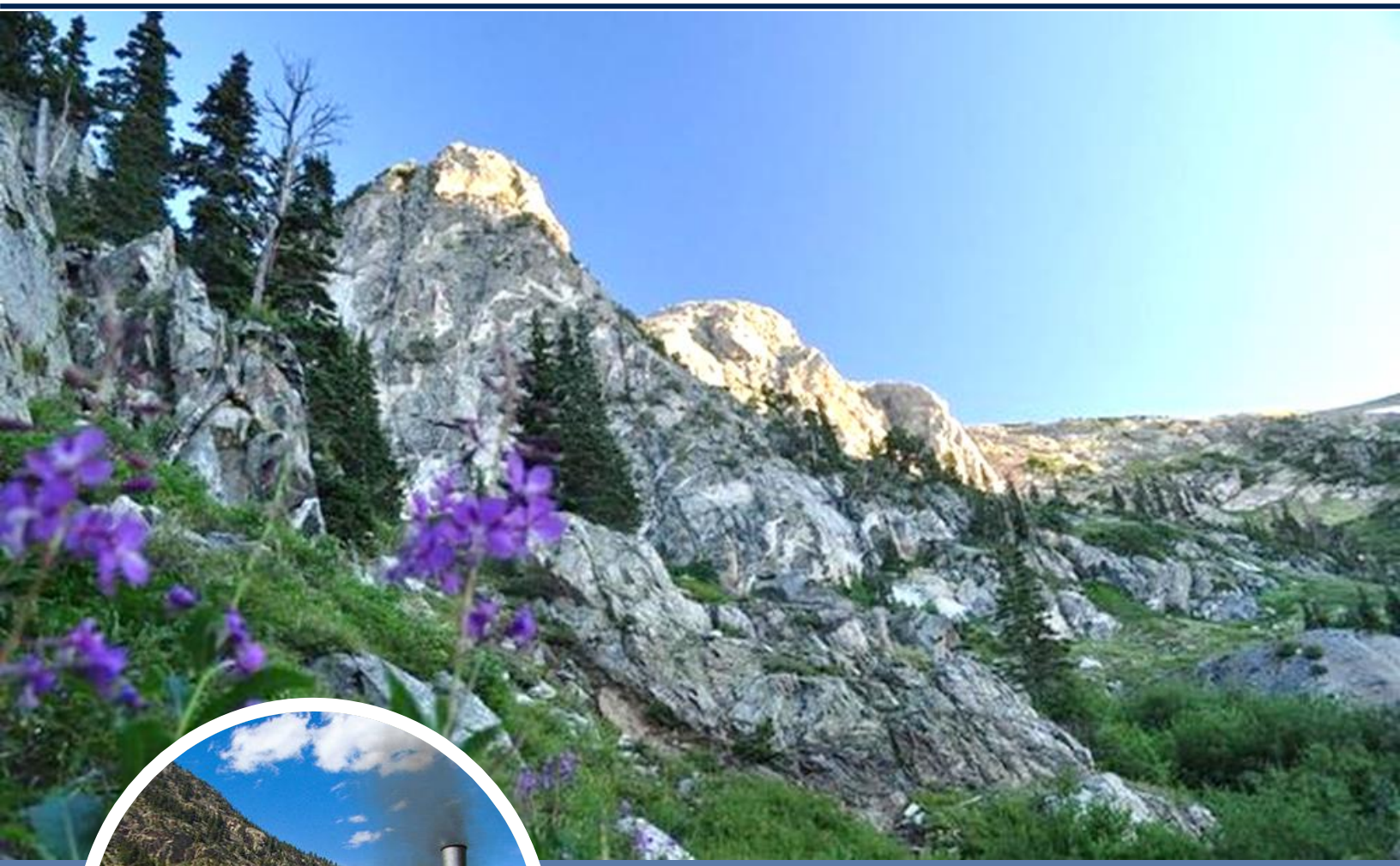
Clear Creek County

Office of Emergency Management

Clear Creek County Hazard Mitigation Plan



DRAFT May 2016

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Clear Creek County
HAZARD MITIGATION PLAN

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MAY 2016

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Clear Creek County
Hazard Mitigation Plan

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EXECUTIVE SUMMARY

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The Disaster Mitigation Act (DMA) is federal legislation that requires proactive, pre-disaster planning as a prerequisite for some funding available under the Robert T. Stafford Act. The DMA encourages state and local authorities to work together on pre-disaster planning. The planning network called for by the DMA helps local governments articulate accurate needs for mitigation, resulting in faster allocation of funding and more cost-effective risk reduction projects.

Hazard mitigation is the use of long- and short-term strategies to reduce or alleviate the loss of life, personal injury, and property damage that can result from a disaster. It involves strategies such as planning, policy changes, programs, projects, and other activities that can mitigate the impacts of hazards. It is impossible to predict exactly when and where disasters will occur or the extent to which they will impact an area, but with careful planning and collaboration among public agencies, stakeholders, and citizens, it is possible to minimize losses that disasters can cause. The responsibility for hazard mitigation lies with many, including private property owners; business and industry; and local, state and federal government.

Clear Creek County and a partnership of local governments within the county (including the City of Idaho Springs and the Towns of Empire, Georgetown, and Silver Plume) have developed and maintained a hazard mitigation plan to reduce risks from natural disasters and to comply with the DMA.

PLAN UPDATE

Federal regulations require monitoring, evaluation, and updating of hazard mitigation plans. An update provides an opportunity to reevaluate recommendations, monitor the impacts of actions that have been accomplished, and evaluate whether there is a need to change the focus of mitigation strategies. A jurisdiction covered by a plan that has expired is no longer in compliance with the DMA.

Clear Creek County participated in previous hazard mitigation plans as part of the Denver Regional Council of Governments (DRCOG). The *DRCOG Natural Hazard Mitigation Plan* included 7 counties (Adams, Arapahoe, Broomfield, Denver, Douglas, Clear Creek, and Gilpin) and 20 cities and towns and was approved by Federal Emergency Management Agency (FEMA) Region VIII in 2011.

In accordance with FEMA preferences for individual hazard mitigation plans for each county or community, this update to the *DRCOG 2011 Natural Hazard Mitigation Plan* was developed to be specific to Clear Creek County and its participating communities.

The development of this new plan specific to Clear Creek County consisted of the following phases:

- **Phase 1, Organize and Review**—A planning team was assembled to provide technical support for the plan update, consisting of key county staff from the Clear Creek County Office of Emergency Management and a technical consultant. The first step in developing the plan was to establish a planning partnership. Planning partners participating in the plan update were the City of Idaho Springs and the Towns of Empire, Georgetown, and Silver Plume. A Steering Committee was assembled to oversee the plan development, consisting of planning partner staff and community representatives from the planning area. Coordination with other county, state, and federal agencies involved in hazard mitigation occurred throughout the plan update process. This phase included a comprehensive review of the *DRCOG 2011 Natural Hazard Mitigation Plan*, the *2013 Colorado State Hazard Mitigation Plan*, and existing programs that may support or enhance hazard mitigation actions.
- **Phase 2, Risk Assessment**—Risk assessment is the process of measuring the potential loss of life, personal injury, economic injury, and property damage resulting from natural hazards. This process assesses the vulnerability of people, buildings, and infrastructure to natural hazards. All facets of the risk assessment of the plan were re-visited by the planning team and updated with the best available data and technology. The work included the following:

  - Hazard identification and profiling
  - Assessment of the impact of hazards on physical, social, and economic assets
  - Vulnerability identification
  - Estimates of the cost of potential damage.

- **Phase 3, Engage the Public**—A public involvement strategy agreed upon by the Steering Committee was implemented by the planning team and the Steering Committee meetings were open to the public. Participation in the hazard mitigation survey occurred across the county.
- **Phase 4, Assemble the Plan**—The planning team and Steering Committee assembled key information into a document to meet the DMA requirements for all planning partners.
- **Phase 5, Adopt/Implement the Plan**—Once pre-adoption approval has been granted by Colorado's Office of Emergency Management and FEMA Region VIII, the final adoption phase will begin. Each planning partner will individually adopt the updated plan. The plan maintenance process includes a schedule for monitoring and evaluating the plan's progress annually and producing a plan revision every 5 years. Throughout the life of this plan, a representative of the original Steering Committee will provide a consistent source of guidance and oversight.

MITIGATION GOALS AND OBJECTIVES

The following guiding principles for this plan process guided the Steering Committee during the plan update:

1. To reduce or eliminate the long-term risks to loss of life and property damage in the jurisdictions from the full range of natural disasters
2. To identify policies, actions, and tools for long-term implementation in order to reduce risk and future losses stemming from natural hazards that are likely to impact the jurisdictions.
3. To create communities whose activities reflect a comprehensive commitment by government, business, non-profit organizations and the public to eliminate or reduce risks and adverse impacts from natural, technological and human-caused hazards.

The following plan goals and objectives were determined by the Steering Committee:

- **Goal 1:** Protection of people, property, and natural, cultural, and environmental resources.
  - **Objective 1.1**: Develop projects focused on preventing loss of life and injuries from natural hazards.
  - **Objective 1.2:** Identify and prioritize actions to protect critical, essential and necessary assets and infrastructure.
  - **Objective 1.3:** Protect and enhance natural resources by adopting and implementing sustainable flood-management policies, debris management programs, snow removal, tree trimming and replacement, or energy conservation programs.
  - **Objective 1.4**: Identify and expand emergency services protocols for people who are at high risk from hazard events, such as the homeless, elderly, disabled, and oxygen-dependent people.
  - **Objective 1.5:** Identify and provide for necessary construction, renovation, retrofitting or refurbishment to protect vulnerable structures and cultural resources from the effects of natural hazards.
- **Goal 2:** Increase awareness of natural hazards and their mitigation.

  - **Objective 2.1**: Continue to develop and expand public awareness and information programs.
  - **Objective 2.2:** Expand public awareness of flood and flash flood hazards in general and at specific high-risk locations.
  - **Objective 2.3:** Expand public awareness of wildfire hazards and measures by which people can protect themselves, their property and their community.
- **Goal 3:** Coordinate and integrate hazard mitigation activities.
  - **Objective 3.1:** Strengthen connections between hazard mitigation activities; and preparedness, response and recovery activities.
  - **Objective 3.2:** Identify systems, and areas of improvement needed, to implement emergency operations plans and services, including Community Emergency Response Team training.
  - **Objective 3.3:** Identify existing local government monitoring and decision-making tools; identify gaps and needed improvements.
  - **Objective 3.4:** Reduce services interruptions and revenue losses to the local community and the region from natural hazards, including traffic interruptions.

IDENTIFIED HAZARDS OF CONCERN

For this plan, the Steering Committee considered the full range of natural hazards that could impact the planning area and then listed hazards that present the greatest concern. The process incorporated review of state and local hazard planning documents, as well as information on the frequency, magnitude and costs associated with hazards that have impacted or could impact the planning area. Anecdotal information regarding natural hazards and the perceived vulnerability of the planning area's assets to them was also used. Based on the review, this plan addresses the following natural hazards of concern:

- Avalanche
- Dam/Levee Failure
- Drought
- Earthquake
- Erosion and Deposition
- Expansive Soil
- Extreme Heat
- Flood
- Hail
- Landslide, Mud/Debris Flow, Rockfall
- Lightning
- Severe Wind
- Space Weather
- Subsidence
- Tornado
- Wildfire

- Winter Storm

Several of these hazards were profiled together because of their common occurrence or damage assessments, such as drought and extreme heat; and hail, lightning, and severe winds.

MITIGATION ACTIONS

Mitigation actions presented in this plan are activities designed to reduce or eliminate losses resulting from natural hazards. The plan update process identified 54 mitigation actions for implementation by individual planning partners as listed in Table ES-1. The Steering Committee ranked the mitigation actions in order of priority, with 1 being the highest priority. The highest priority mitigation actions are shown in red on the table, medium priority actions are shown in yellow and low priority actions are shown in green.

TABLE ES-1.
RECOMMENDED MITIGATION ACTIONS

Action Number	Title	Description	Mitigation Action Ranking	Action Type	Applicable Goals and Objectives	Responsible Department	Estimated Cost	Potential Funding Sources	Timeline	Mitigation Action Worksheet Priority
CLEAR CREEK COUNTY										
1	Wildfire Risk Reduction Public Education Program	Conduct public education program to encourage property owners to manage fuel loads on their own properties and use landscaping materials for existing and older homes built prior to current fire mitigation ordinance.	2	EAP	Goal: 1,2,3 Objective: 1.1; 1.2; 1.3; 1.5; 2.1; 2.3; 3.1; 3.4	Emergency Management	< $10,000	General Budget, FEMA Hazard Mitigation Funding, State Wildfire Risk Reduction Grants, "Ready-Set-Go" and "Firewise Communities" Programs	Short Term	High
2	Wildfire Fuels Reduction	Identify and prioritize areas with heavy fuel loads along county road right-of-ways throughout the county; Implement fuels reduction wildfire mitigation projects following assessments.	4	NSP	Goal: 1,2,3 Objective: 1.1; 1.2; 2.1; 2.3; 3.1; 3.3; 3.4	Public Works Department	$10,000 to $100,000	General Budget, FEMA Hazard Mitigation Funding, State Wildfire Risk Reduction Grants	Short Term	High

TABLE ES-1.
RECOMMENDED MITIGATION ACTIONS

Action Number	Title	Description	Mitigation Action Ranking	Action Type	Applicable Goals and Objectives	Responsible Department	Estimated Cost	Potential Funding Sources	Timeline	Mitigation Action Worksheet Priority
3	Wildfire Fuel's Reduction - DSpace	Work with private landowners to educate and find funding/grants to accomplish defensive space wildfire mitigation.	13	EAP NSP	Goal: 1,2,3 Objective: 1.1; 1.2; 1.3; 1.5; 2.1; 2.3; 3.1; 3.4	Emergency Management	< $10,000	General Budget, FEMA Hazard Mitigation Funding, State Wildfire Risk Reduction Grants, USDA, and CSFS	Short Term	High
4	Improve Access / Egress for Evacuation	Work with public and private landowners and developers to find funding/grants to create/identify safe secondary means of egress/access. There are communities within Clear Creek County that have limited access/egress with only "one way in – one way out".	6	LPR EAP	Goal: 1,2,3 Objective: 1.1; 1.2; 1.3; 1.4; 2.1; 2.3; 3.1; 3.3; 3.4	Emergency Management	>$100,000	General Budget	Long Term	Medium

TABLE ES-1.
RECOMMENDED MITIGATION ACTIONS

Action Number	Title	Description	Mitigation Action Ranking	Action Type	Applicable Goals and Objectives	Responsible Department	Estimated Cost	Potential Funding Sources	Timeline	Mitigation Action Worksheet Priority
5	Identification of Flood Mitigation Projects in High Flood Risk Areas	Work with Urban Drainage, Flood Plain Manager and Public Works Department to identify potential projects within the high-risk flood prone areas. Projects may include channel stabilization, increasing drainage or absorption capacities with detention and retention basins, relief drains, spillways, drain widening/dredging or rerouting, logjam and debris removal, extra culverts, bridge modification, dike setbacks, flood gates and pumps, or channel redirection.	1	NSP SIP	Goal: 1,2,3 Objective: 1.1; 1.2; 1.3; 1.4; 1.5; 2.2; 3.1; 3.3; 3.4	County Manager	$10,000 to $100,000	General Budget, FEMA Hazard Mitigation Funding	Short Term	Medium
6	NFIP Floodplain and Stormwater Management Practices	Continue to participate, implement and improve upon the NFIP Floodplain and Stormwater Management Practices	10	LPR EAP	Goal: 1,2,3 Objective: 1.1; 1.2; 1.3; 1.4; 1.5; 2.1; 2.2, 3.1; 3.3; 3.4	Community Development Department	< $10,000	General County Budget	Long Term	High
7	Floodplain Mapping	Create/Update/Enhance floodplain mapping/GIS database	8	LPR EAP	Goal:1, 2, 3 Objective: 1.1, 1.2, 1.3, 1.4, 2.1, 2.2, 3.1, 3.3, 3.4	County Manager	$10,000 to $100,000	General Budget, FEMA	Short Term	High

TABLE ES-1.
RECOMMENDED MITIGATION ACTIONS

Action Number	Title	Description	Mitigation Action Ranking	Action Type	Applicable Goals and Objectives	Responsible Department	Estimated Cost	Potential Funding Sources	Timeline	Mitigation Action Worksheet Priority
8	Development of a Debris Management Plan	Develop a Debris Management Plan that addresses all aspects of debris management by utilizing the knowledge, skills, and abilities of a consulting firm.	14	LPR	Goal: 1,2,3 Objective: 1.1; 1.2; 1.3; 1.4; 2.2, 3.2; 3.3; 3.4	Emergency Management	$10,000 to $100,000	General Budget	Short Term	Medium
9	Slope Stabilization Projects	Identify slope stabilization projects, and funding for implementation of project(s), to protect homes, buildings, businesses and infrastructure.	11	LPR SIP	Goal: 1,2,3 Objective: 1.1; 1.2; 1.5; 2.2, 3.1; 3.3; 3.4	Community Development Department	>$100,000	FEMA Hazard Mitigation Funding, CDOT project funding	Long Term	High
10	Mapping of Geological Hazard Areas	Create a Geological Hazard mapping/GIS database by coordinating with USGS, CGS and CDOT to further study and map vulnerable geologic hazard areas.	12	LPR	Goal: 1,2,3 Objective: 1.1; 1.2; 2.1; 2.2, 3.1; 3.4	County Manager	$10,000 to $100,000	General Budget	Short Term	High
11	Integration of HMP Components into Master Plans	Coordination between the county's HMP consultant and the county's Master Plan consultant team to ensure that hazard mitigation topics are included in the scope for the public outreach process and plan development for all relevant plan elements.	9	LPR EAP	Goal: 1,2,3 Objective: 1.1; 1.2; 1.3; 1.4; 2.2; 2.3, 3.1; 3.3, 3.4	Community Development	< $10,000	General Budget	Short Term	High

TABLE ES-1.
RECOMMENDED MITIGATION ACTIONS

Action Number	Title	Description	Mitigation Action Ranking	Action Type	Applicable Goals and Objectives	Responsible Department	Estimated Cost	Potential Funding Sources	Timeline	Mitigation Action Worksheet Priority
12	Identifying Functional & Access Needs Population	Identify specific functional & access needs populations that may be exceptionally vulnerable in winter storm, severe wind, or wildfire events that cause long-term power outages	18	EAP	Goal: 1,2,3 Objective: 1.1; 1.2; 1.4; 2.1; 3.1; 3.2; 3.3, 3.4	County Department of Health and Human Services	< $10,000	General Budget	Short Term	Medium
13	Public Education to Mitigate Hazards	Develop an emergency preparedness campaign that includes handouts, brochures, Emergency Preparedness Guide, community meetings, social media, newspapers, radio, etc. to disseminate information to the public, businesses, and tourist regarding best practices on being personally prepared during disasters.	3	EAP	Goal: 1,2,3 Objective: 1.1; 2.1; 3.1; 3.2	Emergency Management	< $10,000	General Budget, FEMA, State, and local Partners	Long Term	High
14	Development of Memorandums of Understanding and Intergovernmental Agreements	Develop and execute MOU's with applicable partners for obtaining needed resources in an event that exceeds local capabilities and resources during and after an incident, event, emergency and/or disaster.	5	LPR	Goal: 1, 3 Objective: 1.2; 1.4; 3.1; 3.2; 3.3, 3.4	Emergency Management	< $10,000	General Budget	Long Term	High
15	Portable Back-up Generator for Critical Infrastructure	Purchase of a portable back-up large capacity generator	15	SIP	Goal: 1, 3 Objective: 1.1, 1.2; 1.4; 3.1; 3.2; 3.4	Public Works Department	$10,000 to $100,000	General Budget	Long Term	High

TABLE ES-1.
RECOMMENDED MITIGATION ACTIONS

Action Number	Title	Description	Mitigation Action Ranking	Action Type	Applicable Goals and Objectives	Responsible Department	Estimated Cost	Potential Funding Sources	Timeline	Mitigation Action Worksheet Priority
16	Identify Mitigation Projects for Critical Facilities in Floodways and Floodplains	Projects may include relocation, elevation, floodproofing, channel stabilization, increasing drainage or absorption capacities with detention and retention basins, relief drains, spillways, drain widening/dredging or rerouting, logjam and debris removal, extra culverts, bridge modification, dike setbacks, flood gates and pumps, or channel redirection.	17	SIP EAP	Goal: 1,2,3 Objective: 1.1, 1.2, 1.4, 1.5, 2.2, 3.1, 3.2, 3.4	County Commissioners, County Manager, County Public Works	$10,000 to $100,000	County General Fund, Hazard Mitigation Assistance Funds	Short Term	High
17	Expand storage capacity at Upper Beaver Brook Reservoir	Current water storage capabilities of the District limit its ability to supply water throughout a long term drought	16	SIP	Goal: 1 Objective: 1.1	Lookout Mountain Water District	>$100,000	CWCB	Short Term	High
18	Repair Lower Beaver Brook Dam	Following the flooding of 2013, the Colorado State Engineer determined that upgrades to the Lower Beaver Brook dam would be necessary.	7	SIP	Goal: 1 Objective: 1.1	Lookout Mountain Water District	>$100,001	CWCB	Long Term	High
CITY OF IDAHO SPRINGS										
1	Maintaining Secondary Water Supply	Maintaining the Idaho Springs Reservoir Dam by getting the dam inspected on a yearly basis and making any repairs as needed. Then exercising the Dam Emergency Action Plan. The City has a lot of future growth potential and it is important to maintain the secondary water supply.	3	LPR	Goal: 1,2,3 Objective: 1.1; 1.2; 1.3; 1.5; 2.2; 3.1;3.4	Water/ Wastewater	$10,000 to $100,000	CRWA, CDPHE, CDLA, FEMA	Ongoing	High

TABLE ES-1.
RECOMMENDED MITIGATION ACTIONS

Action Number	Title	Description	Mitigation Action Ranking	Action Type	Applicable Goals and Objectives	Responsible Department	Estimated Cost	Potential Funding Sources	Timeline	Mitigation Action Worksheet Priority
2	Soda Creek Flood Mitigation	Coordinate with Clear Creek County regarding flood mitigation measures and improvements to portions of Soda Creek Road in the City of Idaho Springs and in Clear Creek County; retain a consultant to perform engineering and design of stormwater, water, sewer, and road improvements	2	NSP SIP	Goal: 1,2,3 Objective: 1.1; 1.2; 1.3; 1.5; 2.2; 3.4	Public Works	>$100,000	CDLA, FEMA	Short Term	High
3	Update Building Codes	Update to the 2015 IBC and IRC. This will be coordinated with Clear Creek County and the other municipalities to try to get all updated at the same time.	1	LPR	Goal: 1, 3 Objective: 1.5; 3.3	City Administrator	< $10,000	General funds	Short Term	High
4	Assess Surge Protectors on City Critical Facilities	The city will assess what critical facilities need surge protectors from lightning strikes and then purchase the necessary protectors and install.	4	LPR	Goal: 1,3 Objective: 1.2; 3.1; 3.4	Public Works	< $10,000	General funds	Short Term	High
5	Assess Sheltering Capabilities	The city will coordinator with the county and American Red Cross to assess public shelter capabilities in the city and create MOUs on shelter operations. Then the city will educate residents and visitors about available shelters.	5	LPR EAP	Goal: 1,2,3 Objective: 1.4; 2.1; 3.1; 3.2	City Administrator	< $10,000	General funds	Short Term	High

TABLE ES-1.
RECOMMENDED MITIGATION ACTIONS

Action Number	Title	Description	Mitigation Action Ranking	Action Type	Applicable Goals and Objectives	Responsible Department	Estimated Cost	Potential Funding Sources	Timeline	Mitigation Action Worksheet Priority
6	Natural Hazard Education	The city will educate homeowners concerning how to mitigate hazard damages to their homes, such as surge protector on electronics, carbon monoxide detectors, proper roofs for high wind and snow load, etc. The city will post information on the city website and use the quarterly newsletters.	7	EAP	Goal: 2 Objective: 2.1; 2.2; 2.3	City Administrator	< $10,000	General funds	Ongoing	High
7	Create MOUs for Equipment Assistance	The city will update/create MOUs with neighboring jurisdictions in the event of needing equipment to assist with a hazard response.	6	LPR	Goal: 1,3 Objective: 1.1; 3.1, 3.2, 3.4	City Administrator, Public Works	< $10,000	General funds	Long Term	High
8	Community Wildfire Protection Implementation Plan – Route 103 Corridor	Work with officials and neighborhoods to facilitate creation of Defensible Space; perform roadside mitigation/hazard tree removal and create fuel breaks south of Interstate 70, along the Route 103 corridor.	9	LPR NSP	Goal: 1,2, 3 Objective: 1.2, 1.3, 1.5, 2.1, 2.3, 3.1, 3.4	Police	$10,000 to $100,000	CDHSEM, CDFPC, CSFS, FEMA	Ongoing	High
9	Community Wildfire Protection Implementation Plan – Virginia Canyon	Work with officials and neighborhoods to facilitate creation of Defensible Space; perform roadside mitigation/hazard tree removal and create fuel breaks south of Interstate 70, in Virginia Canyon	8	LPR NSP	Goal: 1,2, 3 Objective: 1.2, 1.3, 1.5, 2.1, 2.3, 3.1, 3.5	Police	$10,000 to $100,000	CDHSEM, CDFPC, CSFS, FEMA	Ongoing	High

TABLE ES-1.
RECOMMENDED MITIGATION ACTIONS

Action Number	Title	Description	Mitigation Action Ranking	Action Type	Applicable Goals and Objectives	Responsible Department	Estimated Cost	Potential Funding Sources	Timeline	Mitigation Action Worksheet Priority
TOWN OF EMPIRE										
1	Publicize Town Hall as Emergency Shelter	Informing the stranded motorist that shelter can be provided at the Empire Town Hall. New letters will be generated for the residents of Empire informing them in the disaster of an avalanche, winter storm or other natural hazard, and their home is compromised or they are stranded tourists, there will be emergency shelter at the Town Hall.	4	EAP	Goal: 3 Objective: 3.1; 3.2	Mayor's Office	< $10,000	Town funds, ARC	Short Term	Medium
2	Publicize Communications Center	Empire will turn the local fire house into the local communications center to coordinate with red cross for emergency services.	10	EAP	Goal: 3 Objective: 3.1; 3.2; 3.3	Mayor's Office	< $10,000	Town funds, ARC	Short Term	Medium
3	Water conservation techniques	Educate residents on water saving techniques in our monthly newsletter as well as in Board Meetings on measures, including but not limited to, water efficient appliances; low-flow water saving showerheads and toilets; adjusting sprinklers to water lawn only; xeriscaping and the use of recycled water where feasible	5	EAP	Goal: 1,2 Objective: 1.3; 2.1	Mayor's Office	< $10,000	General funds	Short Term	Medium

TABLE ES-1.
RECOMMENDED MITIGATION ACTIONS

Action Number	Title	Description	Mitigation Action Ranking	Action Type	Applicable Goals and Objectives	Responsible Department	Estimated Cost	Potential Funding Sources	Timeline	Mitigation Action Worksheet Priority
4	Ordinance on water usage during drought emergencies	The Town of Empire will write and adopt an Ordinance mandating residence to control and prioritize their water use particularly during firefighting.	6	LPR	Goal: 1,3 Objective: 1.2; 1.3; 3.2; 3.3; 3.4	Mayor's Office	< $10,000	General funds	Long Term	Medium
5	Identify & map old mining areas	Identify and map old mining operations or geologically unstable terrain so that development can be prevented or eliminated.	7	LPR EAP	Goal: 2,3 Objective: 2.1; 3.3	Mayor's Office	< $10,000	General funds, state & federal grants	Long Term	Medium
6	Secure known mining areas and post proper signage	Once old mines are located, secure the site and educate the public with signage of the hazard.	9	EAP	Goal: 2 Objective: 2.1;	Mayor's Office	< $10,000	General funds, state & federal grants	Long Term	Medium
7	Public Education - Tornado safe room	Encouraging home owners to locate a safe room either within their home or nearby will significantly reduce the risk of personal injury and/or death.	11	EAP	Goal: 2 Objective: 2.1;	Mayor's Office	< $10,000	General funds, state & federal grants	Long Term	Medium
8	Reduce flammable vegetation and clearance of trees	Encourage homeowners to reduce flammable vegetation on their property, keep tree limbs trimmed, dead tree removal, and debris cleared from around home to minimize high wind and wildfire damages.	1	EAP NSP	Goal: 1,2 Objective: 1.1; 2.1; 2.3	Mayor's Office	< $10,000	General funds, state & federal grants	Long Term	High

TABLE ES-1.
RECOMMENDED MITIGATION ACTIONS

Action Number	Title	Description	Mitigation Action Ranking	Action Type	Applicable Goals and Objectives	Responsible Department	Estimated Cost	Potential Funding Sources	Timeline	Mitigation Action Worksheet Priority
9	Adopt construction standards for strong wind ratings	Work with the planning department to adopt construction design standards to meet the standards for strong wind ratings.	8	LPR	Goal: 1,3 Objective: 1.1; 3.1	Mayor's Office	< $10,000	General funds, state & federal grants	Long Term	High
10	Community Awareness of Hazards	Educating homeowners on safety techniques to mitigate homes from all hazards	2	EAP	Goal: 2 Objective: 2.1	Mayor's Office	< $10,000	General funds	Long Term	Medium
11	Acquire town volunteers to assist the functional and access needs residents during extreme winter storms	The town will supply volunteers with a list of specific duties and expectations to assist the functional & access needs residents.	3	EAP	Goal: 1,2 Objective: 1.4; 2.1	Mayor's Office	< $10,000	General funds	Long Term	High
TOWN OF GEORGETOWN										
1	Vegetation Thinning Program	Implement vegetation thinning program in and around the Town of Georgetown to create both defensible space and reduce the overall potential impacts of wildfire to residents, the National Historic Landmark District, and the Town.	1	NSP	Goal: 1,2 Objective: 1.1; 1.3; 2.3	Town Administrator	>$100,000	EIAF – DoLA, State and federal grants, local match	Short Term	High

TABLE ES-1.
RECOMMENDED MITIGATION ACTIONS

Action Number	Title	Description	Mitigation Action Ranking	Action Type	Applicable Goals and Objectives	Responsible Department	Estimated Cost	Potential Funding Sources	Timeline	Mitigation Action Worksheet Priority
2	NFIP Floodplain Practices	Continue to participate, implement and improve upon the NFIP Floodplain Practices. This regulates development on South Clear Cleek and Clear Creek within the Town.	2	LPR SIP	Goal: 1 Objective: 1.1; 1.3	Town Administrator	< $10,000	Town funds, CWCB	Long Term	High
3	Adopt Newer IBC	Town of Georgetown plans to update IBC & IRC regulations to address severe wind, winter storm, and flood. It currently uses the 2003 IBC.	8	LPR	Goal: 1, 3 Objective: 1.5; 3.3	Town Administrator	< $10,000	Town funds	Short Term	High
4	Water Conservation Measures	Coordinate with water department to continually identify and promote water conservation measures, including but not limited to, water efficient appliances, xeriscaping, the use of recycled water where feasible and install water meters.	7	EAP	Goal: 1,2 Objective: 1.1; 1.2; 1.3; 2.1	Town Administrator	< $10,000	State and federal grants, local funds	Long Term	High
5	Replace Floodwall along Clear Creek and South Clear Creek	Town of Georgetown has updated flood ordinance and needs funding to replace the flood prone, landslide, mud/debris flow, rockslide floodwall protection along Clear Creek and South Clear Creek through the historic area.	3	SIP	Goal: 1,3 Objective: 1.1; 1.2; 1.5; 3.4	Town Administrator	>$100,000	EIAF – DoLA, State and federal grants, local match	Short Term	Medium
6	Public Education and Outreach	Promote public education of all hazards and how to mitigate damage to homes.	4	EAP	Goal: 2 Objective: 2.1; 2.2; 2.3	Town Administrator	< $10,000	State and federal grants	Short Term	High

TABLE ES-1.
RECOMMENDED MITIGATION ACTIONS

Action Number	Title	Description	Mitigation Action Ranking	Action Type	Applicable Goals and Objectives	Responsible Department	Estimated Cost	Potential Funding Sources	Timeline	Mitigation Action Worksheet Priority
7	Identify slope stabilization projects	Georgetown is vulnerable unstable slopes including damage to private property, historic buildings and infrastructure, bridges and road closures, service disruption and fatalities.	5	NSP SIP	Goal: 1,2,3 Objective: 1.1; 1.2; 1.5; 2.2; 3.1; 3.3; 3.4	Town Administrator	$10,000 to $100,000	FEMA HMA grants	Long Term	Medium
8	Organizing outreach to functional & access needs population	Organize outreach to functional & access needs populations that may be exceptionally vulnerable in winter storm, severe wind, or wildfire events that cause long-term power outages. Maintain public information and awareness programs for the functional & access needs population and create policies and procedures to ensure that needs are met during long-term power outages.	6	EAP	Goal: 1,2 Objective: 1.1; 1.3; 2.9	Town Administrator	< $10,000	Town funds	Short Term	Medium
TOWN OF SILVER PLUME										
1	Identify projects in high risk flood prone areas	Work with the Floodplain Manager to identify potential projects within the high risk flood prone areas within the town of Silver Plume.	2	NSP SIP	Goal: 1,2,3 Objective: 1.5; 2.1; 3.4	Town Board	$10,000 to $100,000	General Fund, state and federal grants	Short Term	Medium
2	Continue to participate in NFIP	Continue to participate, implement and improve upon the NFIP Floodplain Practices.	4	LPR SIP	Goal: 1 Objective: 1.1; 1.3	Town Board	< $10,000	General Fund, CWCB	Long Term	High
3	Community Outreach and Education for Winter Storms	Community Outreach and Education to work with residents and business owners on proactive mitigation measures to reduce the impacts of winter storms on the community	5	EAP	Goal: 1,2,3 Objective: 1.5; 2.1; 3.6	Town Board	< $10,000	General Fund	Ongoing	Medium

TABLE ES-1.
RECOMMENDED MITIGATION ACTIONS

Action Number	Title	Description	Mitigation Action Ranking	Action Type	Applicable Goals and Objectives	Responsible Department	Estimated Cost	Potential Funding Sources	Timeline	Mitigation Action Worksheet Priority
4	Improve Access / Egress for Evacuation	Work with homeowners to improve access/ egress for evacuations and preventative forest maintenance.	3	EAP NSP	Goal: 1 Objective: 1.1; 1.2; 1.3; 1.4; 1.5	Planning/Zoning	< $10,000	General Fund	Short Term	Medium
5	Community Outreach for Severe Wind Events	Encourage homeowners and business owners to implement mitigation measures to reduce the impacts of fallen and blowing debris on homes and businesses during high wind events.	6	EAP	Goal: 1,2,3 Objective: 1.1; 2.1; 3.1	Town Board	< $10,000	General Fund and homeowners	Ongoing	Medium
6	Wildfire Fuels Reduction	Encourage work parties to reduce fuel loads on homeowner property and the impact of wildfires and high wind damage.	1	EAP NSP	Goal: 1,2,3 Objective: 1.1; 1.2; 1.3; 2.1; 2.3; 3.1; 3.4	Town Board	< $10,000	General Fund and grants	Short Term	High
7	Water Restriction Ordinance	Drought events can potentially effect or reduce the availability of water for residents and businesses in the community	7	LPR	Goal: 1,2,3 Objective: 1.2; 2.1; 3.3	Town Board	< $10,000	General Fund	Short Term	Low
8	Water Saving Techniques	Encourage residents to take water-saving measures, including but not limited to, water efficient appliances, adjusting sprinklers to water lawn and not the sidewalk, xeriscaping, checking for leaks in plumping.	8	EAP	Goal: 1,2 Objective: 1.1; 1.2; 1.3; 2.1	Town Board	< $10,000	State and federal grants, local funds	Long Term	Medium

TABLE ES-1.
RECOMMENDED MITIGATION ACTIONS

Action Number	Title	Description	Mitigation Action Ranking	Action Type	Applicable Goals and Objectives	Responsible Department	Estimated Cost	Potential Funding Sources	Timeline	Mitigation Action Worksheet Priority

Notes:

ARC	American Red Cross	FEMA	Federal Emergency Management Agency
CDFPC	Colorado Division of Fire Prevention and Control	IBC	International Building Code
CDHSEM	Colorado Division of Homeland Security and Emergency Management	IRC	International Residential Code
		LPR	Local Plans and Regulations
CDOT	Colorado Department of Transportation	MOU	Memorandum of Understanding
CDPHE	Colorado Department of Public Health and Environment	N/A	Not Applicable
CRWA	Colorado Rural Water Association	NFIP	National Flood Insurance Program
CSFS	Colorado State Forest Service	NSP	Natural System Protection
CWCB	Colorado Water Conservation Board	SIP	Structure and Infrastructure Project
DOLA	Colorado Department of Local Affairs	USDA	U.S. Department of Agriculture
EAP	Education and Awareness Programs		
EIAF	Energy and Mineral Impact Assistance Fund		

PART 1—
PLAN ELEMENTS AND PARTICIPATING COMMUNITIES

Chapter 1.
INTRODUCTION

1.1 WHY PREPARE THIS PLAN?

1.1.1 The Big Picture

Hazard mitigation is defined as a way to alleviate the loss of life, personal injury, and property damage that can result from a disaster through long- and short-term strategies. It involves strategies such as planning, policy changes, programs, projects, and other activities that can mitigate the impacts of hazards. The responsibility for hazard mitigation lies with many, including private property owners; business and industry; and local, state, and federal government.

The federal Disaster Mitigation Act (DMA) of 2000 (Public Law 106-390) required state and local governments to develop hazard mitigation plans as a condition for federal disaster grant assistance. Prior to 2000, federal disaster funding focused on disaster relief and recovery, with limited funding for hazard mitigation planning. The DMA increased the emphasis on planning for disasters before they occur.

The DMA encourages state and local authorities to work together on pre-disaster planning. It promotes "sustainable hazard mitigation," which includes the sound management of natural resources and the recognition that hazards and mitigation must be understood in the largest possible social and economic context. The planning network called for by the DMA helps local governments articulate accurate needs for mitigation, resulting in faster allocation of funding and more cost-effective risk reduction projects. This hazard mitigation plan was prepared for Clear Creek County and the participating communities of City of Idaho Springs and the Towns of Empire, Georgetown, and Silver Plume to reduce risks from natural disasters and to comply with the DMA (Figure 1-1).

1.1.2 Local Concerns

Several factors initiated this planning effort:

- Clear Creek County is exposed to hazards that have caused past damage.
- Limited local resources make it difficult to be pre-emptive in reducing risk. Eligibility for federal financial assistance is paramount to promote successful hazard mitigation in the area.
- Clear Creek County and its planning partners participated in previous hazard mitigation plans as part of the Denver Regional Council of Governments (DRCOG). The *DRCOG* 2011 *Natural Hazard Mitigation Plan* included 7 counties and 20 cities and towns in the region. Because of the lack of specificity in the *DRCOG 2011 Natural Hazard Mitigation Plan* and FEMA's preference for county- or community-specific plans, Clear Creek County elected to develop a new plan specifically for Clear Creek County, the City of Idaho Springs, and the Towns of Empire, Georgetown, and Silver Plume.
- Clear Creek County and its partners participating in this plan want to be proactive in preparing for the probable impacts of natural hazards.

