historic Hotel Colorado has been operating in Glenwood Springs since 1893. The hotel earned the nickname of “the little White House of the West” after extended visits by Presidents Theodore Roosevelt and William Howard Taft. According to legend, the teddy bear was invented during President Roosevelt’s 1905 visit when hotel maids pieced together a stuffed bear for the President after an unsuccessful day of hunting. The Hotel Colorado was listed in the National Register of Historic Places in 1977 in recognition of its colorful past and architectural significance.[24]

Yampah Hot Springs vapor caves are underground steam baths found along the Colorado River. The springs were used by the Ute Indians for rejuvenation and healing properties. Today, the hot springs and mineral caves are prime tourism attractions. Local hotel resorts and spas use the hot springs as a main attractor for visitors.

Sunlight ski area encompasses a summit on Compass Mountain in the White River National Forest. The resort area features 67 trails covering over 470 acres as well as one of the steeper ski runs in the state.

The following table summarizes all of the sites on the National Register of Historic Places located within Garfield County.

Figure 15: Hotel Colorado in Glenwood Springs

Source: Google Images, 2017

Table 22: Historic Sites in Garfield County

Historic Site	Address	Date Listed
Battlement Mesa		
Battlement Mesa Schoolhouse	7201 300 Rd	4/21/1983
Carbondale		
Holland-Thompson Property	1605 Co 133	7/23/2013
Missouri Heights School	Cty Rd. 102	9/23/1999
Satank Bridge	Cty Rd. 106	2/4/1985
Glenwood Springs		
Canyon Creek Schoolhouse	0566 Cty Rd. 137	1/6/2004
Cardiff Coke Ovens	Co. Tr. 116	11/15/1996
Citizen’s National Bank Building	801 Grand Ave	7/15/1999
Earnest Ranch	6471 Co. Rd. 117	4/1/1998

[24] National Parks Service. "National Register of Historic Places." Accessed 2017. https://npgallery.nps.gov/nrhp.

Historic Site	Address	Date Listed
Glenwood Springs Hydroelectric Plant	601 6th St	10/14/1998
Hotel Colorado	526 Pine St.	5/26/1977
Shelton-Holloway House	115 5th St	8/11/1993
South Canon Bridge	Cty Rd. 134	2/4/1985
Starr Manor	901 Palmer Ave	6/20/1986
Sumers Lodge	1200 Mountain Dr.	6/20/1997
Edward T. Taylor House	903 Bennett Ave.	10/14/1986
Western Hotel	716 Cooper Ave	3/15/2016
Parachute		
Wasson-McKay Place	259 Cardinal Way	8/5/2010
Rifle		
Havemeyer-Willcox Canal Pumphouse	West of Rifle	4/22/1980
Rifle Bridge	Off SR 6/24 over Colorado River	2/4/1985
Rifle Post Office	Railroad Ave & 4th St	1/24/1986
Silt		
John Herbert Nunns House	311 N 7th St	12/3/2013

Source: National Register of Historical Place, 2021[25]

[25] National Park Service. 2021. "National Register of Historic Places." https://www.nps.gov/subjects/nationalregister/index.htm.

Section Four: Risk Assessment

Introduction

The ultimate purpose of this Multi-Jurisdictional Hazard Mitigation Plan is to minimize the loss of life and property across the planning area. The basis for the planning process is both the county overall and community specific local risk assessments. This section contains a description of hazards identified by the regional planning team of concern, regional vulnerabilities and exposures, probability of future occurrences, and potential impacts and losses. By conducting a risk assessment, participating jurisdictions can develop specific strategies to these hazards identified through this process. The following table defines terms that will be used throughout this section of the plan.

Table 23: Term Definitions

Term	Definition
Hazard	A potential source of injury, death, or damages
Asset	People, structures, facilities, and systems that have value to the community
Risk	The potential for damages, loss, or other impacts created by the interaction of hazards and assets
Vulnerability	Susceptibility to injury, death, or damages to a specific hazard
Impact	The consequence or effect of a hazard on the community or assets
Historical Occurrence	The number of hazard events reported during a defined period of time
Extent	The strength or magnitude relative to a specific hazard
Probability	Likelihood of a hazard occurring in the future

Methodology

The risk assessment methodology utilized for this plan follows the risk assessment methodology outlined in the FEMA Local Mitigation Planning Handbook. This process consists of four primary steps:

1. Describe the hazard
2. Identify vulnerable community assets
3. Analyze risk
4. Summarize vulnerability

When describing the hazard, this plan will examine the following items: previous occurrences of the hazard within the

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

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

Requirement §201.6(c)(2)(i): The risk assessment shall include a] description of the … location and extent of all natural hazards that can affect the jurisdiction. The plan shall include information on previous occurrences of hazard events and on the probability of future hazard events.

Requirement §201.6(c)(2)(ii): The risk assessment shall include a] description of the jurisdiction's vulnerability to the hazards described in paragraph (c)(2)(i) of this section. This description shall include an overall summary of each hazard and its impact on the community.

Requirement §201.6(c)(2)(ii): The risk assessment] must also address National Flood Insurance Program (NFIP) insured structures that have been repetitively damaged by floods.

Requirement §201.6(c)(2)(ii)(A): The plan should describe vulnerability in terms of the types and numbers of existing and future buildings, infrastructure, and critical facilities located in the identified hazard area.

Requirement §201.6(c)(2)(iii): For multi-jurisdictional plans, the risk assessment must assess each jurisdiction's risks where they vary from the risks facing the entire planning area.

planning area; locations where the hazard has occurred in the past or is likely to occur in the future; extent of past events and likely extent for future occurrences; and probability of future occurrences. While the identification of vulnerable assets will be conducted across the entire planning area, *Section Seven* will discuss community-specific assets at risk for relevant hazards. Analysis for regional risk will examine historic impacts and losses and what is possible should the hazard occur in the future. Risk analysis will include both qualitative (i.e. description of historic or potential impacts) and quantitative data (i.e. assigning values and measurements for potential loss of assets). Finally, each hazard identified the plan will provide a summary statement encapsulating the information provided during each of the previous steps of the risk assessment process.

For each of the hazards profiled the best and most appropriate data available will be considered. Further discussion relevant to each hazard is discussed in the hazard profile portion of this section.

Average Annual Damages and Frequency

FEMA ***Requirement §201.6(c)(2)(ii) (B)*** suggests that when the appropriate data is available, hazard mitigation plans should also provide an estimate of potential dollar losses for structures in vulnerable areas. This risk assessment methodology includes an overview of assets at risk and provides historic average annual dollar losses for all hazards for which historic event data is available. Additional loss estimates are provided separately for those hazards for which sufficient data is available. These estimates can be found within the relevant hazard profiles.

Average annual losses from historical occurrences can be calculated for those hazards for which there is a robust historic record and for which monetary damages are recorded. There are three main pieces of data used throughout this formula.

- **Total Damages in Dollars:** This is the total dollar amount of all property damages and crop damages as recorded in federal, state, or local data sources. The limitation to these data sources is that dollar figures usually are estimates and often do not include all damages from every event, but rather only officially recorded damages from reported events.
- **Total Years of Record:** This is the span of years there is data available for recorded events. Periods of record for data is supplied where appropriate.
- **Number of Hazard Events:** This shows how often an event occurs. The frequency of a hazard event will affect how a community responds.

An example of the event damage estimate is found below:

$$Annual\ Damages\ (\$) = \frac{Total\ Damages\ in\ Dollars\ (\$)}{Total\ Years\ Recorded\ (\#)}$$

Annual probability can be calculated based on the total years of record and the total number of years in which an event occurred. An example of the annual probability estimate is found below:

$$Annual\ Probability\ (\%) = \frac{Total\ Years\ with\ an\ Event\ Recorded(\#)}{Total\ Years\ of\ Record\ (\#)}$$

Data for all the hazards are not always available, so only those with an available dataset are included in the loss estimation.

Hazard Identification

The identification of relevant hazards for Garfield County began with a review of the 2017 Garfield County NHMP and the 2018-2023 Colorado Hazard Mitigation Plan. The Garfield County Planning Team reviewed the list of hazards addressed in the State Mitigation Plan and determined which hazards were relevant for discussion within the planning area.

A quantitative and qualitative analysis was used to determine the hazards that pose the greatest threat to Garfield County. This was done by examining the frequency of occurrence and historical damages associated with the known hazards as well as interviewing plan participants to determine the hazards of greatest concern. The following hazards were determined to be the hazards that pose the greatest threat to Garfield County:

- Wildfire
- Flooding
- Hazardous Materials
- Landslide/Debris Flow/Rockfall
- Hazardous Soils
- Winter Storms
- Drought
- Public Health Emergency

Both Drought and Public Health Emergency were newly identified Tier I hazards of concern for the 2022 HMP update.

The second tier of hazards are hazards that pose a threat to Garfield County but either do not occur as frequently or do not result in impacts as severe as the tier one hazards. These second tier hazards include:

- Avalanche
- Drought
- Earthquakes
- Erosion and Deposition
- Lightning
- Pest Infestation
- Severe Wind
- Terrorism

Several hazards are profiled in the State of Colorado's HMP which are not reviewed here. Given the location and history of the planning area, the following hazards were eliminated from further review. An explanation of how and why the hazards were eliminated is provided in the table below.

Table 24: Hazards Not Included in 2022 HMP

State HMP List of Hazards	Reasoning for Exclusion from 2022 Garfield County HMP
Animal Disease	Animal disease was not identified as a hazard of top concern due to the limited scope of agriculture in the county. Rather, local concerns are centered upon pest infestations in the county which are profiled in Section Four.

State HMP List of Hazards	Reasoning for Exclusion from 2022 Garfield County HMP
Chemical, Biological, Radiological, and Nuclear Attack	Chemical, biological, radiological, and nuclear events typically stem from racial tensions, political movements, or economic and labor disputes. However, this hazard is best addressed by other planning and funding mechanisms. No state emergencies related to these events have occurred in the county. Based on the discretion of the Planning Team, this hazard will not be profiled further in this plan. Terrorism is profiled in this plan with an emphasis on local concerns, capabilities, and cyber terrorism.
Cyber Attack	While this hazard is not specifically profiled, cyber attacks and cyber terrorism are discussed within the Terrorism profile.
Dam and Levee Failure	There are no federal levee systems located within the planning area. Dam failure events and potential impacts from them are discussed as appropriate within the Flooding profile in Section Four.
Dense Fog	While dense fog can occur within the planning area, this hazard was not identified as a top concern for the Regional Planning Team and will not be profiled in this plan.
Explosive Attack	This hazard is best addressed by other planning and funding mechanisms. No state emergencies related to explosive attacks have occurred in the county. Based on the discretion of the Planning Team, this hazard will not be profiled further in this plan.
Extreme Heat	The National Center for Environmental Information (NCEI) database did not record any instances of extreme heat in Garfield County, nor did the Spatial Hazard Events and Losses Database (SHELDUS) report any damages, or injuries due to extreme heat events in Garfield County. The number of 100F days is increasing across the county and country. If this trend continues, or Garfield County experiences impacts from extreme heat, this hazard may be profiled further in future updates to the plan. At this time the Regional Planning Team has determined not to profile this hazard.
Hail	According to the NCEI database, there have been 17 hail events from 1996 – 2021. There are no recorded damages associated with these events. Of the recorded hail events, the average hailstone diameter was 0.9 inches. Due to Garfield County's location and historical record, large damaging hail is unlikely to occur in the County.
Infrastructure Failure	This hazard is best addressed by other planning mechanisms and was not identified as a hazard of top concern for the local planning teams. Additionally Infrastructure Failure is commonly a product of other hazard type events.
Mine Accidents	This hazard is best addressed by other planning and funding mechanisms and was not identified as a hazard of top concern for the local planning teams.
Power Failure	This hazard is best addressed by other planning mechanisms and was not identified as a hazard of top concern for the local planning teams. Additionally Power Failure is commonly a product of other hazard type events.
Radiological Release	While the Rulison Blast Site is located approximately eight miles outside of Parachute, radioactivity in the area has remained constant and the site is maintained by the U.S. Department of Energy. At this

State HMP List of Hazards	Reasoning for Exclusion from 2022 Garfield County HMP
	time there are no other identified concerns for this hazard and it is not further profiled in this HMP.
Radon, Carbon Monoxide, Methane Seeps	This hazard is best addressed by other planning and funding mechanisms. No state emergencies related to these seeps have occurred in the county. Based on the discretion of the Planning Team, this hazard will not be profiled further in this plan.
Subsidence & Abandoned Mine Lands	Subsidence was identified as a hazard of concern and is included in the *Soils (Expansive Soils and Subsidence)* profile in Section Four. Abandoned Mine Lands was not identified as a hazard of concern and is not profiled in this plan. Bureau of Land Management (BLM) and the Colorado DNR Inactive Mine Reclamation Program primarily manage abandoned mines across the State of Colorado.
Thunderstorms and Lightning	Lightning was identified as a hazard of concern in the 2017 HMP and is profiled for 2022. However, while thunderstorms may occur in the planning area, impacts are typically limited and damages minor. Therefore this hazard was not identified as a top concern by the local planning teams.
Tornadoes	Tornadoes occur sporadically in the planning area and impacts are typically limited and damages minor. Therefore this hazard was not identified as a top concern by the local planning teams.
Wildlife-Vehicle Collisions	This hazard was not identified as a top concern by the local planning teams and is not profiled in this plan.

Hazard Assessment Summary Table

The following table provides an overview of the data contained in the hazard profiles. This table is intended to be a quick reference for people using the plan and does not contain source information. Full discussion of individual hazards are included within the hazard profiles.

Table 25: Regional Risk Assessment Summary

Hazard	Previous Occurrences	Approximate Annual Probability*	Likely Extent
Wildfire	2,320	26/26 = 100%	Range ~ <1acre to >10,000 acres. Average ~ 43 acres Evacuations of people may be necessary. Properties and infrastructure at risk.
Drought	477/1,4/1,518 months65 months	>34%	Mild (D0) to Moderate (D1)
Flooding	57	17/25 = 65%	Minor to moderate flooding with some inundation of structures and roads near rivers and streams. Evacuations of people may be necessary.
Hazardous Materials	313	32/32 = 100%	Avg spill ~397 liquid gallons (LGA)
Landslide, Mud/Debris Flow, Rockfall	21	10/62 = 16%	Limited property damage
Public Health Emergency	2 outbreak events	>1%	Varies by event; >1 fatality
Severe Winter Storms	2,581	26/26 = 100%	10-20°below zero (wind chills) 6-12” snow 25-40 mph winds
Avalanche	57	19/26 = 73%	0.5 – 5.0 ton /ft^2
Earthquakes	41	16/121 = 13%	Max ~4.0 mag Avg 2.6 – 3.0 mag
Erosion and Deposition	Unknown	Unknown	Varies by location/event
Lightning	4	3/26 100%^	Undefined
Pest Infestation	Unknown	100%	Undefined
Severe Wind	101	17/25 = 65%	9 BWF (avg. 58mph)
Soils	65	Assumed 100%	Limited damage to property and roadways
Terrorism	1	1/51 = 2%	Cybersecurity attack; magnitude varies by event

**Annual Probability = Total Years with an Event Occurrence / Total Years on Record*
^Lightning strikes likely occur annually but are not reported regularly unless producing damages/fatalities.
For data sources, refer to individual hazard profiles

Historical Disaster Declarations

The following tables show disaster declarations that have been granted within the planning area.

Table 26: State of Colorado Disasters 1980 - 2021

Year	Hazard	Location
2020	COVID-19	Statewide
2020	Wildfire (Pine Gulch)	Garfield County
2020	Wildfire (Grizzly Creek)	Garfield County
2013	Wildfire	Garfield County
2012	Wildfire	Garfield County
2010	Rockslide	I-70
2009	Severe Blizzard	Statewide
2009	Severe Spring Snowstorm	Statewide
2007	Rockfalls	I-70, US 6 Garfield, Clear Creek, Jefferson
2006	Wildfires-Multiple Executive Orders	Garfield, Teller, and Custer Counties
2006	Flooding	Douglas, Teller, Fremont, Pueblo, Garfield Counties
2003	Sinkhole	Interstate 70, Eagle County
2003	Snow Emergency	Statewide
2002	Wildfires	Statewide
2002	Drought	All Counties
1998	Landslides, Rockfalls	Archuleta, Garfield, Mesa, Gunnison, Rio Blanco
1994	Wildfires	Garfield, Delta, Douglas, Jefferson, Statewide
1987	Wildfire	Garfield
1984	Flooding	Delta, Dolores, Hinsdale, Saguache, Mesa, Montrose, Moffat, Rio Blanco, Pitkin, San Miguel, Ouray, Eagle, Gunnison, and Silt

Source: Colorado Division of Homeland Security & Emergency Management, 2021

Table 27: Presidential Disaster and Emergency Declarations, 1977 - 2021

FEMA ID	Incident Name	Period	Individual Assistance	Public Assistance	HMGP
2698	Newcastle Fire	6/19/07 – 6/23/07	None	Category B	None
2672	Red Apple Fire	8/31/06-9/3/06	None	Category B	None
3224	Hurricane Katrina Evacuation	8/29/05-10/1/05	None	Category B	None
2457	Panorama Fire	7/31/02-8/4/02	None	Category B	None
2419	Coal Seam Fire	6/8/02-6/29/02	None	Category B	None
1421	Colorado Wildfires	4/23/02-8/6/02	Yes	None	Yes
719	Severe Storms, Mudslides, Landslides, Flooding	7/27/84-7/27/84	None	Category A, B, C, D, E, F, G	None
3025	Drought	1/29/77	None	Category A, B	None
3436	COVID-19	1/20/20	None	Category B	None
4498	COVID-19 Pandemic	1/20/20	Yes	Category B	None
5334	Grizzly Creek Fire	8/10/20-8/26/20	None	Category B, H	None
5335	Pine Gulch Fire	8/19/20-9/2/20	None	Category B, H	None

Source: Federal Emergency Management Agency, Disaster Search, 2021[26]
Notes:* ***Individual Assistance* *is money or direct assistance to individuals, families and businesses in an area whose property has been damaged or destroyed and whose losses are not covered by insurance.* ***Public Assistance*** *is to provide assistance to State, Tribal and local governments, and certain types of Private Nonprofit organizations so that communities can quickly respond to and recover from major disasters or emergencies declared by the President. Public Assistance Categories: Category A: Debris Removal; Category B: Emergency Protective Work; Category C: Roads and bridges; Category D: Water Control Facilities; Category E: Buildings and Equipment; Category F: Utilities; Category G: Parks, Recreational Facilities, and Other Facilities. Individual Assistance*

Table 28: USDA Secretarial Disasters, 2003 - 2016

Year	Type	Declaration Number	Affected Counties
2003	Drought, Insects	S1843	Alamosa, Archuleta, Chaffee, Conejos, Costilla, Crowley, Custer, Dolores, Fremont, Garfield, Hinsdale, Huerfano, La Plata, Lake, Las Animas, Mesa, Mineral, Moffat, Montezuma, Otero, Pueblo, Rio Blanco, Rio Grande, Routt, Saguache
2004	Drought, Freeze, Hail	S1947	Baca, Chafee, Cheyenne, Custer, Eagle, Fremont, Garfield, Grand, Jackson, Kiowa, Kit Carson, Lake, Lincoln, Phillips, Pitkin, Prowers, Pueblo, Routt, Summit, Yuma
2006	Heat, High Winds, Drought	S2351	Eagle, Garfield, Larimer, Logan, Otero, Pitkin, Rio Blanco, Yuma
2012	Drought, Excessive Heat, High Winds	S3260	Statewide
2012	Drought	S3267, S3269, S3276, S3281, S3282, S3284, S3289, S3290, S3315, S3319, S3347	Statewide
2012	Freezing Conditions	S3307	Delta, Garfield, Gunnison, Mesa, Montrose, Ouray, Pitkin, San Miguel
2013	Drought	S3455, S3456, S3459, S3461, S3463, S3466	Statewide
2013	Drought	S3505, S3508, S3518, S3539	Statewide
2013	Drought	S3548	Eagle, Garfield, Grand, Lake, Pitkin, Routt, Summit
2013	Frost, Freezes	S3583	Delta, Garfield, Gunnison, Mesa, Montrose, Ouray, Pitkin, San Miguel

Source: USDA Disaster Designation, 2017[27]

[26] Federal Emergency Management Agency. "Disaster Declarations by State/Tribal Government." Accessed September 2021. https://www.fema.gov/disasters/state-tribal-government/CO?field_dv2_declaration_type_value=All .

27 United States Department of Agriculture: Farm Service Agency. "Disaster Designation Information." Accessed 2021. https://www.fsa.usda.gov/programs-and-services/disaster-assistance-program/disaster-designation-information/index .

Climate Adaptation

Long-term climate trends have shifted throughout the 21st century and have created significant changes in precipitation and temperature which have altered the severity and subsequent impacts from severe weather events. The communities and stakeholders in this HMP identified changes in the regional climate as a top concern residents, local economies, and infrastructure throughout the planning area. Discussions on temperature, precipitation, and climate impacts are included below.

Garfield County is located within the Southwest portion of the United States which encompasses Arizona, California, Colorado, New Mexico, Nevada, and Utah. These areas reflect a broad range of climate conditions including the hottest and driest climates in the country. A large elevation change across the region contributes to high geographical, ecological, and climatological variability. Significant weather extremes impact this area, including winter storms, extreme heat and cold, flood, drought, and wildfires.

According to recent reports, Coloradans can expect the following from the future climate of Colorado:[28,29]

- All climate model projections indicate future warming in Colorado; the statewide average annual temperatures are projected to warm by +2.5°F to +6.5°F by 2050 relative to a 1971-2000 baseline depending on future emissions
- Typical summer temperatures by 2050 are projected to be similar to the very hottest summers that have occurred in the past 100 years
- Decreased snowpack and earlier spring runoff
- Heat waves, droughts, and wildfires are likely to increase in frequency and severity
- Decreased streamflow in Colorado's major rivers
- Winter precipitation events to increase in frequency and magnitude

The planning area must adapt to these changes, or experience an increase in economic losses, loss of life, property damages, and crop damages. The Colorado Climate Change Vulnerability Study identifies vulnerabilities in the following sectors: ecosystems, water, agriculture, energy, transportation, outdoor recreation and tourism, and public health.[30] This Hazard Mitigation Plan includes strategies for the planning area to address these changes, increase resilience and adapt to the future climate.

The Fourth National Climate Assessment has provided an overview of potential impacts within the planning area.

- **Water Resources**: Water for people and nature in the Southwest has declined during droughts, due in part to human-caused climate change. Intensifying droughts and occasional large floods, combined with critical water demands from a growing population, deteriorating infrastructure, and groundwater depletion, suggest the need for flexible water management techniques that address changing risks over time, balancing declining supplies with greater demands.

28 Lukas, J. 2014. "Climate Change in Colorado: A synthesis to support water resources management and adaptation." University of Colorado Boulder Western Water Assessment.

29 Colorado Water Conservation Board. 2015. "Colorado Climate Plan: State Level Policies and Strategies to Mitigate and Adapt." https://www.codot.gov/programs/environmental/Sustainability/colorado-climate-plan-2015.

30 Gordon, E., and D. Ojima. 2015. "Colorado climate change vulnerability study: A report submitted to the Colorado Energy Office." University of Colorado Boulder and Colorado State University Western Water Assessment.

- **Ecosystems and Ecosystem Services:** The integrity of Southwest forests and other ecosystems and their ability to provide natural habitat, clean water, and economic livelihoods have declined as a result of recent droughts and wildfire due in part to human-caused climate change. Greenhouse gas emissions reductions, fire management, and other actions can help reduce future vulnerabilities of ecosystems and human well-being.

- **Energy:** The ability of hydropower and fossil fuel electricity generation to meet growing energy use in the Southwest is decreasing as a result of drought and rising temperatures. Many renewable energy sources offer increased electricity reliability, lower water intensity of energy generation, reduced greenhouse gas emissions, and new economic opportunities.

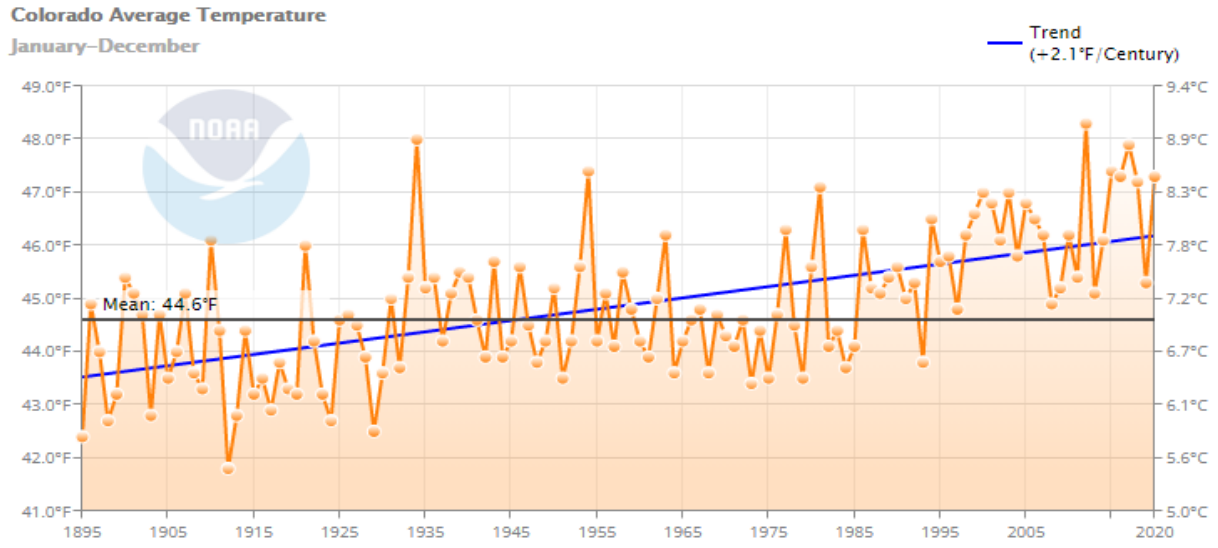
- **Food:** Food production in the Southwest is vulnerable to water shortages. Increased drought, heat waves, and reduction of winter chill hours can harm crops and livestock; exacerbate competition for water among agriculture, energy generation, and municipal uses; and increase future food insecurity. Additionally, food shortages are a concern due to blocked transportation corridors into the planning area.

- **Human Health:** Heat-associated deaths and illnesses, vulnerabilities to chronic disease, and other health risks to people in the Southwest result from increases in extreme heat, poor air quality, and conditions that foster pathogen growth and spread. Improving public health systems, community infrastructure, and personal health can reduce serious health risks under future climate change.

Changes in Temperature

Since 1895 Colorado's overall average temperature has increased by 2.1°F (Figure 16). While overall temperature shifts have not been consistent, the trend for increasing temperatures is apparent. Climate modeling suggests warmer temperature conditions will continue in the coming decades and rise steadily into mid-century. This trend will likely contribute to an increase in the frequency and intensity of hazardous events, which will cause significant economic, social, and environmental impacts on residents in the county. Temperature increased across the southwest region with the greatest increases in southern California and western Colorado (Figure 17).

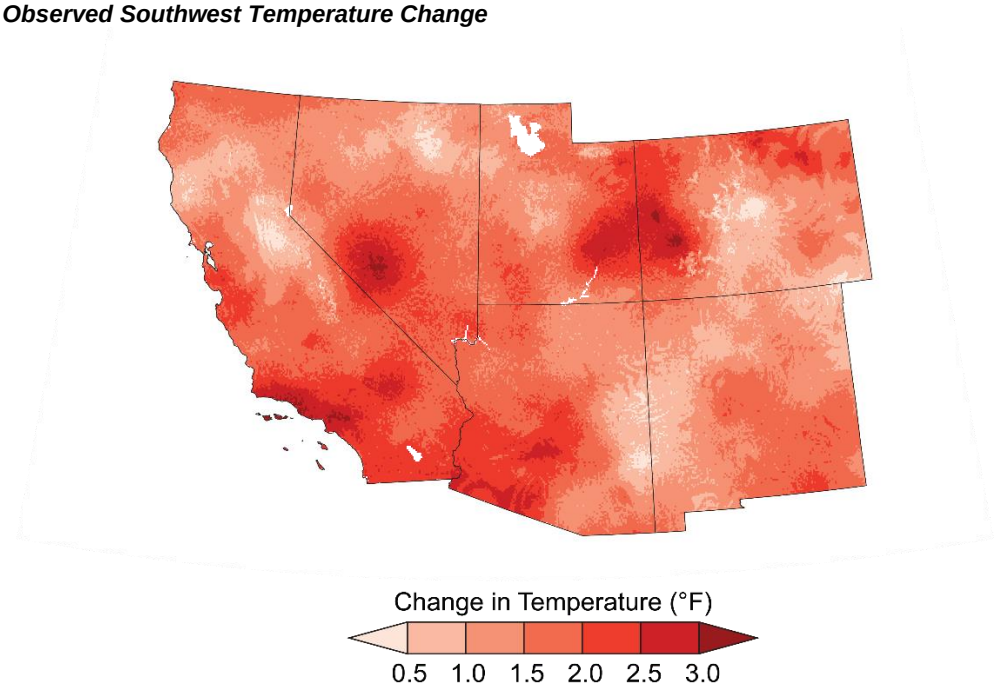
Figure 16: Colorado Average Temperature (1895-2020)



Source: National Oceanic and Atmospheric Administration (NOAA), 2020[31]

Additionally, the length of the frost-free season has been increasing nationally since the 1980s. While a longer warm season may provide some additional recreational opportunities in western Colorado, concurrent changes in temperature, water availability, pest pressures, and tree mortality may cause additional impacts. For instance, fewer frost days coinciding with periods of drought can lower overall snowpack on surrounding mountains, add stress and pressure on local tree populations, or destabilize cliff faces and side slopes along transportation corridors.

Figure 17: Observed Southwest Temperature Change



Source: 4th National Climate Assessment, 2018[32]

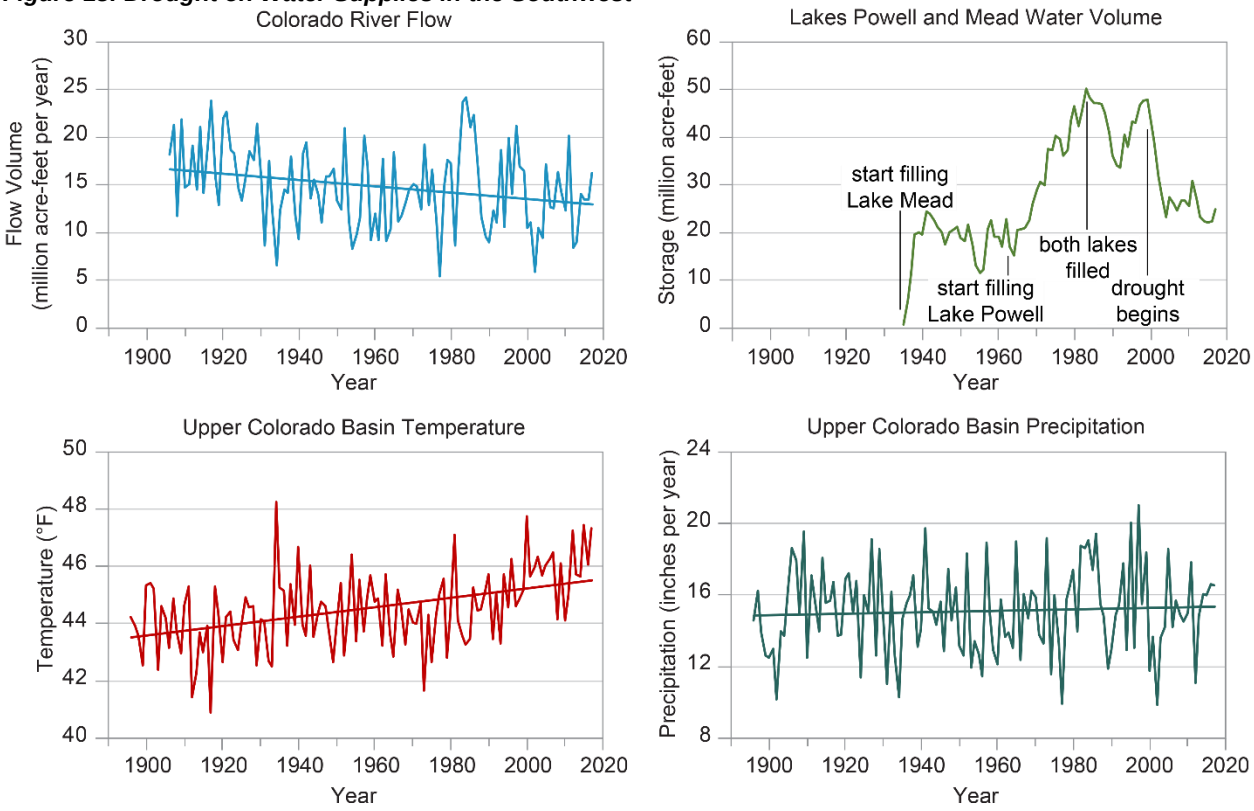
Changes in Precipitation

Changing extremes in precipitation are anticipated in the coming decades, with more significant rain and snowfall events and more intense drought periods. Seasonal variations will be heightened, with more frequent and more significant rainfall expected in the spring and winter and hotter, drier periods in the summer. In the Upper Colorado River Basin that feeds the reservoirs, temperatures have increased (bottom left), which increases plant water use and evaporation, reducing lake inflows and contents. Although annual precipitation (bottom right) has been variable without a long-term trend, there has been a recent decline in precipitation that exacerbates the drought. Combined with increased Lower Basin water consumption that began in the 1990s, these trends explain the recently reduced reservoir contents.

31 NOAA. 2020. "Climate at a Glance: Statewide Time Series.". Accessed October 2021. https://www.ncdc.noaa.gov/cag/statewide/time-series/25/tavg/12/12/1895-2020?base_prd=true&begbaseyear=1901&endbaseyear=2000&trend=true&trend_base=100&begtrendyear=1895&endtrendyear=2020

32 USGCRP, 2018: Impacts, Risks, and Adaptation in the United States: Fourth National Climate Assessment, Volume II [Reidmiller, D.R., C.W. Avery, D.R. Easterling, K.E. Kunkel, K.L.M. Lewis, T.K. Maycock, and B.C. Stewart (eds.)]. U.S. Global Change Research Program, Washington, DC, USA, 1515 pp. doi: 10.7930/NCA4.2018.

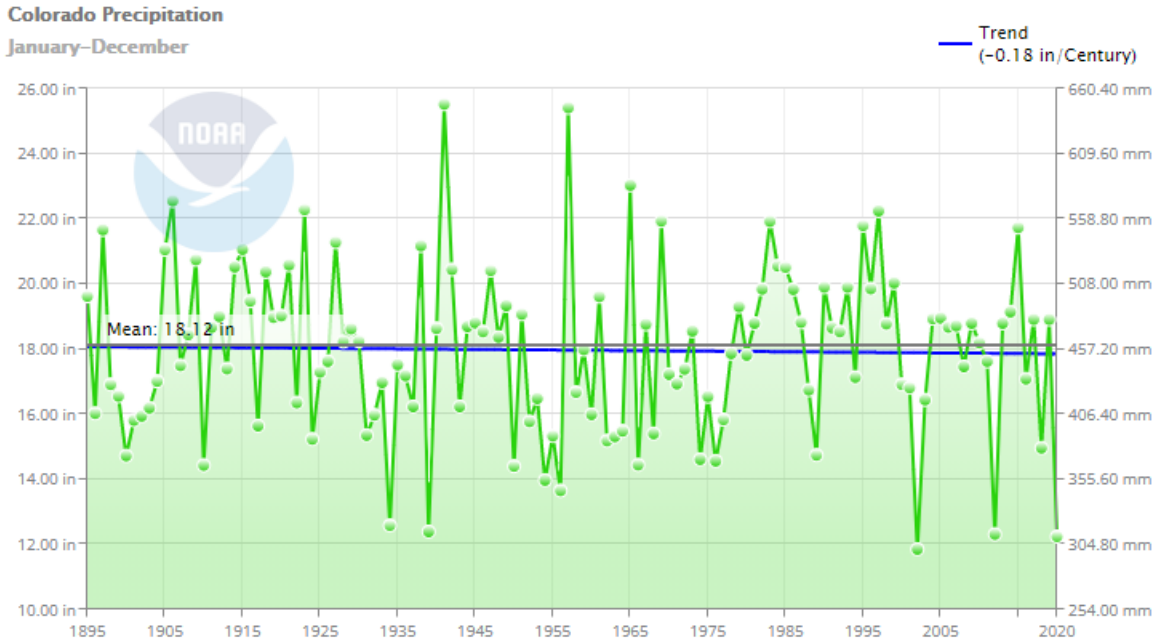
Figure 18: Drought on Water Supplies in the Southwest



Source: 4th National Climate Assessment, 2018

Since 1895, yearly annual precipitation for Colorado has decreased slightly (decline by 1.8" per century). Snow droughts can arise from a lack of precipitation (dry snow drought), temperatures that are too warm for snow (warm snow drought), or a combination of the two. Rivers and reservoir water sources are increasingly important to communities and residents in the planning area to meet water needs during periods of shortage.

Figure 19: Colorado Average Precipitation (1895-2020)



Source: NOAA, 2020

Impacts from Climate Change

Observed changes in the intensity and frequency of extreme events are a significant concern now and in the future because of the social, environmental, and economic costs associated with their impacts. Challenges that are expected to affect communities, environments, and residents as a result of climate change include:

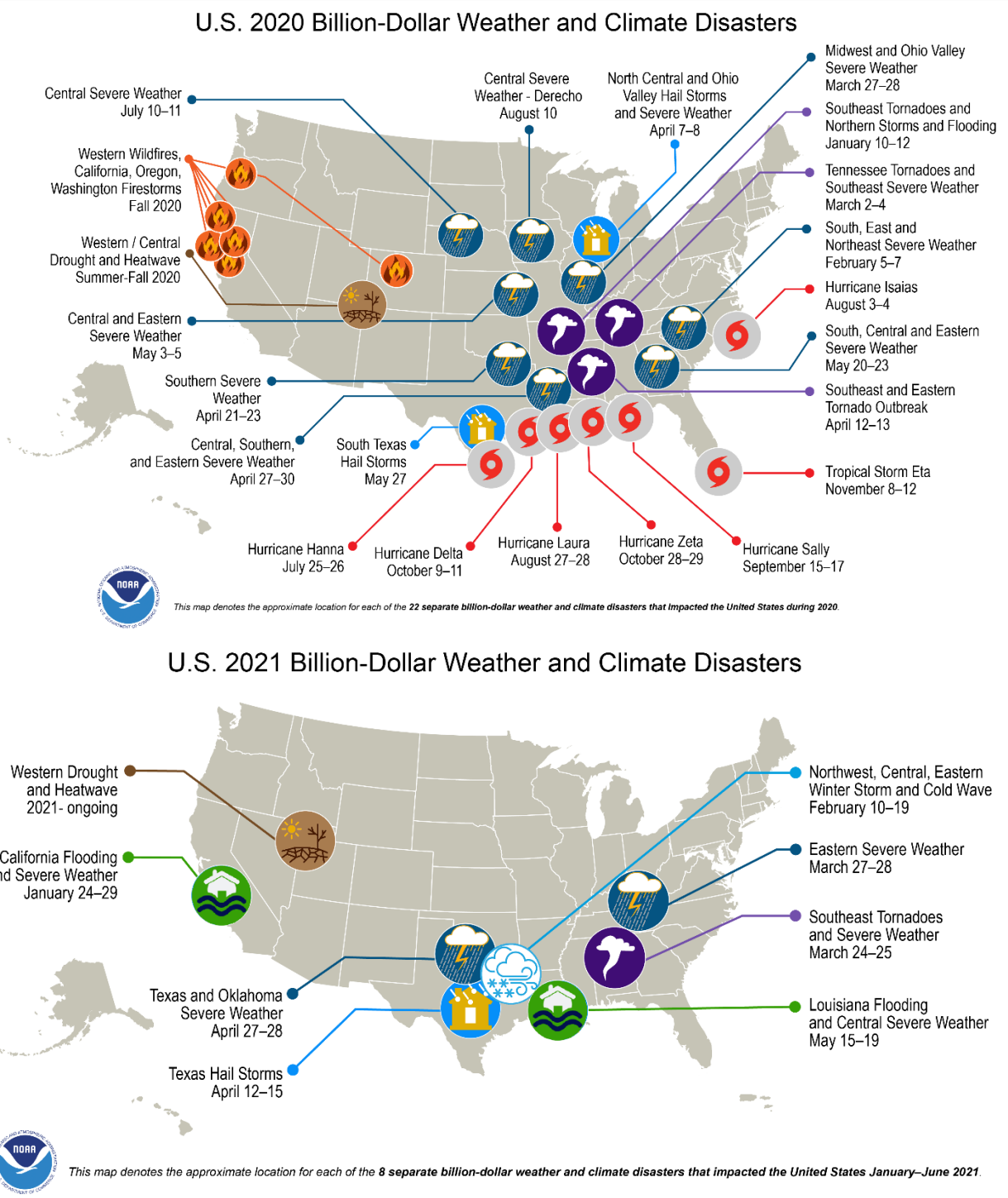
- Developing and maintaining sustainable economic sectors;
- Resolving increasing competition among land, water, and energy resources;
- Conserving vibrant and diverse ecological systems;
- Supporting existing and growing recreational opportunities; and
- Enhancing the resilience of the region's people to the impacts of climatic extremes.

Certain groups of people may face greater difficulty when dealing with the impacts of a changing climate. Older adults, immigrant communities, transient residents (including tourists) and those living in poverty are particularly susceptible. Additionally, specific industries and professions tied to weather and climate, like outdoor tourism, commerce, and the oil and gas industry, are especially vulnerable. Cities, especially those with the greatest growth in population, are especially vulnerable to the impacts of climate change.[33]

As seen in the figure below, the United States is experiencing an increase in the number of billion-dollar natural disasters.

[33] U.S. Environmental Protection Agency. "Climate Impacts on Society." Accessed April 2021. https://19january2017snapshot.epa.gov/climate-impacts/climate-impacts-society_.html

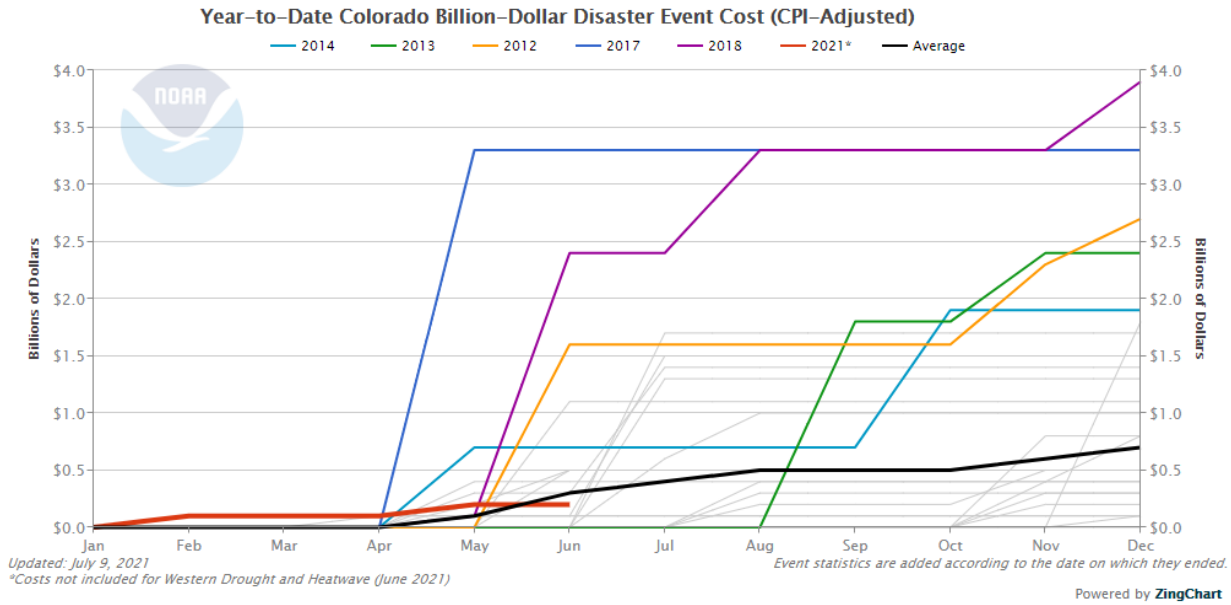
Figure 20: Billion Dollar Weather and Climate Disasters (2020 and 2021)



Source: NOAA, 2021[34]

[34] NOAA. 2020. "Billion-Dollar Weather and Climate Disasters: Overview. Accessed April 2021. https://www.ncdc.noaa.gov/billions/overview

Figure 21: Billion Dollar Disaster Costs in Colorado

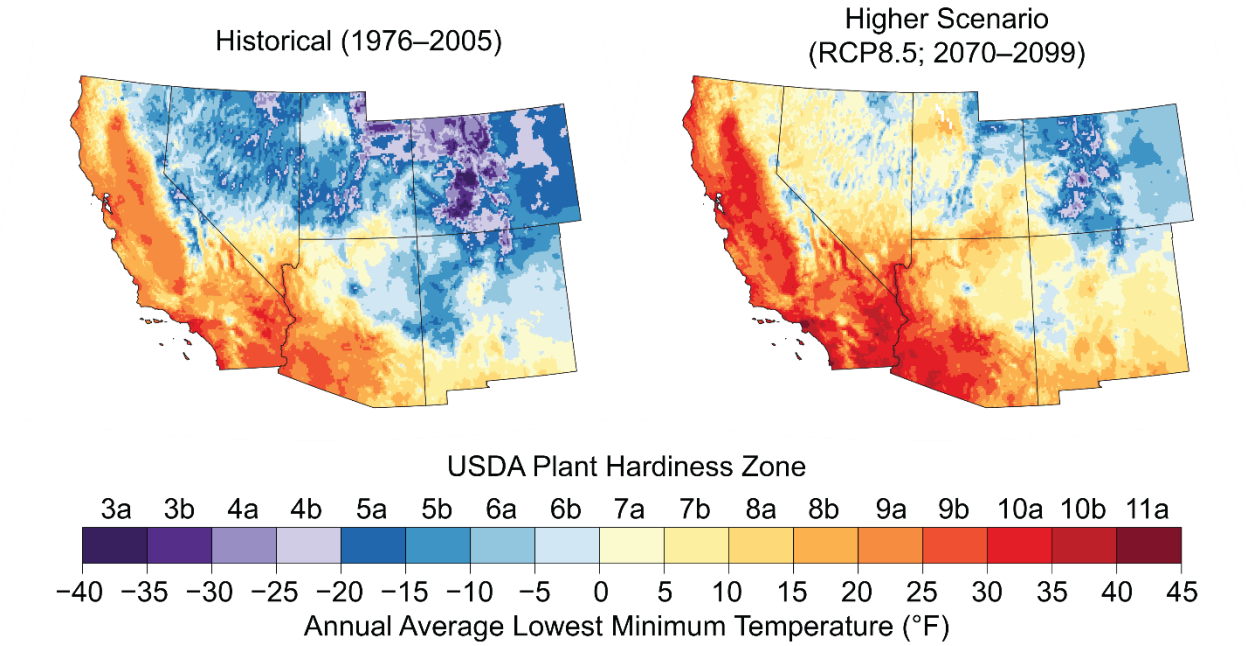


Source: NOAA, 2021

Agriculture and Forests

Agriculture and forestry sectors will experience an increase in droughts, an increase in grass and wildfire events, changes in the growth cycle as winters warm, an influx of new and damaging agricultural diseases or pests, and changes in the timing and magnitude of rainfall. As described in the Plant Hardiness Zone map (Figure 22) available for the United States, these changes have shifted the annual growing season and expected agricultural production conditions. Colorado and Garfield County are particularly vulnerable to increased pest pressures on agricultural and forested lands. These added stressors could have devastating economic effects if new forest management practices are not adopted.

Figure 22: Plant Hardiness Zone Change



Source: 4th National Climate Assessment, 2018[35]

Air Quality

Rising temperatures, ground level ozone air pollution, dust storms, particulate air pollution from wildfires, and increased aeroallergens will also impact air quality. Harmful air pollutants and allergens increase as temperatures increase. More extended periods of warmth contribute to longer pollen seasons that allow plant spores to travel farther and increase exposure to allergens. More prolonged exposure to allergens can increase the risk and severity of asthma attacks and worsen existing allergies in individuals.[36] An increase in air pollutants can occur from the growing number of grass and wildfires. The public can be exposed to harmful particulate matter from smoke and ash that can cause various health issues. Depending on the length of exposure, age, and individual susceptibility, effects from wildfire smoke can range from eye and respiratory irritation to severe disorders like bronchitis, asthma, and aggravation of pre-existing respiratory and cardiovascular diseases. [37]

Drought and Extreme Heat

An increase in average temperatures will contribute to the rise in the frequency and intensity of hazardous events like extreme heat and drought, which will cause significant economic, social, and environmental impacts on Coloradians and visitors to the state. Although drought is a natural part of the climate system, increasing temperatures will increase evaporation rates, decrease soil moisture, and lead to more intense droughts in the future, having negative impacts on snowpack, forest health, and farming or rangeland. Extreme heat events have adverse effects on both human and livestock health. Heatwaves may also impact plant health, with negative effects on crops and

35 USGCRP, 2018: Impacts, Risks, and Adaptation in the United States: Fourth National Climate Assessment, Volume II [Reidmiller, D.R., C.W. Avery, D.R. Easterling, K.E. Kunkel, K.L.M. Lewis, T.K. Maycock, and B.C. Stewart (eds.)]. U.S. Global Change Research Program, Washington, DC, USA, 1515 pp. doi: 10.7930/NCA4.2018.

36 Asthma and Allergy Foundatino of America. 2010. "Extreme Allergies and Climate Change." Accessed 2021. https://www.aafa.org/extreme-allergies-and-climate-change/

37 AirNow. 2019. "Wildfire Smoke: A Guide for Healthcare Professionals." Accessed 2021. https://www.airnow.gov/sites/default/files/2020-10/wildfire-smoke-guide-revised-2019-chapters-1-3_0.pdf

forests during essential growth stages. Prolonged drought can affect drinking water availability, particularly for communities which use surface water resources.

Energy

Shifting climate trends will have a direct impact on water and energy demands. As the number of extreme heat days increases, the stress placed on the energy grid will likely increase and possibly lead to more power outages. In particular the oil and gas industry in the county has served as a major economic sector and is vulnerable to shifting alternative fuel sources. Severe weather events also stress energy production, infrastructure transmission, and transportation. Roads, pipelines, and rail lines are all at risk of damages from flooding, extreme heat, erosion, landslides, debris flows, wildfire, or added stress from increased residential demands.[38] Critical facilities and vulnerable populations that are not prepared to handle periods of power outages, particularly during extreme heat or cold temperatures, will be at greater risk.

Water Quality

Increasing temperatures, shifting precipitation patterns, and extreme weather events impact water quality throughout the state. As average temperatures increase, water temperatures also rise and put water bodies at risk for eutrophication and excess algal growth that reduce water quality. Extreme weather events and shifting precipitation can lead to fluctuating river flows, depleted reservoirs, erosion, sediment accumulation, and morphological changes to water bodies and surrounding landscapes. With many Colorado communities developed alongside rivers, morphological changes in the landscape can put roads, utilities, homes, or other infrastructure at risk. Increased runoff from surrounding landscapes can contribute to the buildup of nutrients in the water, increasing plant and algae growth that can deplete oxygen and kill aquatic life. Nutrient enrichment can lead to toxic cyanobacterial harmful algae blooms (cyanoHABs), which can be harmful to animal and human health. CyanoHABs can cause economic damage such as decreasing property values, reducing recreational revenue, and increasing the costs for treating drinking water.[39]

With the increasing intensity and frequency of extreme precipitation events, impacts to water systems ultimately threaten human health. Events can lead to flooding and stormwater runoff that can carry pollutants across landscapes and threaten human health by contaminating water wells, groundwater, and other bodies of water. Common pollutants include pesticides, bacteria, nutrients, sediment, animal waste, oil, and hazardous waste. Flooding impacts property, infrastructure, economies, and the ecology of water bodies.

Grass/Wildfire

Rising temperatures can increase the frequency and intensity of wildfires across the state. Warmer temperatures cause snow to melt sooner, create drier soils and forests, and contribute to pest infestations such as bark beetle which cause tree mortality. Overall forest mortality act as kindling to ignite and spread fires. Additionally, warmer nighttime temperatures contribute to the continued spread of wildfires over multiple days.[40] Severe storm conditions are also producing more frequent lightning strikes which can spark wildfire events. In addition, historical fire suppression policies have caused unnatural accumulations of understory trees and coarse woody

[38] USGCRP, 2018: Impacts, Risks, and Adaptation in the United States: Fourth National Climate Assessment, Volume II: Report-in-Brief [Reidmiller, D.R., C.W. Avery, D.R. Easterling, K.E. Kunkel, K.L.M. Lewis, T.K. Maycock, and B.C. Stewart (eds.)]. U.S. Global Change Research Program, Washington, DC, USA, 186 pp.

[39] USGS. "Nutrients and Eutrophication". Accessed February 2021. https://www.usgs.gov/mission-areas/water-resources/science/nutrients-and-eutrophication?qt-science_center_objects=0#qt-science_center_objects

[40] NASA Global Climate Change. September 2019. "Satellite Data Record Shows Climate Change's Impact on Fires." Accessed 2021. https://climate.nasa.gov/news/2912/satellite-data-record-shows-climate-changes-impact-on-fires/

debris in many lower-elevation forest types, fueling more intense and extensive wildfires. Post-fire conditions including deadfall, denuded hillsides, and reduced soil stability also increase risk in the county to other hazard types (e.g. flooding and rockfall).

Future Adaptation and Mitigation

The planning area will have to adapt to a changing climate and its impacts or experience an increase in economic losses, property damages, agricultural damages, and loss of life. Past events have typically informed HMPs to be more resilient to future events. This HMP includes strategies for the planning area to address these changes and increase resilience and provides a brief description of climate change's anticipated impact on each hazard type.

Hazard Profiles

Based on research and the experiences of the participating jurisdictions, the following hazards profiled were determined to either have a historical record of occurrence in Garfield County or the potential for occurrence in the future. The following profiles will examine the identified hazards across the region. Local concerns or deviations from the County risk assessment will be addressed in *Section Seven: Participant Sections* of this plan.

For the hazards that had available geographic information system (GIS) data, an additional level of analysis was completed. First, County staff divided the planning area into three study areas: Forest, Resource Lands, and Urban Interface. Next, zoning, census, and infrastructure data was overlaid with the available hazard data to estimate assets at risk. Due to the unique geography of Garfield County and the frequency of specific hazard events, the following hazards include this additional analysis: wildfire; flooding; and landslides, rockfall, and debris flows.

Tier I Hazards

- Wildfire
- Flooding
- Hazardous Materials
- Landslide/Debris Flow/Rockfall
- Drought
- Public Health Emergency
- Severe Winter Storms

Wildfire

Hazard Profile

Wildfire, also known as grass fires, brush fires, forest fires, or wildland fires, is defined as any fire occurring on wildlands that requires suppression response. Wildfires range in size from a few acres to thousands of acres in some cases. Fire events can rapidly spread from their original source, change direction quickly, and jump gaps (such as roads, rivers, and fire breaks). Wildfire events are particularly dependent on the local conditions including temperature, humidity, wind speed, wind direction, slope, and available fuel load. While some wildfires burn in remote forested regions, others can cause extensive destruction of homes and other property located in the wildland-urban interface (WUI), the zone of transition between developed areas and undeveloped wilderness. The wildfire hazard is often characterized by an increased fire risk in the WUI where homes and other structures are built into a densely forested or natural landscape.

There are three categories of interface fire:

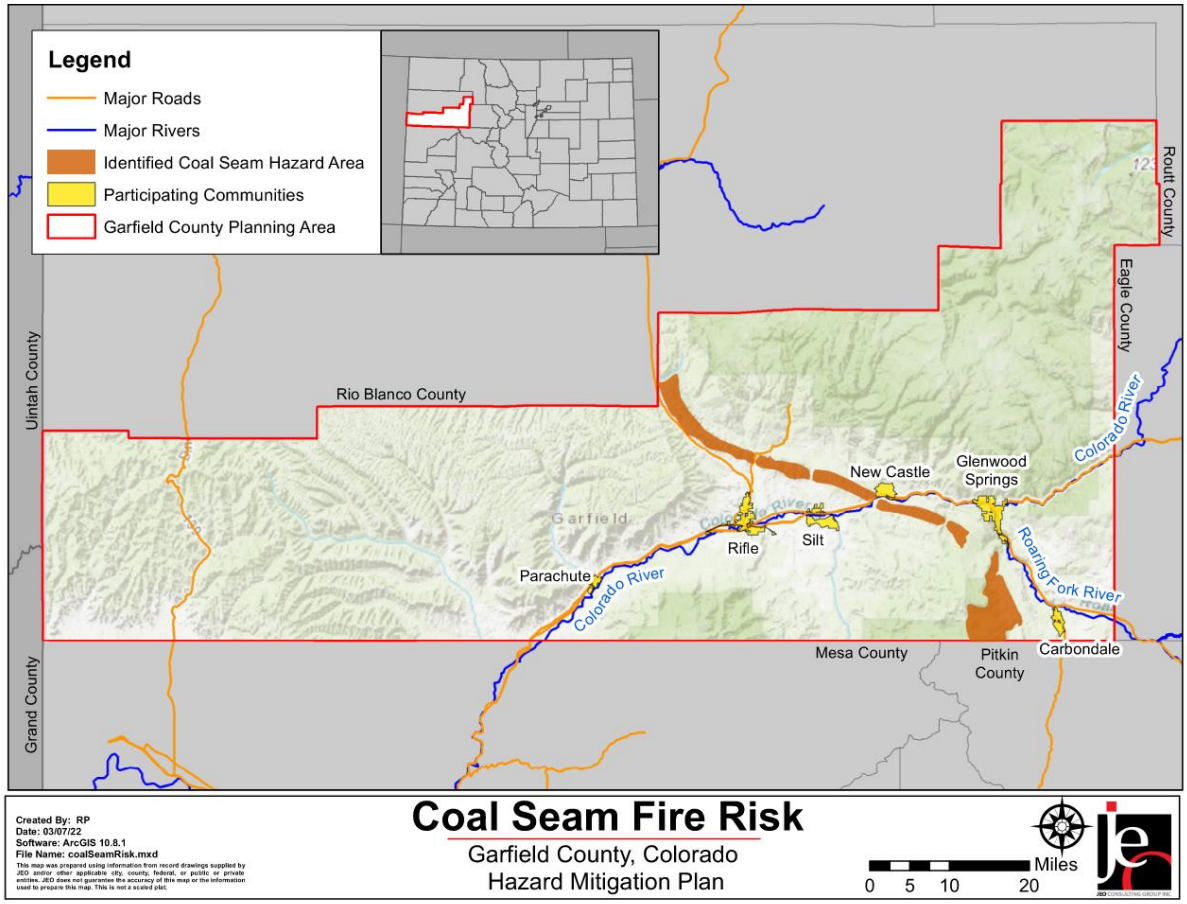
- The classic wildland-urban interface exists where well-defined urban and suburban development presses up against open expanses of wildland areas;
- The mixed wildland-urban interface is characterized by isolated homes, subdivisions, and small communities situated predominantly in wildland settings; and
- The occluded wildland-urban interface exists where islands of wildland vegetation occur inside a largely urbanized area.