Figure 1-1. Clear Creek County and Participating Communities

1.1.3 Purposes for Planning

This hazard mitigation plan identifies resources, information, and strategies for reducing risk from natural hazards. Elements and strategies in the plan were selected because they meet a program requirement and because they best meet the needs of the planning partners and their citizens. One of the benefits of multi-jurisdictional planning is the ability to pool resources and eliminate redundant activities within a planning area that has uniform risk exposure and vulnerabilities. FEMA encourages multi-jurisdictional planning under its guidance for the DMA. This plan will help guide and coordinate mitigation activities throughout the planning area. The plan was developed to meet the following objectives:

- Meet or exceed requirements of the DMA.
- Enable all planning partners to use federal grant funding to reduce risk through mitigation.
- Meet the needs of each planning partner as well as state and federal requirements.
- Create a risk assessment that focuses on Clear Creek County's hazards of concern.
- Create a single planning document that integrates all planning partners into a framework that supports partnerships within the county, and puts all partners on the same planning cycle for future updates.
- Meet the planning requirements of FEMA's Community Rating System (CRS), allowing planning partners that participate in the CRS program to maintain or enhance their CRS classifications.

- Coordinate existing plans and programs so that high-priority initiatives and projects to mitigate possible disaster impacts are funded and implemented.

1.2 WHO WILL BENEFIT FROM THIS PLAN?

All citizens and businesses of Clear Creek County are the ultimate beneficiaries of this hazard mitigation plan. The plan reduces risk for those who live in, work in, and visit the county. It provides a viable planning framework for all foreseeable natural hazards that may impact the county. Participation in development of the plan by key stakeholders in the county helps ensure that outcomes will be mutually beneficial. The resources and background information in the plan are applicable countywide, and the plan's goals and recommendations can lay groundwork for the development and implementation of local mitigation activities and partnerships.

1.3 ELEMENTS OF THIS PLAN

This plan includes all federally required elements of a disaster mitigation plan:

- Countywide elements:
  - A description of the planning process
  - The public involvement strategy
  - A list of goals and objectives
  - A countywide hazard risk assessment
  - Countywide mitigation actions
  - A plan maintenance strategy
- Jurisdiction-specific elements for each participating jurisdiction:
  - A description of the participation requirements established by the Steering Committee
  - Jurisdiction-specific mitigation actions

The following appendices include information or explanations to support the main content of the plan:

- Appendix A—A glossary of acronyms and definitions
- Appendix B—The FEMA Local Mitigation Plan Review Tool
- Appendix C—Public outreach information, including the hazard mitigation questionnaire and summary and documentation of public meetings
- Appendix D—A menu of mitigation alternatives reviewed for this plan
- Appendix E—Worksheets for each recommended mitigation action
- Appendix F—Plan adoption resolutions from planning partners
- Appendix G—A template for progress reports to be completed as this plan is implemented

All planning partners will adopt the plan in its entirety.

1.4 LOCAL MITIGATION PLAN REVIEW TOOL

The Local Mitigation Plan Review Tool demonstrates how the Local Mitigation Plan meets the regulation in Title 44 of the Code of Federal Regulations (44 CFR) §201.6 and offers states and FEMA Mitigation Planners an opportunity to provide feedback to the community.

- The Regulation Checklist provides a summary of FEMA's evaluation of whether the plan has addressed all requirements.

- The Plan Assessment identifies the plan's strengths as well as documents areas for future improvement.
- The Multi-Jurisdiction Summary Sheet is an optional worksheet that can be used to document how each jurisdiction met the requirements of the each element of the plan (Planning Process; Hazard Identification and Risk Assessment; Mitigation Strategy; Plan Review, Evaluation, and Implementation; and Plan Adoption).

The FEMA Mitigation Planner must reference the *Local Mitigation Plan Review Guide* when completing the Local Mitigation Plan Review Tool. The Local Mitigation Plan Review Tool is included in this hazard mitigation plan as Appendix B.

Chapter 2.
PLAN UPDATE – WHAT HAS CHANGED

2.1 THE PREVIOUS PLAN

Clear Creek County and the Towns of Empire, Georgetown, and Silver Plume participated in previous hazard mitigation plan as part of *DRCOG 2011Natural Hazard Mitigation Plan*. The City of Idaho Springs did not participate in the previous *DRCOG 2011 Natural Hazard Mitigation Plan*. The previous plan did not extensively evaluate the hazards pertaining to Clear Creek County in detail due to the regional nature of the plan. This plan update was developed to focus on the goals and objectives and the natural hazards pertaining only to Clear Creek County and the participating jurisdictions of Idaho Springs, Empire, Georgetown, and Silver Plume.

The *DRCOG 2011 Natural Hazard Mitigation Plan* evaluated 14 hazards. The probable frequency, severity, and significance of the natural hazards was estimated for Clear Creek County, as shown on Table 2-1. The probability of future hazard events were inferred from an examination of historical records and past events and projecting the estimate of the frequency of past events into the future. Historical records of occurrences were used to estimate the frequency and severity for each hazard. A frequency rating of high indicates a recurrence rate of more than once every 10 years, a rating of medium corresponds to a rate of once every 10 to 100 years, a rating of low indicates a recurrence rate of once every 100 to 1,000 years, and very low indicates a recurrence rate of once in more than 1,000 years. The severity of the hazard was ranked as:

- Catastrophic – multiple fatalities, complete shutdown of critical facilities for 30 days or more, more than 50% of the property in affected area destroyed or receiving major damage.
- Extensive – fatalities and severe injury or illness, complete shutdown of critical facilities for 14 days or less, more than 25% of the property in affected area destroyed or receiving major damage.
- Serious – injuries or illness not resulting in disability, complete shutdown of critical facilities for 7 days or less, more than 10% of the property in affected area destroyed or receiving major damage.
- Minor – first aid injuries, complete shutdown of critical facilities for 1 day or less, no more than 1% of the property in affected area destroyed or receiving major damage.

The overall significance was rated as high (widespread potential impact, medium or high frequency, serious, extensive or catastrophic severity), medium (moderate potential impact, medium or high frequency, minor, serious, or extensive severity), or low (minimal potential impact, very low or low frequency, minor or serious severity).

TABLE 2-1.
HAZARDS EVALUATED IN DRCOG 2011 NATURAL HAZARD MITIGATION PLAN

	Clear Creek County			Town of Empire			Town of Georgetown			Town of Silver Plume		
Hazard	Frequency	Severity	**Significance**	Frequency	Severity	**Significance**	Frequency	Severity	**Significance**	Frequency	Severity	**Significance**
Avalanche	High	Extensive	**High**	High	Extensive	**High**	High	Extensive	**High**	High	Extensive	**High**
Drought	High	Extensive	**High**	High	Extensive	**High**	High	Extensive	**High**	High	Extensive	**High**
Earthquake	Low	Extensive	**Medium**	Low	Extensive	**Medium**	Low	Extensive	**Medium**	Low	Extensive	**Medium**
Flood	High	Extensive	**High**	High	Extensive	**High**	High	Extensive	**High**	High	Extensive	**High**
Hail	High	Serious	**Low**	High	Serious	**Low**	High	Serious	**Low**	High	Serious	**Low**
Heat Wave	Medium	Serious	**Low**	Medium	Serious	**Low**	Medium	Serious	**Low**	Medium	Serious	**Low**
Landslide	High	Serious	**High**	High	Serious	**High**	High	Serious	**High**	High	Serious	**High**
Land Subsidence	Medium	Serious	**Medium**	Medium	Serious	**Medium**	Medium	Serious	**Medium**	Medium	Serious	**Medium**
Thunderstorms (Lightning)	High	Serious	**Medium**	High	Serious	**Medium**	High	Serious	**Medium**	High	Serious	**Medium**
Tornado	Low	Serious	**Medium**	Low	Serious	**Medium**	Low	Serious	**Medium**	Low	Serious	**Medium**
Severe Storm/Wind	Medium	Serious	**Medium**	Medium	Serious	**Medium**	Medium	Serious	**Medium**	Medium	Serious	**Medium**
Winter Storm/ Freezing	High	Extensive	**High**	High	Extensive	**High**	High	Extensive	**High**	High	Extensive	**High**
Wildland Fire	High	Extensive	**High**	High	Extensive	**High**	High	Extensive	**High**	High	Extensive	**High**
Pandemic Flu/ West Nile Virus	Low	Extensive	**Medium**	Low	Extensive	**Medium**	Low	Extensive	**Medium**	Low	Extensive	**Medium**

Note: The City of Idaho Springs did not participate in the DRCOG *2011 Natural Hazard Mitigation Plan*.

DRCOG Denver Regional Council of Government

The *DRCOG 2011 Natural Hazard Mitigation Plan* identified goals for the entire regional planning area and specific mitigation actions for the Clear Creek County. The goals were:

- **Goal 1:** Protect people, property, and natural resources
- **Goal 2:** Increase public awareness of natural hazards and their mitigation
- **Goal 3:** Strengthen communication and coordination among public agencies, non-governmental organizations, business and private citizens
- **Goal 4:** Coordinate and integrate natural hazard mitigation activities with local land development planning activities and emergency operations planning.

Clear Creek County, and the Towns of Georgetown, and Silver Plume also chose to add the following goals in the *DRCOG 2011 Natural Hazard Mitigation Plan*:

- **Clear Creek County:** Providing additional protection/safety for our emergency responders
- **Town of Georgetown:** Protection of historic structures, places, and persons
- **Town of Silver Plume:** Establish a Geographic Area Coordination Center for hazards

One mitigation action each was developed specifically for Clear Creek County, and the Towns of Empire, Georgetown, and Silver Plume; and 4 multi-jurisdictional mitigation actions were developed that were common to all participating localities. The current status of each of these actions identified in the *DRCOG 2011 Natural Hazard Mitigation Plan* is shown on Table 2-2.

TABLE 2-2.
CLEAR CREEK COUNTY PROJECT IMPLEMENTATION WORKSHEET
(UPDATE OF *DRCOG 2011 NATURAL HAZARD MITIGATION PLAN* PROJECTS)

Action No.	Action	Project Status				Funding				Comments
		In Progress	Delayed	Completed	No Longer Required	Budgeted	Apply for Grant	Grant Received	Target Completion	
Clear Creek County Specific Actions as listed in *DRCOG 2011 Natural Hazard Mitigation Plan*										
1	Bark Beetle/Fuels Reduction Project within road right-of-ways				X					
Town of Empire Specific Actions as listed in *DRCOG 2011 Natural Hazard Mitigation Plan*										
1	Community Wildfire Protection Plan			X						
Town of Georgetown Specific Actions as listed in *DRCOG 2011 Natural Hazard Mitigation Plan*										
1	Clear Creek Flood Mitigation Plan with Town of Georgetown			X						
Town of Silver Plume Specific Actions as listed in *DRCOG 2011 Natural Hazard Mitigation Plan*										
1	Bark Beetle/Fuels Reduction Project within road right-of-ways				X					
DRCOG 2011 Natural Hazard Mitigation Plan Multi-jurisdictional Mitigation Actions Common to All Participating Localities										
2MJ	Continue to participate in the National Flood Insurance Program by implementing and improving upon effective floodplain and stormwater management practices				X					

TABLE 2-2.
CLEAR CREEK COUNTY PROJECT IMPLEMENTATION WORKSHEET
(UPDATE OF *DRCOG 2011 NATURAL HAZARD MITIGATION PLAN* PROJECTS)

Action No.	Action	Project Status				Funding				Comments
		In Progress	Delayed	Completed	No Longer Required	Budgeted	Apply for Grant	Grant Received	Target Completion	
DRCOG 2011 Natural Hazard Mitigation Plan Multi-jurisdictional Mitigation Actions Common to All Participating Localities										
3MJ	Coordinate with local water providers to continually identify and promote water conservation measures, including but not limited to, incentive programs, water efficient appliances, xeriscaping, and the use of recycled water where feasible.				X					
4MJ	Monitor proceedings of the Colorado Water Availability Task Force. When necessary, support water providers in the implementation of conservation measures.									
5MJ	Provide *DRCOG 2011 Natural Hazard Mitigation Plan* to other departments for possible integration into various planning efforts.				X					

Note:
DRCOG Denver Regional Council of Government
WUI Wildland Urban Interface

2.2 WHY UPDATE?

Title 44 of the Code of Federal Regulations (44 CFR) stipulates that hazard mitigation plans must present a schedule for monitoring, evaluating, and updating the plan. As mentioned previously, the Clear Creek County and the Towns of Empire, Georgetown, and Silver Plume participated in a mitigation planning process by DRCOG in 2011 as part 7 counties and 20 cities and towns in the region. This plan will expire in 2016 and regional plans are not preferred by FEMA. This update provides an opportunity to reevaluate recommendations, monitor the impacts of actions that have been accomplished, and evaluate whether there is a need to change the focus of mitigation strategies. A jurisdiction covered by a plan that has expired is not able to pursue elements of federal funding under the Robert T. Stafford Act for which a current hazard mitigation plan is a prerequisite.

2.3 WHAT IS DIFFERENT?

The plan update has been improved to focus on Clear Creek County and the participating communities using the best and most current data and technology available. The updated plan includes a more robust hazard analysis. Mitigation actions were reviewed and amended to include only those that would move the community towards a higher degree of resiliency while being feasible, practical, and implementable given current finances. Federal and state funds for projects have become difficult to obtain. The update recommends 54 mitigation actions for Clear Creek County and its planning partners.

Chapter 3.
PLAN METHODOLOGY

3.1 GRANT FUNDING

Clear Creek County applied for a grant through FEMA's Hazard Mitigation Grant Program (HMGP) to supplement the plan development process. The Clear Creek County Office of Emergency Management (CCCOEM) was the applicant agent for the grant; however, the grant also covered costs to develop a separate hazard mitigation plan for Gilpin County and the participating communities of Black Hawk and Central City. Grant funding was appropriated in 2015. It covered 75% of the cost for development of this plan; 12.5% of the funding was provided by the Colorado Division of Homeland Security and Emergency Management, and the remaining 12.5% through local match. Clear Creek County hired Tetra Tech to assist with development and implementation of the plan. The Tetra Tech project manager assumed the role of the lead planner, reporting directly to a county-designated project manager, Emergency Manager Kathleen Krebs and Interim Emergency Manager Jane Thomas.

3.2 ESTABLISHMENT OF THE PLANNING PARTNERSHIP

Clear Creek County opened this planning effort to all eligible local governments in the county. The planning partners covered under this plan are shown in Table 3-1.

TABLE 3-1.
COUNTY AND PLANNING PARTNERS

Jurisdiction	Point of Contact	Title
Clear Creek County	Kathleen Krebs	Emergency Manager
	Jane Thomas	Interim Emergency Manager
City of Idaho Springs	Mike Hillman	Mayor
Town of Empire	Nichole Lentz	Town Clerk
Town of Georgetown	Tom Hale	Town Administrator
Town of Silver Plume	Tammy Stanford	Town Clerk

Each jurisdiction wishing to join the planning partnership was asked to commit to the process and have a clear understanding of expectations. These include:

- Each partner will support and participate in the meetings of the Steering Committee overseeing the development of the plan. Support includes allowing this body to make decisions regarding plan development and scope on behalf of the partnership.
- Each partner will provide support as needed for the public involvement strategy developed by the Steering Committee in the form of mailing lists, possible meeting space, and media outreach such as newsletters, newspapers or direct-mailed brochures.
- Each partner will participate in plan development activities such as:
  - Steering Committee meetings
  - Public meetings or open houses
  - Workshops and planning partner training sessions
  - Public review and comment periods prior to adoption

Attendance will be tracked at such activities, and attendance records will be used to track and document participation for each planning partner. All participating communities are expected to attend and actively participate in all meetings.

- Each partner will be expected to review the risk assessment and identify hazards and vulnerabilities specific to its jurisdiction. Contract resources will provide jurisdiction-specific mapping and technical consultation to aid in this task, but the determination of risk and vulnerability ranking will be up to each partner.
- Each partner will be expected to review the mitigation recommendations chosen for the overall county and evaluate whether they will meet the needs of its jurisdiction. Projects within each jurisdiction consistent with the overall plan recommendations will need to be identified, prioritized, and reviewed to identify their benefits and costs.
- Each partner will sponsor at least one public meeting to present the draft plan at least two weeks prior to adoption.
- Each partner will be required to formally adopt the plan.
- Each partner agrees to the plan implementation and maintenance protocol.

Failure to meet these criteria may result in a partner being dropped from the partnership by the Steering Committee, and thus losing eligibility under the scope of this plan.

3.3 DEFINING THE PLANNING AREA

The planning area was defined to consist of all of Clear Creek County. All partners to this plan have jurisdictional authority within this planning area. The planning area and partners are shown on Figure 1-1.

3.4 THE STEERING COMMITTEE

Hazard mitigation planning enhances collaboration and support among diverse parties whose interests can be affected by hazard losses. A Steering Committee was formed to oversee all phases of the plan. The members of this committee included key planning partner staff, citizens, and other stakeholders from within the planning area. Table 3-2 lists the committee members.

TABLE 3-2.
STEERING COMMITTEE MEMBERS

Name	Jurisdiction/Title
Kathleen Krebs	Clear Creek County/Director of Emergency Management
Jane Thomas	Clear Creek County/Interim Director of Emergency Management
Donna Kline	Clear Creek County/ Admin. Assistant in Office of Emergency Management
Fred Rollenhagen	Clear Creek County/Planning Department Director
Matt Taylor	Clear Creek County/Mapping Director
Ezekiel Peters	Clear Creek County/EMS Deputy Director
Mike Hillman	City of Idaho Springs/Mayor
Andrew Marsh	City of Idaho Springs/City Administrator
Richard Sprague	Town of Empire/Mayor
Nichole Lentz	Town of Empire/Town Clerk
Richard McClellan	Town of Empire/Public Works

TABLE 3-2.
STEERING COMMITTEE MEMBERS

Name	Jurisdiction/Title
Tom Hale	Town of Georgetown/Town Administrator
Jennifer Yobski	Town of Georgetown/Town Clerk
Tammy Stanford	Town of Silver Plume/Town Clerk
Kelly Babeon	Clear Creek Fire Authority/Fire Chief
Brian Oppenheimer	Clear Creek Fire Authority/Assistant Fire Chief
Roslin Marshall	Clear Creek School District/Superintendent
Dane Matthews	Clear Creek Metropolitan Recreation District/District Director
David Holm	Clear Creek Watershed Foundation/Executive Director
Robert Heine	Lookout Mountain Water District/Vice President
Steven Watson	Gilpin County/Emergency Manager (pre 12/31/2015)
Kevin Armstrong	Gilpin County/Emergency Manager (post 12/31/2015)

The Steering Committee agreed to meet a minimum of three times or as needed throughout the course of the plan's development. The consultant and Clear Creek County Emergency Manager facilitated three Steering Committee meetings, which addressed a set of objectives based on the work plan established for the plan. The Clear Creek County Steering Committee meetings were held along with representatives from the neighboring communities of Gilpin County and the Cities of Black Hawk and Central City. Meeting agendas, notes and attendance logs can be found in Appendix C of this document. All Steering Committee meetings were open to the public and notices of the meetings were posted to the county website and released to the press.

The planning team made a presentation at a Steering Committee meeting on September 15, 2015, to introduce the mitigation planning process. The Steering Committee, planning partners and public were all encouraged to participate in the plan update process. At this kickoff meeting, the participation levels were discussed. Clear Creek County and the municipalities are considered planning partners that will adopt the final plan. The fire protection districts, watershed districts, and all other special districts are considered stakeholders in the planning process and can add mitigation actions to the plan, but do not need to adopt the final plan. Key meeting objectives were as follows:

- Steering Committee purposes and responsibilities
- Plan partners and signators and responsibilities
- Provide an overview of the DMA
- Describe the reasons for a plan
- Discuss community participation and the survey
- Develop plan mitigation goals and objectives
- Describe hazard analysis
- Discuss critical facilities

The Steering Committee met on November 16, 2015, to review the hazard risk assessment for Clear Creek County and the results of the community survey. Based on the risk assessment and survey results, the Steering Committee then ranked the natural hazards. The hazards were ranked based on their probability of occurrence and their potential impact on people, property, and the economy. The results of the hazard

ranking is discussed in Chapter 20. The consultant also met with representatives from the Town of Empire on December 17, 2015, and held a conference call with the Town of Silver Plume on December 18, 2015, to present the material discussed during the Steering Committee meetings.

The third Steering Committee meeting was held on April 7, 2016. The main objective of the meeting was to present and rank mitigation actions, which were developed to address hazards ranked "medium" or "high." The mitigation actions are discussed in Chapter 21. The meeting also asked for input on how the plan would be maintained and presented a fact sheet a Hazard Mitigation Assistance grants.

3.5 COORDINATION WITH OTHER AGENCIES

Opportunities for involvement in the planning process must be provided to neighboring communities, local and regional agencies involved in hazard mitigation, agencies with authority to regulate development, businesses, academia, and other private and nonprofit interests (44 CFR, Section 201.6(b)(2)). This task was accomplished by the planning team as follows:

- **Steering Committee Involvement**—Agency representatives were invited to participate on the Steering Committee.
- **Agency Notification**—The following agencies were invited to participate in the plan development process from the beginning and were kept apprised of plan development milestones:
  - Colorado Division of Homeland Security and Emergency Management
  - Clear Creek School District
  - Clear Creek Metropolitan Recreation District
  - Clear Creek Sanitation District
  - Clear Creek Watershed Foundation
  - U.S. Forest Service Ranger District
  - Clear Creek Fire Authority
  - Lookout Mountain Water District

  These agencies received meeting announcements, meeting agendas, and meeting minutes by e-mail throughout the plan development process and supported the effort by attending meetings or providing feedback on issues.
- **Pre-Adoption Review**—The agencies listed above were provided an opportunity to review and comment on this plan, primarily through the county's website and during the Steering Committee meetings. Each agency was sent an email message informing them that draft portions of the plan were available for review. In addition, the Colorado Division of Homeland Security and Emergency Management reviewed and commented on this plan for a pre-adoption review to ensure program compliance.

3.6 REVIEW OF EXISTING PROGRAMS

Hazard mitigation planning must include review and incorporation, if appropriate, of existing plans, studies, reports and technical information (44 CFR, Section 201.6(b)(3)). Chapter 6.9 of this plan provides a review of laws and ordinances in effect within the planning area that can affect hazard mitigation initiatives. In addition, the following programs can affect mitigation within the planning area:

- Clear Creek County Master Plan
- Clear Creek County Community Wildfire Protection Plan (CWPP) and other wildfire implementation plans within the county, including Community Wildfire Protection

Implementation Plans for the City of Idaho Springs Area, the Floyd Hill/Beaver Brook/Saddleback Area, Fall River Watershed Area, Town of Empire, Town of Silver Plume, Upper Bear Creek Area, and the Echo Hills Area

- Comprehensive Plans, Zoning Regulations, and Municipal Codes for the participating communities of Idaho Springs, Empire, Georgetown, and Silver Plume

An assessment of all planning partners' regulatory, technical, and financial capabilities to implement hazard mitigation initiatives is presented in Chapter 7. Many of these relevant plans, studies, and regulations are cited in the capability assessment. The review of existing programs and the assessment of capabilities identify the plans, regulations, personnel, and funding mechanisms available to the county and planning partners to impact and mitigate the effects of natural hazards. The review also helps identify opportunities for the planning partners to strengthen and expand their abilities to proactively mitigate natural hazards in the community through the expansion of existing departments and programs; completion of applicable plans; adoption of necessary regulations or ordinances; creation and hiring of new departments and staff; or mutual aid agreements and memorandums of understanding with neighboring communities. The planning partners reviewed the findings of the capabilities assessment during the second Steering Committee meeting and used this information to identify mitigation actions.

3.7 PUBLIC INVOLVEMENT

Broad public participation in the planning process helps ensure that diverse points of view about the planning area's needs are considered and addressed. The public must have opportunities to comment on disaster mitigation plans during the drafting stages and prior to plan approval (44 CFR, Section 201.6(b)(1)). The CRS expands on these requirements by making CRS credits available for optional public involvement activities. The strategy for involving the public in this plan emphasized the following elements:

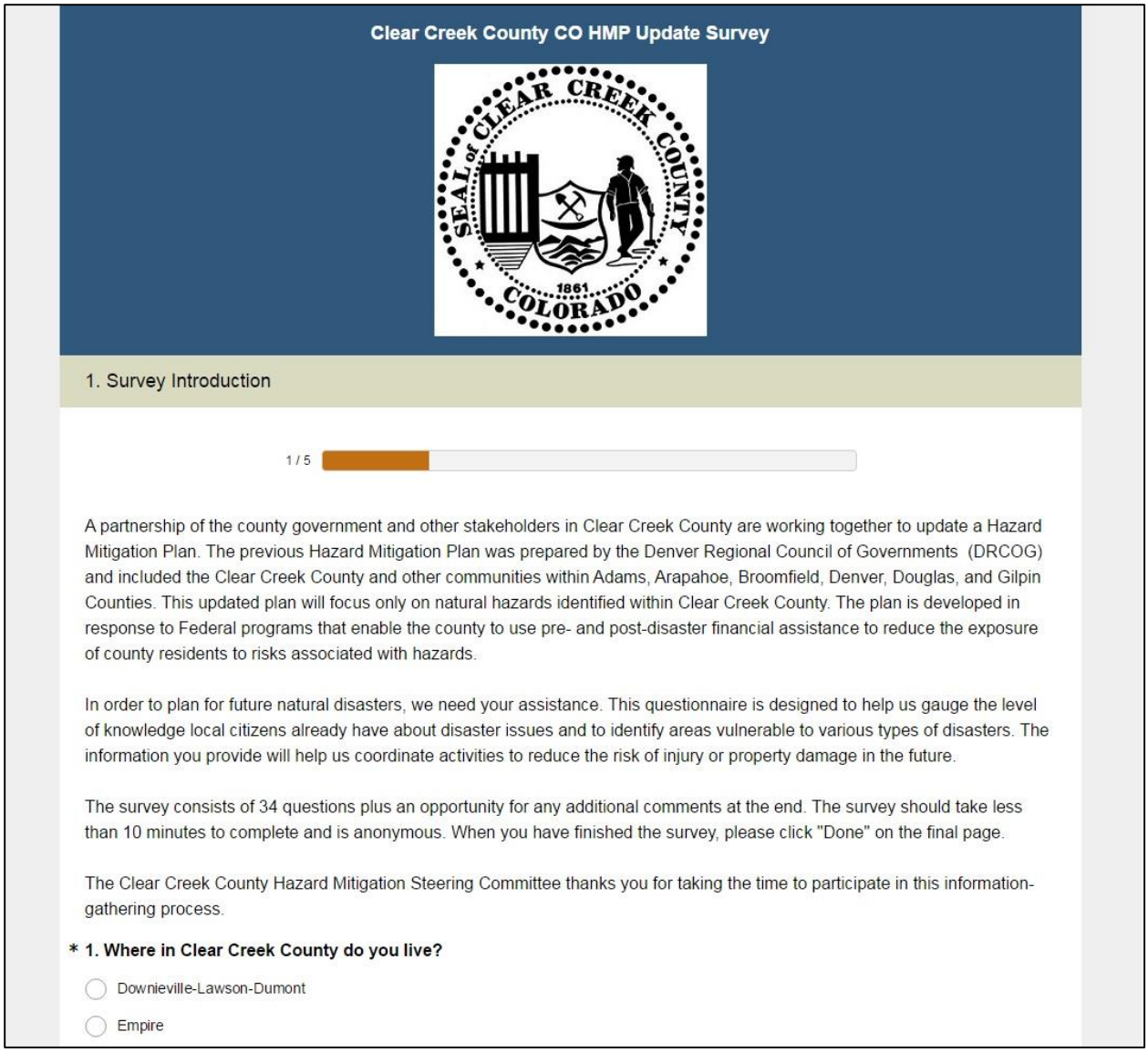
- Include members of the public on the Steering Committee
- Use a community survey/questionnaire to evaluate whether the public's perception of risk and support of hazard mitigation has changed since the initial planning process
- Attempt to reach as many planning area citizens as possible using multiple media
- Identify and involve planning area stakeholders
- Solicit public feedback at each state of plan implementation, monitoring, and evaluation

3.7.1 Stakeholders and the Steering Committee

Stakeholders are the individuals, agencies, and jurisdictions that have a vested interest in the recommendations of the hazard mitigation plan, including planning partners. The effort to include stakeholders in this process included stakeholder participation on the Steering Committee. Stakeholders were encouraged to attend and participate in all committee meetings.

3.7.2 Survey/Questionnaire

A hazard mitigation plan questionnaire (see Figure 3-1) was developed to gauge household preparedness for natural hazards; the level of knowledge of tools and techniques that assist in reducing risk and loss from natural hazards; and the perceived impact of natural hazards on Clear Creek County residents and businesses. This questionnaire was designed to help identify areas vulnerable to one or more natural hazards. The answers to its 35 questions helped guide the Steering Committee in prioritizing hazards of impact and in selecting goals, objectives, and mitigation strategies. A total of 39 questionnaires were completed during the course of this planning process. The complete questionnaire and a summary of its findings can be found in Appendix C.



Clear Creek County CO HMP Update Survey

1. Survey Introduction

1 / 5

A partnership of the county government and other stakeholders in Clear Creek County are working together to update a Hazard Mitigation Plan. The previous Hazard Mitigation Plan was prepared by the Denver Regional Council of Governments (DRCOG) and included the Clear Creek County and other communities within Adams, Arapahoe, Broomfield, Denver, Douglas, and Gilpin Counties. This updated plan will focus only on natural hazards identified within Clear Creek County. The plan is developed in response to Federal programs that enable the county to use pre- and post-disaster financial assistance to reduce the exposure of county residents to risks associated with hazards.

In order to plan for future natural disasters, we need your assistance. This questionnaire is designed to help us gauge the level of knowledge local citizens already have about disaster issues and to identify areas vulnerable to various types of disasters. The information you provide will help us coordinate activities to reduce the risk of injury or property damage in the future.

The survey consists of 34 questions plus an opportunity for any additional comments at the end. The survey should take less than 10 minutes to complete and is anonymous. When you have finished the survey, please click "Done" on the final page.

The Clear Creek County Hazard Mitigation Steering Committee thanks you for taking the time to participate in this information-gathering process.

* 1. Where in Clear Creek County do you live?

Downieville-Lawson-Dumont

Empire

Figure 3-1. Sample Page from Questionnaire Distributed to the Public

3.7.3 Meetings

Three Steering Committee meetings were held during the planning process on September 16, 2015, October 16, 2015, and April 7, 2016, in the City of Idaho Springs or the Town of Georgetown (see Figure 3-2). There was also two Steering Committee #2 make-up meetings with the Towns of Empire and Silver Plume on December 17, 2015 and December 18, 2015 respectively. The draft plan was then presented and reviewed before the Clear Creek County BOCC on XXX XX, 2016. The meeting format allowed attendees to access to handouts, maps and other resources and have direct conversations with project staff. Reasons for planning and information generated for the risk assessment were shared with attendees via a PowerPoint presentation. Planning partners and the planning team were present to answer questions.

Figure 3-2. Steering Committee Meeting October 16, 2015

3.7.4 Press Releases/News Articles

Press releases were distributed over the course of the plan's development as key milestones were achieved and prior to each public meeting. The planning effort received press coverage as shown in Figure 3-3.

Figure 3-3. Planning Process Press Coverage

3.7.5 Internet

At the beginning of the plan development process, the county posted information regarding the update process, a link to the community survey and a link to the mitigation plan on the Clear Creek County website (https://www.co.clear-creek.co.us/; see Figure 3-4). The county website was used to keep the public posted on plan development milestones and to solicit relevant input. Information on the plan development process, the Steering Committee, the questionnaire, and phased drafts of the plan were made available to the public on the site throughout the process. The county intends to keep a link on the website active after the plan's completion to keep the public informed about successful mitigation projects and future plan updates.

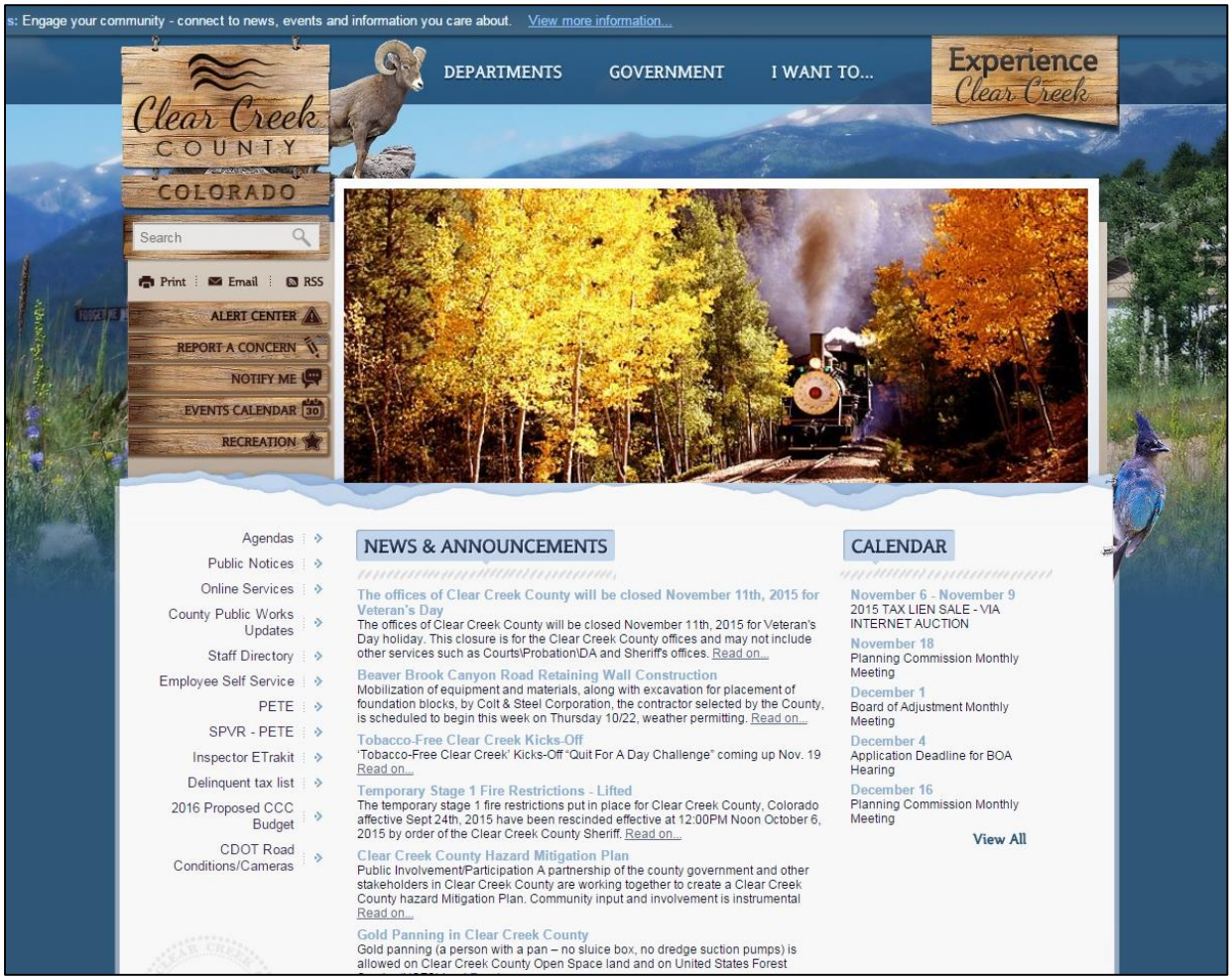


Figure 3-4. Sample Page from the Clear Creek County Website

3.8 PLAN DEVELOPMENT CHRONOLOGY/MILESTONES

Table 3-3 summarizes important milestones in the development of the plan.

TABLE 3-3.
PLAN DEVELOPMENT MILESTONES

Date	Event	Description	Attendance
2015			
5/6	Notified grant funding secured	Funding secured	N/A
7/17	Contract signed	Notice to proceed given to Tetra Tech	N/A
9/15	Steering Committee/ Stakeholder Meeting #1	Presentation on plan process given, participation, review of goals and objectives, etc.	Clear Creek County
11/16	Steering Committee Meeting #2	Review community survey, review of hazard risk assessment, review and update plan goals and objectives	Clear Creek County, Idaho Springs and Georgetown
12/17	Steering Committee Make-up Meeting	Review materials presented at Steering Committee Meetings #1 and 2, review hazard assessment, review and update plan goals and objectives	Empire
12/18	Steering Committee Make-up Meeting	Review materials presented at Steering Committee Meetings #1 and 2, review hazard assessment, review and update plan goals and objectives	Silver Plume
2016			
4/7	Steering Committee Meeting #3	Mitigation actions presentation and project development	Clear Creek County, Idaho Springs, Empire, Georgetown, and Silver Plume
Ongoing	Public Outreach	News articles and website posting	N/A
	Draft Plan	Internal review draft provided to Steering Committee	N/A
	Public Comment Period	Initial public comment period of draft plan opens. Draft plan posted on plan website with press release notifying public of plan availability	N/A
X/X	Plan Review	Final draft plan submitted to Colorado Division of Homeland Security and Emergency Management for review	N/A
X/X	Plan Approval Pending Adoption	Final draft plan submitted to FEMA for approval pending adoption	N/A
X/X	Public Outreach	Final public meeting on draft plan	N/A
X/X	Adoption	Adoption window of final plan opens	N/A
X/X	Plan Approval	Final plan approved by FEMA	N/A

Notes:
FEMA Federal Emergency Management Agency
N/A Not applicable

Chapter 4.
GOALS AND OBJECTIVES

Hazard mitigation plans must identify goals for reducing long-term vulnerabilities to identified hazards (44 CFR Section 201.6(c)(3)(i)). The Steering Committee established guiding principles, a set of goals, and measurable objectives for this plan, based on data from the preliminary risk assessment and the results of the public involvement strategy. The guiding principles, goals, objectives, and mitigation actions in this plan all support each other. Goals were selected to support the guiding principles. Objectives were selected that met multiple goals. Mitigation actions were prioritized based on the action meeting multiple objectives.

4.1 GUIDING PRINCIPLES

The following guiding principles for this plan process guided the Steering Committee during the plan update:

1. To reduce or eliminate the long-term risks to loss of life and property damage in the jurisdictions from the full range of natural disasters.
2. To identify policies, actions, and tools for long-term implementation in order to reduce risk and future losses stemming from natural hazards that are likely to impact the jurisdictions.
3. To create communities whose activities reflect a comprehensive commitment by government, business, non-profit organizations and the public to eliminate or reduce risks and adverse impacts from natural, technological and human-caused hazards.

4.2 GOALS

The following are the mitigation goals for this plan:

- **Goal 1:** Protection of people, property, and natural, cultural, and environmental resources.
- **Goal 2:** Increase awareness of natural hazards and their mitigation.
- **Goal 3:** Coordinate and integrate hazard mitigation activities.

4.3 OBJECTIVES

The objectives are used to help establish priorities and support the agreed upon goals. The objectives are as follows:

- Objectives in support of Goal 1:
  - **Objective 1.1**: Develop projects focused on preventing loss of life and injuries from natural hazards.
  - **Objective 1.2:** Identify and prioritize actions to protect critical, essential and necessary assets and infrastructure.
  - **Objective 1.3:** Protect and enhance natural resources by adopting and implementing sustainable flood-management policies, debris management programs, snow removal, tree trimming and replacement, or energy conservation programs.
  - **Objective 1.4**: Identify and expand emergency services protocols for people who are at high risk from hazard events, such as the homeless, elderly, disabled, and oxygen-dependent people.
  - **Objective 1.5:** Identify and provide for necessary construction, renovation, retrofitting or refurbishment to protect vulnerable structures and cultural resources from the effects of natural hazards.

- Objectives in support of Goal 2:
  - **Objective 2.1**: Continue to develop and expand public awareness and information programs.
  - **Objective 2.2:** Expand public awareness of flood and flash flood hazards in general and at specific high-risk locations.
  - **Objective 2.3:** Expand public awareness of wildfire hazards and measures by which people can protect themselves, their property and their community.
- Objectives in support of Goal 3:
  - **Objective 3.1:** Strengthen connections between hazard mitigation activities; and preparedness, response and recovery activities.
  - **Objective 3.2:** Identify systems, and areas of improvement needed, to implement emergency operations plans and services, including Community Emergency Response Team training.
  - **Objective 3.3:** Identify existing local government monitoring and decision-making tools; identify gaps and needed improvements.
  - **Objective 3.4:** Reduce services interruptions and revenue losses to the local community and the region from natural hazards, including traffic interruptions.

Chapter 5.
IDENTIFIED HAZARDS OF CONCERN AND RISK ASSESSMENT METHODOLOGY

Risk assessment is the process of measuring the potential loss of life, personal injury, economic injury, and property damage resulting from natural hazards. It allows emergency management personnel to establish early response priorities by identifying potential hazards and vulnerable assets. The process focuses on the following elements:

- Hazard identification—Use all available information to determine what types of disasters may affect a jurisdiction, how often they can occur, and their potential severity.
- Vulnerability identification—Determine the impact of natural hazard events on the people, property, environment, economy, and lands of the region.
- Cost evaluation—Estimate the cost of potential damage or cost that can be avoided by mitigation.

The risk assessment for this hazard mitigation plan evaluates the risk of natural hazards prevalent in the planning area and meets requirements of the DMA (44 CFR, Section 201.6(c)(2)).

5.1 IDENTIFIED HAZARDS OF CONCERN

For this plan, the Steering Committee considered the full range of natural hazards that could impact the planning area and then listed hazards that present the greatest concern. The process incorporated review of state and local hazard planning documents, as well as information on the frequency, magnitude, and costs associated with hazards that have impacted or could impact the planning area. Anecdotal information regarding natural hazards and the perceived vulnerability of the planning area's assets to them was also used. Based on the review, this plan addresses the following hazards of concern:

- Avalanche
- Dam/Levee Failure
- Drought
- Earthquake
- Erosion and Deposition
- Expansive Soil
- Extreme Heat
- Flood
- Hail
- Landslide, Mud/Debris Flow, Rockfall
- Lightning
- Severe Wind
- Space Weather
- Subsidence
- Tornado
- Wildfire
- Winter Storm

Several of these hazards were profiled together because of their common occurrence or damage assessments, such as drought and extreme heat, and hail, lightning, and severe winds.

5.2 CLIMATE CHANGE

Climate includes patterns of temperature, precipitation, humidity, wind and seasons. Climate plays a fundamental role in shaping natural ecosystems, and the human economies and cultures that depend on them. "Climate change" refers to changes over a long period of time. It is generally perceived that climate change will have a measurable impact on the occurrence and severity of natural hazards around the world. Impacts include the following:

- Snow cover losses will continue, and declining snowpack will affect snow-dependent water supplies and stream flow levels around the world.
- The risk of drought and the frequency, intensity, and duration of heat waves are expected to increase.
- More extreme precipitation is likely, increasing the risk of flooding.
- The world's average temperature is expected to increase.

Climate change will affect communities in a variety of ways. Impacts could include an increased risk for extreme events such as drought, storms, flooding, and wildfires; and more heat-related stress. In many cases, communities are already facing these problems to some degree. Climate change influences the frequency, intensity, extent, or magnitude of the problems.

This hazard mitigation plan addresses climate change as a secondary impact for each identified hazard of concern. Each chapter addressing one of the hazards of concern includes a section with a qualitative discussion on the probable impacts of climate change for that hazard. While many models are being developed to assess the potential impacts of climate change, none are currently available to support hazard mitigation planning. As these models are developed in the future, this risk assessment may be enhanced to better measure these impacts.

5.3 METHODOLOGY

The risk assessments in Chapter 8 through Chapter 18 describe the risks associated with each identified hazard of concern. Each chapter describes the hazard, the planning area's vulnerabilities, and probable event scenarios. The following steps were used to define the risk of each hazard:

- Identify and profile each hazard – The following information is given for each hazard:
  - Geographic areas most affected by the hazard
  - Event frequency estimates
  - Severity estimates
  - Warning time likely to be available for response
- Determine exposure to each hazard – Exposure was evaluated by overlaying hazard maps, when available, with an inventory of structures, facilities, and systems to identify which of them would be exposed to each hazard. When hazard mapping was not available, a more qualitative discussion of exposure is presented.
- Assess the vulnerability of exposed facilities – Vulnerability of exposed structures and infrastructure was evaluated by interpreting the probability of occurrence of each event and assessing structures, facilities, and systems that are exposed to each hazard. Tools such as geographic information system (GIS) and FEMA's hazard modeling program called Hazards, United States-Multi Hazard (HAZUS-MH) were used to perform this assessment for the flood,

dam failure, and earthquake hazards. Outputs similar to those from HAZUS were generated for other hazards, using maps generated by the HAZUS program.

5.4 RISK ASSESSMENT TOOLS

5.4.1 HAZUS-MH—Dam Failure, Earthquake, and Flood

Overview

In 1997, FEMA developed the standardized Hazards U.S., or HAZUS, model to estimate losses caused by earthquakes and identify areas that face the highest risk and potential for loss. HAZUS was later expanded into a multi-hazard methodology, HAZUS-MH, with new models for estimating potential losses from hurricanes and floods.

HAZUS-MH is a GIS-based software program used to support risk assessments, mitigation planning, and emergency planning and response. It provides a wide range of inventory data, such as demographics, building stock, critical facility, transportation, and utility lifeline, and multiple models to estimate potential losses from natural disasters. The program maps and displays hazard data and the results of damage and economic loss estimates for buildings and infrastructure. Its advantages include the following:

- Provides a consistent methodology for assessing risk across geographic and political entities.
- Provides a way to save data so that it can readily be updated as population, inventory, and other factors change and as mitigation planning efforts evolve.
- Facilitates the review of mitigation plans because it helps to ensure that FEMA methodologies are incorporated.
- Supports grant applications by calculating benefits using FEMA definitions and terminology.
- Produces hazard data and loss estimates that can be used in communication with local stakeholders.
- Is administered by the local government and can be used to manage and update a hazard mitigation plan throughout its implementation.

Levels of Detail for Evaluation

HAZUS-MH provides default data for inventory, vulnerability, and hazards; this default data can be supplemented with local data to provide a more refined analysis. The model can carry out three levels of analysis, depending on the format and level of detail of information about the planning area:

- **Level 1** – All of the information needed to produce an estimate of losses is included in the software's default data. These data are derived from national databases and describe in general terms the characteristic parameters of the planning area.
- **Level 2** – More accurate estimates of losses require more detailed information about the planning area. To produce Level 2 estimates of losses, detailed information is required about local geology, hydrology, hydraulics, and building inventory, as well as data for utilities and critical facilities. This information is needed in a GIS format.
- **Level 3** – This level of analysis generates the most accurate estimate of losses. It requires detailed engineering and geotechnical information to customize it for the planning area.

Application for This Plan

The following methods were used to assess specific hazards for this plan:

- Flood – A Level 2, general building stock analysis, was performed. GIS building and assessor data (replacement cost values and detailed structure information) were loaded into HAZUS-MH. An

updated inventory was used in place of the HAZUS-MH defaults for essential facilities, transportation, and utilities. Current Clear Creek County digital flood insurance rate maps (DFIRM) were used to delineate flood hazard areas and estimate potential losses from the 100-year flood event and a 500-year flood event. Using the DFIRM floodplain boundaries and a countywide 10-meter digital elevation model (DEM), flood depth grids were generated using the Enhanced Quicklook tool and integrated into the model.

Note: Flood maps for Clear Creek County are available through the CCCOEM.

- Dam Failure – Dam failure inundation mapping for the planning area was provided by Colorado Division of Water Resources. The mapping was not in a format that could be used by HAZUS, but HAZUS was used to determine cost estimate losses and damage to buildings in the inundation areas.
- Earthquake – A Level 2 analysis was performed to assess earthquake risk and exposure. The arbitrary event and probabilistic options in the HAZUS earthquake module were used for the analysis of this hazard. The arbitrary events were chosen based on the Colorado Geological Survey's 2005 statewide earthquake analysis using HAZUS. An updated general building stock inventory was developed using replacement cost values and detailed structure information from assessor tables. An updated inventory of essential facilities, transportation and utility features was used in place of the HAZUS-MH defaults. Two scenario events and one probabilistic event were modeled:
  - The scenario events were a Magnitude-6.5 event on the Golden Fault and a Magnitude-7.0 event on the Mosquito Fault.
  - The standard HAZUS analysis for the 500-Year Probabilistic Event was run.

5.4.2 Other Hazards of Concern

For hazards of concern that are not directly modeled in HAZUS, future losses could not be estimated. However, HAZUS-MH is able to map hazard areas and calculate exposures if geographic information is available on the locations of the hazards and inventory data. Areas and inventory susceptible to some of the hazards of concern were mapped and exposure was evaluated. For other hazards, a qualitative analysis was conducted using the best available data and professional judgment. Locally-relevant information was gathered from a variety of sources. Frequency and severity indicators include past events and the expert opinions of geologists, emergency management specialists, and others. The primary data source was the Clear Creek County GIS database, augmented with state and federal data sets. Additional data sources for specific hazards were as follows:

- **Avalanche** – Data provided by Colorado Avalanche Information Center
- **Drought** – National Drought Mitigation Center
- **Erosion and Deposition, Expansive Soil, and Subsidence** – Datasets from the Colorado Geological Society regarding evaporite-bearing bedrock and known coal mining hazard areas
- **Extreme Heat**– Western Regional Climate Center
- **Hail, Lightning, Tornado, Severe Wind, and Winter Storm –** Data provided by National Oceanic and Atmospheric Administration (NOAA) Storm Prediction Center.
- **Landslide, Mud/Debris Flow, and Rockfall** – Datasets of mapped landslides at various scales provided by the Colorado Geological Survey's Landslide Inventory Program
- **Space Weather –** NOAA's Space Weather Prediction Center

- **Wildfire** – Information on wildfire hazards areas was provided by the Colorado State Forest Service's Colorado Wildfire Risk Assessment Portal (CO-WRAP)

5.4.3 Limitations

Loss estimates, exposure assessments, and hazard-specific vulnerability evaluations rely on the best available data and methodologies. Uncertainties are inherent in any loss estimation methodology and arise in part from incomplete scientific knowledge concerning natural hazards and their effects on the built environment. Uncertainties also result from the following:

- Approximations and simplifications necessary to conduct a study
- Incomplete or outdated inventory, demographic, or economic parameter data
- The unique nature, geographic extent, and severity of each hazard
- Mitigation measures already employed
- The amount of advance notice residents have to prepare for a specific hazard event

These factors can affect loss estimates by a factor of two or more. Therefore, potential exposure and loss estimates are approximate. The results do not predict precise results and should be used only to understand relative risk. Over the long term, Clear Creek County and its planning partners will collect additional data to assist in estimating potential losses associated with other hazards.

Chapter 6.
CLEAR CREEK COUNTY PROFILE

Clear Creek County covers approximately 396 square miles and is located in central Colorado (see Figure 6-1). Clear Creek County was one of the original 17 counties created by the Colorado legislature on November 1, 1861, and is one of the only two counties to have persisted with its original boundaries unchanged. The county was named after Clear Creek, which runs down from the continental divide through the county. Idaho Springs was originally designated the county seat, but the county government was moved to Georgetown in 1867. According to the 2000 U.S. Census, the county had a population of 9,322.

Clear Creek County is surrounded by Jefferson County to the east, Gilpin County to the northeast, Park County to the south, Summit County to the west, and Grand County to the northwest. National protected areas within the county include: Pike National Forest, Roosevelt National Forest, James Peak Wilderness, and Mount Evans Wilderness. The county encompasses the mountain communities of Idaho Springs, Dumont, Downieville, Lawson, Empire, Georgetown, and Silver Plume.

Clear Creek County has a history of gold mining and tourist can travel to working mines and take part in panning for gold. The county also offers other tourism attractions, such as white water rafting, hiking, biking, fishing, ziplining, wildlife viewing, and the highest paved road in North America.

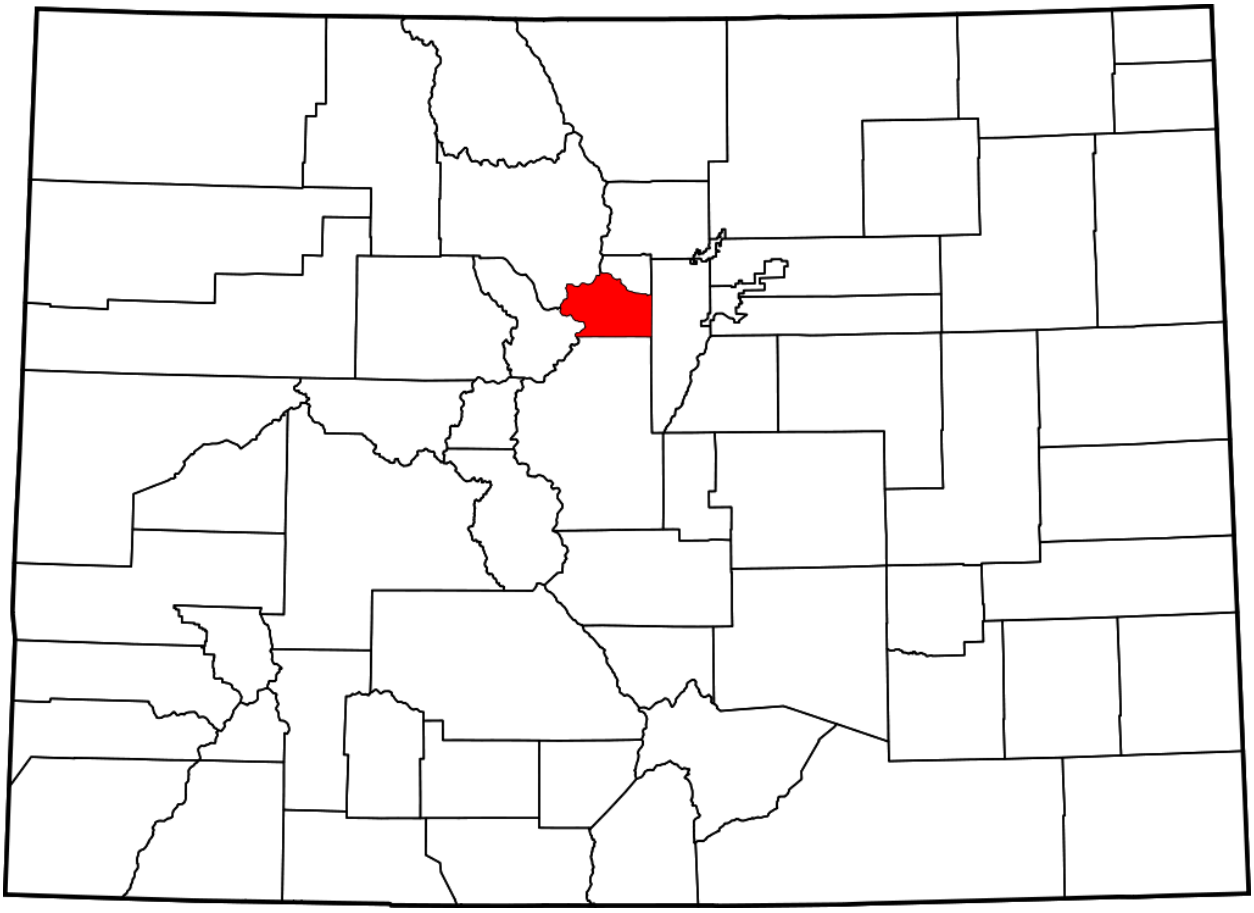


Figure 6-1. Location of the Clear Creek County Planning Area within the State of Colorado

6.1 HISTORICAL OVERVIEW

Clear Creek County was founded as a result of George Andrew Jackson's discovery of gold on January 7, 1859. Four months later, what is now Idaho Springs, was inundated with miners. The first settlement was two miles above Idaho Springs and was named Spanish Bar, due to evidence of earlier mining by Spaniards.

Mining districts were founded creating their laws and civil government in order to protect their claims from claim jumper, thieves, and other unlawful acts. On November 1, 1861, the territorial legislature of Colorado subdivided the territory into 17 counties and Idaho Springs was named county seat in the legislative act of establishment. Colorado Governor Gilpin appointed the first three county commissioners to organize the civil government of Clear Creek County. In November 1861, the commissioners met and divided the county into 7 voting precincts. The first county election resulted in elections for a sheriff, clerk and recorder, treasurer, assessor, county attorney, superintendent of schools, and a probate judge.

As more and more miners moved into the county, the prospecting moved west following Clear Creek, which runs most of the length of the county. John Dumont settled in the Mill City area. In 1860, the settlement was renamed Dumont, in honor of the founder, John M. Dumont. Shortly after, Dumont was awarded their first post office.

Further west, the Griffith brothers, David and George, were instrumental in settling Georgetown where they discovered the rich silver veins. The Griffith Mining District incorporated in June 1860. The miners established procedures for recording property transactions, settling boundary or mineral disputes, claim size, and a variety of civil laws: restrictions on timber harvesting, health regulations, etc. Shortly after the formation of the Griffith Mining District, several early residents joined together to form the "Georgetown Company," claiming 640 acres for a townsite. The commercial district was tagged "Main Street," a name which would continue into the 20th century. The center of the nascent town was roughly in the area of the Interstate 70 interchange, close to the present-day Rutherford Stables. In the fall of 1867, citizens of the area began meeting to discuss the formation of a town. In 1867, the Colorado Legislature called a special election and the county seat was moved from Idaho Springs to Georgetown. On January 28, 1868, the Territorial Legislature passed a law incorporating the Town of Georgetown.

Silver Plume is a Home Rule Town (as discussed further in Chapter 6.9.7) and was incorporated in 1880. Silver Plume is a former silver mining camp along Clear Creek in the Front Range of the Rocky Mountains. The federally designated Georgetown-Silver Plume National Historic District comprises Silver Plume, the neighboring Town of Georgetown, and the Georgetown Loop Historic Mining & Railroad Park between the two towns.

6.2 MAJOR PAST HAZARD EVENTS

Federal disaster declarations are typically issued for hazard events that cause more damage than state and local governments can handle without assistance from the federal government. However, no specific dollar loss threshold has been established for these declarations. A federal disaster declaration puts federal recovery programs into motion to help disaster victims, businesses, and public entities. Some of the programs are matched by state programs. The planning area has experienced 7 events since 1969 for which federal disaster declarations were issued. These events are listed in Table 6-1.

Review of these events helps identify targets for risk reduction and ways to increase a community's capability to avoid large-scale events in the future. Still, many natural hazard events do not trigger federal disaster declaration protocol but have significant impacts on their communities. These events are also important to consider in establishing recurrence intervals for hazards of concern. More detailed event tables can be found in the individual hazard profile sections.

TABLE 6-1.
FEDERAL DISASTER DECLARATIONS IN CLEAR CREEK COUNTY

Disaster Declaration[a]	Description	Incident Date
DR-4145	Severe Storms, Flooding, Landslides and Mudslides	09/14/2013
EM-3365	Severe Storms, Flooding, Landslides and Mudslides	09/12/2013
EM-3224	Hurricane Katrina Evacuation	09/05/2005
EM-3185	Snow	04/09/2003
DR-1421	Wildfires	06/19/2002
DR-1186	Severe Storms, Heavy Rain, Flash Floods, Flooding, Mudslides	08/01/1997
DR-261	Severe Storms and Flooding	05/19/1969

a. Federal disaster declarations are coded as follows: DR = Major Disaster Declaration; EM = Emergency Declaration

Source: FEMA Disaster Declarations Summary – Open Government Dataset (http://www.fema.gov/media-library/assets/documents/28318?id=6292)

U.S. Department of Agriculture's (USDA) Secretary of Agriculture is authorized to designate counties as disaster areas to make emergency loans (EM) to producers suffering losses in those counties and in counties that are contiguous to a designated county. In addition to EM eligibility, other emergency assistance programs, such as Farm Service Agency (FSA) disaster assistance programs, have historically used disaster designations as an eligibility requirement trigger.

Table 6-2 provides the USDA Secretarial disaster declarations that included Clear Creek County from the recent years of 2012 - 2015. These include declarations in Clear Creek County and when the county is contiguous to a designated county. Prior years of historic disaster declarations can be requested from USDA.

TABLE 6-2.
USDA SECRETARIAL DISASTER DECLARATIONS IN CLEAR CREEK COUNTY 2012-2015

Disaster Number[a]	Crop Disaster Year	Cause
S3260	2012	Drought, High Winds, & Heat
S3456	2013	Drought, High Winds, Wildfire, Heat, & Insects
S3548	2013	Drought, High Winds, Wildfire, Heat, & Insects

a. Secretarial Disaster Number

Source: U.S. Department of Agriculture, (http://www.fsa.usda.gov/programs-and-services/disaster-assistance-program/index)

6.3 CLIMATE

Weather in Clear Creek County is fairly moderate and can vary drastically throughout the county. In summer, the day temperature ranges from 60 to 80 degrees Fahrenheit (°F). The county experiences an average of 300 days of sunshine per year. In winter, the day temperature ranges from 20 to 45°F with an average snowfall ranging from 70 inches in lower lying areas to 400 inches at Loveland Ski Resort.

The Western Regional Climate Center reports data from the Town of Georgetown weather station in Clear Creek County. Table 6-3 contains temperature summaries for the station. Figure 6-2 graphs the daily temperature averages and extremes from 1893 through 2015 for the Town of Georgetown. Figure 6-3 and Figure 6-4 show the geographic distribution of annual average minimum and maximum temperatures in Clear Creek County.

TABLE 6-3.
CLEAR CREEK COUNTY TEMPERATURE SUMMARY GEORGETOWN STATION

Period of record	1893-2012
Winter[a] Average Minimum Temperature	15.9°F
Winter[a] Mean Temperature	26.5ºF
Summer[a] Average Maximum Temperature	75.1°F
Summer[a] Mean Temperature	60.5ºF
Maximum Temperature	92°F; June 23, 1954
Minimum Temperature	-28°F; January 4, 1972
Average Annual Number of Days >90°F	0.2
Average Annual Number of Days <32°F	87.2

a. Winter: December, January, February; Summer: June, July, August

ºF degrees Fahrenheit

Source: Southern Regional Climate Center (www.srcc.lsu.edu/)

Source: Western Regional Climate Center, www.srcc.lsu.edu/

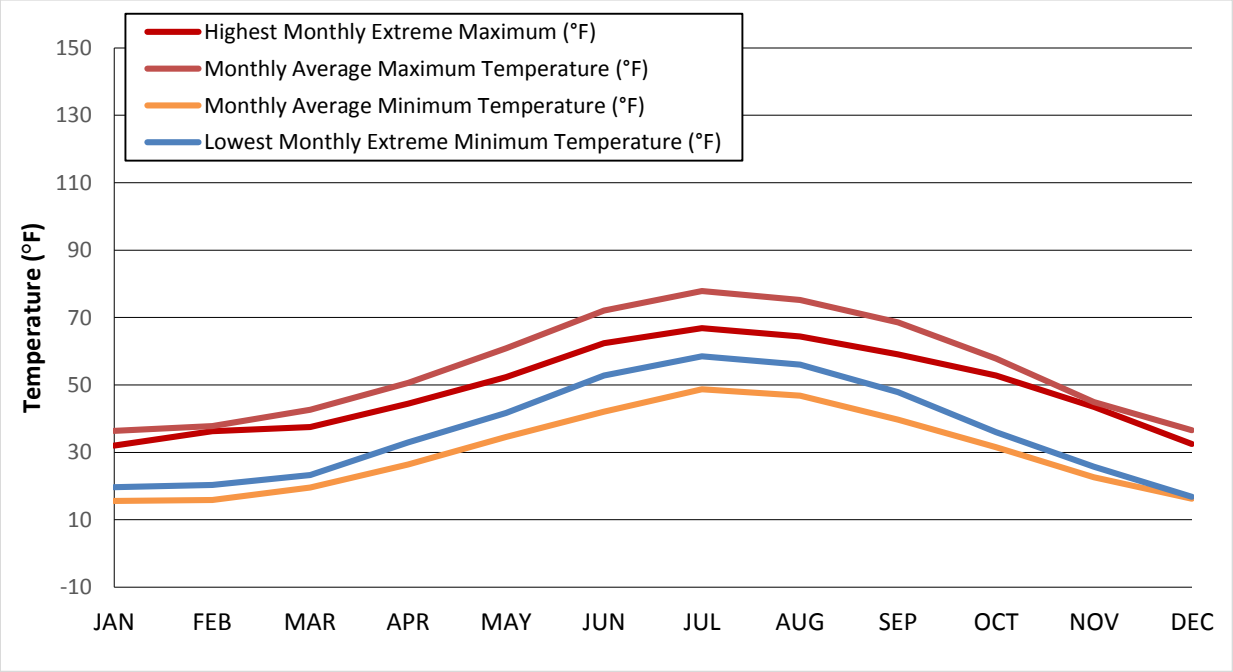


Figure 6-2. Georgetown Station Monthly Temperature Data (1893–2015)

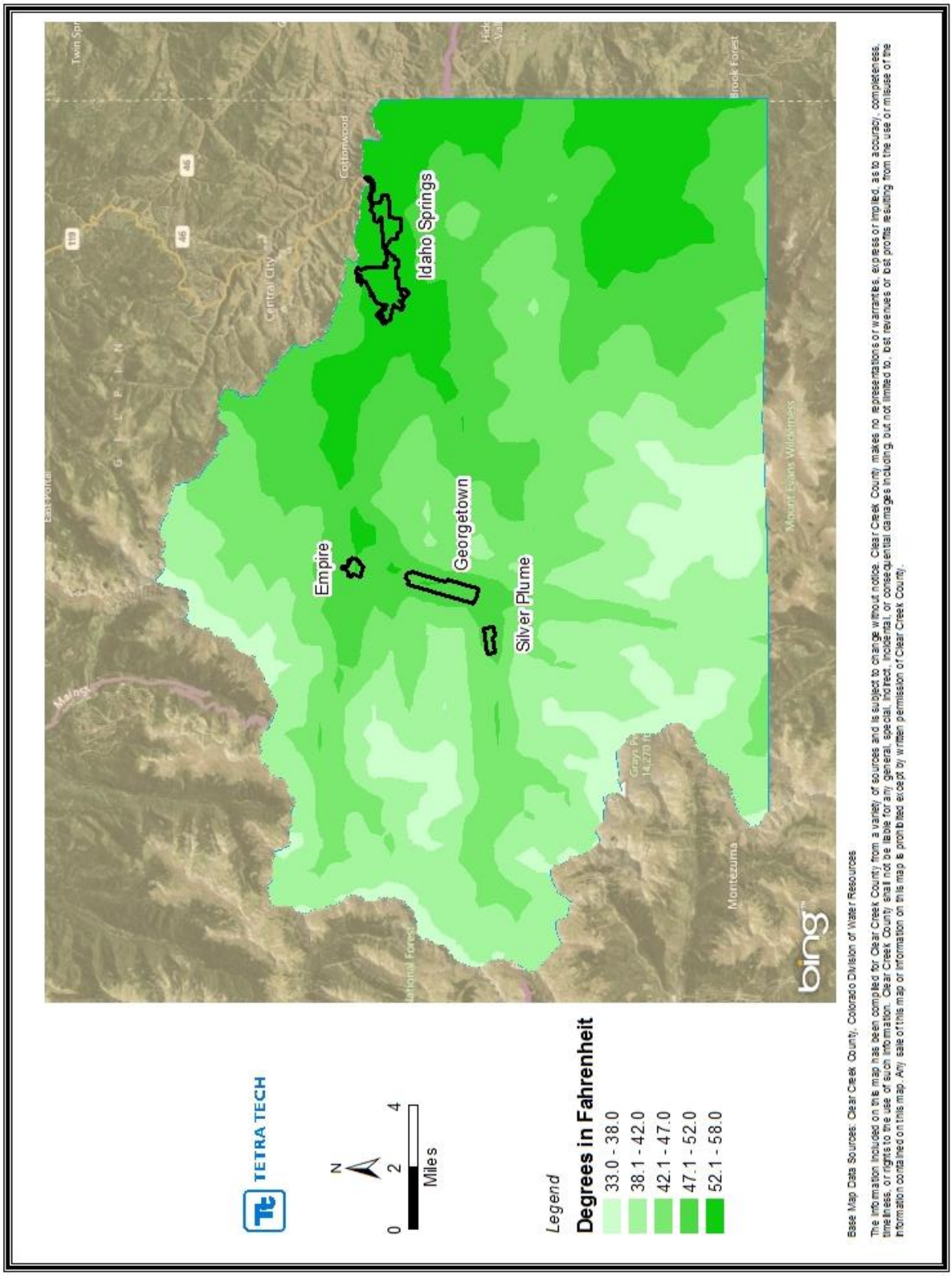


Figure 6-3. Annual Average Maximum Temperature (1981-2010)

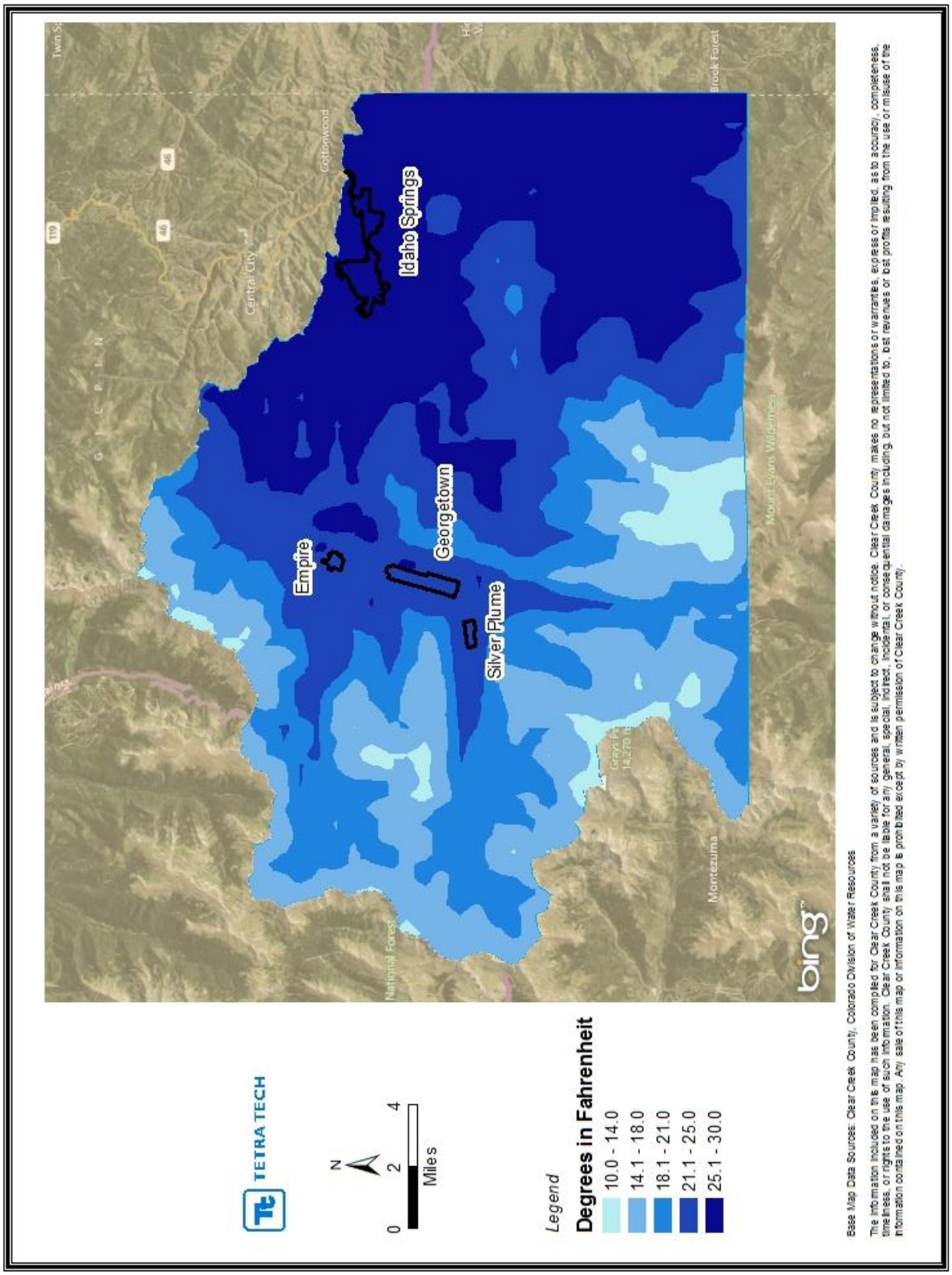


Figure 6-4. Annual Average Minimum Temperature (1981-2010)

Precipitation is highest during July and August. The average annual precipitation is 16.44 inches of rain and 92.8 inches of snowfall. Severe thunderstorm occur mostly in the summer. Based on information from NOAA, Colorado receives an average of 520,833 cloud-to-ground lightning strikes per year. Figure 6-5 shows the average monthly precipitation of rainfall in Clear Creek County. Figure 6-6 shows geographic distribution of annual average precipitation in Clear Creek County compared to the State of Colorado.

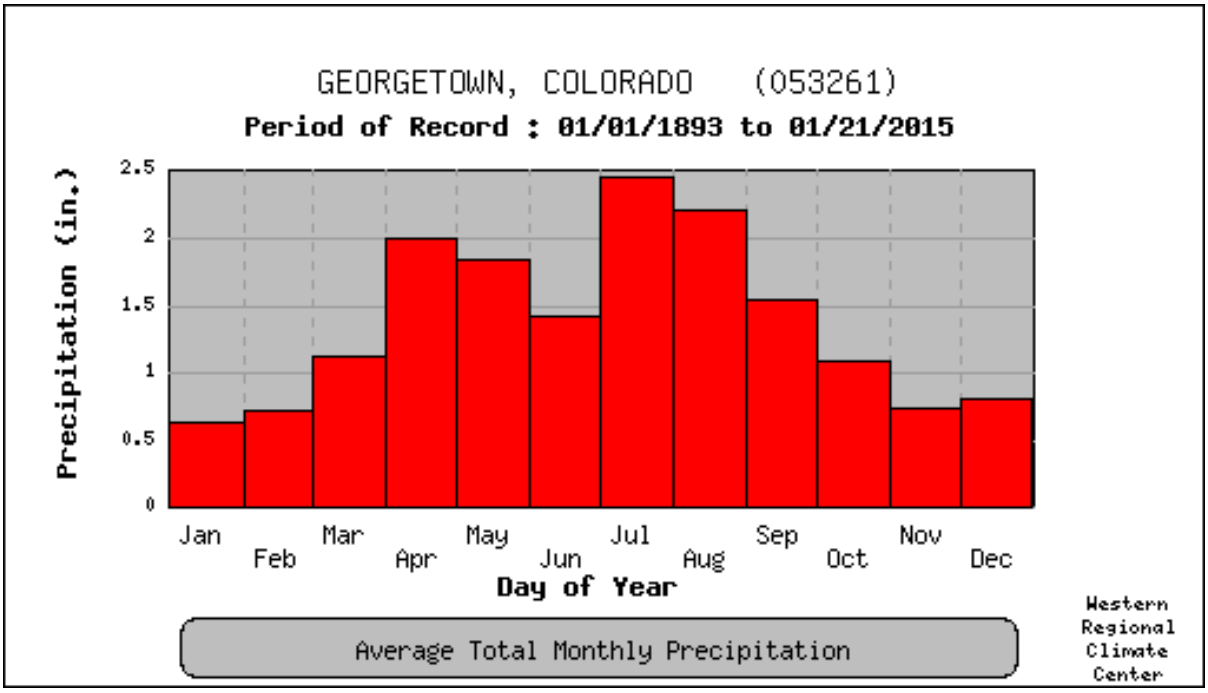


Figure 6-5. Average Monthly Rainfall Precipitation for Clear Creek County (1893-2015)

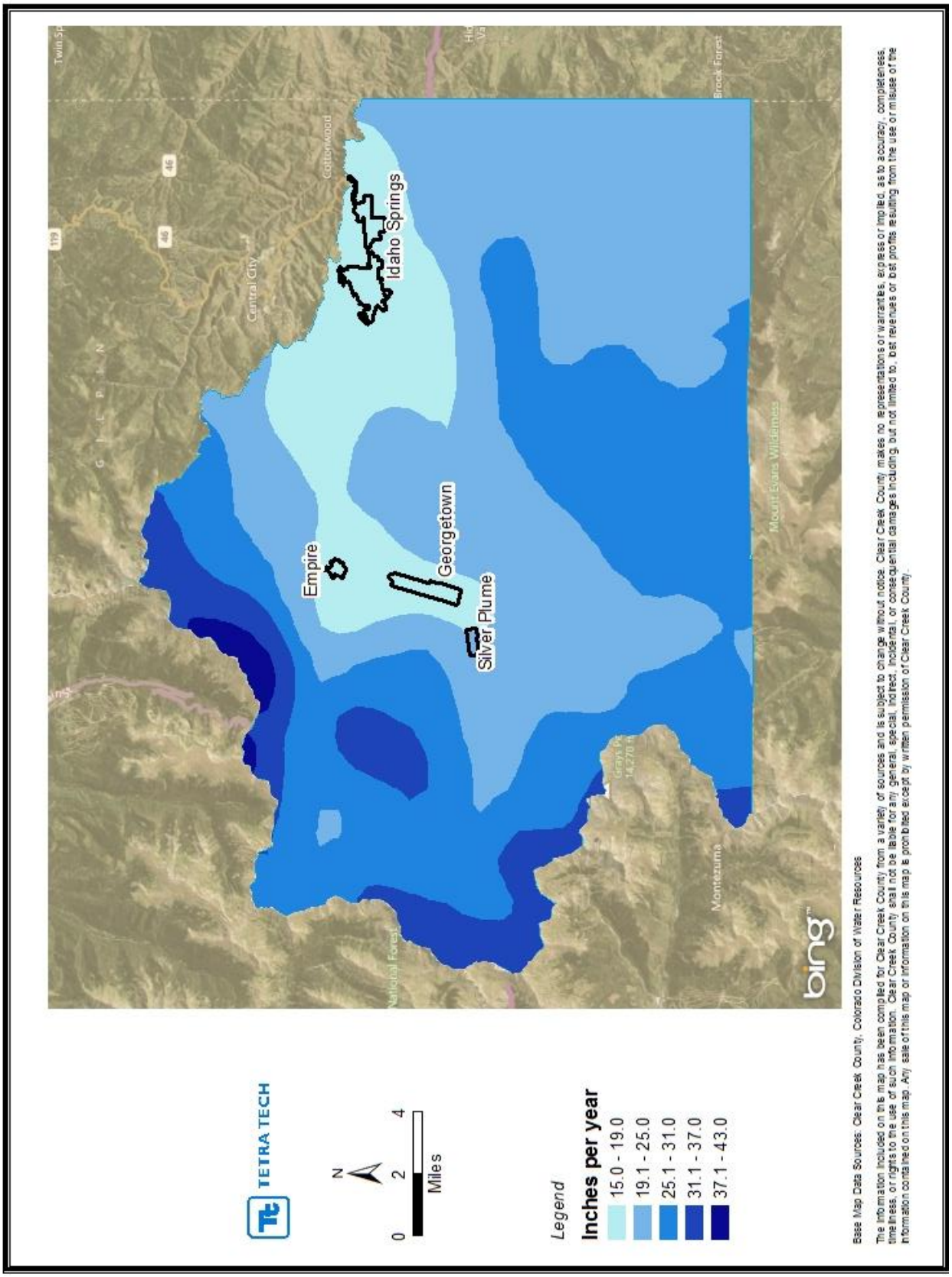


Figure 6-6. Geographic Distribution of Annual Average Precipitation (1981-2010)

6.4 GEOLOGY AND SOILS

Gold ore was discovered in 1859 near the mouth of the Chicago Creek. This discovery led to the spread of searches along the area of Trail Creek. Gold, silver, copper, zinc and lead was mined until 1952. Igneous rocks and metasedimentary rocks of Precambrian age can be found throughout the planning area. Schist of Precambrian age predominates in the Idaho Springs region of Clear Creek County; numerous lenses of granite gneiss and pegmatite can be found as well. Tertiary-aged dikes, sills, and irregular bodies of pegmatite are also scattered throughout the Idaho Springs region.