Certain conditions must be present for significant interface fires to occur. The most common are: hot, dry, and windy weather; the inability of fire protection forces to contain or suppress the fire; the occurrence of multiple fires that overwhelm committed resources; and a large fuel load (dense vegetation). Once a fire has started, other conditions influence its behavior, including fuel, topography, weather, drought, and development. Although fire is a natural and often beneficial process, long-term fire suppression can also lead to more severe fires due to the buildup of vegetation, which creates more fuel and increases the intensity and devastation of future fires.

Garfield County experiences an increased fire risk seasonally, typically April through October. Lightning is the primary source of ignition; secondary causes include agricultural burns and other human caused ignitions. County-wide, fuel sources are trees, ladder brush, underbrush, cheat grass, and beetle-killed trees. Fuel and structure durability are the primary factors people can control and are the target of most mitigation efforts. The NWS monitors the risk factors including high temperature, high wind speed, fuel moisture (greenness of vegetation), low humidity, and cloud cover in the state on a daily basis.

Another concern in Garfield County are coal seam fires. The coal seam is an underground coal deposit that is close enough to the surface to be ignited by a lightning strike or even extreme temperatures. These fires challenge traditional firefighting techniques by continuing to smolder underground for extended periods of time and traveling along the coal deposit to ignite brush or dry ground cover nearby. The figure below shows the location of the coal seam in Garfield County.

Figure 23: Coal Seam Fire Risk in Garfield County



Location

Wildfires can occur throughout the County. GIS data and wildfire occurrence data was collected from the Colorado State Forest Service's Wildfire Risk Assessment Summary Report.

The United States Department of Agriculture and U.S. Forest Service created the interactive web resource *Wildfire Risk to Communities* to help communities and jurisdictions understand, explore, and reduce wildfire risk. In comparison to the State of Colorado, populated areas in Garfield County have, on average, greater risk than 52% of all other counties.

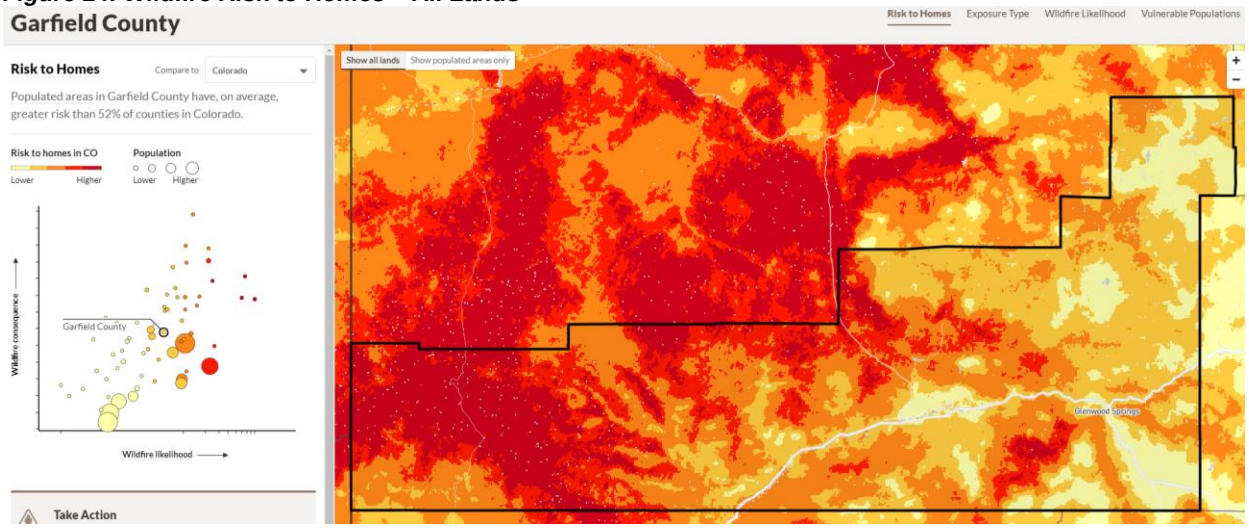
Table 29: Wildfire Risk Factors for Garfield County

Risk Factor	Garfield County	State of Colorado
Families in Poverty	892 (5.9%)	10.9%
People with Disabilities	4,734 (8.2%)	575,430 (10.2%)
Population over 65	7,034 (12%)	740,638 (13.4%)
Difficulty with English	2,765 (5.1%)	N/A
Households with no Vehicle	599 (2.8%)	60,272 (2.2%)
Mobile Homes	2,219 (10.5%)	97,247 (4.1%)

Source: USDA/USFS, Wildfire Risk to Communities, 2021
Note data from 2018 US Census American Community Survey 5-yr survey

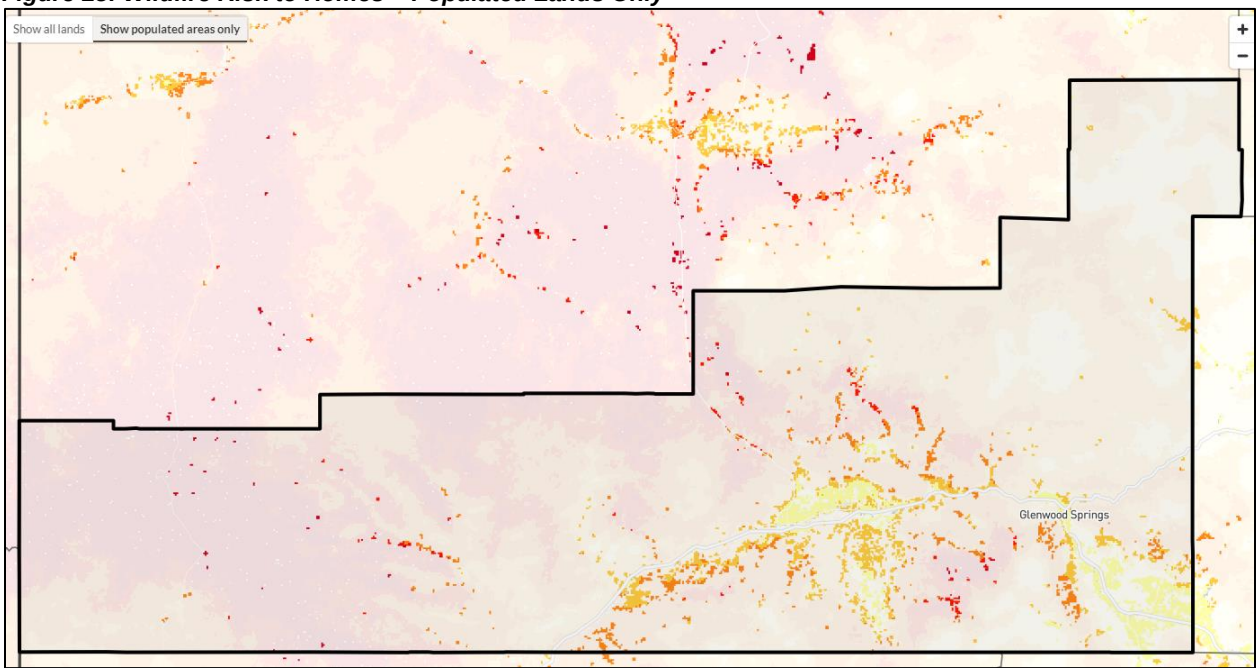
The following figures show wildfire risk to homes in the Garfield County planning area.

Figure 24: Wildfire Risk to Homes – All Lands



Source: USDA/USFS, Wildfire Risk to Communities, 2021

Figure 25: Wildfire Risk to Homes – Populated Lands Only

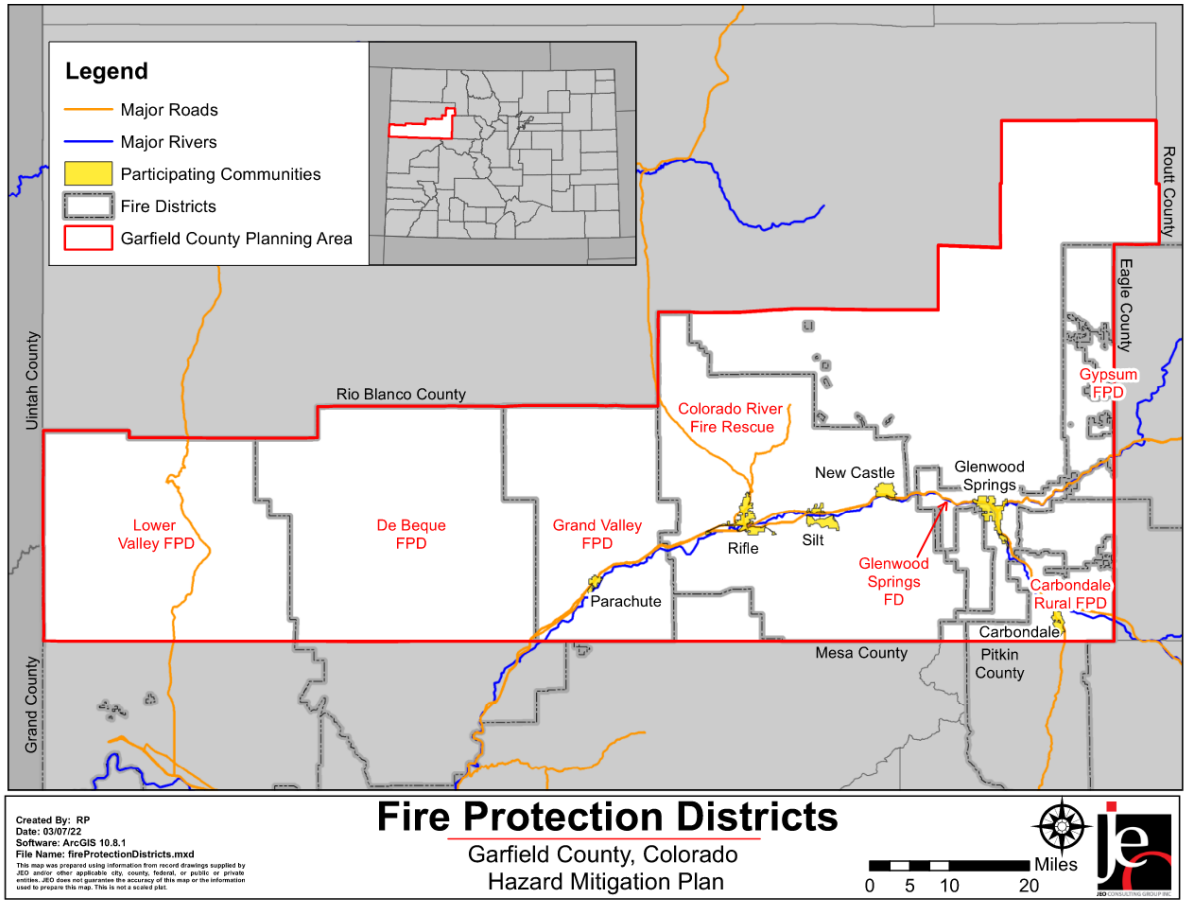


Source: USDA/USFS, Wildfire Risk to Communities, 2021

There are seven fire protection districts located in Garfield County. These include:

- Glenwood Springs Rural Fire Protection District
- Grand Valley Fire Protection District
- Colorado River Fire Protection District
- Carbondale and Rural Fire Protection District
- Lower Valley Fire Protection District
- DeBeque Fire Protection District
- Gypsum Fire Protection District

Figure 26: Garfield County Fire Protection Districts



Extent

The average wildfire in Garfield County burned 44 acres. Of the reported between 2010 and 2017, over 84 percent burned less than one acre. Only two percent of the recorded fires burned more than 100 acres.

Wildfire also contributes to an increased risk from other hazard events, compounding damages and straining resources. FEMA has provided additional information in recent years detailing the relationship between wildfire and flooding (Figure 27). Wildfire events remove vegetation and harden soil, reducing infiltration capabilities during heavy rain events. Subsequent severe storms that bring heavy precipitation can then escalate into flash flooding, dealing additional damage to jurisdictions.

Figure 27: FEMA Flood After Fire Impacts

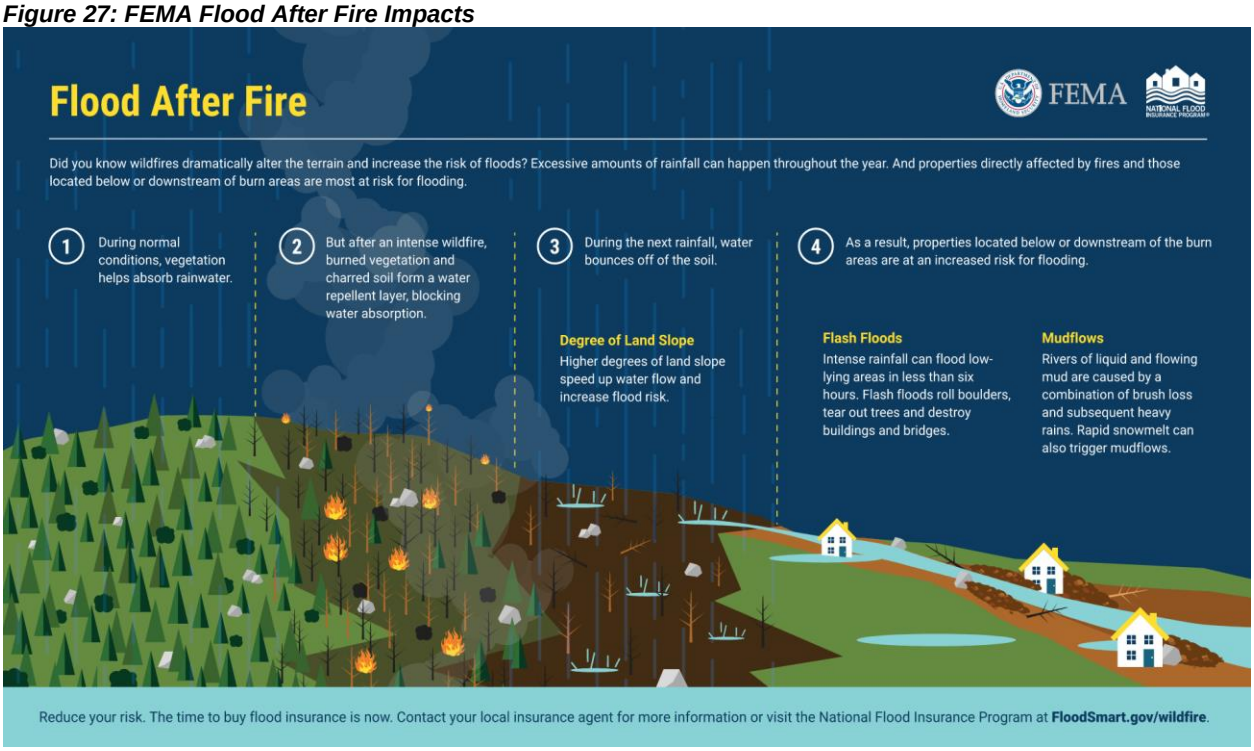
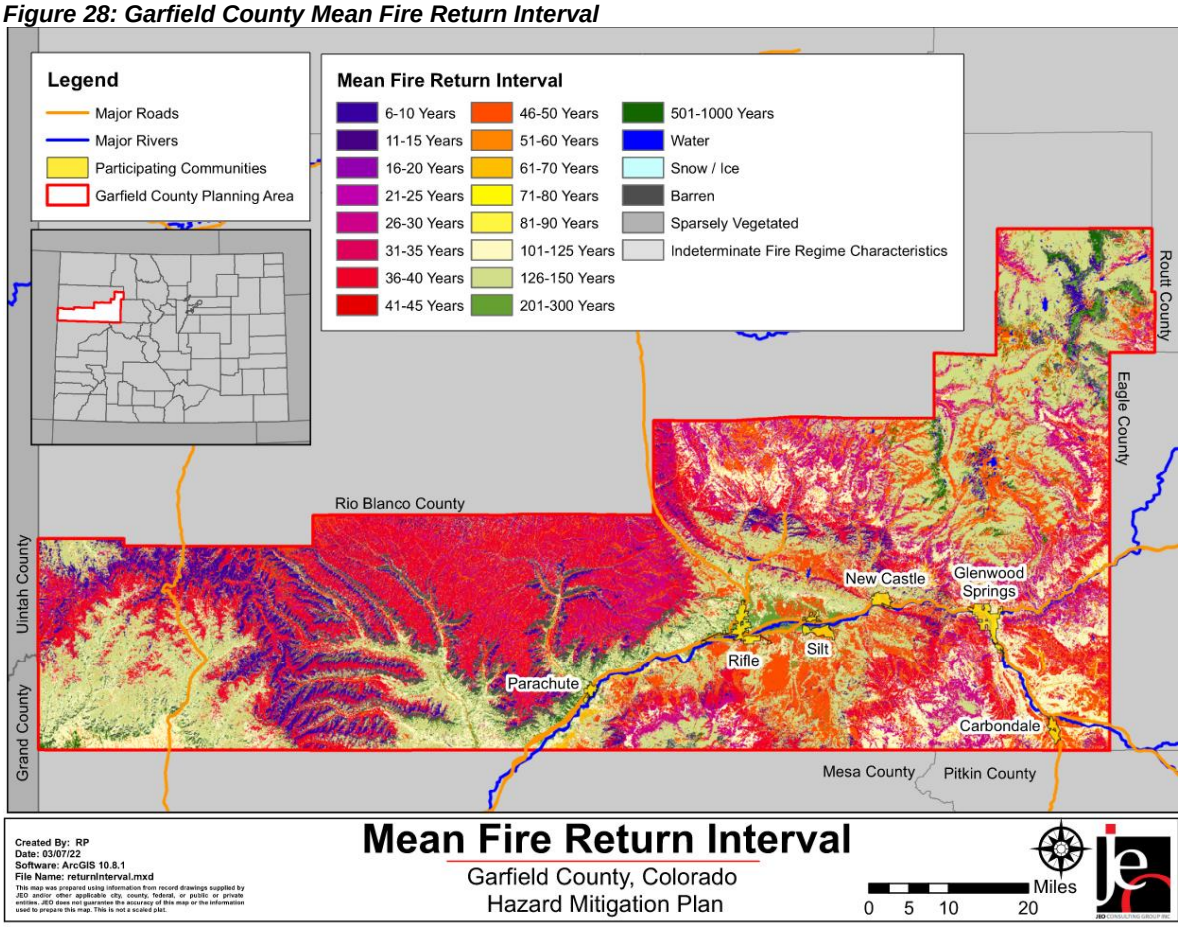


Figure 28 shows the USGS' Mean Fire Return Interval. This model considers a variety of factors, including landscape, fire dynamics, fire spread, fire effects, and spatial context. These values show how often fires occur in each area under natural conditions.

Figure 28: Garfield County Mean Fire Return Interval



Historical Occurrences

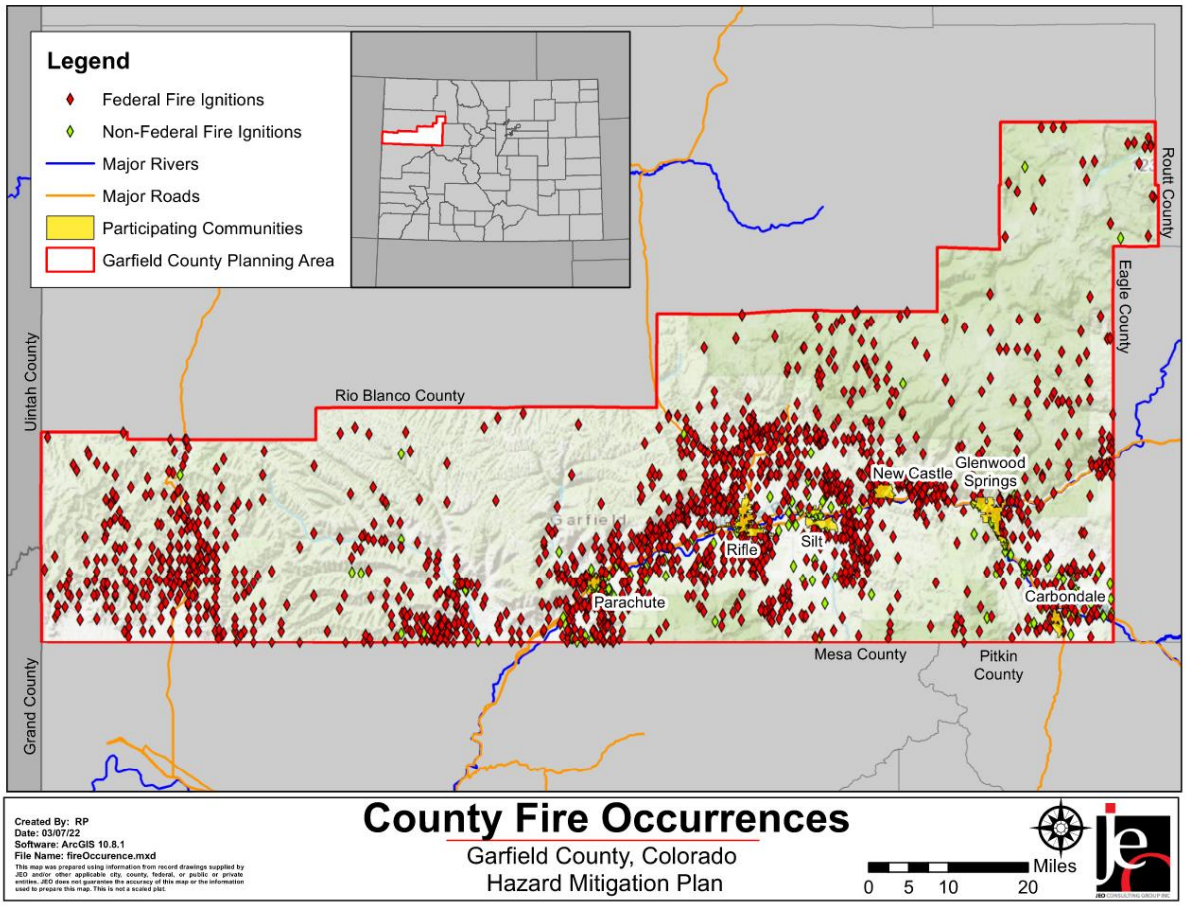
Garfield County is a fire-prone area with many fire events occurring annually; however, it is important to note that there is no comprehensive fire event database. Fire events, magnitude, and local responses were reported voluntarily by local fire departments and local reporting standards can vary between departments. Actual fire events and their impacts are likely underreported in the available data.

According to data available from the Colorado State Forest Service, 2,320 fire events has been reported between 1992 and 2017. In this time frame, Garfield County averaged approximately 89 fires per year. The average fire size was 43 acres which events ranging from less than one acre to over 17,000 acres. Fire districts and response agencies in Garfield County report fires in the NFIRS; however this information, particularly for fires for state and private lands along the Colorado River corridor were not available during this planning process. There are undoubtedly many more fires occurring that are unaccounted for through the federal/state reporting system. While most fires are relatively insignificant in terms of size and fire intensity, several high-intensity fires have not only burned thousands of acres but also posed significant threats to structures or other human developments.

Historically notable fires include: the Battlement Creek Fire (1976: 3 firefighter fatalities, 1 pilot fatality); Battlement Mesa Fire (1987); the South Canyon Fire (1994: 14 firefighter fatalities); the Big Fish Fire (17,056 acres); and the Coal Seam Fire (2002) that burned into the town limits of Glenwood Springs and covered over 12,000 acres. While not reported in the available dataset,

major fire events occurred in the county in 2020. The Pine Gulch Fire was a lightning started fire in July 2020 which burned on private and public lands, threatened gas and oil infrastructure, and caused road closures and evacuations in Garfield and Mesa Counties. This fire burned over 139,000 acres and caused some small injuries to firefighters. The Grizzly Creek Fire ignited in Glenwood Canyon in August 2020 and burned over 32,631 acres. This fire event prompted a 13-day closure of Interstate 70 through Garfield County. Most large fires in the County quickly cross ownership lines and require a multi-jurisdictional response.

Figure 29: Garfield County Fire Ignition Reports



Average Annual Losses

The average annual losses estimate was taken from the SHELDUS database. This does not include losses from displacement, functional downtime, economic loss, injury, or loss of life. According to SHELDUS, wildfires have caused $15,047,444.56 in property damages in Garfield County from 1960-2019.

Table 30: Historical Wildfire Damages

Total Property Damages	Average Annual Property Damages	Total Crop Damages	Average Annual Crop Damages
$15,047,444.56	$250,790.74	$0	$0

Source: SHELDUS, 2021[41]

41 University of South Carolina. "Spatial Hazard Events and Losses Database for the United States." Period of Record: January 1960 – December 2019. http://hvri.geog.sc.edu/SHELDUS/.

Damages caused by wildfires extend past the loss of building stock, recreation areas, timber, forage, wildlife habitat, and scenic views. Secondary effects of wildfires, including erosion, landslides, introduction of invasive species, and changes in water quality, all increase due to the exposure of bare ground and loss of vegetative cover following a wildfire, and can often be more disastrous than the fire itself in long-term recovery efforts.

Probability

Given the historic record of occurrence for wildfire events (at least one fire event reported in each year on record) for the purposes of this plan, the annual probability of wildfire occurrence is 100 percent.

Wildland Urban Interface

The Garfield County Community Wildfire Protection Plan local planning team defined the WUI as the areas adjacent and within development which meet landscapes at risk to wildland fire. This definition allows areas to be included in the WUI such as within a set radius of a community; those that have specific geographic features which influence fire behavior; areas surrounding key transportation corridors for evacuation; remote residential lots; or where tree mortality has significantly impacted available fuel loads. Specific areas of concern identified in the Community Wildfire Protection Plan (CWPP) included Missouri Heights, Spring Valley, Puma Paw, and Four-Mile Corridor.

Climate Trends

Current climate trends are expected to result in an increase in frequency and severity of wildfires throughout the state of Colorado. Periods of drought can occur throughout the year while extreme heat conditions during summer months greatly increase the potential for and magnitude of wildland fires. Drought has a high probability of occurring in the planning area and the planning area sees, on average, six days above 100°F each year. During a severe drought, dry conditions, and/or windy conditions, large wildfires can more easily spread.

A specific tool developed and utilized in the State of Colorado includes the Future Avoided Cost Explorer[42] (FACE) for Wildfire. This tool presents an in-depth look at potential future economic impacts of wildfire on specific sectors of the Colorado economy. Based on the FACE assessments, it is likely that Garfield County will experience worsening impacts from climate change regarding wildfire. At the current growth rate and only moderate climate impacts, the county may experience up to $250million in total damages annually from wildfire. Damages may vary across sectors and regions such as bridges, buildings, cattle, crops, rafting, skiing, and fire suppression activities.

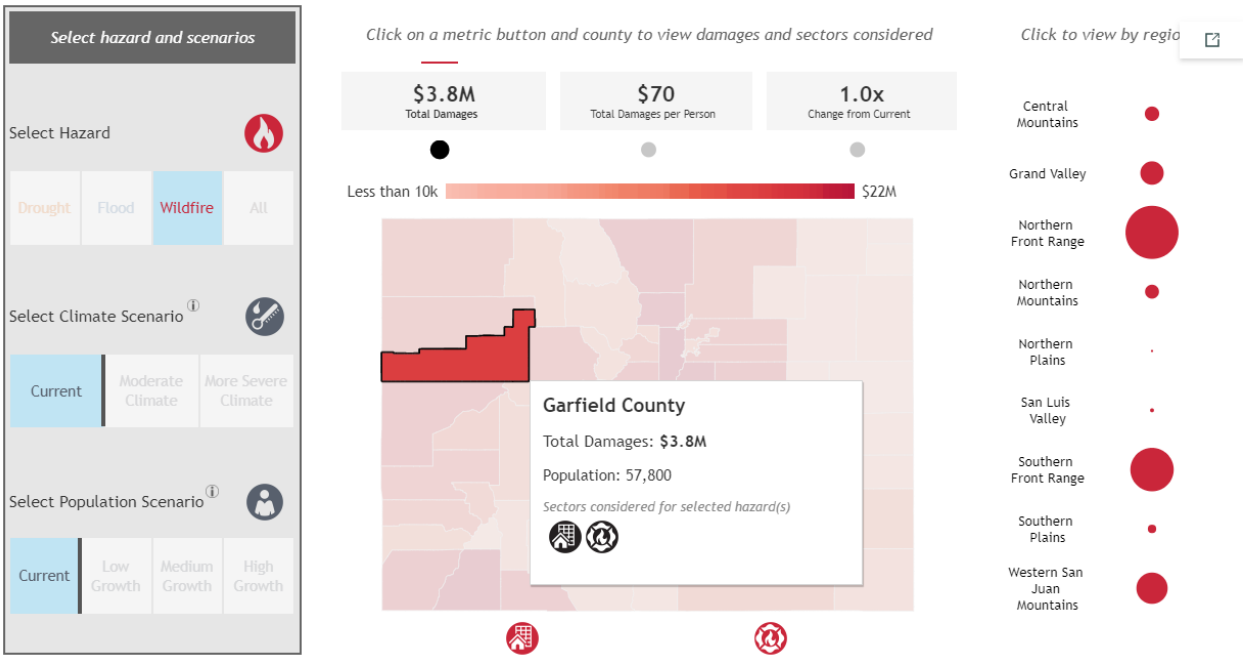
[42] Colorado Water Conservation Board. 2021. “Future Avoided Cost Explorer: Colorado Hazards.” https://storymaps.arcgis.com/stories/4e653ffb2b654ebe95848c9ba8ff316e.

Table 31: FACE Anticipated Damages for Wildfire Matrix

Population Scenario	Climate Scenario		
	Current Climate	Moderate Climate	More Severe Climate
Current Growth Rate	$3.8M Total Damages $70 total damages/person	$5.0M Total Damages $90 total damages/person	$5M Total Damages $90 total damages/person
Low Growth Rate	$6.0M Total Damages $60 total damages/person	$9.0M Total Damages $100 total damages/person	$10M Total Damages $110 total damages/person
Medium Growth Rate	$8.0M Total Damages $80 total damages/person	$10M Total Damages $90 total damages/person	$11M Total Damages $100 total damages/person
High Growth Rate	$9.0M Total Damages $80 total damages/person	$11M Total Damages $90 total damages/person	$12M Total Damages $100 total damages/person

Source: CWB FACE, 2021

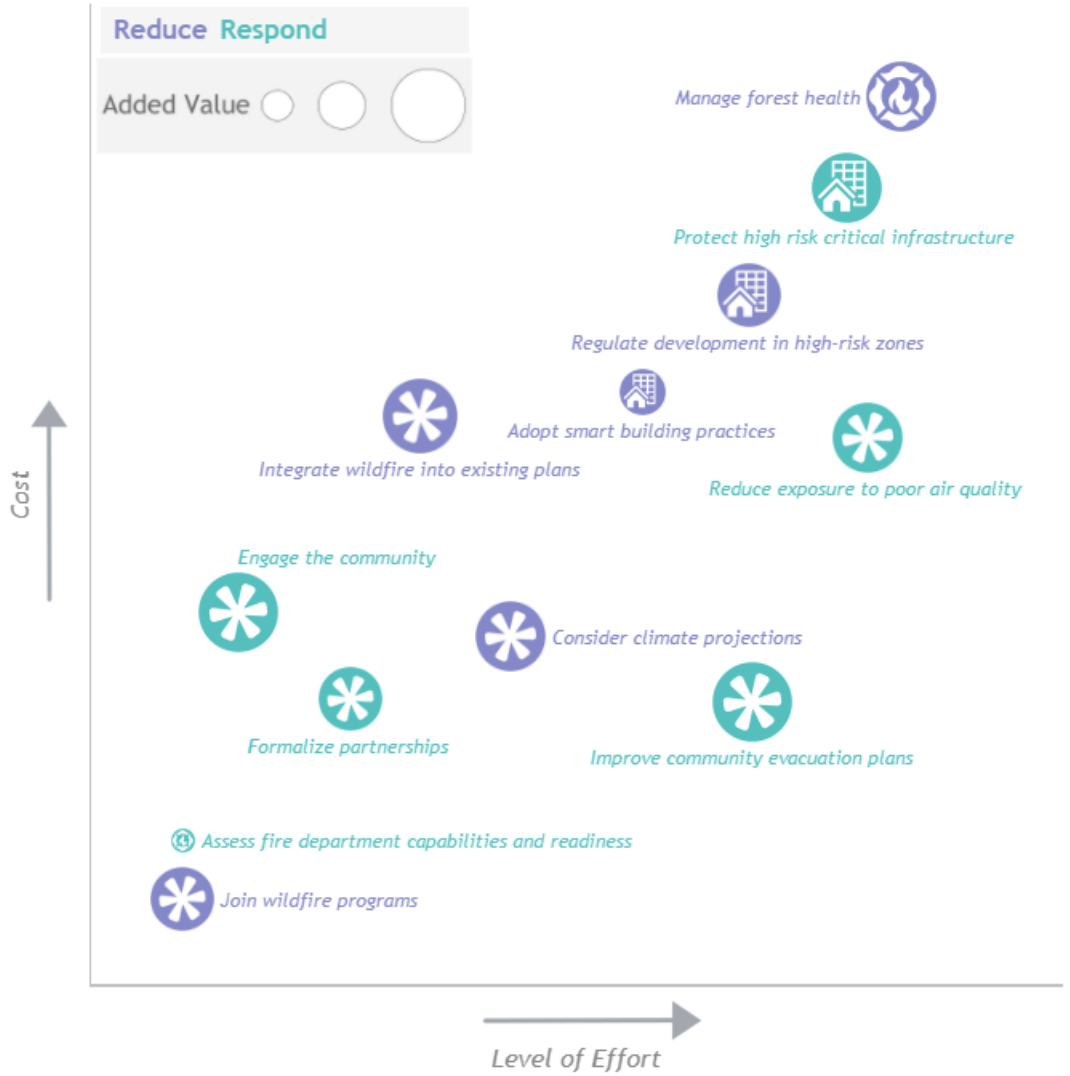
Figure 30: FACE Wildfire Analysis Example



Source: CWB FACE, 2021

Suggested actions to improve resilience to wildfire from FACE are shown in the graphic below.

Figure 31: Exploring Resilience Actions for Wildfire,



Source: CWB FACE, 2021

Community Wildfire Protection Plan

Even though wildfires are a natural part of the ecosystem in the Rocky Mountain West, they can present a substantial hazard to life and property, especially along the Wildland Urban Interface area. During this planning process the Garfield County Office of Emergency Management also updated the 2022 Garfield County Community Wildfire Protection Plan (CWPP). The CWPP summarizes the current state of fire prevention, preparedness, and suppression in the County; identifies and prioritizes areas most at risk of wildland-urban interface fires; presents a strategy for appropriate fire response; and articulates mitigation actions. The CWPP is the authoritative document on wildfire hazards in Garfield County and represents a comprehensive hazard profile, vulnerability analysis, risk assessment, and statement of mitigation actions.

Vulnerability Assessment

Wildfire poses a threat to a range of demographic groups. Wildfire within the WUI and urban fire could result in major evacuations of residents in impacted and threatened areas. Groups and individuals lacking reliable transportation could be trapped in dangerous locations. Lack of

transportation is common among the elderly, low-income individuals, and racial minorities, including on tribal reservation lands. Wildfires can cause extensive damage to both urban and rural building stock and properties including critical facilities and infrastructure, as well as agricultural producers which support the local industry and economy. Damaged homes can reduce available housing stock for residents, causing them to leave the area. Additionally, fire events threaten the health and safety of residents and emergency response personnel. Recreation areas, timber and grazing land, wildlife habitat, and scenic views can also be threatened by wildfires. Several oil and gas companies have drilling operations in wildfire interface areas.

The diversity and amount of equipment and the number of personnel can be substantially limited in rural areas. Fire protection may rely more on the landowner's personal initiative to take measures to protect their own property. Therefore, public education and awareness may play a greater role in rural or interface areas. The CWPP documents past and ongoing efforts, such as Firewise Community workshops that inform County residents about wildfire risk and engage property owners in wildfire mitigation.

In the event of a wildfire, vegetation, structures, and other flammables can combine to create unwieldy and unpredictable events. Factors relevant to the fighting of such fires include access, firebreaks, proximity of water sources, distance from fire stations, and available firefighting personnel and equipment. The vulnerability of structures and homes in the interface area is increased by: combustible roofing and construction material; no/insufficient defensible space; poor access to structures; heavy natural fuel types; steep slopes; limited water supply; and winds over 30 miles per hour.

Future Development

People living in or near wildland settings in Garfield County are vulnerable to the threat of wildfire. The development of homes and other structures is encroaching into the forest wildland and natural areas and is expanding the Wildland-Urban Interface. Interface neighborhoods are characterized by a diverse mixture of varying housing structures, development patterns, ornamental and natural vegetation, and natural fuels. Problems can arise if this new development increases the amount of fuel without coordinated thinning of the forests and the creation of defensible space around homes.

Urban areas may experience the residual effects of a nearby fire in several ways. The canyons can trap smoke, ash, and fire particulates in the air for extended periods of time. Poor air quality is not only a health concern for residents, but can deter tourism activities. Local officials can adopt codes and ordinances that can guide growth in ways to mitigate potential losses from wildfires. These may include more stringent building code standards, setback requirements, or zoning regulations. Other notable vulnerabilities exist for fire departments which service both urban and rural areas as many fire districts lack adequate staff to respond to multi-fire complexes or events in separate areas. The utilization and development of mutual aid agreements or memorandum of understandings are an important tool for districts to share resources and/or coverage.

Vegetative conditions vary widely throughout the County, ranging from semi-desert grass and shrubland to sub-alpine forests. Much of the development in the County is located in the lower elevation zones of sagebrush, Gambel oak, and pinyon-juniper woodlands. The combination of steep terrain, highly flammable vegetation, and hot, dry summers creates a high-risk situation for wildland fire. Much of the land in Garfield County is publicly owned and managed under federal regulations. While this land may have higher fire risk, the risk incurred by people, economic factors, or physical infrastructure is minimal. The key to managing fire risk on these lands and the

impacts on communities in Garfield County will be coordination between the County administration, the fire districts, and the federal agencies that have ultimate responsibility for the public land.

Study Area Analysis

Due to the available GIS data, an additional level of analysis was completed for Wildfire. First, County staff divided the planning area into three study areas: Forest, Resource Lands, and Urban Interface. Next, zoning, census, and infrastructure data from Garfield County GIS was overlaid with wildfire hazard data from the Colorado Forest Service to evaluate assets at risk. The following maps and tables show the wildfire hazard areas and summarize the percentage of assets at risk within each study area.

Table 32: Forest Study Area Community Lifelines and Assets Vulnerable to Wildfire

Forest Study Area					
Infrastructure	**Total Sites**	**% of Total Sites**	**Structures**	**Total Sites**	**% of Total Sites**
Right of Way (Miles)	25.30 mi	64.3%	Residential	15	8.9%
Public Airport	N/A	N/A	Commercial	N/A	N/A
Highway Bridges	1	2.3%	Public Structures	N/A	N/A
Communication Facilities	0	0%	Agricultural	N/A	N/A
Electric Utilities Lines (Miles)	19.38 mi	100%	Church	N/A	N/A
Railroad (Miles)	21.6 mi	100%	Schools	N/A	N/A
Railroad Bridges	1	12.5%	Hospital	N/A	N/A
Road - Aspalt Hight Traffic (Miles)	0 mi	0%	Other	1	5%
Road - Chipseal Moderate Traffice (Miles)	6.17 mi	36.6%	**Number of Improvements**	**Improvements Value**	
Road - Gravel Low Traffic (Miles)	29.04 mi	22.1%	60	$30,597,640	
Gas Wells	0	0%			
Pipeline (Miles)	22.34 mi	61.5%			
Ag and Natural Resource Lands (Square Miles)	58.95 sq mi	94.5%			

Source: Garfield County GIS, Colorado Forest Service, JEO Consulting Group

Figure 32: Forest Study Area Wildfire Hazard

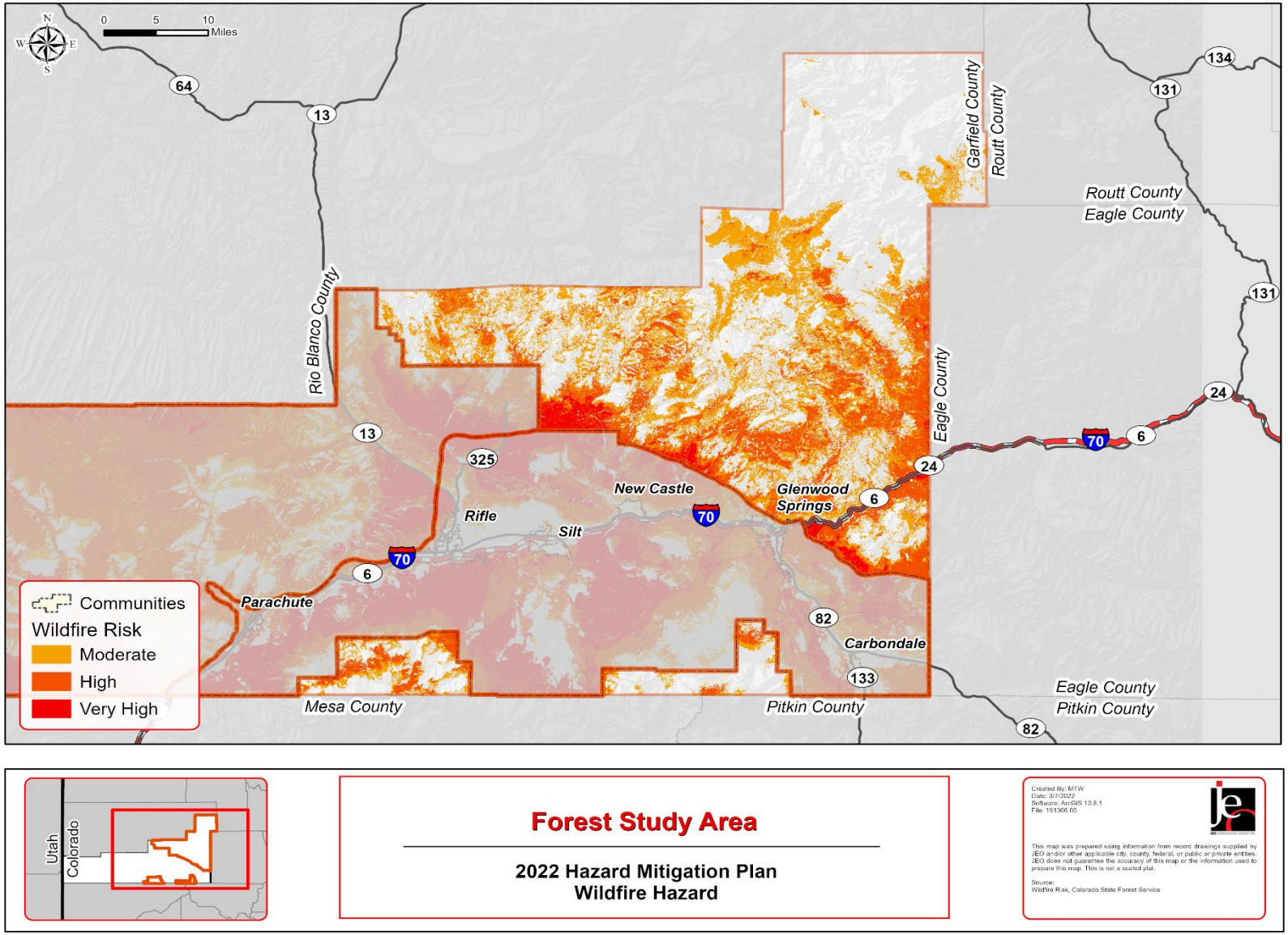


Table 33: Resource Lands Study Area Assets Vulnerable to Wildfire

Resource Study Area					
Infrastructure	**Total Sites**	**% of Total Sites**	**Structures**	**Total Sites**	**% of Total Sites**
Right of Way (Miles)	7.86 miles	9.8%	Residential	15	13.4%
Public Airport	N/A	N/A	Commercial	0	0%
Highway Bridges	4	28.6%	Public Structures	0	0%
Communication Facilities	0	0%	Agricultural	0	0%
Electric Utilities Lines (Miles)	6.32 miles	55.2%	Church	N/A	N/A
Railroad (Miles)	N/A	N/A	Schools	N/A	N/A
Railroad Bridges	N/A	N/A	Hospital	N/A	N/A
Road - Aspalt Hight Traffic (Miles)	7.65 miles	31.1%	Other	0	0%
Road - Chipseal Moderate Traffice (Miles)	7.62 miles	85.7%	**Number of Improvements**	**Improvements Value**	
Road - Gravel Low Traffic (Miles)	80.55 miles	47.5%	114	$38,162,950	
Gas Wells	342	4.2%			
Pipeline (Miles)	613.22 miles	42.0%			
Ag and Natural Resource Lands (Square Miles)	85.41 sq mi	97.4%			

Source: Garfield County GIS, Colorado Forest Service, JEO Consulting Group

Figure 33: Resource Lands Study Area Wildfire Hazard

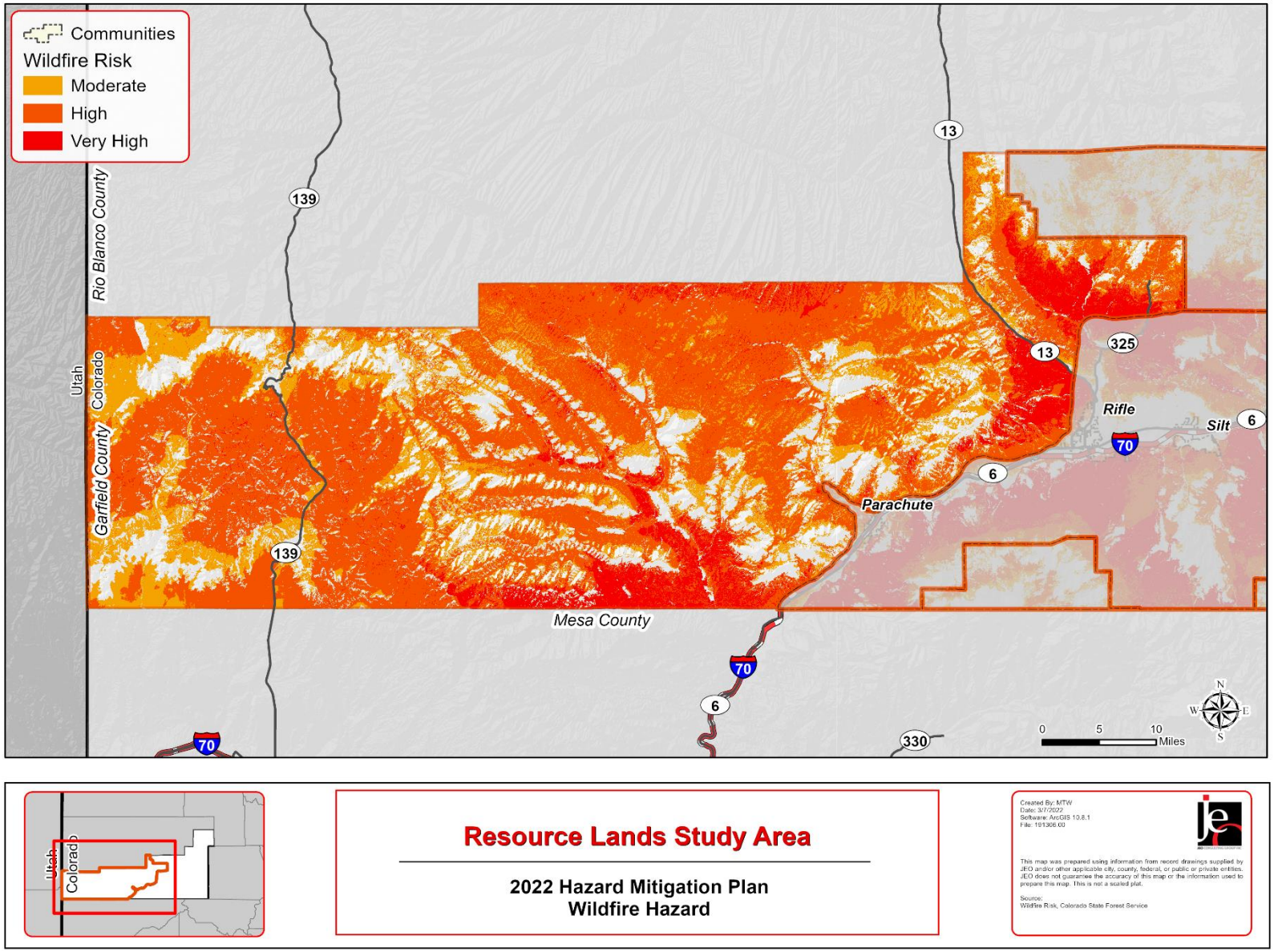
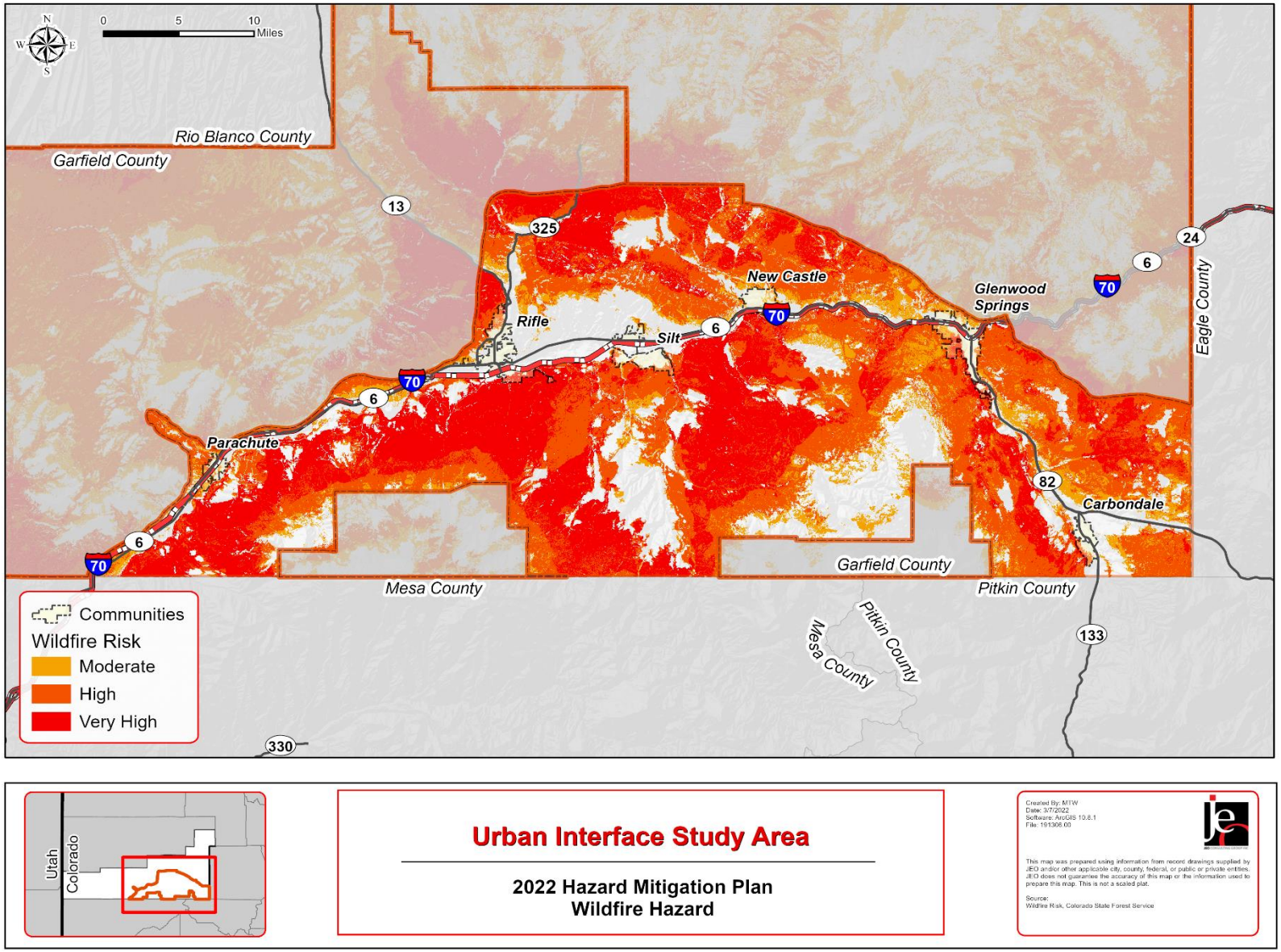


Table 34: Urban Interface Study Area Assets Vulnerable to Wildfire

Urban Interface Study Area					
Infrastructure	**Total Sites**	**% of Total Sites**	**Structures**	**Total Sites**	**% of Total Sites**
Right of Way (Miles)	530.08 miles	53.9%	Residential	1,100	7.5%
Public Airport	1	50%	Commercial	15	1.8%
Highway Bridges	6	4.1%	Public Structures	5	16.7%
Communication Facilities	31	31.3%	Agricultural	5	17.2%
Electric Utilities Lines (Miles)	109.62 miles	62.4%	Church	0	0%
Railroad (Miles)	39.18 miles	56.8%	Schools	0	0%
Railroad Bridges	1	2.8%	Hospital	0	0%
Road - Aspalt Hight Traffic (Miles)	86.1 miles	59.6%	Other	46	7.2%
Road - Chipseal Moderate Traffice (Miles)	107.35 miles	57.4%	**Number of Improvements**	**Improvements Value**	
Road - Gravel Low Traffic (Miles)	98.41 miles	65.6%	4,208	$1,509,530,850	
Gas Wells	3,760	42.5%			
Pipeline (Miles)	582.32 miles	59.6%			
Ag and Natural Resource Lands (Square Miles)	65.46 sq mi	97.5%			

Source: Garfield County GIS, Colorado Forest Service, JEO Consulting Group

Figure 34: Urban Interface Study Area Wildfire Hazard



Drought

Hazard Profile

Drought is generally defined as a natural hazard that results from a prolonged period of below normal precipitation. Although many erroneously consider it a rare and random event, drought is actually a normal, recurrent feature of climate. It occurs in virtually all climatic zones, but its characteristics vary significantly from one region to another. A drought often coexists with periods of extreme heat, which together can cause significant social stress, economic losses, and environmental degradation.

Drought is a slow-onset, creeping phenomenon and its impacts are largely non-structural. Drought normally affects more people than other natural hazards, and its impacts are spread over a larger geographical area. As a result, the detection and early warning signs of drought conditions and assessment of impacts is more difficult to identify than that of quick-onset natural hazards (e.g., flood and storm) that result in more visible impacts. In addition, drought has more than 150 definitions and this lack of a universal definition makes it even harder to indicate the onset and ending. According to the National Drought Mitigation Center (NDMC), droughts are classified into four major types:

- **Meteorological Drought** – is defined based on the degree of dryness and the duration of the dry period. Meteorological drought is often the first type of drought to be identified and should be defined regionally as precipitation rates and frequencies ("norms") vary.

- **Agricultural Drought** – occurs when there is deficient moisture that hinders planting germination, leading to low plant population per hectare and a reduction of final yield. Agricultural drought is closely linked with meteorological and hydrological drought, as agricultural water supplies are contingent upon the two sectors.

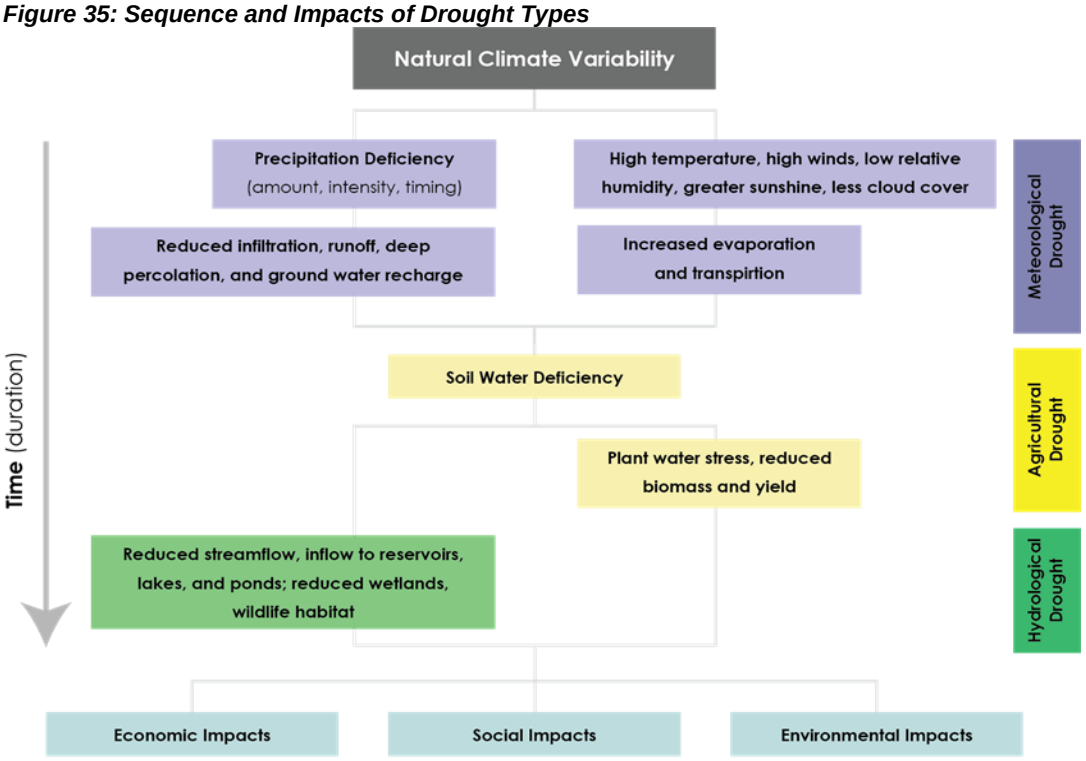
- **Hydrological Drought** – occurs when water available in aquifers, lakes, and reservoirs falls below the statistical average. This situation can arise even when the area of interest receives average precipitation. This is due to the reserves diminishing from increased water usage, usually from agricultural use or high levels of evapotranspiration, resulting from prolonged high temperatures. Hydrological drought often is identified later than meteorological and agricultural drought. Impacts from hydrological drought may manifest themselves in decreased hydropower production and loss of water based recreation.

- **Socioeconomic Drought**– occurs when the demand for an economic good exceeds supply due to a weather-related shortfall in water supply. The supply of many economic goods include, but are not limited to, water, forage, food grains, fish, and hydroelectric power.[43]

The following figure indicates different types of droughts, their temporal sequence, and the various types of effects that they can have on a community.

[43] National Drought Mitigation Center. 2017. "Drought Basics." https://drought.unl.edu/Education/DroughtBasics.aspx.

Figure 35: Sequence and Impacts of Drought Types



Source: National Drought Mitigation Center, University of Nebraska-Lincoln, 2017[44]

Location

The entire County is susceptible to the impacts of drought. Rural areas without redundant sources of water may be more vulnerable to the impacts of drought.

Extent

Due to drought's unique nature and characteristics, there is not one best way to predict and monitor drought. Among the various indices, the Palmer Drought Severity Index (PDSI) has been widely used by state and local governments in the U.S.[45] The USDA uses the U.S. Drought Monitor in determining when to grant emergency drought assistance.[46] Table 35 shows the details of the Palmer classifications. Table 36 shows the classification for the Drought Monitor. Due to the historical record (1895-2021), Garfield County is likely to experience: D1 drought 8.8% of the time, D2 drought 6.1% of the time, D3 drought 3.4% of the time, and D4 drought 3.6% of the time. The county has a cyclical wet and dry period.

Table 35: Palmer Drought Severity Index Classification

Numerical Value	Description	Numerical Value	Description
4.0 or more	Extremely wet	-0.5 to -0.99	Incipient dry spell
3.0 to 3.99	Very wet	-1.0 to -1.99	Mild drought
2.0 to 2.99	Moderately wet	-2.0 to -2.99	Moderate drought
1.0 to 1.99	Slightly wet	-3.0 to -3.99	Severe drought

[44] National Drought Mitigation Center. 2017. "Types of Drought." https://drought.unl.edu/Education/DroughtIn-depth/TypesofDrought.aspx.

[45] National Centers for Environmental Information: National Oceanic and Atmospheric Administration. "Historical Palmer Drought Indices." Accessed 2017. https://www.ncdc.noaa.gov/temp-and-precip/drought/historical-palmers/ .

[46] United States Drought Monitor. "U.S. Drought Monitor." Accessed September 2021. http://droughtmonitor.unl.edu/ .

Numerical Value	Description	Numerical Value	Description
0.5 to 0.99	Incipient wet spell	-4.0 or less	Extreme drought
0.49 to -0.49	Near normal	--	--

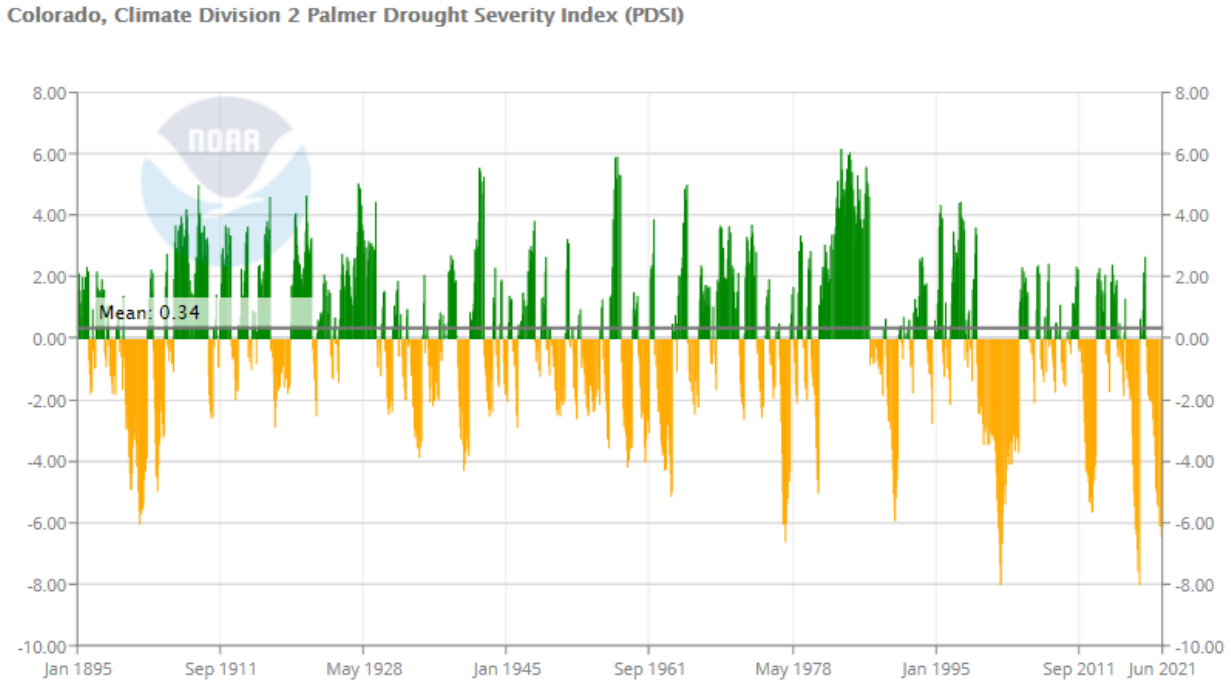
Source: Climate Prediction Center, 2017[47]

Table 36: United States Drought Monitor Classification

Category	Description	PDSI Ranges	Possible Impacts
D0	Abnormally Dry	-1.0 to -1.9	Going into drought: short-term dryness slowing planting, growth of crops or pastures. Coming out of drought: some lingering water deficits; pastures or crops not fully recovered.
D1	Moderate Drought	-2.0 to -2.9	Some damage to crops, pastures; streams, reservoirs, or wells low, some water shortages developing or imminent; voluntary water-use restrictions requested
D2	Severe Drought	-3.0 to -3.9	Crop or pasture losses likely, water shortages common; water restrictions imposed
D3	Extreme Drought	-4.0 to -4.9	Major crop/pasture losses; widespread water shortages or restrictions
D4	Exceptional Drought	-5.0 or less	Exceptional and widespread crop/pasture losses; shortages of water in reservoirs, streams and wells creating water emergencies.

Source: NDMC, 2017

Figure 36: Palmer Drought Severity Index



Source: NOAA

[47] National Drought Mitigation Center. 2021. "Drought Classification." https://droughtmonitor.unl.edu/About/AbouttheData/DroughtClassification.aspx

Historical Occurrences

The PDSI is utilized by climatologists to standardize global long-term drought analysis. The data for Garfield County was collected for Colorado Climate Region 2. This region's period of record started in 1895. The county has experienced several 'extreme' drought and future moderate, severe, and extreme droughts are likely in the future.

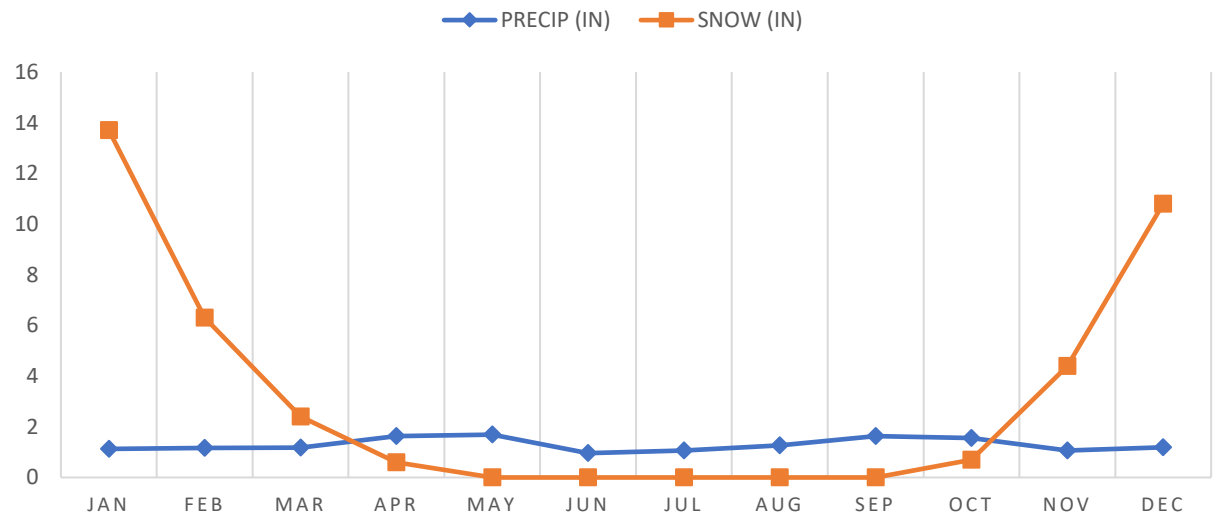
Table 37: Historical Drought Occurrences

Drought Magnitude (PDSI)	Months in Drought	Percent Chance
-1 Magnitude (D0)	185/1,518	12.2%
-2 Magnitude (D1)	134/1,518	8.8%
-3 Magnitude (D2)	93/1,518	6.1%
-4 Magnitude (D3)	51/1,518	3.4%
-5 Magnitude (D4)	55/1,518	3.6%
Total Months in Drought	**518/1,518**	**34.1%**

Source: NDMC, Jan 1895-April 2021

On average, the county receives 22.53 inches of precipitation annually. The following figure shows average precipitation per month in the planning area. Prolonged deviations from the norm showcase drought conditions and influence growing conditions for farmers or resource management needs for local agricultural producers.

Figure 37: Average Monthly Precipitation (inches)



Source: NCEI, 2021

Average Annual Damages

The average annual damages estimate was taken from the SHELDUS database. This does not include losses from displacement, functional downtime, economic loss, injury, or loss of life. Historically, drought causes an average of $0 per year in property damages and $32,860.94 per year in crop damages in the County.

Table 38: Historical Drought Damages

Hazard Type	Total Property Loss	Average Annual Property Loss	Total Crop Loss	Average Annual Crop Loss
Drought	$0	$0	$1,971,656.14	$32,860.94

Source: SHELDUS, 1960-2021

Probability

Drought conditions are also likely to occur regularly in the county. The following table summarizes the magnitude of drought and monthly probability of occurrence.

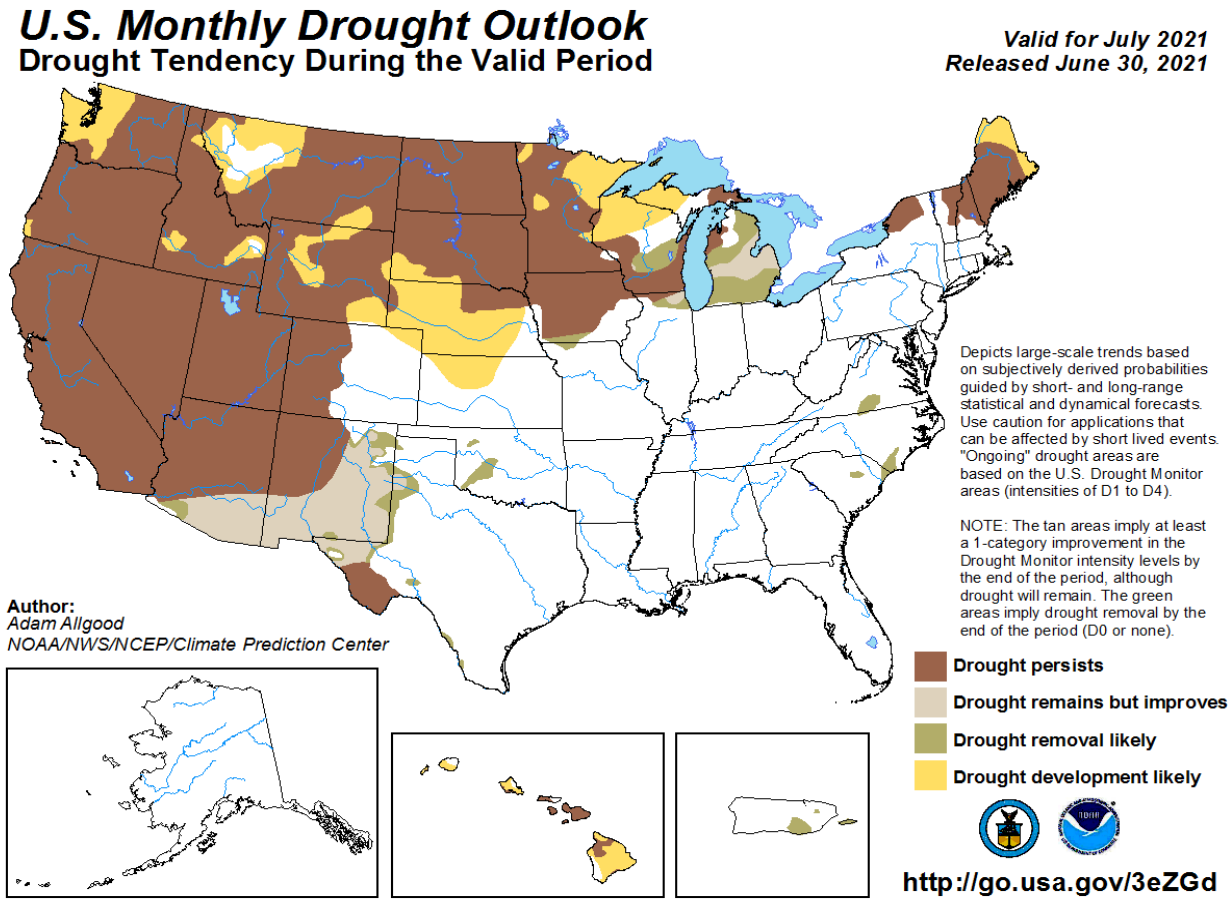
Table 39: Drought Probability

Magnitude	Months in Drought/ Period of Record	Percent Chance
Abnormally Dry	185/1,518	12.2%
Moderate Drought	134/1,518	8.8%
Severe Drought	93/1,518	6.1%
Extreme Drought	51/1,518	3.4%
Exceptional Drought	55/1,518	3.6%

Source: NDMC, Jan 1895-April 2021

The U.S. Seasonal Drought Outlook provides a short-term drought forecast that can be utilized by local officials and residents to examine the likelihood of drought developing or continuing depending on the current situation. The drought outlook is updated consistently throughout the year and should be reviewed on an ongoing basis. The following figure provides the drought outlook for July 2021 as an example.

Figure 38: U.S. Seasonal Drought Outlook



Source: NCEI, July 2021[48]

Climate Trends

Drought is expected to increase in frequency and severity in Colorado due to the projected overall warming. A specific tool developed and utilized in the State of Colorado includes the Future Avoided Cost Explorer[49] (FACE) for Drought. This tool presents an in-depth look at potential future economic impacts of drought on specific sectors of the Colorado economy. The following figures show expected impacts for drought for the current climate and projected future 'Moderate' and 'More Severe Climate' impacts with the anticipated high growth for Garfield County.

Based on the FACE assessments, it is likely that Garfield County will experience worsening impacts from climate change regarding drought. At the current growth rate and only moderate climate impacts, the county may experience up to $1.5 million in total damages annually. Damages may vary across sectors and regions such as bridges, buildings, cattle, crops, rafting, skiing, and fire suppression activities.

[48] National Weather Service. 2021. "U.S. Seasonal Drought Outlook." https://www.cpc.ncep.noaa.gov/products/expert_assessment/sdo_summary.php.

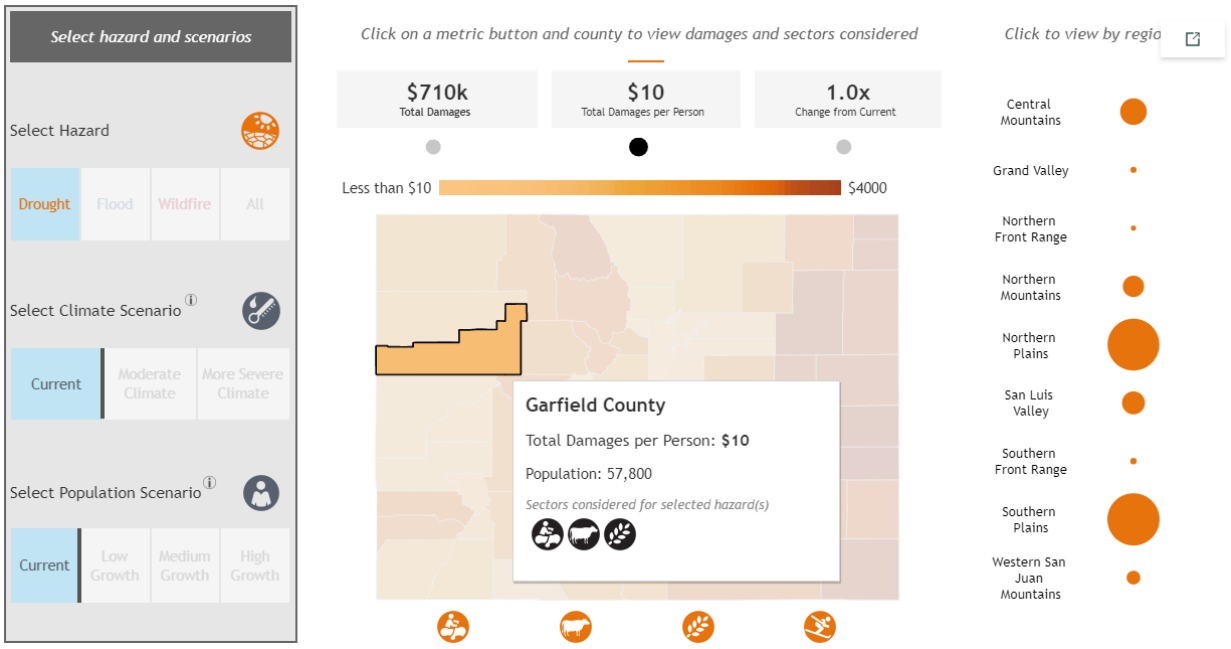
[49] Colorado Water Conservation Board. 2021. "Future Avoided Cost Explorer: Colorado Hazards." https://storymaps.arcgis.com/stories/4e653ffb2b654ebe95848c9ba8ff316e.

Table 40: FACE Anticipated Damages for Drought Matrix

Population Scenario	Climate Scenario		
	Current Climate	Moderate Climate	More Severe Climate
Current Growth Rate	$710k Total Damages $10 total damages/person	$1.5M Total Damages $30 total damages/person	$2M Total Damages $30 total damages/person
Low Growth Rate	$1.2M Total Damages $10 total damages/person	$2.0m Total Damages $20 total damages/person	$4.0M Total Damages $40 total damages/person
Medium Growth Rate	$1.3M Total Damages $10 total damages/person	$2.0m Total Damages $20 total damages/person	$4.0M Total Damages $40 total damages/person
High Growth Rate	$1.3M Total Damages $10 total damages/person	$3.0m Total Damages $30 total damages/person	$4.0M Total Damages $30 total damages/person

Source: CWB FACE, 2021

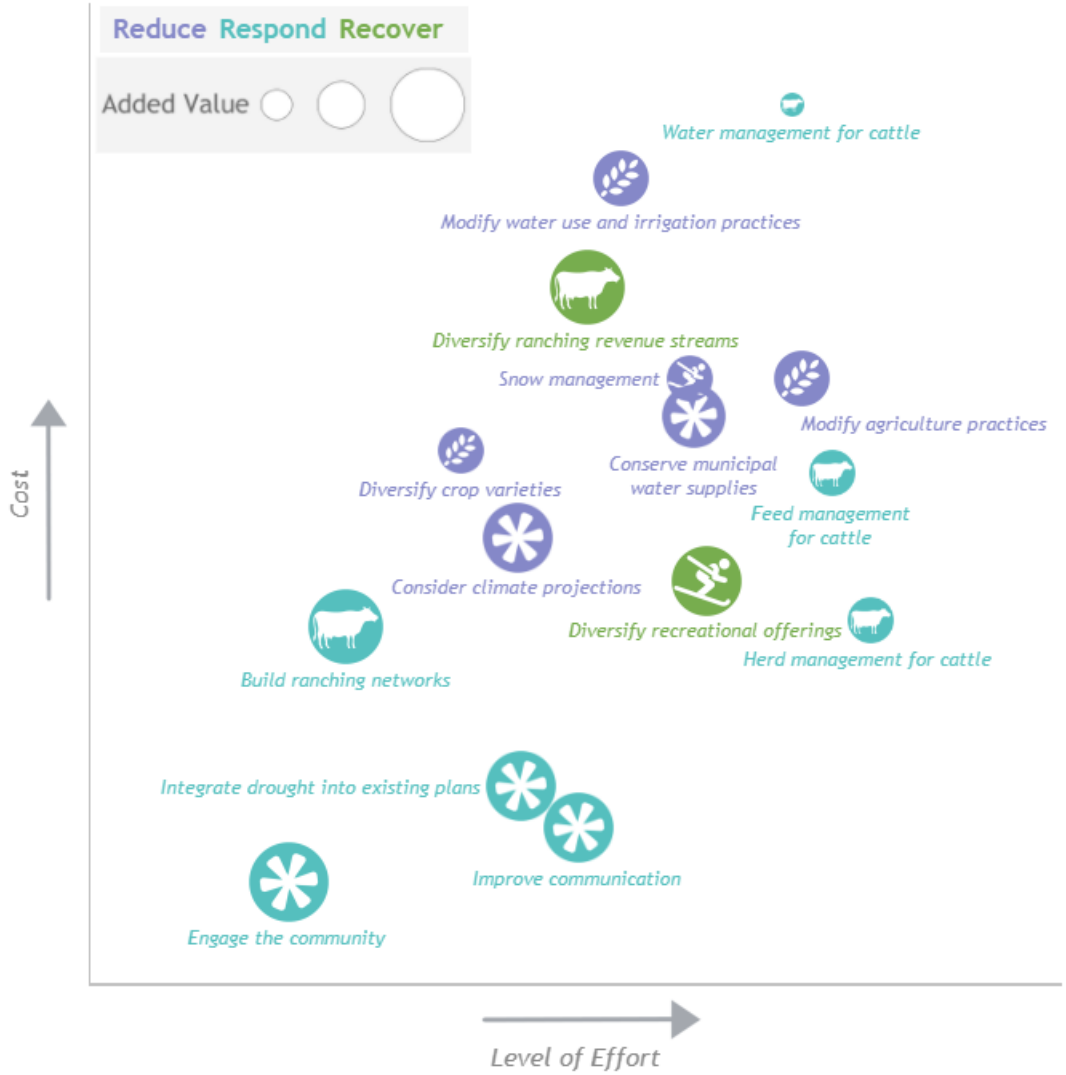
Figure 39: FACE Drought Analysis Example



Source: CWB FACE, 2021

Suggested actions to improve resilience to drought from FACE are shown in the graphic below.

Figure 40: Exploring Resilience Actions for Drought,



Source: CWB FACE, 2021

Vulnerability Assessment

The Drought Impact Reporter is a database of drought impacts throughout the United States with data going back to 2000. The Drought Impact Reporter has recorded a total of 55 drought-related impacts throughout the county. This is not a comprehensive list of droughts which may have impacted the planning area, but only those with reported impacts. These impacts are summarized in the following table.

Table 41: Drought Impacts in Planning Area

Categories	Post Date	Title	Description
Plants & Wildlife	9/30/2005	Plants & Wildlife impact from Media submitted on 9/30/2005	The lower Elk Creek's fish habitat has degraded due to continued drought, increased summer water use, and the creek's flat layout. Lower summer water levels drive away various species of fish that prefer cooler, deeper waters, according to an official with the

Categories	Post Date	Title	Description
			Colorado Division of Wildlife district manager. Without slow-moving, deep-water pools, the fish retreat to other waters and do not spawn in Elk Creek's tributaries.
Relief, Response & Restrictions	10/7/2005	Relief, Response & Restrictions impact from Media submitted on 10/7/2005	The U.S. Department of Agriculture has designated the following Colorado counties as primary agricultural disaster areas due to damages and losses caused by drought that occurred from Jan. 1, 2004 and continuing: Baca, Eagle, Jackson, Pitkin, Summit, Chaffee, Fremont, Kit Carson, Pueblo, Cheyenne, Garfield, Lake, Prowers, Custer, Grand, Lincoln, Routt, Phillips, Yuma, and Kiowa.
Society & Public Health	11/22/2005	Society & Public Health impact from Media submitted on 11/22/2005	Lowered water levels, decreased river flows, and clearer water along the state's upper Colorado River -- all impacts from continued drought conditions-- are benefiting anglers. Fishing flies and lures are more visible to trout through the clear water, and anglers are able to reach areas normally inaccessible due to water levels and flows.
Relief, Response & Restrictions	2/20/2006	Relief, Response & Restrictions impact from Government submitted on 2/20/2006	As of October 2005, the U.S. Department of Agriculture has declared seventeen Colorado counties as primary agricultural disaster areas due to continued drought conditions. These counties included: Archuleta, Conejos, Delta, Dolores, Eagle, Garfield, Kiowa, La Plata, Larimer, Logan, Moffat, Montezuma, Morgan, Phillips, San Miguel, Sedgwick, Washington. Twenty-nine contiguous counties also received drought disaster designations.
Society & Public Health	7/16/2007	Society & Public Health impact from Media submitted on 7/16/2007	A community meeting for Missouri Heights to discuss wildfire prevention and preparedness is planned for July 25, 2007, at the fire station on County Road 100 at 7 pm. The fire chief of Carbondale will speak about wildfire danger, wildfire mitigation, and firefighting and evacuation plans. Other meetings are planned for Marble on July 24 and Redstone on July 26. A meeting is planned for Crystal Valley also. The fire chiefs of Basalt and Carbondale want to make residents aware of the fire danger and encourage wildfire prevention. Both fire chiefs say that this is the worst conditions have been during their tenures.
Relief, Response & Restrictions, Water	4/30/2012	Colorado Water Trust, Nature Conservancy	The Colorado Water Trust was seeking water rights holders willing to temporarily lease water rights to allow water to flow in tributaries to the Colorado, Eagle, Fraser and Gunnison rivers.

Categories	Post Date	Title	Description
Supply & Quality		seeking to purchase water rights to benefit wildlife in Colorado rivers	Meager snowfall this winter will not likely provide enough water for wildlife once municipal and agricultural demands were met, spurring the Colorado Water Trust to act. The agency may have up to $400,000 to use for funding leases. The Nature Conservancy was considering leasing water rights on the Cache la Poudre River to Fort Collins and the Dolores River below the McPhee Reservoir to preserve wildlife. The mountain snowpack was 39 percent of normal, foretelling a summer of tight water supplies. The Denver Post (Colo.), April 26, 2012.A water leasing program put forth by the Colorado Water Trust was successful this summer in directing water to dwindling rivers and streams in the state. The Colorado Water Trust paid for water from water rights holders who did not intend to use their water and allowed the water to remain in the streams for the benefit of wildlife. The Yampa River flowing through Steamboat Springs was one stretch of the more than 190 miles of rivers and streams to profit from the program. Aspen Public Radio (Colo.), Nov. 20, 2012
Relief, Response & Restrictions, Water Supply & Quality	5/21/2012	A drought task force in Colorado requested that the governor increase the response level for the Colorado, Gunnison and Yampa-White river basins	A drought task force in Colorado requested that the governor increase the response level for the Colorado, Gunnison and Yampa-White river basins. This year the snowpack in Colorado was the lowest in the past 10 years and precipitation forecasts through July were not encouraging. Grand Junction Sentinel (Colo.), May 17, 2012
Society & Public Health, Tourism & Recreation	5/21/2012	Low snowpack closed some Colorado ski resorts early	Some ski resorts in Colorado shut their doors early and roads closed for the winter reopened earlier than usual due to the diminished snowpack. The statewide snowpack was 10 percent of normal on May 17. Anchorage Daily News (Alaska), May 17, 2012
Plants & Wildlife, Water Supply & Quality	7/10/2012	Wild horses were relocated from their grazing land near Douglas Pass in	Wild horses were relocated from their grazing land near Douglas Pass because their water supply was depleted. The Denver Post (Colo.), July 9, 2012

Categories	Post Date	Title	Description
		western Colorado	
Agriculture, Relief, Response & Restrictions	7/13/2012	USDA Announces Streamlined Disaster Designation Process	Agriculture Secretary Tom Vilsack July 11 announced a package of program improvements that will deliver faster and more flexible assistance to farmers and ranchers devastated by natural disasters. Vilsack announced three significant improvements to decades-old USDA programs and processes related to Secretarial disaster designations: a final rule that simplifies the process for Secretarial disaster designations and will result in a 40 percent reduction in processing time for most counties affected by disasters; a reduced interest rate for emergency loans that effectively lowers the current rate from 3.75 percent to 2.25 percent; and a payment reduction on Conservation Reserve Program (CRP) lands qualified for emergency haying and grazing in 2012, from 25 to 10 percent. ... The final rule for Secretarial disaster designations is amended as follows: 1) Nearly automatically qualifies a disaster county once it is categorized by the U.S. Drought Monitor as a severe drought for eight consecutive weeks during the growing season. Effective July 12, 1,016 primary counties in 26 states will be designated as natural disaster areas, making all qualified farm operators in the designated areas eligible for low interest emergency loans from USDA Farm Service Agency (FSA), provided eligibility requirements are met. 2) Streamlines the USDA Secretarial designation process, which is expected to provide better service to farmers and ranchers by reducing by approximately 40 percent the amount of time required for designating a disaster area. 3) Removes the requirement that a request for a disaster designation be initiated by a state governor or Indian tribal council, increasing the likelihood that counties will be covered. Indian tribal councils and governors may still submit a request for a designation, but it will not be required in order to initiate a disaster declaration.
Agriculture, Plants & Wildlife	7/23/2012	Grasshoppers, other pests further damaging	Swarms of grasshoppers were devouring crops in parts of Colorado, according to a report in The Denver Post. Farmers must decide whether to use pesticides at a cost of $35 to

Categories	Post Date	Title	Description
		Colorado crops	$45 per acre to salvage crops that were already languishing in drought. Large numbers of western corn root worm and spider mites have appeared in the northeastern part of the state, stated a Colorado State University extension agent for a five-county region in northeast Colorado. The mild winter did not kill the insects and warm, dry spring allowed greater numbers than usual to emerge. The Denver Post (Colo.), July 20, 2012.
Tourism & Recreation, Water Supply & Quality	8/8/2012	Parks and wildlife managers in western Colorado urged anglers to stop fishing in some depleted rivers and streams	Parks and wildlife managers in western Colorado urged anglers to stop fishing in some rivers and streams because flows were reduced and water temperatures climbed to the low 70s, which can be harmful to cold-water fish like trout. Bloomberg (N.Y.), Aug. 7, 2012
Business & Industry, Plants & Wildlife	10/10/2012	Drought played a role in oil and gas drilling companies in northern Colorado struggling to pass state inspections	Drought played a role in oil and gas drilling companies in northern Colorado struggling to pass state inspections. The companies must cover the cost of restoring the land when they leave and must remove equipment, restore 80 percent of the previous vegetation and, in some circumstances, remove traces of service roads that were used to get to drilling sites. With drought in the region and no irrigation, many of the oil companies struggled most with restoring plant life. Between April 2010 and August 2012, the Colorado Oil and Gas Conservation Commission (COGCC) made 154 reclamation inspections and failed 66 of the sites. Sometimes it has taken two to three years and reseeding to return a site to near pre-drilling conditions. Northern Colorado Business Report (Colo.), Oct. 5, 2012
Agriculture, Plants & Wildlife, Relief, Response & Restrictions	4/9/2013	Bulls sales down in Loma, Colorado with poor pasture foreseen for the growing season	Twenty to thirty percent fewer bulls were sold recently at the Western Slope Cattlemen Livestock Auction in Loma as ranchers expected their pastures could carry fewer head of livestock. Consequently, the ranchers did not purchase bulls, stated the co-owner and manager of the auction. The thin snowpack and decreased irrigation water point toward a challenging summer of decreased pasture production for livestock producers. The auction manager also stated that federal agencies, like

Categories	Post Date	Title	Description
			the Bureau of Land Management and the U.S. Forest Service that lease out land for grazing, were reducing the length of time that they will permit grazing and the number of animals permitted to graze. In many cases, the length of time or head count has been trimmed by 10 to 40 percent. Fewer stocker cattle were being fed in the high country and were being purchased because prices for the stockers were down as ranchers wondered if or how they might feed them. Grand Junction Sentinel (Colo.), April 4, 2013
Agriculture, Relief, Response & Restrictions	5/17/2013	Drought-related USDA disaster declarations in 2013	The U.S. Department of Agriculture began declaring counties as primary and secondary disaster areas related to drought in January, for the 2013 growing season. Farmers in affected counties have eight months from the date of the declaration to apply for low-interest emergency loans. For more information, agricultural producers should contact their Farm Service Agency office. From Farm Service Agency press releases, beginning Jan. 9, 2013.
Fire, Relief, Response & Restrictions	6/26/2013	Huge fire burning in Garfield County, Colorado	Six hundred and eighty-two acres burned by fire started by lightning strikes, type three incident management team took over on 6/15/2013. Nearby areas being evacuated.
Tourism & Recreation	6/26/2013	Dust and dirt affecting snow in Western Slope, Colorado	Dirty making snow brown and red, making skiing difficult, increases snowmelt.
Plants & Wildlife, Society & Public Health, Water Supply & Quality	7/18/2013	Drought, low flow and rising water temperatures prompted the Roaring Fork Conservancy in Colorado to hold the Hot Spots for Trout program	The ongoing drought, low flow in the Roaring Fork River and rising water temperatures means that the Roaring Fork Conservancy (RFC) is requesting the publics participation in the Hot Spots for Trout program for a second consecutive year. The Hot Spots for Trout program involves people in monitoring stream temperatures and weather conditions at the hottest time of the day. The observations must be uploaded and shared with the Colorado Parks and Wildlife fisheries staff, White River National Forest and others. The rising water temperatures that accompany low flows can be extremely taxing for fish. In the past week, temperatures of the Roaring Fork River in Glenwood Springs have been hovering around 70 degrees, which is warmer than trout can

Categories	Post Date	Title	Description
			thrive explained the executive director of Roaring Fork Conservancy. Help from local fisherman and other interested citizens will be invaluable in the effort to minimize stressful conditions for our local fish populations during the current drought. The RFC held the program in 2012 because the Roaring Fork River was low, due to drought. Glenwood Springs Post Independent (Colo.), July 16, 2013
Agriculture, Relief, Response & Restrictions	2/7/2014	Drought-Related USDA Disaster Declarations in 2014	The U.S. Department of Agriculture began declaring counties as primary and secondary disaster areas related to drought in January, for the 2014 growing season. Farmers in affected counties have eight months from the date of the declaration to apply for low-interest emergency loans. For more information, agricultural producers should contact their Farm Service Agency office. From Farm Service Agency press releases.
Agriculture, Relief, Response & Restrictions	2/3/2015	Drought-Related USDA Disaster Declarations in 2015	The U.S. Department of Agriculture began declaring counties as primary and secondary disaster areas related to drought in January, for the 2015 growing season. Farmers in affected counties have eight months from the date of the declaration to apply for low-interest emergency loans. For more information, agricultural producers should contact their Farm Service Agency office. From Farm Service Agency press releases.
Tourism & Recreation	3/31/2017	Below-average snowfall causes ski resort to shut down runs in Garfield County, Colorado	Way below average for snowfall this March. Only about 6" for the whole month. Our local ski resort Sunlight had to start shutting down runs over the last couple of weeks due to too much snow melt.CoCoRaHS Report from Station #Glenwood Springs 7.0 S on 3/30/2017
Agriculture	12/1/2017	Cattle sales up in western Colorado	Ranchers in western Colorado were selling more cattle at auction as severe drought gripped the region. At a Loma auction, the auctioneer reported the number of animals being sold to be nearly quadruple the 200 to 400 cattle typically sold weekly. Scottsbluff Star Herald (Neb.), June 20, 2012
Business & Industry, Society & Public Health,	1/10/2018	Low snowpack, limited terrain at Sunlight Mountain	Sunlight Mountain Resort has only had one ski run in operation, due to thin snowpack since the area opened on Dec. 21. Because terrain was limited, Sunlight was not fully staffed for the season and lost some workers, largely lift

Categories	Post Date	Title	Description
Tourism & Recreation		Resort in Garfield County, Colorado	operators, who opted to seek work elsewhere. Idled workers were reassigned duties to keep them busy and were also offered gift cards to local restaurants until more work hours were available. Park City Record (Utah), Jan. 8, 2018
Business & Industry, Tourism & Recreation	1/16/2018	Snow drought reduced visits to Colorado ski resorts	Early season skier visits to Colorado resorts were down 11 to 13 percent in comparison with the previous year, due to low snow conditions, resort operators observed. Colorado Ski Country USA, representing 23 resorts, reported 13 percent fewer visits at its member operations through Dec. 31, as reported in The Aspen Daily News on Jan. 13. Another ski operator, Vail Resorts, reported that visits were down 10.8 percent at its North American ski areas, including four in Colorado, through Jan. 8. Fort Collins Coloradoan (Colo.), Jan. 14, 2018
Agriculture, Relief, Response & Restrictions	5/15/2018	Colorado Drought Mitigation and Response Plan activated	Gov. Hickenlooper activated the Colorado Drought Mitigation and Response Plan on May 2, due to persistent and prolonged drought in parts of the state. Affected counties included Montezuma, La Plata, Archuleta, Conejos, Costilla, Las Animas, Baca, Prowers, Bent, Otero, Huerfano, Alamosa, Rio Grande, Mineral, Hinsdale, San Juan, Dolores, San Miguel, Ouray, Montrose, Saguache, Custer, Pueblo, Crowley, Kiowa, Cheyenne, Lincoln, El Paso, Elbert, Gunnison, Mesa, Delta, Garfield and Rio Blanco. The Drought Task Force was activated with the first meeting taking place on May 7. The Agricultural Impact Task Force will have its first call on May 16.The Prowers Journal (Lamar, Colo.), May 11, 2018
Fire, Relief, Response & Restrictions	6/15/2018	Fire, fireworks restrictions in Garfield County, Colorado	The Garfield County commissioners voted on June 11 to pass an ordinance banning the use of fireworks in the unincorporated parts of the county while the fire danger remained. The Rifle city council also voted to prohibit the use of fireworks within city limits. Garfield County and the Bureau of Land Management enacted stage 1 fire restrictions in the county. Glenwood Springs Post Independent (Colo.), June 11, 2018
Fire, Relief, Response & Restrictions	6/29/2018	Stricter fire regulations in central and western Colorado	The White River National Forest was in stage II fire restrictions, prohibiting all outdoor fires even in established campgrounds. Area counties including Pitkin, Eagle, Summit and Garfield have also enacted stage II restrictions. The stricter regulations were needed, due to the

Categories	Post Date	Title	Description
			dry vegetation and dry forecast. Aspen Times & Aspen Times Weekly (Colo.), June 29, 2018
Agriculture, Water Supply & Quality	7/6/2018	Producer hauling water to sheep in Garfield County, Colorado	It is the first year since we have been in the sheep industry since the early sixties that we have had to haul water to the sheep on the National Forest Permits. It takes me about 5 hrs. a day and we are hauling about 2500 gallons per day which will increase to about 4000 in one more week. From Garfield County, Colorado, on July 3, 2018
Plants & Wildlife, Relief, Response & Restrictions, Tourism & Recreation, Water Supply & Quality	7/23/2018	Colorado anglers urged to fish early and at higher elevations	Anglers in Colorado were urged by Colorado Parks and Wildlife to fish early in the day and to fish rivers and streams at higher elevations. The reasons for the plea was that the drought reduced the amount of flowing water and elevated the temperature of the water. Warmer water holds less oxygen, which stresses the fish. CPW encouraged anglers to fish in reservoirs in state parks. Montrose Daily Press (Colo.), July 22, 2018
Fire	8/2/2018	Active wildfires in western Colorado	Colorado firefighters and firefighting resources have been moved from the southern parts of the state to the western regions as more wildfires spark there. The Cache Creek fire in Garfield County charred 400 acres and was burning in heavy timber near private oil and gas wells and facilities. The Red Canyon fire burned more than 3,000 acres in Rio Blanco County and was extremely active. The Lake Christine fire blackened 12,588 acres in Eagle County and was nearly contained. Denver Post (Colo.), Aug. 1, 2018
Relief, Response & Restrictions, Water Supply & Quality	8/13/2018	Call on the Crystal River in Garfield County, Colorado	Low flows on the Crystal River led the Colorado Water Conservation Board to place a call on the river, asking Division of Water Resources officials to administer an instream flow right on the river. Glenwood Springs Post Independent (Colo.), Aug. 5, 2018
Business & Industry, Tourism & Recreation, Water Supply & Quality	8/17/2018	Fishing, rafting activities altered by drought in Western Colorado	Flows were historically low on the Colorado, Roaring Fork, Frying Pan and Crystal rivers on the Western Slope, which was affecting fishing and altering the schedule of rafting trips. Glenwood Springs Post Independent (Colo.), Aug. 12, 2018
Business & Industry, Plants & Wildlife,	8/30/2018	Low flows threatening trout in west	The Roaring Fork, Frying Pan and Crystal Rivers were flowing at near-record lows, some as low as 30 percent of average, leaving anglers and ecologists worried about the

Categories	Post Date	Title	Description
Relief, Response & Restrictions, Tourism & Recreation, Water Supply & Quality		central Colorado	effects on trout. Trout need cold water to survive, but the low flows warm up quickly and the warm water holds less oxygen. Some guiding services were working to protect the fish by supporting voluntary fishing restrictions and encouraging anglers to monitor stream temperatures. Aspen Public Radio (Colo.), Aug. 29, 2018
Plants & Wildlife	9/21/2018	Fall color arrived early in Colorado	Tree leaves were turning color early across Colorado and the Roaring Fork Valley, due to drought stress. Aspen Public Radio (Colo.), Sept. 18, 2018
Fire, Relief, Response & Restrictions	9/24/2018	Stage one fire restrictions returned to western Colorado	Drought conditions led several counties in western Colorado to return to stage one fire restrictions, including Eagle County, Garfield County, Pitkin County, Rio Blanco County, Summit County, White River National Forest, and the BLM Colorado River Valley Field Office. KJCT-TV ABC 8 (Grand Junction, Colo.), Sept. 21, 2018
Fire, Relief, Response & Restrictions, Tourism & Recreation	10/22/2019	Hunters urged to be cautious with campfires in southern Colorado	Hunters in southern Colorado and on the Western Slope were cautioned by Forest Service officials and Colorado Parks and Wildlife to be especially cautious with campfires, due to extremely dry conditions. The Denver Post (Colo.), Oct. 22, 2019
Fire, Relief, Response & Restrictions	5/8/2020	Campfires prohibited in Colorado's national forests	With April being among the driest in recorded history for Colorado, snowpack was melting quickly. Fire danger was rising, and campfires and charcoal fires were prohibited in national forests throughout the state, due to coronavirus concerns. Associated Press (N.Y.), May 7, 2020
Plants & Wildlife, Relief, Response & Restrictions, Water Supply & Quality	7/24/2020	Increased water releases requested to aid Colorado River endangered fish	The U.S. Fish and Wildlife Service is requesting water releases from high-country reservoirs to increase flows in the Colorado River upstream of the Gunnison River confluence to aid endangered fish. Flow conditions were deteriorating rapidly in the 15-Mile Reach of the Colorado River from the Gunnison confluence to the Grand Valley irrigation diversions upstream and had dropped to about 450 cubic feet per second. Median flow for this time of year at Palisade below where Grand Valley diversion occur is 1,780 cfs, according to U.S. Geological Survey streamflow data. Endangered fish in the Colorado River include â€" the humpback chub, bonytail, Colorado

Categories	Post Date	Title	Description
			pikeminnow and razorback sucker. Grand Junction Sentinel (Colo.), July 24, 2020
Fire, Relief, Response & Restrictions	8/14/2020	Stage 2 fire restrictions on BLM lands in northwest Colorado	The Bureau of Land Management enacted Stage 2 fire restrictions on its lands in Summit, Garfield, Grand, Eagle, Pitkin, Mesa and Rio Blanco counties, effective Aug. 13. Recent fire activity prompted the increased restrictions. Summit Daily News (Frisco, Colo.), Aug. 13, 2020
Fire, Relief, Response & Restrictions	8/18/2020	Coloradoans urged to be "fire-wise" outdoors	Colorado Parks and Wildlife reminded the public to be firewise while recreating outdoors in late summer as numerous large wildfires, such as the Pine Gulch Fire and Grizzly Creek Fire, burned in the state. Montrose Daily Press (Colo.), Aug 18, 2020
Plants & Wildlife, Relief, Response & Restrictions, Tourism & Recreation, Water Supply & Quality	8/20/2020	Fishing closures in northwest Colorado	Voluntary fishing closures were in effect from 2 p.m. to midnight on the White River in Rio Blanco County and on the Colorado River in Garfield County as flows were low. Steamboat Pilot & Today (Steamboat Springs, Colo.), Aug 18, 2020
Agriculture, Plants & Wildlife, Water Supply & Quality	8/21/2020	Drought affected Colorado agriculture, livestock statewide	Drought curbed Colorado's winter wheat harvest, amounting to 46.5 million bushels, which was half of the 98 million bushels harvested in 2019, according to the U.S. Department of Agriculture. Overall yield in 2020 was 30 bushels per acre, compared to 49 bpa in 2019. Nearly 2 million acres of wheat were planted in the Centennial State, but only 1.55 million acres were harvested. Colorado's corn crop is forecast to be about 152 million bushels, down 5 percent from the 2019 harvest of almost 160 million bushels. Twenty-five percent of the corn was rated very poor or poor as of Aug. 2.Irrigation water was short for junior rights holders on the Bessemer Ditch near Pueblo. Irrigation water from the Paonia Reservoir in southwest Colorado ended a month early. Southeastern Colorado ranchers were considering significant herd reductions as the lack of rain severely limited available forage and water for livestock. The Denver Post (Colo.), Aug. 21, 2020

Categories	Post Date	Title	Description
Agriculture, Plants & Wildlife	8/21/2020	Dryland crops, pastures deteriorating in Northwest Colorado	Rangeland grass production and regrowth in northwest Colorado was greatly diminished without rain. Kiowa County Press (Eads, Colo.), Aug 19, 2020
Fire, Relief, Response & Restrictions	8/25/2020	Stage I fire restrictions for areas of western Colorado	Stage I fire restrictions took effect again for the unincorporated parts of Montrose County on Aug. 20, due to high temperatures, numerous large wildfires statewide and intensifying drought. In addition, Grand Mesa, Uncompahgre and Gunnison National Forests, City of Ouray and Ouray County and Delta County enacted the same level of restrictions. Montrose Daily Press (Colo.), Aug. 20, 2020
Fire	9/2/2020	Grizzly Creek Fire burned nearly 51 square miles in Garfield County, Colorado	The Grizzly Creek Fire charred 32,464 acres, or nearly 51 square miles, as of Sept. 1. The blaze was 75 percent contained. Broomfield Enterprise (Colo.), Sept. 2, 2020The Grizzly Fire, east of Glenwood Springs, has kept Interstate 70 closed for more than a week as the flames blackened more than 28,000 acres. The fire was 4 percent contained. The Colorado Sun (Denver, Colo.), Aug. 19, 2020The Grizzly Creek Fire, east of Glenwood Springs in Garfield County, consumed 7.2 square miles and closed a section of Interstate 70 for four days. The Durango Herald (Colo.), Aug. 13, 2020
Agriculture, Plants & Wildlife	9/3/2020	Pastures suffering in Northwest Colorado	Northwest Colorado pasture conditions continued to suffer from drought and heat. The Prowers Journal (Lamar, Colo.), Sept 1, 2020
Agriculture, Plants & Wildlife	9/14/2020	Low hay supplies leading to livestock sales in Colorado	Colorado farmers were not able to sell livestock in February and March as they normally would, due to COVID-19 causing the closing or reduced production in meatpacking plants. Drought has limited hay supplies, putting additional pressure on ranchers and forcing them to sell at low prices. The Aspen Times (Colo.), Sept 6, 2020
Agriculture, Relief, Response & Restrictions	10/2/2020	Colorado drought plan expanded, request for emergency relief	As drought worsened in Colorado, with an area of exceptional drought appearing in the western part of the state, Gov. Jared Polis expanded the second phase of the state drought response plan to all counties. A drought task force will assess initial damages and drought impacts and make recommendations on mitigation measures. Polis also requested that the U.S. Department of Agriculture provide emergency

Categories	Post Date	Title	Description
			relief for Colorado producers as they endure financial losses. Colorado Public Radio (Centennial), Oct 1, 2020
Fire, Relief, Response & Restrictions	3/31/2021	Colorado counties adopt stage 1 fire restrictions	San Miguel County entered Stage 1 fire restrictions on June 30, as did Montrose County on July 2, along with the Uncompahgre Plateau and the Fruita Division of the Grand Mesa, Uncompahgre and Gunnison national forests. Ouray County and city entered into Stage 1 on July 1. Mesa County has been in Stage 1 fire restrictions since June 26.The Daily Sentinel (Grand Junction, Colo.), July 3, 2020
Relief, Response & Restrictions, Water Supply & Quality	4/2/2021	Water conservation encouraged in Colorado's Grand Valley	Residents of the Grand Valley were urged to conserve water as spring runoff is predicted to be 66% of normal. Dry soil is expected to absorb some of the runoff from the below average snowpack. The snow water equivalent was about 80% of normal. The Daily Sentinel (Grand Junction, Colo.), April 1, 2021
Agriculture, Plants & Wildlife	6/18/2021	Western Colorado livestock producers shipping cattle out	Some ranchers in western Colorado were shipping livestock to better pasture or selling them. Water supplies were at historic lows or stopped, due to poor runoff, as dry soil soaked up all moisture. Pasture production was down considerably, making maybe 25% of normal, according to a Saguache County rancher. The Colorado Sun (Denver), June 14, 2021
Fire, Relief, Response & Restrictions	6/19/2021	Stage 1 fire restrictions for Colorado mountains, Western Slope	Stage 1 fire restrictions took effect on June 16 on Bureau of Land Management lands in Grand, Jackson, Eagle, Summit, Larimer, Moffat and Rio Blanco counties, along with BLM lands in the Kremmling, White River and Little Snake field office areas, due to continuing drought, heat and dry lightning. Stage 1 fire restrictions were also enacted in the Arapaho National Forest, the Medicine Bow-Routt National Forests, the San Juan National Forest and Thunder Basin National Grassland. Stage 1 fire restrictions also took effect in Pitkin, Eagle, Routt, Summit, Garfield and Mesa counties. The Denver Channel (Colo.), June 16, 2021
Agriculture, Relief, Response & Restrictions, Water Supply & Quality	7/3/2021	Drought emergency for Western Colorado	Gov. Jared Polis declared a drought emergency for western Colorado as impacts continued and water shortages occurred as the region endured years of intense drought. Colorado Water Conservation Board (Denver), July 1, 2021

Categories	Post Date	Title	Description
Plants & Wildlife, Relief, Response & Restrictions, Tourism & Recreation, Water Supply & Quality	7/21/2021	Stretches of Colorado, Gunnison rivers in Colorado closed to fishing	Anglers were urged to not fish the Colorado and Gunnison rivers, due to unusually low flows and high water temperatures. Some of the Yampa River will likely soon be closed to fishing. With Colorado River flows about half of historical normal in western Colorado, fishing was voluntarily closed between Kremmling and Rifle beginning July 7. The USGS gauge on the Colorado River at Catamount Bridge registered 600 to 700 cubic feet per second, compared to the normal of 1,500 to 2,000 cfs. Some fish mortality has already occurred. 9News (Denver, Colo.), July 7, 2021
Agriculture, Plants & Wildlife	7/27/2021	Cattle being culled heavily in Northwest Colorado	Northwest Colorado ranchers were culling cattle heavily due to drought and short feed supplies. Hay production was lower than normal, whether irrigated or not. Kiowa County Press (Eads, Colo.), July 20, 2021

Source: NDMC, 2021[50]

Drought often causes significant economic, environmental, and social impacts. Although agriculture is the major sector affected, impacts on rural and municipal water supplies, fish and wildlife, tourism, recreation, water quality, soil erosion, the incidence of wildfires, electricity demand, and other sectors are also significant. Also, the indirect impacts of drought on personal and business incomes, tax revenues, unemployment, and other areas are important to note. In general, drought produces a complex web of impacts that ripple through many sectors of the economy. This is largely due to the dependence of so many sectors on water to produce goods and provide services. Along with humans, animals also can be affected by high temperatures, drought conditions, and humidity levels. Additionally, government authorities report that civil disturbances and riots are more likely to occur during heat waves or when water supplies are threatened. It is impossible to predict all the potential impacts, but the common impacts of drought have been compiled by the NDMC and are illustrated in Table 42.

Table 42: Classification of Drought-Related Impacts

Problem Sectors	Impacts
Economic	• Loss from crop production ▪ Annual and perennial crop losses; damage to crop quality ▪ Reduced productivity of cropland (wind erosion, etc.) ▪ Insect infestation ▪ Plant disease ▪ Wildlife damage to crops • Loss from dairy and livestock production ▪ Reduced productivity of range land ▪ Forced reduction of foundation stock ▪ Closure/limitation of public lands to grazing ▪ High cost/unavailability of water for livestock ▪ High cost/unavailability of feed for livestock ▪ High livestock mortality rates

[50] National Drought Mitigation Center. 2021. "NDMC Drought Impact Reporter." https://droughtreporter.unl.edu/map/

Problem Sectors	Impacts
	▪ Increased predation ▪ Range fires • Loss from timber production ▪ Forest fires ▪ Tree disease ▪ Insect infestation ▪ Impaired productivity of forest land • Loss from fishery production ▪ Damage to fish habitat ▪ Loss of young fish due to decreased flows • Loss of national economic growth, hindrance of economic development • Income loss for farmers and others directly affected • Loss of farmers through bankruptcy • Loss to recreational and tourism industry • Loss to manufacturers and sellers of recreational equipment • Increased energy demand and reduced supply because of drought-related power curtailments • Costs to energy industry and consumers associated with substituting more expensive fuels (oil) for Hydroelectric power • Loss to industries directly dependent on agricultural production (e.g., machinery) • Decline in food production/disrupted food supply ▪ Increase in food prices ▪ Increased importation of food (higher costs) • Disruption of water supplies • Unemployment from drought-related production declines • Strain on financial institutions (foreclosures, greater credit risks, capital shortfalls, etc.) • Revenue losses to federal, state, and local governments (from reduced tax base) • Deterred capital investment, expansion • Dislocation of businesses • Revenues to water supply firms • Loss from impaired navigability of streams, rivers, and canals • Cost of water transport or transfer • Cost of new or supplemental water resource development
Environmental	• Damage to animal species ▪ Reduction and degradation of fish and wildlife habitat ▪ Lack of feed and drinking water ▪ Disease ▪ Increased vulnerability to predation (e.g., from species concentration near water) • Loss of biodiversity • Wind and water erosion of soils • Reservoir and lake drawdown • Damage to plant species

Problem Sectors	Impacts
	• Water quality effects (e.g., salt concentration, increased water temperatures, pH, dissolved oxygen) • Air quality effects (dust, pollutants) • Visual landscape quality (dust, vegetative cover, etc.) • Increased fire hazard • Estuarine impacts; changes in salinity levels, reduced flushing • Insect infestation
Social	• Increased groundwater depletion (mining), land subsidence • Loss of wetlands • Loss of cultural sites • Food shortages (decreased nutritional level, malnutrition, famine) • Loss of human life (e.g., food shortages, heat) • Public safety from forest and range fires • Conflicts between water users, public policy conflicts • Increased anxiety • Loss of aesthetic values • Health-related low flow problems (e.g., diminished sewage flows, increased pollutant concentrations, etc.) • Recognition of institutional constraints on water use • Inequity in the distribution of drought impacts/relief • Decreased quality of life in rural areas • Increased poverty • Reduced quality of life, changes in lifestyle • Social unrest, civil strife • Population migration (rural to urban areas) • Reevaluation of social values • Increased data/information needs, coordination of dissemination activities • Loss of confidence in government officials • Recreational impacts

Source: NDMC, 2017

Future Development

Future developments throughout the county are likely to increase the county's water demand, increase travel on local transportation routes, and influence continued growth on economic sectors at risk from the impacts of drought. Growing communities will need to adapt and account for increased water demands for residential, commercial and industrial development. Economic sectors including forestry, tourism, and recreation are likely to be negatively impacted by drought.

Flooding

Flooding occurs when climate or localized weather patterns, geology, and hydrology combine to create conditions where water flows outside of its usual course. A flood is a temporary condition of partial or complete inundation of normally dry land areas. Types of floods include riverine flooding (the overflow of stream banks); urban flooding (rapid accumulation of runoff of surface waters from any source); mudflows or the sudden collapse of shoreline land.

Rate of rise, magnitude (or peak discharge), duration, and frequency of floods are a function of specific geographic characteristics. Generally, the rise in water surface elevation is quite rapid in small (and steep gradient) streams and slow in large (and flat sloped) streams. The causes of floods relate directly to the accumulation of water from precipitation, rapid snowmelt, or the failure of man-made structures, such as dams or levees. Floods caused by precipitation are further classified as coming from: rain in a general storm system; rain in a localized intense thunderstorm; melting snow; rain on melting snow; and ice jams. Garfield County is at greatest risk to riverine and sheet flooding in steep sloped regions.

Each of these causes result in floods that have distinct characteristics relative to flow rate, rate of rise, volume, duration, and flood season.