The geology is similar around Empire; tertiary stocks of quartz monozonite and dikes of bostonite and alaskite intrude into the terrain of Idaho Springs Precambrian metamorphic rocks. Gold and copper were the primary products mined. Around Georgetown, the most intrusive rocks are Silver Plume Granite with the Idaho Springs Precambrian metamorphic rocks. Tertiary stocks and dikes of various compositions are abundant in the area. Mineralization occurs in two types of silver, lead, zinc veins and veins of pyritic gold.

6.5 CRITICAL FACILITIES AND INFRASTRUCTURE

Critical facilities and infrastructure are essential to the health and welfare of the population. These assets become especially important after a hazard event. As defined for this hazard mitigation plan update, critical facilities include but are not limited to the following (as defined by the Colorado Water Conservation Board [CWCB]):

- Essential services facilities:
  - Public safety facilities (police stations, fire and rescue stations, emergency vehicle and equipment storage, and, emergency operation centers)
  - Emergency medical facilities (hospitals, ambulance service centers, urgent care centers having emergency treatment functions, and non-ambulatory surgical structures but excluding clinics, doctors' offices, and non-urgent care medical structures that do not provide these functions)
  - Designated emergency shelters
  - Communications (main hubs for telephone, broadcasting equipment for cable systems, satellite dish systems, cellular systems, television, radio, and other emergency warning systems, but excluding towers, poles, lines, cables, and conduits)
  - Public utility plant facilities for generation and distribution (hubs, treatment plants, substations and pumping stations for water, power and gas, but not including towers, poles, power lines, buried pipelines, transmission lines, distribution lines, and service lines)
  - Air transportation lifelines (airports [municipal and larger], helicopter pads and structures serving emergency functions, and associated infrastructure [aviation control towers, air traffic control centers, and emergency equipment aircraft hangars])
- Hazardous materials facilities:
  - Chemical and pharmaceutical plants
  - Laboratories containing highly volatile, flammable, explosive, toxic, or water-reactive materials
  - Refineries
  - Hazardous waste storage and disposal sites
  - Aboveground gasoline or propane storage or sales centers
- At-risk population facilities:

  - Elder care centers (nursing homes)
  - Congregate care serving 12 or more individuals (day care and assisted living)
  - Public and private schools (pre-schools, K-12 schools, before-school and after-school care serving 12 or more children)
- Facilities vital to restoring normal services:
  - Essential government operations (public records, courts, jails, building permitting and inspection services, community administration and management, maintenance and equipment centers)
  - Essential structures for public colleges and universities (dormitories, offices, and classrooms only)

Table 6-4 and Table 6-5 summarize the critical facilities and infrastructure in each municipality and unincorporated county areas. This information was obtained from HAZUS-MH, county assessor data, or from community personnel.

TABLE 6-4.
CRITICAL FACILITIES IN THE PLANNING AREA

Facility Type	City of Idaho Springs	Town of Empire	Town of Georgetown	Town of Silver Plume	Unincorporated or Other	**Total**
Fire Stations	1	1	1	0	3	**6**
Police Stations	1	0	1	0	0	**2**
Medical and Health	0	0	0	0	0	**0**
School	1	0	1	0	4	**6**
Hazardous Materials	12	2	1	0	13	**28**
Government Functions	1	1	4	1	1	**8**
Total	**16**	**4**	**8**	**1**	**21**	**50**

TABLE 6-5.
CRITICAL INFRASTRUCTURE IN THE PLANNING AREA

Facility Type	City of Idaho Springs	Town of Empire	Town of Georgetown	Town of Silver Plume	Unincorporated or Other	**Total**
Communication	1	0	0	0	3	**4**
Power Facility	0	0	0	0	0	**0**
Wastewater Facility	1	0	1	0	1	**3**
Potable Water Facility	1	0	1	0	0	**2**
Dam Location	0	0	1	0	24	**25**
Airport Facility	0	0	0	0	0	**0**
Bridge	18	1	5	0	55	**79**
Total	**21**	**1**	**8**	**0**	**83**	**113**

Figure 6-7 and Figure 6-8 show the location of critical facilities in the county; Figure 6-9 and Figure 6-10 show the location of critical facilities in the City of Idaho Springs; and Figure 6-11and Figure 6-12 show the location of critical facilities in the Towns of Empire, Georgetown, and Silver Plume. Due to the sensitivity of this information, a detailed list of facilities is not provided. The list is on file with each planning partner. Critical facilities and transportation were analyzed in HAZUS to help rank risk and identify mitigation actions. The risk assessment for each hazard discusses critical facilities with regard to that hazard.

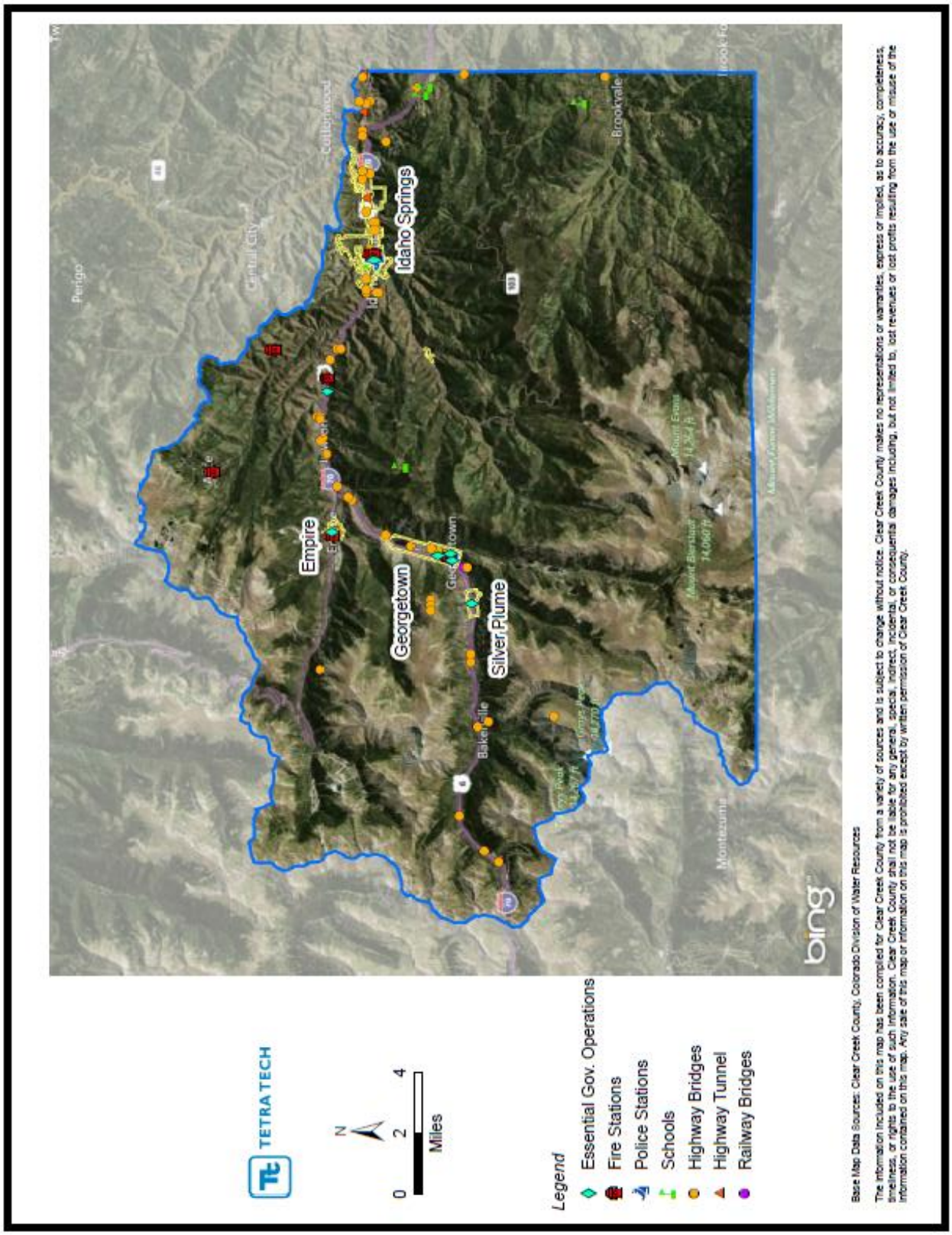


Figure 6-7. Critical Facilities and Infrastructure in Clear Creek County

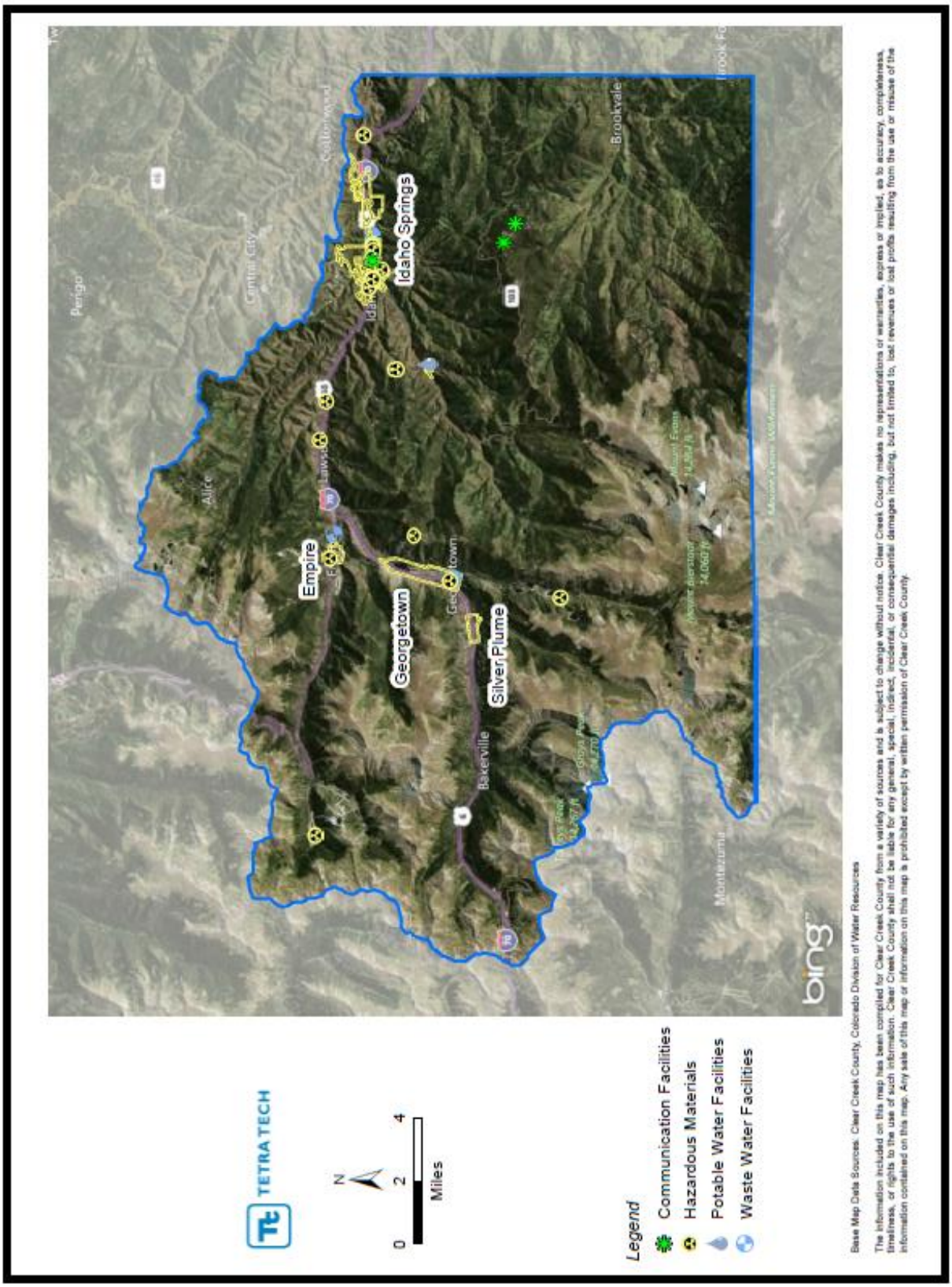


Figure 6-8. Critical Hazardous Materials and Utilities in Clear Creek County

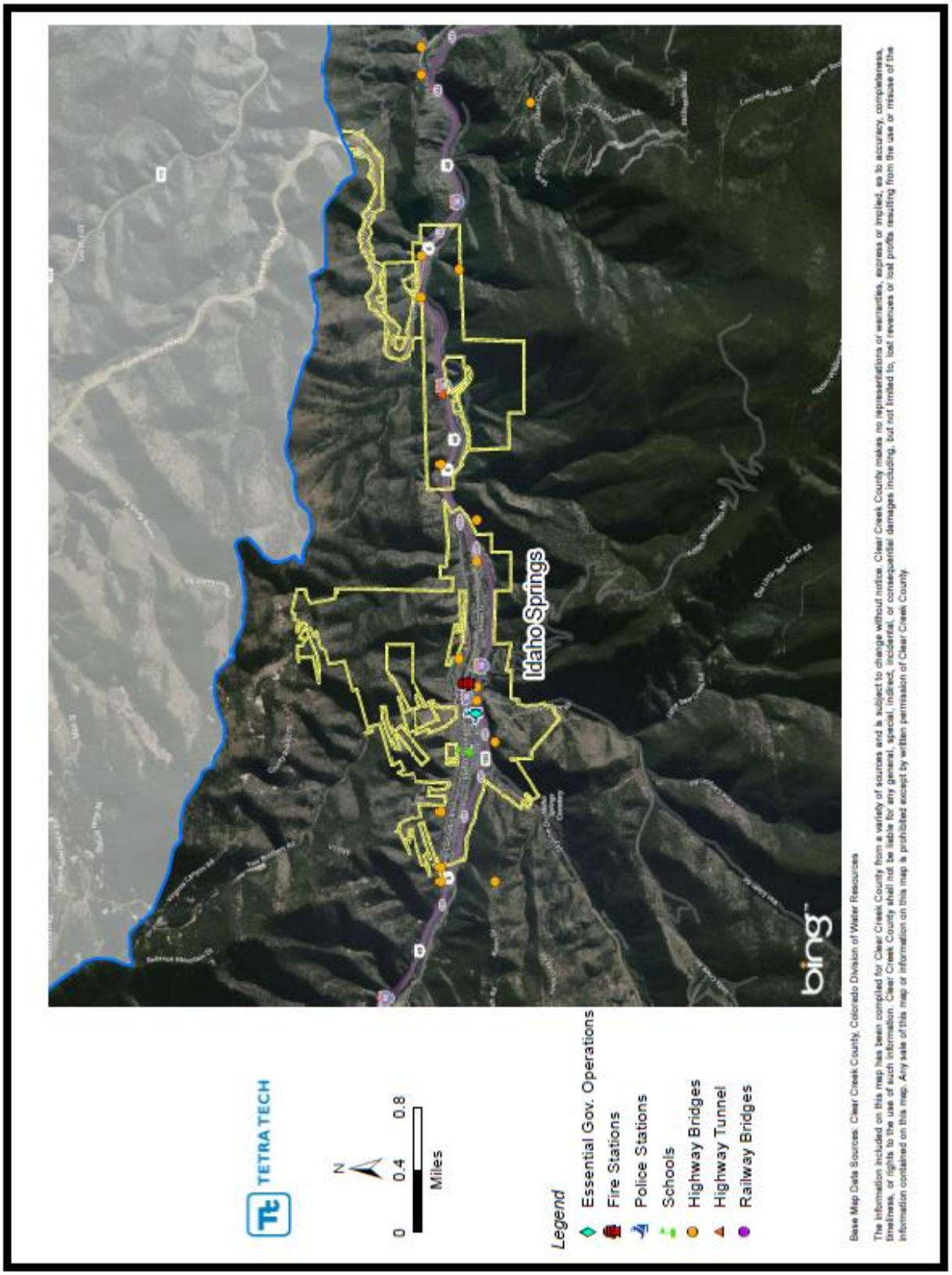


Figure 6-9. Critical Facilities and Infrastructure in the City of Idaho Springs

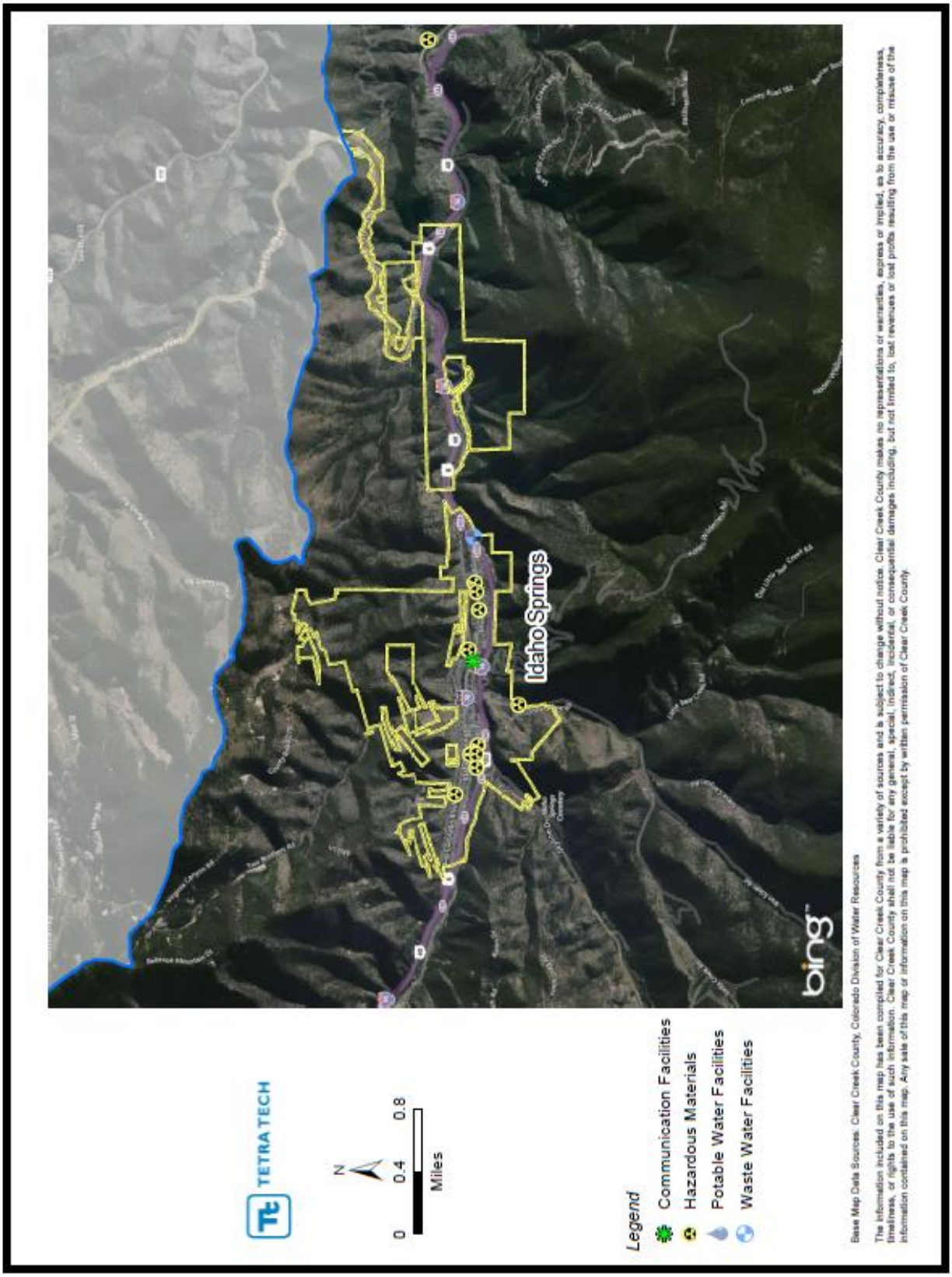


Figure 6-10. Critical Hazardous Materials and Utilities in the City of Idaho Springs

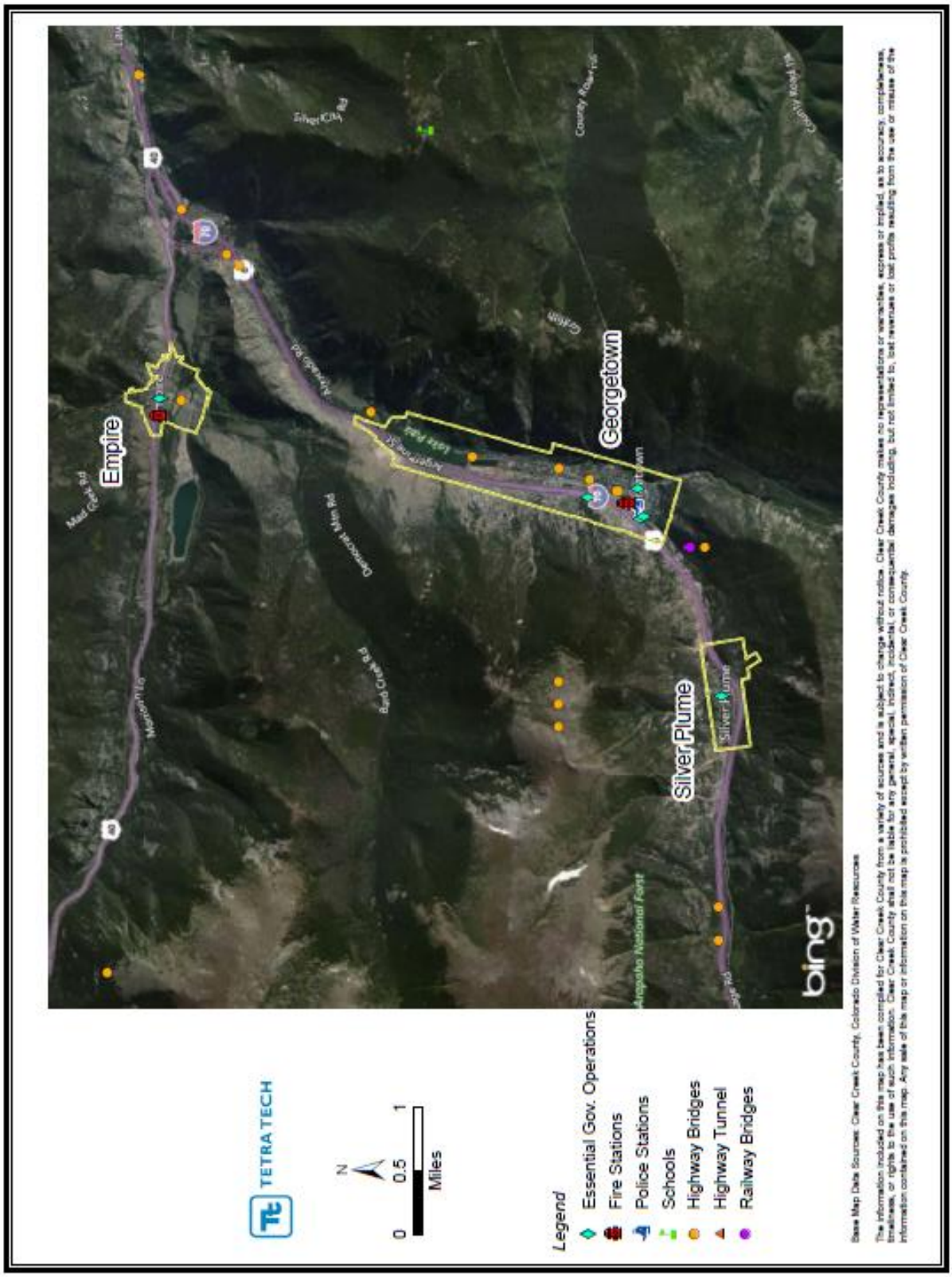


Figure 6-11. Critical Facilities and Infrastructure in the Towns of Empire, Georgetown, and Silver Plume

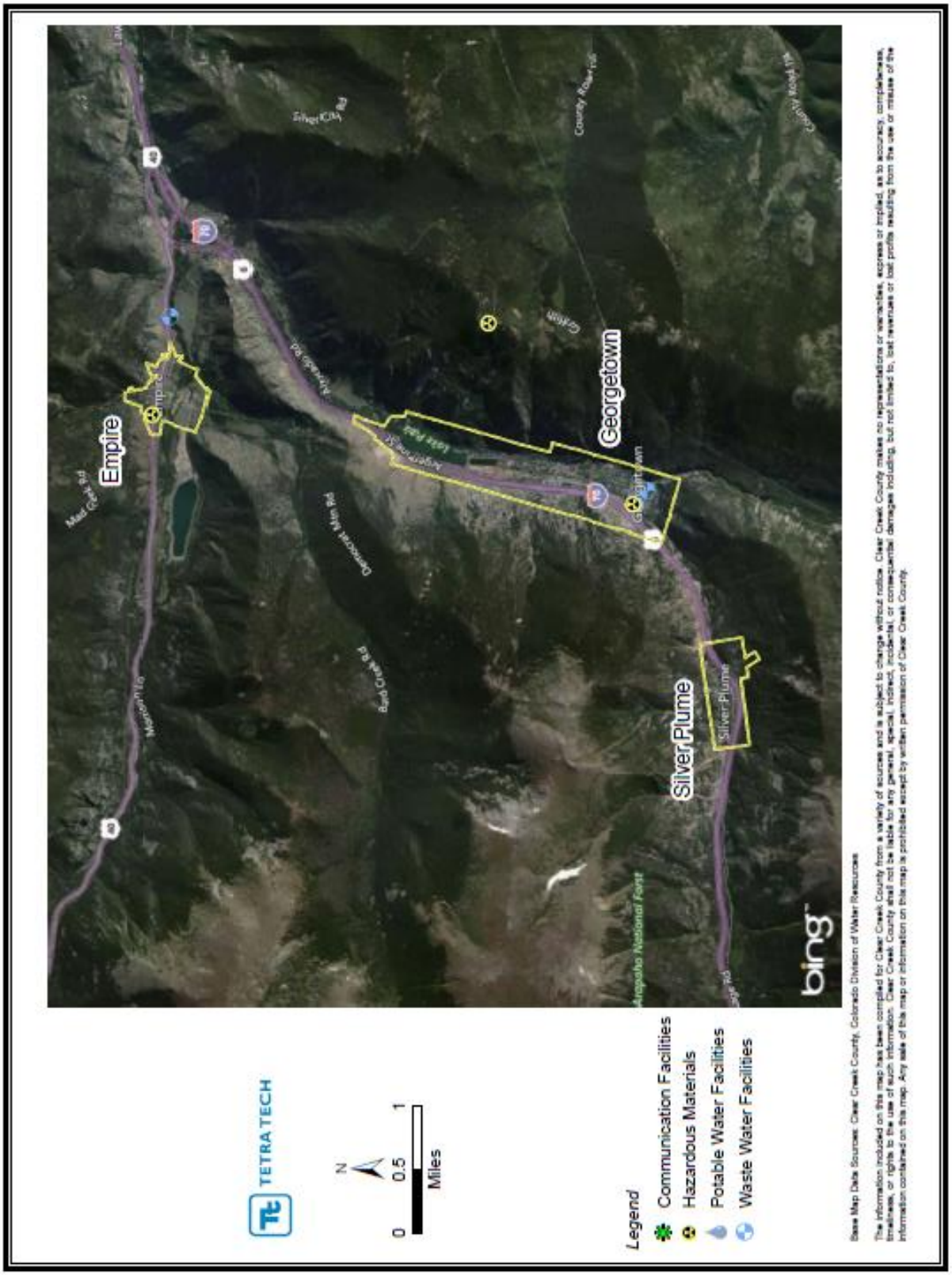


Figure 6-12. Critical Hazardous Materials and Utilities in the Towns of Empire, Georgetown, and Silver Plume

6.6 DEMOGRAPHICS

Information on current and historic population levels and future population projections is needed for making informed decisions about future planning. Population directly relates to land needs such as housing, industry, stores, public facilities and services, and transportation. Population changes are useful socio-economic indicators, as a growing population generally indicates a growing economy, and a decreasing population signifies economic decline.

Some populations are at greater risk from hazard events because of decreased resources or physical abilities. Elderly people, for example, may be more likely to require additional assistance. Research has shown that people living near or below the poverty line, the elderly (especially older single men), the disabled, women, children, ethnic minorities and renters all experience, to some degree, more severe effects from disasters than the general population. These vulnerable populations may vary from the general population in risk perception; living conditions; access to information before, during and after a hazard event; capabilities during an event; and access to resources for post-disaster recovery. Indicators of vulnerability—such as disability, age, poverty, and minority race and ethnicity—often overlap spatially and often in the geographically most vulnerable locations. Detailed spatial analysis to locate areas where there are higher concentrations of vulnerable community members would assist the county in extending focused public outreach and education to these most vulnerable citizens. Select 2010 U.S. Census demographic and social characteristics for Clear Creek County are shown in Table 6-6.

TABLE 6-6.
CLEAR CREEK COUNTY DEMOGRAPHIC AND SOCIAL CHARACTERISTICS (2010)

	Clear Creek County	City of Idaho Springs	Town of Empire	Town of Georgetown	Town of Silver Plume
Gender/Age (% of Total Population)					
Male	52.1	51.3	53.9	52.1	56.5
Female	47.9	48.7	46.1	47.9	43.5
Under 5 years	4.9	5.6	2.8	4.0	4.1
65 years and over	12.5	14.1	11.0	13.6	10.1
Race/Ethnicity (% of Total Population)					
White	95.3	95.0	94.3	93.9	92.9
American Indian/Alaska Native	0.5	0.8	0.4	1.2	2.4
Asian	0.8	0.5	0	0.8	0.6
Black or African American	0.0	0.4	1.8	1.4	0.0
More Than One Race	2.1	1.9	1.1	1.6	1.8
Hispanic or Latino (of any race)[1]	4.2	6.0	3.9	8.4	2.9
Education (% of Total Population, 25+ years)					
High school graduate or higher	96.9	94.2	93.5	93.5	97.4

Source: 2010 U.S. Census data and U.S. Census Bureau, factfinder.census.gov

[1]The U.S. Census Bureau considers the Hispanic/Latino designation an ethnicity, not a race. The population self-identified as "Hispanic/Latino" is also represented within the categories in the "Race" demographic.

6.6.1 Population

The U.S. Census Bureau estimated the Clear Creek County population at 9,187 as of July 2014. Table 6-7 shows planning area population data from 1990 through 2013. The total Clear Creek County population increased 22% from 1990 to 2000, and decreased by 3% from 2000 to 2013.

TABLE 6-7.
CLEAR CREEK COUNTY POPULATION

	Total Population			
	1990	2000	2010	2013
City of Idaho Springs	1,874	1,931	1,719	1,685
Town of Empire	413	354	281	276
Town of Georgetown	892	1,093	1,036	1,028
Town of Silver Plume	134	202	170	166
Unincorporated Areas[1]	4,319	5,730	5,897	5,876
County Total	**7,632**	**9,310**	**9,103**	**9,031**

Source: United States Census Bureau
http://www.census.gov/popest/about/terms.html

[1]Includes non-participating communities

The City of Idaho Springs and the Town of Georgetown are the county's principal population centers. However, the majority of county residents live outside the incorporated areas and this percentage continues to decrease. In 2000, 36.3% of the county's residents lived outside the incorporated areas, compared to 33.4% in 2010, and 33.1% in 2013.

Figure 6-13 shows 5-year population changes in the planning area and the State of Colorado from 1990 to 2010 and the 3-year change from 2010 to 2013. Between 1990 and 2013, the State of Colorado's population grew by 59.4% (about 2.6% per year) while the planning area's population increased by 18.3% (0.8% per year).

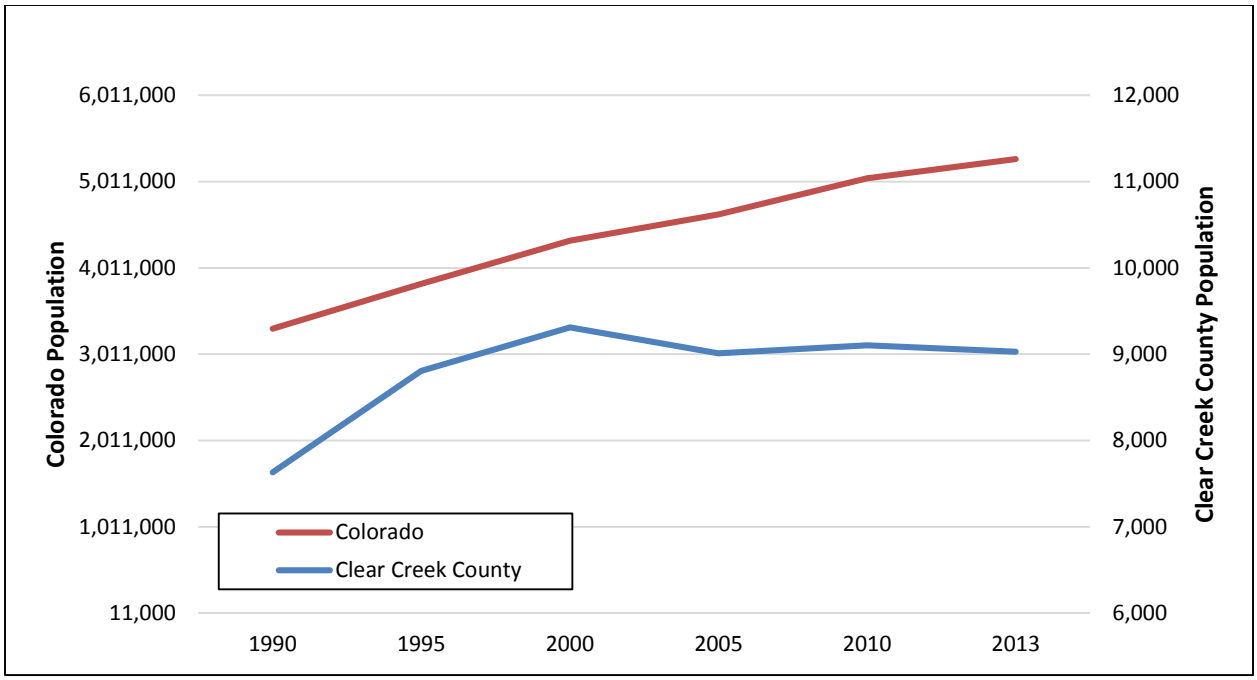


Figure 6-13. State of Colorado and Planning Area Population Growth

6.6.2 Age Distribution

As a group, the elderly are more apt to lack the physical and economic resources necessary for response to hazard events and are more likely to suffer health-related consequences making recovery slower. They are more likely to be vision, hearing, or mobility impaired, and more likely to experience mental impairment or dementia. Additionally, the elderly are more likely to live in assisted-living facilities where emergency preparedness occurs at the discretion of facility operators. These facilities are typically identified as "critical facilities" by emergency managers because they require extra notice to implement evacuation. Elderly residents living in their own homes may have more difficulty evacuating their homes and could be stranded in dangerous situations. This population group is more likely to need special medical attention, which may not be readily available during natural disasters due to isolation caused by the event. Specific planning attention for the elderly is an important consideration given the current aging of the national population.

Children under 14 are particularly vulnerable to disaster events because of their young age and dependence on others for basic necessities. Very young children may additionally be vulnerable to injury or sickness; this vulnerability can be worsened during a natural disaster because they may not understand the measures that need to be taken to protect themselves from hazards.

The overall age distribution for the planning area is illustrated in Figure 6-14. Based on 2013 U.S. Census data estimates, 14.1% of the planning area's population is 65 or older. U.S. Census data does not provide information regarding disabilities in the planning area's over-65 population. U.S. Census estimates for 2013 indicate that 8.6% of Clear Creek County families have children under 18 and are below the poverty line.

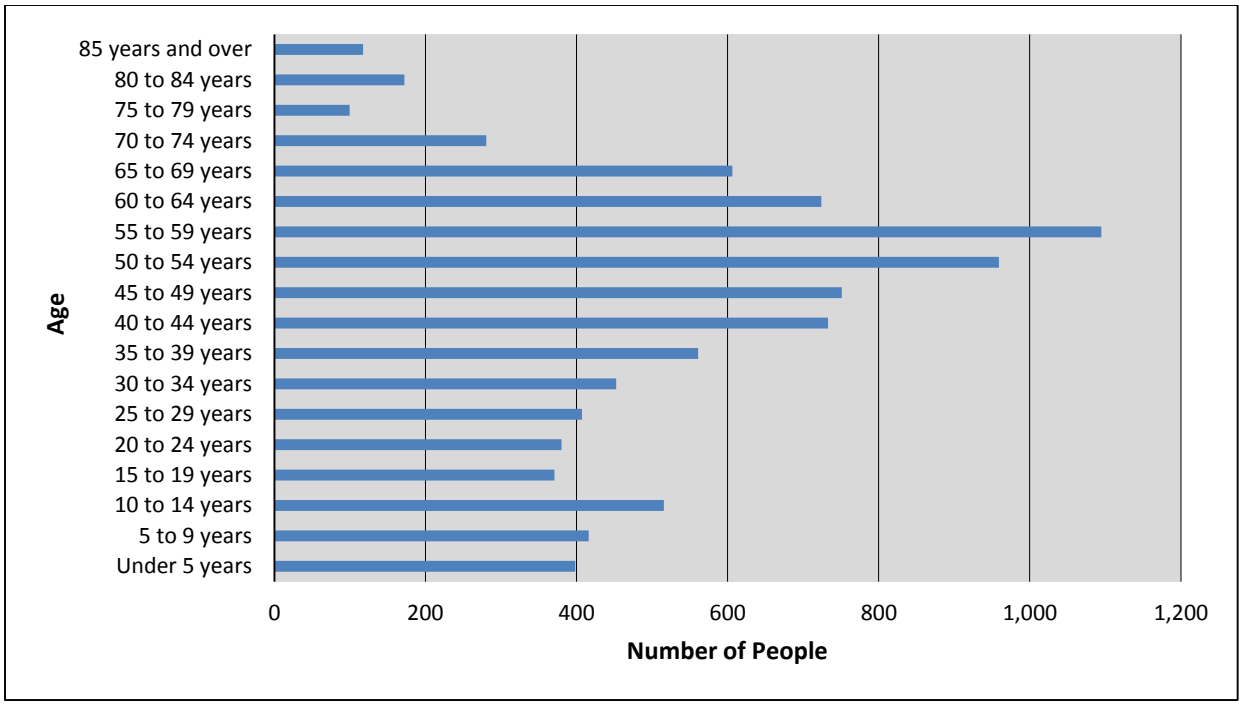


Figure 6-14. Clear Creek County Age Distribution

6.6.3 Disabled Populations

The 2010 U.S. Census estimated that 57 million non-institutionalized Americans with disabilities live in the U.S. This equates to about one-in-five persons. People with disabilities are more likely to have difficulty responding to a hazard event than the general population. Local government is the first level of response to assist these individuals, and coordination of efforts to meet their access and functional needs is paramount to life safety efforts. It is important for emergency managers to distinguish between functional and medical needs in order to plan for incidents that require evacuation and sheltering. Knowing the percentage of population with a disability will allow emergency management personnel and first responders to have personnel available who can provide services needed by those with access and functional needs. According to the 2013 American Community Survey 5-year Estimates, 19.2% of the population in the planning area lives with some form of disability.