- **General rain floods** are characterized by a slow steady rise in stream stage and a peak flood of long duration. They typically result from moderate to heavy rainfall occurring over a wide geographic area lasting several days. The capacity of a given waterway is altered both by accumulated precipitation and by the various minor streams or channels that feed into the waterway. The general rain flood season is historically from the beginning of May through October. Because the rate of rise is slow and the time available for warning is great, few lives are usually lost, but millions of dollars in valuable public and private property are at risk.

- **Thunderstorm floods/Flash floods** are caused by intense rain over basins of relatively small areas. They are characterized by a sudden rise in stream level, a short duration, and a relatively small volume of runoff. Because there is little or no warning time, the term “flash flood” is often used to describe thunderstorm floods. They are often more severe following a fire event, when vegetation that normally slows the flow of water into waterways is burned.

  Colorado’s thunderstorm flood season is from the middle of July through October. During this time of year, large general rainstorms occur over western Colorado. These rainstorms are most often caused when warm moist air from the

Flood Hazard 101

What is a *floodplain*?

A floodplain is a land area adjacent to a river, stream, lake, estuary, or other water body that is subject to flooding. These areas, if left undisturbed, act to store excess floodwater. The floodplain is made up of two sections: the flood fringe and the floodway.

What is the *floodway*?

The floodway is one of two main sections that make up the floodplain. Unlike floodplains, floodways do not reflect a recognizable geologic feature, but are defined for regulatory purposes. For National Flood Insurance Program (NFIP) purposes, floodways are defined as the channel of a river or stream, and the overbank areas adjacent to the channel. The floodway carries the bulk of the floodwater downstream and is usually the area where water velocities and forces are the greatest. NFIP regulations require that the floodway be kept open and free from development or other structures so that flood flows are not obstructed or diverted onto other properties. The NFIP floodway definition is “the channel of a river or other watercourse and adjacent land areas that must be reserved in order to discharge the base flood without cumulatively increasing the water surface elevation more than one foot. Floodways are not mapped for all rivers and streams but are generally mapped in developed areas.

What is the *flood fringe*?

The flood fringe refers to the outer portions of the floodplain, beginning at the edge of the floodway and continuing outward. This is the area where development is most likely to occur, and where precautions to protect life and property need to be taken.

Gulf of Mexico combines with cold fronts moving into Colorado from the Pacific Northwest. When these weather phenomena collide, long lasting general rainstorms can occur.

- **Snowmelt floods** result from the melting of the winter snowpack in high mountain areas. Snowmelt floods typically begin as spring runoff appears, after the first spring warming trend. If the trend continues up to eight to ten consecutive days in a basin where the snowpack has a water content more than about 150 percent of average, serious flooding can develop. The total duration of snowmelt floods is usually over a period of weeks rather than days. They yield a larger total volume in comparison to other types of floods in Colorado. Peak flows, however, are generally not as high as flows for the other types. A single cold day or cold front can interrupt a melting cycle causing the rising water to decline and stabilize until the cycle can begin again. Rain on snowmelt exacerbates an already tenuous situation as snowmelt waters rush down heavily incised stream channels. Usually such rain is over a small part of a basin, and the resulting flood is of short duration and may often go unnoticed in the lower reaches of a large drainage basin. Once snowmelt floods have peaked, the daily decreases are moderate, but fairly constant. Snowmelt flooding usually occurs in May, June, and early July.

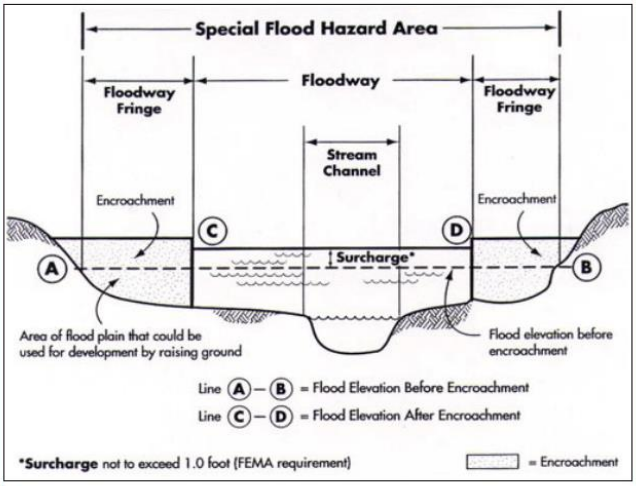
- **Ice jam floods** can occur by two phenomena. Streams in mountain floodplains ice over during extended cold periods of 20 to 40 degrees below zero. Channels become frozen solid and overbank flow occurs, resulting in ice inundation in the floodplains. Ice jam floods occur when frozen water in the upper reaches of a stream abruptly begins to melt due to warm Chinook winds. Blocks of ice floating downstream can become lodged at constrictions and form a jam. The jam can force water to be diverted from the stream channel causing a flood. The ice jam can also break up, suddenly causing a surge of water as the "reservoir" that was formed behind it is released. Ice jamming occurs in slow moving streams where prolonged periods of cold weather are experienced.

Flood Hazard 101

When structures or fill are placed in the floodway, water is displaced. Development raises the base flood elevation by forcing the river to compensate for the flow space obstructed by the structures and/or fill. When structures or materials are added to the floodway and no fill is removed to compensate, serious problems can arise. Floodwaters may be forced away from historic floodplain areas. As a result, other existing floodplain areas may experience floodwaters that rise above historic levels.

In highly urbanized areas, increased paving can lead to an increase in volume and velocity of runoff after a rainfall event, exacerbating the potential flood hazards. Care should be taken in the development and implementation of stormwater management systems to ensure that these runoff waters are dealt with effectively.

Floodplain Schematic



Location

Garfield County is located within Division 6 Yampa River Basin and Division 5 Colorado River Basin drainage areas in the state. Risk Mapping, Assessment, and Planning (Risk MAP) is a FEMA program that provides communities with flood information and additional flood risk data that can be used to enhance their mitigation plans and take action to better protect residents. According to the Colorado Water Conservation Board, "A FEMA Risk MAP county-wide study, impacting the communities of communities of Carbondale, Cattle Creek, Glenwood Springs, New Castle, Parachute, Rifle, Silt, and Unincorporated areas of the county is underway. Garfield County currently uses paper FIRM maps that were effective in 1986. Once this study is complete, Garfield County will be updated to

digital mapping with updated special flood hazard areas for all effective streams. In total, 93 miles of detailed (Zone AE) and 97 miles of approximate (Zone A) are being studied, which includes 31.4 miles of previously non-model backed Zone A streams were updated by enhancing the county-wide 2-Dimensional (2D) base level engineering (BLE) analysis of Garfield County conducted in 2018 to Zone A quality. These values include additional stream reaches that were scoped in coordination with the county and communities in Spring 2021 and are being incorporated into the Risk MAP study. It is anticipated that hydrology and hydraulics for the additional streams will be performed through 2021 and early 2022, and the next Flood Risk Review meeting with the county will occur in Spring 2022."

As such, Digital Effective Digital Flood Insurance Rate Maps (DFIRM) were not available for jurisdictions within the planning area. Therefore, the FIRM maps were georeferenced to estimate vulnerability. Table 43 shows the current status of FIRM panels within the county.

The flood hazard area shown in this plan are not regulatory, and are only approximations of vulnerability. Specific areas of concern for flooding exist along the Colorado River and Roaring Fork River. Other creeks of concern may include Parachute Creek, East Divide Creek, Canyon Creek, Deep Creek, and Rifle Creek. For additional details on localized flood risk such as flood zone types, please refer to the official FIRM available from FEMA's Flood Map Service Center

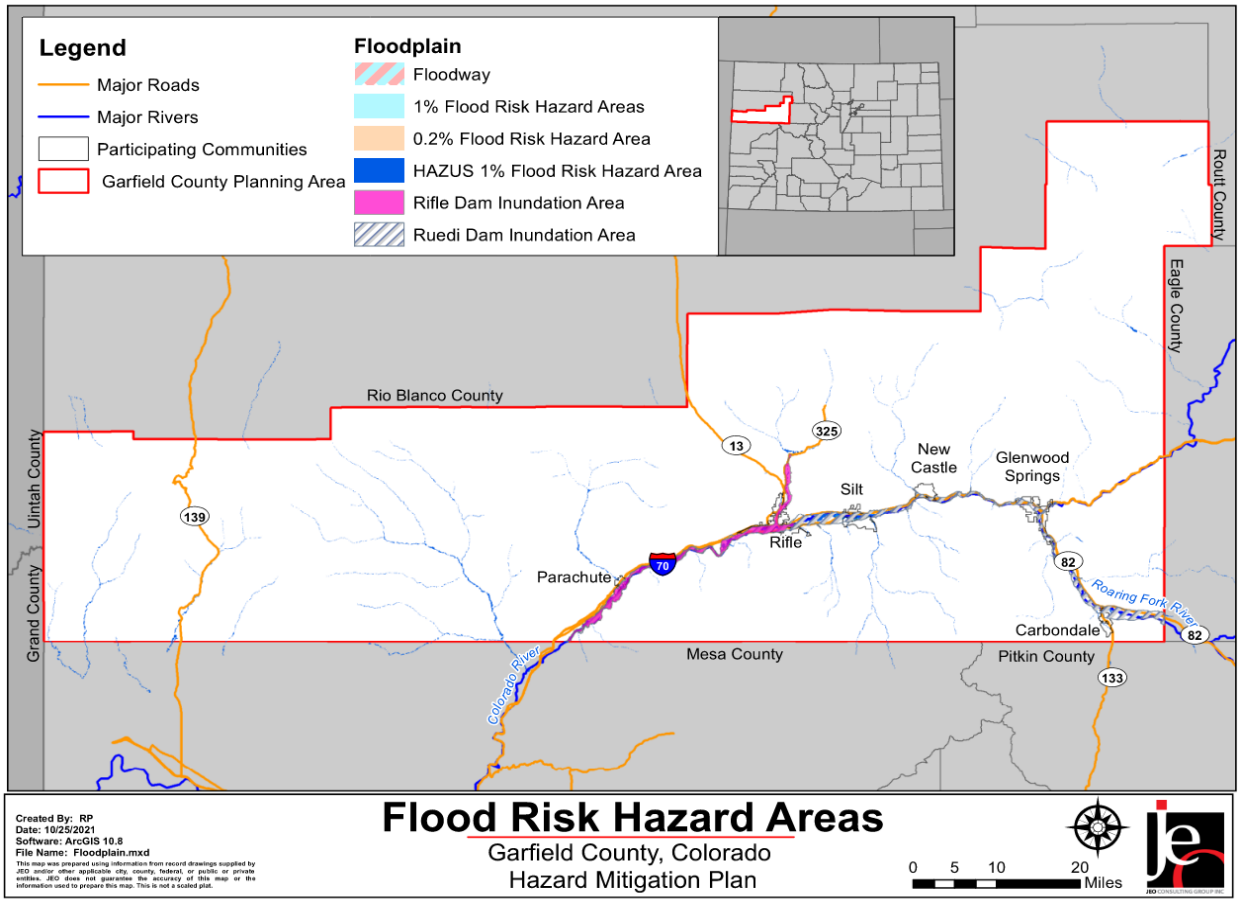
Table 43: FEMA FIRM Panel Status

Jurisdiction	Panel Number	Effective Date
Garfield County	080205IND0A; 080205FND0A; 0802051091C; 0802051092C; 0802051111C; 0802050955B; 0802050964B; 0802050965B; 0802051015B; 0802051043B; 0802051045B; 0802051315B; 0802051351B; 0802051352B; 0802051353B; 0802051354B; 0802051431B; 0802051432B; 0802051434B; 0802051445B; 0802051453B; 0802051465B; 0802051470B; 0802051705B; 0802051855B; 0802051856B; 0802051857B; 0802051858B; 0802051859B; 0802051870B; 0802051880B; 0802050955; 0802050964; 0802050965; 0802051015; 0802051043; 0802051351; 0802051352; 0802051353; 0802051354; 0802051431; 0802051432; 0802051434; 0802051445; 0802051453; 0802051465; 0802051470; 0802051855; 0802051856; 0802051857; 0802051858; 0802051859; 0802051870; 0802051880	08/02/2006 01/03/1986
Carbondale	080234INDO; 08234FNDO; 0802341858A; 0802341859A; 0802341858; 0802341859	02/05/1986
Glenwood Springs	080071INDO; 080071FNDO; 0800711045C; 0800711431C; 0800711432C; 0800711434C; 0800711453C; 0800711431; 0800711432; 0800711434; 0800711453	10/15/1985
New Castle	080256	07/25/1975
Parachute	080215001A	09/27/1991

Jurisdiction	Panel Number	Effective Date
Rifle	085078INDO; 085078FNDO; 0850780964D; 0850781351D; 0850781352D; 0850781353D; 0850781354D; 0850780964; 0850781351; 0850781352; 0850781353; 0850781354	01/03/1986
Silt	080223IND0A; 0802231091B; 0802231092B; 0802231093B; 0802231111B; 080223113B	08/02/2006

Of note, Garfield County is currently in a floodplain remapping effort. Therefore, a Tier 1 HAZUS analysis was used to determine flood hazard risk areas. Specific areas within community boundaries (Silt and Rifle) do include a FEMA designated floodplain which has also been included here.

Figure 41: Floodplain Areas in Garfield County



Extent

The NWS has three categories to define the severity of a flood once a river reaches flood stage as indicated in Table 44. Based on the historic record, future flooding events in Garfield County are likely to be minor or moderate flooding events.

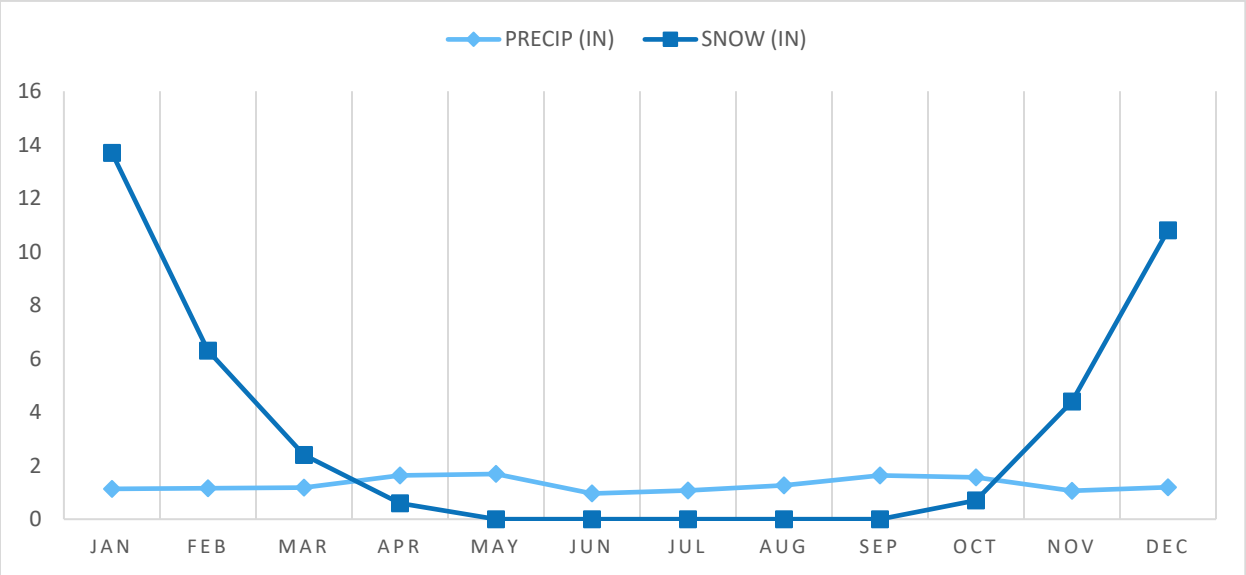
Table 44: Flood Stages

Flood Stage	Description of Flood Impacts
Minor Flooding	Minimal or no property damage, but possible public threat or inconvenience
Moderate Flooding	Some inundation of structures and roads near streams; some evacuations of people and/or transfer of property to higher elevations are necessary
Major Flooding	Extensive inundation of structures and roads. Significant evacuations of people and/or transfer of property to higher elevations

Source: NWS, 2012[51]

The following figure shows the normal average monthly precipitation and snowfall for the county from NCEI, which is helpful in determining whether any given month is above, below, or near normal in precipitation. As indicated in Figure 43 the most common month for flooding within the county is July.

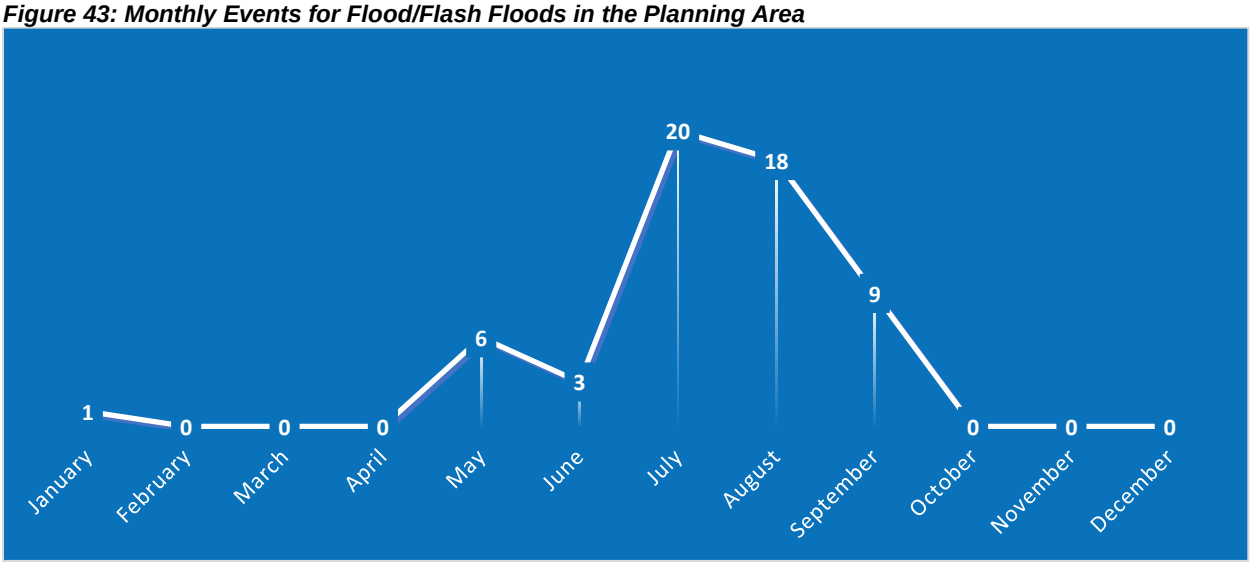
Figure 42: Average Monthly Precipitation



Source: NCEI, 1991-2020

[51] National Weather Service. "National Weather Service Manual 10-950 December 4, 2012." Accessed 2017. https://www.nws.noaa.gov/directives/sym/pd01009050curr.pdf.

Figure 43: Monthly Events for Flood/Flash Floods in the Planning Area



Source: NCEI, 2021

National Flood Insurance Program (NFIP)

The NFIP was established in 1968 to reduce flood losses and disaster relief costs by guiding future development away from flood hazard areas where feasible; by requiring flood resistant design and construction practices; and by transferring the costs of flood losses to the residents of floodplains through flood insurance premiums. In return for availability of federally backed flood insurance, jurisdictions that participate in the NFIP must agree to adopt and enforce floodplain management standards to regulate development in special flood hazard areas (SFHA) as defined by FEMA's flood maps. One of the strengths of the program has been keeping people away from flooding rather than keeping the flooding away from people – through historically expensive flood control projects.

The following tables summarize NFIP participation and active policies within Garfield County. It should be noted that while the number of policies in force may change monthly and annually as representatives enroll, maintain, or lapse policies, the total number of losses and payments are cumulative over time.

Table 45: NFIP Participation

Jurisdiction	Initial FHBM Identified	Initial FIRM Identified	Current Effective Map Date	Reg-Emer Date	Participation in NFIP
Garfield County	-	12/15/1977	8/2/2006	12/15/1977	Yes
Carbondale	8/29/1975	2/5/1986	2/5/1986	2/5/1986	Yes
Glenwood Springs	11/14/1975	10/15/1985	10/15/1985	7/16/1979	Yes
New Castle	7/25/1975	-	7/25/1975	7/22/2004(E)	Yes
Parachute	8/13/1976	9/27/1991	9/27/1991	9/27/1991	Yes
Rifle	-	6/15/1973	1/3/1986	6/15/1973	Yes
Silt	7/25/1975	4/1/1987	8/2/06(L)	4/1/1987	Yes

Source: NFIP Community Status Book, September 2021[52]
(E) indicates entry in emergency program; (L) indicates original FIRM by letter – All Zone A, C, and X

Table 46: NFIP Policies In-Force and Total Payments

Jurisdiction	Policies In-Force	Total Coverage	Total Premiums	Total Losses	Total Net Dollars Paid
Garfield County	87	$27,903,200	$87,345	9	$5,728
Carbondale	8	$2,800,000	$3,918	0	$0
Glenwood Springs	20	$8,467,100	$44,263	10	$26,590
New Castle	-	-	-	-	-
Parachute	-	-	-	-	-
Rifle	26	$7,289,800	$20,067	8	$44,686
Silt	-	-	-	-	-

Source: NFIP HUDEX Data by Geography, August 2021[53]

Other regulatory products reviewed and utilized in this planning process include Letter of Map Amendments (LOMAs), Letter of Map Revisions (LOMRs), and Flood Insurance Studies (FIS) as available and applicable. This plan highly recommends and strongly encourages each plan participant to remain in good standing and continue involvement in the NFIP. Jurisdictions are also encouraged to initiate activities above the minimum participation requirements, which are described in the Community Rating System (CRS) Coordinator's Manual (FIA-15/2013).[54] No communities in Garfield County participate in the CRS.

NFIP Repetitive Loss Structures

The Colorado NFIP Coordinator was contacted to determine if any existing buildings, infrastructure, or critical facilities are classified as an NFIP Repetitive Loss Structure. As of September 2021, there are no repetitive loss structures located within Garfield County.

Historical Occurrences

According to the NCEI, there have been 57 flooding events since 1996.

Table 47: Historical Flooding Occurrences

Event Type	Number of Events	Average Number of Events per Year	Total Injuries	Total Deaths
Flash Flood	40	1.6	0	1
Flood	17	0.7	0	0

Source: NCEI January 1996 to July 2020

Average Annual Damages

The average annual damages estimate was taken from the SHELDUS database and includes aggregated calculations for each type of flooding as provided in the database. This does not include losses from displacement, functional downtime, economic loss, injury, or loss of life.

[52] Federal Emergency Management Agency. "The National Flood Insurance Program Community Status Book." Accessed September 2021. https://www.fema.gov/flood-insurance/work-with-nfip/community-status-book.

[53] Federal Emergency Management Agency. "Flood Insurance Data and analytics: Claims Data." August 2021. https://nfipservices.floodsmart.gov/reports-flood-insurance-data.

[54] Federal Emergency Management Agency. 2017. "National Flood Insurance Program Community Rating System Coordinator's Manual." https://www.fema.gov/sites/default/files/documents/fema_community-rating-system_coordinators-manual_2017.pdf.

According to SHELDUS, flooding caused $7,428,653.20 in property damages and $635,493.16 in crop damages in Garfield County from 1960-2019.

Table 48: Historical Flooding Damages

Total Property Damages	Average Annual Property Damages	Total Crop Damages	Average Annual Crop Damages
$1,505,457.44	$27,371.95	$272,413.79	$4,952.98

Source: SHELDUS, 1960-2015

Probability

Given the historic record of occurrence for flooding events (at least one flood event reported in 17 out of 26 years on record), for the purposes of this plan, the annual probability of flood occurrence is 65 percent.

Climate Trends

Current climatic trends are expected to result in decreased streamflow in Colorado's major rivers. As a result, the risk of riverine flooding may reduce. However, it is probable that the state will experience an increase in frequency and magnitude of winter precipitation, this in combination in warming air and surface temperatures may produce earlier spring runoff. This may lead to an increase in riverine flooding during the early months of the year, and a decrease in riverine flooding towards the end of the year.

A specific tool developed and utilized in the State of Colorado includes the Future Avoided Cost Explorer[55] (FACE) for Flooding. This tool presents an in-depth look at potential future economic impacts of flooding on specific sectors of the Colorado economy. The following figures show expected impacts for flooding for the current climate and projected future 'Moderate' and 'More Severe Climate' impacts with the anticipated high growth for Garfield County.

Based on the FACE assessments, it is likely that Garfield County will experience worsening impacts from climate change regarding flooding. At the current growth rate and only moderate climate impacts, the county may experience up to $12,000,000 in total damages annually. Damages may vary across sectors and regions such as bridges, buildings, cattle, crops, rafting, skiing, and fire suppression activities.

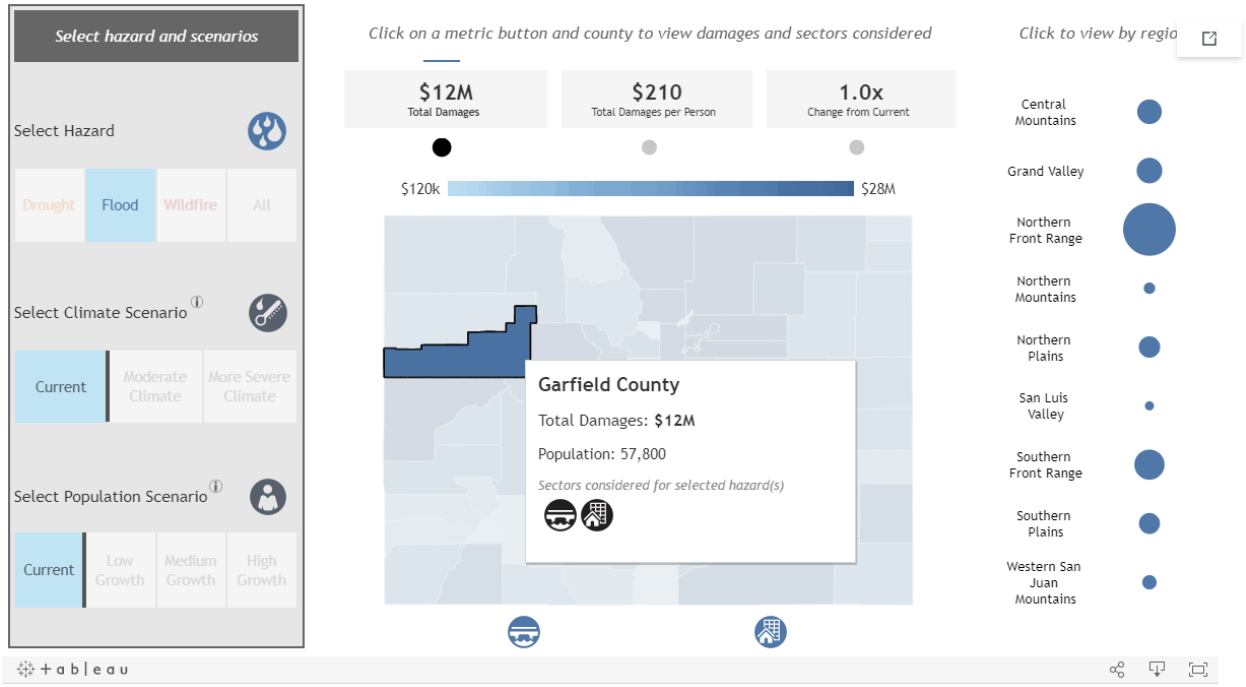
Table 49: FACE Anticipated Damages for Flooding Matrix

Population Scenario	Climate Scenario		
	Current Climate	Moderate Climate	More Severe Climate
Current Growth Rate	$12M Total Damages $210 total damages/person	$35M Total Damages $610 total damages/person	$46M Total Damages $800 total damages/person
Low Growth Rate	$15M Total Damages $160 total damages/person	$40M Total Damages $430 total damages/person	$60M Total Damages $640 total damages/person
Medium Growth Rate	$15M Total Damages $140 total damages/person	$40M Total Damages $380 total damages/person	$60M Total Damages $570 total damages/person
High Growth Rate	$15M Total Damages $130 total damages/person	$40M Total Damages $340 total damages/person	$60M Total Damages $510 total damages/person

Source: CWB FACE, 2021

[55] Colorado Water Conservation Board. 2021. "Future Avoided Cost Explorer: Colorado Hazards." https://storymaps.arcgis.com/stories/4e653ffb2b654ebe95848c9ba8ff316e.

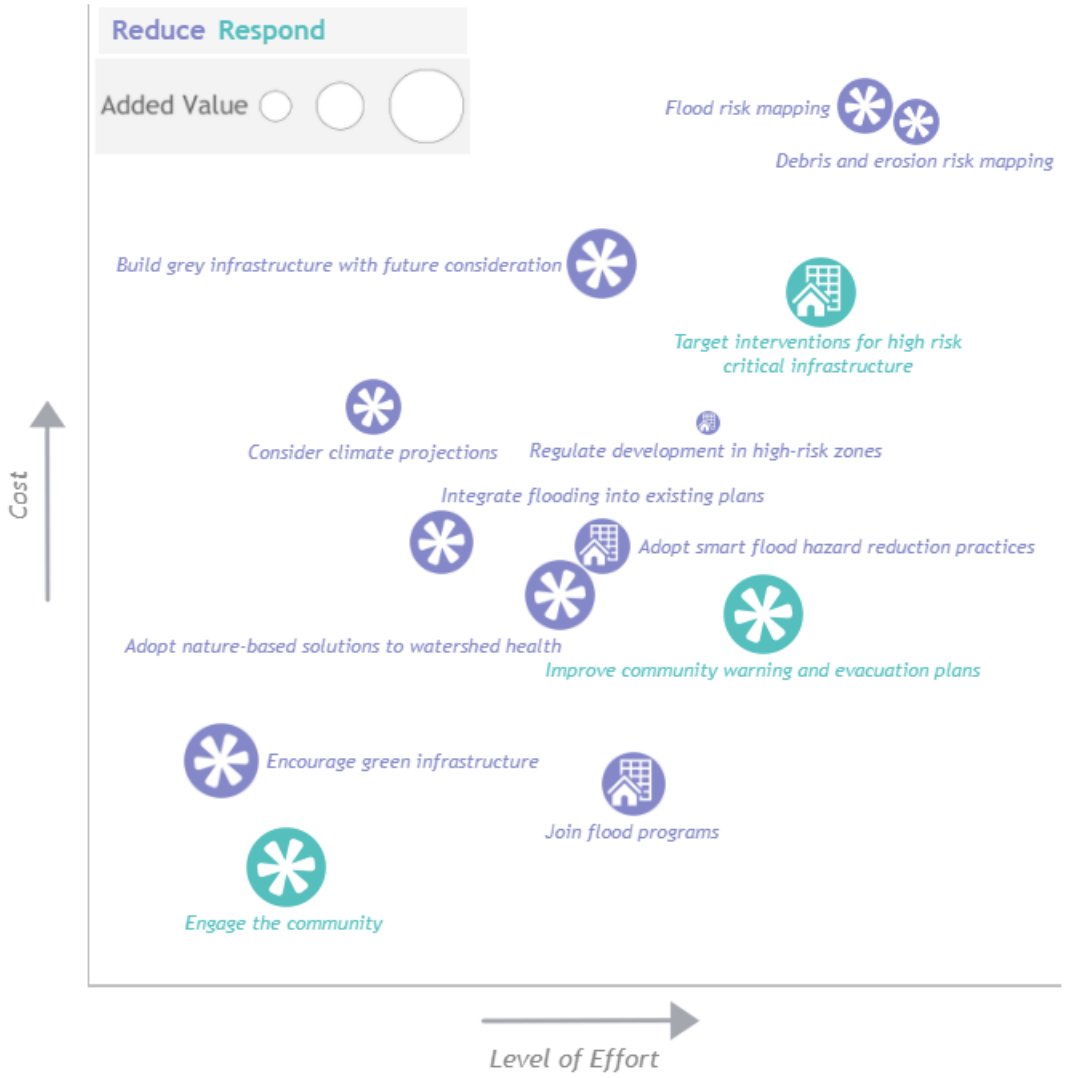
Figure 44: FACE Flooding Analysis Example



Source: CWB FACE, 2021

Suggested actions to improve resilience to flooding from FACE are shown in the graphic below.

Figure 45: Exploring Resilience Actions for Flooding,



Source: CWB FACE, 2021

Vulnerability Assessment

People experience vulnerability to hazards when they choose (wittingly or unwittingly) to live near the areas where these extreme events occur. Vulnerability is also related to preparedness. People who prepare for the occurrence of an extreme event are less vulnerable to it than those who do not. The vulnerability of Colorado's population is rooted in a relationship between the occurrences of extreme events, the proximity of people to these occurrences, and the degree to which these people are prepared to cope with the event.

To help mitigate vulnerability, local governments can require proposed developments to obtain an engineering review certifying developments will not cause the base flood (100-year flood) elevation to rise. Displacement of only a few inches of water can mean the difference between no structural damage occurring in a given flood event, and the inundation of many homes, businesses, and other facilities. Careful attention should be paid to development that occurs within the floodway to ensure that structures are prepared to withstand base flood events.

- **Property loss** from floods affects both private property and public property. The type of property damage caused by flood events depends on the depth and velocity of the floodwaters. Fast floodwaters can wash buildings off foundations and sweep cars downstream. Pipelines, bridges, and other infrastructure can be damaged when high waters contain flood debris. Floods can cause basement flooding and landslide damage related to soil saturation. Seepage into basements is common during flood events, even on hillsides and other areas that are far removed from floodplains. There are certain materials prone to water saturation, and thus more susceptible to flood damage (e.g., wood, insulation, fabric, furnishings, floor coverings, and appliances). Loss of property constructed from these materials accounts for most flood damage.

- **Residential structures** with access to rivers and creeks may be in areas at risk to flooding. Homes in frequently flooded areas can suffer damage to septic systems and drain fields. Inundation of these systems may result in leakage of wastewater into surrounding areas. In many cases, flooding damage to homes renders them uninhabitable. Manufactured homes have a lower level of structural stability than stick built homes. Manufactured homes in floodplain zones must be anchored to provide additional structural stability during flood events.

- **Business and industry** may experience property damage and interrupted business due to flood events. Flood events can cut off customer access to a business as well as close a business for repairs. A quick response to the needs of businesses affected by flood events can help a community maintain economic vitality in the face of flood damage. Responses to business damages can include funding to assist owners in elevating or relocating flood-prone business structures.

- **Infrastructure and publicly-owned facilities** are a key component of daily life for all citizens of the County. Damage to public water and sewer systems, transportation networks, flood control facilities, emergency facilities, and offices can hinder the ability of the government to deliver services. Government can take action to reduce risk to public infrastructure from flood events by introducing public policy that reduces risk to private property from flood events. The I-70 interstate highway is the main transportation corridor through Garfield County, and it plays a significant role in the smooth functioning of the County and regional economy. The Highway was built along the bank of the Colorado River and numerous bridges crisscross the river along its route. Though built with environmentally sensitive components, flooding can impact this critical piece of transportation infrastructure. Railroad tracks built alongside the river face similar flood hazards.

Public parks and publicly-owned open spaces can provide a buffer between flood hazards and private property. Preserved open space in the floodplain can help mitigate flood impacts by reducing the amount of allowable development in flood hazard areas.

Future Development

Future development in the county is anticipated to occur along the outskirts of existing communities. Many of the communities in the county have historically developed along the rivers in the county and/or have established rules for development along riverways. Any new facilities or developments which are constructed along rivers, tributaries, or creeks should evaluate local flood risks. Particular concerns should be evaluated for the effect of erosion and deposition on the course of rivers and potential flood impacts from increased precipitation in the coming

decades. Homes or facilities which house vulnerable populations, such as schools, nursing homes, or hospitals, should be built in areas with minimal flood risk.

Inundation Due to Dam Failure

Dam failure floods are primarily a result of hydrologic or structural deficiencies. The operation of a reservoir can also influence the safety of the structure. Dam failure by hydrologic deficiency is a result of inadequate spillway capacity, which can cause the level of a reservoir to exceed the capacity or height of the dam - also known as overtopping, - during large flows into the reservoir. Dam failure by hydrologic deficiency occurs from excessive runoff after unusually heavy precipitation in the basin. Large waves generated from landslides into a reservoir, or the sudden inflow from upstream dam failures, are other causes of dam failure by overtopping. Overtopping is especially dangerous for an earth dam. This is because the down-rush of water over the crest erodes the dam face. If continued long enough, the down-rush of water breaches the dam embankment and releases all the stored water suddenly into the downstream floodplain.

The mechanics of a structural failure depend on the type of dam and the mode of failure. Dam failure floods are characterized by a sudden rise in stream level and a relatively short duration, similar to a thunderstorm flood. They can occur at any time, but earthen dams appear to be most susceptible to structural failure during the fall and spring freezing and thawing cycles.

Examples of structural deficiencies include seepage through the embankment, piping along internal conduits, erosion, cracking, sliding, overturning, rodent tunneling, and other weakness in the structure. Old age is often at the root of structural deficiencies. Seismic activity in Colorado has also been recognized as a potential source of structural problems due to liquefaction of sand layers in the embankment of a dam.

Table 50: Dam Classification

Classification	Description
Class I – High	Loss of human life is expected.
Class II – Significant	Significant damage is expected, but not loss of human life. Significant damage refers to structural damage where humans live, work, or recreate or public or private facilities exclusive of unpaved roads and picnic areas. Damage refers to making the structures uninhabitable or inoperable.
Class III – Low	Loss of human life and damage to structures and public facilities not expected.
Class IV – No Public Hazard	No loss of human life is expected and damage will only occur to the dam owner's property in the event of dam failure.

Source: FEMA, 2004[56]

According to the U.S. Army Corps of Engineers National Inventory of Dams, there are a total of 41 dams located within Garfield County (Figure 16).[57] Of these dams, ten are high hazard, 11 are significant hazard, and 20 are low hazard. The following table summarizes the high hazard dams in Garfield County.

[56] Federal Emergency Management Agency. April 2004. "Federal Guidelines for Dam Safety: Hazard Potential Classification System for Dams." Accessed 2017. https://www.ferc.gov/sites/default/files/2020-04/fema-333.pdf.

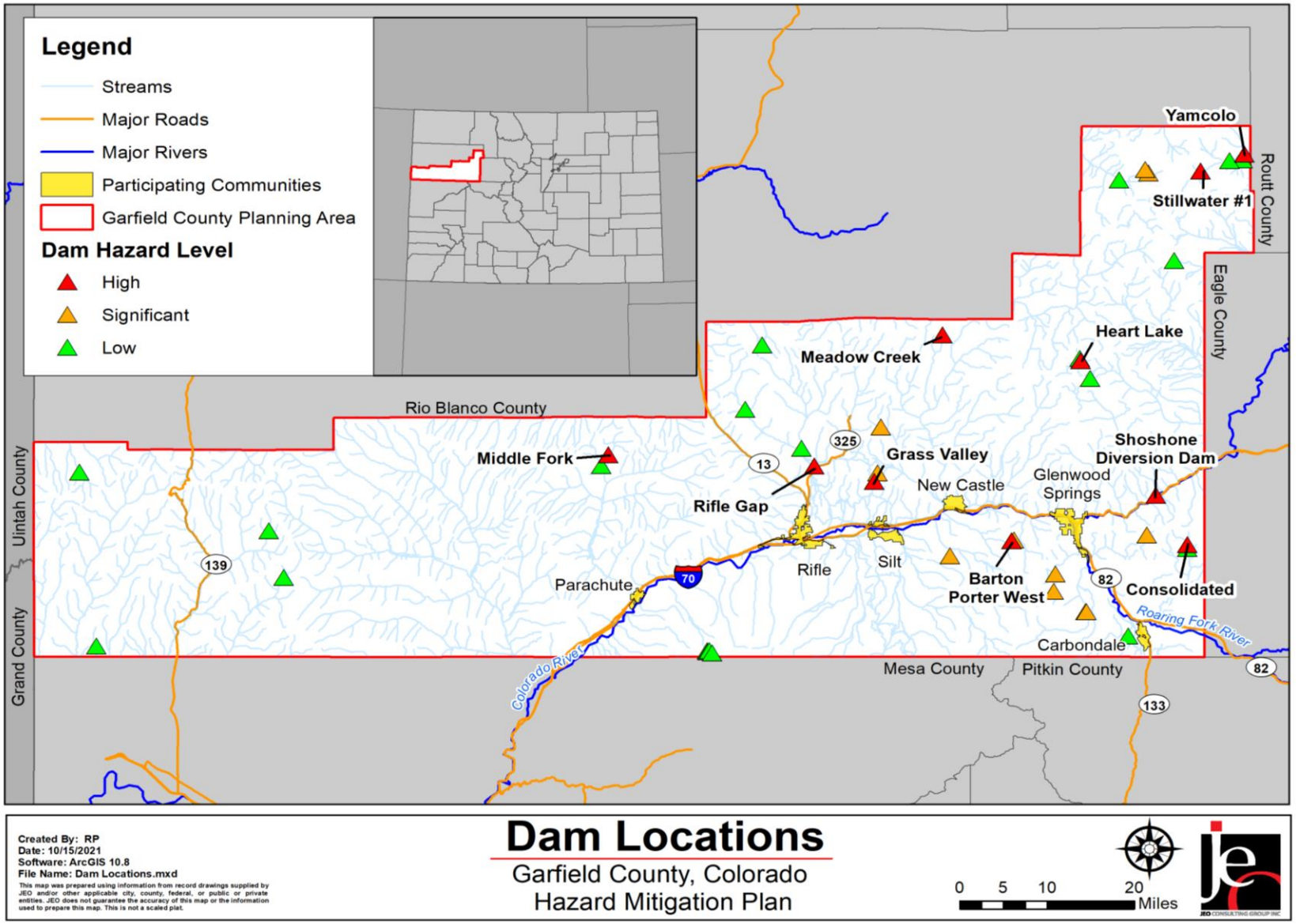
[57] Colorado Department of Natural Resources. "Colorado Department of Natural Resources." https://dnr.colorado.gov/.

Table 51: High Hazard Dams in Garfield County

Dam Name	EAP? Yes/No	Overall Condition	Owner	Downstream Town
Consolidated	Yes	Satisfactory	Consolidated Reservoir Co.	Glenwood Springs
Grass Valley	Yes	Conditionally Satisfactory	Silt Water Conservancy District	Silt
Rifle Gap	Yes	Satisfactory	U.S. Bureau of Reclamation	Rifle
Middle Fork	Yes	Satisfactory	Exxon Mobil Global Services Co.	Grand Valley
Barton Porter West	Yes	Satisfactory	Porter Seed and Cattle Inc.	Silt
Heart Lake	Yes	Conditionally Satisfactory	Colorado Parks & Wildlife	Dotsero
Shoshone Diversion Dam	Yes	Conditionally Satisfactory	Xcel Energy	Glenwood Springs
Stillwater #1	Yes	Conditionally Satisfactory	Bear River Reservoir Company	Yampa
Yamcolo	Yes	Conditionally Satisfactory	Upper Yampa Water Conservancy District	Yampa
Meadow Creek	Yes	Satisfactory	Colorado Parks & Wildlife	New Castle

Source: USACE National Inventory of Dams, 2021

Figure 46: Garfield County Dams



According to Garfield County Emergency Management, the following upstream dams could impact Garfield County if they were to fail:

- Williams Fork
- Dillon
- Lake Christine
- Cheesman
- Green Mountain
- Alsbury
- Wildcat
- Homestake
- Ruedi Reservoir
- Polaris
- Spring Park

Study Area Analysis

Due to the available GIS data, an additional level of analysis was completed for Flooding. First, County staff divided the planning area into three study areas: Forest, Resource Lands, and Urban Interface. Next, zoning, census, and infrastructure data from Garfield County GIS was overlaid with the georeferenced one percent flood hazard area data from a Level 1 HAZUS analysis to evaluate assets at risk. The following maps and tables show the flood hazard areas and summarize the percentage of assets at risk within each study area.

Table 52: Forest Study Area Assets Vulnerable to Flooding

Forest Study Area					
Infrastructure	**Total Sites**	**% of Total Sites**	**Structures**	**Total Sites**	**% of Total Sites**
Right of Way (Miles)	37.45 miles	95.1%	Residential	1	0.6%
Public Airport	N/A	N/A	Commercial	0	0%
Highway Bridges	9	20.9%	Public Structures	N/A	N/A
Communication Facilities	2	5.9%	Agricultural	N/A	N/A
Electric Utilities Lines (Miles)	0 miles	0%	Church	N/A	N/A
Railroad (Miles)	21.6 miles	100%	Schools	N/A	N/A
Railroad Bridges	0	0%	Hospital	N/A	N/A
Road - Aspalt Hight Traffic (Miles)	0.95 miles	33%	Other	0	0%
Road - Chipseal Moderate Traffice (Miles)	7.29 miles	43.3%	**Number of Improvements**	**Improvements Value**	
Road - Gravel Low Traffic (Miles)	28.83 miles	21.9%	42	$22,765,930	
Gas Wells	0	0%			
Pipeline (Miles)	16.46 miles	45.3%			
Ag and Natural Resource Lands (Square Miles)	51.18 sq mi	83%			

Source: Garfield County GIS, JEO Consulting Group

Figure 47: Forest Study Area Flood Hazard

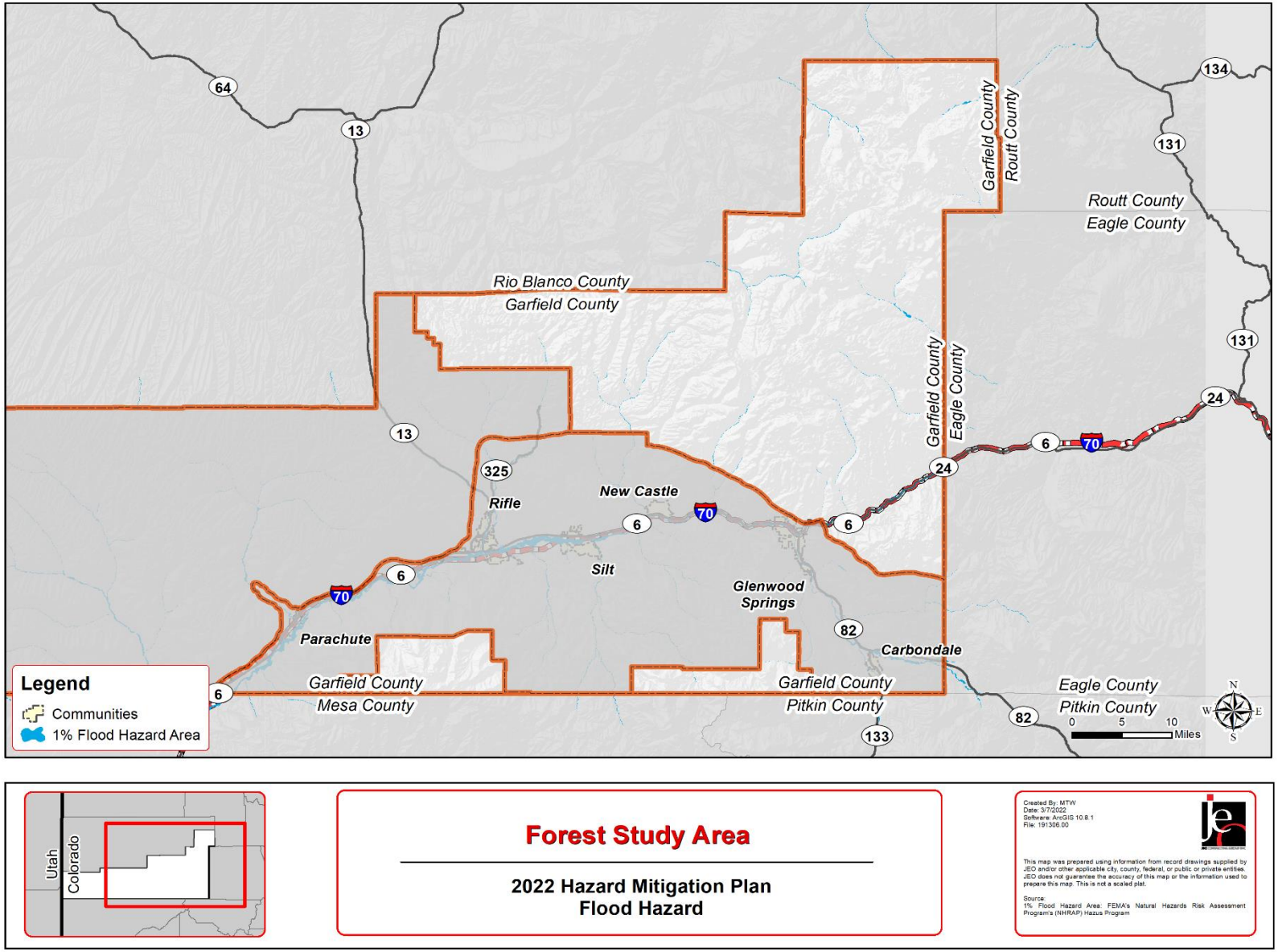


Table 53: Resource Lands Study Area Assets Vulnerable to Flooding

Resource Study Area					
Infrastructure	**Total Sites**	**% of Total Sites**	**Structures**	**Total Sites**	**% of Total Sites**
Right of Way (Miles)	38.62 miles	47.9%	Residential	13	11.6%
Public Airport	N/A	N/A	Commercial	0	0%
Highway Bridges	7	50%	Public Structures	0	0%
Communication Facilities	N/A	N/A	Agricultural	0	0%
Electric Utilities Lines (Miles)	0.71 miles	6.2%	Church	N/A	N/A
Railroad (Miles)	N/A	N/A	Schools	N/A	N/A
Railroad Bridges	N/A	N/A	Hospital	N/A	N/A
Road - Aspalt Hight Traffic (Miles)	5.45 miles	22.2%	Other	0	0%
Road - Chipseal Moderate Traffice (Miles)	0.35 miles	3.9%	**Number of Improvements**	**Improvements Value**	
Road - Gravel Low Traffic (Miles)	73.42 miles	43.3%	83	$31,053,600	
Gas Wells	56	0.7%			
Pipeline (Miles)	623.19 miles	42.7%			
Ag and Natural Resource Lands (Square Miles)	81.13 sq mi	92.6%			

Source: Garfield County GIS, JEO Consulting Group

Figure 48: Resource Lands Study Area Flood Hazard

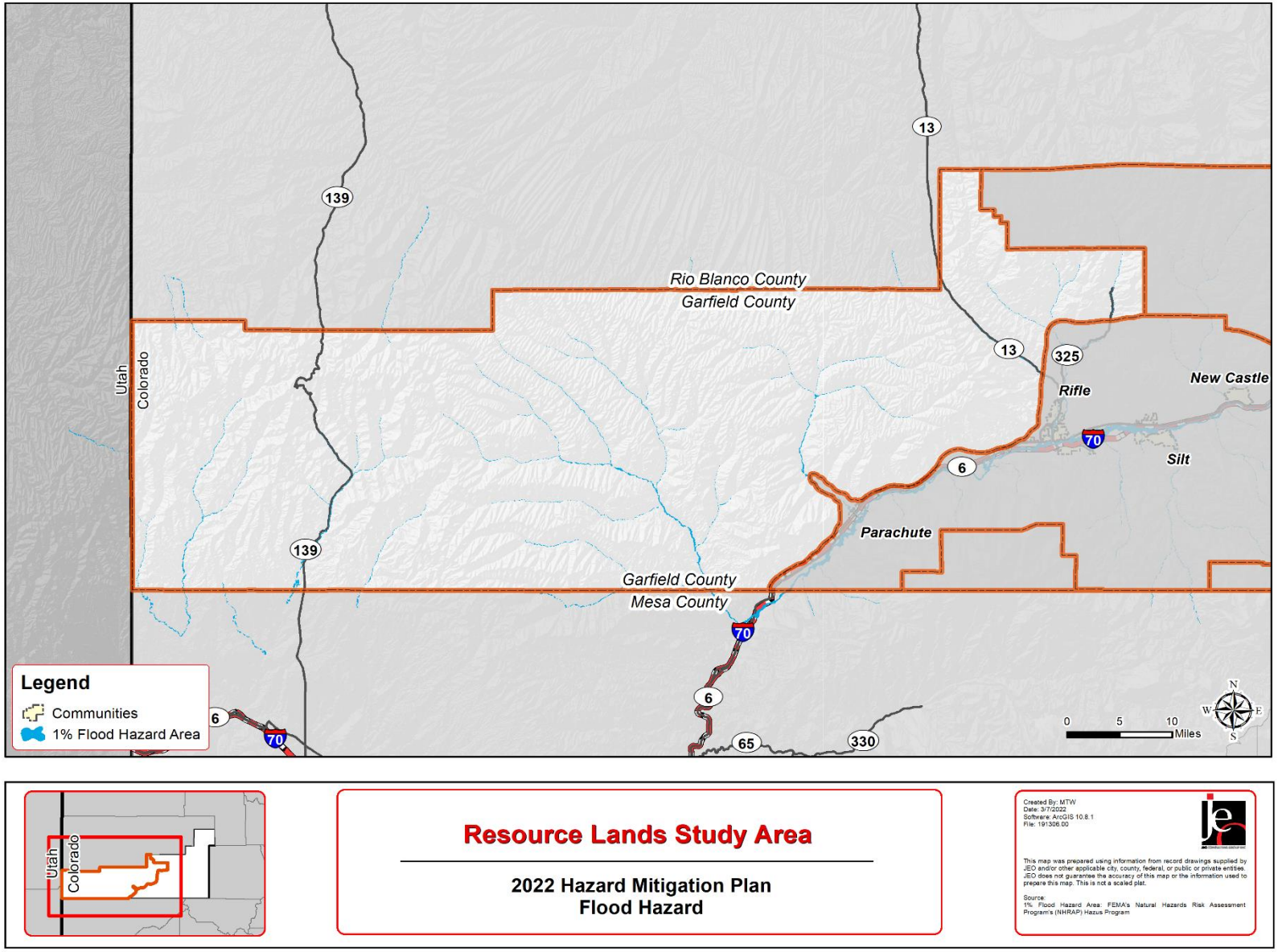
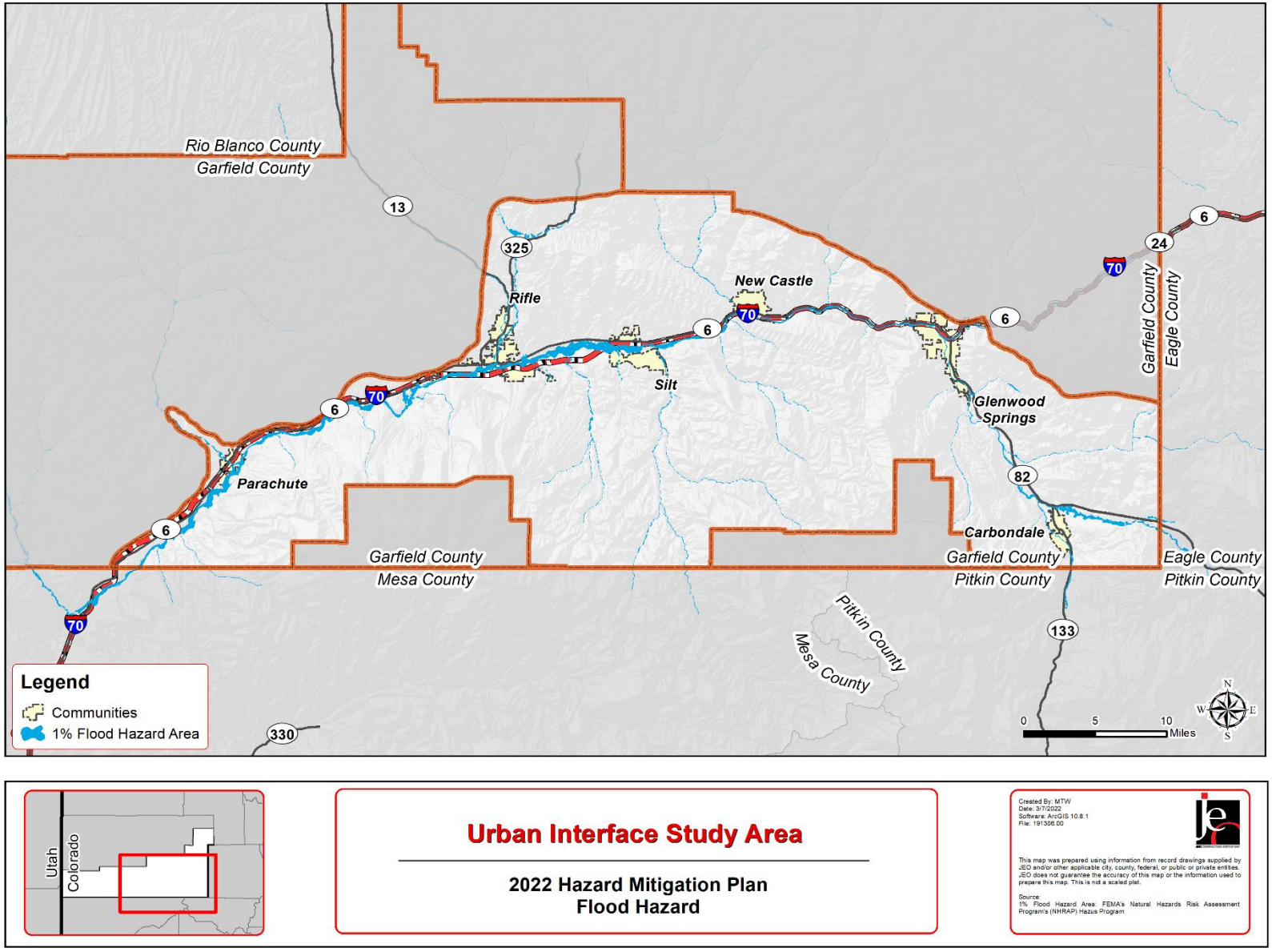


Table 54: Urban Interface Study Area Assets Vulnerable to Flooding

Urban Interface Study Area					
Infrastructure	**Total Sites**	**% of Total Sites**	**Structures**	**Total Sites**	**% of Total Sites**
Right of Way (Miles)	634.88 miles	64.6%	Residential	355	2.4%
Public Airport	0	0%	Commercial	44	5.2%
Highway Bridges	48	32.9%	Public Structures	0	0%
Communication Facilities	3	3%	Agricultural	0	0%
Electric Utilities Lines (Miles)	9.64 miles	5.5%	Church	0	0%
Railroad (Miles)	68.79 miles	99.7%	Schools	0	0%
Railroad Bridges	10	27.8%	Hospital	0	0%
Road - Aspalt Hight Traffic (Miles)	52.1 miles	36%	Other	27	4.3%
Road - Chipseal Moderate Traffice (Miles)	49.04 miles	26.2%	**Number of Improvements**	**Improvements Value**	
Road - Gravel Low Traffic (Miles)	47.96 miles	25.7%	1,463	$781,525,890	
Gas Wells	89	1%			
Pipeline (Miles)	398.1 miles	40.8%			
Ag and Natural Resource Lands (Square Miles)	59.93 sq mi	89.3%			

Source: Garfield County GIS, JEO Consulting Group

Figure 49: Urban Interface Study Area Flood Hazard



Hazardous Materials

Profile

Chemicals are found everywhere. They purify drinking water, increase crop production, and simplify household chores. But chemicals also can be hazardous to humans or the environment if used or released improperly. Hazards can occur during production, storage, transportation, use, or disposal.

Hazardous materials are substances that are either flammable or combustible, explosive, toxic, noxious, corrosive, oxidizable, an irritant or radioactive. A hazardous materials spill or release can pose a risk to life, health or property. An incident can result in the evacuation of a few people, a section of a facility, or an entire neighborhood.

The Environmental Protection Agency (EPA) requires the submission of the types and locations of hazardous chemicals being stored at any facility within the state over the previous calendar year. This is completed by submitting a Tier II form to the EPA as a requirement of the Emergency Planning and Community Right-to-Know Act of 1986. Likewise, the U.S. Department of Transportation, through the U.S. Pipeline and Hazardous Materials Safety Administration (PHMSA), has broad jurisdiction to regulate the transportation of hazardous materials, including the discretion to decide which materials shall be classified as hazardous.

Location

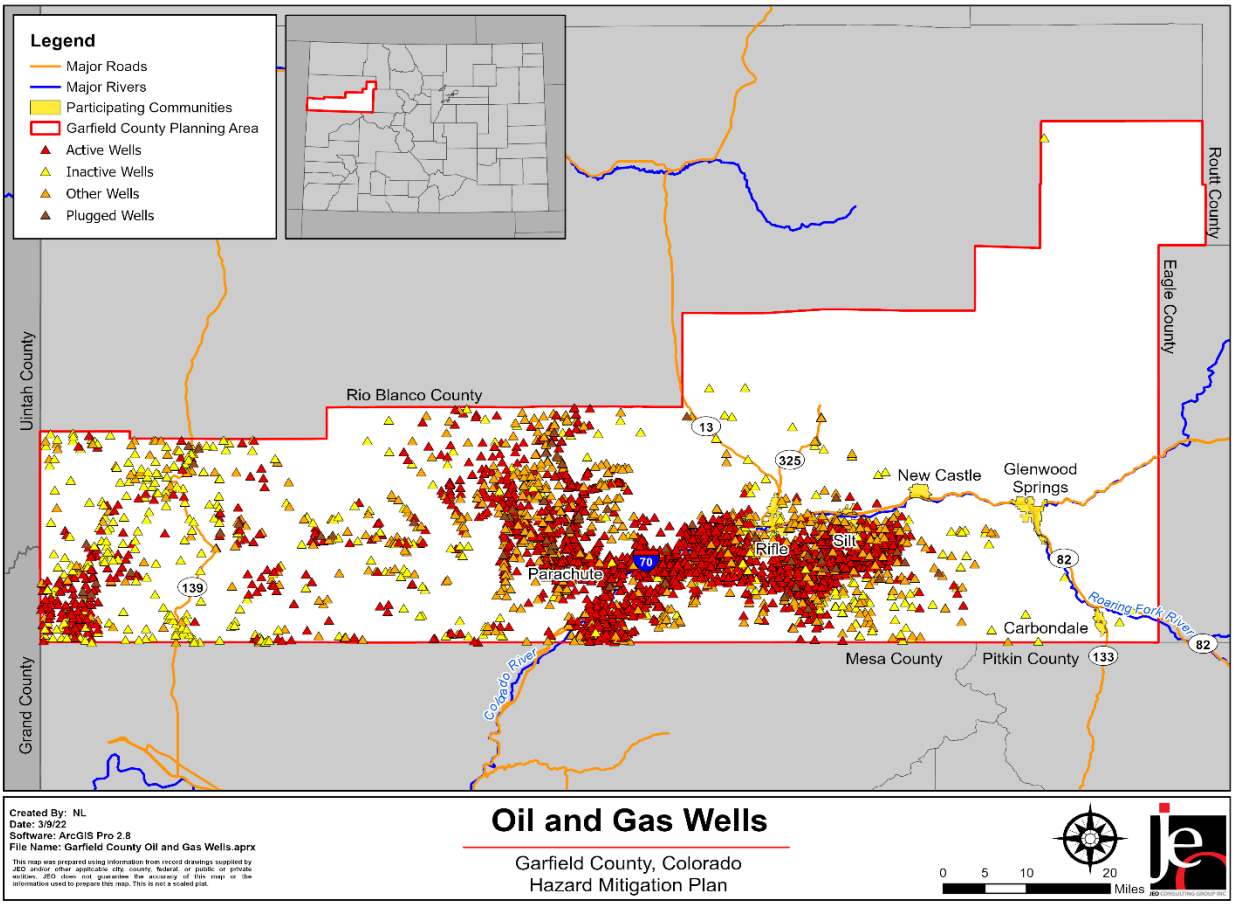
Facilities that house hazardous materials are located across Garfield County. Chemical manufacturers are one source of hazardous materials, but there are many others, including service stations, hospitals, wells, pipelines, and hazardous materials waste sites. The oil and gas industry is a large sector of the local economy. According to the Colorado Oil and Gas Conservation Commission (COGCC) there are over 17,000 wells in Garfield County, the majority of which are located around Parachute, Rifle, and Silt.

Table 55: Oil and Gas Wells in Garfield County

Active Wells	Inactive Wells	Other Status Wells	Plugged Wells	Total
11,933	739	4,481	86	17,239

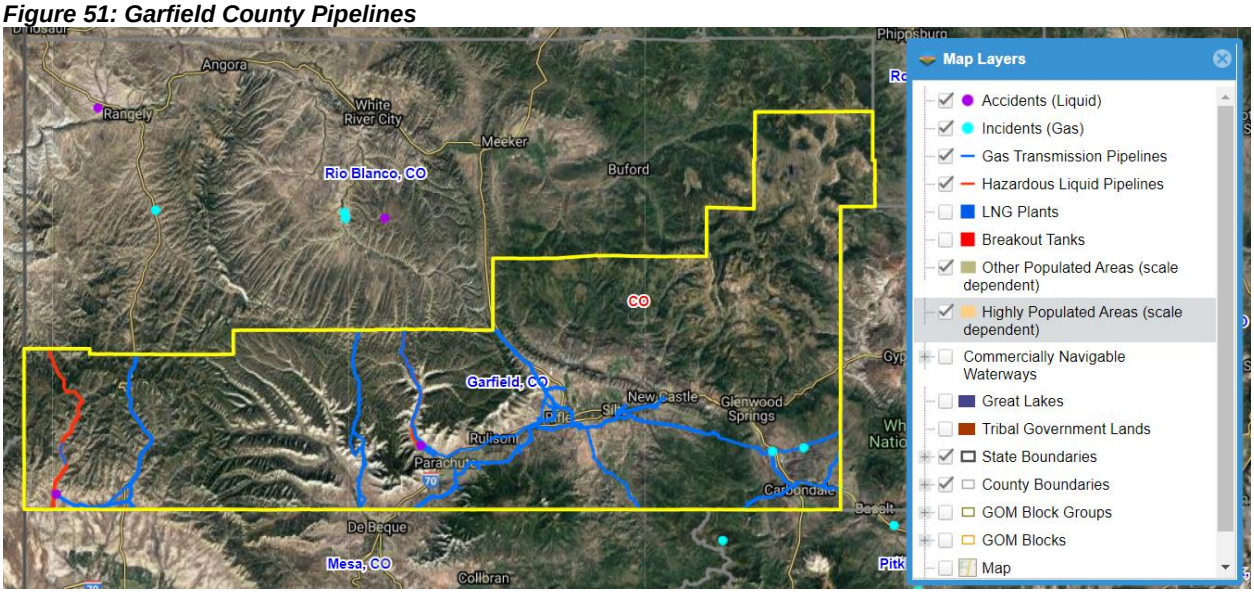
Source: Colorado Oil and Gas Conservation Commission, 2022

Figure 50: Oil and Gas Wells in Garfield County



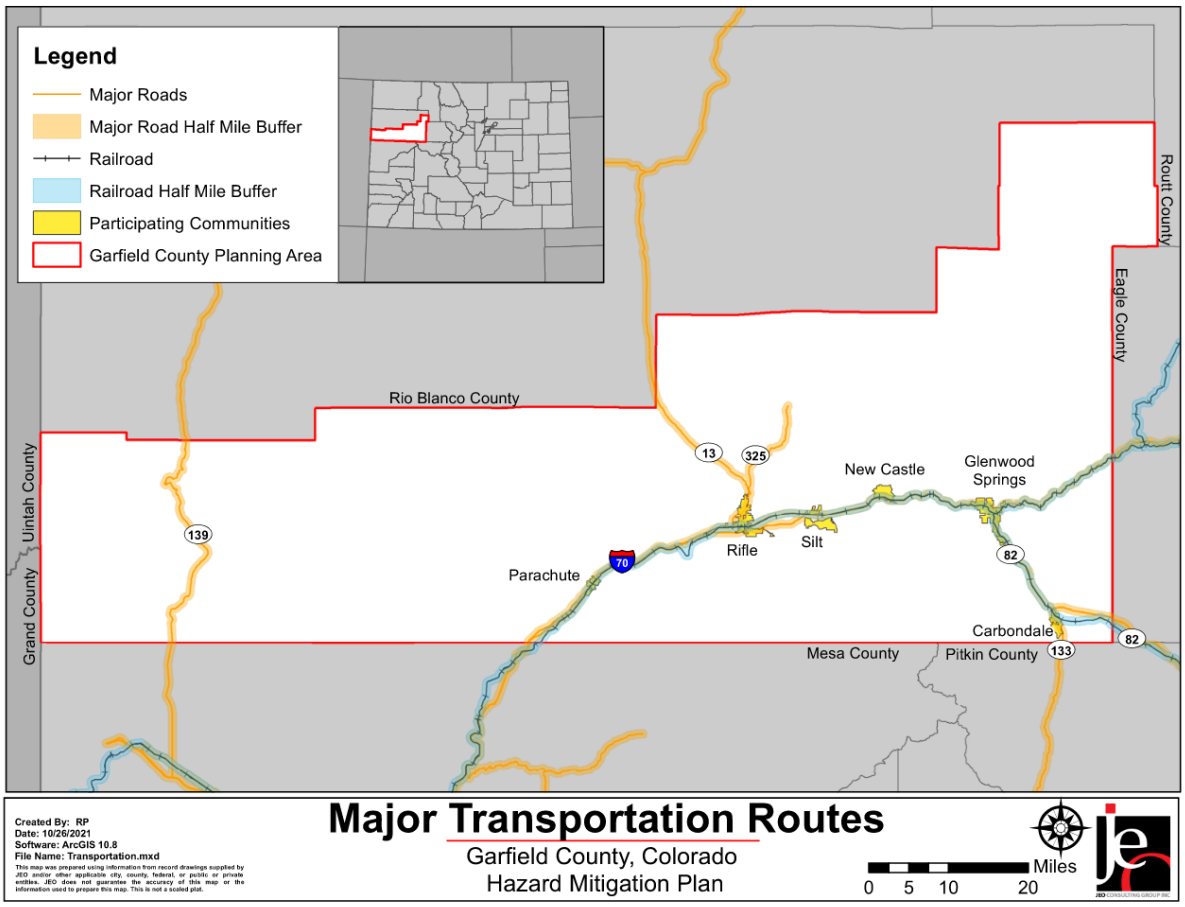
Numerous pipelines are also located within the County (Figure 51). According to the Pipeline and Hazardous Materials Safety Administration (PHSMA), gas transmission lines are located throughout the county while a hazardous liquid pipeline is located only in western Garfield County. Pipelines which bisect steep topography and roadways are at higher risk during debris flow/mud slide/avalanche events. Hazardous materials spills can also occur along transportation routes, specifically the I-70 corridor and railroads.

Figure 51: Garfield County Pipelines



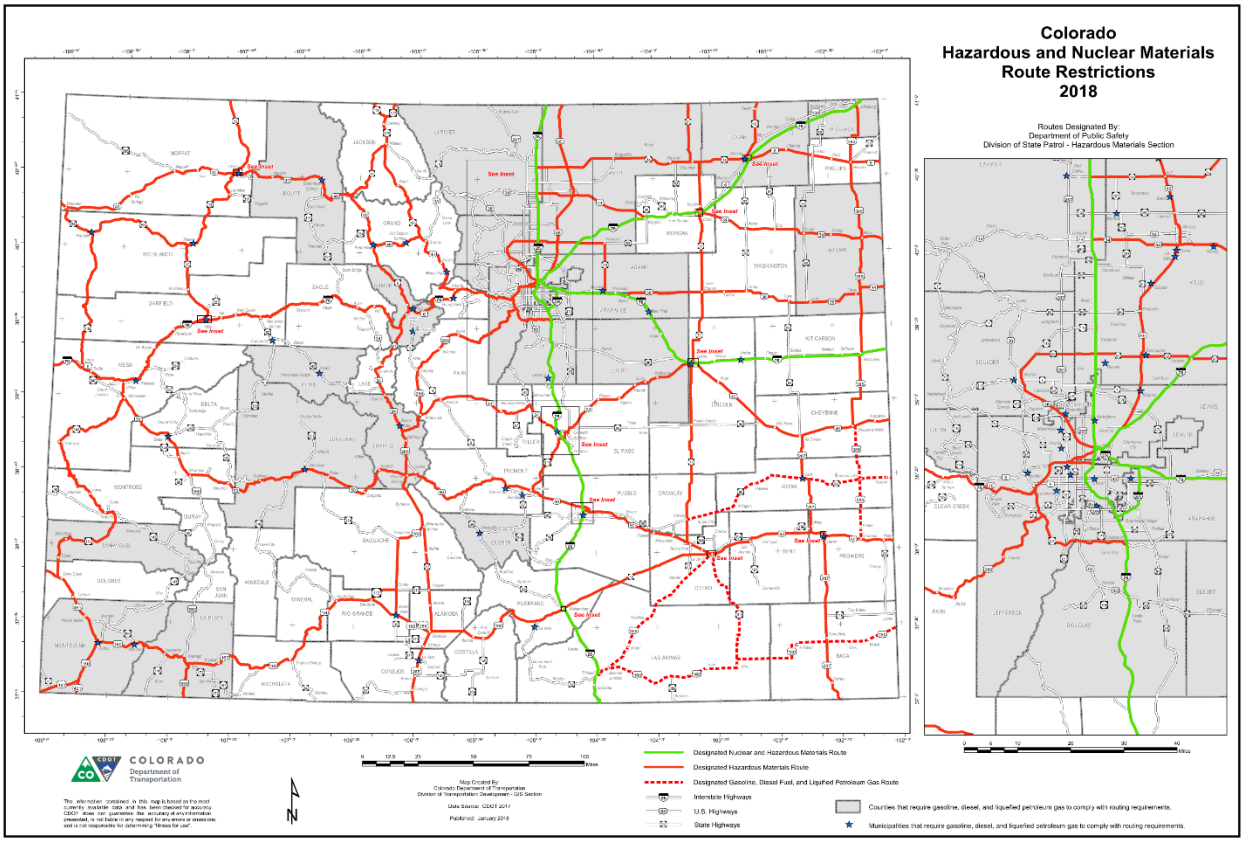
Source: PHMSA, 2021

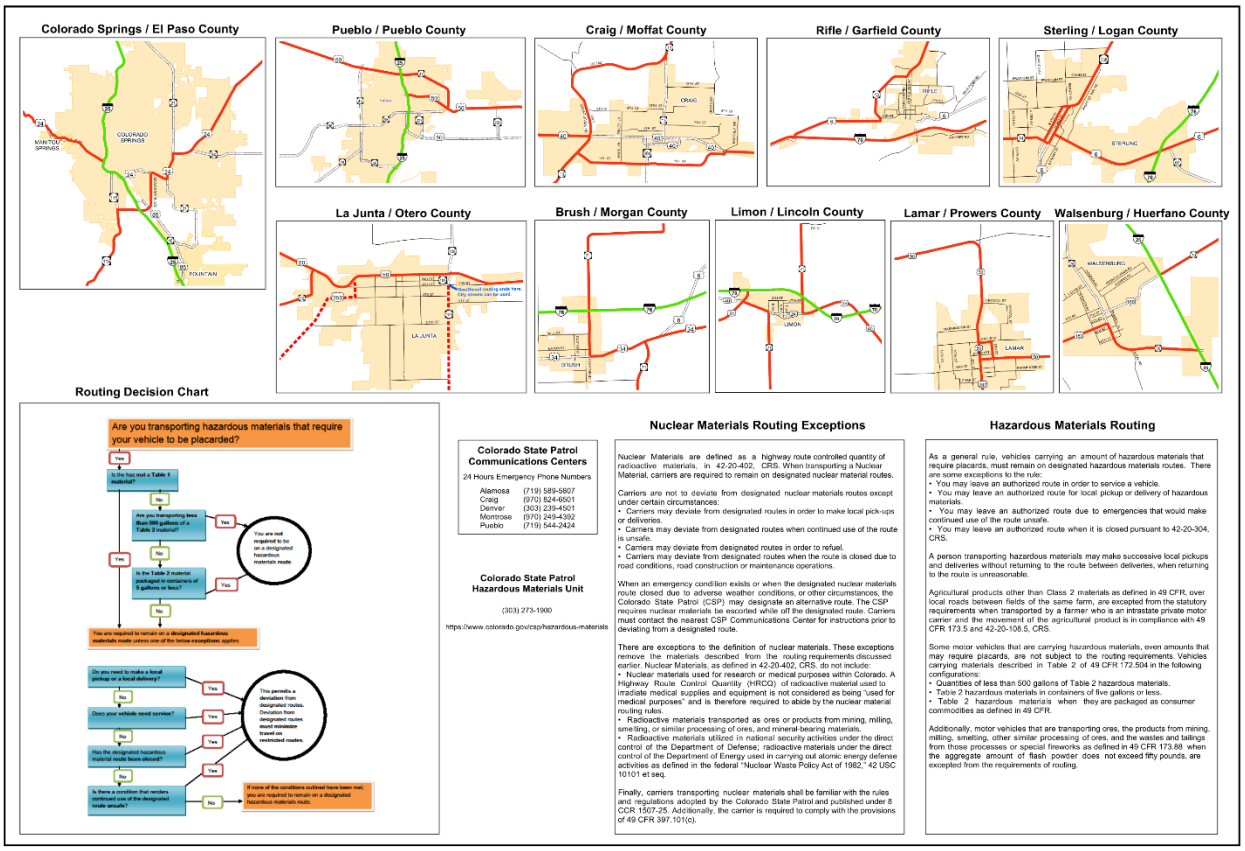
Figure 52: Garfield County Transportation Corridors with Buffer



In addition to semi-truck highway transport or pipelines in the county, the State of Colorado has designated highways in Garfield County as part of the Hazardous and Nuclear Materials Route Restrictions in 2018. Highways 139, 13, and I-70 are Designated Hazardous Material Routes (Figure 53). Of note, Rifle and Carbondale require gasoline, diesel, and liquefied petroleum gas to comply with routing requirements.

Figure 53: Hazardous Materials Route Restrictions





Historical Occurrences

According to the U.S. Coast Guard's National Response Center database (NRC), there have been 313 chemical spills in Garfield County from 1990 – August 2021.[58] These spills accounted for $316,700 in property damages, 41 injuries, and 14 deaths. After analyzing the narratives of the chemical spills, all the fatalities associated from these events were caused by the accidents, not the chemicals released. These spills range from 0.99 gallons to 40,000 gallons. The average spill released 397 LGA of material.

Additionally, the Colorado Oil and Gas Conservation Commission provides spill counts from oil and gas wells in the county. Event narratives and damage estimates are not available for these events. There were 263 spills reported for the period of record (2018-2022).

Average Annual Damages

The average annual damages estimate is based on the historical damages reported in the NRC database.

Table 56: Historical Hazardous Spill Damages

Total Property Damages	Average Annual Property Damages	Total Crop Damages	Average Annual Crop Damages
$316,700	$9,897	$0	$0

Source: NRC, 1990 - 2021

[58] United States Coast Guard. "United States Coast Guard National Response Center." Accessed 2021. http://nrc.uscg.mil/.

Extent
The extent of chemical spills at fixed sites varies and depends on the type of chemical that is released with a majority of events localized to the facility. The probable extent of chemical spills during transportation is difficult to anticipate and depends on the type and quantity of chemical released. There were 313 fixed site and 263 oil and gas well chemical release events that have occurred in the planning area. Of these events, 34 events led to 41 injuries, 13 spills led to 14 fatalities, and one spill led to the evacuation of two individuals. Based on historic records, it is likely that any spill involving hazardous materials will not affect an area larger than a quarter mile from the spill location.

Figure 54 shows a fictional scenario that shows the potential extent of a hazardous materials release in an urban area of the County. The type and amount of the selected material released for the scenario has previously occurred in Garfield County; however, in a different location.

Probability
Given the historic record of occurrence for hazardous materials spills (at least one spill reported in all 32 years from the NRC and at least one spill reported in all five years from COGCC), for the purposes of this plan, the annual probability of a hazardous material spill is 100 percent.

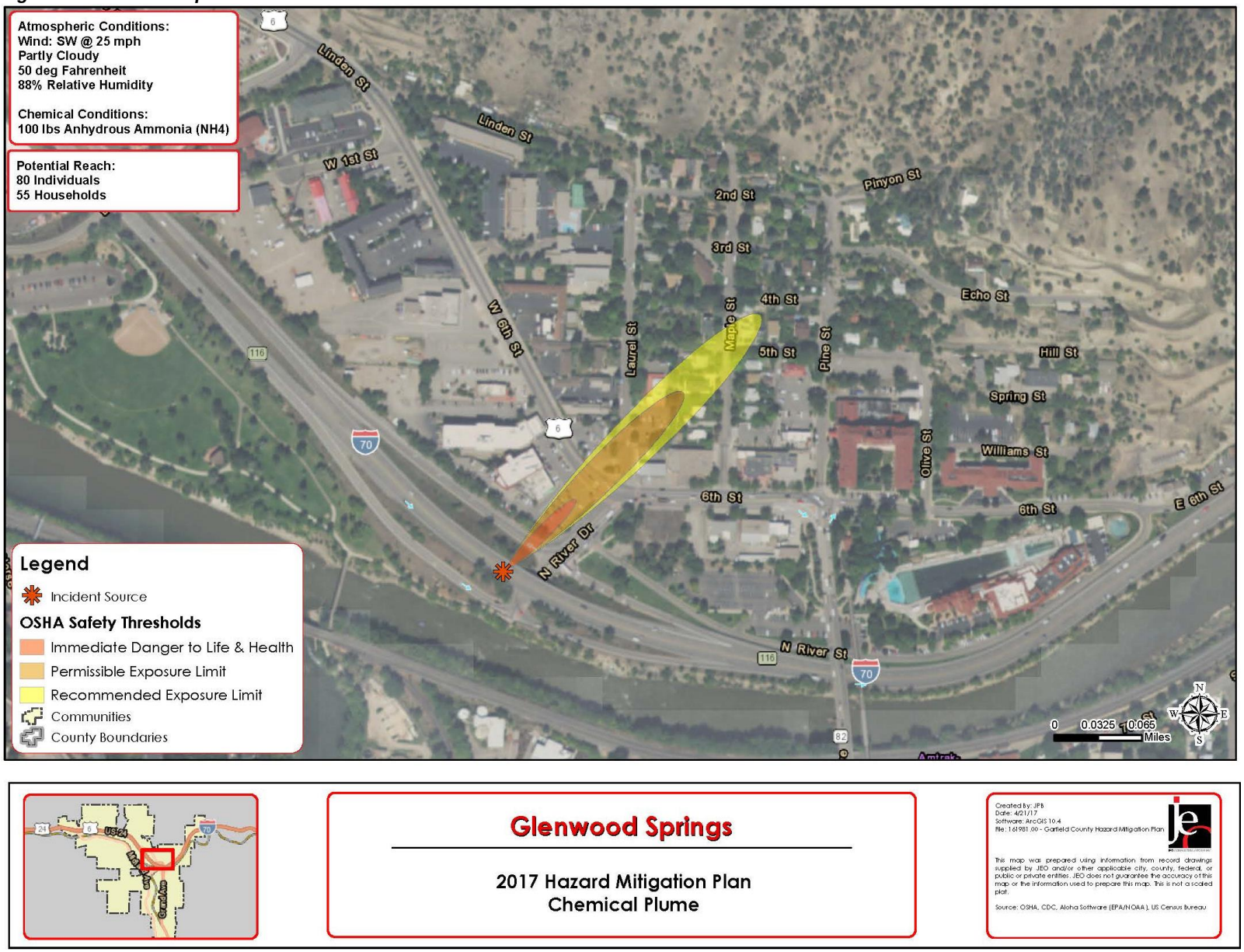
Climate Trends
Climate trends are not anticipated to have a direct impact on hazardous materials spills. However, as events continue to impact infrastructure used by and for hazardous materials, spills may occur. For example, facilities located within or adjacent to flood risk hazard areas which store or produce hazardous materials may experience increased risk in the future.

Vulnerability Assessment
Communities and households adjacent to sites that house hazardous materials, pipelines, railroads, and I-70 may be more vulnerable to hazardous materials spills. If an incident were to occur where an evacuation was necessary, populations that may be especially vulnerable include: households without access to a vehicle, the elderly, and facilities with populations with low mobility such as hospitals, nursing homes, and housing units.

Hazardous materials are shipped daily on I-70 and along the railroad. These hazardous materials routes run near the County's major population centers and adjacent to the rivers that serve as the County's drinking water sources. Should anything happen to hazardous materials cargo enroute through the County, the canyon may trap contaminants in the air or hamper a safe and timely evacuation.

Future Development
Future development in the county is anticipated to occur along the outskirts of existing communities. Any new facilities which house vulnerable populations, such as schools, nursing homes, or hospitals, should be built in areas with adequate buffer space and evacuation corridors to fixed chemical sites.

Figure 54: Chemical Spill Scenario



Landslides, Mud/Debris Flow, Rockfall

Hazard Profile

Landslides are downhill or lateral movements of rock, debris, or soil mass. The size of a landslide usually depends on the geology and the landslide triggering mechanism. Landslides initiated by rainfall tend to be smaller, while those initiated by earthquakes may be very large. Slides associated with volcanic eruptions can include as much as one cubic mile of material.

Landslides are typically triggered by periods of heavy rainfall or rapid snowmelt. Earthquakes, changes to the hydrology, removal of vegetation, and excavations may also trigger landslides. Certain geologic formations are more susceptible to landslides than others. Human activities, including locating development near steep slopes, can increase susceptibility to landslide events. Landslides on steep slopes are more dangerous because movements can be rapid.

Some characteristics that determine the type of landslide are slope of the hillside, moisture content, and the nature of the underlying materials. Landslides are given different names depending on the type of failure, their composition, and characteristics. Types of landslides include slides, rock falls, and flows. Landslides

Mud and debris flows are defined as flood events with sediment concentrations that range between approximately 20 and 55 percent by volume. The volume of fine sediment (silt, clay and fine sands in the fluid matrix) controls the properties of the flow, including, viscosity, density, and yield stress. Due to their density and sediment, mudflows have significantly slower velocities compared to water floods on the same slope. The fine sediments increase the density of the fluid matrix, which increases the buoyancy of sediments thereby creating conditions that allow gravel to boulder-sized material to be transported near the flow surface by mudflows. [59]

Landslides are the downward and outward movement of slopes with debris. These events include names such as slumps, rockslides, debris slide, lateral spreading, debris avalanche, earth flow, and soil creep. Slow moving landslides can occur on relatively gentle slopes and can cause significant property damage. However, slow moving landslides are far less likely to result in serious injuries than rapidly moving landslides that can leave little time for evacuation.

Rock falls occur when blocks of material come loose on steep slopes. Weathering, erosion, or excavations, such as those along highways, can cause falls where the road has been cut through bedrock. They are fast moving with the materials free falling or bouncing down the slope. The volume of material involved could be large or small, and the velocity of the fall may cause significant damage.

Mud and debris flows are plastic or liquid movements in which land mass (e.g. soil and rock) breaks up and flows during movement. Debris flows normally occur when a landslide moves downslope as a semi-fluid mass scours soils from the slope along its path. When more than half of the materials are larger than sand grains, the event is classified as a debris flow. Flows are typically rapidly moving and can occur during heavy rainfall or are triggered by earthquakes. They can occur on gentle slopes, move rapidly for large distances, and increase in size as they move.

Location

[59] Mussetter Engineering Inc. May 2009. "Cornet Creek Watershed and Alluvial Fan Debris Flow Analysis." https://www.sanmiguelcountyco.gov/DocumentCenter/View/273/Telluride-2009-Cornet-Creek-Debris-Flow-Report-PDF.

This hazard is correlated with elevation change, thus this hazard largely occurs in the high sloped, mountainous areas of the County. In 2002, the Colorado Geological Survey and the Colorado Office of Emergency Management updated the Colorado Landslide Mitigation Plan.[60] The updated plan contains a ranked list of communities, areas, and facilities most at risk from landslides. Hazard areas are grouped by relative severity into three tiers:

- **Tier One** listings are serious cases needing immediate or ongoing action or attention because of the severity of potential impacts.
- **Tier Two** listings are very significant but less severe; or where adequate information and/or some mitigation is in place; or where current development pressures are less extreme.
- **Tier Three** listings are similar to Tier Two but with less severe consequences or primarily local impacts.

The plan identified three areas in Garfield County that should be targeted for mitigation activities:

- **Tier One Landslide/Rockfall Area**: Douglas Pass-Baxter Pass Region, landslide and debris flow areas.
- **Tier One Debris Flow Area**: Glenwood Springs and vicinity, multiple debris flows and associated hydrocompactive soils.
- **Tier Three Debris Flow Area**: Sweetwater Creek area, debris flows.

In addition to the above areas, the Planning Team identified the following areas as prone to regular debris flow events: County Road 215, I-70 west of Parachute, Highway 82 near Carbondale, Highway 325, and Highway 233.

In addition to areas that are mapped as prone to landslides, post-wildfire burn areas are highly susceptible to mud and debris flow events. After a wildfire, the probability of a mud and debris flow increases significantly. The loss of the vegetative cover in burn areas increases run-off rates. The burned and barren slopes are more prone to erosion, resulting in increased peak discharge and bulking rates.[61] Relatively frequent storm events of high intensity, and short durations, have the potential to cause unusually large mudflow events in post-wildfire conditions.[62] The burning of organic material matter on the ground can: (1) create high temperatures on the ground causing hydrophobicity, which is the tendency of the soil to resist wetting or infiltration of moisture; (2) decrease the roughness of the ground; and (3) increase the erosive capacity of the soil. The 1994 debris flows on Storm King Mountain west of Glenwood Springs[63] and landslides after the Waldo Canyon Fire outside Colorado Springs in 2012 are key examples.

Extent

Rapidly moving landslides (debris flows and earth flows) present the greatest risk to human life. Persons living in or traveling through areas prone to rapidly moving landslides should take caution. Slow moving landslides can cause significant property damage but are less likely to result in serious human injuries.

Landslides can be massive, or they may disturb only a few cubic feet of material. The majority of events in Garfield County are likely to cause limited property damage; limited or no deaths and

[60] Rogers, W.P. 2005. "Critical Landslides of Colorado." Colorado Geological Survey. https://coloradogeologicalsurvey.org/hazards/landslides/

[61] White, J. L., Wait, TC, and Morgan M.L. 2008. "Geologic Hazards Mapping Project for Montrose County, Colorado." Colorado Geological Survey Department of Natural Resources.

[62] Rosgen, D. and Rosgen, B. 2013. "Restoring Alluvial Fan Connectivity for Post-Fire Flood Alleviation and Sediment Reduction."

[63] Kirkham, R.M., Parise, M., and Cannon, S.H. 2000. "Geology of the 1994 South Canyon Fire Area, and a Geomorphic Analysis of the September 1, 1994 Debris Flows, South Flank of Storm King Mountain, Glenwood Springs, Colorado." Colorado Geological Survey: Special Publication 46.

injuries; and little or no impacts to critical facilities and infrastructure. However, single events near populated areas or key infrastructure may have significant impacts.

In response to the increase of wildfires in the western United States, the United States Geological Survey (USGS) has developed equations for estimating the potential for post-wildfire debris flows, as well as estimating the potential volume of debris resulting from a debris flow event.[64] A statistical evaluation of data collected from recently burned basins in the western United States was used to develop the empirical equations.[65] The estimate of volume is a function of a drainage basin's soil properties, basin characteristics, burn severity, and rainfall conditions.

Therefore, should a basin in Garfield County burn, the following regression equation could be used to estimate the volume of debris flow that could be produced:

$$Ln\,V = 7.2 + 0.6(\ln SG30) + 0.7(AB)^{0.5} + 0.2(T)^{0.5} + 0.3,$$

where, *V* is the debris-flow volume, including water, sediment, and debris (cubic meters); *SG30* is the area of drainage basin with slopes equal to or greater than 30 percent (square kilometers); *AB* is the drainage basin area burned at moderate to high severity (square kilometers); *T* is the total storm rainfall (millimeters); and 0.3 is a bias correction factor that changes the predicted estimate from a median to a mean value.[66]

An example of how this equation can be used to estimate the debris flow volume that might be produced in a post-fire condition in Garfield County is provided in the table below. The information listed in Table 57 uses the 1994 Storm King Mountain fire as an example scenario. In 1995, the USGS produced a report in response to the fire related debris flow on Storm King Mountain.[67] In this report, the drainage areas, burned areas, and rainfall totals were identified. The information from this report was used to compare the debris flow volume calculated via the equation above to the actual recorded deposit volume.

Table 57: Comparison of USGS Regression Equation Debris Volume Estimate with Actual Calculated Debris Volumes for the 1994 Storm King Mountain Fire

Drainage	Drainage Area*		Drainage Area Burned*	Percent of Drainage Area Burned*	Storm Rainfall*	SG30**	Calculated Debris-Flow Volume	Deposit Volume*
	(ac)	(km^2)	(km^2)		(mm)	(km^2)	(CY)	(CY)
A	496	2.01	0.10	5.0%	17.018	0.80	3,473	0
B	555	2.25	2.07	92.0%	17.018	0.90	8,141	27,400
C	568	2.30	2.28	99.0%	17.018	1	12,002	51,400
D	186	0.75	0.72	95.0%				
E	127	0.51	0.29	57.0%	17.018	0.21	1,794	1,800
F	562	2.27	1.32	58.0%	17.018	0.91	6,700	5,600

[64] Cannon, S.H., Gartner, J.E., Rupert, M.G., Michael, J.A., Rea, A.H., and Parrett, C. 2010. "Predicting the Probability and Volume of Postwildfire Debris Flows in the Intermountain Western United States." Geological Society of America Bulletin v. 122; no 1-2 pp. 127-144.

[65] Stevens, M.R., Flynn, J.L., Stephens, V.C., and Verdin, K.L. 2011. "Estimated Probabilities, Volumes, and Inundation Areas Depths of Potential Postwildfire Debris Flows from Carbonate, Slate, Raspberry, and Milton Creeks, near Marble, Gunnison County, Colorado." U.S. Geological Survey: Scientific Investigations Report 2011–5047.

[66] Helsel, D.R. and Hirsch, R.M. 1992. "Statistical Methods in Water Resources." Elsevier Science: Volume 49.

[67] Cannon, S.H., Powers, P.S., Pihl, R.A., and Rogers, W.P. 1995. "Preliminary Evaluation of the Fire-Related Debris Flows on Storm King Mountain, Glenwood Springs, Colorado." U.S. Geological Survey: Open-File Report 95-508.

Drainage	Drainage Area*		Drainage Area Burned*	Percent of Drainage Area Burned*	Storm Rainfall*	SG30**	Calculated Debris-Flow Volume	Deposit Volume*
	(ac)	(km^2)	(km^2)		(mm)	(km^2)	(CY)	(CY)
G	99	0.40	0.32	80.0%	17.018	0.16	1,572	1,400
H	153	0.62	0.51	82.0%	17.018	0.25	2,262	1,800
I	174	0.70	0.00	0.0%	17.018	0.28	1,484	1,800
TOTAL	2,920	12	8	--	--	5	37,429	91,200

Source: Cannon et al., 1995
**SG30 is the area of drainage basin with slopes equal to or greater than 30 percent. For this analysis, it was assumed that 40 percent of drainage area was equal to or greater than 30 percent.*

The regression equation for debris flow volume is more accurate for smaller basins. Watershed size is an important factor in estimating mud and debris flow probability. Watersheds over 100 acres are more likely to produce flood events, with a significant amount of entrained sediment, while smaller watersheds are more likely to produce a mud and debris event.

Common mitigation techniques include construction of conveyance channels, diversions, catchment basins, and debris-trapping structures. Small debris racks can also be located throughout the watershed as appropriate to capture debris before it makes its way to major drainages or critical road crossings, culverts, bridges and other critical infrastructure.

Historical Occurrences

Historically, the Douglas Pass-Baxter Pass landslide and debris flow areas is one of the most active landslide areas in Colorado. Affected facilities include Highway 139, a Garfield County road, and numerous energy related pipe lines. It is located along the drainage divide between the White River and the Colorado River. The most unstable area extends for a few miles on each side of the divide. Slope failures include earthflows, debris flows, rockfall, and a variety of rotational and translational landslides. During some years, landslides are so active that the entire terrain can change within the course of a year, and highways have been closed for months at a time.

The Roan Creek Landslide in 1985 was a slump-earthflow complex caused by water infiltration and saturation of old landslide material. A detailed study and continued follow-up observations show no indication of serious further advance of the Roan Creek earthflow since 1985. The Sweetwater Creek area is a debris flow area in Northeastern Garfield County and Western Eagle County. This remote area is sparsely developed with recreational and residential facilities near Sweetwater Lake. No new accounts of disruptive debris flow activity have been reported for this area since the mid-1980s.

Interstate 70, the primary transportation route through Garfield County, has experienced significant landslide events in the past. In 1994, the Storm King Mountain wildfire area produced multiple debris flows and hyper-concentrated flows that engulfed three miles of I-70 with mud, rock debris, and floodwater. Debris covered many cars traveling on the Interstate, and two were swept into the Colorado River. In 2000, rockfall closed the westbound lanes of I-70 near Glenwood Springs. A rockslide on Thanksgiving Day in 2004 rolled down a nearby patch of road west of Glenwood Springs.

A large rockfall incident occurred just after midnight on March 8, 2010. The incident hit I-70 in Glenwood Canyon, near mile marker 125, just west of Hanging Lake Tunnel. It is estimated that this slide brought 20 boulders onto the Interstate, ranging in size from three feet to ten feet in diameter. I-70 was closed in both directions to all traffic.

During the 2021 season, I-70 through Glenwood Canyon experienced several significant landslides. Due to heavy rains on charred burn scars on July 31, landslides closed the interstate for several weeks. The mudslides stranded motorists and led to hours-long detours; however, no injuries were reported. The state requested federal emergency assistance to repair damages which exceeded $116 million.

Table 58: Historical Landslide Occurrences

Event Type	Number of Events	Average Number of Events per Year	Total Injuries	Total Deaths
Landslide, Mud/Debris Flow, Rockfall	21	0.3	8	2

Source: SHELDUS, 1960-2021

Average Annual Damages

The average annual damages estimate was taken from the SHELDUS database and includes aggregated calculations for each type of landslide as provided in the database. This does not include losses from displacement, functional downtime, economic loss, injury, or loss of life. According to SHELDUS, landslides have caused $2,060,393.33 in property damages and no crop damages in Garfield County from 1960-2019.

Table 59: Historical Landslide Damages

Total Property Damages	Average Annual Property Damages	Total Crop Damages	Average Annual Crop Damages
$2,733,456.40	$45,557.61	$0	$0

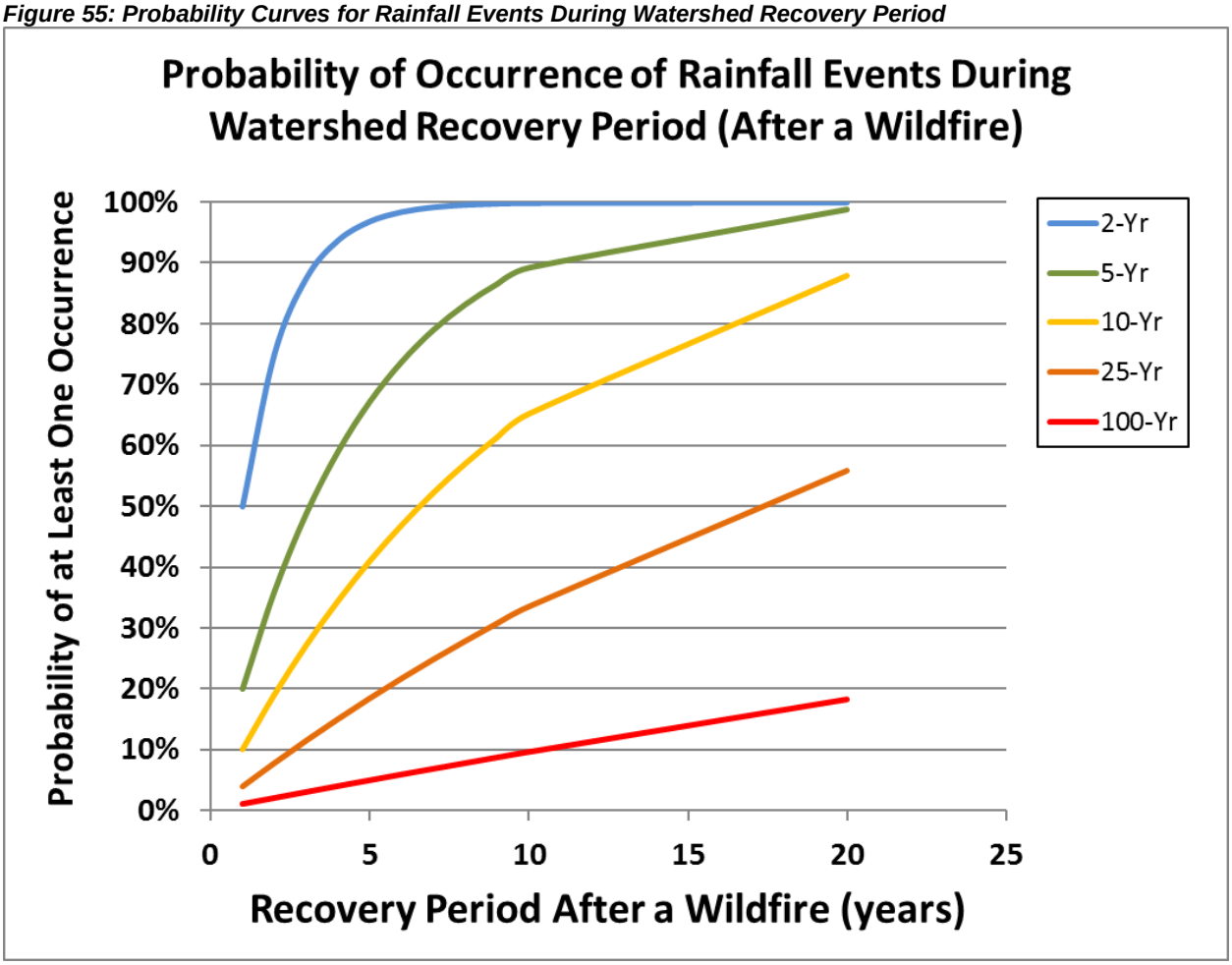
Source: SHELDUS, 1960-2021

Probability

Given the historic record of occurrence for landslides/debris flows/mudslide events (ten years with at least one event reported in the 62-year period of record by SHELDUS), for the purposes of this plan, the annual probability of landslide occurrence is 16 percent. However, in the case of a post-wildfire condition and in combination of heavy precipitation, it is likely landslides, debris flows and mudslides may occur more frequently.

Large mudflows can occur when a relatively common rainfall event (for example, a two-year event) happens over a watershed that has been exposed to wildfire. As the vegetation and soil in a burned area recover and the watershed returns to its pre-burn hydrologic condition, the depth and intensity of rainfall necessary to generate a mudflow will generally increase for a given location. Probability curves have been developed to understand the relationship between storm event return frequency and the probability that a given storm will occur at least once over a period of 20 years, as shown in the following figure:

Figure 55: Probability Curves for Rainfall Events During Watershed Recovery Period



As shown in Figure 55, the probability of occurrence for a 2-year event within 10 years (a relatively typical time frame for hydrologic recovery of a burned watershed is virtually 100 percent, while the probability of a 25-year event and 100-year event are 34 percent and ten percent respectively, within ten years.[68,69]

Climate Trends

While specific projections related to landslides' probability and extent are not available certain deductions can be made based on weather/climatic phenomenon that influence landslides. Climate reports indicate there will likely be an increase in drought and wildfire events across the state, as previously stated drought and wildfire events increase the probability and intensity of landslides. The connection between drought, fire and flood are all likely to influence the occurrence of landslides. For the purposes of this plan it is assumed that as current climate trends continue to develop it is probable that landslide events will increase in frequency for Garfield County.

Vulnerability Assessment and Future Development

[68] Earles, T.A., K.R. Wright, C. Brown and T.E. Langan. 2004. "Los Alamos Forest Fire Impact Modeling." Journal of American Water Resources Association. Volume 40, No. 2, pp. April.

[69] Wright Water Engineering. 2003. "Compilation of Technical Research: Part 1: A Curve Number Approach to Evaluation of Post-Fire Subbasin Recovery Following the Cerro Grande Fire, Los Alamos, New Mexico. Part 2: Post-Burn Assessment of Hydrologic Conditions and Forest Recovery at the Three-Year Anniversary of the Cerro Grande Fire. Part 3: Summary of Mesa Verde 2000 Bircher Fire Basin Recovery in Morefield Canyon."

Although landslides are a natural geologic process, the incidence of landslides and their impacts on people can be exacerbated by human activities. Grading for road construction and development can increase slope steepness and decrease the stability of a hillslope by adding weight to the top of the slope, removing support at the base of the slope, and increasing water content. Other human activities affecting landslides include: excavation, drainage and groundwater alterations, and changes in vegetation.

Development sites with the greatest risk from landslides are against the base of very steep slopes, in confined stream channels (small canyons), and on fans (rises) at the mouth of these confined channels. Landslides are a constant threat in Glenwood Springs where the central business district and several residential districts are built on a debris fan. Contributing to hazard vulnerability, there are more than 20 identified steep mountain streams that converge into the Colorado River. Three development-related actions that can put people at risk include:

- **Creating Steeper Slopes:** Excavation practices, sometimes aggravated by drainage, can reduce the stability of otherwise stable slopes. These failures commonly affect only a small number of homes. Without these excavation practices, there is little risk of landslides in areas not prone to landslide movement.
- **Development on or Adjacent to Existing Landslides:** Existing landslides are generally at risk of future movement regardless of excavation practices. Excavation and drainage practices can further increase risk of landslides. In many cases, there are no development practices that can completely assure stability. Homeowners and communities in these situations accept some risk of future landslide movement.
- **Development on Gentle Slopes:** Development on gentle slopes can be affected by landslides that begin a long distance from the development.

Landslides can affect utility services, transportation systems, and critical lifelines. Communities may suffer immediate damages and loss of service. Disruption of infrastructure, roads, and critical facilities may also have a long-term effect on the economy. Utilities, including potable water, wastewater, telecommunications, natural gas, and electric power are all essential community needs. Loss of electricity has the most widespread impact on other utilities and on the whole community. Natural gas pipes may also be at risk of breakage from landslide movements as small as one to two inches.

Roads and bridges are subject to closure during landslide events. Because many Garfield County residents are dependent on roads and bridges for travel to work, delays and detours are likely to have an economic impact. All communities in Garfield County identified blocked transportation routes as a primary concern due to hazard events, specifically landslides. Due to the unique geographic profile of Garfield County and the reliance on Interstate 70 significant vulnerability exists for these communities. Lifelines and critical facilities should remain accessible, if possible, during a natural hazard event. The impact of closed transportation arteries may increase if the closed road or bridge is a critical lifeline to hospitals or other emergency facilities. Therefore, inspection and repair of critical transportation facilities and routes are essential and should receive high priority. Losses of power and phone service are also potential consequences of landslide events. Due to heavy rains, soil erosion in hillside areas can be accelerated, resulting in loss of soil support beneath high voltage transmission towers in hillsides and remote areas. Flood events can also cause landslides, which can have serious impacts on gas lines.

To evaluate landslide mitigation for roads, the community can assess the number of vehicle trips per day, detour time around a road closure, and road use for commercial traffic or emergency access. Mitigation measures such as debris racks and debris barriers can be placed to protect culverts, roads, and structures from debris flows during smaller events (i.e., potentially up to the

two-year event). However, it is important to recognize that larger events (e.g., larger than a two-year event) will most likely overwhelm any measures intended to capture or divert debris flows.

Study Area Analysis

Due to the available GIS data, an additional level of analysis was completed for landslides. First, County staff divided the planning area into three study areas: Forest, Resource Lands, and Urban Interface. Next, zoning, census, and infrastructure data from Garfield County GIS was overlaid with landslide hazard data from the Colorado Geological Survey to evaluate assets at risk. The following maps and tables show the landslide, rockfall, and debris flow hazard areas and summarize the percentage of assets at risk within each study area.

Table 60: Forest Study Area Assets Vulnerable to Landslides, Debris Flow, and Rockfall

Forest Study Area					
Infrastructure	**Total Sites**	**% of Total Sites**	**Structures**	**Total Sites**	**% of Total Sites**
Right of Way (Miles)	38.07 miles	96.7%	Residential	20	11.8%
Public Airport	N/A	N/A	Commercial	0	0%
Highway Bridges	37	86%	Public Structures	N/A	N/A
Communication Facilities	7	20.6%	Agricultural	N/A	N/A
Electric Utilities Lines (Miles)	17.86 miles	92.2%	Church	N/A	N/A
Railroad (Miles)	21.6 miles	100%	Schools	N/A	N/A
Railroad Bridges	8	100%	Hospital	N/A	N/A
Road - Aspalt Hight Traffic (Miles)	1.93 miles	67%	Other	0	0%
Road - Chipseal Moderate Traffice (Miles)	7 miles	41.6%	**Number of Improvements**	**Improvements Value**	
Road - Gravel Low Traffic (Miles)	10.03 miles	7.6%	39	$16,773,360	
Gas Wells	0	0%			
Pipeline (Miles)	19.98 miles	55%			
Ag and Natural Resource Lands (Square Miles)	53.82 sq mi	86.3%			

Source: Garfield County, Colorado Geological Survey[70], JEO Consulting Group

[70] Colorado School of Mines. "Colorado Geological Survey." Accessed October 2021. http://coloradogeologicalsurvey.org/ .

Figure 56: Forest Study Area Landslides, Debris Flow, and Rockfall

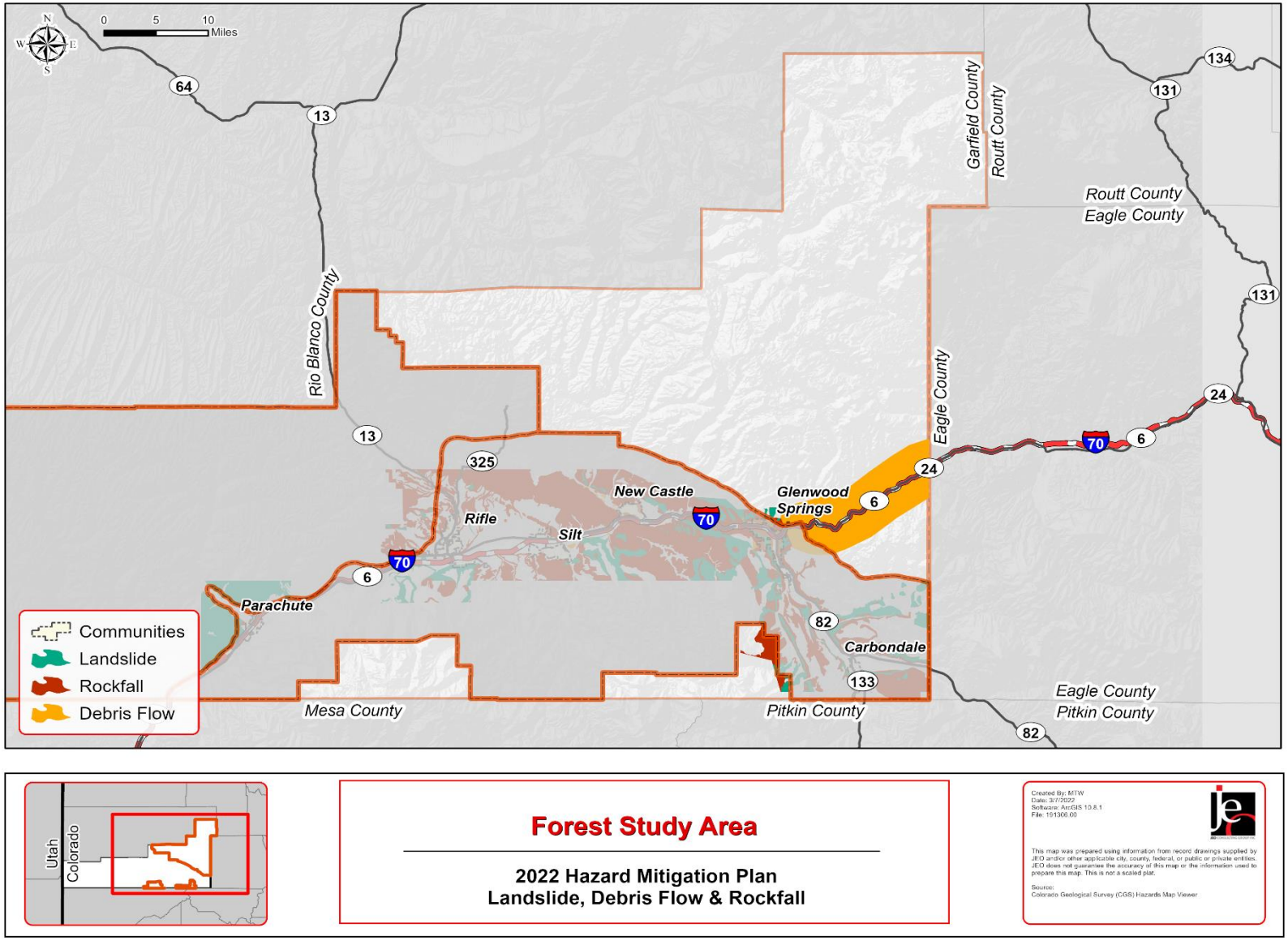


Table 61: Resource Lands Study Area Assets Vulnerable to Landslides, Debris Flow, and Rockfall

Resource Study Area					
Infrastructure	**Total Sites**	**% of Total Sites**	**Structures**	**Total Sites**	**% of Total Sites**
Right of Way (Miles)	35.69 miles	44.3%	Residential	12	10.7%
Public Airport	N/A	N/A	Commercial	0	0
Highway Bridges	0	0%	Public Structures	0	0%
Communication Facilities	N/A	N/A	Agricultural	0	0%
Electric Utilities Lines (Miles)	1.76 miles	15.4%	Church	N/A	N/A
Railroad (Miles)	N/A	N/A	Schools	N/A	N/A
Railroad Bridges	N/A	N/A	Hospital	N/A	N/A
Road - Aspalt Hight Traffic (Miles)	9.28 miles	37.7%	Other	0	0%
Road - Chipseal Moderate Traffice (Miles)	0 miles	0%	**Number of Improvements**	**Improvements Value**	
Road - Gravel Low Traffic (Miles)	29.74 miles	17.5%	38	$674,580	
Gas Wells	830	10.1%			
Pipeline (Miles)	568.9 miles	39%			
Ag and Natural Resource Lands (Square Miles)	78.43 sq mi	89.5%			

Source: Garfield County, Colorado Geological Survey[71], JEO Consulting Group

[71] Colorado School of Mines. "Colorado Geological Survey." Accessed October 2021. http://coloradogeologicalsurvey.org/ .