6.6.4 Ethnic Population

Research shows that minorities are less likely to be involved in pre-disaster planning and experience higher mortality rates during a disaster event. Post-disaster recovery can be less effective for ethnic populations and is often characterized by cultural insensitivity. Since higher proportions of ethnic minorities live below the poverty line than the majority white population, poverty can compound vulnerability. According to the 2010 U.S. Census, the ethnic composition of the planning area is predominantly white, at about 95.3%. The largest minority population is Hispanic or Latino at 4.2%.

Figure 6-15 shows the population distribution by race and ethnicity in the planning area. The values shown on the figure exceed 100% because Hispanic or Latino is listed as an ethnicity, not a race, by the U.S. Census. Therefore, Hispanic or Latino encompasses several races.

Source: 2010 U.S. Census

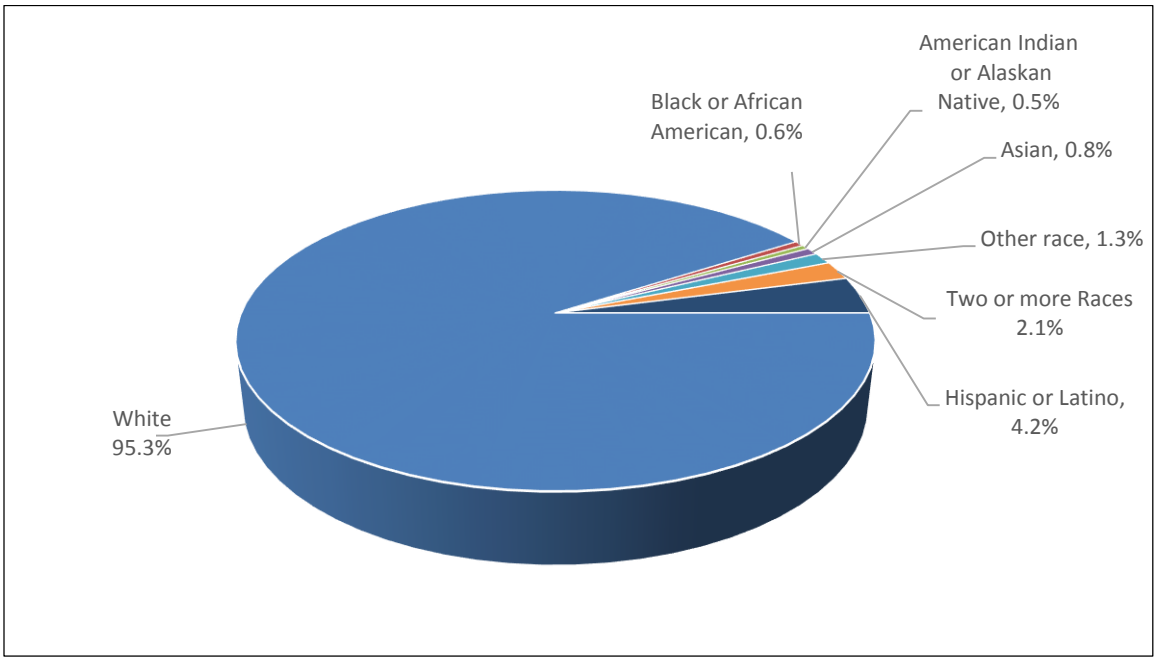


Figure 6-15. Clear Creek County Ethnic Distribution

According to the 2010 U.S. Census, the planning area has a 3.1% foreign-born population. Other than English, the most commonly spoken language in the planning area is Spanish. The 2010 U.S. Census estimates 1.1% of the residents speak English "less than very well."

6.7 ECONOMY

Select 2013 economic characteristics estimated for Clear Creek County by the U.S. Census Bureau are shown in Table 6-8.

TABLE 6-8.
CLEAR CREEK COUNTY ECONOMIC CHARACTERISTICS

	Clear Creek County	City of Idaho Springs	Town of Empire	Town of Georgetown	Town of Silver Plume
Families Below Poverty Level	5.3%	3.7%	4.7%	4.0%	0%
Individuals Below Poverty Level	10.2%	15.9%	15.9%	7.3%	14.4%
Median Home Value	$256,200	$187,600	$159,000	$201,900	$176,100
Median Household Income	$67,259	$51,118	$38,929	$66,625	$45,208
Per Capita Income	$41,716	$28,722	$26,070	$34,174	$26,621
Population >16 Years Old in Labor Force	72.6%	76.8%	71.5%	67.4%	83.4%
Population Employed	67.1%	69.7%	68.8%	61.6%	72.3%

Source: U.S. Census 2013 data from factfinder.census.gov; www.city-data.com

6.7.1 Income

In the United States, individual households are expected to use private resources to some extent to prepare for, respond to, and recover from disasters. This means that households living in poverty are automatically disadvantaged when confronting hazards. Additionally, the poor typically occupy more poorly built and inadequately maintained housing. Mobile or modular homes, for example, are more susceptible to damage in earthquakes and floods than other types of housing. In urban areas, the poor often live in older houses and apartment complexes, which are more likely to be made of un-reinforced masonry, a building type that is particularly susceptible to damage during earthquakes. Furthermore, residents below the poverty level are less likely to have insurance to compensate for losses incurred from natural disasters. This means that residents below the poverty level have a great deal to lose during an event and are the least prepared to deal with potential losses. The events following Hurricane Katrina in 2005 illustrated that personal household economics significantly impact people's decisions on evacuation. Individuals who cannot afford gas for their cars will likely decide not to evacuate.

Based on U.S. Census Bureau estimates, per capita income in the planning area in 2013 was $41,716 and the median household income was $67,259. It is estimated that about 27.6% of households have an annual income between $100,000 and $149,999 and 17.5% have an annual income above $150,000. Families with incomes below the poverty level in 2013 made up 5.3% of all families and 10.2% of the total county population.

6.7.2 Employment Trends

According to the U.S. Bureau of Labor Statistics, Clear Creek County's unemployment rate as of December 2014 was 3.6%, compared to a statewide rate of 4.2%. Figure 6-16 compares the State of Colorado and Clear Creek County's unemployment trends from 2000 through 2014. Clear Creek County's unemployment rate was lowest in 2000 at 2.3% and peaked in 2010 at 8.4%.

Source: U.S. Bureau of Labor Statistics, 2014

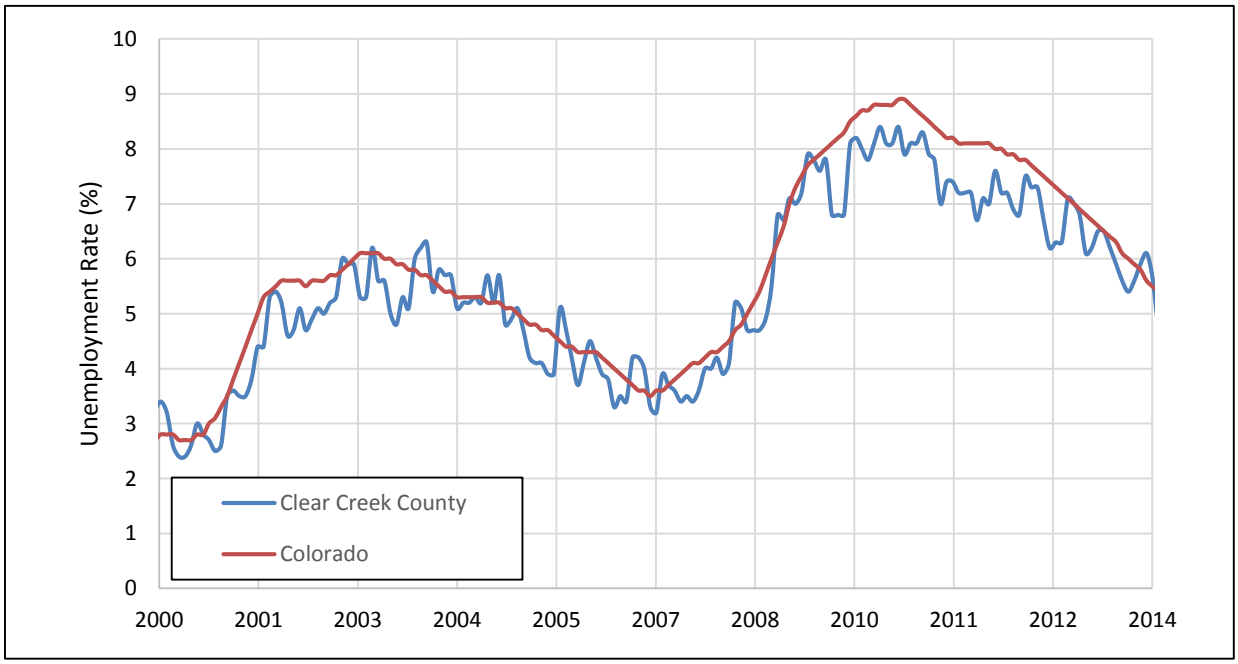


Figure 6-16. State of Colorado and Clear Creek County Unemployment Rate (2000-2014)

According to the American Community Survey, 72.6% of Clear Creek County's population 16 years and older is in the labor force.

6.7.3 Occupations and Industries

According to 2013 U.S. Census data, the planning area's economy is based in the professional, scientific management, administrative, and waste management services (14% of total employment), arts, entertainment, recreation, and accommodation and food services (14%), and education, health care, and social assistance industries (13%). Figure 6-17 shows the distribution of industry types in Clear Creek County, based on share of total employment.

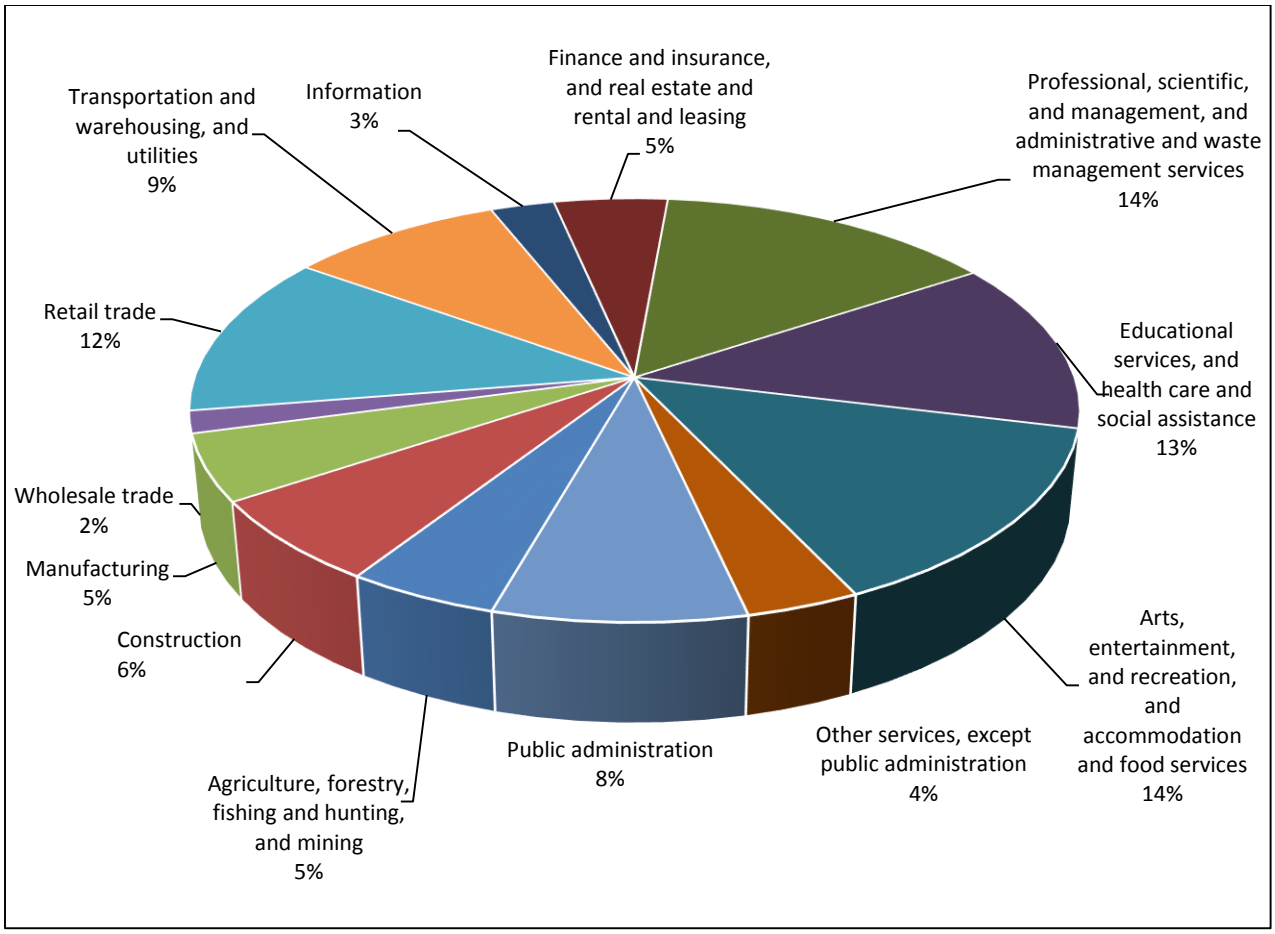


Figure 6-17. Percent of Total Employment by Industry in Clear Creek County

6.8 FUTURE TRENDS IN DEVELOPMENT

The municipal planning partners have adopted plans that govern land use decision and policy making in their jurisdictions. Decisions on land use will be governed by these programs. This plan will work together with these programs to support wise land use in the future by providing vital information on the risk associated with natural hazards in the planning area.

It is the goal that all municipal planning partners will incorporate this hazard mitigation plan update in their comprehensive plans (if applicable) by reference. This will help ensure that future development trends can be established with the benefits of the information on risk and vulnerability to natural hazards identified in

this plan. Table 6-9 lists the present land use in Clear Creek County. Clear Creek County consists primarily of grassland/prairie and forest.

TABLE 6-9.
PRESENT LAND USE IN PLANNING AREA

Present Use Classification	Area (acres)	% of Total Land Area
Agriculture	210	<0.1
Developed, Open Space	2,379	1.1
Developed, High Intensity	35	<0.1
Developed, Medium Intensity	367	0.2
Developed, Low Intensity	1,557	0.7
Forest Land	153,943	71.8
Grassland/Prairie	50,779	23.7
Water/Wetland	4,998	2.3
Total	**214,268**	**100.0**

Note: Acreage covers only mapped parcels and thus excludes many rights of way and major water features.

6.9 LAWS, ORDINANCES, AND AGENCIES

Existing laws, ordinances and plans at the federal, state and local level can support or impact hazard mitigation initiatives identified in this plan. In addition, federal, state, and local agencies perform functions that support hazard mitigation. Hazard mitigation plans are required to include a review and incorporation, if appropriate, of existing plans, studies, reports, and technical information as part of the planning process (44 CFR, Section 201.6(b)(3)). Pertinent federal, state and local laws are described below.

6.9.1 Federal

Disaster Mitigation Act

The DMA is the current federal legislation addressing hazard mitigation planning. It requires that state and local governments develop, adopt, and routinely update a hazard mitigation plan in order to remain eligible for pre- and post-disaster mitigation funding. These funds include the Hazard Mitigation Assistance (HMA) grants of the Hazard Mitigation Grant Program (HMGP), Pre-Disaster Mitigation (PDM), and the Flood Mitigation Assistance (FMA) programs that are administered by FEMA. This plan is designed to meet the requirements of DMA, allowing the planning partners to be eligibility for future HMA grants.

Endangered Species Act

The federal Endangered Species Act (ESA) was enacted in 1973 to conserve species facing depletion or extinction and the ecosystems that support them. The act sets forth a process for determining which species are threatened and endangered and requires the conservation of the critical habitat in which those species live. The ESA provides broad protection for species of fish, wildlife, and plants that are listed as threatened or endangered. Provisions are made for listing species, as well as for recovery plans and the designation of critical habitat for listed species. The ESA outlines procedures for federal agencies to follow when taking

actions that may jeopardize listed species and contains exceptions and exemptions. It is the enabling legislation for the Convention on International Trade in Endangered Species of Wild Fauna and Flora. Criminal and civil penalties are provided for violations of the ESA and the Convention.

Federal agencies must seek to conserve endangered and threatened species and use their authorities in furtherance of the ESA's purposes. The ESA defines three fundamental terms:

- **Endangered** means that a species of fish, animal or plant is "in danger of extinction throughout all or a significant portion of its range." For salmon and other vertebrate species, this may include subspecies and distinct population segments.
- **Threatened** means that a species "is likely to become endangered within the foreseeable future." Regulations may be less restrictive for threatened species than for endangered species.
- **Critical habitat** means "specific geographical areas that are…essential for the conservation and management of a listed species, whether occupied by the species or not."

Five sections of the ESA are of critical importance to understanding it:

- **Section 4: Listing of a Species**—The NOAA Fisheries Service is responsible for listing marine species; the U.S. Fish and Wildlife Service is responsible for listing terrestrial and freshwater aquatic species. The agencies may initiate reviews for listings, or citizens may petition for them. A listing must be made "solely on the basis of the best scientific and commercial data available." After a listing has been proposed, agencies receive comment and conduct further scientific reviews for 12 to 18 months, after which they must decide if the listing is warranted. Economic impacts cannot be considered in this decision, but it may include an evaluation of the adequacy of local and state protections. Critical habitat for the species may be designated at the time of listing.
- **Section 7: Consultation**—Federal agencies must ensure that any action they authorize, fund, or carry out is not likely to jeopardize the continued existence of a listed or proposed species or adversely modify its critical habitat. This includes private and public actions that require a federal permit. Once a final listing is made, non-federal actions are subject to the same review, termed a "consultation." If the listing agency finds that an action will "take" a species, it must propose mitigations or "reasonable and prudent" alternatives to the action; if the proponent rejects these, the action cannot proceed.
- **Section 9: Prohibition of Take**—It is unlawful to "take" an endangered species, including killing or injuring it or modifying its habitat in a way that interferes with essential behavioral patterns, including breeding, feeding, or sheltering.
- **Section 10: Permitted Take**—Through voluntary agreements with the federal government that provide protections to an endangered species, a non-federal applicant may commit a take that would otherwise be prohibited as long as it is incidental to an otherwise lawful activity (such as developing land or building a road). These agreements often take the form of a "Habitat Conservation Plan."
- **Section 11: Citizen Lawsuits**—Civil actions initiated by any citizen can require the listing agency to enforce the ESA's prohibition of taking or to meet the requirements of the consultation process.

The Clean Water Act

The federal Clean Water Act (CWA) employs regulatory and non-regulatory tools to reduce direct pollutant discharges into waterways, finance municipal wastewater treatment facilities, and manage polluted runoff. These tools are employed to achieve the broader goal of restoring and maintaining the chemical, physical, and biological integrity of the nation's surface waters so that they can support "the protection and propagation of fish, shellfish, and wildlife and recreation in and on the water."

Evolution of CWA programs over the last decade has included a shift from a program-by-program, source-by-source, pollutant-by-pollutant approach to more holistic watershed-based strategies. Under the watershed approach, equal emphasis is placed on protecting healthy waters and restoring impaired ones. A full array of issues are addressed, not just those subject to CWA regulatory authority. Involvement of stakeholder groups in the development and implementation of strategies for achieving and maintaining water quality and other environmental goals is a hallmark of this approach.

National Flood Insurance Program

The National Flood Insurance Program (NFIP) provides federally backed flood insurance in exchange for communities enacting floodplain regulations. Participation and good standing under NFIP are prerequisites to grant funding eligibility under the Robert T. Stafford Act. Clear Creek County and all of the planning partners except the Town of Empire participate in the NFIP and have adopted regulations that meet the NFIP requirements. At the time of the preparation of this plan, the County, City of Idaho Springs, and Towns of Georgetown and Silver Plume were in good standing with NFIP requirements. The County's current Digitized Federal Insurance Rate Map (DFIRM) has been effective since July 17, 2012.

Federal Emergency Management Agency

FEMA's mission remains "to lead America to prepare for, prevent, respond to, and recover from disasters with a vision of 'A Nation Prepared.'" FEMA coordinates the federal government's role in preparing for, preventing, mitigating the effects of, responding to, and recovering from all domestic disasters, whether natural or man-made, including acts of terror.

The Robert T. Stafford Disaster Relief and Emergency Assistance Act, Public Law 100-707, was signed into law November 23, 1988; and amended the Disaster Relief Act of 1974, Public Law 93-288. It created the system in place today by which a presidential disaster declaration of an emergency triggers financial and physical assistance through FEMA. The Act gives FEMA the responsibility for coordinating government-wide relief efforts. On March 1, 2003, FEMA became part of the U.S. Department of Homeland Security (DHS).

United States Forest Service

The United States Forest Service (USFS) is an agency of the U.S. Department of Agriculture (USDA) that administers the nation's 154 national forests and 20 national grasslands. The mission of the USFS is "To sustain the health, diversity, and productivity of the Nation's forests and grasslands to meet the needs of present and future generations." Its motto is "Caring for the land and serving people." As the lead federal agency in natural resource conservation, the USFS provides leadership in the protection, management, and use of the nation's forest, rangeland, and aquatic ecosystems. The agency's ecosystem approach to management integrates ecological, economic, and social factors to maintain and enhance the quality of the environment to meet current and future needs. Through implementation of land and resource management plans, the agency ensures sustainable ecosystems by restoring and maintaining species diversity and ecological productivity that helps provide recreation, water, timber, minerals, fish, wildlife, wilderness, and aesthetic values for current and future generations of people.

6.9.2 State and Regional

Colorado Division of Emergency Management

Pursuant to House Bill 12-1283, the former Colorado Division of Emergency Management moved from the Department of Local Affairs to the newly created Division of Homeland Security and Emergency Management under the Colorado Department of Public Safety, effective July 1, 2012. The division is now comprised of three offices:

- Office of Emergency Management
- Office of Preparedness
- Office of Prevention and Security

Homeland Security and Emergency Management operate under the following division mission: "The mission of the Division of Homeland Security and Emergency Management is to support the needs of local government and partner with them before, during, and after a disaster and to enhance preparedness statewide by devoting available resources toward prevention, protection, mitigation, response, and recovery, which will ensure greater resiliency of our communities." The Division vision is: "to unify homeland security and emergency management within the Colorado Department of Public Safety to support tribal and local government and ensure State and Federal agency coordination."

Colorado Water Conservation Board

The CWCB is an agency of the State of Colorado. The CWCB Flood Protection Program is directed to review and approve statewide floodplain studies and designations prior to adoption by local governments. The CWCB is also responsible for the coordination of the NFIP in Colorado and for providing assistance to local communities in meeting NFIP requirements. This includes CWCB prepared or partnered local floodplain studies.

Colorado Geological Survey

The Colorado Geological Survey is a state government agency within the Colorado Department of Natural Resources whose mission is to help reduce the impact of geologic hazards on the citizens of Colorado, to promote responsible economic development of mineral and energy resources, provide geologic insight into water resources, provide avalanche safety training and forecasting, and to provide geologic advice and information to a variety of constituencies. The Colorado Avalanche Information Center is housed in the Colorado Geological Survey.

Colorado State Forest Service

The mission of the Colorado State Forest Service is to provide for the stewardship of forest resources and to reduce related risks to life, property, and the environment for the benefit of present and future generations. Its fire preparedness and response strategic priority is to provide leadership in wildland fire protection for state and private lands in Colorado and reduce wildfire-related loss of life, property, and critical resources.

Denver Regional Council of Governments

For more than 50 years, the cities and counties of the Denver region have worked together as DRCOG to further a shared vision of the future of the metro area and to make life better for residents. That vision has taken various forms over the years. The current version, referred to as Metro Vision, is founded on six core principles which local communities developed in collaboration with the region's business, civic and environmental leaders and formally adopted in 1992. The six core principles of Metro Vision are:

- To protect and enhance the region's quality of life
- To be aspirational and long-range in focus
- Offer direction for local implementation
- Respect local plans
- Encourage communities to work together
- Plan is dynamic and flexible

Clear Creek County is a participant in the *DRGOG 2011 Natural Hazard Mitigation Plan*. This multi-jurisdictional plan identifies natural hazards in the region, assesses their risk to communities, and identifies local mitigation strategies and outlines actions that will mitigate the hazards' effects and break the cycle of repetitive losses. The plan includes a risk assessment for the natural hazards by county, identification of the number of people and businesses potentially at risk, and the assessed valuation of properties vulnerable to each natural hazard. This information can be used to prioritize pre-disaster mitigation actions and post-disaster recovery efforts.

6.9.3 Clear Creek County

The Clear Creek County government is made up of the following offices and departments:

- Administration
- Animal Shelter
- Archives and Records
- Assessor
- Clerk and Recorder
- Community Development
- CSU Extension Program
- Emergency Management
- EMS
- Treasurer & Public Trustee
- Victim Advocates
- Fire Authority
- Health and Human Services
- Housing Authority
- Mapping and GIS
- Open Space
- Public and Environmental Health
- Public Works
- Sheriff
- Special Project Division
- Veteran Service Office
- Waste & Recycling

Excerpts from applicable policies, regulations, and plans and program descriptions follow to provide more detail on existing mitigation capabilities.

Clear Creek County Master Plan 2030

The role of the Clear Creek County Master Plan is to serve as a policy document for development decisions in the unincorporated area of the county. The Master Plan can be considered as the foundation that establishes guiding principles for all development in the county. Potential Intergovernmental Agreements (IGA) with other agencies and municipalities will be identified in the Master Plan.

Significant changes have occurred in Clear Creek County since the 1992 Clear Creek County Comprehensive Plan was prepared. These changes can be attributed to the increase in population, not only in Clear Creek County but along the Colorado Front Range and in the central mountains. Growth has led to impacts on the transportation system and the provision of adequate public services and facilities. In addition, the potential closing of the Henderson Mine will significantly change the community. It will create shortfalls in revenues for public services and facilities and cause the loss of the highest paying jobs in the county. This prospect is one of the reasons for updating the Master Plan. There is a need to identify and plan for economic activities that will offset some of the changes within the county.

The Clear Creek Master Plan 2030 has several purposes:

- To communicate the land use policy of Clear Creek County to citizens, landowners, development interests and other governmental jurisdictions.

- To provide a policy basis for updating the zoning, subdivision regulations and other land use regulations and procedures and to evaluated whether they are consistent with the community's vision for the future.
- To provide a basis for IGAs with the municipalities of Clear Creek County, adjacent jurisdictions and numerous public and semi-public agencies that provide services to Clear Creek County residents.
- To encourage county departments, other agencies and private development interests to design and develop projects which are compatible with the natural resources and capabilities of the land and the capabilities of public services and facilities.
- To provide a basis for establishing priorities and developing funding mechanisms for public capital improvements in Clear Creek County.

Clear Creek County Flood Damage Prevention Regulation

Clear Creek County adopted Flood Damage Prevention Regulations as listed in Chapter 12 of the Clear Creek County Guidelines and Regulations for Matters of State Interest. The Legislature of the State of Colorado has, in Title 29, Article 20 of the Colorado Revised Statutes, delegated the responsibility of local governmental units to adopt regulations designed to minimize flood losses. Therefore, the Clear Creek Board of County Commissioners adopted the following floodplain management regulations follows:

Finding of Fact

1. The flood hazard areas of Clear Creek County are subject to periodic inundation which can result in loss of life and property, health and safety hazards, disruption of commerce and governmental services, and extraordinary public expenditures for flood protection and relief, all of which adversely affect the public health, safety and general welfare.
2. These flood losses are created by the cumulative effect of obstructions in floodplains which cause an increase in flood heights and velocities, and by the occupancy of flood hazards areas by uses vulnerable to floods and hazardous to other lands because they are inadequately elevated, flood proofed or otherwise protected from flood damage.

Statement of Purpose

It is the purpose of this regulation to promote the public health, safety and general welfare and to minimize public and private losses due to flood conditions in specific areas by provisions designed to:

1. Protect human life and health;
2. Minimize expenditure of public money for costly flood control projects;
3. Minimize the need for rescue and relief efforts associated with flooding and generally undertaken at the expense of the general public;
4. Minimize prolonged business interruptions;
5. Minimize damage to public facilities and utilities such as water and gas mains, electric, communication stations, sewer lines, streets and bridges located in floodplains;
6. Help maintain a stable tax base by providing for the sound use and development of flood prone areas in such a manner as to minimize future flood blight areas;
7. Insure that potential buyers are notified that property is in a flood area;
8. Insure that those who occupy the areas of special flood hazards assume responsibility for their actions;

9. Minimize significant hazards to public health and safety or to property in flood hazards areas to encourage open space activities such as agriculture, recreation, and mineral extraction, and to ensure that any combination of these activities are conducted in a mutually compatible manner; and
10. Prohibit all activities which, in time of flooding, would create significant hazards to public health and safety or to property, and to protect shallow wells, solid waste disposal sites, and septic tanks and sewage disposal systems from inundation by floodwaters.

Methods of Reducing Flood Losses

In order to accomplish its purposes, this regulation uses the following methods:

1. Restrict or prohibit uses that are dangerous to health, safety or property in times of flood, or cause excessive increases in flood heights or velocities;
2. Require that uses vulnerable to floods, including facilities which serve such uses, be protected against flood damage at the time of initial construction;
3. Control the alteration of natural floodplains, stream channels, and natural protective barriers, which are involved in the accommodation of flood waters;
4. Control filling, grading, dredging and other development which may increase flood damage;
5. Prevent or regulate the construction of flood barriers which will unnaturally divert flood waters or which may increase flood hazards to other lands.

Clear Creek County Floodplain Map

Clear Creek County provides its residents information on emergency preparedness which includes a link to Colorado Floodplain maps.

Community Wildfire Protection Plans

The CWPP is a strategic plan that identifies specific wildland fire risks facing communities and neighborhoods and provides prioritized mitigation recommendations designed to reduce those risks. Once the CWPP is certified and adopted, it is the community's responsibility to move forward and implement the action items and maintain the currency of the plan's content. Implementation may require further planning at the project level, acquisition of funds, continued collaboration with public agencies, or simply motivating homeowner associations (HOA), property owner associations (POA), and individual homeowners.

The CWPPs are authorized and defined in Title I of the Healthy Forests Restoration Act (HFRA) passed by Congress on November 21, 2003, and signed into law by President Bush on December 3, 2003. The HFRA places renewed emphasis on community planning by extending a variety of benefits to communities with a wildfire protection plan in place. Critical among these benefits is the option of establishing a localized definition and boundary for the wildland-urban interface (WUI) and the opportunity to help shape fuels treatment priorities for surrounding federal and non-federal lands.

The CWPP, as described in the Act, brings together diverse local interests to discuss their mutual concerns for public safety, community sustainability, and natural resources. It offers a positive, solution-oriented environment in which to address challenges such as local firefighting capability, the need for defensible space around homes and subdivisions, and where and how to prioritize land management – on both federal and nonfederal land (CWPPs; Guidelines for Implementation, CSFS, No date).

The implementation of effective wildfire mitigation is a dynamic process. The characteristics of forests and interface communities are constantly changing. Flexibility is designed into the CWPP implementation

process in order to accommodate this changing landscape. Regular plan maintenance and annual updates can document these changes and highlight progress.

The Clear Creek County CWPP was developed in August 2008. The CWPP is a strategic plan that delineates WUI communities and neighborhoods within the county, identifies wildfire threats facing these areas, and prioritizes mitigation actions that are design to reduce those threats. The plan also takes into account headwater resources the county maintains and recognizes downstream municipal water users located outside the primary assessment. In addition, Community Wildfire Protection Implementation Plans have been developed for the City of Idaho Springs Area; the Floyd Hill/Beaver Brook/Saddleback Area; Fall River Watershed Area; Town of Empire, Town of Silver Plume, Upper Bear Creek Area; and the Echo Hills Area. These plans are under the umbrella of the Clear Creek County CWPP.

Clear Creek County Zoning Regulations

Clear Creek County provides its residents the zoning regulations on the county website, through the Planning Department.

Clear Creek County Emergency Management

The CCCOEM is responsible for establishing and facilitating a process and structure for the systematic coordination and effective delivery of public safety services. These services address the consequences of the destructive forces of natural and man-made disasters through a comprehensive program of mitigation, preparedness, response, and recovery.

Activities and responsibilities of the CCCOEM include:

- **Mitigation:** Activities that eliminate or reduce the chance of occurrence or effects of a disaster
- **Preparedness:** The time prior to the onset of a threat, emergency, or disaster; it involves planning and activities that are focused on improving the overall capability of responding to and managing emergencies or disasters
- **Increased Readiness:** Responding to the forecast of a disaster; county departments monitor and assess conditions that could develop into a major emergency or disaster situation and keep the CCCOEM informed of any potential problems
- **Response:** This starts at the onset of an emergency or disaster event and continues until the situation is stabilized or brought under control
- **Initial Relief and Recovery:** This starts as soon as the situation becomes stabilized and continues until essential services are re-established and long-term recovery planning and redevelopment activities can begin

The burden of disaster management, and the resources to deal with it, require a partnership among all levels of government, the private/business sector, voluntary organizations, and the general public/community.

The CCCOEM is currently revising the Emergency Operations Plan.

Clear Creek County Community Development Division

The Community Development Division director coordinates the efforts of the building, planning, site development and permits – as well as working with other county divisions. Permits must be submitted and picked up through this division. The Community Development Division consists of the following departments and services:

- **Building Department:** The services provided by the Building Department are aimed at protecting the public's safety by regulating the design, construction, materials, use and occupancy, and maintenance of buildings and structures within the unincorporated areas of Clear Creek County.

- **Environmental Health:** The Environmental Health Department focuses on controlling and preventing diseases and hazardous conditions that can be harmful to the health of the public. The department is split into two main areas of focus: environmental protection and consumer protection.
- **Mapping:** The Mapping Department was created with the mission of providing support to all county offices in the area of mapping services. Historically, this meant providing the departments with actual maps but more recently it has grown to include digital mapping systems. With the advancement of computer technology and computer graphics, geographic information can be accessed more easily and efficiently through GIS.
- **Permits:** The Land Use Division departments all work together in the review and approval of permits. Each department provides residents and businesses with the information on the submittal requirements and application forms necessary for the permitting.
- **Planning and Zoning:** The Planning and Zoning Department is responsible for administration and processing of applications for rezonings, division of lands, subdivisions and other land use cases.
- **Site Development:** The Site Development Department reviews design and excavation plans, issues permits, and monitors performance for driveways and building sites. The Site Development Department is the builders' "initial contact" and guide through the process prior to applying for a building permit.

Clear Creek County EMS

Clear Creek Emergency Medical Services (EMS) is a paid ambulance service that responds to all 911 medical calls from the Eisenhower/Johnson Tunnels to Floyd Hill on Interstate 70 - a service district of 350 square miles. Clear Creek County EMS provides medical services and community outreach programs to the City of Idaho Springs, and the Towns of Empire, Georgetown, and Silver Plume, as well as the many unincorporated areas of Clear Creek County. In addition, the Clear Creek EMS provides emergency care and transport for outdoor enthusiasts and visitors to two ski areas, numerous hiking and biking trails, hundreds of mountain peaks, and motorists who travel Interstate 70, U.S. Highway 40 and other mountain roads.

Averaging 1500 emergency medical calls per year, the EMS employs 7 full-time paramedics and 30 part-time personnel. Two advanced life support ambulances are staffed 24 hours a day, 7 days a week with 3 more fully equipped ambulances available if the need arises.

Clear Creek County Special Projects Division – County Lands

The Clear Creek County, Colorado, Public Lands Transfer Act of 1993 (Public Law 103) was signed into law on May 24, 1994, by President Clinton. By 1995, all of the land previously owned by the Bureau of Land Management (BLM) was transferred into county ownership. The county had until May 19, 2015, to sell certain parcels of land to private parties (Part III lands). Clear Creek County, through its County Lands Department offered the land to contiguous property owners with the requirement that parcels be combined with private property.

The Public Law divided the approximately 14,000 acres of BLM lands in Clear Creek County into three major parts. Part I created more logical national forest boundaries by designating approximately 3,400 acres to become part of the Roosevelt-Arapahoe National Forest. These are referred to as the "Part I lands". Part II lands included the scenic and history-rich backdrop of the Georgetown-Silver Plume National Historic Landmark District. Approximately 3,200 acres were granted to the following entities: 600+ acres to the Town of Silver Plume; 800+ acres to the Town of Georgetown; 600+ acres to the County of Clear Creek/Open Space Commission; and 1,200+ acres to the State of Colorado (History Colorado & Colorado

Parks & Wildlife). The Historic District Public Lands Commission was created to cooperatively manage and preserve these Part II lands for future generations.

Part III lands encompassed the approximately 7,300 acres (1,530+) parcels, transferred to Clear Creek County under different conditions than the first two parts. This transfer began the County Lands Program and the lands that were determined best suited for private ownership were sold and added to the tax rolls. Of the 7,303+ acres transferred, approximately 2,868 acres (46%) of the lands have been conveyed into private ownership and 525+ acres have been transferred to towns, other government agencies and non-profit entities. Of the 3,910+ acres remaining under county ownership, approximately 2,785 acres, or 71%, of the lands remaining in the program have been designated for long-term management by the Open Space Commission.

Clear Creek Fire Authority

Clear Creek Fire Authority (CCFA) is a consolidated fire protection and emergency service agency serving the municipalities of Empire, Georgetown, Idaho Springs and Silver Plume and the unincorporated lands of Clear Creek County previously represented by the Clear Creek Emergency Services District (ESD). CCFA was organized January 4, 1999, when the municipal fire departments in Empire, Georgetown, Idaho Springs, Silver Plume and the ESD fire departments of Dumont, St. Mary's and York Gulch consolidated their resources and missions under a single intergovernmental agreement. This contract outlines the governance, funding and operation of the CCFA. An eight-member board of directors governs CCFA; each director is appointed by a municipality or the ESD.

CCFA's 50 volunteers and 4 paid administrative and maintenance personnel operate 8 fire stations and, in 2008, responded to more than 1,100 emergencies throughout the 335 square miles of Clear Creek County. Most firefighters have medical training as emergency medical technicians (EMT)-paramedics, EMT-basics and first responders. Other specialized training enables CCFA firefighters to respond safely and professionally to structure and wildland fires, extrications, hazardous materials incidents, backcountry rescues, swiftwater rescues, ice rescues and investigations.

Clear Creek County Public Works Division

The Division of Public Works is responsible for administration, engineering and surveying, construction management and inspection, public infrastructure operations and maintenance, fleet maintenance, solid waste/recycling and noxious weed management.

The division includes the Streets/Bridges and Storm Drain Department, which is responsible for maintaining the condition of over 200 miles of roads within the county's approved maintenance plan, as well as performing selected road construction projects and other special construction projects as requested by the Clear Creek Board of County Commissioners. Winter maintenance includes snow removal from roadways, ice and water control, sanding icy conditions, and some avalanche control. Summer maintenance involves the grading of roadways; the replacement or addition of road surface materials such as road base, gravel, or asphalt; and some water control.