Figure 57: Resource Lands Study Area Landslides, Debris Flow, and Rockfall

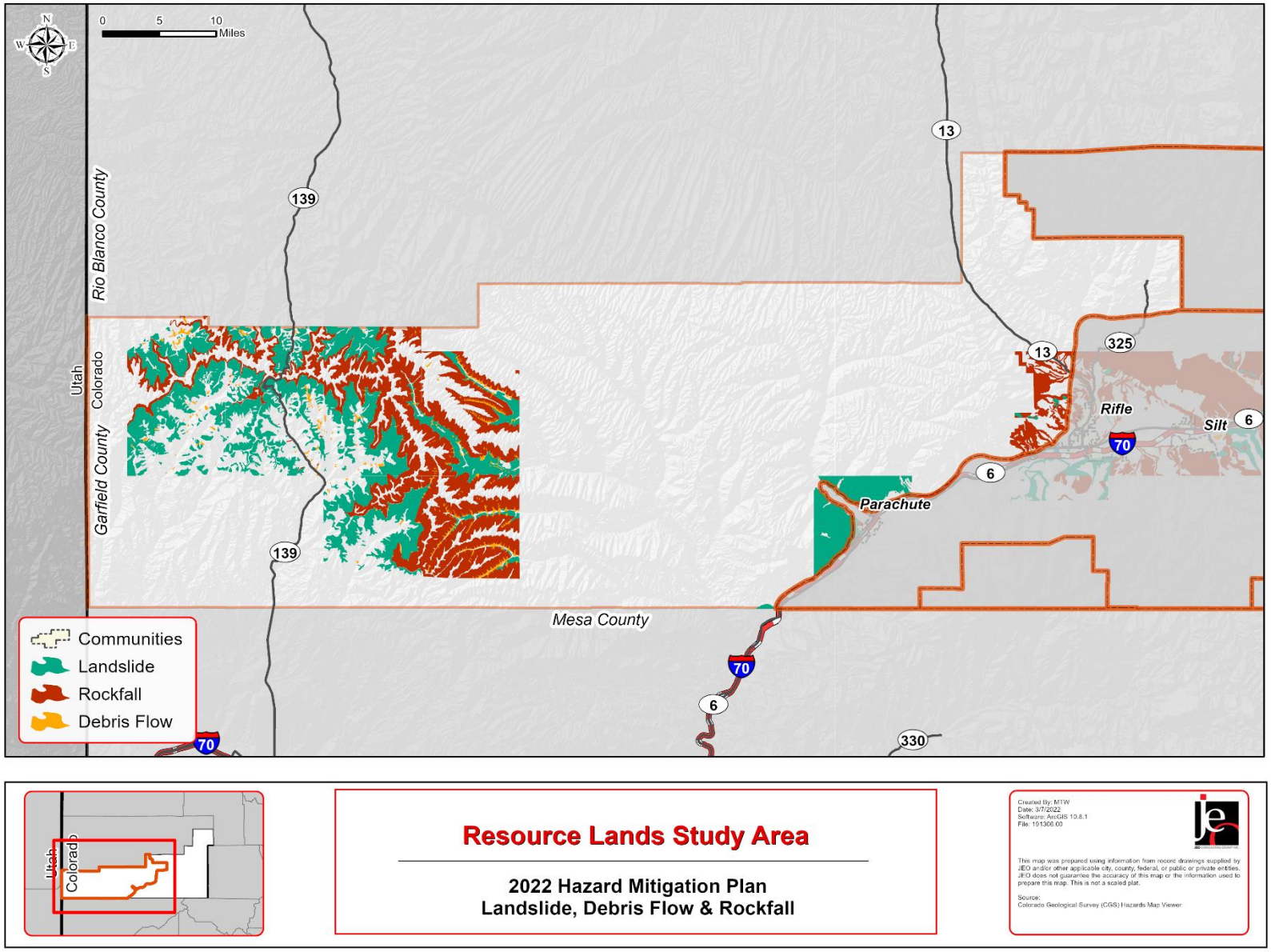


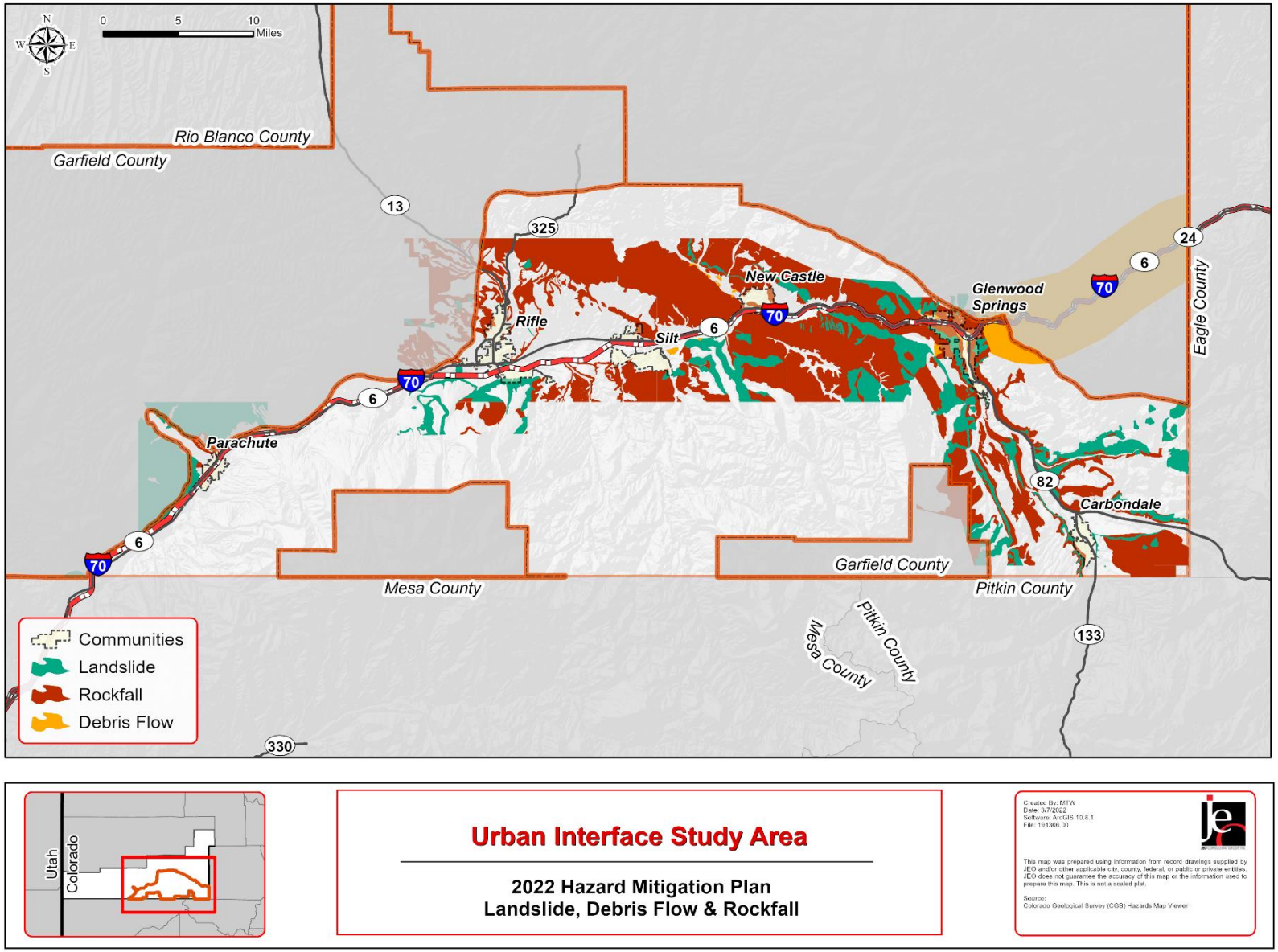
Table 62: Urban Interface Study Area Assets Vulnerable to Landslides, Debris Flow, and Rockfall

Urban Interface Study Area					
Infrastructure	**Total**	**% of Total**	**Structures**	**Total Sites**	**% of Sites**
Right of Way (Miles)	675.2 miles	68.7%	Residential	2,818	19.2%
Public Airport	0	0%	Commercial	161	19.1%
Highway Bridges	13	8.9%	Public Structures	2	6.7%
Communication Facilities	45	45.5%	Agricultural	2	6.9%
Electric Utilities Lines (Miles)	64.02 miles	36.5%	Church	0	0%
Railroad (Miles)	45.09 miles	65.3%	Schools	0	0%
Railroad Bridges	3	8.3%	Hospital	0	0%
Road - Aspalt Hight Traffic (Miles)	68.42 miles	47.3%	Other	152	23.9%
Road - Chipseal Moderate Traffice (Miles)	75.12 miles	40.2%	**Number of Improvements**	**Improvements Value**	
Road - Gravel Low Traffic (Miles)	35.22 miles	23.5%	5,848	$2,290,386,340	
Gas Wells	669	7.6%			
Pipeline (Miles)	422.78 miles	43.3%			
Ag and Natural Resource Lands (Square Miles)	62.92 sq mi	93.7%			

Source: Garfield County, Colorado Geological Survey[72], JEO Consulting Group

[72] Colorado School of Mines. "Colorado Geological Survey." Accessed October 2021. http://coloradogeologicalsurvey.org/ .

Figure 58: Urban Interface Study Area Landslides, Debris Flow, and Rockfall



Public Health Emergency

According to the World Health Organization, a public health emergency is:

> "an occurrence or imminent threat of an illness or health condition, caused by bio terrorism, epidemic or pandemic disease, or (a) novel and highly fatal infectious agent or biological toxin, that poses a substantial risk of a significant number of human facilities or incidents or permanent or long-term disability" (WHO/DCD, 2001). The declaration of a state of public health emergency permits the governor to suspend state regulations, change the functions of state agencies.[73]

The number of cases that qualifies as a public health emergency depends on several factors including the illness, it's symptoms, ease in transmission, incubation period, and available treatments or vaccinations. With the advent of sanitation sewer systems and other improvements in hygiene since the 19th century, the spread of infectious disease has greatly diminished. Additionally, the discovery of antibiotics and the implementation of universal childhood vaccination programs have played a major role in reducing human disease impacts. Today, human disease incidences are carefully tracked by the Centers for Disease Control and Prevention (CDC) and state organizations for possible epidemics and to implement control systems. The Colorado Department of Public Health and Environment (CDPHE) is the state agency responsible for tracking and providing information regarding public health measures in Colorado. CDPHE requires doctors, hospitals, and laboratories to report on many communicable diseases and conditions to monitor disease rates for epidemic events.

Some of the best actions or treatments for public health emergencies are nonpharmaceutical interventions (NPI). These are readily available behaviors or actions and response measures people and communities can take to help slow the spread of respiratory viruses such as influenza or coronavirus. Understanding NPIs and increasing the capacity to implement them in a timely way, can improve overall community resilience during a pandemic. Using multiple NPIs simultaneously can reduce influenza transmission in communities even before vaccination is available.[74] Pandemics are global or national disease outbreaks. These types of illnesses, such as influenza, can spread easily person-to-person, cause severe illness, and are difficult to contain. An especially severe pandemic can lead to high levels of illness, death, social disruption, and economic turmoil. Past public health emergency events include:

- 1918 Spanish Flu: the H1N1 influenza virus spread world-wide during 1918 and 1919. It is estimated that at least 50 million people worldwide died during this pandemic with about 675,000 deaths alone in the United States. No vaccine was ever developed and control efforts included self-isolation, quarantine, increased personal hygiene, disinfectant use, and social distancing.
- 1957 H2N2 Virus: a new influenza A (H2N2) virus emerged in Eastern Asia and eventually crossed into coastal U.S. cities in summer of 1957. In total 1.1 million people worldwide died of the flu with 116,000 of those in the United States.
- 1968 H3N2 Virus: an influenza A virus discovered in the United States in September 1968 which killed over 100,000 citizens. The majority of deaths occurred in people 65 years and older.
- 2009 H1N1 Swine Flu: a novel influenza A virus discovered in the United States and spread quickly across the globe. This flu was particularly prevalent in young people while

[73] World Health Organization. 2008. Accessed April 2020. "Glossary of humanitarian Terms." https://www.who.int/hac/about/definitions/en/.
[74] U.S. Department of Health and Human Services. 2017. "Pandemic Influenza Plan: 2017 Update." https://www.cdc.gov/flu/pandemic-resources/pdf/pan-flu-report-2017v2.pdf

those over 65 had some antibody resistance. The CDC estimated the U.S. had over 60.8 million cases and 12,469 deaths.

- 2019 COVID-19: the coronavirus disease 2019 is a contagious disease caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), which originated in Wuhan China and spread globally. As of August 2021 the CDC reported in the U.S. over 38.9 million cases and 637,000 deaths attributed to COVID-19 and its variants. Efforts to control and limit the virus included face coverings, self-isolation, quarantine, increased cleaning measures, and social distancing. Significant impacts to the national and global economy have been caused by COVID-19.

Location

Human disease outbreaks can occur anywhere in the planning area and novel illnesses or diseases have the potential to develop annually and significantly impact residents and public health systems. Public heath emergencies or pandemic threshold levels are dependent on the outbreak type, transmission vectors, location, and season. Normal infectious disease patterns are changing due to increasing human mobility and climate change. Rural populations are particularly at risk for animal-related diseases while urban areas are at greater risk from community spread type illnesses. All residents throughout the county are at risk during public health emergencies.

Historical Occurrences

Cases and fatalities associated with Public Health Emergencies vary between illness types and severity of outbreak. Past major outbreaks in Colorado have specifically included the H1N1 Swine Flu in 2009 and COVID-19 in 2020.

- H1N1 Swine Flu (2009) – outbreaks were first reported in mid-April 2009 and spread rapidly. The new flu strand for which immunity was nonexistent in persons under 60 years old was similar in many ways to typical seasonal influenza. Symptoms of H1N1 included fever greater than 100F, cough, and sore throat. During this outbreak 54 counties in Colorado were impacted, there were 2,014 hospitalizations, and 69 people died.[75] The U.S. Public Health Emergency for the H1N1 Influenza outbreak expired on June 23, 2010. The CDC developed and encouraged all US residents to receive a yearly flu vaccination to protect against potential exposures. The H1N1 continues to appear annually and persons in the planning area are at risk of infection in the future.

- COVID-19 (2021) – In January 2020 the CDC confirmed the first case of COVID-19 in the United States and it quickly spread across the country. By March 2020 the World Health Organization declared COVID-19 a pandemic and travel bans were instituted around the globe. Primary symptoms of the infection included cough, fever or chills, shortness of breath or difficulty breathing, fatigue, muscle and body aches, headache, loss of taste or smell, sore throat, and others.

  Due to the strong tourism industry in the state, it is assumed the first COVID-19 cases occurred in Colorado prior to many of the directed health measures and safety precautions. The county and communities have utilized masks and other directed health measures to protect residents from the spread of COVID-19.

The table below displays COVID-19 confirmed cases and deaths as of August 30, 2021 in Garfield County.

[75] State of Colorado. 2018. “Enhanced State of Colorado Hazard Mitigation Plan.” https://mars.colorado.gov/mitigation/enhanced-state-hazard-mitigation-plan-e-shmp

Table 63: COVID-19 in the Planning Area

Garfield County	
Total Cases	6,708
Total Fatalities	54
% Eligible Population Fully Vaccinated	51%
% Eligible Population with at least one dose	57.5%
Community Transmission Rate	High

Source: CDC COVID-19 Dashboard, CDPHE COVID-19 Tracker, August 30, 2021

Average Annual Losses

The national economic burden of influenza medical costs, medical costs plus lost earnings, and total economic burden was $10.4 billion, $26.8 billion, and $87.1 billion respectively in 2007.[76] However, associated costs with pandemic response are much greater. Current estimated costs for COVID-19 in the United States exceed $16 trillion (as of December 2020). A preliminary independent research project by the U.S. Census Bureau did note that: "There was a weak correlation between increased mortality rates and negative economic impact across states. There were states that experienced significant employment displacement but no additional mortality for example. On the other hand, there were states that experienced large mortality impacts but modest economic impacts."

Estimated costs for Garfield County are unknown at this time. Specific costs do not include losses from displacement, functional downtime, economic loss, injury, or loss of life. The direct and indirect effects of significant health impacts are difficult to quantify and will vary depending on the type and spread of the virus.

Extent

Those most affected by public heath emergencies are typically the very young, the very old, the immune-compromised, the economically vulnerable, and the unvaccinated. Roughly 28% of the planning area's population is 19 years old or younger, and 13% of the planning area is 64 years old or older, while approximately 9% of the population lives below the poverty line. As of August 2021, vaccinations for COVID-19 were available to all residents and approximately 51% of the population of Garfield County was fully vaccinated. Additional booster shots were also available to immunocompromised individuals who had already received the two-dose vaccine series.

These factors increase vulnerability to the impacts of pandemics. Refer to *Section Three* for further discussion of age and economic vulnerability in the county. It is not possible to determine the extent of individual public health emergency events, as the type and severity of a novel outbreak cannot be predicted. However, depending on the disease type, a significant portion of residents may be at risk to illness or death.

The extent of a public health emergency is also closely tied to the proximity or availability of health centers. The following table identifies hospitals in the planning area.

[76] Molinari, N.M., Ortega-Sanchez, I.R., Messonnier, M., Thompson, W.W., Wortley, P.M., Weintraub, E., & Bridges, C.B. April 2007. "The annual impact of seasonal influenza in the US: measuring disease burden and costs." DOI: 10.1016/j.vaccine.2007.03.046.

Table 64: Hospitals in the Planning Area

Facility Name	Nearest Community	Service Type
Valley View Hospital	Glenwood Springs	Acute Hospital
Grand River Hospital District	Rifle	Critical Access Hospital

Probability

The CDPHE considers pandemics to be an inevitable event in the state. However, there is no accurate way to predict when or to what extent public health emergencies will occur. Based on historical records, it is likely that small-scale disease outbreaks will occur annually within the planning area for communicable diseases. However, large scale emergency events (such as seen with COVID-19) cannot be predicted.

Climate Trends

The relationship between climate change and pandemic outbreaks is still unknown. However, it is likely that climate change impacts on extreme weather, air quality, transmission of disease via insects and pests, food security, and water quality increase threats of disease and can increase communicable and chronic disease burdens.

Vulnerability Assessment

Residents and businesses are vulnerable to the impacts from a pandemic outbreak. Emergency responders and medical personnel can become quickly overtaxed; employees utilizing sick leave or vacation can reduce productivity or shut down local businesses. Large scale or prolonged events may cause businesses to close, which could lead to significant revenue loss and loss of income for workers. People at greatest risk during pandemics will be the very young, the very old, the unvaccinated, the economically vulnerable, and those with immunodeficiency disorders or other comorbidities. Institutional settings such as prisons, dormitories, long-term care facilities or health care facilities, meat-packing plants, daycares, and schools are at higher risk to contagious diseases.

Future Development

As the population in the county continues to grow, additional residents will be at risk to public health disease outbreaks. Communities in Garfield County are growing in density as well. As only two hospitals are located within the county, one in Glenwood Springs and one in Rifle, residents also face reduced care capacity.

Severe Winter Weather

Profile

A severe winter storm is generally a prolonged event involving snow, ice, sleet, freezing rain, and extreme cold temperatures. The characteristics of severe winter storms are determined by a number of meteorological factors including the amount and extent of snow or ice, air temperature, wind speed, and event duration. Even though Garfield County does not typically experience crippling winter weather, some winter weather is a regular occurrence and has the potential to disrupt day-to-day life throughout the County.

Severe winter storms pose a significant risk to life and property by creating conditions that disrupt essential regional systems such as public utilities, telecommunications, and transportation routes. Severe winter storms can produce rain, freezing rain, ice, snow, cold temperatures, and wind. Ice storms accompanied by high winds can have destructive impacts, especially to trees, power lines, and utility services.

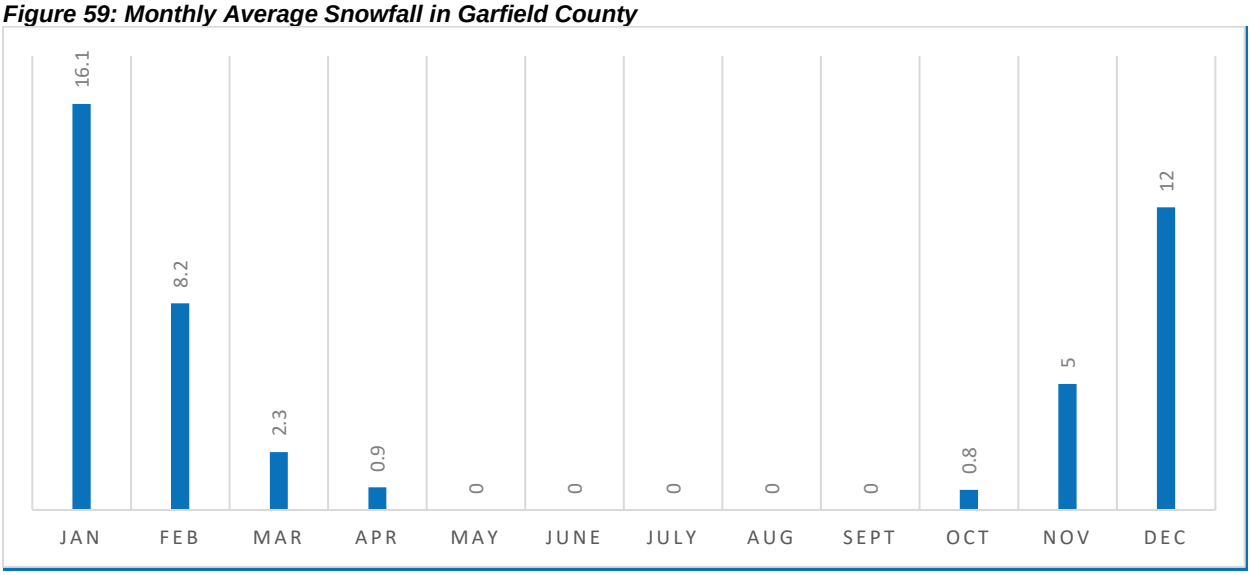
Location

The entire county is at risk of severe winter weather. Resources that exist at higher elevations or at greater slopes will experience more risk of snow and ice, but the entire County is susceptible to damaging severe weather. It is important to focus mitigation actions on areas that may incur the most damage due to severe winter weather. For example, inventorying the structural integrity of County infrastructure that is exposed to high snow loads, mapping areas with overhead powerlines, and cataloguing the health and maturity of trees near critical infrastructure will help better prepare the County against adverse impacts of severe winter weather.

Extent

In general, the winter storm season runs from November to April each year. Several times a year, Garfield County receives heavy snow, and periods of extremely cold temperatures. Past winter storms have resulted in six to 12 inches of snow in urban and low lying areas and 12-18 inches of snow in higher mountainous areas in a 24-hour period.

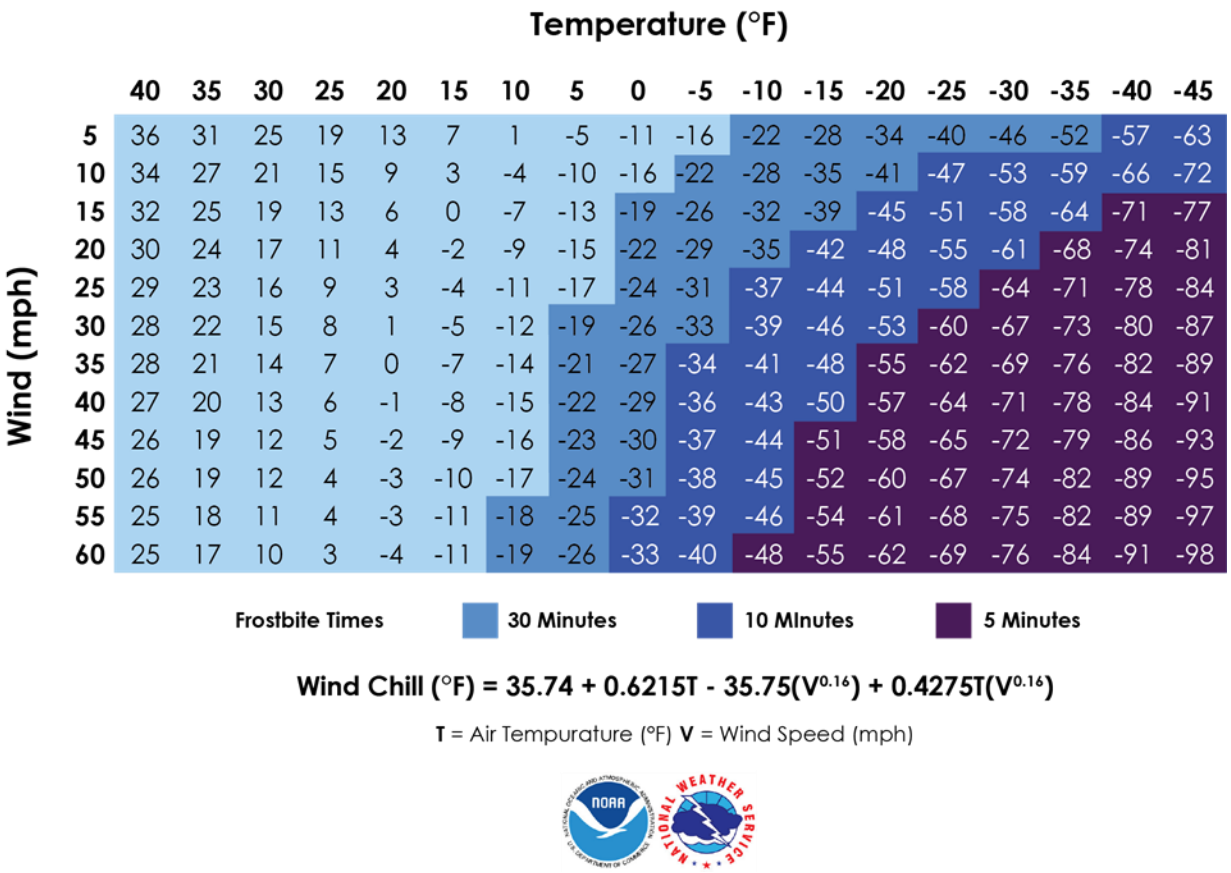
Figure 59: Monthly Average Snowfall in Garfield County



Source: Monthly Climate Normals - High Plains Regional Climate Center, 2021

Extreme cold temperatures occur throughout the winter months and can pose serious concerns for residents throughout the county. The NWS developed the wind chill index to determine the decrease in air temperature felt by the body on exposed skin due to wind. The wind chill is always lower than the air temperature and can quicken the effects of hypothermia or frost bite as it gets lower. The following figure shows the Wind Chill Index used by the NWS.

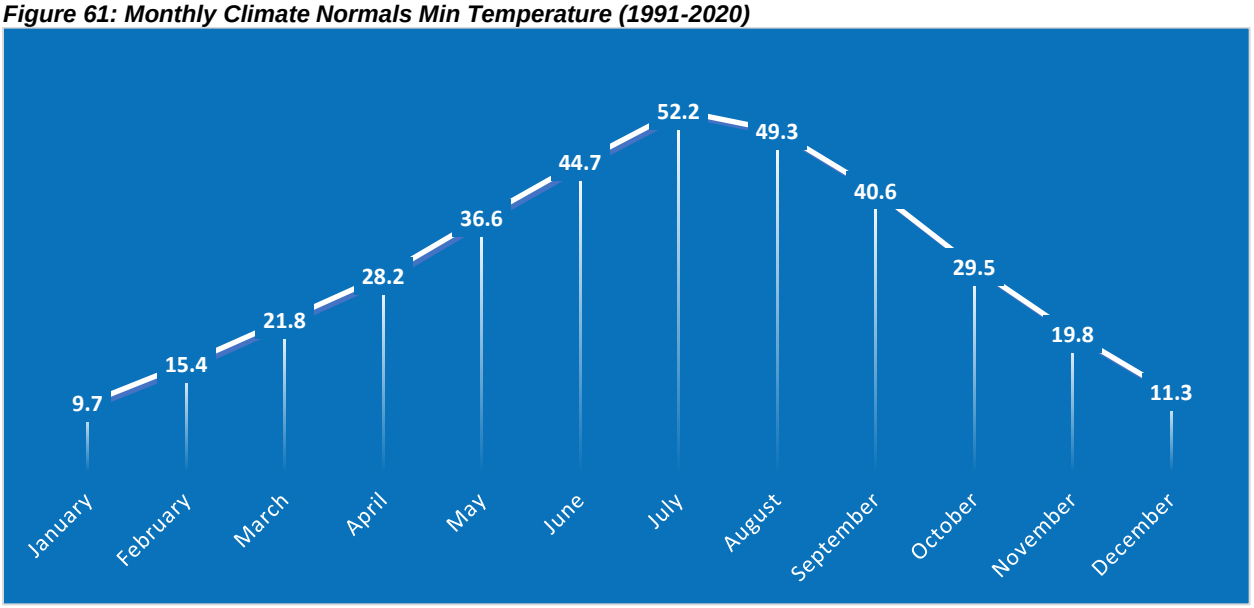
Figure 60: Wind Chill Index Chart



Source: NWS

The following figure shows the average minimum temperatures from 1991 to 2020 for the county. The coldest months in the planning area are January, February, and December.

Figure 61: Monthly Climate Normals Min Temperature (1991-2020)



Source: NCEI, 1991-2020

Historical Occurrences

Due to the regional scale of severe winter weather, the NCEI reports events as they occur in each forecast zone. According to the NCEI, there were a combined 2,581 severe winter weather events in forecast zones which include the planning area from January 1996 to April 2021.

Table 65: Historical Winter Weather Occurrences

Event Type	Number of Events	Average Number of Events per Year	Total Injuries	Total Deaths
Blizzard	10	0.4	0	0
Extreme Cold/Wind Chill	5	0.2	0	0
Heavy Snow	330	12.7	2	1
Ice Storm	3	0.1	0	0
Winter Storm	734	28.2	5	0
Winter Weather	1,499	57.7	0	0
Total	**2,581**	**99.3**	**7**	**1**

Source: NCEI January 1996 to April 2021

Garfield County has never been included in a presidentially declared disaster relating to winter storms. However, winter weather is a chronic hazard that impacts communities across Garfield County. Past major events have led to significant impacts in the county. On March 17, 2011, a storm produced three to nine inches of snow overnight that caused power outages for as many as 1,100 customers and several multi-vehicle accidents. The Post Independent newspaper reported 13 accidents in the stretch of highway between Parachute and Glenwood Springs during the morning commute, and 18 incidents of single car accidents, the majority in the area from Silt to New Castle and Canyon Creek.[77] The accidents resulted in temporary closures of I-70. Two winter storms in February 1996 led to one death and seven injuries in the county. During these

[77] Colson, John. March 18, 2011. "Snowstorm closes I-70, cuts power." Post Independent: Citizen Telegram. Accessed 2021 http://www.postindependent.com/news/snowstorm-closes-i-70-cuts-power/ .

storms approximately 12-24 inches of snow fell over the central and northern mountains. There were numerous vehicle accidents, including a 20 car/truck pile up on I-70 near Vail. Avalanches and snow accumulations resulted in numerous road closures over the mountain passes.

Average Annual Damages

The average annual damages estimate was taken from the SHELDUS database and includes aggregated calculations for each type of winter weather as provided in the database. This does not include losses from displacement, functional downtime, economic loss, injury, or loss of life. According to SHELDUS, severe winter weather has caused $2,627,707 in property damages and $18,301,618 in crop damages in Garfield County from 1960-2019.

Table 66: Historical Winter Weather Damages

Total Property Damages	Average Annual Property Damages	Total Crop Damages	Average Annual Crop Damages
$2,627,707.20	$43,795.12	$18,301,618.04	$305,026.97

Source: SHELDUS, 1960-2019

Probability

Given the historic record of occurrence for severe winter events (at least one severe winter weather event reported in all 26 years on record), for the purposes of this plan, the annual probability of severe winter storm occurrence is 100 percent.

Climate Trends

Winter conditions including extreme temperatures and precipitation are projected to change in the coming future. Cold and mountainous areas are anticipated to receive more rain in the fall and spring months as well as more snow during mid-winter months. However, as increasing temperatures persist throughout the years, the total volume of snowpack may decrease over time and earlier snowmelt will change the timing and efficiency of runoff.

Vulnerability Assessment

Winter storms that bring snow, ice, and high winds can cause significant impacts on life and property. Many severe winter storm deaths occur as a result of traffic accidents on icy roads, heart attacks when shoveling snow, and hypothermia from prolonged exposure to the cold. The temporary loss of home heating can be particularly hard on the elderly, young children, and other vulnerable individuals.

Property is at risk due to flooding and landslides that may result if there is a heavy snowmelt. Additionally, ice, wind, and snow can affect the stability of trees, power and telephone lines, and TV and radio antennas. Downed trees and limbs can become major hazards for houses, cars, utilities and other property. Below freezing temperatures can also lead to breaks in uninsulated water lines serving schools, businesses and industry, and individual homes. Such damage in turn can become major obstacles to providing critical emergency response, police, fire, and other disaster recovery services.

Severe winter weather also can cause the temporary closure of key roads and highways, air and train operations, businesses, schools, government offices, and other important community services. These effects, if lasting more than several days, can create significant economic impacts for the communities affected as well for the surrounding region.

Future Development

As the population in Garfield County continues to grow, communities throughout the county are at greater risk to the impacts of severe winter storms. Communities can become isolated when severe weather closes I-70 or Highway 82 as those are the primary transportation routes in and through the County. Additionally, rising population growth and new infrastructure in the County creates a higher probability for damage to occur from severe winter weather as more life and property are exposed to risk. Snowpack and extreme temperatures can down powerlines, stress water pipes, gas lines, or cause dead or snag trees to fall.

Tier II Hazards

- Avalanche
- Earthquakes
- Erosion and Deposition
- Lightning
- Pest Infestation
- Hazardous Soils
- Severe Wind
- Terrorism

Avalanche

Hazard Profile

An avalanche is a mass of snow, ice, and debris flowing and sliding rapidly down a steep slope. Avalanches are also referred to as snow slides. Avalanches can be extremely destructive due to the great impact forces of the rapidly moving snow and debris and the burial of areas in the run out zone. Four factors contribute to an avalanche: a steep slope, a snow cover, a weak layer in the snow cover, and a trigger.

Location

The greatest avalanche threats are in the mountainous areas of Garfield County. Steeply sloped areas (30 to 45 degrees) are highly subject to avalanches, primarily on south exposed slopes where unstable snow conditions are most likely to occur. The majority of avalanches that occur in the state occur on slopes of 25-50 degrees. The Colorado Avalanche Information Center (CAIC) forecasts backcountry avalanche and mountain weather conditions for ten zones in the mountains of Colorado (Figure 62).[78] This figure is not intended to show current risk, as it constantly changes throughout the winter season. This figure is included to show forecast zone boundaries as an indication of where avalanches tend to occur. Parts of Garfield County are located within the following forecast zones: Steamboat and Flat Tops, Grand Mesa, and Aspen. No areas within Garfield County were identified as historic avalanche zones or potential avalanche zones in the 2018-2023 Colorado Enhanced State Hazard Mitigation Plan.

Extent

As local avalanche extent data is limited, the following information is taken from the state plan. The maximum measured impact pressure of an avalanche is 10 ton/ft^2 while 1 ton /ft^2 is more common. A typical range is from 0.5 to 5.0 ton/ft^2. Air blasts from powder avalanches commonly exert a pressure of 100lbs/ft^2 of force. Pressures of only 20-50lbs/ft^2 can knock out most windows and doors. Additional damages associated with impact pressure are shown below.

Table 67: Avalanche Impact Pressure Damage Estimates

Impact Pressure (lbs/ft^2)	Potential Damage
40-80	Break windows
60-100	Push in doors, damage walls, roofs
200	Severely damage wood frame structures
400-600	Destroy wood-frame structures, break trees
1000-2000	Destroy mature forests
>6000	Move large boulders

Source: 2018-2023 Colorado Enhanced Hazard Mitigation Plan

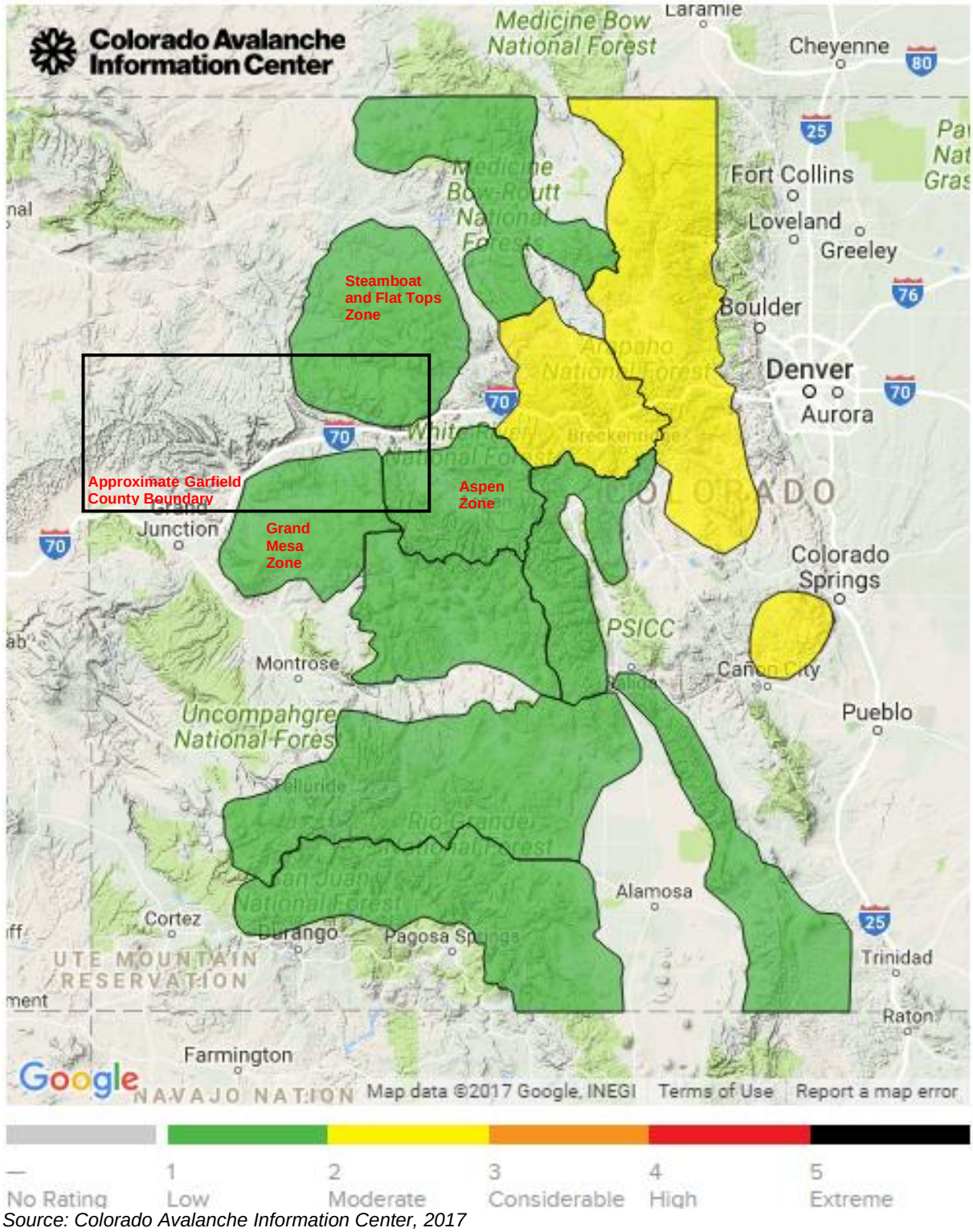
Structures in avalanche prone areas, roads or highways, recreation areas, and vehicles in the way of an avalanche are all at risk of damage or destruction during an avalanche.

Historical Occurrences

According to the NCEI, there were 57 avalanche events in Garfield County between 1996 – 2021. These reported events caused 18 injuries and thirty-two deaths.

[78] State of Colorado. "Colorado Avalanche Information Center." Accessed 2021. http://avalanche.state.co.us/ .

Figure 62: CAIC Avalanche Forecast Zones



Source: Colorado Avalanche Information Center, 2017

Average Annual Losses

The average annual losses estimate was taken from the SHELDUS database. This does not include losses from displacement, functional downtime, economic loss, injury, or loss of life.

According to SHELDUS, avalanches have caused $16,236 in property damages in Garfield County from 1960-2019.

Table 68: Historical Avalanche Damages

Total Property Damages	Average Annual Property Damages	Total Crop Damages	Average Annual Crop Damages
$16,236.30	$270.61	$0	$0

Source: SHELDUS, 1960-2019

Probability

Avalanches may not occur during every winter season in the county. Serious avalanche events may occur every five to 15 years. Avalanches occur most frequently between November and April with February, March, and January as the most common months in order. Based on historical records and reported events (at least one avalanche reported in 19 of the 26 year period of record) it is likely that avalanches will continue to occur within Garfield County. For the purposes of this plan the annual probability of avalanche is 76%. The Colorado State HMP notes Garfield County is one of the top counties projected to experience the highest exposure to avalanches through 2030.

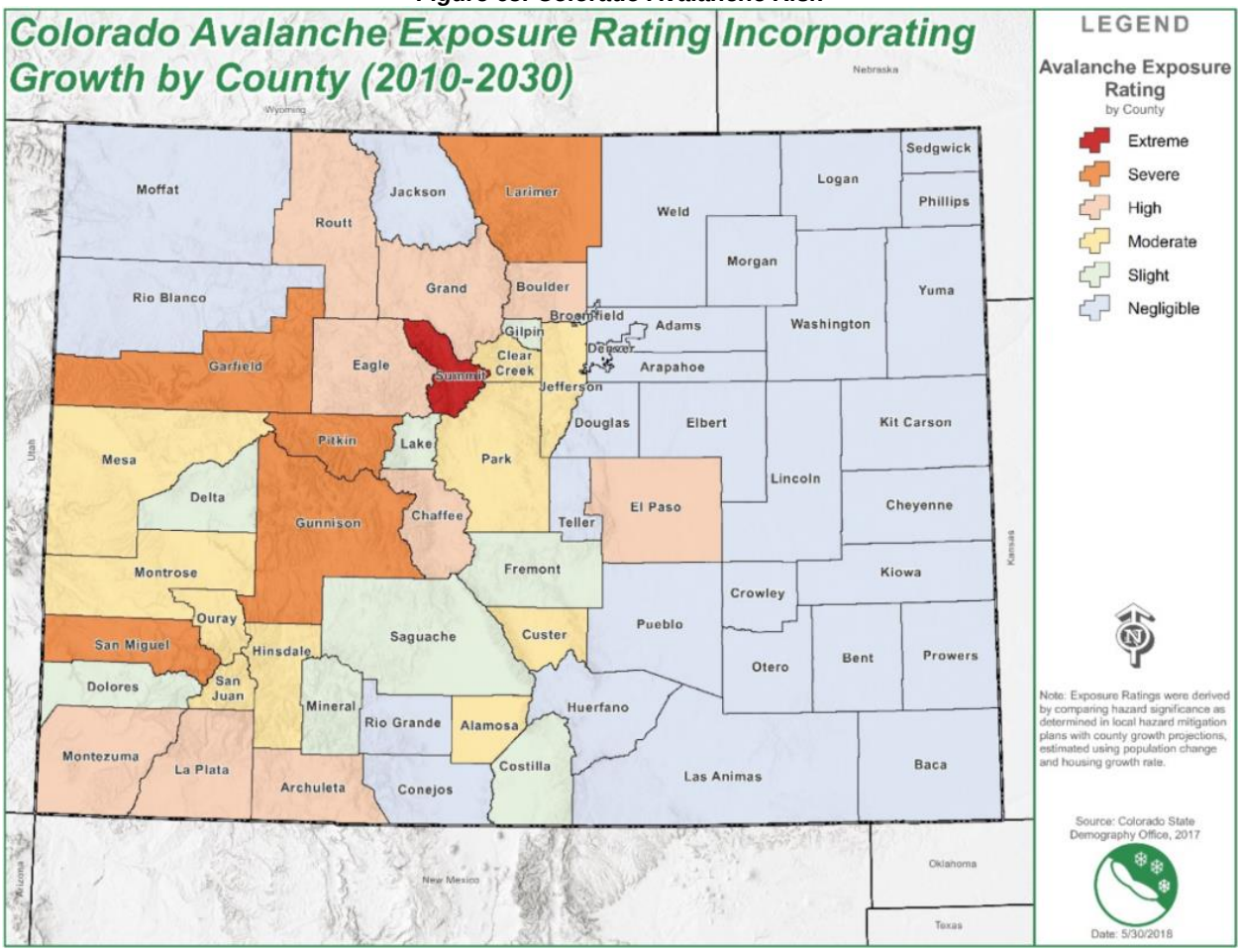
Climate Trends

Impacts from climate change are anticipated to affect the frequency and magnitude of avalanche events. Avalanches areas are anticipated to decline and snow fall declines. Overall snowpack is projected to decline and spring runoff is projected to shift one to three weeks earlier in the future Colorado climate. Wet avalanches are expected to occur earlier in the year than historical averages. Additionally, as snowfall occurs earlier in the winter season followed by a dry period, snowpack remains thin and unstable throughout the winter.

Vulnerability Assessment

Areas of Garfield County where development has encroached into steep mountainous terrain have an increased vulnerability to avalanches. A lack of recognition of avalanche run out potential has resulted in some residential buildings construction within high risk areas in the state and in Garfield County. Based on the historic record, avalanches will not likely result in significant property damages within Garfield County. According to the Colorado State Hazard Mitigation Plan (2018), Garfield County has a "*Severe*" exposure rating to avalanches due to overall risk (total deaths plus historical avalanche events) and population growth in the county. According to NCEI there have been 32 fatalities and 18 injuries in the county. Injuries and fatalities due to avalanches may occur as winter recreation activities are popular for individuals in the planning area. Individuals that engage in winter recreation activities in mountainous areas of the County have an increased risk of exposure to this hazard. Education and outreach will be the most effective strategy in mitigating the impacts of avalanches.

Figure 63: Colorado Avalanche Risk



Source: Colorado State Hazard Mitigation Plan, 2018

Future Development

Population growth and development contribute to increased risk to people and property from avalanches. As many communities in Garfield County continue to grow and expand development into mountainous areas, risks to avalanche events may also increase, specifically in eastern Garfield County where topography is steepest and avalanches are most common. Prior to construction, communities should evaluate surrounding grades, annual average snowpack loads, and run-out potential zones in high risk areas. Additionally, as local populations grow the number of hikers, backpackers, and skiers also increases. These individuals are at greatest risk to avalanche events which many events caused by recreational activities and emergency access is typically limited.

Earthquakes

Profile

Ground shaking, landslides, liquefaction, and amplification are the specific hazards associated with earthquakes. The severity of these hazards depends on several factors, including soil and slope conditions, proximity to a fault, earthquake magnitude, and type of earthquake.

- **Ground shaking** is the motion felt on the earth's surface caused by seismic waves generated by an earthquake. Ground shaking is the primary cause of earthquake damage. The strength of ground shaking depends on the magnitude of the earthquake, the type of fault, and distance from the epicenter (where the earthquake originates). Buildings on poorly consolidated and thick soils will typically see more damage than buildings on consolidated soils and bedrock.

- **Earthquake-induced landslides** are secondary earthquake hazards that occur from ground shaking. They can destroy roads, buildings, utilities, and other critical facilities necessary to respond to recover from an earthquake.

- **Liquefaction** occurs when ground shaking causes wet granular soils to change from a solid state to a liquid state. This results in the loss of soil strength and the soil's ability to support weight. Buildings and their occupants are at risk when the ground can no longer support these buildings and structures.

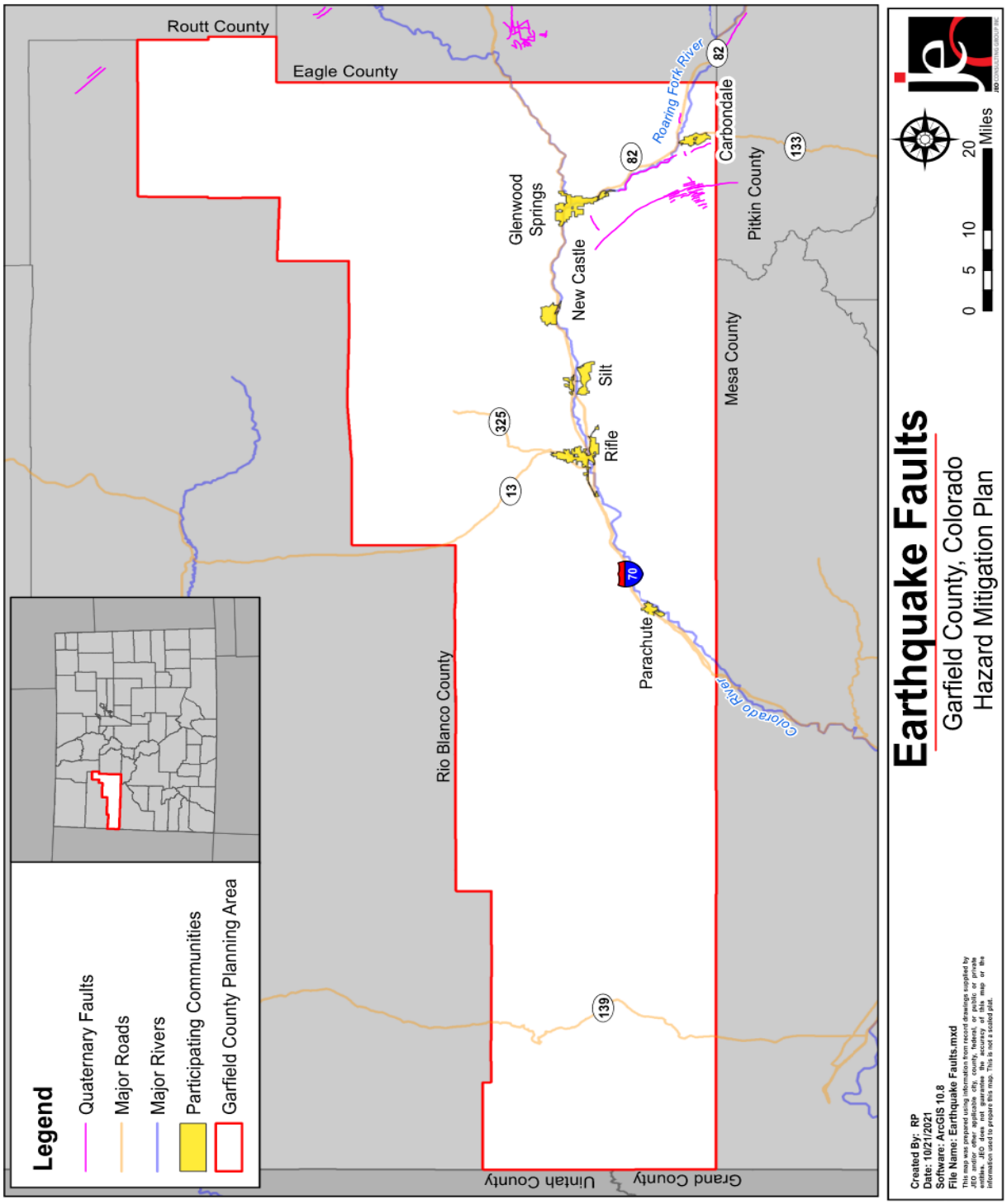
- **Amplification** is the phenomenon when soils and soft sedimentary rocks near the earth's surface increase the magnitude of the seismic waves generated by the earthquake. The amount of amplification is determined by the thickness of geologic materials and their physical properties. Buildings and structures built on soft and unconsolidated soils face greater risk.

Location

The locations most likely to experience an earthquake within Garfield County are those near fault lines. According to the USGS, several fault lines exist to the southwest of Glenwood Springs and Carbondale. These fault lines are categorized as Class B (various age) well constrained, moderately constrained, or inferred location. Class B is defined as "Geologic evidence demonstrates the existence of a fault or suggests Quaternary deformation, but either (1) the fault might not extend deeply enough to be a potential source of significant earthquakes, or (2) the currently available geologic evidence is too strong to confidently assign the feature to Class C but not strong enough to assign it to Class A."

Figure 64 shows the faults located within Garfield County. These faults are located primarily in the southeastern portion of the County. Figure 65 shows a national seismic hazard map from the USGS. This map is derived from seismic hazard curves calculated on a grid of sites across the United States that describe the annual frequency of exceeding a set of ground motions.

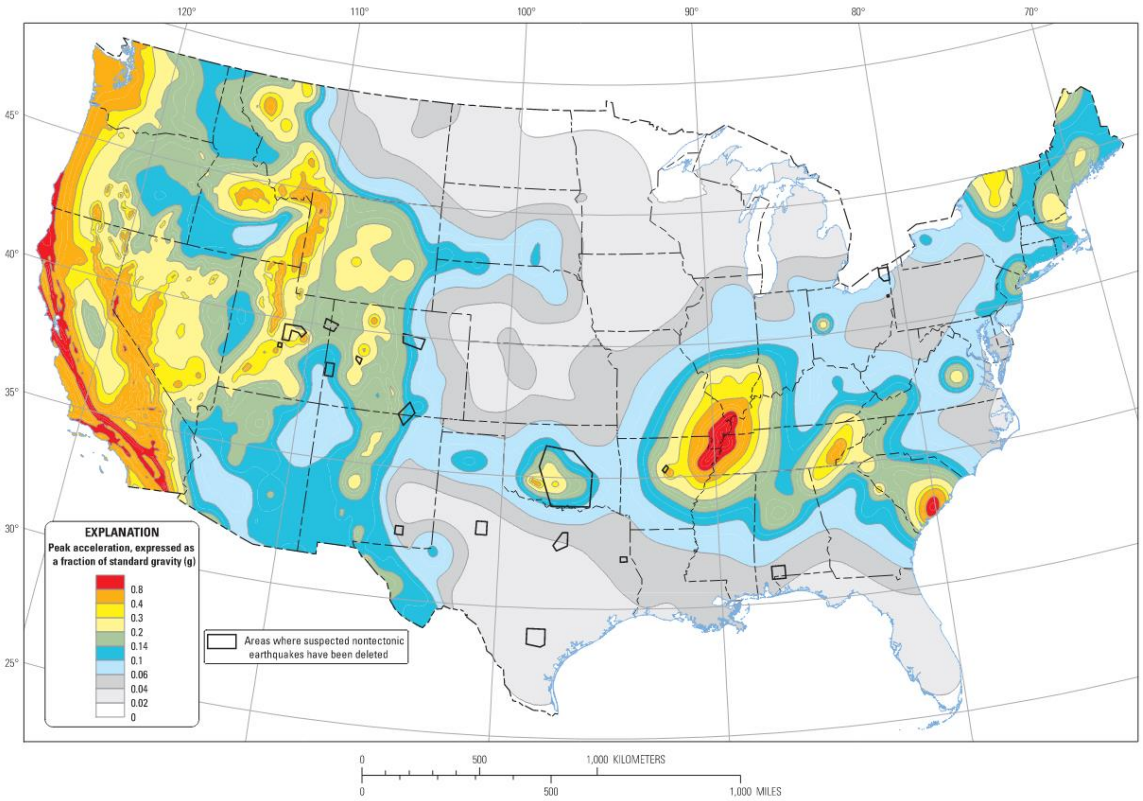
Figure 64: USGS Quaternary Faults in Garfield County



Source: USGS Geologic Hazards Science Center, 2021[79]

[79] USGS Geological Hazards Science Center. Accessed September 2021. "Earthquake Hazards – Interactive Fault Map." [Data File]. https://www.usgs.gov/natural-hazards/earthquake-hazards/faults?qt-science_support_page_related_con=4#qt-science_support_page_related_con.

Figure 65: Two Percent Probability of Exceedance in 50 Years Map of Peak Ground Acceleration



Source: USGS, 2017

Extent

Earthquakes are measured by magnitude and intensity. Magnitude is measured by the Richter Scale, a base-10 logarithmic scale, which uses seismographs around the world to measure the amount of energy released by an earthquake. Intensity is measured by the Modified Mercalli Intensity Scale, which determines the intensity by comparing actual damage against damage patterns of earthquakes with known intensities. The following tables summarize the Richter Scale and Modified Mercalli Scale. The Colorado Division of Homeland Security and Emergency Management noted the State of Colorado is likely to experience a magnitude 6.5 earthquake at some unknown point in the future; however, based on the historical record, earthquakes in the planning area are likely to measure 3.0 or less on the Richter Scale.

Table 69: Richter Scale

Richter Magnitudes	Earthquake Effects
Less than 3.5	Generally, not felt, but recorded.
3.5 – 5.4	Often felt, but rarely causes damage.
Under 6.0	At most, slight damage to well-designed buildings. Can cause major damage to poorly constructed buildings over small regions.
6.1 – 6.9	Can be destructive in areas up to about 100 kilometers across where people live.
7.0 – 7.9	Major earthquake. Can cause serious damage over larger areas.
8 or greater	Great earthquake. Can cause serious damage in areas several hundred kilometers across.

Source: FEMA, 2016[80]

Table 70: Modified Mercalli Intensity Scale

Scale	Intensity	Description of Effects	Corresponding Richter Scale Magnitude
I	Instrumental	Detected only on seismographs	
II	Feeble	Some people feel it	< 4.2
III	Slight	Felt by people resting, like a truck rumbling by	
IV	Moderate	Felt by people walking	
V	Slightly Strong	Sleepers awake; church bells ring	< 4.8
VI	Strong	Trees sway; suspended objects swing, objects fall off shelves	< 5.4
VII	Very Strong	Mild alarm; walls crack; plaster falls	< 6.1
VIII	Destructive	Moving cars uncontrollable; masonry fractures, poorly constructed buildings damaged	
IX	Ruinous	Some houses collapse; ground cracks; pipes break open	< 6.9
X	Disastrous	Ground cracks profusely; many buildings destroyed; liquefaction and landslides widespread	< 7.3
XI	Very Disastrous	Most buildings and bridges collapse; roads, roadways, pipes and cables destroyed; general triggering of other hazards	< 8.1
XII	Catastrophic	Total destruction; trees fall; ground rises and falls in waves	> 8.1

Source: FEMA, 2016

Historical Occurrences

According to the United States Geological Service, there have been 41 earthquakes within Garfield County between 1900 – 2020 greater than 1.0 magnitude. There were no reported damages or injuries associated with these earthquake events. The following figure shows the breakdown of reported earthquakes by magnitude.

[80] Federal Emergency Management Agency. 2020. "Earthquake Risk." https://www.fema.gov/emergency-managers/risk-management/earthquake

Figure 66: Earthquakes by Magnitude in Garfield County

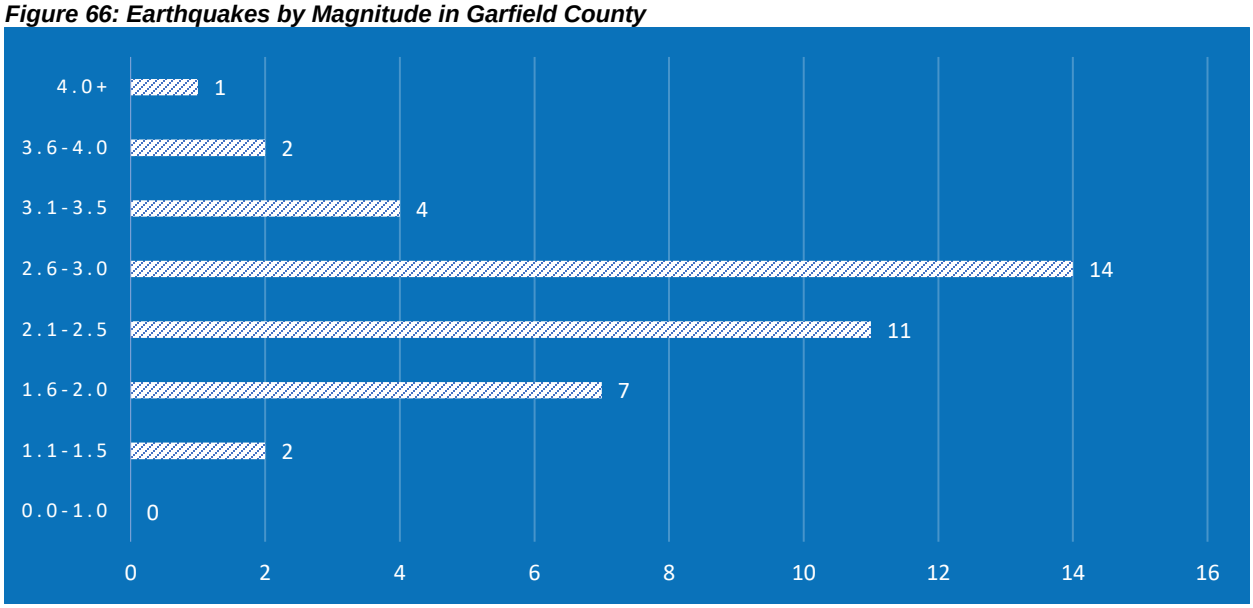
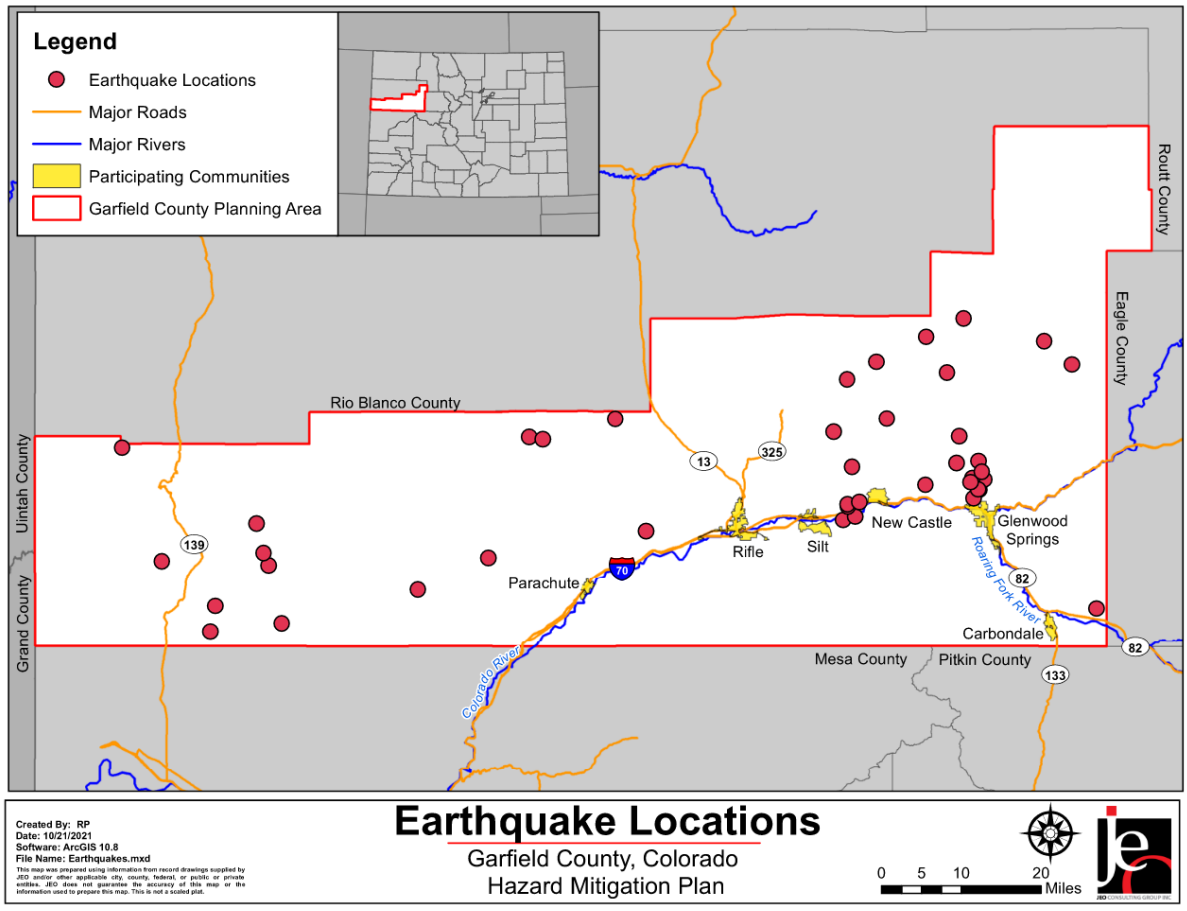


Figure 67: Earthquakes in Garfield County



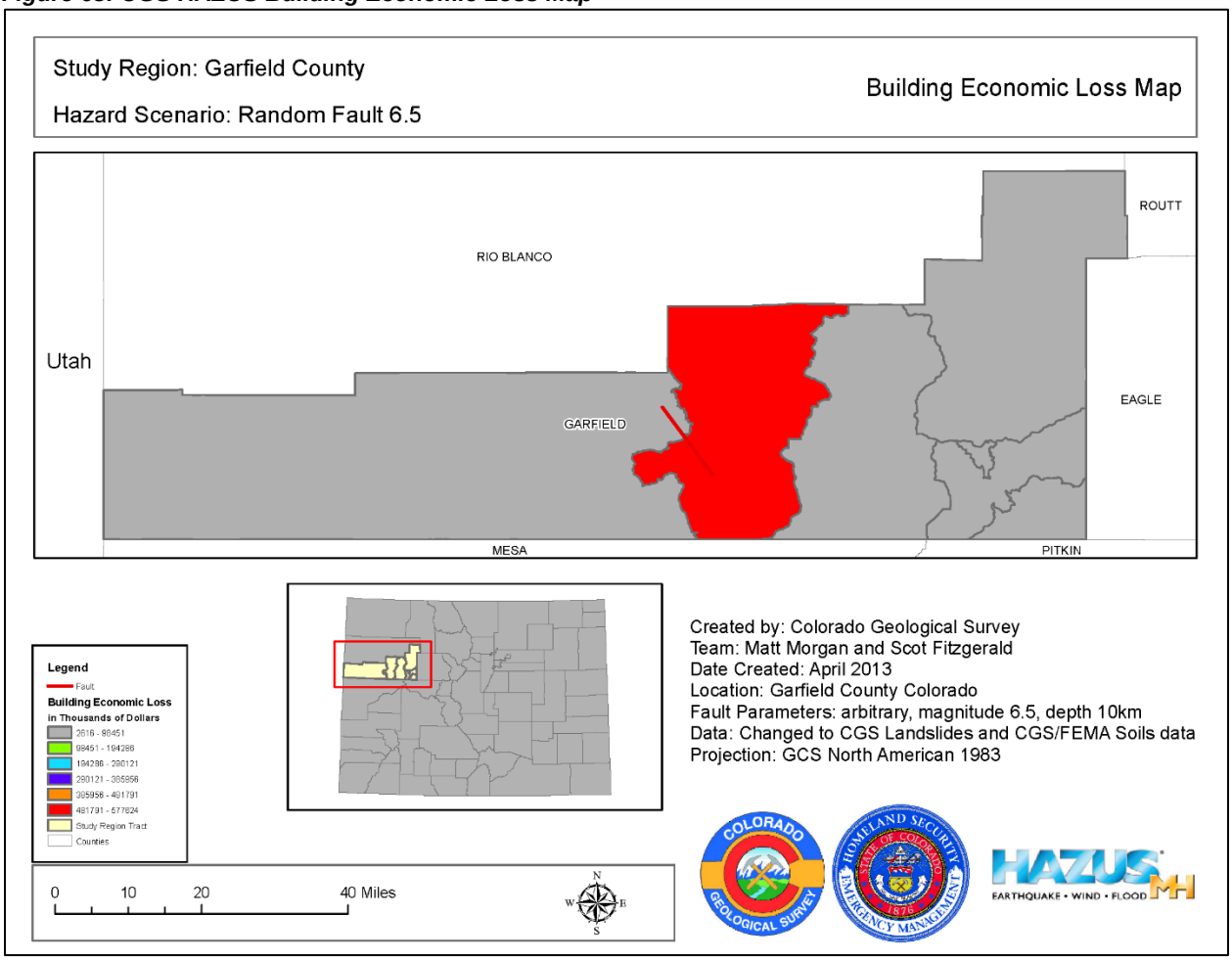
Source: USGS Geologic Hazards Science Center, 2021[81]

[81] USGS Geological Hazards Science Center. Accessed September 2021. "Earthquake Hazards – Interactive Fault Map." [Data File]. https://www.usgs.gov/natural-hazards/earthquake-hazards/faults?qt-science_support_page_related_con=4#qt-science_support_page_related_con.

Average Annual Damages

There have been no reported damages associated with past earthquake events in Garfield County. In 2013, the Colorado Geological Survey utilized HAZUS to estimate losses in Garfield County if a magnitude 6.5 earthquake were to occur in the geographic center of the County. The total economic loss estimated for this scenario is $739.8 million dollars. Figure 68 shows one of the maps from this report. Visit the Colorado Geological Survey's website to view the full report.[82]

Figure 68: CGS HAZUS Building Economic Loss Map



Source: Colorado Geological Survey, 2013

Probability

Given earthquake events occurred in 16 of the 120 years on record (1900-2020), for the purposes of this plan the probability of an earthquake in the county in any given year is approximately 13%.

Climate Trends

Currently, there is no known direct association with climate change and earthquake events. However, as climate change exacerbates effects on other hazard types such as drought, it may produce more frequent or greater earthquake events. A report in 2017 by NASA's Jet Propulsion

[82] Colorado Geological Survey. 2013. "Potential Losses (HAZUS)." Accessed September 2021. https://coloradogeologicalsurvey.org/publications/hazus-report-garfield/.

Lab[83] found that alternating periods of drought and heavy precipitation caused the Sierra mountain range in California to rise and fall as the ground swelled/contracted. The study did not specifically look at potential impacts on quaternary fault lines but such stress changes could potentially be felt on faults.

Vulnerability Assessment

Earthquake damage occurs when humans build structures that cannot withstand severe shaking. Buildings, airports, schools, and lifelines (highways and phone, gas, and water lines) suffer damage in earthquakes and can cause death or injury to humans.

The welfare of homes, major businesses, and public infrastructure is very important. Addressing the reliability of buildings, critical facilities, and infrastructure is a challenge faced by Garfield County. Further, understanding the potential costs to government, businesses, and individuals as a result of an earthquake is important to consider.

Garfield County has several unique social and physical characteristics that affect earthquake hazard vulnerability:

- **Oil and gas infrastructure** represents a large portion of Garfield County's economic base as both an employment sector and a source of revenue for the County and support industries. The pipelines carry high pressure liquid and gas throughout the County, both aboveground and buried. The proximity of these pipes to communities and to the Colorado River increases the vulnerability of contamination of the air or water if the infrastructure is damaged in an earthquake.

- **Transportation infrastructure** in Garfield County is not only of critical importance to the County and its residents, but I-70 is a key regional and national Highway. An earthquake could greatly damage the bridges and highway surfaces, hampering the movement of people and goods. Damaged infrastructure strongly affects the economy of the community – it disconnects people from work, school, food, and leisure, and separates businesses from their customers and suppliers.

More generally, any community assessing the vulnerability of its systems to damage from and earthquake should consider:

- **Buildings**: The built environment is susceptible to damage from earthquakes. Collapsed buildings can trap and bury people. Lives are at risk and the cost to clean up damages is great.

- **Damage to lifelines**: Lifelines are the connections between communities and outside services. They include water and gas lines, transportation systems, electricity, and communication networks. Ground shaking and amplification can cause pipes to break open, power lines to fall, roads and railways to crack or move, and radio and telephone communication to cease. Disruption to transportation makes it especially difficult to bring in supplies or services. All lifelines need to be functional after an earthquake to allow for rescue, recovery, and rebuilding efforts and to relay important information to the public.

- **Disruption of critical services**: Critical facilities include police stations, fire stations, hospitals, shelters, and other facilities that provide important services to the community.

[83] Argus, D. et al. 2017. "Sierras lost water weight, grew taller during drought." NASA's Jet Propulsion Labratories. https://climate.nasa.gov/news/2663/sierras-lost-water-weight-grew-taller-during-drought/.

These facilities and their services need to be functional after an earthquake event. Many critical facilities are housed in older buildings that are not up to current seismic codes.

- **Businesses**: Seismic activity can cause great loss to businesses, large and small. Even one day of disruption can cause enormous economic losses. Earthquake damage can present a significant burden to small shop owners who may have difficulty recovering from their losses.

- **Death and injury**: Death and injury can occur both inside and outside of buildings from falling equipment, furniture, debris, and structural materials. Damaged infrastructure can also endanger human life.

- **Fire**: Downed power lines or broken gas mains can trigger fires. When fire stations suffer building or lifeline damage, quick response to suppress fires or provide emergency medical services is less likely.

- **Debris**: After an earthquake, efforts focus on cleaning up building elements (brick, glass, wood, steel or concrete), office and home contents, and other materials. Developing strong debris management strategies can assist in post-disaster recovery.

Future Development

Future development is not currently planned along corridors with identified quaternary fault lines in Garfield County. However, specific vulnerable populations including low income households and elderly residential housing facilities should avoid development along earthquake risk zones. Future development and growth would likely increase the intensity of earthquake impacts across the planning area. Future development and growth in these areas could have impacts including increased density in underserved areas and new structures built without reinforcements.

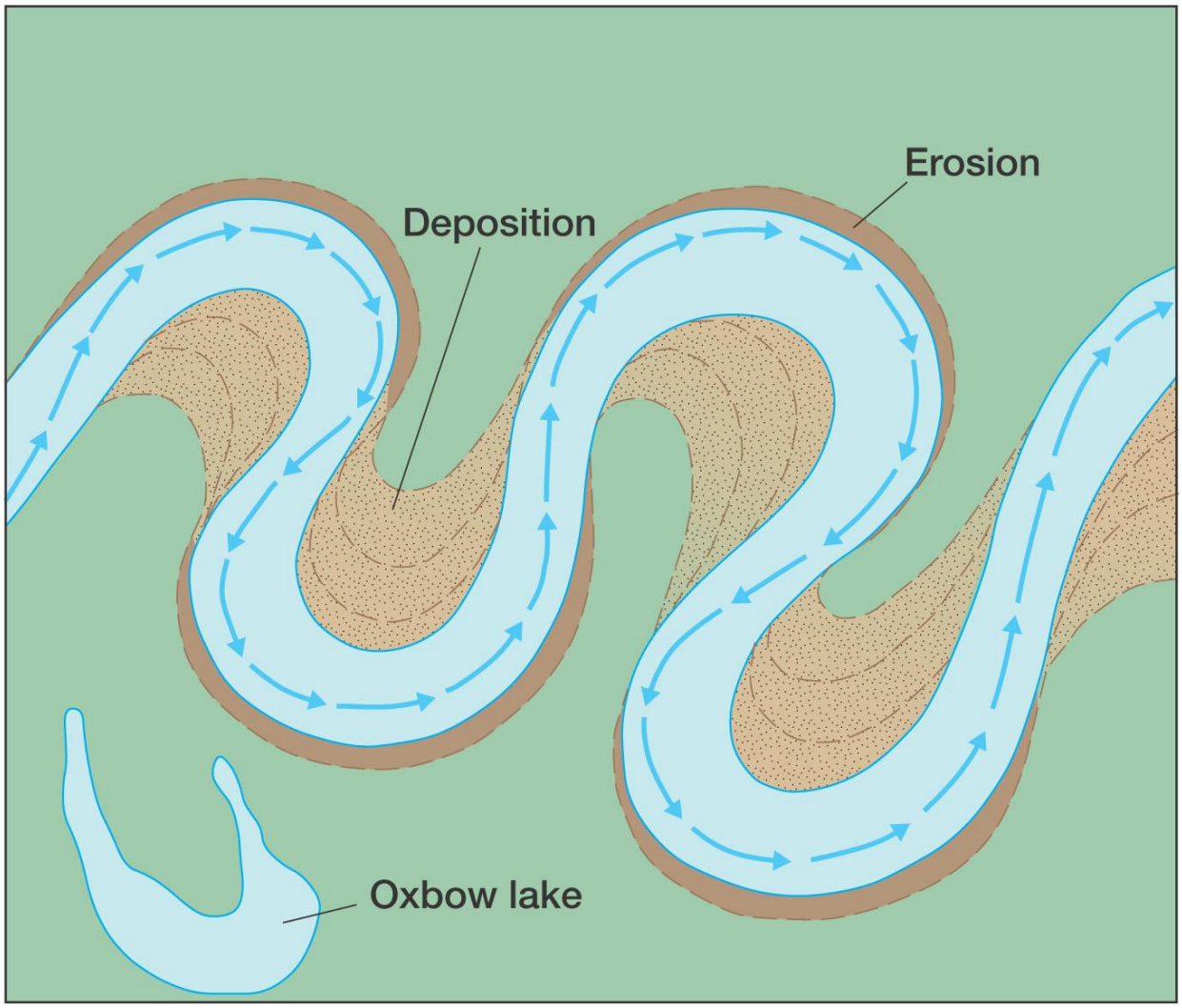
Erosion and Deposition

Hazard Profile

The Colorado Geological Survey (GCS) defines erosion as "the removal and simultaneous transportation of earth materials from one location to another by water, wind, waves or moving ice." Deposition is defined as the placing of eroded material in a new location.

An example of one type of erosion and deposition is shown in the following figure.

Figure 69: Stream Erosion and Deposition



Source: Pearson Prentice Hall, Inc., 2005

Location

Erosion and deposition occur continually throughout Garfield County. The State of Colorado has developed a Colorado Hazard Mapping and Risk Map product for fluvial and erosion risk areas.[84] There are no risk areas identified in Garfield County.

[84] Colorado Water Conservation Board. 2021. "Colorado Hazard Mapping & Risk MAP Portal – MAP Fluvial/Erosion Hazard Mapping." https://coloradohazardmapping.com/hazardMapping/fluvialMapping/Map.

Point sources of erosion often occur in areas where humans interact with exposed earth, such as construction sites. Waterways perpetually remove and carry soil downstream. Erosion and deposition problems are exacerbated in wildfire burn areas. Locations of greatest risk include along the Colorado River, major transportation routes (I-70), and along burn scars.

Erosion on County Road 237 near Harvey Gap in 2016

Extent

The extent of erosion and deposition is largely related to the impacted area's location. Erosion can result in minor inconveniences or total destruction. Events near human development can cause property damage and loss of life. However, events may also occur in remote areas of Garfield County with little impact to people or property.

Erosion and deposition is aggravated by natural events such as heavy rain or stream flow, high wind, and wildfires. Erosion can remove earth from beneath bridges, roads, and foundations of structures adjacent to streams. The deposition of material can block culverts, aggravate flooding, destroy crops and lawns by burying them, and cause overall degradation of the water supply. Undercutting can lead to an increased risk of landslide and rockfall.

Historical Occurrences

There are no known sources for historical erosion events. Erosion can commonly occur after wildfire events and heavy rains when runoff wash down over dead and loosened trees, grasses, shrubs, or other debris.

In 2016, a portion of County Road 237 collapsed due to water flowing under the roadway. Heavy rain and flooding led to another erosion event occurring in the roadway at Baxter Pass in 2014.

Average Annual Losses

There are no known sources of erosion losses. Often, damages from erosion and deposition are combined with flooding damages. However, costs for the County to repair the roadways from two recent erosion events on County Road 237 and Baxter Pass totaled $589,404 according to the Garfield County Road and Bridge Department.

Probability

Erosion and deposition is an ongoing natural event and is expected to continue throughout the county. Due to a lack of available historical occurrences, it is not currently possible to estimate annual probability.

Climate Trends

Climate trends may result in decreased snow pack, intensification of winter precipitation events, and an increased frequency of drought and wildfires. Erosion/deposition will be a secondary hazard following these other hazards. Overall land area exposed to erosion and deposition may increase as wildfire events occur throughout the County. Additionally, the increase in frequency, duration, and magnitude of drought conditions is anticipated to cause increased wind-born erosion.

Vulnerability Assessment

Erosion can cause impacts to property, critical facilities, and water quality. Structures located near streams have an increased risk of damages to stream erosion and deposition. Erosion from wind can adversely impact populations who have respiratory issues. These populations are more vulnerable during erosion events that negatively impact air quality.

Efforts to control erosion may include drainage management, vegetation of disturbed lands, and the riprapping of erosion-prone stream banks.

Future Development

Communities in Garfield County continue to grow and expand. Future development should incorporate erosion mitigation best management practices, as development in at risk areas may exacerbate existing erosion and deposition conditions. Future development along riverways, creeks, and tributaries are at greatest risk.

Lightning

Hazard Profile
Lightning is a luminous, electrical discharge in the atmosphere caused by the electric-charge separation of precipitation particles within a cumulonimbus (thunderstorm) cloud. Thunder is the resulting sound wave caused by the sudden expansion of air heated by a lightning discharge.

Location
Lightning can occur throughout Garfield County.

Extent
Cloud-to-ground lightning is the most threatening due to its ability to cause death, injury, and damage to property. The extent of lightning is dependent on a multitude of factors, some of which explain the geographic extent of the most frequent lightning strikes in Colorado. Ground elevation, ground humidity, and wind currents are all ingredients that enhance the frequency of lightning.

Historical Occurrences
The 2013 Colorado Natural Hazards Mitigation Plan noted that Garfield County experiences approximately 10,700 flashes annually. The NCEI reported four past lightning events in the county which resulted in two fatalities from 1996-2021. One event in 2003 led to both fatalities as described NCEI: "*The two victims had been riding horses in a remote area of Battlement Mesa when the storm arrived. They sought shelter under a tree which was struck by lightning. The surviving horses which were not under the tree did not get struck by lightning."*

Average Annual Losses
The average annual losses estimate was taken from the SHELDUS database. This does not include losses from displacement, functional downtime, economic loss, injury, or loss of life. According to SHELDUS, lightning has caused $196,983.30 in property damages and $1,669.81 in crop damages in Garfield County from 1960-2019.

Table 71: Historical Lightning Damages

Total Property Damages	Average Annual Property Damages	Total Crop Damages	Average Annual Crop Damages
$196,983.30	$3,283.11	$1,669.81	$27.83

Source: SHELDUS, 1960-2019

Probability
While the NCEI reported lightning events in only three out of 26 years in the period of record, lightning is likely to occur several times annually in Garfield County. For the purposes of this plan the annual probability of lightning is 100 percent.

Climate Trends
Nationwide, the frequency and magnitude of severe storms is expected to increase due to climate trends. These storms likely will include lightning. Currently, climate change impacts on lightning are still not fully understood.

Vulnerability Assessment
Building stock, infrastructure, and people outdoors during storms are at risk of lightning strikes. In addition to direct damages from lightning strikes, the potential for lightning to start wildfires is of great concern to the Planning Team. Lightning from one storm can start dozens of wildfires

throughout the County. Common locations for lightning strikes include open fields, under trees, boats, golf courses, near heavy or large scale equipment, telephone poles, or other raised platforms. Those who work outside and emergency responders are also more vulnerable to lightning strikes.

Future Development

Lightning strikes will continue to pose a threat to future development in and throughout Garfield County. As future developments expand around communities, adequate protection from lightning strikes should be incorporated into building designs and plans. Lightning rods, protected rooftop utilities, surge protectors, and fuels reduction projects are possible steps new developments can take to reduce impacts from lightning. Lightning strikes can easily and quickly spark wildfire events during dry conditions. Of particular concern as new developments expand into the WUI is the reduction of fuel loads.

Pest Infestation

Hazard Profile

An infestation is defined as a state of being invaded or overrun by parasites that attack plants, animals, or humans. Insect, fungi, and parasitic infestations can destroy various natural habitats and cropland, impact human health, and cause disease and death among native plant, wildlife, and livestock. Pests are any organisms including insects, mammals, birds, parasite/pathogens, fungi, or non-native species that threaten other species in the surrounding environments.

Location

Pest infestations can occur throughout Garfield County. Forestland throughout the county is most vulnerable to insect infestations and disease. Areas of Pinon Pines are vulnerable to the Pinon Ips beetle (*Ips confuses*), lodgepole pines are vulnerable to lodgepole pine beetle, the spruce beetle (*Dendroctonus rufipennis*) has decimated hundreds of thousands of acres across Colorado, and the Mountain Pine Beetle (*Dendroctonus ponderosae)* have impacted the county's forest stock.

Extent

Insect infestations can range from very isolated occurrences of minimal damages to large scale impacts to forestland. The extent of pest infestations and subsequent impacts can vary depending on the specific pest. The primary pests of concern in Garfield County are likely able to spread across vast tracts of rangeland and forested areas.

Historical Occurrences

There is no known data sources of historical occurrences of pests by county. However, pests are a regular part of the ecosystem within Garfield County, as well as Colorado. In 2003 a USDA Secretarial Disaster was declared for Drought and Insects which included Garfield County. The Colorado State Forest Service releases Forest Health Reports annually. Information from 2017 through 2020 reports related to pest infestation is summarized in the following sections.

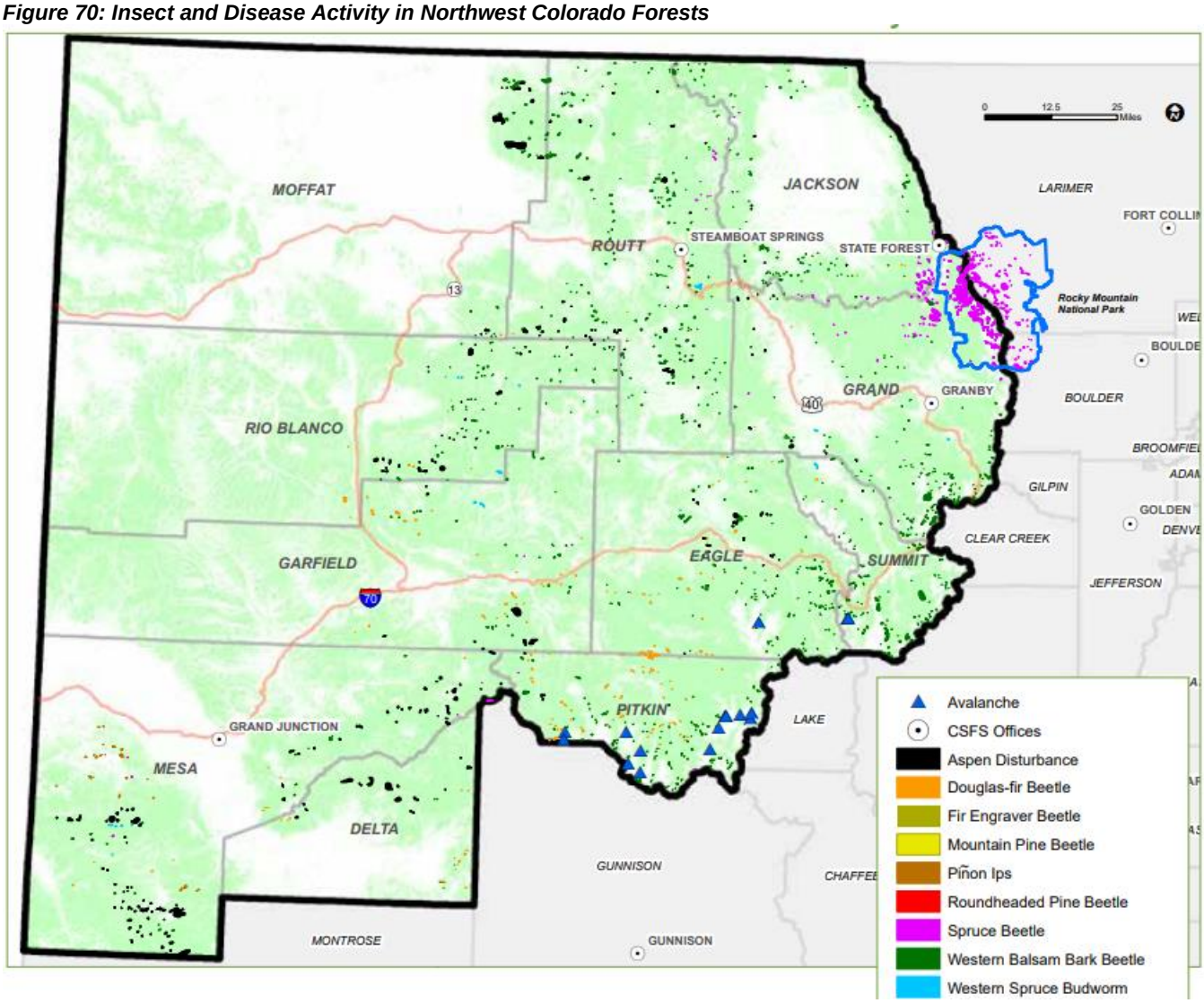
The 2020 report noted the spruce beetle remains the most damaging forest pest in Colorado. Since the mid-1990s, mountain pine beetle has affected more than 3 million acres of ponderosa-lodgepole pine in the state with an average mortality of 40% of all trees infected. The following table lists types of pests found in the state which can cause widespread damage and tree mortality.

Table 72: Pest Types in State of Colorado

Pest Name	Type of Damage
Spruce Beetle (*Dendroctonus rufipennis*)	-high elevation Engelmann spruce trees
Douglas-fir Beetle (*Dendroctonus pseudotsugae*)	-significant Douglas-fir tree mortality in central and southern Colorado
Western Spruce Budworm (*Choristoneura freemani*)	-defoliates Douglas-fir, white fir, and Engelmann and blue spruce trees -increase risk of mortality from Douglas-fir beetle
Emerald Ash Borer (*Agrilus planipennis*)	-significant bark and inner tree damage to Ash trees
Roundheaded Pine Beetle (*Dendroctonus adjunctus*)	-contributes to bark beetle complex in dying Ponderosa pine trees, typically alongside western pine beetle, pine engraver beetles, and mountain pine beetles

Pest Name	Type of Damage
Western Balsam Bark Beetle (*Dryocoetes confusus*)	-causing decline and mortality in young and mature subalpine fir trees
Lodgepole Pine Beetle	-significant tree mortality led to areas with up to 90% dead timber leading to high fuel connectivity
Pinon Ips (*Ips confuses*)	-endemic tree-killing beetle affecting pinon-juniper forests, especially around Rifle in Garfield County.

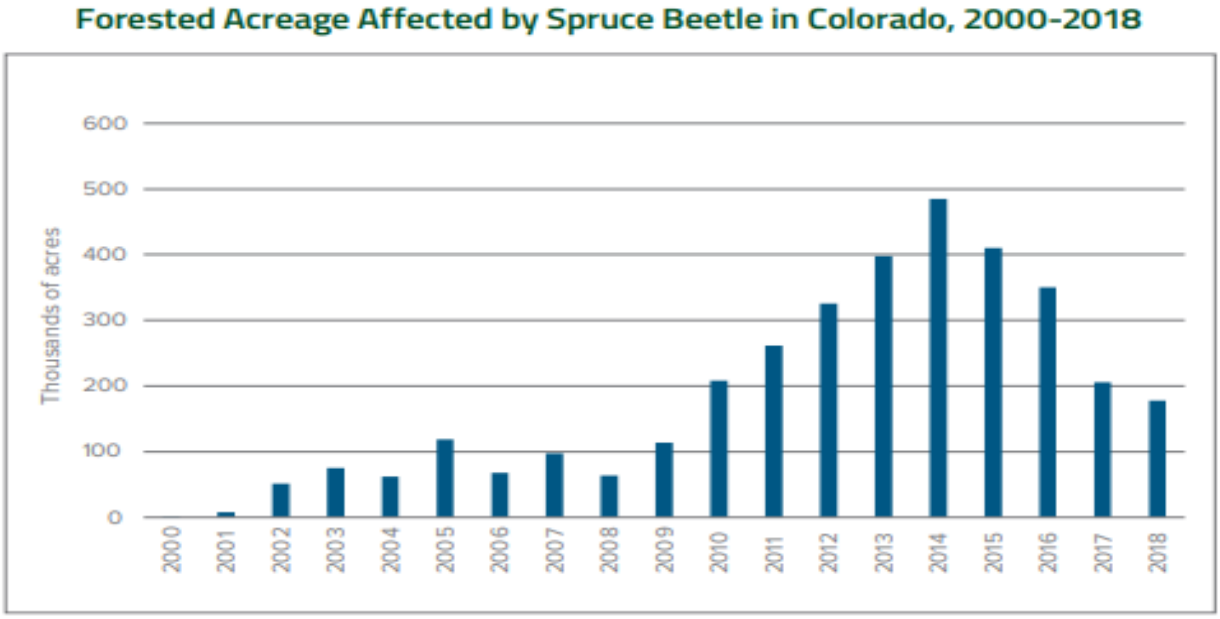
Figure 70: Insect and Disease Activity in Northwest Colorado Forests



Source: Colorado State Forest Service, 2019[85]

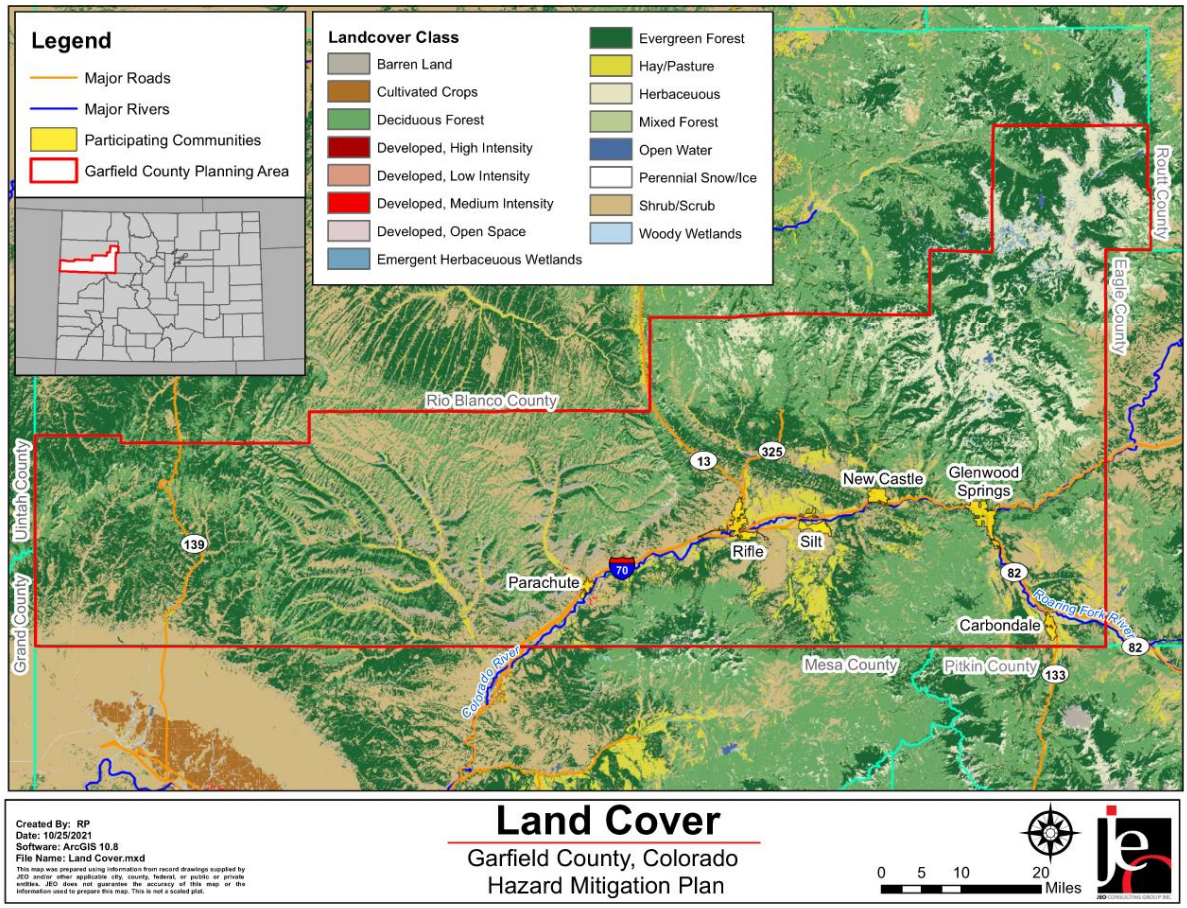
[85] Colorado State Forest Service. 2019. "2019 Report on the Health of Colorado's Forests: 15 Years of Change." https://csfs.colostate.edu/media/sites/22/2020/03/CSFS_Forest_Health_Report_2019-web.pdf.

Figure 71: Spruce Beetle Infestation 2000-2018



Source: Colorado State Forest Service, 2019

Figure 72: Garfield County Vegetation and Landuse



Average Annual Losses
The economic impact and estimated losses of pest infestations are difficult to measure and quantify. The Colorado State Forest Service reports acres impacted by year in their annual publication: *Report on the Health of Colorado's Forests* available online.[86]

Probability
Pest infestation and related disease is currently occurring in Garfield County and is a continual process in nature. For the purposes of this plan, pest infestation has a 100 percent chance of annual occurrence.

Climate Trends
Changing climatic conditions, including more frequent periods of drought, increased temperature, and the suppression of natural wildfire regimes are resulting in an increase in insect and disease activity across the state. Increased temperature, decreasing precipitation, high winds, challenging and changing landscapes are all exacerbating tree mortality caused by pest infestations.

Other specific concerns from climate change include increased risk of damage to properties and resident safety. As widespread infestations cause tree mortality, falling trees and limbs are more likely to occur during severe storms, high winds, or ice/snow accumulation. Downed limbs can disrupt power lines, cause damage to public and private structures, and cause injuries or death to residents.

Vulnerability Assessment
No structures are anticipated to be impacted by pest infestation. However, infestations may have significant impacts for the local economy and affect the frequency and/or magnitude of other hazard events. Pest infestations can cause damages to crops and rangeland; negative impacts on tourism and recreational activities; an increase in municipal spending in urban areas for pest or tree management; and hazardous conditions for wildfire, flooding, or debris flows due to dead or dying trees. Pest infestations may lead to an increased risk to overhead utilities as dead or dying trees drop limbs onto powerlines or transportation corridors. Forest management can maintain healthy forests that are more resilient to insect and disease activity, and reduce the likelihood of forest pest epidemics.

Future Development
Future development is not anticipated to be impacted by pest infestation directly. However, tree mortality leads to greater fuel loads and dead fall on the landscape increasing the risk of and from wildfire events. As future development encroaches into the WUI or into areas where tree mortality has become prevalent, residents and structures are at greater risk.

[86] Colorado State Forest Service. "Colorado State Forest Service Publications: Forest Health Reports." https://csfs.colostate.edu/csfspublications/#1554913279900-4bb50819-6608.

Severe Wind

Hazard Profile

The NWS defines severe winds as sustained wind speeds of 40 mph or greater lasting for one hour or longer, or winds of 58 mph or greater for any duration. The NWS issues High Wind Advisories when there are sustained winds of 25 to 39 miles per hour (mph) and/or gusts to 57 mph. Severe winds typically accompany severe thunderstorms and severe winter storms. They can cause significant property and crop damage, downed power lines, loss of electricity, obstruction to traffic flow, and significant damage to trees. All building stock and aboveground infrastructure, including critical facilities, are at risk of being damaged or affected by severe winds. High wind speeds and flying debris can pose a significant threat to human life.

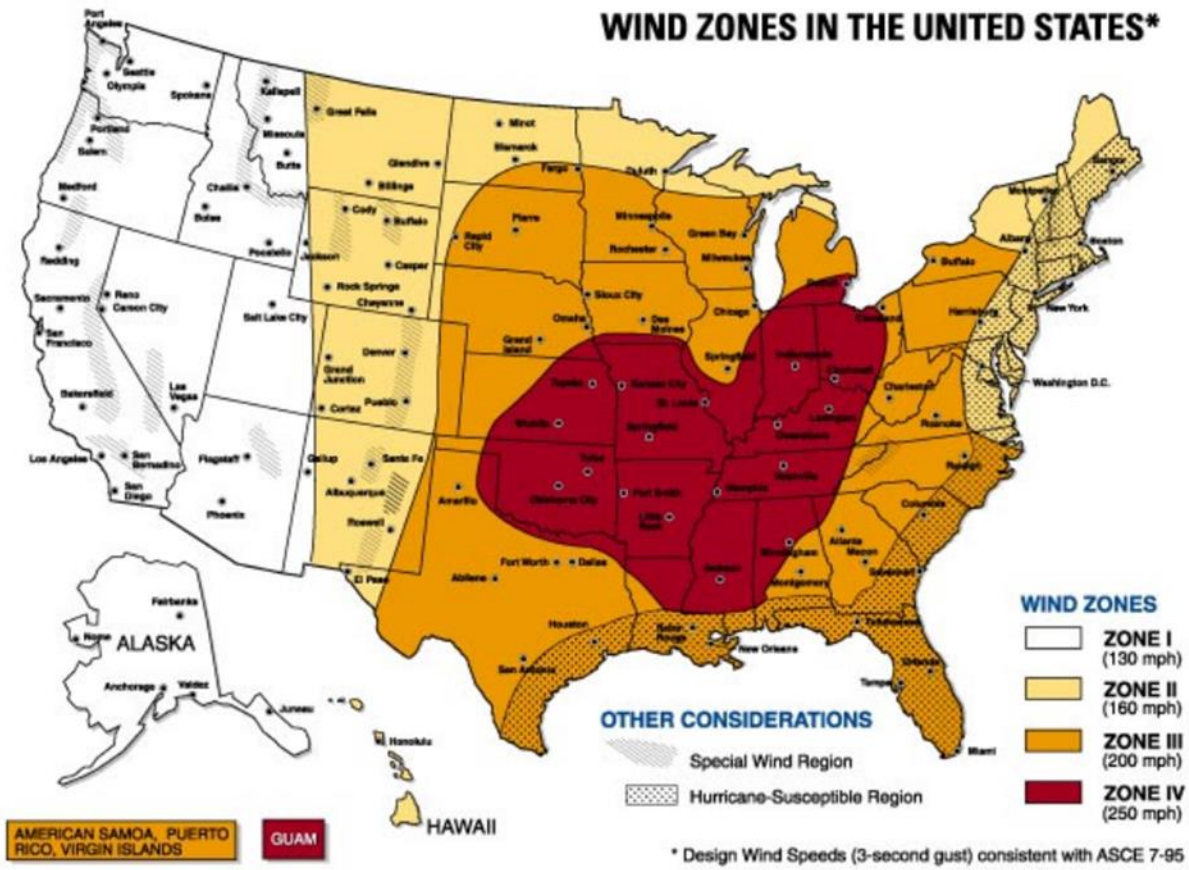
Location

Severe winds occur throughout the county. Developed areas are at a greater risk of damages than rural, less densely populated portions of the County.

Extent

Figure 73 shows the wind zones in the United States. The wind zones are based on the maximum wind speeds that can occur from a tornado or hurricane event. The planning area, approximately located within the box below, is in Zone II, which has maximum winds of 160 mph.

Figure 73: Wind Zones in the United States



Source: FEMA

The Beaufort Wind Scale can be used to classify wind strength. Table 73 outlines the scale, providing wind speed ranking, range of wind speeds per ranking, and a brief description of conditions for each ranking.

Table 73: Beaufort Wind Ranking

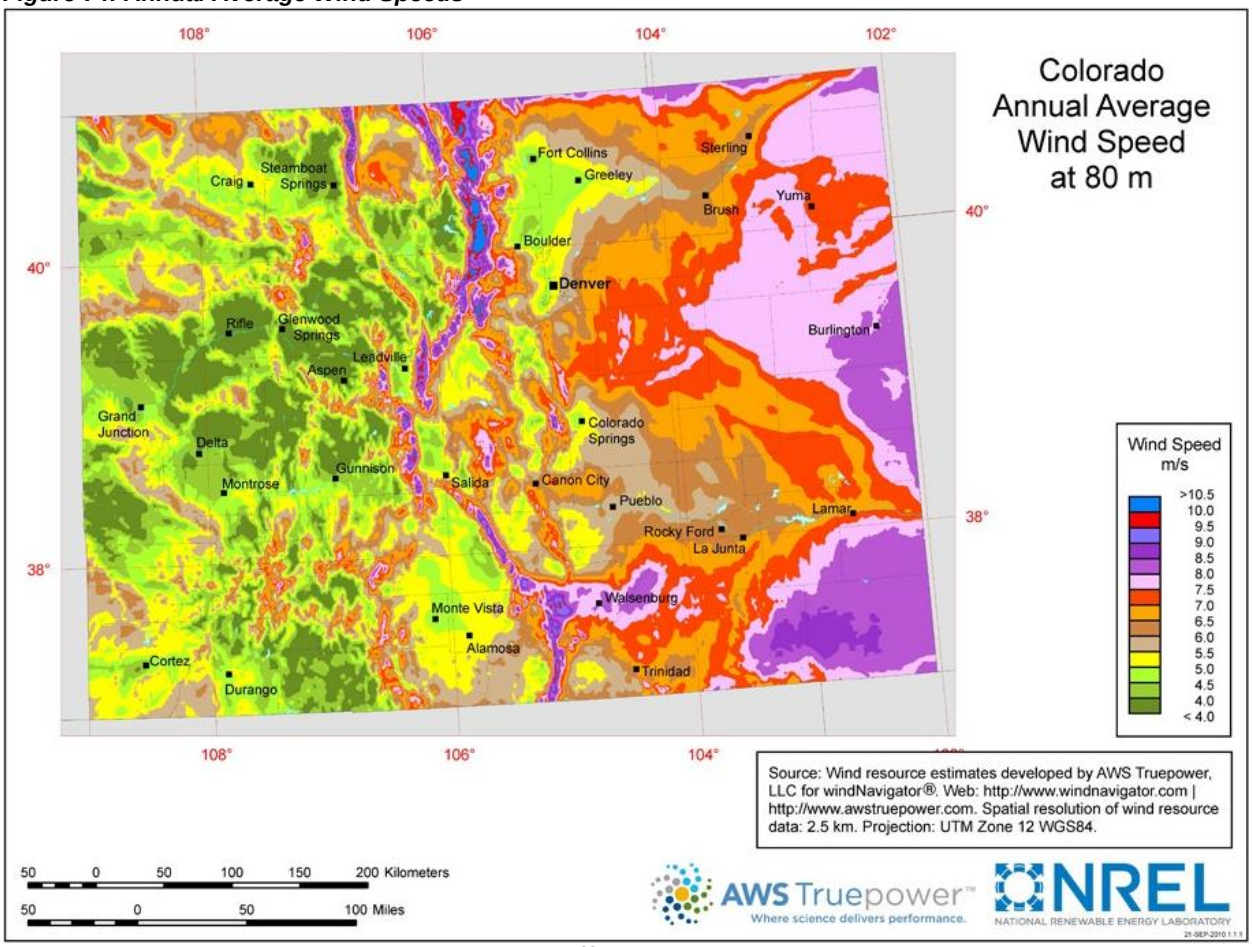
Beaufort Wind Force Ranking	Range of Wind	Conditions
0	<1 mph	Smoke rises vertically
1	1-3 mph	Direction shown by smoke but not wind vanes
2	4-7 mph	Wind felt on face; leaves rustle; wind vanes move
3	8-12 mph	Leaves and small twigs in constant motion
4	13-18 mph	Raises dust and loose paper; small branches move
5	19-24 mph	Small trees in leaf begin to move
6	25-31 mph	Large branches in motion; umbrellas used with difficulty
7	32-38 mph	Whole trees in motion; inconvenience felt when walking against the wind
8	39-46 mph	Breaks twigs off tree; generally, impedes progress
9	47-54 mph	Slight structural damage; chimneypots and slates removed
10	55-63 mph	Trees uprooted; considerable structural damages; improperly or mobiles homes with no anchors overturned
11	64-72 mph	Widespread damages; very rarely experienced
12 - 17	72 - > 200 mph	Hurricane; devastation

Source: Storm Prediction Center, 2017[87]

Using the NCEI reported events, the most common high wind event in Garfield County is a level 9. The reported high wind events had an average of 58 mph winds. Wind speed is also correlated with elevation. While the highest winds in the state are concentrated along the mountains west of Fort Collins, Garfield County has some of the lowest wind speeds in the state.

[87] National Oceanic and Atmospheric Administration/National Weather Service. "Storm Prediction Center." Accessed 2017. http://www.spc.noaa.gov/ .

Figure 74: Annual Average Wind Speeds



Source: National Renewable Energy Laboratory, 2021[88]

Historical Occurrences

According to the NCEI, there were 101 severe wind events between 1996 and 2021. These reported events caused a total of $421,000 in property damages and three injuries.

Average Annual Losses

The average annual losses estimate was taken from the SHELDUS database and includes aggregated calculations for each type of severe wind as provided in the database. This does not include losses from displacement, functional downtime, economic loss, injury, or loss of life. According to SHELDUS, severe wind has caused $862,939.72 in property damages and $18,000.65 in crop damages in Garfield County from 1960-2019.

Table 74: Historical High Wind Damages

Total Property Damages	Average Annual Property Damages	Total Crop Damages	Average Annual Crop Damages
$862,939.72	$14,382.33	$18,000.65	$300.01

Source: SHELDUS, 1960-2019

[88] National Renewable Energy Laboratory. 2021. "Wind Energy in Colorado: Colorado Annual Average Wind Speed at 80m." https://windexchange.energy.gov/states/co.

Probability
Given the historic record of occurrence for severe wind events (at least one wind event reported in 17 of the 26 year period of record), for the purposes of this plan, the annual probability of severe wind occurrence is 65 percent.

Climate Trends
Studies have indicated that the frequency and magnitude of high winds may increase in Colorado due to climate trends. Stronger winds throughout the county have the potential to increase the spread of wildfire events. However, currently there is no known direct relationship between climate trends and severe wind.

Vulnerability Assessment
All building stock and aboveground infrastructure, including critical facilities, are at risk of being damaged or affected by severe winds. Severe winds can cause structure damage or loss, downed power lines, loss of electricity, obstruction to traffic flow, and significant damage to trees. A catastrophic event could lead to major economic loss for the jurisdiction. High wind speeds and flying debris can pose a significant threat to human life. Blow down of trees from severe wind could lead to an increased fire hazard and block transportation routes, hindering access for emergency responders.

Severe winds can impact a wide range of people and properties. People living in mobile homes or unanchored trailers are particularly susceptible to the effects of severe winds. Mobile homes that are not anchored or are not anchored properly can be blown over by winds as fast as 60 to 70 mph. Other factors that may increase vulnerability to the threat posed by severe winds include age, poverty levels, and rental homes which have not been properly maintained.

Future Development
Future development should take steps to reduce potential damages and risks to high winds. Building codes for new structures can be strengthened, requiring increased rebar in foundations, enhanced nailing patterns for wall sheathing, the use of Simpson Strong Ties and Straps, and require the use of anchors and tie-downs of mobile homes. Additionally, individuals can choose to build to an optional Code Plus Standard, such as Fortified for Safer Living. The installation of public shelters to protect residents caught outside or in vulnerable areas, such as mobile home parks, can increase safety of residents in those areas.

Soils (Expansive Soils and Subsidence)

Hazard Profile

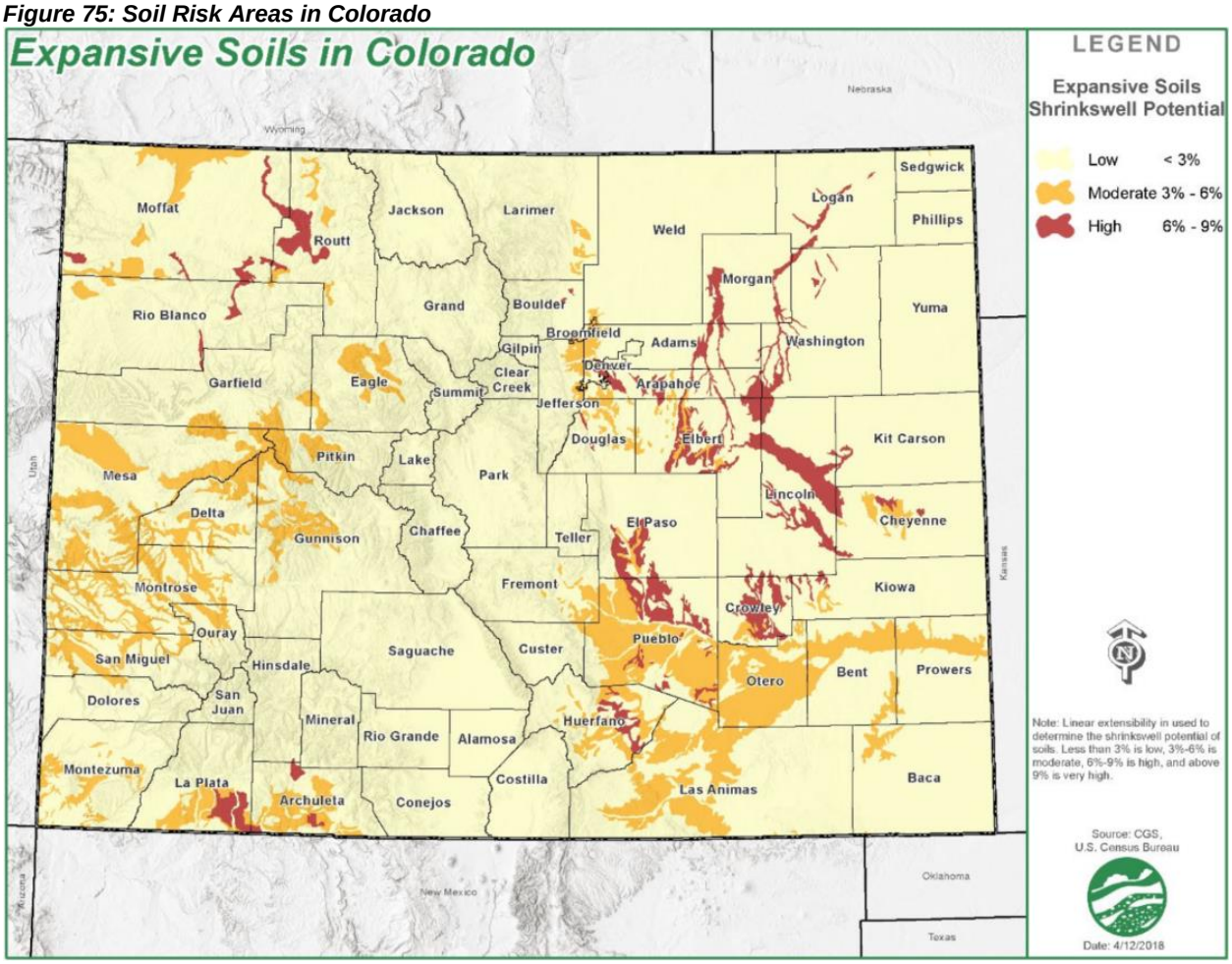
Expansive or swelling soils are soils or soft bedrock that increase in volume as they get wet and shrink as they dry out. Swelling soils contain a high percentage of clay particles capable of absorbing large quantities of water. Soil volume may expand ten percent or more as the clay becomes wet. The powerful force of expansion is capable of exerting pressures of 20,000 pounds per square foot or greater on foundations, slabs, or other confining structures. These soils tend to remain at constant moisture content in their natural state. Exposure to natural or human-caused water sources throughout development results in swelling. In many instances, the soils do not regain their original dryness after construction but remain moist and expanded due to the changed environment.

Ground subsidence is the sinking of the land over human caused or natural underground voids and the settlement of native low-density soils. The type of subsidence of greatest concern in Garfield County, and the rest of Colorado, is the settling of the ground over abandoned mines. Collapsing and settling soils are relatively low-density materials that shrink in volume when they become wet, and/or are subjected to great weight such as from a building or road. Bedrock consisting of soft clay and heavy silt deposits, combined with low density and low moisture contents, can lead to ground which easily erodes or collapse.

Location

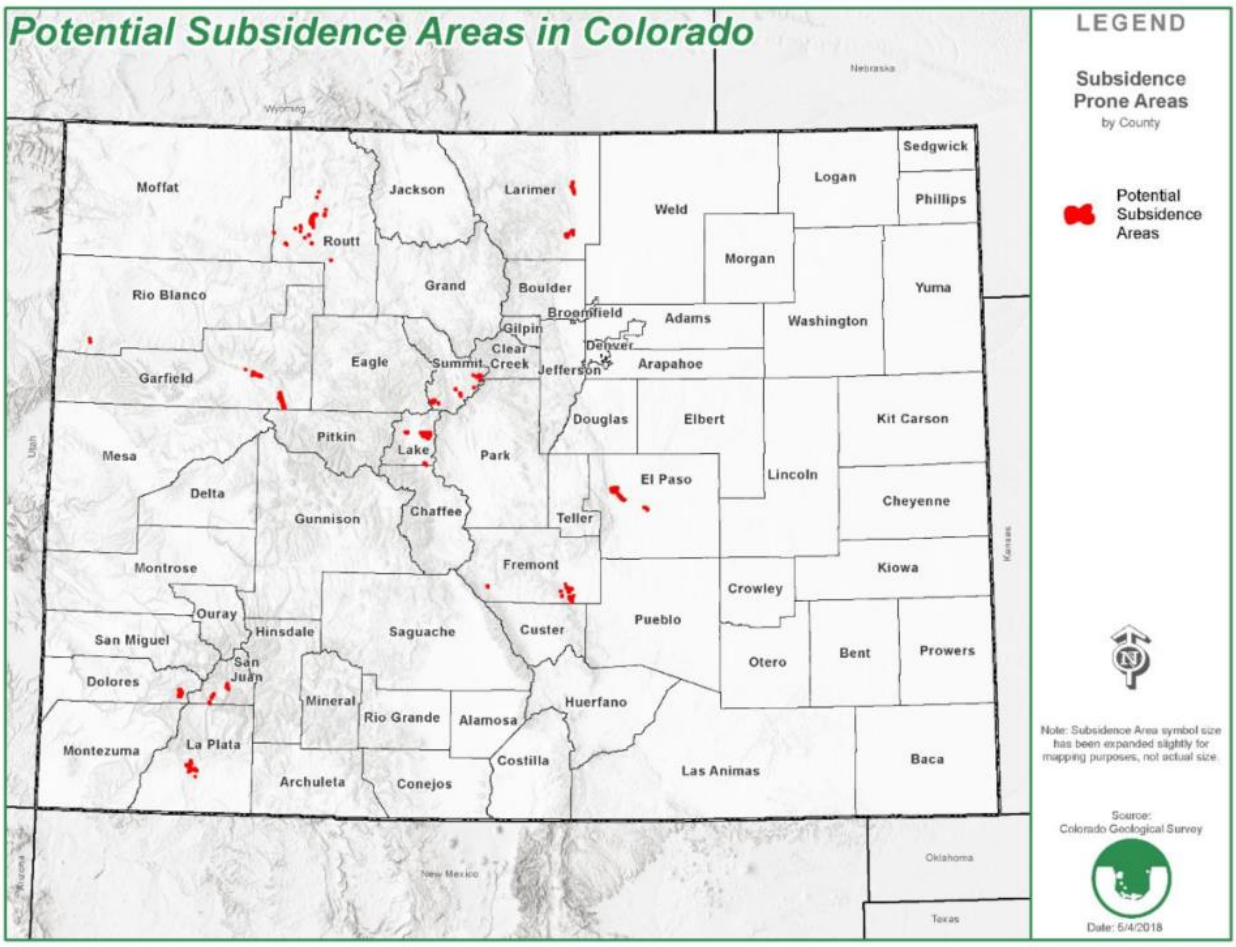
Expansive soils are located primarily in the southeastern portion of Garfield County (Figure 75). Due to the softer nature of swelling clay and its increased erosion rate from wind and precipitation, expansive soils are more likely to occur along mountain valleys and in plains or low-lying areas than in the mountains. Garfield County also has a concentration of subsidence-prone areas clustered around steep slopes (Figure 76). In addition to expansive soils and subsidence, Garfield County has a greater risk collapsible soils than most areas of the state (Figure 77).