6.9.4 City of Idaho Springs

The City of Idaho Springs government is made up of the following offices and departments:

- Administrative Clerk/Court Clerk
- Building Official
- City Clerk
- City Administrator
- City Attorney
- City Treasurer
- Municipal Prosecutor
- Municipal Court Judge
- Police
- Public Works

The City of Idaho Springs has multiple plans and functions in place that guide growth and development within the community. The city also has relationships with the following organizations: Clear Creek County Tourism, Chamber of Commerce, Historical Society of Idaho Springs, Colorado Tourism Board, Clear Creek Ranger District, Colorado Scenic Byways, Historic Georgetown, and Clear Creek Metropolitan Recreation District.

Excerpts from applicable policies, regulations, and plans and program descriptions follow to provide more detail on existing mitigation capabilities.

City of Idaho Springs Comprehensive Plan 2008

The City of Idaho Springs is dedicated to preserving its culture as a historic mining community, ensuring its economic future through both preservation and development, fostering open and timely public dialogue on local and regional issues, implementing the wise use of community and natural resources, and celebrating successful, progressive municipal action.

The City of Idaho Springs has set specific goals and policies for the overall community, general land use, transportation, parks and recreation, residential land use and economic development. These goals and policies are supported by a series of implementation steps in Section V that are intended to provide residents and staff with the direction and flexibility to address issues that will arise over time. Several of these goals and policies support hazard mitigation, including:

Community

Goal C.1: Preserve and protect the environment of the Idaho Springs area.

- **Policy C.1.1:** Preserve ridgelines in as natural a state as possible.
- **Policy C.1.2:** Encourage the active involvement of state and federal agencies to minimize the adverse effects of mining.
- **Policy C.1.3:** Prevent development or intrusion into floodplains and wetlands without adequate mitigation.
- **Policy C.1.4:** Encourage the enhancement of creeks, riparian and wetland areas through public and private investment.
- **Policy C.1.5:** Protect, maintain and improve the water quality of Clear, Soda, Beaver Brook and Chicago Creek watersheds.
- **Policy C.1.6:** Protect and preserve groundwater resources.
- **Policy C.1.7:** Preserve established winter grounds for migratory herds.

- **Policy C.1.8:** Establish standards for noise abatement in the historic business district and in other areas of the city which can be adversely affected by noise and reverberation.
- **Policy C.1.9:** Support the maintenance of high air quality standards.
- **Policy C.1.10:** Protect natural drainages and forest lands.

Goal C.2: Provide efficient and cost-effective utility services to the community.

- **Policy C.2.1:** Develop a specific plan for capitalizing upon the city's water assets.
- **Policy C.2.2:** Maintain and protect Idaho Springs water rights and resources.
- **Policy C.2.3:** Develop, update and implement capital improvement plans for city utilities.
- **Policy C.2.4:** Identify and continue to resolve wastewater collection line infiltration problems.
- **Policy C.2.5:** Monitor water and wastewater enterprise funds to ensure adequate revenues are generated to address debt service, operational and maintenance expenses.
- **Policy C.2.6:** Analyze utility line service extensions in terms of long-term costs including maintenance and operations.
- **Policy C.2.7:** Develop and work to implement a program to place all utilities underground.
- **Policy C.2.8:** Work to implement efficient utility system improvements using appropriate technology.
- **Policy C.2.9:** Develop and work to implement a policy on alternative energy sources.

Goal C.3: Cooperate with local and regional entities.

- **Policy C.3.1:** Assist in the formation and operation of neighborhood organizations in Idaho Springs as appropriate.
- **Policy C.3.2:** Actively participate in Denver Regional Council of Government programs and projects.
- **Policy C.3.3:** Maintain positive working relationships with Clear Creek, Gilpin and Jefferson county governments.
- **Policy C.3.4:** Foster and maintain positive working relationships with area municipalities.
- **Policy C.3.5:** Work with special districts to provide cost-effective services to the residents of the community.
- **Policy C.3.6:** Cooperate with the Historical Society of Idaho Springs to preserve, protect and renovate the historic assets of Idaho Springs.

General Land Use

Goal GL.1: Review and update city policy documents.

- **Policy GL.1.1**: Set an annual program and timeframe for Planning Commission review and Council approval of the 3-Mile Area Plan.
- **Policy GL1.2:** Set an annual timeframe for Planning Commission review of the Comprehensive Plan.
- **Policy GL1.3:** Update the Comprehensive Plan as needed with full review every 4 years.

Goal GL.2: Develop and implement an annexation policy.

- **Policy GL.2.1:** Incorporate open, public meetings early in the annexation process to identify and address issues of concern.
- **Policy GL.2.1:** Use the Clear Creek Economic Development Corporation to analyze the long-term costs and benefits of any annexation.
- **Policy GL.2.2:** Encourage urban density development to occur in/near Idaho Springs service areas.
- **Policy GL.2.3:** Support the annexation of developments that provide a net long-term benefit to the community.
- **Policy GL.2.4:** Ensure that all agreements and commitments between the City and an annex or clearly identify the responsibilities and roles of each party.
- **Policy GL.2.5:** Balance residential and commercial development so that services are maximized and costs to the community are minimized.

Goal GL.3: Promote and support redevelopment efforts.

- **Policy GL.3.1:** Support changes in the east end business district through redevelopment of commercial properties and the conversion of residential areas to commercial and mixed use development as appropriate.
- **Policy GL.3.2:** Work with the School District and others when the District begins efforts to sell the transportation facility and athletic field.

Policy GL.3.3: Establish, refine and monitor business development incentives.

Goal GL.4: Protect & preserve the historic assets of the Idaho Springs area.

- **Policy GL.4.1:** Maintain the integrity of the Idaho Springs 1041 Regulations and the associated 1041 Impact Area.
- **Policy GL.4.2:** Support the Historic Commercial District.
- **Policy GL.4.3:** Partner with local and national organizations to identify and preserve additional historic resources in the Idaho Springs planning area.
- **Policy GL.4.4:** Develop preservation tourism opportunities that help increase the economic viability of the historic resources of the community.
- **Policy GL.4.5:** Ensure that any proposal for expansion or reconstruction of Interstate 70 enhances historic assets.
- **Policy GL.4.6:** Identify incentives for local property owners to assist with preservation efforts.
- **Policy GL.4.7:** Work with the Historic Society of Idaho Springs and its leadership committee to preserve, protect and improve the historic resources of the community.
- **Policy GL.4.8:** Work to implement provisions of the Programmatic (106) Agreement signed by the City of Idaho Springs on June 10, 2008.

City of Idaho Springs Subdivision Regulations

The purpose of the subdivision regulations is to control and regulate the division and development of all land, for any purpose whatsoever, contained within the city. It includes re-subdivision and relates to the process of subdividing or to the land or territory subdivided or developed. These regulations also provide: (1) for the proper arrangement of streets in relation to the other existing or planned streets and to the master plan, (2) for adequate and convenient open spaces for traffic, utilities, (3) access for fire-fighting equipment, (4) recreation, (5) light and air, and (6) for the avoidance of congestion of populations, including minimum

area and width of lots, (7) for the coordination of subdivision development with requirements of schools, parks, recreation areas and other community facilities, and (8) for the assurance of the provision of such facilities.

City of Idaho Springs Zoning Regulations

These regulations are enacted for the purpose of promoting the health, safety, morals, convenience, order, prosperity and welfare of the present and future inhabitants of the City of Idaho Springs. This objective is achieved by (1) lessening of congestion in the streets and roads; (2) securing safety from fire and other dangers; (3) providing adequate light and air; (4) classifying land uses and the distribution and land development and utilization; (5) avoiding undue congestion of population; (6) facilitating the adequate provision of transportation, water, schools, sewerage, and other public requirements; and (7) other means in accordance with the Comprehensive Plan and its adopted zoning maps.

6.9.5 Town of Empire

The Town of Empire is a statutory town and was incorporated on April 12, 1882. The Town of Empire has an elected mayor and a board of trustees. The town government also includes a town clerk and a public works officer. Police and fire services are provided by the CCFA and the Clear Creek County Sheriff's Office.

6.9.6 Town of Georgetown

The Town of Georgetown government is made up of the following offices and departments:

- Town Administrator
- Town Clerk
- Town Treasurer
- Road and Bridge Superintendent
- Public Works and Water/Sewer
- Solid Waste Services including recycling and (contracted to Progressive Solid Waste)
- Police Department
- Town Attorney
- Municipal Court

Excerpts from applicable policies, regulations, and plans and program descriptions follow to provide more detail on existing mitigation capabilities.

Town of Georgetown Comprehensive Plan 2000

The Town of Georgetown Comprehensive Plan 2000 is intended for the development and preservation of the Town of Georgetown. The plan provides themes for action, strategies, and a land use plan to guide the physical development and preservation of the Town of Georgetown and surrounding area. The plan responds to a series of key issues identified by the citizens of the community and provides clear direction for addressing these issues. The plan will be used to assist the Town of Georgetown's elected and appointed officials as they make decisions about capital investments, as they review proposals for new development or redevelopment, and as they move forward in tackling the issues facing the town.

Town of Georgetown Municipal Code

The following sections from the Territorial Charter and Municipal Code of the Town of Georgetown, Colorado apply to hazard mitigation:

- Title 1 – General Provisions
- Title 2 – Administration and Personnel
- Title 3 – Revenue and Finance

- Title 6 – Animals
- Title 8 – Health and Safety
- Title 10 – Vehicles and Traffic
- Title 12 – Streets Sidewalks and Public Places
- Title 14 – Clear Creek Channel
- Title 15 – Buildings and Construction
- Title 17 – Land Use Code
- Title 21 – Flood Damage Prevention

Town of Georgetown Building Department

The Building Department's services are supplemented by SAFEbuilt. SAFEbuilt provides building permit and inspection every Tuesday and Thursday as needed.

6.9.7 Town of Silver Plume

The Town of Silver Plume government is made up of the following offices and departments:

- Mayor
- Town Clerk
- Bookkeeper
- Public Works Director
- Building Inspector
- Zoning Board
- Planning Commission
- Board of Adjustment

The Town of Silver Plume is covered by the Clear Creek County Sheriff's Office. The Clear Creek County Sheriff will only handle state and federal crimes; all other issues must be addressed by the Silver Plume Town Hall. Fire protection and response is provided by the Georgetown Volunteer Fire Department, which is a part of the CCFA. In addition, Fire Station 8 of the CCFA is located in the Town of Silver Plume.

Home Rule Charter Town of Silver Plume, Colorado 2003

The charter is intended to be as simple and brief as possible, while incorporating directly or by reference to other sources all legal provisions necessary for governance. Since a home rule charter is a document of limitation, and since virtually all of the additional powers available to a home rule town may be exercised by its town board without specific mention of those powers in its charter, the less said in a charter, the better. The charter simply claims for the Town of Silver Plume any new or additional powers permitted or granted to home rule towns in Colorado, and rather than attempting to restate or modify the many provisions of law already applicable to statutory towns, the people of Silver Plume prefer to continue applying those provisions until the need for particular changes presents itself and has been carefully studied.

Town of Silver Plume Land Use Code

The Town of Silver Plume Land Use Code was adopted on April 13, 2015, (Ordinance No. 340) and includes the following divisions:

- **Division 1:** General
- **Division 2:** Building Inspector, Planning and Zoning Board, Board of Adjustment and Floodplain Administrator
- **Division 3:** Zoning

- **Division 4:** Application Process for Building Permits and Development Plans
- **Division 5:** Review and Decision Process for Building Permits and Development Plans
- **Division 6:** Development Standards
- **Division 7:** Variances and Appeals of Building Permit or Sign Permit Decision
- **Division 8:** Rezoning and Text Amendments
- **Division 9:** Subdivision and Lot Mergers
- **Division 10:** Nonconforming Uses
- **Division 11:** Notice and Conduct of Public Hearings
- **Division 12:** Permit Administration and Enforcement
- **Division 13:** Security Agreement and Financial Security
- **Division 14:** Signs and Outdoor Advertising
- **Division 15:** Watershed Protection district Regulations
- **Division 16:** Guidelines and Regulations for Areas and Activities of State Interest: Site Selection of Arterial Highways, Interchanges, and Collector Highways and Areas Around Interchanges Involving Arterial Highways (Ordinance No. 334)
- **Division 17:** Definitions of Words and Terms in these Regulations

The purpose of Land Use Code is to: (1) protect and promote the health, safety and general welfare of the existing and future residents of the town and to protect the environment; (2) implement the goals and policies of the Town of Silver Plume Master Plan; (3) preserve and promote the value of property, to protect the tax base of the town, and to respect the property rights of citizens; (4) provide for balanced, orderly growth patterns; (5) ensure compatibility between uses within the town; (6) preserve, promote, and enhance the historical and architectural significance and character of the community; and (7) regulate the use of land based on impacts to the surrounding areas and the community.

Town of Silver Plume Community Wildfire Protection Implementation Plan

The Silver Plume Community Wildfire Protection Implementation Plan is under the umbrella of the Clear Creek County CWPP. As such, it provides local analysis and implementation recommendations for the Silver Plume area. The plan was collaboratively developed, including input from residents, interested parties and state and federal land management agencies managing land in the Silver Plume area. The implementation plan identifies and prioritizes areas for hazardous fuels reduction treatments and recommends the types and methods of treatment to reduce the wildfire threat to values at risk in the area. The plan also presents measures to reduce the ignitability of structures throughout the plan area.

Chapter 7.
HAZARD MITIGATION CAPABILITIES ASSESSMENT

The planning team performed an inventory and analysis of existing authorities and capabilities called a "capability assessment." A capability assessment creates an inventory of an agency's mission, programs and policies, and evaluates its capacity to carry them out.

7.1 CLEAR CREEK COUNTY

7.1.1 Legal and Regulatory Capabilities

Table 7-1 lists planning and land management tools typically used by local jurisdictions to implement hazard mitigation activities and indicates those that are in place in Clear Creek County.

TABLE 7-1.
CLEAR CREEK COUNTY REGULATORY MITIGATION CAPABILITIES MATRIX

Regulatory Tool (ordinances, codes, plans)	Yes/No	Comments
General plan	Yes	Clear Creek County Master Plan 2030, dated 2004 2016 update in progress
Zoning ordinance	Yes	Clear Creek County Zoning Regulations
Subdivision ordinance	Yes	Clear Creek County Subdivision Regulations
Growth management	Yes	Growth in Clear Creek County is controlled through the Master Plan and zoning and subdivision regulations
Floodplain ordinance	Yes	Clear Creek County Floodplain Map and Flood Damage Prevention Regulations
Other special purpose ordinance (stormwater, steep slope, wildfire)	Yes	Banning of Open Fires in Unincorporated Areas (Ordinance 8); Noxious Weeds (Ordinance 11); Slash Burning (Ordinance 12)
Building code	Yes	Clear Creek County adopted the 2009 International Building Code
Erosion or sediment control program	Yes	Clear Creek County Best Management Practices Manual and permitting process
Stormwater management	Yes	Clear Creek County Stormwater Manual
Site plan review requirements	Yes	Planning and Zoning Department
Capital improvement plan	Yes	Capital Improvement Trust Fund; Comprehensive Annual Financial Report
Economic development plan	Yes	Capital Improvement Trust Fund; Comprehensive Annual Financial Report
Local emergency operations plan	Yes	Clear Creek County Emergency Operations Plan (currently under revision)
Other special plans	Yes	Clear Creek County Community Wildfire Protection Plan; other wildfire protection implementation plans for Floyd Hill Area, Fall River Watershed Area, Upper Bear Creek Area, and Echo Hills Area; Strategic Water Plan; Interstate 70Visioning Plan

TABLE 7-1.
CLEAR CREEK COUNTY REGULATORY MITIGATION CAPABILITIES MATRIX

Regulatory Tool (ordinances, codes, plans)	Yes/No	Comments
Flood insurance study or other engineering study for streams	Yes	The County Department of Land Development and Permitting is the local repository for the FEMA FIRMs for the unincorporated areas of the county and makes the maps available for public review. The department maintains FIRMs in conjunction with the NFIP.
Elevation certificates	Yes	

Notes:
FEMA Federal Emergency Management Agency
FIRM Flood Insurance Rate Map
NFIP National Flood Insurance Program

7.1.2 Administrative and Technical Capabilities

Table 7-2 identifies the county personnel responsible for activities related to mitigation and loss prevention in Clear Creek County.

TABLE 7-2.
CLEAR CREEK COUNTY ADMINISTRATIVE/TECHNICAL MITIGATION CAPABILITIES MATRIX

Personnel Resources	Yes/No	Department/Position
Planner/engineer with knowledge of land development/land management practices	Yes	Planning Department and Special Projects Department
Engineer/professional trained in construction practices related to buildings or infrastructure	Yes (limited)	All floodplain applications receive review and home inspection are conducted for floodplain properties. Building Official is trained in construction practices related to buildings. Public Works Division personnel are trained in construction practices related to roads/bridges.
Planner/engineer/scientist with an understanding of natural hazards	Yes	Planning Department/Special Projects Department
Personnel skilled in GIS	Yes	GIS Director
Full-time building official	Yes	Building Department Building Official
Floodplain manager	Yes	Site Development Inspector
Emergency manager	Yes	Office of Emergency Management
Grant writer	No	
Other personnel	Yes	Environmental Health Department and Public Health Department
GIS data: Hazard areas	Yes	Floodplain only
GIS data: Critical facilities	Yes	GIS/Mapping Department
GIS data: Building footprints	Yes	GIS/Mapping Department
GIS data: Land use	Yes	GIS/Mapping Department

TABLE 7-2.
CLEAR CREEK COUNTY ADMINISTRATIVE/TECHNICAL MITIGATION CAPABILITIES MATRIX

Personnel Resources	Yes/No	Department/Position
GIS data: Links to Assessor's data	Yes	GIS/Mapping Department
Warning systems/services (Reverse callback, cable override, outdoor warning signals)	Yes	911-based emergency phone notifications; CodeRed
Other	No	

Notes:
GIS Geographic Information System

7.1.3 Financial Capabilities

Table 7-3 identifies financial tools or resources that Clear Creek County could use to help fund mitigation activities.

TABLE 7-3.
CLEAR CREEK COUNTY FINANCIAL MITIGATION CAPABILITIES MATRIX

Financial Resources	Accessible/Eligible to Use (Yes/No)
Community Development Block Grants	Yes
Capital improvements project funding	No
Authority to levy taxes for specific purposes	Yes (with voter approval)
Fees for water, sewer, gas, or electric services	No
Impact fees for new development	Yes
Incur debt through general obligation bonds	Yes (with voter approval)
Incur debt through special tax bonds	Yes (with voter approval)
Incur debt through private activities	Yes (with voter approval)
Withhold spending in hazard prone areas	No
Other	No

7.2 CITY OF IDAHO SPRINGS

7.2.1 Legal and Regulatory Capabilities

Table 7-4 lists planning and land management tools typically used by local jurisdictions to implement hazard mitigation activities and indicates those that are in place in the City of Idaho Springs.

TABLE 7-4.
CITY OF IDAHO SPRINGS REGULATORY MITIGATION CAPABILITIES MATRIX

Regulatory Tool (ordinances, codes, plans)	Yes/No	Comments
General plan	Yes	Idaho Springs Comprehensive Plan 2008
Zoning ordinance	Yes	Idaho Springs Zoning Regulations

TABLE 7-4.
CITY OF IDAHO SPRINGS REGULATORY MITIGATION CAPABILITIES MATRIX

Regulatory Tool (ordinances, codes, plans)	Yes/No	Comments
Subdivision ordinance	Yes	Idaho Springs Subdivision Regulations
Growth management	Yes	Growth management is accomplished through compliance with the subdivision regulations
Floodplain ordinance	Yes	Adopted the Standard for Floodplain Management (1996)
Other special purpose ordinance (stormwater, steep slope, wildfire)	No	
Building code	Yes	City of Idaho Springs adopted the 2006 International Building Code
Erosion or sediment control program	No	
Stormwater management	No	
Site plan review requirements	No	
Capital improvements plan	No	
Economic development plan	No	
Local emergency operations plan	No	The City of Idaho Springs is covered under the Clear Creek County Emergency Operations Plan
Other special plans	No	
Flood insurance study or other engineering study for streams	No	Available from Clear Creek County
Elevation certificates	Yes	

7.2.2 Administrative and Technical Capabilities

Table 7-5 identifies the City of Idaho Springs personnel responsible for activities related to mitigation and loss prevention in Idaho Springs.

TABLE 7-5.
CITY OF IDAHO SPRINGS ADMINISTRATIVE/TECHNICAL MITIGATION CAPABILITIES MATRIX

Personnel Resources	Yes/No	Department/Position
Planner/engineer with knowledge of land development/land management practices	No	
Engineer/professional trained in construction practices related to buildings or infrastructure	No	

TABLE 7-5.
CITY OF IDAHO SPRINGS ADMINISTRATIVE/TECHNICAL MITIGATION CAPABILITIES MATRIX

Personnel Resources	Yes/No	Department/Position
Planner/engineer/scientist with an understanding of natural hazards	No	
Personnel skilled in GIS	Yes	Clear Creek County GIS staff has and will continue to provide services to the city on a limited basis
Full-time building official	No	
Floodplain manager	No	
Emergency manager	No	Emergency management is coordinated through Clear Creek County Office of Emergency Management
Grant writer	No	
Other personnel	No	
GIS data: Hazard areas	Yes	Clear Creek County GIS
GIS data: Critical facilities	Yes	Clear Creek County GIS
GIS data: Building footprints	Yes	Clear Creek County GIS
GIS data: Land use	Yes	Clear Creek County GIS
GIS data: Links to Assessor's data	Yes	Clear Creek County GIS
Warning systems/services (Reverse callback, cable override, outdoor warning signals)	Yes	Clear Creek County 911-based emergency phone notifications; CodeRed
Other	Yes	Local TV or radio station

Notes:
GIS Geographic Information System

7.2.3 Financial Capabilities

Table 7-6 identifies financial tools or resources that City of Idaho Springs could use to help fund mitigation activities.

TABLE 7-6.
CITY OF IDAHO SPRINGS FINANCIAL MITIGATION CAPABILITIES MATRIX

Financial Resources	Accessible/Eligible to Use (Yes/No)
Community Development Block Grants	No
Capital improvements project funding	Yes
Authority to levy taxes for specific purposes	Yes
Fees for water, sewer, gas, or electric services	Yes
Impact fees for new development	No
Incur debt through general obligation bonds	No
Incur debt through special tax bonds	No

TABLE 7-6. CITY OF IDAHO SPRINGS FINANCIAL MITIGATION CAPABILITIES MATRIX	
Financial Resources	Accessible/Eligible to Use (Yes/No)
Incur debt through private activities	No
Withhold spending in hazard prone areas	No
Other	No

7.3 TOWN OF EMPIRE

7.3.1 Legal and Regulatory Capabilities

Table 7-7 lists regulatory and planning tools typically used by local jurisdictions to implement hazard mitigation activities and indicates those that are in place in the Town of Empire.

TABLE 7-7. TOWN OF EMPIRE REGULATORY MITIGATION CAPABILITIES MATRIX		
Regulatory Tool (ordinances, codes, plans)	Yes/No	Comments
General plan	No	
Zoning ordinance	Yes	
Subdivision ordinance	Yes	
Growth management	No	
Floodplain ordinance	No	
Other special purpose ordinance (stormwater, steep slope, wildfire)	No	
Building code	Yes	Uniform Building Code (1979)
Erosion or sediment control program	No	
Stormwater management	Yes	Community-specific plans
Site plan review requirements	Yes	Plan reviews conducted by part-time volunteer code enforcement officer
Capital improvements plan	Yes	In progress
Economic development plan	Yes	In progress
Local emergency operations plan	No	The Town of Empire is covered under the Clear Creek County Emergency Operations Plan
Other special plans	No	
Flood insurance study or other engineering study for streams	No	Available from Clear Creek County

TABLE 7-7.
TOWN OF EMPIRE REGULATORY MITIGATION CAPABILITIES MATRIX

Regulatory Tool (ordinances, codes, plans)	Yes/No	Comments
Elevation certificates	No	

7.3.2 Administrative and Technical Capabilities

Table 7-8 identifies the city personnel responsible for activities related to mitigation and loss prevention in the Town of Empire.

TABLE 7-8.
TOWN OF EMPIRE ADMINISTRATIVE/TECHNICAL MITIGATION CAPABILITIES MATRIX

Personnel Resources	Yes/No	Department/Position
Planner/engineer with knowledge of land development/land management practices	No	
Engineer/professional trained in construction practices related to buildings or infrastructure	Yes	Town contracts Diamondback Engineering for water infrastructure projects (wastewater treatment, sewer, etc.)
Planner/engineer/scientist with an understanding of natural hazards	No	
Personnel skilled in GIS	Yes	Clear Creek County GIS staff has and will continue to provide services to the town on a limited basis
Full-time building official	No	Part-time services provided by qualified volunteer
Floodplain manager	No	
Emergency manager	No	Emergency management is coordinated through Clear Creek County Office of Emergency Management
Grant writer	No	
Other personnel	No	
GIS data: Hazard areas	Yes	Clear Creek County GIS
GIS data: Critical facilities	Yes	Clear Creek County GIS
GIS data: Building footprints	Yes	Clear Creek County GIS
GIS data: Land use	Yes	Clear Creek County GIS
GIS data: Links to Assessor's data	Yes	Clear Creek County GIS
Warning systems/services (Reverse callback, cable override, outdoor warning signals)	Yes	Clear Creek County 911-based emergency phone notifications; CodeRed
Other	No	

Notes:
GIS Geographic Information System

7.3.3 Financial Capabilities

Table 7-9 identifies financial tools or resources that the Town of Empire could use to help fund mitigation activities.

TABLE 7-9.
TOWN OF EMPIRE FINANCIAL MITIGATION CAPABILITIES MATRIX

Financial Resources	Accessible/Eligible to Use (Yes/No)
Community Development Block Grants	No
Capital improvements project funding	No
Authority to levy taxes for specific purposes	Yes, with board and voter approval
Fees for water, sewer, gas, or electric services	Yes
Impact fees for new development	No, in progress
Incur debt through general obligation bonds	Yes, with board and voter approval
Incur debt through special tax bonds	No
Incur debt through private activities	No
Withhold spending in hazard prone areas	No
Other	No

7.4 TOWN OF GEORGETOWN

7.4.1 Legal and Regulatory Capabilities

Table 7-10 lists regulatory and planning tools typically used by local jurisdictions to implement hazard mitigation activities and indicates those that are in place in the Town of Georgetown.

TABLE 7-10.
TOWN OF GEORGETOWN REGULATORY MITIGATION CAPABILITIES MATRIX

Regulatory Tool (ordinances, codes, plans)	Yes/No	Comments
General plan	Yes	Town of Georgetown Comprehensive Plan 2000
Zoning ordinance	No	
Subdivision ordinance	No	
Growth management	No	
Floodplain ordinance	Yes	Title 21 Flood Damage Prevention
Other special purpose ordinance (stormwater, steep slope, wildfire)	No	
Building code	No	
Erosion or sediment control program	No	
Stormwater management	No	

TABLE 7-10.
TOWN OF GEORGETOWN REGULATORY MITIGATION CAPABILITIES MATRIX

Regulatory Tool (ordinances, codes, plans)	Yes/No	Comments
Site plan review requirements	No	
Capital improvements plan	No	
Economic development plan	No	
Local emergency operations plan	No	The Town of Georgetown is covered under the Clear Creek County Emergency Operations Plan
Other special plans	No	
Flood insurance study or other engineering study for streams	No	Available from Clear Creek County
Elevation certificates	No	

7.4.2 Administrative and Technical Capabilities

Table 7-11 identifies the town personnel responsible for activities related to mitigation and loss prevention in the Town of Georgetown.

TABLE 7-11.
TOWN OF GEORGETOWN ADMINISTRATIVE/TECHNICAL MITIGATION CAPABILITIES MATRIX

Personnel Resources	Yes/No	Department/Position
Planner/engineer with knowledge of land development/land management practices	No	
Engineer/professional trained in construction practices related to buildings or infrastructure	No	
Planner/engineer/scientist with an understanding of natural hazards	No	
Personnel skilled in GIS	Yes	Town coordinates with Clear Creek County GIS. County GIS staff has and will continue to provide services to the town on a limited basis
Full-time building official	No	Building inspector visits the town Tuesday and Thursday and when requested Monday or Wednesday. Arranged through SAFEbuilt.
Floodplain manager	No	
Emergency manager	No	Emergency management is coordinated through Clear Creek County Office of Emergency Management

TABLE 7-11.
TOWN OF GEORGETOWN ADMINISTRATIVE/TECHNICAL MITIGATION CAPABILITIES MATRIX

Personnel Resources	Yes/No	Department/Position
Grant writer	No	
Other personnel	No	
GIS data: Hazard areas	Yes	Clear Creek County GIS
GIS data: Critical facilities	Yes	Clear Creek County GIS
GIS data: Building footprints	Yes	Clear Creek County GIS
GIS data: Land use	Yes	Clear Creek County GIS
GIS data: Links to Assessor's data	Yes	Clear Creek County GIS
Warning systems/services (Reverse callback, cable override, outdoor warning signals)	Yes	911-based emergency phone notifications; CodeRed
Other	Yes	Local television and radio channels

Notes:
GIS Geographic Information System

7.4.3 Financial Capabilities

Table 7-12 identifies financial tools or resources that the Town of Georgetown could use to help fund mitigation activities.

TABLE 7-12.
TOWN OF GEORGETOWN FINANCIAL MITIGATION CAPABILITIES MATRIX

Financial Resources	Accessible/Eligible to Use (Yes/No)
Community Development Block Grants	No
Capital improvements project funding	Yes
Authority to levy taxes for specific purposes	No
Fees for water, sewer, gas, or electric services	Yes
Impact fees for new development	Yes
Incur debt through general obligation bonds	No
Incur debt through special tax bonds	No
Incur debt through private activities	No
Withhold spending in hazard prone areas	No
Other	No

7.5 TOWN OF SILVER PLUME

7.5.1 Legal and Regulatory Capabilities

Table 7-13 lists planning and land management tools typically used by local jurisdictions to implement hazard mitigation activities and indicates those that are in place in the Town of Silver Plume.

TABLE 7-13.
TOWN OF SILVER PLUME REGULATORY MITIGATION CAPABILITIES MATRIX

Regulatory Tool (ordinances, codes, plans)	Yes/No	Comments
General plan	Yes	Town of Silver Plume Master Plan
Zoning ordinance	Yes	Division 3 of Land Use Code (Ordinance No. 340)
Subdivision ordinance	Yes	Division 9 of Land Use Code (Ordinance No. 340)
Growth management	Yes	Growth in Silver Plume is controlled through the Master Plan and zoning and subdivision regulations
Floodplain ordinance	Yes	Division 3.6 of Land Use Code (Ordinance No. 340)
Other special purpose ordinance (stormwater, steep slope, wildfire)	Yes	Watershed Protection District Regulations (Division 15 of Land Use Code)
Building code	Yes	
Erosion or sediment control program	No	
Stormwater management	No	
Site plan review requirements	Yes	Division 4 of Land Use Code (Ordinance No. 340)
Capital improvements plan	No	
Economic development plan	No	
Local emergency operations plan	No	The Town of Silver Plume is covered under the Clear Creek County Emergency Operations Plan
Other special plans	No	
Flood insurance study or other engineering study for streams	No	Available from Clear Creek County
Elevation certificates	No	

7.5.2 Administrative and Technical Capabilities

Table 7-14 identifies the Town of Silver Plume personnel responsible for activities related to mitigation and loss prevention in the Town of Silver Plume.

TABLE 7-14.
TOWN OF SILVER PLUME ADMINISTRATIVE/TECHNICAL MITIGATION CAPABILITIES MATRIX

Personnel Resources	Yes/No	Department/Position
Planner/engineer with knowledge of land development/land management practices	No	

TABLE 7-14.
TOWN OF SILVER PLUME ADMINISTRATIVE/TECHNICAL MITIGATION CAPABILITIES MATRIX

Personnel Resources	Yes/No	Department/Position
Engineer/professional trained in construction practices related to buildings or infrastructure	No	
Planner/engineer/scientist with an understanding of natural hazards	No	
Personnel skilled in GIS	Yes	Clear Creek County GIS staff has and will continue to provide services to the town on a limited basis
Full-time building official	No	The town employs a part-time building official
Floodplain manager	Yes	According to Division 2.4 of the Land Use Code, the town Board of Trustees or its designated representative serves as the Floodplain Administrator
Emergency manager	No	Emergency management is coordinated through Clear Creek County Office of Emergency Management
Grant writer	No	
Other personnel	No	
GIS data: Hazard areas	Yes	Clear Creek County GIS
GIS data: Critical facilities	Yes	Clear Creek County GIS
GIS data: Building footprints	Yes	Clear Creek County GIS
GIS data: Land use	Yes	Clear Creek County GIS
GIS data: Links to Assessor's data	Yes	Clear Creek County GIS
Warning systems/services (Reverse callback, cable override, outdoor warning signals)	Yes	Clear Creek County 911-based emergency phone notifications; CodeRed
Other	Yes	Local TV or radio station

Notes:
GIS Geographic Information System

7.5.3 Financial Capabilities

Table 7-15 identifies financial tools or resources that Silver Plume could use to help fund mitigation activities.

TABLE 7-15.
TOWN OF SILVER PLUME FINANCIAL MITIGATION CAPABILITIES MATRIX

Financial Resources	Accessible/Eligible to Use (Yes/No)
Community Development Block Grants	Yes
Capital improvements project funding	Yes
Authority to levy taxes for specific purposes	Yes, with voter approval

TABLE 7-15.
TOWN OF SILVER PLUME FINANCIAL MITIGATION CAPABILITIES MATRIX

Financial Resources	Accessible/Eligible to Use (Yes/No)
Fees for water, sewer, gas, or electric services	Yes, water and sewer
Impact fees for new development	Yes
Incur debt through general obligation bonds	No
Incur debt through special tax bonds	No
Incur debt through private activities	No
Withhold spending in hazard prone areas	No
Other	No

7.6 SUMMARY OF CAPABILITIES ASSESSMENT

The capabilities assessment identifies the plans, regulations, personnel, and funding mechanisms available to the county and planning partners to impact and mitigate the effects of natural hazards. Clear Creek County as well as the participating communities strive to find the appropriate balance between regulatory authority and private property owners' rights.

Clear Creek County has many plans and programs in place to directly and indirectly address emergency management and the implementation of a proactive hazard mitigation plan. These plans include the Clear Creek County Master Plan, CWPP, and several specific programs, such as the flood damage prevention resolution. While many of the plans address erosion control and economic development, the county does not have separate erosion control or economic development plans. While the BOCC and the County Emergency Manager (working under the BOCC) have primary responsibility for the implementation of the hazard mitigation plan, it takes cooperation and coordination on the part of all county and community departments to successfully implement the mitigation plan. In addition to CCCOEM, the county has a Mapping and GIS Department, Public Works Department, CCFA, and other departments to coordinate the planning, mitigation, and response to natural hazard events. In addition, the county has a full-time building official and a floodplain manager. The county has adopted the 2009 International Building Code and enforces it through the Building Department. In addition to the traditional FEMA funding mechanisms, the county can obtain funds for hazard mitigation projects through community development block grants, taxes, and fees.

The City of Idaho Springs and the Town of Georgetown have comprehensive plans, municipal codes, and regulations that direct development within their municipalities. The City of Idaho Springs has adopted the International Building Code and has codes and ordinances in place that restrict the development of land within hazard areas, such as floodplains. These plans and codes provide a framework for future ordinances and programs to further mitigate natural hazard events. The City of Idaho Springs, as the largest municipality in the county, has more administrative and technical capabilities than the other participating communities, including a building official. Emergency management for the all participating municipalities is coordinated with the CCCOEM. All planning partners have limited financial resources to fund mitigation actions through grants, taxes, or fees.

While the capabilities of Clear Creek County are strong, there are opportunities to strengthen the abilities of the municipal planning partners. These can include: to proactively mitigate natural hazards in the community through adoption of building codes and floodplain regulations, the expansion of existing department staffs, and the creation and hiring of new departments and staff, for example building code

enforcement, or sharing resources and personnel with neighboring communities. However, like most communities within the region, Clear Creek County, the City of Idaho Springs, and the Towns of Empire, Georgetown, and Silver Plume are all challenged with similar financial constraints—not enough funding for all potential positions. Consideration can be given as to whether there is grant funding or funding from other non-traditional sources available to fund positions and activities in the future.

PART 2—
RISK ASSESSMENT

Chapter 8.
AVALANCHE

AVALANCHE HAZARD RANKING	
Clear Creek County	High
City of Idaho Springs	Low
Town of Empire	Low
Town of Georgetown	No Exposure
Town of Silver Plume	High
See Chapter 20 for more information on hazard ranking.	

DEFINITIONS

Avalanche—Any mass of loosened snow or ice and/or earth that suddenly and rapidly breaks loose from a snowfield and slides down a mountain slope, often growing and accumulating additional material as it descends.

Slab avalanches—The most dangerous type of avalanche, occurring when a layer of coherent snow ruptures over a large area of a mountainside as a single mass. Like other avalanches, slab avalanches can be triggered by the wind, by vibration, or even by a loud noise, and will pull in surrounding rock, debris, and even trees.

Climax avalanches—An avalanche involving multiple layers of snow, usually with the ground as a bed surface.

Loose snow avalanches—An avalanche that occurs when loose, dry snow on a slope becomes unstable and slides. Loose snow avalanches start from a point and gather more snow as they descend, fanning out to fill the topography.

Powder snow avalanches—An avalanche that occurs when sliding snow has been pulverized into powder, either by rapid motion of low-density snow or by vigorous movement over rugged terrain.

Surface avalanches—An avalanche that occurs only in the uppermost snow layers.

Wet snow avalanche—An avalanche in wet snow, also referred to as a wet loose avalanche or a wet slab avalanche. Often the basal shear zone is a water-saturated layer that overlies an ice zone.

8.1 GENERAL BACKGROUND

Avalanches can occur whenever a sufficient depth of snow is deposited on slopes steeper than approximately 20 degrees, with the most dangerous coming from slopes in the 35- to 40-degree range. Avalanche-prone areas can be identified with some accuracy, since they typically follow the same paths year after year, leaving scarring on the paths. However, unusual weather conditions can produce new paths or cause avalanches to extend beyond their normal paths.

In the spring, warming of the snowpack occurs from below (from the warmer ground) and above (from warm air, rain, etc.). Warming can be enhanced near rocks or trees that transfer heat to the snowpack. The effects of a snowpack becoming weak may be enhanced in steeper terrain where the snowpack is shallow, and over smooth rock faces that may focus meltwater and produce "glide cracks." Such slopes may fail during conditions that encourage melt.

Wind can affect the transfer of heat into the snowpack and associated melt rates of near-surface snow. During moderate to strong winds, the moistening near-surface air in contact with the snow is constantly mixed with drier air above through turbulence. As a result, the air is continually drying out, which enhances evaporation from the snow surface rather than melt. Heat loss from the snow necessary to drive the evaporation process cools off near-surface snow and results in substantially less melt than otherwise might occur, even if temperatures are well above freezing.

When the snow surface becomes uneven in spring, air flow favors evaporation at the peaks, while calmer air in the valleys favors condensation there. Once the snow surface is wet, its ability to reflect solar energy drops dramatically; this becomes a self-perpetuating process, so that the valleys deepen (favoring calmer air and more heat transfer), while more evaporation occurs near the peaks, increasing the differential between peaks and valleys. However, a warm wet storm can quickly flatten the peaks as their larger surface area exposed to warm air, rain or condensation hastens their melt over the sheltered valleys.