Figure 75: Soil Risk Areas in Colorado



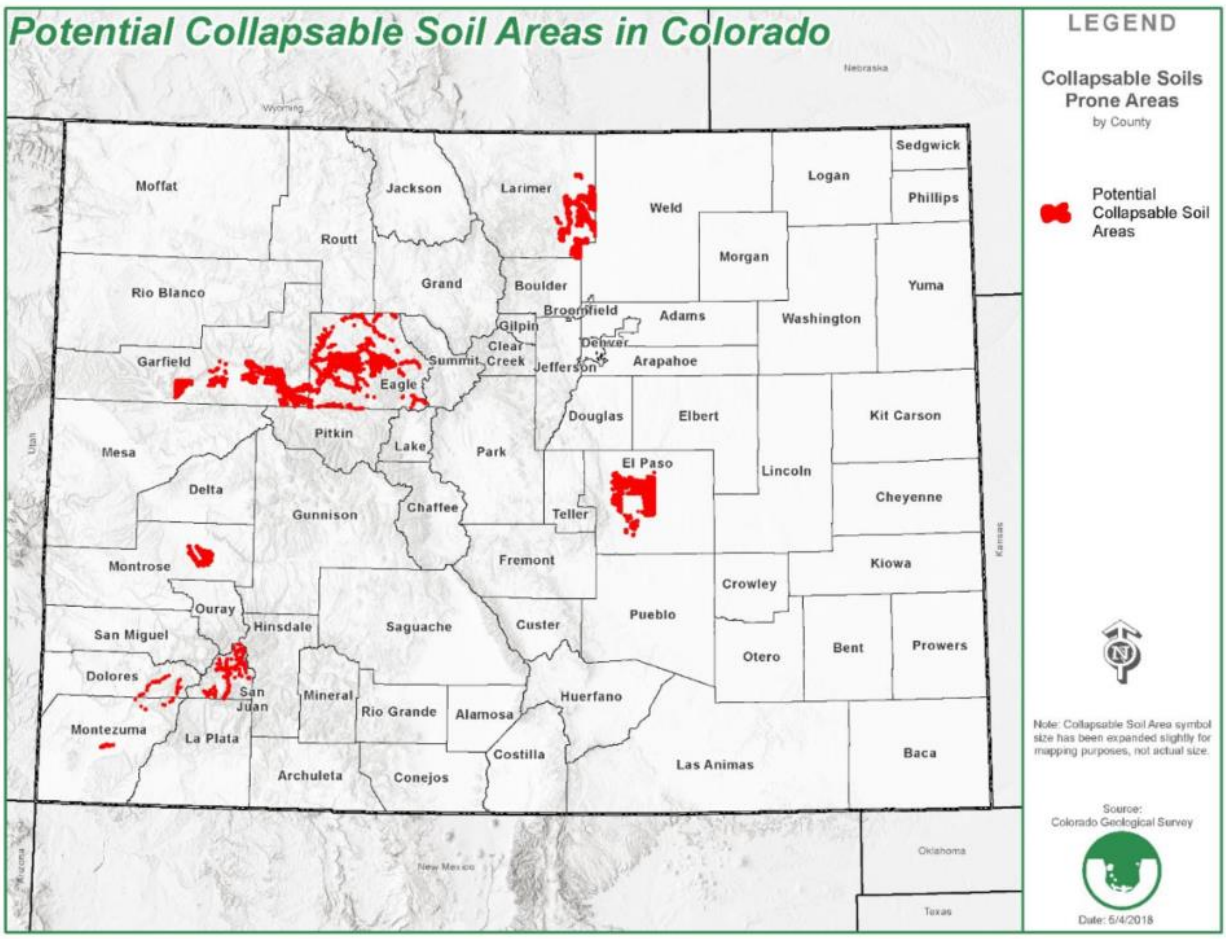
Source: Colorado State HMP - CGS

Figure 76: Subsidence Areas in Colorado



Source: Colorado State HMP - CGS

Figure 77: Collapsible Soils in Colorado



Source: Colorado State HMP - CGS

Extent

Linear extensibility is used to determine the shrink-swell potential of soils. The shrink-swell potential is low if the soil has a linear extensibility of less than three percent; moderate if three to six percent; high if six to nine percent; and very high if more than nine percent. If the linear extensibility is more than three, shrinking and swelling can cause damage to buildings, roads, and other structures. Areas in Garfield County with identified soil risk range from 0-3% and 3-6%. Linear extensibility of less than 3 percent have low shrink-swell potential and are less likely to produce damage to buildings or infrastructure. According to Colorado Geologic Survey (CGS), Garfield County has approximately 113,166 to 235,583 acres vulnerable to moderate to highly expansive soils.

Historical Occurrences

According to the Colorado Geological Survey (CGS), there were 65 recorded soil hazard occurrences from 1980 – 2009. No new records of soil hazard occurrence have been reported since 2009 according to CGS. However, according to the Planning Team, soil hazards regularly impact structures and roadways throughout Garfield County.

The Colorado State Hazard Mitigation Plan noted that highways in some areas of Colorado have been damaged by swelling soils and numerous case studies were reported in Garfield County from collapsible soil events (Figure 78). As soils contract and expand it places pressure on

roadways and requires additional engineering design to mitigate such stress loads. The State HMP specifically notes the following historical occurrences in Garfield County:

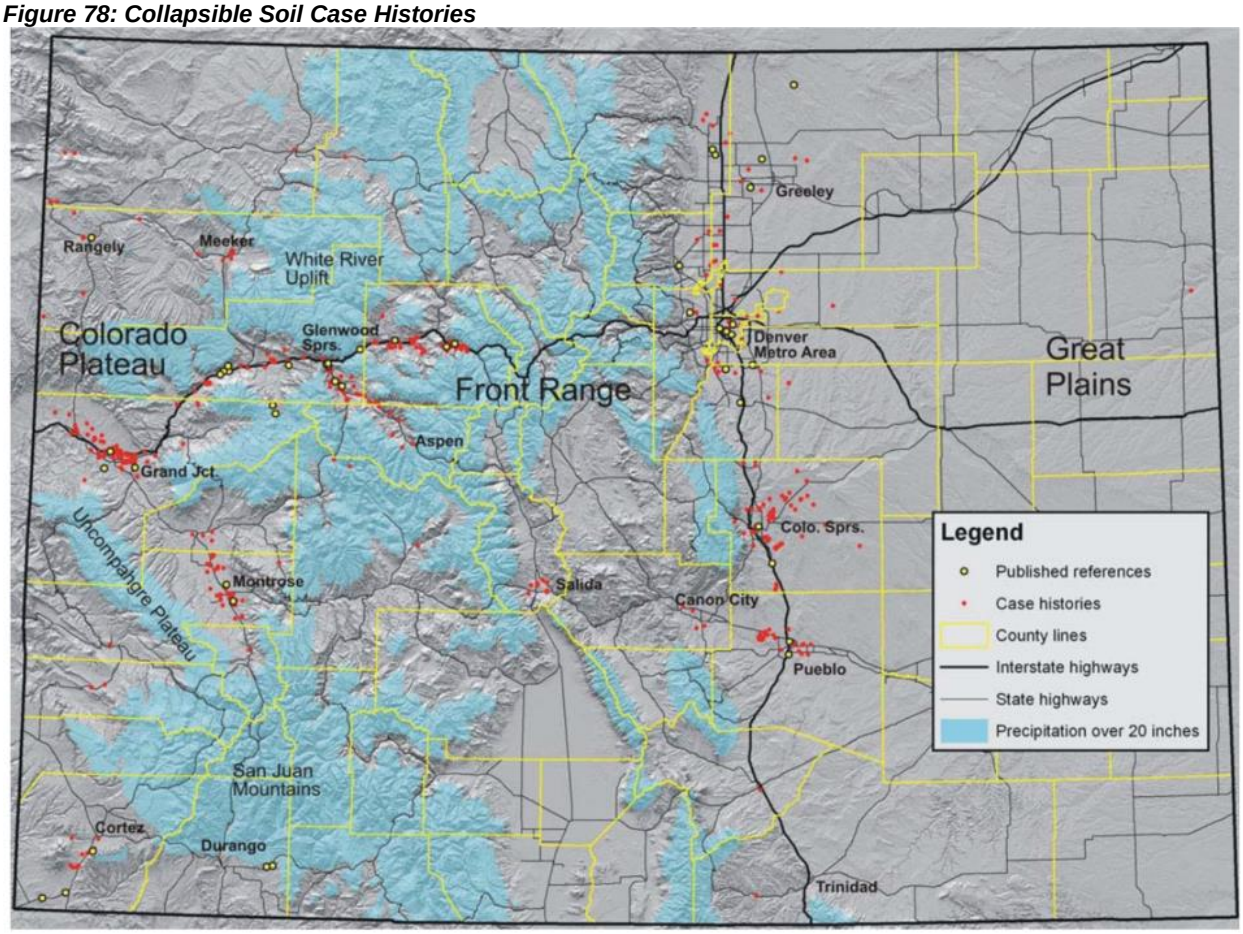
Sinkholes

- February 2003 – a 24-foot wide sinkhole spontaneously opened on a soccer field at the Colorado Mountain College Roaring Fork Campus near Spring Valley, about 7 ½ miles southeast of Glenwood Springs. After filling by the CMC physical plan maintenance staff, the sinkhole reopened the next year and enlarged to about 35 feet in diameter.
- January 2005 – A large sinkhole opened off of County Road 109, across the Roaring Fork River from Highway 82, between Glenwood Springs and Carbondale. The sinkhole occurred in the Iron Bridge community development, previously known as the Rose Ranch. In 2002, the CGS published a map of evaporite karst hazards for this area of the state. The sinkhole opened up at the clubhouse golf cart maintenance and storage facility. Reportedly, a small hole, about 10-foot by 10-foot, opened very early Sunday morning that quickly enlarged to a 42-foot diameter and 40-foot deep sinkhole by the middle of the day.

Collapsible Soils

- Garfield County (no date) – A rancher's stock-watering pond excavated in a pasture collapsed because of hydro-compaction. A bowl-shaped depression 60 feet across and eight feet deep resulted when he attempted to pond water in his field. The soils were so permeable that the pond would not hold water and the wetted soils under the pond collapsed. Many roads and other improvements in the vicinity have been destroyed or damaged by soaking of collapsible, low density soils.
- 2003 – The town of Glenwood Springs lies within the valley confluence of the Roaring Fork and Colorado Rivers. Almost the entire town lies on coalesced alluvial fan and colluvial soils that were derived from sediments shed from the steep valley sides. These soil deposits are highly susceptible to hydro compaction. The terrace development included 13 two-story structures with basement-level garage drive-outs. Thick collapsible soils were previously mapped and identified at the site. These units were built from 2001 to 2003 and within six months of the first units completed and sold, collapse of the soil was causing settlement of the back concrete retaining-wall foundations, which caused deflection of interior beams, a host of interior cracks and structural offsets, and distortion of windows and doors. The homeowner's association settled a lawsuit against the developer, the engineering consultants, and builder for $12 million in 2005. Compaction grouting was used to structurally lift the settled area of the buildings.
- Garfield County (no date) – The Colorado Highway Department, recognizing that severe hydro-compaction along a highway alignment could totally destroy a road, investigated the potential for hydro-compaction along the alignment of Interstate 70 from Rifle to DeBeque. Water was impounded in a small pond and a road fill was placed beside the pond as a model of probable future conditions. The result of the test was that the ground surface sank three feet in one month. The test provided design information to prevent the possible future total failure of a portion of the highway. The engineering geologic investigation may have saved taxpayers millions of dollars.

Figure 78: Collapsible Soil Case Histories



Source: Colorado State HMP - CGS

Average Annual Losses

Losses due to collapsible soils were gathered by the CGS for the 65 recorded occurrences from 1980 - 2009. These events caused a total of $2,683,000 in damages. This results in an average of $92,517.24 in damages per year. There are no injuries or fatalities associated with soil hazards.

Table 75: Historical Soil Damages

Total Property Damages	Average Annual Property Damages	Total Crop Damages	Average Annual Crop Damages
$2,683,000	$92,517.24	$0	$0

Source: Colorado Geological Survey, 1980-2009

Probability

Conditions related to natural causes such as precipitation and drought cycles, in addition to development and land use prevalent in the past, are expected to continue. Due to a lack of recently reported data, it is not possible to predict annual probability for expansive soils. However, the expansion and settling of soils is a naturally occurring process that has happened historically and will continue to do so.

Climate Trends

While specific projections related to the probability and extent of hazardous soil events are not available, based on weather/climatic phenomenon that influence hazardous soils it is likely that

continued changes to the regional climate will lead to an increase in frequency and intensity of drought or rainfall/flash flooding events across the state. Both drought and heavy rainfall can increase the frequency of subsidence.[89] For the purposes of this plan, it is assumed that if current climate trends continue, it is probable that hazardous soils events will increase in frequency for Garfield County.

Vulnerability Assessment

Soil hazards can affect buildings, driveways, roadways, pipelines, and other infrastructure. When soil hazards are not identified, improper structure design, faulty construction, inappropriate landscaping, and long-term maintenance practices unsuited to the specific soil conditions can lead structures to be more vulnerable to the impacts of soil hazards.

Garfield County is ranked as #2 in the state in overall areas in the county at risk to subsidence (subsidence areas compared to the total area of the county). Garfield County is ranked #4 and it also has one of the highest amounts of collapsible soil areas compared total acres in the county.

Future Development

As communities continue to grow and expand throughout the county, new buildings and infrastructure becomes at risk in zones with expansive soils. Of particular concern are areas surrounding the Town of Silt and Town of Carbondale as much of the surrounding land has significant expansive soil risk. Residential, commercial, and utility developments must meet specific building code requirements when developed in these areas. Extensive soil surveys and engineering must be conducted in these risk areas to ensure new development is properly constructed or placed appropriately in hazardous areas.

[89] USGS. December 21, 2016. "Drought Impacts." Accessed November 2021. https://ca.water.usgs.gov/data/drought/drought-impact.html.

Terrorism

Hazard Profile

According to the Federal Bureau of Investigation (FBI), there is no single, universally accepted, definition of terrorism. Terrorism is defined in the Code of Federal Regulations as "the unlawful use of force and violence against persons or property to intimidate or coerce a government, the civilian population, or any segment thereof in furtherance of a political or social objectives" (28 C.F.R. Section 0.85).

The FBI further describes terrorism as either domestic or international, depending on the origin, base, and objectives of the terrorist organization. For the purpose of this report, the following definitions from the FBI will be used:

- Domestic terrorism is the unlawful use, or threatened use, of force or violence by a group or individual based and operating entirely within the United States or Puerto Rico without foreign direction committed against persons or property to intimidate or coerce a government, the civilian population, or any segment thereof in furtherance of political or social objectives.
- International terrorism involves violent acts or acts dangerous to human life that are a violation of the criminal laws of the United States or any state, or that would be a criminal violation if committed within the jurisdiction of the United States or any state. These acts appear to be intended to intimidate or coerce a civilian population, influence the policy of a government by intimidation or coercion, or affect the conduct of a government by assassination or kidnapping. International terrorist acts occur outside the United States or transcend national boundaries in terms of the means by which they are accomplished, the persons they appear intended to coerce or intimidate, or the locale in which their perpetrators operate or seek asylum.

There are different types of terrorism depending on the target of attack, which are

- Political Terrorism
- Cyber-Terrorism
- Bio-Terrorism
- Eco-Terrorism
- Agro-terrorism

Terrorist activities are also classified based on motivation behind the event such as ideology (i.e. religious fundamentalism, national separatist movements, and social revolutionary movements). Terrorism can also be random with no ties to ideological reasoning. The FBI also provides clear definitions of a terrorist incident and prevention:

- A terrorist *incident* is a violent act or an act dangerous to human life, in violation of the criminal laws of the United States, or of any state, to intimidate or coerce a government, the civilian population, or any segment thereof, in furtherance of political or social objectives.
- Terrorism *prevention* is a documented instance in which a violent act by a known or suspected terrorist group or individual with the means and a proven propensity for violence is successfully interdicted through investigative activity.

Note: The FBI investigates terrorism-related matters without regard to race, religion, national origin, or gender. Reference to individual members of any political, ethnic, or religious group in this report is not meant to imply that all members of that group are terrorists. Terrorists represent a small criminal minority in any larger social context.

Primarily, threat assessment, mitigation and response to terrorism are federal and state directives and work primarily with local law enforcement. The Office of Infrastructure Protection within the Federal Department of Homeland Security is a component within the National Programs and Protection Directorate.

The Office of Infrastructure Protection leads the coordinated national program to reduce and mitigate risk within 18 national critical infrastructure and key resources (CIKR) sectors from acts of terrorism and natural disasters and to strengthen sectors' ability to respond and quickly recover from an attack or other emergency. This is done through the National Infrastructure Protection Plan (NIPP).

Under the NIPP, a Sector-Specific Agency (SSA) is the federal agency assigned to lead a collaborative process for infrastructure protection for each of the 18 sectors. The NIPP's comprehensive framework allows the Office of Infrastructure Protection to provide the cross-sector coordination and collaboration needed to set national priorities, goals, and requirements for effective allocation of resources. More importantly, the NIPP framework integrates a broad range of public and private CIKR protection activities.

The SSAs provide guidance about the NIPP framework to state, tribal, territorial and local homeland security agencies and personnel. They coordinate NIPP implementation within the sector, which involves developing and sustaining partnerships and information-sharing processes, as well as assisting with contingency planning and incident management.

The Office of Infrastructure Protection has SSA responsibility for six of the 18 CIKR sectors. Those six are Chemical, Commercial Facilities, Critical Manufacturing, Dams, Emergency Services, Nuclear Reactors, Materials and Waste. SSA responsibility for the other 12 CIKR sectors is held by other Department of Homeland Security components and other federal agencies. Those 12 are:

- Agriculture and Food – Department of Agriculture; Food and Drug Administration
- Banking and Finance – Department of the Treasury
- Communications – Department of Homeland Security
- Defense Industrial Base – Department of Defense
- Energy – Department of Energy
- Government Facilities – Department of Homeland Security
- Information Technology – Department of Homeland Security
- National Monuments and Icons – Department of the Interior
- Postal and Shipping – Transportation Security Administration
- Healthcare and Public Health – Department of Health and Human Services
- Transportation Systems – Transportation Security Administration; U.S. Coast Guard
- Water – Environmental Protection Agency

The NIPP requires that each SSA prepare a Sector-Specific Plan, review it annually, and update it as appropriate.

The Department of Homeland Security and its affiliated agencies are responsible for disseminating any information regarding terrorist activities in the country. The system in place is the National Terrorism Advisory System (NTAS). NTAS replaced the Homeland Security Advisory

System (HSAS) which was the color coded system put in place after the September 11th attacks by Presidential Directive 5 and 8 in March of 2002. NTAS replaced HSAS in 2011.

NTAS is based on a system of analyzing threat levels and providing either an imminent threat alert or an elevated threat alert. An ***Imminent Threat Alert*** warns of a credible, specific and impending terrorist threat against the United States. An ***Elevated Threat Alert*** warns of a credible terrorist threat against the United States.

The Department of Homeland Security, in conjunction with other federal agencies, will decide whether a threat alert of one kind or the other should be issued should credible information be available. Each alert provides a statement summarizing the potential threat and what, if anything should be done to ensure public safety. The NTAS Alerts will be based on the nature of the threat: in some cases, alerts will be sent directly to law enforcement or affected areas of the private sector, while in others, alerts will be issued more broadly to the American people through both official and media channels.

An individual threat alert is issued for a specific time period and then automatically expires. It may be extended if new information becomes available or the threat evolves. The ***sunset provision*** contains a specific date when the alert expires as there will not be a constant NTAS Alert or blanket warning that there is an overarching threat. If threat information changes for an alert, the Secretary of Homeland Security may announce an updated NTAS Alert. All changes, including the announcement that cancels an NTAS Alert, will be distributed the same way as the original alert.

Location

Terrorist activities could occur throughout the entire planning area. In rural areas, concerns are primarily related to agro-terrorism and tampering with water supplies. In urban areas, concerns are related to political unrest, activist groups, and others that may be targeting businesses, police, and governmental buildings. Eco-terrorism is a concern for development in forest and mountainous areas as well as recreational areas. Specifically, cyber-terrorism was identified as a concern for any of the communities and local governments in the planning area.

Extent

Terrorist attacks can vary greatly in scale and magnitude, depending on the location of the attack. Previous terrorist attacks in the planning area have pertained to malicious cyber-terrorism programs. No injuries, fatalities, or damage reports have been identified regarding terrorist attacks in the county. It is not currently possible to estimate the total extent of terrorist attacks as events can vary greatly in scale and impact.

Historical Occurrences

Previous accounts of terrorism in the planning area were gathered from the Global Terrorism Database, maintained by the University of Maryland and the National Consortium for the Study of Terrorism and Responses to Terrorism (START). This database contains information for over 140,000 terrorist attacks. According to this database, there are no historical occurrences of terrorism within Garfield County. However, there has been a terrorist occurrence in nearby Eagle County.

In 1998, Members of the Animal and Earth Liberation Fronts (ALF and ELF) claimed responsibility for setting multiple fires at the Vail Ski Resort outside of Vail, causing an estimated $24 million in damages. There were no casualties in the incident; however, the fires caused structural damage

to radio towers, ski lift towers, restaurants, and the ski patrol office. Altogether there was damage to eight structures, including four ski lifts, at two sites on a stretch of land about a mile apart; five structures were damaged at one site and three at the second. In a statement sent via email to the Liberation Collective and various local universities, newspapers, and public radio stations, both ALF and ELF claimed responsibility for the incident, stating that the motive was to protect the lynx habitat and warned that skiers should choose alternative destinations. The perpetrators were part of a group calling themselves "The Family," which committed nearly 20 arson and ecotage attacks over a 6-year period.

In the State of Colorado several database breaches and ransomware attacks on public facilities and organizations have occurred. These have included:

- February 2018 – Colorado Department of Transportation was hit by ransomware. The state did not pay the ransom and spent $1.7M to contain and recover lost data.
- February 2019 – Fort Collins Loveland Water District struck by ransomware. Did not pay, total cost unknown.
- Fall 2019 – Hacked email address scammed the Town of Erie to wire $1M to a falsified contractor's account.
- November 2019 – Archuleta County hit by ransomware resulting in a 12-day outage. Ransom of $300,000, unknown if paid.
- July 2020 – City of Lafayette hit by ransomware. Paid the $45,000 ransom.

According to the Privacy Rights Clearinghouse which has been tracking breaches, ransomware attacks and other cyber threats since 2005, one malicious software breach has occurred in the planning area when a company in Glenwood Springs was hacked and customer data was compromised between November 8, 2015 and March 26, 2016.[90]

A former 25-year FBI agent trained in counter terrorism reported that the extensive network of natural gas wells, pipelines, compressor stations, gas plants and other facilities in western Garfield County are likely not a target for terrorist groups. Additionally it was noted that terrorist events are much more likely to occur from domestic terrorism groups rather than radical extremists from the Middle East or other countries.[91]

Average Annual Losses

As there have not been terrorist events with specific damage estimates, it is not possible to calculate average annual losses.

Probability

Given one year with a reported incident in the 51-year period (2005-2020 Privacy Rights Advocacy; 1970-2017 GTD), the annual probability for terrorism in this HMP is stated as approximately 2% annually. This does not indicate that a terrorist event will occur with that frequency. Terrorist events are typically clustered in timeframe due to extenuating circumstances.

Climate Trends

Terrorist events may occur more frequently as climate change and policies regarding climate become more prevalent. The impacts from climate change can and will likely exacerbate existing social inequalities and worsen social vulnerabilities. Social vulnerability has been linked to the spread of terroristic groups and events. Facilities related to energy production may be at greater risk of eco-terrorism attacks.

[90] 2016. Privacy Rights Clearinghouse. "Notice of Data Breach." https://oag.ca.gov/system/files/49932072_6_1.pdf
[91] The Aspen Times. February 2018. "Ex-FBI agent says terrorism unlikely in Rifle-area gas fields." https://www.aspentimes.com/news/ex-fbi-agent-says-terrorism-unlikely-in-rifle-area-gas-fields/.

Vulnerability Assessment

The unpredictable nature of terrorism is such that impacts can range from isolated occurrences of property damage with limited injuries to large scale events with catastrophic impacts to lives and property. Infrastructure that may be vulnerable include: water supply, power plants, utilities, and governmental buildings. As communities and industries continue to develop in Garfield County, the threat of terrorism continues to grow, specifically from cyber-terrorism.

Future Development

All future development in the county is at risk from terroristic events; specifically as communities continue to grow and accommodate additional residents, have more complicated computer systems, or expand infrastructure and resources in communities.

Section 5: Mitigation Strategy

The following section summarizes actions that aim to reduce the risks posed by hazards in Garfield County. The actions also identify strategies for implementation, including education and outreach programs, the development of partnerships, and preventative activities. The actions described in the HMP can be accomplished through existing plans and programs within the County such as the County Development Code, 5-Year Plan, Source Water Protection Plan, Community Wildfire Protection Plan, and Emergency Operations Plan.

Implementation of the actions will vary based upon the availability of existing information, funding opportunities and limitations, and administrative capabilities. Establishment of a cost-benefit analysis is out of the scope of this plan and must be completed prior to submittal of a project grant application or as part of a five-year update. Actions developed by each jurisdiction are included within that jurisdiction's section in *Section Seven: Participant Sections*.

Mitigation Actions

Data collection and research, together with a public participation process, resulted in the development of a comprehensive range of action items. The following information is provided to support each mitigation action:

- Action and description – general summary of the mitigation action
- Goals – which goal(s) the mitigation action addresses
- Potential funding – a list of any potential funding mechanisms that may be used to fund the action, specifically the local funding match or resource
- Timeline – a general timeline until project implementation as established by planning participants
- Priority – a general description of the importance and workability in which an action may be implemented (high/medium/low); mitigation actions were prioritized by evaluating each action by: their relevance, whether funding has been identified, political support for the action, consistency with other planning mechanisms, and the jurisdiction's technical ability to implement them
- Lead agency – listing of agencies or departments which may lead or oversee the implementation of the mitigation action
- Status – a description of what has been done, if anything, to implement the mitigation action

To achieve the HMP's goals, the County will remain flexible in its response to available resources. Changes to project prioritization can occur at any point during plan implementation based on past or ongoing major events; changes in community characteristics, vulnerability, or risk; and to take advantage of available resources. The County planning team developed prioritization for potential mitigation alternatives as a part of the planning process. It is important to note that while some projects may be listed as high priority, they may not be accomplished first due to outstanding limitations (funding, political support, technical needs, permitting, etc.). Factors which influenced project prioritization include:

- Will residents of the county support the implementation of this project?
- Is this project the best technical approach to accomplish risk reduction?
- Is this project consistent with approaches/needs identified in other planning mechanisms?
- Is there political will to implement the project?
- Will the project have positive/negative environmental impacts?
- Have funding sources been identified to implement this project?

The following tables summarize the mitigation actions selected by Garfield County to reduce the impact of hazard events. Although not all the actions below fit the definition of mitigation, they add to the overall resilience of Garfield County and are thus included within the hazard mitigation plan. Additionally, not all projects listed here may be eligible for Hazard Mitigation Assistance funding. Other funding mechanisms have been listed as identified or available.

Multi-Hazard Mitigation Actions

Action and Description	Goals	Hazards Addressed	Estimated Cost	Potential Funding	Timeline	Priority	Lead Agency	Status
Develop maintenance and update processes, in coordination with the other emergency management related plans, and with multi-jurisdictional partners.	3	Wildfire, Flooding, Hazardous Materials, Geologic Hazards, Drought, Public Health, Severe Winter Storms	Staff Time	County General Fund	Ongoing	High	Emergency Management	Emergency Operations Plan is anticipated to be updated in 2023 and will include hazard specific information.
Develop, enhance, and implement education programs aimed at mitigating hazards, and reducing the risk to citizens and private property owners, owners' associations, public agencies, businesses, and schools. Coordinate with participating towns, cities, health departments, and fire districts on outreach inside of their jurisdictions. Coordinate implementation	1, 4, 5	Wildfire, Flooding, Hazardous Materials, Geologic Hazards, Drought, Public Health, Severe Winter Storms, Severe Wind	Staff Time, $10,000	County General Fund	Ongoing	High	Emergency Management	Emergency Management currently provides and routinely updates educational information on the Garfield County website. Evacuation outreach to begin within a year (2022-23). All education materials and programs should be provided in both English and Spanish.

Action and Description	Goals	Hazards Addressed	Estimated Cost	Potential Funding	Timeline	Priority	Lead Agency	Status
efforts with the update of recovery and other emergency management plans, as appropriate.								
Collaborate and work with local, regional, state, federal agencies, and/or private industry to update and release relevant hazard risk data. Specifically flood risk areas for mapping.	2, 5	Wildfire, Flooding, Geologic Hazards, Public Health, Severe Winter Storms	Staff Time, $50,000	County General Fund	Ongoing	High	Information Technology Department	Floodplain mapping is currently under development with FEMA. Additional LIDAR flight data is needed for the County.
Evaluate lifeline and evacuation routes to identify any necessary mitigation actions to ensure that they remain viable in an emergency situation requiring evacuation.	1, 3, 5	Wildfire, Flooding, Hazardous Materials, Geologic Hazards, Public Health, Severe Winter Storms, Severe Wind, Avalanche	Varies by project	CDOT, County General Fund	5-10 years	Medium	Emergency Management	County has completed construction on Grand Avenue Bridge and examined egresses. Wildfire mitigation projects have also been completed along evacuation routes. Garfield County and Glenwood Springs are continuing to evaluate the

Action and Description	Goals	Hazards Addressed	Estimated Cost	Potential Funding	Timeline	Priority	Lead Agency	Status
								need for a south bridge. The County shall continue to evaluate evacuation routes and share information with new residents to the area, especially as new hazard risk areas are identified. Public health facilities such as care homes and hospitals should be considered during evacuation planning efforts.
Establish critical infrastructure mitigation and protection plans for communication towers.	2	Wildfire, Flooding, Hazardous Materials, Geologic Hazards, Severe Winter Storms, Severe Wind	$30,000	HMA, Title III Funds	2-5 years	Medium	Emergency Management	This project has not yet been started.

Action and Description	Goals	Hazards Addressed	Estimated Cost	Potential Funding	Timeline	Priority	Lead Agency	Status
Reduce impacts of hazard events on existing developments by developing a tool kit for homeowners regarding resources that are available for risk reduction.	1, 4, 5	Wildfire, Flooding, Hazardous Materials, Geologic Hazards, Drought, Public Health, Severe Winter Storms, Lightning, Severe Wind	Staff Time	County General Fund	2-5 years	High	Community Development, Emergency Management	This project has not yet been started. Toolkits should be developed in both English and Spanish.

Flood Hazard Mitigation Actions

Action and Description	Goals	Estimated Cost	Potential Funding	Timeline	Priority	Lead Agency	Status
Emphasize critical public infrastructure and facilities located in special flood hazard areas for mitigation and preparedness measures.	1, 2	Varies by project	County General Fund, FMA	Ongoing	High	County Manager	This action was originally identified in the 2012 plan. This is an ongoing effort. Identification of critical public infrastructure to be completed once updated county floodplain maps are available.
Remove floodway obstructions as projects are identified for all parts of Garfield County.	2, 5	Varies by project	County General Fund, FMA	Ongoing	Low	County Manager	This action was originally identified in the 2012 plan. Obstructions are removed as they are identified as a part of the County's maintenance program. There are no currently identified obstructions in the floodway.
Ensure continued compliance in the NFIP through enforcement of local floodplain management ordinances.	2, 3, 5	Staff Time	County General Fund	Ongoing	High	Floodplain Administrator	This action was originally identified in the 2012 plan Garfield County is currently in the process of updating their floodplain maps.
Continue to incorporate hazard mapping information into development review process to avoid or reduce risk of development in flood hazard areas.	2, 3, 4, 5	Staff Time	County General Fund	Ongoing	High	Community Development	This action was originally identified in the 2012 plan. The county shall review development requirements and restrictions once new floodplain maps are available.
Utilize land use regulations and collaborate with natural	1, 4, 5	Staff Time	County General Fund	Ongoing	High	Community Development	This is a new action. Garfield County has utilized land use regulations for this purpose in

Action and Description	Goals	Estimated Cost	Potential Funding	Timeline	Priority	Lead Agency	Status
resource organizations to maintain healthy wetlands and riparian areas.							the past and will continue to do so in the future. This is an ongoing effort.

Geologic Hazard Mitigation Actions

Action and Description	Goals	Estimated Cost	Potential Funding	Timeline	Priority	Lead Agency	Status
Partner with Colorado Geological Survey to enhance mapping of Garfield County landslide, debris flow, and soil instability risk areas, especially in residential development areas (Roaring Fork and Colorado River Valleys).	2, 5	Unknown	County General Fund	2-5 years	High	Information Technology, Community Development	This action was originally identified in the 2012 plan. Currently, Garfield County refers developers to the CGS for the identification of geological hazard areas.
Conduct engineering studies to identify feasible mitigation actions for high activity landslide or debris flow areas.	1, 2, 5	Unknown	County General Fund, HMA	2-4 years	Low	Community Development, County Engineer, CDOT	This action was originally identified in the 2012 plan. As new development occurs in the County, geological hazard areas are identified. Developers are required to mitigate known hazards.
Digitize existing paper maps to update geologic hazard areas.	1, 2, 5	$40,000	County General Fund, HMA	1-3 years	Medium	Information Technology	This is a new action. Not yet started.

Wildfire Hazard Mitigation Actions

Action and Description	Goals	Estimated Cost	Potential Funding	Timeline	Priority	Lead Agency	Status
Continue to update the database of the location of industry assets for use by fire responders (industry or fire protection district personnel) in real time. Transfer data for use in Emergency Responders vehicles.	3	Staff Time	General Fund, CDBG-Disaster Recovery	2-4 years	Medium	Emergency Management, Information Technology	This action was originally identified in the 2012 plan. This is an ongoing effort. Data transfer has not yet been completed.
Ensure all areas of future development in Garfield County are adequately serviced by a fire protection district. Increase local fire protection district capability to provide service to new areas.	1, 3	Staff Time	County General Funds, Fire Protection District	2-5 years	Low	Emergency Management, Fire Protection Districts	This action was originally identified in the 2012 plan. Not yet started. All fire protection districts have mutual aid agreements and will respond to fires outside of their district boundaries. However, as development expands across the county, new equipment, personnel, and training is needed.
Implement fuel management projects in vulnerable areas and projects as identified in the Garfield County CWPP	1,5	Varies by project	Fire District Budget, County General Funds	5+ Years	High	Emergency Management, Fire Protection Districts	The county implements fuel management projects as funds or resources are available. See the Garfield County CWPP for a list of specific fuel management projects identified for the district.

Actions to Enhance Response Capabilities

Action and Description	Goals	Estimated Cost	Potential Funding	Timeline	Priority	Lead Agency	Status
Update and implement the Public Health Improvement Plan to address emerging threats (pandemic)	1, 3	Varies by project	Unknown	2-5 years	Medium	Public Health	The Public Health Improvement Plan was last updated for 2013-2017. A new updated is needed.
Develop a Recovery Response Plan.	2, 3	$30,000	Unknown	3-5 years	Low	County Manager	This action was originally identified in the 2012 plan. Not yet started.
Develop a response and recovery plan specifically for hazardous materials spills.	1, 3	$30,000	Unknown	2-5 years	Medium	Emergency Management	This action was originally identified in the 2012 plan. Not yet started.
Update and maintain the Airport Emergency Procedures Manual on an annual basis.	2, 3	$1,200	Airport Fund	Ongoing	Medium	Airport Director	This action was originally identified in the 2012 plan. The manual was last updated in 2017.
Evaluate specific needs and implement Flood after Fire Mitigation Actions in Glenwood Canyon or other areas as needed.	2,3	Varies by project	County General Fund, HMA	2-5 years	Medium	Emergency Management, USGS, CGS	This is a new mitigation action.

Completed Mitigation Actions

Action and Description	Hazards Addressed	Status
Review and evaluate development codes to incorporate soil type in addition to slope as a criterion for further environmental studies before permitting.	Geologic Hazards	This action was originally identified in the 2012 plan. Garfield County completed an update to their development code in 2013.
Coordinate with stakeholders that manage public lands to mitigate hazards on federally owned lands.	All hazards	This is an ongoing action by the County and has been fully integrated into normal operations by county departments.
Support existing cross training efforts that coordinate industry and fire district response to fires affecting the oil and gas fields.	Wildfire	Current training programs for fire district personnel address oil and gas field fire events.
Increase coordination among mitigation planning efforts and actions with the soon-to-be-updated countywide Community Wildfire Protection Plan (CWPP). Coordinate future updates of the mitigation plan with CWPP updates.	Wildfire	The CWPP was updated alongside this HMP and will continue to be updated alongside mitigation plans.
Create in-house training for Department Heads and Steering Committee members.	All hazards – enhance response capabilities	County staff members have taken certification courses including the L947 IEMC EOC/ IMT Interface Course from FEMA.
Develop a debris management plan with a defined transition team.	All hazards – enhance response capabilities	This plan has been developed and is integrated as part of the County's Local Emergency Operations Plan.

Removed Mitigation Actions

Action and Description	Hazards Addressed	Reason for Removal
Conduct ongoing public outreach activities during mitigation plan implementation, and in conjunction with the update and maintenance of other emergency management plans.	All Hazards	This action was originally identified in the 2012 plan. This action was considered redundant with other mitigation actions.
Collaborate with neighboring counties and cities with established GIS services to develop Memoranda of	All Hazards	This action was originally identified in the 2012 plan. This action was determined to be no longer needed.

Action and Description	Hazards Addressed	Reason for Removal
Understanding or Service Agreements for the provision of GIS services in the event of staffing issues.		
Reduce impacts of landslides on existing developments by developing a tool kit for homeowners regarding resources that are available for risk reduction.	Geologic Hazards	This action was originally identified in the 2012 plan. A multi-hazard tool kit was determined more appropriate.
Continue to develop and maintain a GIS inventory of hazard risks and vulnerable assets, to include all critical facilities, large employers, public assembly areas, lifelines, and mitigation successes.	All hazards	This action was originally identified in the 2012 plan. Relevant data is currently held by the county and is updated as needed.

Section Six: Plan Integration, Implementation, and Maintenance

Plan maintenance is a critical component of the Garfield County Multi-Jurisdictional Hazard Mitigation Plan. Proper maintenance of the plan ensures that this plan will maximize the County's efforts to reduce the risks posed by natural hazards, and that the County's efforts are coordinated with the efforts of participating jurisdictions and other partners. This section describes a process to ensure that a regular review and update of the plan occurs.

Coordination with other plans and processes

The HMP includes a range of actions that, when implemented, will reduce loss from hazard events in the County. Within the plan, FEMA requires the identification of existing programs that might be used to implement these actions and, where applicable, the updated actions call out potential connections to existing plans. Where possible, the County should implement the recommended actions through existing plans and policies. Plans and policies already in existence have support from local residents, businesses, and policy makers. Many land-use, comprehensive, and strategic plans get updated regularly, and can adapt easily to changing conditions and needs. When the County updates these planning mechanisms, the County Planning Team will review the HMP for opportunities to incorporate the goals and objectives, risk and vulnerability data, and mitigation actions into the plan update. The following describes the existing County planning mechanisms that integrate hazard mitigation. The County utilized this process since the last plan update by reviewing the mitigation actions of the 2017 HMP for potential opportunities to integrate mitigation actions into the Five Year Plan and Garfield County Strategic Plan. Risk data and mitigation actions from the HMP were integrated into the most recent Garfield County CWPP update.

Five Year Plan – Each year, the County develops a Five-Year Plan that identifies the need for program, project, process, system, equipment, and infrastructure improvements. This plan provides guidance to the County in their annual budget.

Garfield County Strategic Plan – The Strategic Plan is developed alongside the county budget and allows the Board of County Commissioners to establish policies and priorities for the coming year. The plan outlines specific project goals regarding infrastructure investments, health and human services, community outreach, fiscal sustainability, economic development, community support, and internal services.

Comprehensive Plan 2030 – Many of the goals and strategies of the Garfield County Comprehensive Plan 2030 align with the Hazard Mitigation Plan. These include, but are not limited to:

- Preserve natural drainage patterns so the cumulative impact of public and private land use activities will not cause storm drainage and floodwater patterns to exceed the capacity of natural or constructed drainage ways, or to subject other areas to an increased potential for damage due to flooding, erosion or sedimentation or result in pollution to streams, rivers or other natural bodies of water.
- Mineral resource extraction activities will protect critical wildlife habitat as identified by state and federal agencies and preserve or mitigate natural drainage patterns from the impacts of extraction activities.

- Plan for increased probability of drought conditions including expanded requirements for wildland fire mitigation for major subdivisions[92]

As part of the Comprehensive Plan, Garfield County developed an interactive Future Land Use Map which outlines specific areas around communities in the county where future development is anticipated. These include anticipated urban growth areas, land use type (mixed, industrial, residential, commercial, etc.), and public land or open space lands. (https://garfieldcolorado.maps.arcgis.com/apps/webappviewer/index.html?id=3fb7922108e34a2fb267272e7cb99198).

Land Use and Development Code – The Land Use and Development Code includes specific sections to flooding, wildfire, and geologic hazard areas. These sections outline the standards for development within these hazardous areas with a focus on mitigation. The Code also includes: a floodplain overlay that determines the permitted uses within the floodway and floodplain; defines critical facilities and establishes building standards for such facilities; and defines at-risk population facilities.[93] Specific requirements in the code include:

- No habitable building may be constructed within any known geologic or wildfire or other natural hazard area without appropriate mitigation of the natural hazard.
- All buildings shall be located a minimum of thirty feet from the high water mark of all perennial streams or outside of the designated floodplain, whichever is the greater distance
- Unbuildable land includes land on slopes steeper than 30%

Building Permit Review – The County utilizes the permit review process to ensure development located in or near hazard prone areas implement appropriate mitigation measures. The permitting process also evaluates the location of potential development regarding the floodplain, steep slopes, hazardous geological features, or wetland delineations.

Economic Development County Profile – The County Profile provides a clear description of the changing trends regarding physical, social, and economic factors in Garfield County which drive future development.

Emergency Operations Plan (EOP) – The plan provides a clear assignment of responsibility during an emergency, identifies the hazards of greatest concern as outlined in the hazard mitigation plan, identifies the need for mitigation following a disaster, and identifies the connection to other planning mechanisms including the hazard mitigation plan.[94] The EOP should identify the hazards of greatest concern and high priority mitigation strategies. If the EOP is activated, special note should be taken of potential mitigation strategies or capability gaps to be included in future HMP updates.

2022 Garfield County Community Wildfire Protection Plan (CWPP) – This plan identifies areas within the County with an increased risk of wildfire and identifies strategies to mitigate wildfire impacts.[95]

[92] Garfield County. 2020. "Garfield County 2030 Comprehensive Plan." https://www.garfield-county.com/community-development/filesgcco/sites/12/Garfield-County-Comprehensive-Plan-2030-2020-Update.pdf.

[93] Garfield County. October 2021. "Garfield County Land Use and Development Code." Last modified October 17. https://www.garfield-county.com/community-development/land-use-code/

[94] Garfield County. December 2017. "Garfield County: Emergency Operations Plan."

[95] JEO Consulting Group. 2022. "Garfield County Community Wildfire Protection Plan." https://www.garfield-county.com/emergency-management/community-wildfire-protection-plan/

These planning mechanisms are regularly updated. Garfield County will continue to identify opportunities to integrate hazard mitigation into existing and future planning mechanisms where appropriate. The State of Colorado and others are important planning partners that can contribute to mitigation planning efforts; their roles are called out in more detail below.

Capability Assessment

The capability assessment consisted of a Capability Assessment Survey completed by the jurisdiction and a review of local existing policies, regulations, plans, and the programs. The survey is used to gather information regarding the jurisdiction's planning and regulatory capability; administrative and technical capability; fiscal capability; and educational and outreach capability.

Table 76: Garfield County Capability Assessment

Survey Components/Subcomponents		Yes/No
Planning & Regulatory Capability	Comprehensive Plan	Yes
	Capital Improvements Plan	Yes
	Economic Development Plan	Yes
	Emergency Operational Plan	Yes
	Floodplain Management Plan	No
	Storm Water Management Plan	No
	Zoning Ordinance	Yes
	Subdivision Regulation/Ordinance	Yes
	Floodplain Ordinance	Yes
	Building Codes	Yes
	National Flood Insurance Program	Yes
	Community Rating System	No
	Other (if any)	
Administrative & Technical Capability	Planning Commission	Yes
	Floodplain Administration	Yes
	GIS Capabilities	Yes
	Chief Building Official	Yes
	Civil Engineering	Yes – Contracted
	Local Staff Who Can Assess Community's Vulnerability to Hazards	Yes
	Grant Manager	Yes
	Mutual Aid Agreement	Yes
	Other (if any)	
Fiscal Capability	Capital Improvement Plan/ 1 & 6 Year plan	Yes
	Applied for grants in the past	Yes
	Awarded a grant in the past	Yes
	Authority to Levy Taxes for Specific Purposes such as Mitigation Projects	Yes
	Gas/Electric Service Fees	No
	Storm Water Service Fees	No
	Water/Sewer Service Fees	No
	Development Impact Fees	Yes
	General Obligation Revenue or Special Tax Bonds	Yes
	Other (if any)	

Survey Components/Subcomponents		Yes/No
Education & Outreach Capability	Local citizen groups or non-profit organizations focused on environmental protection, emergency preparedness, access and functional needs populations, etc. Ex. CERT Teams, Red Cross, etc.	Yes
	Ongoing public education or information program (e.g., responsible water use, fire safety, household preparedness, environmental education)	Yes
	Natural Disaster or Safety related school programs	No
	StormReady Certification	No
	Firewise Communities Certification	No
	Tree City USA	No
	Other (if any)	

Overall Capability	Limited, Moderate, High
Does the County have the financial resources needed to implement mitigation projects?	Moderate
Does the County have the staff/expertise to implement projects?	High
Does the County have the community support to implement projects?	High
Does the County have the time to devote to hazard mitigation?	Moderate

The State of Colorado

All mitigation is local. The primary responsibility for development and implementation of risk reduction strategies and policies lies with local jurisdictions. Local jurisdictions, however, are not alone. Partners and resources exist at the state and federal levels. Numerous Colorado state agencies have a role in natural hazards and natural hazard mitigation. Some of the key agencies include:

- Division of Homeland Security and Emergency Management (DHSEM) is responsible for disaster mitigation, preparedness, response, recovery, and the administration of federal funds after a major disaster declaration;
- Colorado Division of Fire Prevention and Control is responsible for all aspects of wildland fire protection on state forest lands;
- Colorado Geologic Survey (CGS) provides information and new knowledge about geologic hazards, mineral and energy resources, water resources, and more to contribute to economic growth and improve the quality of life;
- Colorado Department of Local Affairs (DOLA) provides financial and technical assistance, response and recovery services, property tax administration and programs addressing affordable housing and homelessness to local communities;
- Colorado Department of Transportation (CDOT) is responsible for highways and bridges throughout the state and in Garfield County. CDOT also provides support to local airports;
- The Colorado Water Conservation Board (CWCB) provides policy direction and information resources on water issues. The CWCB's responsibilities range from protecting Colorado's streams and lakes to water conservation, flood mitigation, watershed protection, stream restoration, drought planning, water supply planning and water project financing;

- The Colorado Division of Water Resources (DWR), also known as the Office of the State Engineer, administers water rights, issues water well permits, represents Colorado in interstate water compact proceedings, monitors streamflow and water use, approves construction and repair of dams and performs dam safety inspections, issues licenses for well drillers and assures the safe and proper construction of water wells, and maintains numerous databases of Colorado water information; and
- Colorado Division of Housing, Housing Technology and Standards (HTS) Section can provide technical assistance related to manufactured housing to ensure that currently adopted building codes are enforced.

Federal Partners

- National Weather Service (NWS) provides weather, hydrologic, and climate forecasts and warnings.
- Federal Emergency Management Agency (FEMA) supports citizens and first responders to build, sustain, and improve capabilities to prepare for, protect against, respond to, recover from, and mitigate all hazards.
- Bureau of Land Management (BLM) works to sustain and maintain the productivity of public lands. BLM managed lands can be used for recreation, energy development, conservation, wildlife habitat, cultural resource protection, and livestock grazing.
- The United States Geological Survey (USGS) provides key scientific research and information on natural hazards, specifically seismic or geologic, land resources, and environmental health.
- The United States Department of Agriculture (USDA) provides resources and guidance regarding food, agriculture, and rural development. USDA also provides a key funding opportunity through both grants and long-term, low-interest loans.

Other Partners

Mitigation actions can be implemented through the ongoing efforts of County partners, many of whom were involved in the process of developing this plan. The County will actively seek out opportunities to further develop such partnerships, in the furtherance of HMP objectives.

- Planning Team: 5-Year Plan and other strategic planning that occurs in the future will also contribute to the goals in the HMP. County departments develop plans and review them on an annual basis. At the time of annual review, the Hazard Mitigation Planning Team will work with the departments to integrate the Garfield County HMP actions into appropriate sections of the 5-Year Plan.
- Multi-Jurisdictional Partners: The HMP partners will continue to be critical partners for identifying vulnerabilities, identifying risks, and implementing mitigation. Coordination and collaboration of mitigation plans between cities, fire districts, and the County will ensure these levels of government achieve their mitigation goals. A process for involving the jurisdictions covered under this plan is described later in this section, but the County will continue outreach to all jurisdictions throughout the planning process.
- Public Health and Social Service Providers: As organizations that interface with the public daily, public health and social service providers can be a conduit for direct public information dissemination. They can also provide County Emergency Management with critical information about vulnerabilities that exist in the population. These organizations are natural partners in hazard mitigation.
- Utilities and Conservation Districts (or other special districts): essential to identifying vulnerability, identifying risks, and helping implementation mitigation measures, when and where appropriate.

- Citizens: There are numerous ways in which citizens and residents of Garfield County are already involved in mitigation actions. The inclusion of groups such as Community Emergency Response Teams (CERTs), Neighborhood Watch groups, and the Medical Reserve Corps in mitigation activities will not only facilitate implementation, but also increase public awareness. Connections with the activities of other partners are part of the County's strategy for ongoing public involvement. It allows the County to present mitigation actions and ideas more holistically, within the context of existing groups.

Convener

Garfield County Sheriff's Office and the Garfield County Manager's Office will be the convener for the ongoing plan maintenance process including: adoption of the plan; ongoing monitoring of plan implementation; yearly steering committee meeting agenda development and facilitation; and prioritizing action items for implementation. This agency will also be responsible for the 2027 formal update of this Plan and continued public involvement. The rest of this section describes these responsibilities in more detail.

Plan Adoption

The Garfield County Board of Commissioners are responsible for adopting the updated Garfield County Natural Hazards Mitigation Plan and providing the support necessary to ensure plan implementation. The governing boards of all other participating jurisdictions must adopt the plan in order to be considered a participant of the plan. Once the plan has been adopted, the County Emergency Manager will be responsible for submitting it to the State Hazard Mitigation Officer in the Division of Homeland Security and Emergency Management. Colorado Division of Homeland Security and Emergency Management will submit the plan to the Federal Emergency Management Agency (FEMA) for review. Upon acceptance of the plan by FEMA, Garfield County will maintain eligibility for FMA, HMGP, and BRIC funds. The plan shall be monitored and updated on a routine basis to maintain compliance with the legislation – Section 322, Mitigation Planning, of the Robert I. Stafford Disaster Relief and Emergency Assistance Act, as enacted by Section 104 of the DMA 2000 (P.L. 106-390) and by FEMA's Final Rule (FR) published in the Federal Register on November 30, 2007, at 44 Code of Federal Regulations (CFR) Part 201.

Ongoing Monitoring

The Garfield County Manager will ensure that the Emergency Management Advisory Committee discusses the HMP on an annual basis and prior to the annual kick-off of the 5-Year Plan update process. As part of the monitoring and maintenance program for the Integrated Emergency Management and Continuity Framework, an Emergency Management Advisory Committee is recommended to meet annually to review all plans and identify opportunities for collaboration and integration. This committee would serve as the HMP Steering Committee for all future updates as well.

The purpose of the annual review meeting will be to determine the effectiveness of programs and to reflect changes in land development or programs that may affect mitigation priorities. Committee members should be prepared to discuss any expected updates or changes to the plans for which they are responsible and look for opportunities to share funding and other resources to achieve shared outcomes. In addition, the Emergency Management Advisory Committee will review the plan goals to determine their relevance to changing situations in the County, as well as changes in state or federal policies, and to ensure they are addressing current and expected conditions. The Committee will also review the risk assessment portion of the plan to determine if the information should be updated or modified. The designated parties responsible for the various implementation actions will report on the status of their projects and note which

implementation processes worked well, any difficulties encountered, how coordination efforts were proceeding, and which strategies should be revised.

Topics that the Emergency Management Advisory Committee could consider when reviewing the Hazard Mitigation Plan and implementation of mitigation actions include:

- Continued appropriateness of action items
- New, changes to existing, or reallocation of funding
- Prioritization of potential mitigation projects
- Education and outreach on the plan and mitigation in general
- New science or data that changes or updates the risk assessment
- New major disaster events, their impacts, or identified projects to reduce future damages
- Any additional issues that may not have been identified when the plan was developed
- Lessons learned from drills, exercises, training, or hazard events
- Coordination with other emergency management-related plans and procedures

The Garfield County Manager's office will be responsible for documenting the discussion and outcomes of meetings where this plan and/or the implementation of any identified or potential action items are addressed by the steering committee for use in future updates of this plan. The format of this plan allows any pressing or urgent updates to be made at any time – it is designed to be a living document that remains current and relevant to County and the participating jurisdictions.

Yearly Steering Committee Meetings

In addition to the annual Emergency Management Advisory Committee meeting convened by the Garfield County Manager, the following actions will be taken:

- A member of the Emergency Management Advisory Committee will provide an update to the Public Safety Council annually, or as necessary; and,
- A meeting should be convened between the Emergency Management Advisory Committee and representatives from the multi-jurisdictional partners to determine the effectiveness of the programs and to review any changes necessary to the plan and associated action items. Depending upon the calendar year, the Emergency Management Advisory Committee should also consider the following agenda:

    - Year 1 (2023): Review Actions for implementation progress and prioritization. Document mitigation successes.
    - Year 2 (2024): Review Risk Assessment to include new data if applicable. Document mitigation successes.
    - Year 3 (2025): Review Actions for implementation progress and prioritization. Document mitigation successes
    - Year 4 (2026): Review Risk Assessment to include new data if applicable. Begin formal 5-year update of the Mitigation Plan
    - Year 5 (2027): Formal Update of the Hazard Mitigation Update Plan for FEMA review.

Five-Year Formal Review Process

This plan will be updated every five years in accordance with the update schedule outlined in the Disaster Mitigation Act of 2000. During this plan update, the following questions will be asked to

determine what actions are necessary to update the plan. The County Manager's office will be responsible for engaging in the formal update process to address the questions outlined below.

- Are the plan's goals still applicable?
- Do the plan's priorities align with State priorities?
- Are there new partners that should be brought to the table?
- Are there new local, regional, state or federal policies addressing hazards that should be incorporated?
- Has the community successfully implemented any mitigation activities?
- Have new hazard related issues or problems been identified?
- Do existing actions need to be reprioritized for implementation?
- Are the actions still appropriate, given current resources, community needs, and priorities?
- Have there been any changes in development patterns that could influence the effects of hazards?
- Are there new studies or data available that would enhance the risk assessment?
- Has the community been affected by any disasters? If yes, did the plan accurately address the impacts of this event?

Continued Public Involvement

Garfield County is committed to involving the public directly in the maintenance and update of the Hazard Mitigation Plan. Although the Emergency Management Advisory Committee members are responsible for annual review and update of the plan and represent the public to some extent, the public will have multiple opportunities to provide direct feedback about the plan.

The County Manager's office and County's Public Information office will support public involvement through existing community organizations, and the County Website.

Copies of the plan and annual revisions will be posted on the County's website and notification of updates will be sent to the community stakeholders. It is also the intent of the County to continue to conduct surveys via the County Website and by distributing surveys to stakeholders and multi-jurisdictional representatives.

Section Seven: Participant Sections

Participant sections contain information specific to jurisdictions which have participated in the Garfield County planning effort. Participant sections were developed with the intention of highlighting each jurisdiction's unique characteristics that affect its risk to hazards. Participant sections may serve as a short reference of identified vulnerabilities and mitigation actions for a jurisdiction as they implement the mitigation plan. Information from individual communities was collected at project meetings and used to establish the plan. Each profile may include the following elements:

- Local Planning Team members
- Location/Geography
- Population and Demographics Trends
- Employment and Economics
- Land use, Development and Transportation
- Critical Facilities and Infrastructure
- Historic and Cultural Resources
- Local Capabilities
- Hazard Prioritization
- Plan Integration
- Mitigation Actions

In addition, maps specific to each jurisdiction are included such as: jurisdictional boundary; identified critical facilities; dam or levee locations; flood prone areas; and other hazard risk areas of concern. The hazard prioritization information, as provided by individual participants, in *Section Seven: Community Profiles* varies due in large part to the unique geographical context for each jurisdiction, localized capabilities, and specific impact information provided by the local planning team.

The overall risk assessment for the identified hazard types represents the presence and vulnerability to each hazard type throughout the entire county. A discussion of certain hazards selected for each Community Profile were prioritized by the local planning team based on the identification of hazards of greatest concern, hazard history, and the jurisdiction's capabilities. The hazards not examined in depth can be found in *Section Four: Risk Assessment*.