Avalanches can reach speeds of up to 200 miles per hour (mph) and can exert forces great enough to destroy structures and uproot or snap off large trees. Avalanche paths consist of a starting zone, a track, and a runout zone. The runout zone is often an attractive setting for development.

According to the Colorado Avalanche Information Center (CAIC), avalanches have killed more people in Colorado than any other natural hazard since 1950, and Colorado accounts for one-third of all avalanche deaths in the United States (CAIC no date). Avalanche forecasts were first issued by the Colorado Avalanche Warning Center in 1973. The program was originally part of a federal research program, but has been a part of the Colorado State government since 1983. The CAIC is now a program within the Colorado Department of Natural Resources (DNR), Executive Director's Office. The program is a partnership between the DNR, Colorado Department of Transportation (CDOT), and the Friends of the CAIC (FoCAIC) a 501(c)3 group. The mission of the CAIC is to provide avalanche information and education and to promote research for the protection of life, property, and the enhancement of the state's economy (CAIC no date).

8.2 HAZARD PROFILE

8.2.1 Past Events

Clear Creek County is a relatively mountainous area and avalanches do occur frequently, occasionally resulting in death. There were 11 recorded deaths attributable to avalanches in Clear Creek County between 1998 and 2013. The fatalities occurred primarily in the western border of the county. Each of the fatalities were from backcountry activities. Three backcountry tourers, one snowshoer, one climber, one hiker, and five backcountry skiers died between 1998 and 2013 from avalanches. The five backcountry skiers died in the Sheep's Creek Slide along Loveland Pass in April 2013; all were trained backcountry skiers and rescuers. That avalanche was one of the deadliest backcountry skiing death events to occur in Colorado since January 21, 1962. On December 31, 2014, one snowshoer was killed in an avalanche on Kelso Mountain. Recently, a climber was caught in an avalanche and killed on January 16, 2016, during a powerful winter storm. The climber was swept down to St. Mary's Lake.

8.2.2 Location

The greatest impact from an avalanche is in the western portion of Clear Creek County in the western Front Range Mountains. The City of Idaho Springs and Towns of Empire and Georgetown are in avalanche prone areas but the Town of Georgetown is not.

Figure 8-1 shows the CAIC forecast zones in Colorado.

There is no mapped avalanche risk zone information available for Clear Creek County; however, a slope analysis was performed in order to identify areas that may potentially be at risk for an avalanche event. The slope analysis identifies areas in the county that have a slope greater than 25 degrees. The slope analysis is not mapped because the majority of the county has slopes greater than 25 degrees. Figure 8-3 shows the location of several previous avalanche fatalities in the county.

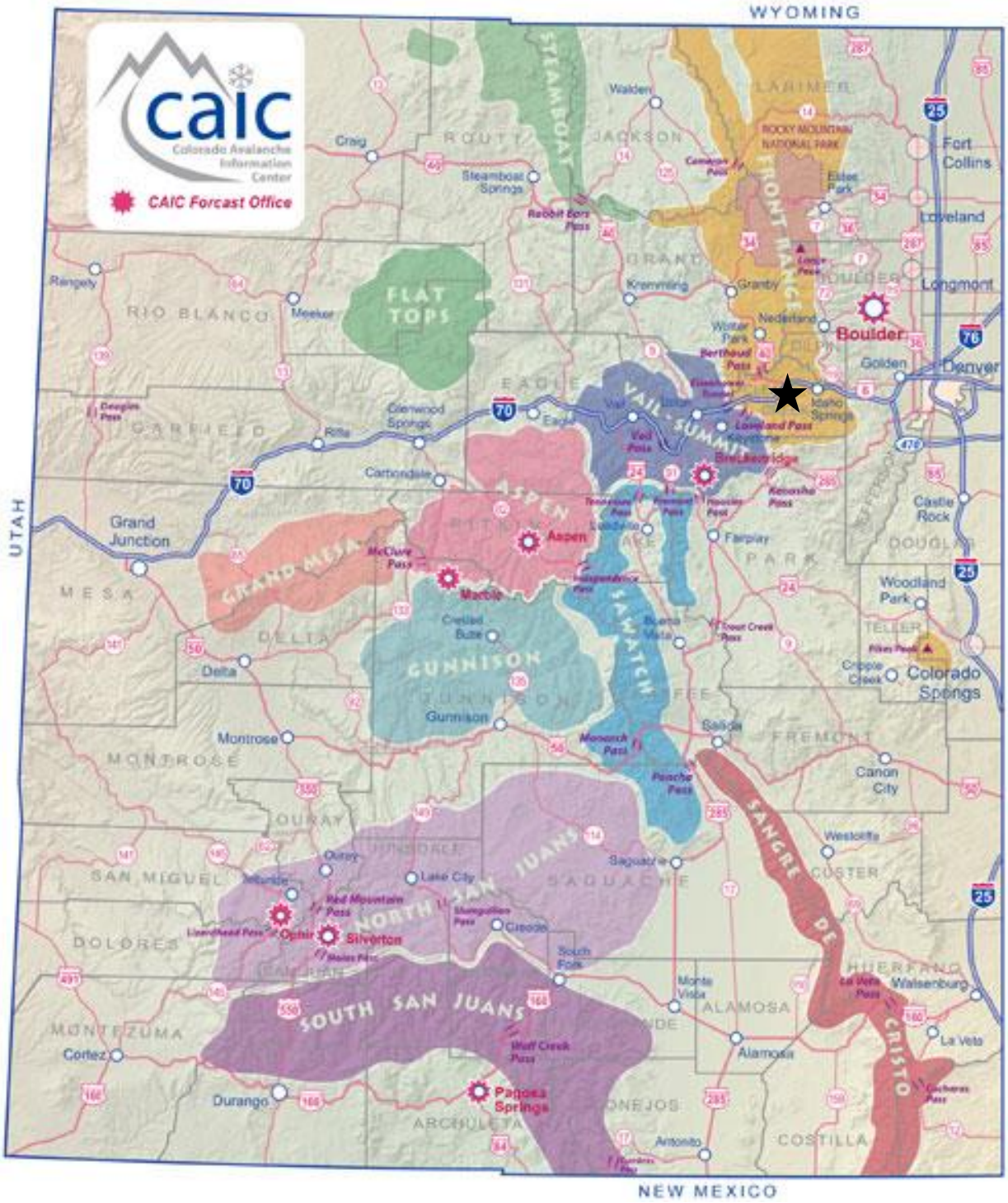


Figure 8-1. Avalanche Forecast Zones in Colorado

8.2.3 Frequency and Severity

The probability of an avalanche occurring in the county and Town of Silver Plume is high. Avalanche probability for the City of Idaho Springs and Town of Empire is relatively low, and the Town of Georgetown has no exposure. The risk for recreational users can be high because of high potential for avalanches and known avalanche deaths in the county.

A number of weather and terrain factors determine avalanche severity and danger:

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

The common factors contributing to the avalanche hazard are old snow depth, old snow surface, new snow depth, new snow type, density, snowfall intensity, precipitation intensity, settlement, wind direction and speed, temperature, and subsurface snow crystal structure.

According to the CAIC an average of 27 people have died each year in avalanches in the United States over the past 10 years (2006-2015) and occurred in the months of January and February. Most fatal incidents are investigated and reported; however, non-fatal incidents are likely to go unreported (CAIC no date). Colorado has recorded the greatest number of fatalities from avalanches of all states in the United States, as shown in Figure 8-2. Six of the recorded fatalities on Figure 8-2 occurred in Clear Creek County. The other recent avalanche fatality in January 2016 is outside the range of the CAIC data. The locations of avalanche fatalities in Clear Creek are shown on Figure 8-3.

The Steering Committee members assessed the avalanche severity impact in three categories: impact on people, impact on property, and impact on the local economy. There are isolated deaths and injuries and frequent rescues of recreational users are needed. But there has been minimal property damage and no interruption of essential facilities and services. Based on the information in this hazard profile, including the recent fatalities in 2014 and 2016, the magnitude/severity impact of an avalanche is moderate for the county and high for the Town of Silver Plume. Historical avalanches in the county have occurred outside of populated areas and affected recreational users, such as backcountry skiers, climbers, and hikers. The magnitude/severity impact of an avalanche for the City of Idaho Springs and Town of Empire are low and the Town of Georgetown has no exposure.

*Source: Colorado Avalanche Information Center Website (*http://avalanche.state.co.us/accidents/statistics-and-reporting/*)*

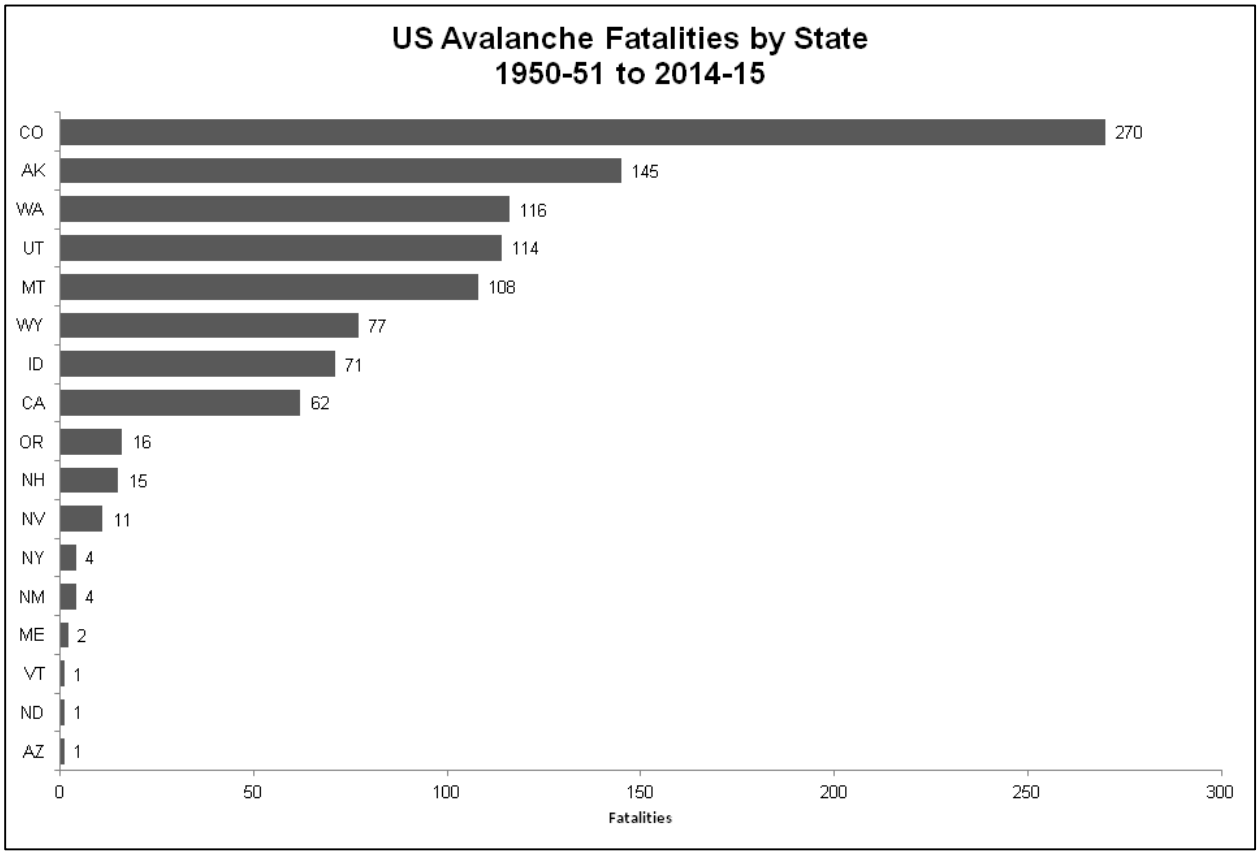


Figure 8-2. Avalanche Fatalities by State, 1950/1951 to 2014/2015

*Source: Colorado Avalanche Information Center Website (*http://avalanche.state.co.us/accidents/statistics-and-reporting/*)*

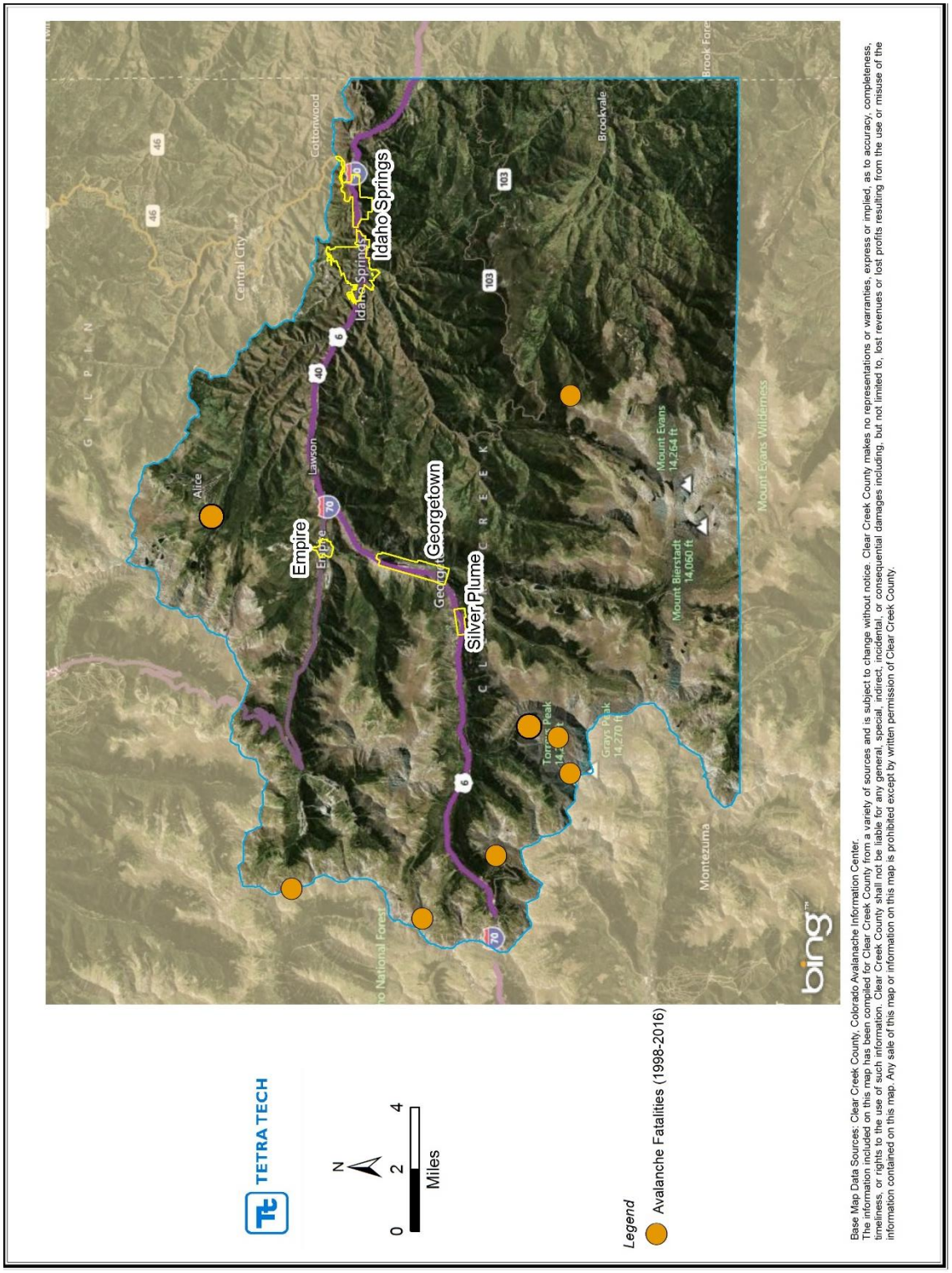


Figure 8-3. Clear Creek County Avalanche Fatality Locations

8.2.4 Warning Time

The time of an avalanche release depends on the condition of the snow pack; which can change rapidly during a day and particularly during rainfall. Although forecasts can provide information regarding when avalanches are more likely to occur, an avalanche can occur with little or no warning time.

CAIC issues watches and warnings by zone to communicate avalanche danger levels to those recreating in backcountry areas. The North American Danger Scale, which ranges from low to extreme danger is shown in Figure 8-4. An example of this forecast for the Front Range area is shown in Figure 8-5.

Source: Colorado Avalanche Information Center Website (http://avalanche.state.co.us/wp-content/uploads/2013/09/ads.jpg.)

North American Public Avalanche Danger Scale

Avalanche danger is determined by the likelihood, size and distribution of avalanches.

Danger Level		Travel Advice	Likelihood of Avalanches	Avalanche Size and Distribution
5 Extreme	4 5	Avoid all avalanche terrain.	Natural and human-triggered avalanches certain.	Large to very large avalanches in many areas.
4 High	4 5	Very dangerous avalanche conditions. Travel in avalanche terrain not recommended.	Natural avalanches likely; human-triggered avalanches very likely.	Large avalanches in many areas; or very large avalanches in specific areas.
3 Considerable	3	Dangerous avalanche conditions. Careful snowpack evaluation, cautious route-finding and conservative decision-making essential.	Natural avalanches possible; human-triggered avalanches likely.	Small avalanches in many areas; or large avalanches in specific areas; or very large avalanches in isolated areas.
2 Moderate	2	Heightened avalanche conditions on specific terrain features. Evaluate snow and terrain carefully; identify features of concern.	Natural avalanches unlikely; human-triggered avalanches possible.	Small avalanches in specific areas; or large avalanches in isolated areas.
1 Low	1	Generally safe avalanche conditions. Watch for unstable snow on isolated terrain features.	Natural and human-triggered avalanches unlikely.	Small avalanches in isolated areas or extreme terrain.

Safe backcountry travel requires training and experience. You control your own risk by choosing where, when and how you travel.

No Rating	?	Insufficient information to establish avalanche danger rating. Check zone forecast for local information.	

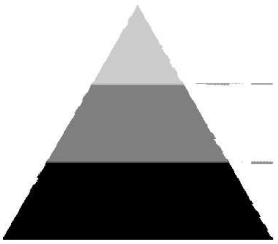
Figure 8-4. Avalanche Danger Scale

Source: Colorado Avalanche Information Center Website (http://avalanche.state.co.us/forecasts/backcountry-avalanche/front-range/)

CAIC Colorado Avalanche Information Center

Backcountry Avalanche Forecast
Front Range

Thursday, September 4, 2014 at 10:38 AM Issued by: Spencer Logan



	Today	Tomorrow
Above Treeline	**Moderate (2)** Heightened avalanche conditions on specific terrain features. Evaluate snow and terrain carefully.	
Near Treeline	**Moderate (2)** Heightened avalanche conditions on specific terrain features. Evaluate snow and terrain carefully.	
Below Treeline	**Moderate (2)** Heightened avalanche conditions on specific terrain features. Evaluate snow and terrain carefully.	

Danger Scale

—	1	2	3	4	5
No Rating	Low	Moderate	Considerable	High	Extreme

Summary

The areas around Loveland and Berthoud Passes picked up a few inches of very dense, slushy snow. An observer reported a period of heavy rain in Dillon Saturday evening. Overnight temperatures were near freezing, with the freeze level around 10,500 feet. The snowpack will be soggy and weak today. Travel early and avoid steep slopes in the heat of the day.

You may encounter Loose Wet avalanches on all aspects and elevations today. They will be easiest to trigger when you are sinking more than a few inches into wet, sloppy snow. If you are, it is time to move to low angled terrain or shadier slopes. They can be surprisingly strong and powerful for their size, and drag you over cliffs or pound you into rocks.

Overnight temperatures have been near or above freezing since Friday. Saturday's rain and dense snow added additional water to the snowpack. These are warning signs for Wet Slab avalanche activity. Observers have reported several wet slabs, scattered from Cameron Pass to Ten Mile Canyon. Wet Slab avalanches are very hard to assess and predict. With that uncertainty, choosing conservative routes and lower angled terrain are good options.

Vail Resorts has put up $20,000 to support Friends of CAIC's Stay Informed, Stay Alive Challenge. Help match that $20,000 today! Donate now.

Weather Forecast for 11,000ft Issued Thursday, September 4, 2014 at 10:38 AM by Spencer Logan

	Thursday Night	Friday	Friday Night
Temperature (ºF)	35 to 40	50 to 55	35 to 40
Wind Speed (mph)	5 to 15	5 to 15	8 to 18
Wind Direction	WSW	WSW	SW
Sky Cover	Mostly Cloudy	Mostly Cloudy	Mostly Cloudy
Snow (in)	0	0	0

Avalanche conditions can change rapidly during snow storms, wind storms, or rapid temperature change. For the most current information, go to www.colorado.gov/avalanche.

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Figure 8-5. Sample Front Range Avalanche Danger Forecast

8.3 SECONDARY HAZARDS

Avalanches can cause several types of secondary effects, such as blocking roads, which can isolate residents and businesses and delay commercial, public, and private transportation. This could result in economic losses for businesses. Other potential problems resulting from avalanches are power and communication failures. Avalanches also can damage rivers or streams, potentially harming water quality, fisheries, and spawning habitat.

8.4 CLIMATE CHANGE IMPACTS

Unlike other phenomena such as tropical storms, snow avalanches are rarely used as indicators of climate change. The effects of climate change on avalanche frequency and magnitude are uncertain and will likely be dependent on local climate change impacts, such as changes in snow fall events and temperature series. Some studies have indicated that the types of avalanche events (wet or dry) may shift as a result of changes in snow cover (Martin et al. 2001). Avalanches, however, are not influenced by snow cover

alone, but several interrelated factors including forest structure, surface energy balance, melt water routing, precipitation, air temperature, and wind (Teich et al. 2012; Eckert 2009; and Lazar and Williams 2008).

Secondary and tertiary impacts of climate change may also alter avalanche events. For example, climate change may modify the distribution of arboreal species across mountain landscapes. Some case studies in the Swiss and French Alps indicate that climate change impacts may reduce the frequency or severity of such events, while other assessments indicate that events may occur more frequently in other mountain regions (Kohler 2009; Teich et al. 2012; and Eckert 2009). No studies assessing the relative frequency and severity of avalanches in the Colorado Rocky Mountain Range were located, but an analysis of wet avalanche hazards in an Aspen ski area indicated that such effects may occur more frequently under high emissions scenarios (Lazar and Williams 2008). Feedback loops affecting snow cover, forest structure, meteorological norms, and land use planning decisions are all likely to influence the future frequency and severity of impacts from avalanche events.

8.5 EXPOSURE

Mountain communities are exposed to avalanche risk; however, the greatest exposure to the avalanche hazard is to persons participating in outdoor recreation in backcountry areas. Transportation routes, including Interstate 70, are also exposed to avalanches. The CDOT monitors and controls 278 of 522 known avalanche paths in Colorado. According to their website "When there is a high risk of avalanche danger, CDOT will close highways at the location of the avalanche path in order to conduct avalanche control. Once all the unstable snow has been brought down, CDOT crews have to clear all of the snow and debris from the roadway before reopening the highway to traffic. Since it is impossible to predict how much snow will be brought down during a control mission, CDOT cannot estimate how long a highway closure will be in place. CDOT will open the highway as soon as it is safe for the traveling public" (CDOT no date).

8.5.1 Population

The greatest impact from an avalanche is to mountain communities in the western Front Range Mountains as well as the major transportation route of Interstate 70. However, avalanches are also a danger to hikers, skiers, snowmobilers, and others involved in outdoor sports in these areas. The populations of Idaho Springs, Empire, Georgetown, and Silver Plume are always at a small level of avalanche risk, though that risk is minimal.

8.5.2 Property

Avalanche exposure of property in the county is minimal. Property and buildings within runout areas are exposed, but of the approximate 5,244 buildings in Clear Creek County, most are not in avalanche runout areas. The City of Idaho Springs and Towns of Georgetown, Empire, and Silver Plume have the potential for property damage, but damage is still likely to be insignificant.

8.5.3 Critical Facilities and Infrastructure

It is unlikely that there are critical facilities exposed to avalanche hazards, although there may be some facilities exposed in the unincorporated mountain communities. The most critical infrastructure to be exposed to avalanche is Interstate 70. Interstate 70 is a major transportation route that transects Colorado and is a major national east-west highway. Disruption of transportation could cause major impacts to Clear Creek County, the State of Colorado, and potentially areas throughout the country.

8.5.4 Environment

Avalanches are a natural event, but they can negatively affect the environment. This includes trees located on steep slopes. A large avalanche can knock down many trees and kill the wildlife that live in them. In spring, this loss of vegetation on the mountains may weaken the soil, causing landslides and mudflows.

8.6 VULNERABILITY

In general, everything that is exposed to an avalanche event is vulnerable. As more people work, build, and play in mountain communities, there will be more people exposed to avalanche hazard areas. These individuals may have little experience with, caution regarding, or preparation for avalanche conditions. The increasing development of recreational sites in the mountains brings added exposure to the people using these sites and the access routes to them. The risk to human life is especially great at times of the year when rapid warming follows heavy, wet snowfall.

The major issues of concern in the event of an avalanche are the threat to recreational users and property and the possibility of disruptions to the electrical grid network and major transportation corridors. According to CDOT during the 2011-2012 winter there were 332 hours of road closures due to avalanche control, resulting in a total of 13,221 feet of snow covering the centerline of the roadway. These roads were closed a total of 370 hours. There is no effective way to keep the public out of avalanche-prone recreational areas, even during times of highest risk. A coordinated effort is needed among state, county, and local law enforcement, fire, emergency management, public works agencies and media to better provide winter snow pack and avalanche risk information to the public.

8.7 FUTURE TRENDS IN DEVELOPMENT

Future trends in development cannot be determined until the avalanche hazard areas are accurately mapped. The population of Clear Creek County is increasing and some of this new development may be occurring in avalanche hazard areas.

8.8 SCENARIO

In a worst-case scenario, an avalanche would occur in the Front Range Mountains after a series of storms. Storms starting with low temperatures and dry snow, followed by rising temperatures and wetter snow, are more likely to cause avalanches than storms that start warm and then cool with snowfall.

8.9 ISSUES

A national program to rate avalanche risk has been developed to standardize terminology and provide a common basis for recognizing and describing hazardous conditions. The avalanche danger scale relates degree of avalanche danger (low, moderate, considerable, high, extreme) to descriptors of avalanche probability and triggering mechanism, degree and distribution of avalanche hazard, and recommended action in backcountry. Avalanche danger scale information should be explained to the public and made available through appropriate county and local agencies and the media.

Measures that have been used in other jurisdictions to reduce avalanche threat include monitoring timber harvest practices in slide-prone areas to ensure that snow cover is stabilized as well as possible, and encouraging reforestation in areas near highways, buildings, power lines, and other improvements. The development of a standard avalanche report form, and the maintenance of a database of potential avalanche hazards likely to affect proposed developments in mountain wilderness areas, would be of significant value to permitting agencies.

Chapter 9.
DAM/LEVEE FAILURE

DAM/LEVEE FAILURE HAZARD RANKING	
Clear Creek County	Medium
City of Idaho Springs	Low
Town of Empire	Medium
Town of Georgetown	Low
Town of Silver Plume	Low
See Chapter 20 for more information on hazard ranking.	

DEFINITIONS

Dam—A man-made barrier, together with appurtenant structures, constructed above the natural surface of the ground for the purpose of impounding water. Flood control and storm runoff detention dams are included (2-CCR 402-1, Rule 4, Section 4.2.5).

Dam Failure—An uncontrolled release of impounded water due to structural deficiencies in dam.

Emergency Action Plan—A document that identifies potential emergency conditions at a dam and specifies actions to be followed to minimize property damage and loss of life. The plan specifies actions the dam owner should take to alleviate problems at a dam. It contains procedures and information to assist the dam owner in issuing early warning and notification messages to responsible downstream emergency management authorities of the emergency situation. It also contains inundation maps to show emergency management authorities the critical areas for action in case of an emergency. (FEMA 64)

High Hazard Dam—Dams where failure or operational error will probably cause loss of human life. (FEMA 333)

Significant Hazard Dam—Dams where failure or operational error will result in no probable loss of human life but can cause economic loss, environmental damage, or disruption of lifeline facilities, or can impact other concerns. Significant hazard dams are often located in rural or agricultural areas but could be located in areas with population and significant infrastructure. (FEMA 333)

Levee—A man-made structure, usually an earthen embankment or concrete floodwall, designed and constructed in accordance with sound engineering practices to contain, control, or divert the flow of water so as to provide reasonable assurance of excluding temporary flooding from the leveed area.

9.1 GENERAL BACKGROUND

9.1.1 Causes of Dam Failure

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

- Overtopping of the primary dam structure, which accounts for 34% of all dam failures, can occur due to inadequate spillway design, settlement of the dam crest, blockage of spillways, and other factors.
- Foundation defects due to differential settlement, slides, slope instability, uplift pressures, and foundation seepage can also cause dam failure. These account for 30% of all dam failures.
- Failure due to piping and seepage accounts for 20% of all failures. These are caused by internal erosion due to piping and seepage, erosion along hydraulic structures such as spillways, erosion due to animal burrows, and cracks in the dam structure.
- Failure due to problems with conduits and valves, typically caused by the piping of embankment material into conduits through joints or cracks, constitutes 10% of all failures.

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

Poor construction, lack of maintenance and repair, and deficient operational procedures are preventable or correctable by a program of regular inspections.

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

9.1.2 Causes of Levee Failure

The following information is excerpted from the *State of Colorado Flood Mitigation Plan*. The Hazards, United States-Multi Hazard (HAZUS-MH) database and the U.S. Army Corp of Engineers (USACE) National Levee Database list no known levees in Clear Creek County. It is possible that there are levees located within the county that are not listed in these databases.

A levee breach occurs when part of a levee gives way, creating an opening through which floodwaters may pass. A breach may occur gradually or suddenly. The most dangerous breaches happen quickly during periods of high water. The resulting torrent can quickly swamp a large area behind the failed levee with little or no warning.

Earthen levees can be damaged in several ways. For instance, strong river currents and waves can erode the surface. Debris and ice carried by floodwaters—and even large objects such as boats or barges—can collide with and gouge the levee. Trees growing on a levee can blow over, leaving a hole where the root wad and soil used to be. Burrowing animals can create holes that enable water to pass through a levee. If severe enough, any of these situations can lead to a zone of weakness that could cause a levee breach. In seismically active areas, earthquakes and ground shaking can cause a loss of soil strength, weakening a levee and possibly resulting in failure. Seismic activity can also cause levees to slide or slump, both of which can lead to failure. Unfortunately, in the rare occurrence when a levee system fails or is overtopped, severe flooding can occur due to increased elevation differences associated with levees and the increased water velocity that is created. It is also important to remember that no levee provides protection from events for which it was not designed, and proper operation and maintenance are necessary to reduce the probability of failure. In some cases, flooding may not be directly attributable to a river, stream, or lake overflowing its banks. Rather, it may simply be the combination of excessive rainfall or snowmelt, saturated ground, and inadequate drainage. With no place to go, the water will find the lowest elevations – areas that are often not in a floodplain. This type of flooding, often referred to as sheet flooding, is becoming increasingly prevalent as development outstrips the ability of the drainage infrastructure to properly carry and disburse the water flow. Flooding also occurs due to combined storm and sanitary sewers that cannot handle the amount of water.

The complicated nature of levee protection was made evident by events such as Hurricane Katrina. Flooding can be exacerbated by levees that are breached or overtopped. As a result, the Federal Emergency Management Agency (FEMA) and the USACE are re-evaluating their policies regarding enforcement of levee maintenance and post-flood rebuilding. Both agencies are also conducting stricter inspections to determine how much protection individual levees actually provide. The Colorado Water Conservation Board (CWCB) is committed to aiding local governments with the increased levels of compliance with federal regulations. CWCB will assist qualifying entities who are in good standing with the National Flood Insurance Program (NFIP) through technical and financial assistance. CWCB assistance may include grant funding, participation in levee inspections, assistance in developing Maintenance Deficiency Correction Plans, site visits, and participation in public hearings. In addition, the CWCB will also discourage the construction of new levees to protect new developments, and instead encourage other types of flood mitigation projects.

9.1.3 Regulatory Oversight

The potential for catastrophic flooding due to dam failures led to passage of the National Dam Safety Act (Public Law 92-367). The National Dam Safety Program requires a periodic engineering analysis of every major dam in the country. The goal of this FEMA-monitored effort is to identify and mitigate the risk of dam failure so as to protect the lives and property of the public.

Colorado Rules and Regulations for Dam Safety and Dam Construction

The *Colorado Rules and Regulations for Dam Safety and Dam Construction* (2-CCR 402-1, January 1, 2007) apply to any dam constructed or used to store water in Colorado. These rules apply to applications for review and approval of plans for the construction, alteration, modification, repair, enlargement, and removal of dams and reservoirs, quality assurance of construction, acceptance of construction, non-jurisdictional dams, safety inspections, owner responsibilities, emergency action plans, fees, and restriction of recreational facilities within reservoirs. Certain structures (defined in Rule 17) are exempt from these rules. The purpose of the rules is to provide for the public safety through the Colorado Safety of Dams Program by establishing reasonable standards and to create a public record for reviewing the performance of a dam.

U.S. Army Corps of Engineers Dam Safety Program

The USACE is responsible for safety inspections of some federal and non-federal dams in the United States that meet the size and storage limitations specified in the National Dam Safety Act. The USACE has inventoried dams; surveyed each state and federal agency's capabilities, practices, and regulations regarding design, construction, operation and maintenance of the dams; and developed guidelines for inspection and evaluation of dam safety (USACE 1997).

Federal Energy Regulatory Commission Dam Safety Program

The Federal Energy Regulatory Commission (FERC) cooperates with a large number of federal and state agencies to ensure and promote dam safety. More than 3,000 dams are part of regulated hydroelectric projects in the FERC program. Two-thirds of these are more than 50 years old. As dams age, concern about their safety and integrity grows, so oversight and regular inspection are important. FERC inspects hydroelectric projects on an unscheduled basis to investigate the following:

- Potential dam safety problems
- Complaints about constructing and operating a project
- Safety concerns related to natural disasters
- Issues concerning compliance with the terms and conditions of a license

Every 5 years, an independent engineer approved by the FERC must inspect and evaluate projects with dams higher than 32.8 feet (10 meters) or with a total storage capacity of more than 2,000 acre-feet.

FERC monitors and evaluates seismic research and applies it in investigating and performing structural analyses of hydroelectric projects. FERC also evaluates the effects of potential and actual large floods on the safety of dams. During and following floods, FERC visits dams and licensed projects, determines the extent of damage, if any, and directs any necessary studies or remedial measures the licensee must undertake. The FERC publication *Engineering Guidelines for the Evaluation of Hydropower Projects* guides the FERC engineering staff and licensees in evaluating dam safety. The publication is frequently revised to reflect current information and methodologies.

FERC requires licensees to prepare emergency action plans and conducts training sessions on how to develop and test these plans. The plans outline an early warning system if there is an actual or potential sudden release of water from a dam due to failure. The plans include operational procedures that may be used, such as reducing reservoir levels and reducing downstream flows, as well as procedures for notifying affected residents and agencies responsible for emergency management. These plans are frequently updated and tested to ensure that everyone knows what to do in emergency situations.

9.2 HAZARD PROFILE

9.2.1 Past Events

Colorado has a history of dam failure, with more than 130 known dam failures since 1890. A number of dams were breeched in September 2013, but none were in Clear Creek County. According to the *State Engineer's 26th Annual Report on Dam Safety to the Colorado General Assembly Fiscal Year 2010-11 and Engineer's 27th Annual Report on Dam Safety to the Colorado General Assembly Fiscal Year 2011-12*, no jurisdictional dam failures occurred in Colorado in water year 2010-2011 or water year 2011-2012. Fourteen dam safety incidents were logged for the same time period statewide. Dam safety incidents are defined as situations at dams that require an immediate response by dam safety engineers.

Incidents also included on the water year 2011-2012 list were associated with the large and damaging wildfires that occurred, particularly the High Park Fire and the Waldo Canyon Fire. These fires were tracked to ensure no damage would occur on dams within or near the fire areas.

According to the Association of State Dam Safety Officials, there have been no reported dam failures in Clear Creek County. If failure were to occur on dams outside of Clear Creek County that lie along the Clear Creek or associated tributaries, there may be significant impacts for the people and property within the county.

9.2.2 Location

HAZUS-MH contains a database of dams based on the National Inventory of Dams. This database lists 25 dams in the county and classifies dams based on the potential hazard to the downstream area resulting from failure or mis-operation of the dam or facilities:

- **High Hazard Potential**—Probable loss of life (one or more)
- **Significant Hazard Potential**—No probable loss of human life but can cause economic loss, environment damage, disruption of lifeline facilities, or impact other concerns; often located in predominantly rural or agricultural areas but could be located in areas with population and significant infrastructure
- **Low Hazard Potential**—No probable loss of human life and low economic or environmental losses; losses are principally limited to the owner's property

Based on these classifications, there are 9 high hazard dams and 3 significant hazard dams in Clear Creek County. These dams are listed in Table 9-1 with their associated stream, downstream town, the distance to town, the normal storage capability of the dam, its hazard classification, and the date of their Emergency Action Plan as listed with the Colorado Division of Water Resources (CDWR). Figure 9-1 through Figure 9-3 show locations of the high-potential-loss dams in the county and the locations of critical facilities and infrastructure within the dam inundation areas. Dam inundation areas were provided by the CDWR and include significant portions of the City of Idaho Springs.

TABLE 9-1.
HIGH- AND SIGNIFICANT-HAZARD DAMS IN CLEAR CREEK COUNTY

Name	Stream	Downstream Town	Town Distance (Miles)	Normal Storage (Acre-Feet)	Hazard Class	Date of EAP
Idaho Springs	Chicago Creek	Idaho Springs	9	9980	High	07/2015
Upper Cabin Creek	South Clear Creek	Georgetown	4	1,602	High	12/2015
Lower Cabin Creek	South Clear Creek	Georgetown	3	1,988	High	12/2015

TABLE 9-1.
HIGH- AND SIGNIFICANT-HAZARD DAMS IN CLEAR CREEK COUNTY

Name	Stream	Downstream Town	Town Distance (Miles)	Normal Storage (Acre-Feet)	Hazard Class	Date of EAP
Clear Lake	South Clear Creek	Georgetown	3	523	High	12/2011
Upper Beaver Brook	Beaver Brook	Golden	14	257	High	05/2014
Lower Beaver Brook	Beaver Brook	Golden	11	30	High	05/2014
Georgetown	South Clear Creek	Lawson	5	386	High	06/2015
Guanella	West Fork of Clear Creek	Empire	0.5	1,340	High	11/2013
Fall River	Fall River	Idaho Springs	8	890	High	08/2015
Lower Urad	Woods Creek	Empire	7	252	Significant	11/2013
Upper Chinns	Fall River	Idaho Springs	9	100	Significant	08/2015
Loch Lomond	Fall River	Idaho Springs	9	875	Significant	08/2015

Source: Colorado Division of Water Resources, Dam Safety Jurisdictional Dam

There are an uncounted number of ‘non-jurisdictional’ dams on public and private lands in the county. These are small dams that normally do not store water but may impound water during heavy precipitation events. Because they are not monitored or maintained, there is potential for them to overtop or fail and cause flooding and property damage during a significant rainfall event. The extent and risk associated with these dams is not known.

The areas of the county most likely to be impacted by a dam failure are along Clear Creek. Nine high and three significant-hazard dams could impact the Towns of Empire and Georgetown, and the City of Idaho Springs.

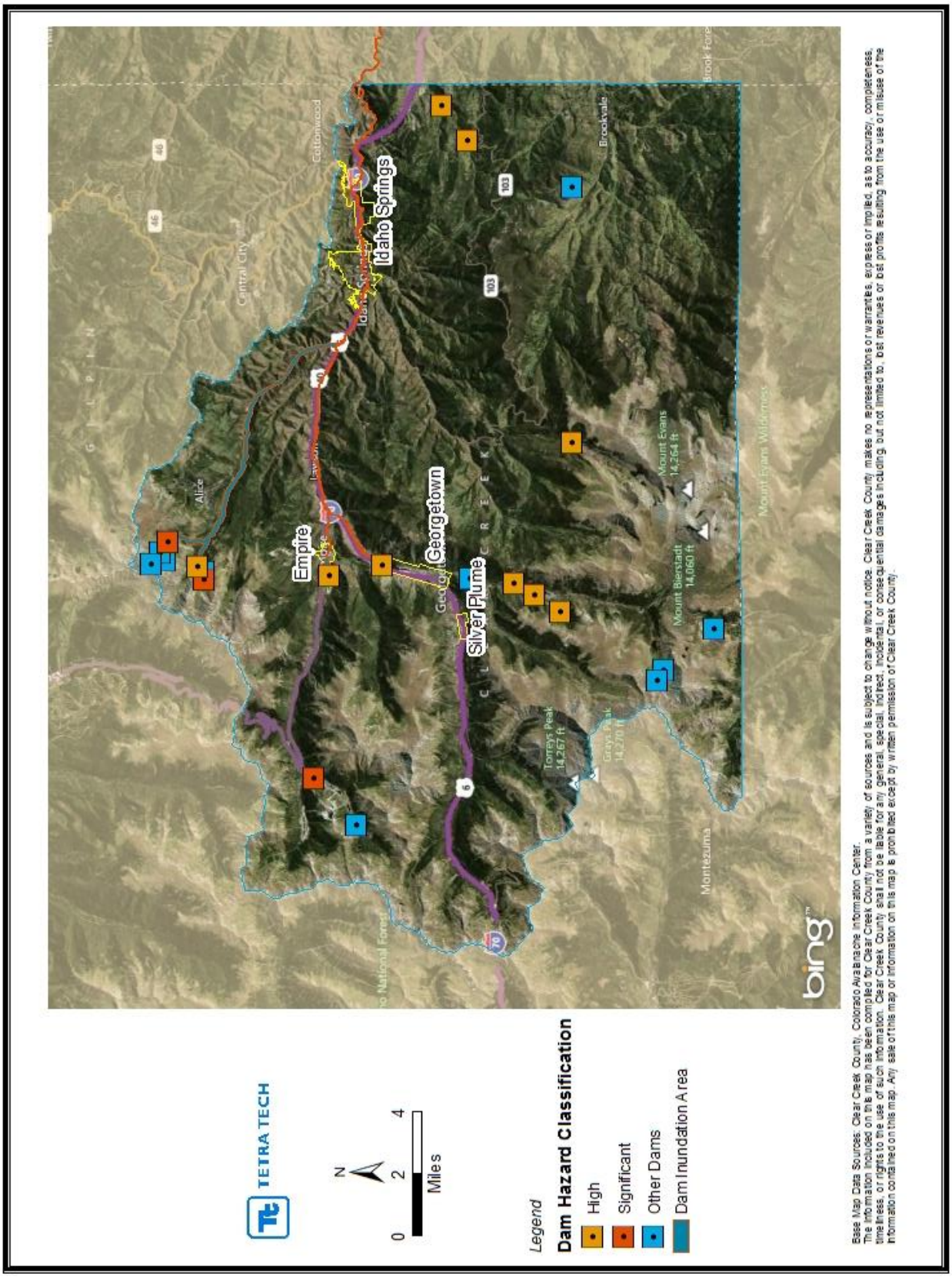


Figure 9-1. Dams with Inundation Areas within Clear Creek County

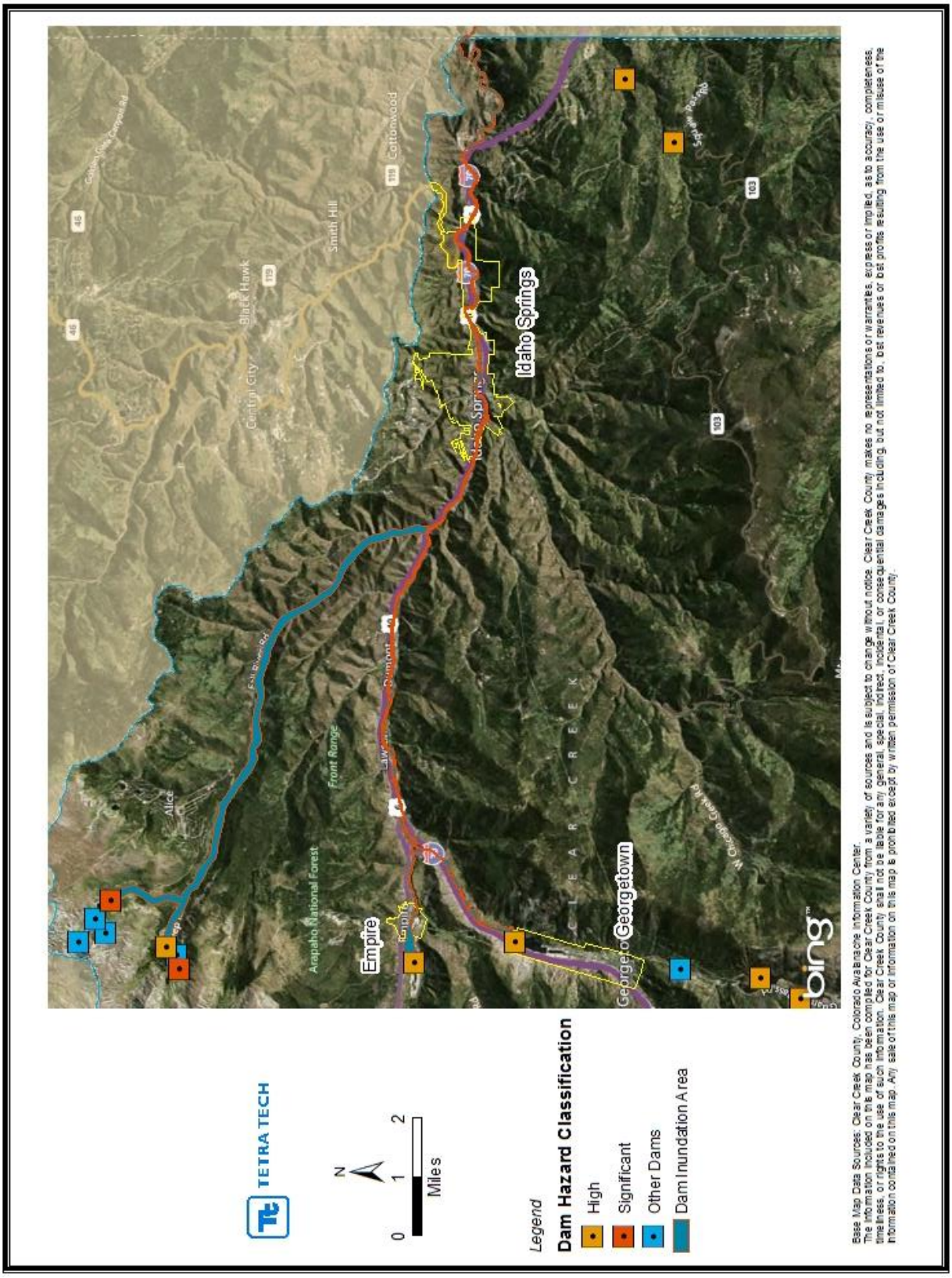


Figure 9-2. High and Significant-Hazard Dams near the City of Idaho Springs and Towns of Empire and Georgetown

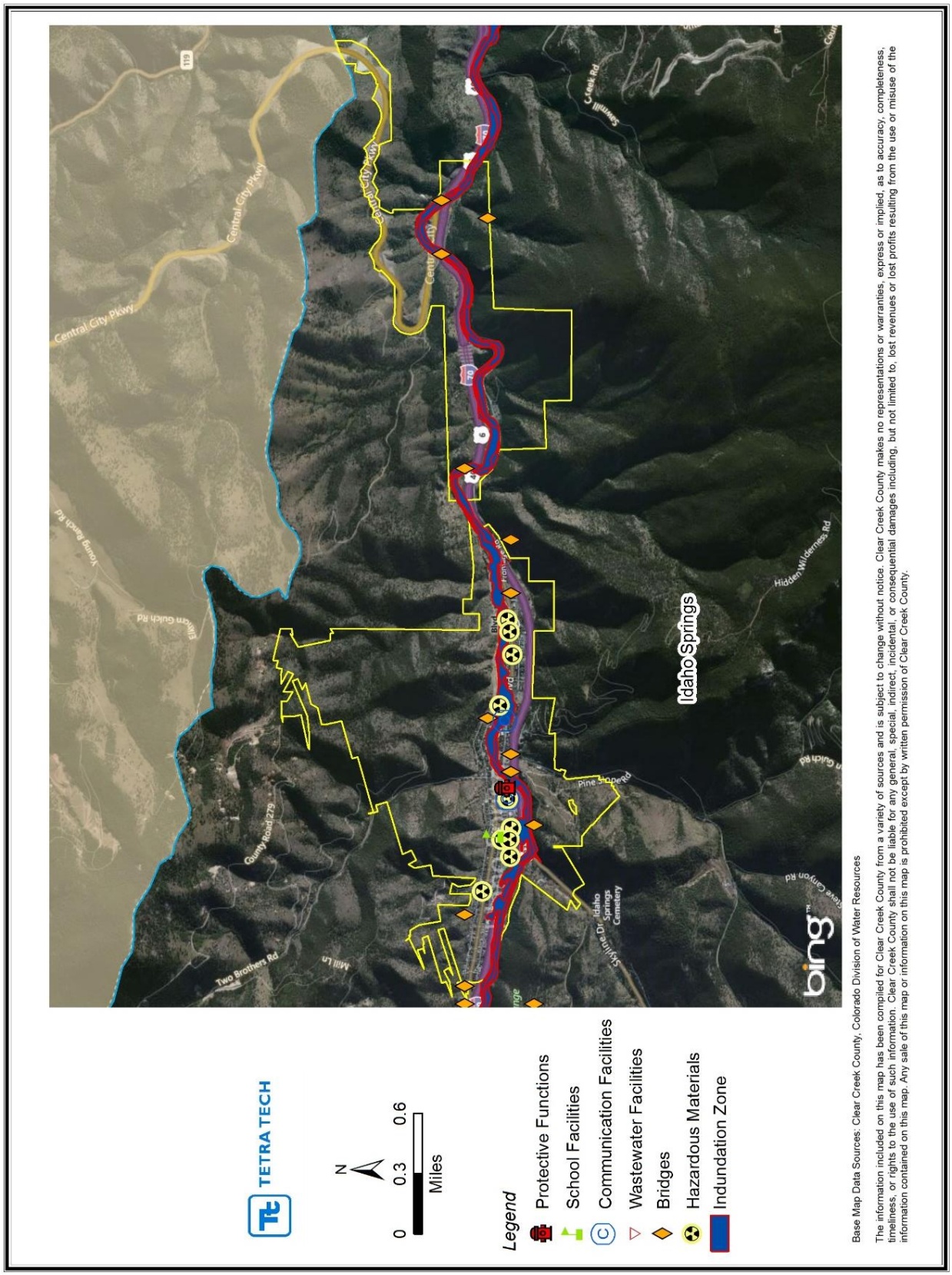


Figure 9-3. Dam Inundation Zone with Critical Facilities in Idaho Springs

9.2.3 Frequency and Severity

There have been no recorded occurrences of dam failures in Clear Creek County in the past 80 years. There are no levees in the county. But since there are nine high and three significant hazard dams located in the county, the County and the Town of Empire ranked the probability of occurrence as medium thus an event is likely to occur within 100 years. The City of Idaho Springs, and the Towns of Georgetown and Silver Plume ranked the probability of a dam failure in the future as low.

The USACE developed the classification system shown in Table 9-2 for the hazard potential of dam failures. The USACE hazard rating system is based only on the potential consequences of a dam failure and does not take into account the probability of such failures.

TABLE 9-2.
U.S. ARMY CORPS OF ENGINEERS HAZARD POTENTIAL CLASSIFICATION

Hazard Category[a]	Direct Loss of Life[b]	Lifeline Losses[c]	Property Losses[d]	Environmental Losses[e]
Low	None (rural location, no permanent structures for human habitation)	No disruption of services (cosmetic or rapidly repairable damage)	Private agricultural lands, equipment, and isolated buildings	Minimal incremental damage
Significant	Rural location, only transient or day-use facilities	Disruption of essential facilities and access	Major public and private facilities	Major mitigation required
High	Certain (one or more) extensive residential, commercial, or industrial development	Disruption of essential facilities and access	Extensive public and private facilities	Extensive mitigation cost or impossible to mitigate

a. Categories are assigned to overall projects, not individual structures at a project.
b. Loss of life potential based on inundation mapping of area downstream of the project. Analyses of loss of life potential should take into account the population at risk, time of flood wave travel, and warning time.
c. Indirect threats to life caused by the interruption of lifeline services due to project failure or operational disruption; for example, loss of critical medical facilities or access to them.
d. Damage to project facilities and downstream property and indirect impact due to loss of project services, such as impact due to loss of a dam and navigation pool, or impact due to loss of water or power supply.
e. Environmental impact downstream caused by the incremental flood wave produced by the project failure, beyond what would normally be expected for the magnitude flood event under which the failure occurs.

Source: U.S. Army Corps of Engineers 1995

The Steering Committee members assessed the dam failure severity impact in three categories: impact on people, impact on property, and impact on the local economy. The severity of the dam failure hazard for the County and City of Idaho Springs is considered to be moderate as it could impact residents, extensive residential, commercial, and industrial development, and disrupt essential facilities and infrastructure. The Towns of Empire, Georgetown, and Silver Plume ranked the severity impact as low.

9.2.4 Warning Time

Warning time for dam failure varies depending on the cause of the failure. In events of extreme precipitation or massive snowmelt, evacuations can be planned with sufficient time. In the event of a structural failure due to earthquake, there may be no warning time. A dam's structural type also affects warning time. Earthen dams do not tend to fail completely or instantaneously. Once a breach is initiated, discharging water erodes the breach until either the reservoir water is depleted or the breach resists further erosion. Concrete gravity

dams also tend to have a partial breach as one or more monolith sections are forced apart by escaping water. The time of breach formation ranges from a few minutes to a few hours (USACE 1997).

9.3 SECONDARY HAZARDS

Dam failure can cause severe downstream flooding, depending on the magnitude of the failure. Other potential secondary hazards of dam failure are landslides around the reservoir perimeter, bank erosion on the rivers, and destruction of downstream habitat.

9.4 CLIMATE CHANGE IMPACTS

Dams are designed partly based on assumptions about a river's flow behavior, expressed as hydrographs. Changes in weather patterns can have significant effects on the hydrograph used for the design of a dam. If the hygrograph changes, it is conceivable that the dam can lose some or all of its designed margin of safety, also known as freeboard. If freeboard is reduced, dam operators may be forced to release increased volumes earlier in a storm cycle in order to maintain the required margins of safety. Such early releases of increased volumes can increase flood potential downstream. Throughout the west, communities downstream of dams have historically experienced increases in stream flows from earlier dam releases.

Dams are constructed with safety features known as "spillways." Spillways are put in place on dams as a safety measure in the event of the reservoir filling too quickly. Spillway overflow events, often referred to as "design failures," result in increased discharges downstream and increased flooding potential. Although climate change will not increase the probability of catastrophic dam failure, it may increase the probability of design failures.

9.5 EXPOSURE

Information for the exposure analysis provided in the sections below is based off of dam inundation area provided by the county. These areas are indicated in Figure 9-1 and Figure 9-2.

9.5.1 Population

The population impacted by dam failure was estimated using the structure count of buildings within the dam inundation area and applying the U.S. Census value of 2.21 persons per household for Clear Creek County. A significant portion of the City of Idaho Springs, and Towns of Empire and Georgetown are within dam inundation zones. Approximately 400 people are exposed within the dam inundation areas in the county.

9.5.2 Property

A total of 217 buildings are exposed in the inundation areas, with approximately $57,501,700 in exposed value. Total building value and exposure numbers were based on 2015 county tax assessor data.

9.5.3 Environment

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

The environment would be vulnerable to a number of risks in the event of dam failure. The inundation could introduce many foreign elements into local waterways, potentially causing the destruction of downstream habitats.

9.6 VULNERABILITY

Structures, aboveground infrastructure, critical facilities, and natural environments are all vulnerable to dam failure. With no known failures in the past, failure impacts would likely be limited in Clear Creek County. Roads closed due to dam failure floods could result in serious transportation disruptions due to the limited number of roads in the county.

9.6.1 Population

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

9.6.2 Property

Vulnerable properties are those within and close to the dam inundation area. These properties would experience the largest, most destructive surge of water. Low-lying areas are also vulnerable since they are where the dam waters would collect. Transportation routes are vulnerable to dam inundation and have the potential to be wiped out, creating isolation issues. This includes all roads, railroads, and bridges in the path of the dam inundation. Those that are most vulnerable are those that are already in poor condition and would not be able to withstand a large water surge. Utilities such as overhead power lines, cable and phone lines could also be vulnerable. Loss of these utilities could create additional isolation issues for the inundation areas.

9.6.3 Environment

The vulnerability of the environment to dam/levee failure is the same as the exposure, discussed in Section 9.5.3.

9.7 FUTURE TRENDS IN DEVELOPMENT

Land use in the planning area will be directed by general plans. The safety elements of the general plans establish standards and plans for the protection of the community from hazards. Dam failure is not typically addressed as a standalone hazard in the safety elements, but flooding is. The planning partners have established comprehensive policies regarding sound land use in identified flood hazard areas. Most of the areas vulnerable to the more severe impacts from dam failure are likely to intersect the mapped flood hazard areas. Flood-related policies in the general plans will help to reduce the risk associated with the dam failure hazard for all future development in the planning area.

9.8 SCENARIO

An earthquake in the region could lead to liquefaction of soils around a dam. This could occur without warning during any time of the day. A human-caused failure such as a terrorist attack also could trigger a catastrophic failure of a dam that impacts the planning area. While the probability of dam failure is very low, the probability of flooding associated with changes to dam operational parameters in response to climate change is higher. Dam designs and operations are developed based on hydrographs with historical record. If these hydrographs experience significant changes over time due to the impacts of climate change, the design and operations may no longer be valid for the changed condition. This could have significant impacts on dams that provide flood control. Specified release rates and impound thresholds may have to be changed. This would result in increased discharges downstream of these facilities, thus increasing the probability and severity of flooding.

9.9 ISSUES

The most significant issue associated with dam failure involves the properties and populations in the inundation areas. Flooding as a result of a dam failure would significantly impact these areas. There is often

limited warning time for dam failure. These events are frequently associated with other natural hazard events such as earthquakes, landslides or severe weather, which limits their predictability and compounds the hazard. Important issues associated with dam failure hazards include the following:

- Federally regulated dams have an adequate level of oversight and sophistication in the development of emergency action plans for public notification in the unlikely event of failure. However, the protocol for notification of downstream citizens of imminent failure needs to be tied to local emergency response planning.
- Mapping for federally regulated dams is already required and available; however, mapping for non-federal-regulated dams that estimates inundation depths is needed to better assess the risk associated with dam failure from these facilities.
- Most dam failure mapping required at federal levels requires determination of the probable maximum flood. While the probable maximum flood represents a worst-case scenario, it is generally the event with the lowest probability of occurrence. For non-federally regulated dams, mapping of dam failure scenarios that are less extreme than the probable maximum flood but have a higher probability of occurrence can be valuable to emergency managers and community officials downstream of these facilities. This type of mapping can illustrate areas potentially impacted by more frequent events to support emergency response and preparedness.
- The concept of residual risk associated with structural flood control projects should be considered in the design of capital projects and the application of land use regulations.
- Addressing security concerns and the need to inform the public of the risk associated with dam failure is a challenge for public officials.

Chapter 10.
DROUGHT AND EXTREME HEAT

DROUGHT AND EXTREME HEAT HAZARD RANKING		
	Drought	**Extreme Heat**
Clear Creek County	Low	Low
City of Idaho Springs	Low	Low
Town of Empire	High	Low
Town of Georgetown	Medium	No Exposure
Town of Silver Plume	Medium	Low
See Chapter 20 for more information on hazard ranking.		

DEFINITIONS

Drought—The cumulative impacts of several dry years on water users. It can include deficiencies in surface and subsurface water supplies and generally impacts health, well-being, and quality of life.

Extreme Heat— Summertime weather that is substantially hotter or more humid than average for a location at that time of year.

10.1 GENERAL BACKGROUND

10.1.1 Drought

Drought is a normal phase in the climatic cycle of most geographical areas. According to the National Drought Mitigation Center, drought originates from a deficiency of precipitation over an extended period, usually a season or more. This results in a water shortage for some activity, group, or environmental sector. Drought is the result of a significant decrease in water supply relative to what is "normal" in a given location. Unlike most disasters, droughts normally occur slowly but last a long time. There are four generally accepted operational definitions of drought (National Drought Mitigation Center 2006):

- **Meteorological drought** is an expression of precipitation's departure from normal over some period of time. Meteorological measurements are the first indicators of drought. Definitions are usually region-specific, and based on an understanding of regional climatology. A definition of drought developed in one part of the world may not apply to another, given the wide range of meteorological definitions.
- **Agricultural drought** occurs when there is not enough soil moisture to meet the needs of a particular crop at a particular time. Agricultural drought happens after meteorological drought but before hydrological drought. Agriculture is usually the first economic sector to be affected by drought.
- **Hydrological drought** refers to deficiencies in surface and subsurface water supplies. It is measured as stream flow and as lake, reservoir, and groundwater levels. There is a time lag between lack of rain and less water in streams, rivers, lakes, and reservoirs, so hydrological measurements are not the earliest indicators of drought. After precipitation has been reduced or deficient over an extended period of time, this shortage is reflected in declining surface and subsurface water levels. Water supply is controlled not only by precipitation, but also by other factors, including evaporation (which is increased by higher than normal heat and winds), transpiration (the use of water by plants), and human use.
- **Socioeconomic drought** occurs when a physical water shortage starts to affect people, individually and collectively. Most socioeconomic definitions of drought associate it with the supply and demand of an economic good.

Defining when drought begins is a function of the impacts of drought on water users, and includes consideration of the supplies available to local water users as well as the stored water they may have

available in surface reservoirs or groundwater basins. Different local water agencies have different criteria for defining drought conditions in their jurisdictions. Some agencies issue drought watch or drought warning announcements to their customers. Determinations of regional or statewide drought conditions are usually based on a combination of hydrologic and water supply factors.

10.1.2 Extreme Heat

Excessive heat events are defined by the U.S. Environmental Protection Agency (EPA) as "summertime weather that is substantially hotter or more humid than average for a location at that time of year" (EPA 2006). Criteria that define an excessive heat event may differ among jurisdictions and in the same jurisdiction depending on the time of year. Excessive heat events are often a result of more than just ambient air temperature. Heat index tables (see Figure 10-1) are commonly used to provide information about how hot it feels, which is based on the interactions between several meteorological conditions. Since heat index values were devised for shady, light wind conditions, exposure to full sunshine can increase heat index values by up to 15 degrees Fahrenheit (°F). Also, strong winds, particularly with very hot, dry air, can be extremely hazardous.

NOAA's National Weather Service

Heat Index

Temperature (°F)

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

Likelihood of Heat Disorders with Prolonged Exposure or Strenuous Activity

Caution | Extreme Caution | Danger | Extreme Danger

Figure 10-1. Heat Index Table

10.2 HAZARD PROFILE

Droughts originate from a deficiency of precipitation resulting from an unusual weather pattern. If the weather pattern lasts a short time (a few weeks or a couple months), the drought is considered short-term. If the weather pattern becomes entrenched and the precipitation deficits last for several months or years, the drought is considered to be long-term. It is possible for a region to experience a long-term circulation pattern that produces drought, and to have short-term changes in this long-term pattern that result in short-term wet spells. Likewise, it is possible for a long-term wet circulation pattern to be interrupted by short-term weather spells that result in short-term drought.

Precipitation, as snowmelt runoff, is the main source of Colorado's water supply. Annual precipitation in the populated areas of the planning area is approximately 11 to 15 inches per year. According to the *2013 Colorado State Drought Mitigation and Response Plan*, "there are no major rivers that flow into Colorado (McKee et al. 1999). There are several major river basins originating in the Colorado Rockies, which flow out of the state, providing water to much of the southwestern United States, and contributing to the Missouri and Mississippi Rivers as well. Thus, Colorado earns its title as "the Mother of Rivers" (CWCB 2013). This supply is stored in five forms throughout the state: snowpack, streamflow, reservoir water, soil moisture, and groundwater (McKee and others 2000).

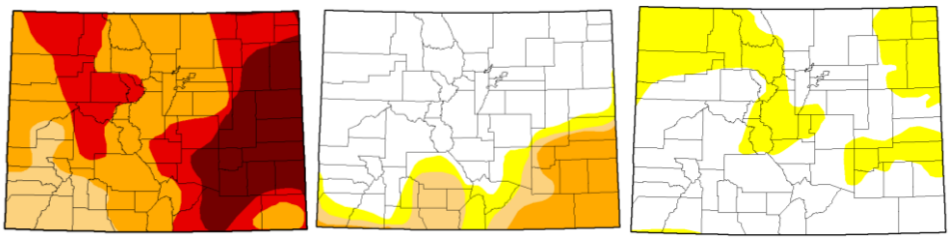
10.2.1 Past Events

Drought

According to the *2004 Drought and Water Supply Assessment*, Colorado has experienced multiple severe droughts. Colorado has experienced drought in 2011-2013, 2009, 2005-2006, 2003, 1996, 1994, 1990, 1989, 1975-1979, 1963-1965, 1951-1957, 1931-1941, and 1893-1905. Clear Creek County has not experienced as much severe drought as compared to other areas of the state. This is mainly because of their precipitation occurring from snowmelt and later summer monsoon rains that keep the county under normal drought conditions most of the time. The county's high elevation and proximity to the continental divide play a major role in moderate summertime temperatures that also help keep drought conditions under normal.

Figure 10-2 compares the severity of the drought in Colorado in March 2013, with increased precipitation in October 2014 as well as minimal drought conditions as of October 2015. The maps illustrate significantly improved conditions in Colorado and Clear Creek County in 2014 and 2015 over the 2013 conditions.

Source: National Drought Mitigation Center



3/19/2013 **10/28/2014** **10/27/2015**

State Drought Conditions

	None	D0-D4	D1-D4	D2-D4	D3-D4	D4
3/19/2013	0	100	100	88.97	48.06	21.22
10/28/2014	69.94	30.06	21.28	12.26	0	0
10/27/2015	68.15	31.85	0	0	0	0

Intensity:

D0 Abnormally Dry
D1 Moderate Drought
D2 Severe Drought
D3 Extreme Drought
D4 Exceptional Drought

Figure 10-2. U.S. Drought Monitor for the State of Colorado from 2013 Compared to 2015

The National Drought Mitigation Center developed the Drought Impact Reporter in response to the need for a national drought impact database for the United States. Information comes from a variety of sources: on-line, drought-related news stories and scientific publications, members of the public who visit the website and submit a drought-related impact for their region, members of the media, and members of relevant government agencies. The database is being populated beginning with the most recent impacts and working backward in time. The Drought Impact Reporter contains information on 242 impacts from droughts that affected the entire State of Colorado and some specific impacts for Clear Creek County between January 2006 and December 2015. The following are the categories and reported number of impacts. Note that some impacts have been assigned to more than one category.

- Agriculture—125
- Energy—5
- Plants and Wildlife—28
- Society and Public Health—56
- Business and Industry— 24
- Fire—31
- Tourism and Recreation—12
- Relief, Response, and Restrictions—75

Extreme Heat

According to the Western Regional Climate Center, the weather station record from 1983-2012 shows the extreme maximum temperature in June and July is 92°F and the average number of days above 90°F is 0.1 in June and July. Thus the temperature in the county rarely exceeds 90°F. Table 10-1 contains temperature summaries related to extreme heat for the station.

TABLE 10-1.
TEMPERATURE DATA CLEAR CREEK WEATHER STATION (1893-2012)

	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Temperature (degrees Fahrenheit)												
Average Maximum Temperature	36.4	37.8	42.7	50.6	60.9	72.1	77.9	75.2	68.6	57.8	44.9	36.6
Average Minimum Temperature	15.6	15.9	19.6	26.4	34.6	42.1	48.7	46.8	39.7	31.5	22.6	16.3
Average Temperature	26.0	26.8	31.2	38.4	47.8	57.1	63.4	61.0	54.2	44.6	33.9	26.6
Extreme Temperatures (degrees Fahrenheit)												
Extreme Maximum Temperature	60	62	67	76	83	92	92	89	86	81	70	60
Average Number of Days												
Maximum Temperature above 90 degrees Fahrenheit	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.0	0.0

10.2.2 Location

Drought

The National Oceanic and Atmospheric Administration (NOAA) has developed several indices to measure drought impacts and severity and to map their extent and locations:

- The ***Palmer Crop Moisture Index*** measures short-term drought on a weekly scale and is used to quantify drought's impacts on agriculture during the growing season.
- The ***Palmer Z Index*** measures short-term drought on a monthly scale.
- The ***Palmer Drought Index*** **(PDI)** measures the duration and intensity of long-term, drought-inducing circulation patterns. Long-term drought is cumulative, so the intensity of drought during a given month is dependent on the current weather patterns plus the cumulative patterns of previous months. Weather patterns can change quickly from a long-term drought pattern to a long-term wet pattern, and the PDI can respond fairly rapidly.
- The hydrological impacts of drought (e.g., reservoir levels, groundwater levels, etc.) take longer to develop and it takes longer to recover from them. The ***Palmer Hydrological Drought Index*** **(PHDI)**, another long-term index, was developed to quantify hydrological effects. The PHDI responds more slowly to changing conditions than the PDI.
- While the Palmer indices consider precipitation, evapotranspiration and runoff, the ***Standardized Precipitation Index*** **(SPI)** considers only precipitation. In the SPI, an index of zero indicates the median precipitation amount; the index is negative for drought and positive for wet conditions. The SPI is computed for time scales ranging from 1 to 24 months.

In Colorado, drought is a natural but unpredictable occurrence in the state. However, because of natural variations in climate and precipitation sources, it is rare for all of Colorado to be deficient in moisture at the same time. Single season droughts over some portion of the state are quite common.

The entire county is at risk to drought conditions and it can increase their vulnerability to wildfires interfacing with the city and towns**.** Drought is one of the few hazards that has the potential to directly or indirectly impact every person in the county as well as adversely affect the local economy.

Extreme Heat

Most of the county is low risk to extreme heat events because of the high elevation, proximity to the continental divide, and mountainous conditions. This is even evident in the more urban areas, such as Idaho Springs. Extreme heat events are unlikely to occur at higher elevations in Clear Creek County. Average temperatures tend to decrease with increases in elevation, roughly 4°F per 1,000 feet above mean sea level.

10.2.3 Frequency and Severity

Drought

The probability of a future drought in Clear Creek County is only moderately likely, with a recurrence interval of 10 years or less, but the severity of a drought in Clear Creek County is minimal. Droughts occur as short durations in Clear Creek County. According to a study cited in the *2013 Colorado Drought Mitigation and Response Plan*, they occur somewhere in Colorado in nearly 9 out of every 10 years. (McKee and others 2000).

Drought impacts are wide-reaching and may be economic, environmental, or societal. The most significant impacts associated with drought in Colorado are those related to water intensive activities such as agriculture, wildfire protection, municipal usage, commerce, tourism, recreation, and wildlife preservation. An ongoing drought may leave an area more prone to beetle kill and associated wildfires. Drought conditions can also cause soil to compact, increasing an area's susceptibility to flooding, and reduce

vegetation cover, which exposes soil to wind and erosion. A reduction of electric power generation and water quality deterioration are also potential problems. Drought impacts increase with the length of a drought, as carry-over supplies in reservoirs are depleted and water levels in streams and groundwater decline.

The severity of a drought depends on the degree of moisture deficiency, the duration, and the size and location of the affected area. The longer the duration of the drought and the larger the area impacted, the more severe the potential impacts. Droughts are not usually associated with direct impacts on people or property, but they can have significant impacts on agriculture, which can impact people indirectly.

Based on the information in this hazard profile, the magnitude/severity of drought is considered to have a minimal potential impact for the county. The City of Idaho Springs and the Towns of Empire, Georgetown, and Silver Plume are considered to have a moderate potential impact for drought. The jurisdictions are expected to have a higher potential impact for drought than the entire county because the areas are more urban and are at lower elevation resulting in the potential for more moderate drought occurrences.

Extreme Heat

There are no recorded instances of extreme heat or heat events in Clear Creek County from 1950 to 2014 in the National Centers for Environmental Information's Storm Events Database. In addition, temperatures in the county rarely exceed 90°F.

Based on the information in this hazard profile, the magnitude/severity of extreme heat is considered to have a minimal potential impact for the county, including the City of Idaho Springs and the Towns of Empire, and Silver Plume. The Town of Georgetown has no exposure.

10.2.4 Warning Time

Drought

Droughts are climatic patterns that occur over long periods of time. Only generalized warnings can take place due to the numerous variables that scientists have not pieced together well enough to make accurate and precise predictions. Empirical studies conducted over the past century have shown that meteorological drought is never the result of a single cause. It is the result of many causes, often synergistic in nature.

Scientists at this time do not know how to predict drought more than a month in advance for most locations. Predicting drought depends on the ability to forecast precipitation and temperature. Anomalies of precipitation and temperature may last from several months to several decades. How long they last depends on interactions between the atmosphere and the oceans, soil moisture and land surface processes, topography, internal dynamics, and the accumulated influence of weather systems on the global scale.

Colorado is semiarid, thus, drought is a regular and natural occurrence in the state. The main source of water supply in the state is precipitation and much of this occurs in the winter as snowfall. Although drought conditions are difficult to predict, low levels of winter snowpack may act as an indicator that drought conditions are occurring.

Extreme Heat

NOAA issues watch, warning and advisory information for extreme heat. Meteorologists can often predict extreme heat days in advance.

10.3 SECONDARY HAZARDS

Drought

The secondary hazard most commonly associated with drought is wildfire. A prolonged lack of precipitation dries out vegetation, which becomes increasingly susceptible to ignition as the duration of the drought extends. According to the *2013 Colorado State Drought Mitigation and Response Plan*, economic impacts

may also occur for industries that are water intensive such as agriculture, wildfire protection, municipal usage, commerce, tourism, recreation and wildfire preservation. Additionally, a reduction of electric power generation and water quality deterioration are also potential effects. Drought conditions can also cause soil to compact, decreasing its ability to absorb water, making an area more susceptible to flash flooding and erosion. A drought may also increase the speed at which dead and fallen trees dry out and become more potent fuel sources for wildfires. Drought may also weaken trees in areas already affected by mountain pine beetle infestations, causing more extensive damage to trees and increasing wildfire risk, at least temporarily. An ongoing drought that severely inhibits natural plant growth cycles may impact critical wildlife habitats. Drought impacts increase with the length of a drought, as carry-over supplies in reservoirs are depleted and water levels in groundwater basins decline (CWCB 2013).

Extreme Heat

Excessive heat events can cause failure of motorized systems such as ventilation systems used to control temperatures inside buildings.

10.4 CLIMATE CHANGE IMPACTS

The long-term effects of climate change on regional water resources are unknown, but global water resources are already experiencing the following stresses without climate change:

- Growing populations
- Increased competition for available water
- Poor water quality
- Environmental claims
- Uncertain reserved water rights
- Groundwater overdraft
- Aging urban water infrastructure

With a warmer climate, droughts could become more frequent, more severe, and longer-lasting. From 1987 to 1989, losses from drought in the U.S. totaled $39 billion (Congressional Office of Technology Assessment [OTA] 1993). More frequent extreme events such as droughts could end up being more cause for concern than the long-term change in temperature and precipitation averages.

The best advice to water resource managers regarding climate change is to start addressing current stresses on water supplies and build flexibility and robustness into any system. Flexibility helps to ensure a quick response to changing conditions, and robustness helps people prepare for and survive the worst conditions. With this approach to planning, water system managers will be better able to adapt to the impacts of climate change.

10.5 EXPOSURE

All people, property, and environments in the planning area would be exposed to some degree to the impacts of moderate to extreme drought conditions. Populations living in densely populated urban areas are likely to be more exposed to extreme heat events. People who live at higher elevations would be less susceptible to heat events.

According to the USDA, the market value of crops grown in Clear Creek County was $343,000 in 2012. There were no recorded livestock sales. Drought and extreme heat may impact all crops grown in Clear Creek County and the pastureland used to sustain private livestock.

Figure 6-3 shows exposure locations for annual average maximum temperatures. The warmest locations in Clear Creek County are located in the eastern portion of the county and in valleys. The City of Idaho Springs

has an annual average temperate several degrees higher than the Towns of Empire, Georgetown, and Silver Plume.

Economic impact will be largely associated with industries that use water or depend on water for their business. For example, landscaping businesses were affected in the droughts of the past as the demand for service significantly declined because landscaping was not watered. Agricultural industries will be impacted if water usage is restricted for irrigation.

10.6 VULNERABILITY

Drought produces a complex web of impacts that spans many sectors of the economy and reaches well beyond the area experiencing physical drought. This complexity exists because water is integral to the ability to produce goods and provide services. Drought can affect a wide range of economic, environmental, and social activities. The vulnerability of an activity to the effects of drought usually depends on its water demand, how the demand is met, and what water supplies are available to meet the demand. Extreme heat can exacerbate the effects of drought.

10.6.1 Population

Drought

The planning partnership has the ability to minimize any impacts on residents and water consumers in the county should several consecutive dry years occur. No significant life or health impacts are anticipated as a result of drought within the planning area.

Extreme Heat

According to the EPA, the individuals with the following combinations or characteristics are typically at greater risk to the adverse effects of excessive heat events: individuals with physical or mobility constraints, cognitive impairments, economic constraints, and social isolation.

10.6.2 Property

Drought

No structures will be directly affected by drought conditions, though some structures may become vulnerable to wildfires, which are more likely following years of drought. Droughts can also have significant impacts on landscapes, which could cause a financial burden to property owners. However, these impacts are not considered critical in planning for impacts from the drought hazard.

Extreme Heat

Typically the only impact extreme heat has on general building stock is increased demand on air conditioning equipment, which in turn may cause strain on electrical systems.

10.6.3 Critical Facilities and Infrastructure

Drought

Critical facilities as defined for this plan will continue to be operational during a drought. Critical facility elements such as landscaping may not be maintained due to limited resources, but the risk to the planning area's critical facilities inventory will be largely aesthetic. For example, when water conservation measures are in place, landscaped areas will not be watered and may die. These aesthetic impacts are not considered significant.

Extreme Heat

Power outages may occur as a result of extreme heat events. Additionally, transportation systems may experience disruption in services. According to the *2013 State of Colorado Hazard Mitigation Plan*,

concrete pavements have experienced “blowouts or heaves” both on local highway and the higher volume parkway and interstate systems. Blowouts occur when pavements expand and cannot function properly within their allotted spaces. Pavement sections may rise up several inches during such events. These conditions can cause motor vehicle accidents in their initial stages and can shut down traffic lanes or roadways entirely until such times as the conditions are mitigated (Colorado Division of Emergency Management 2013).

10.6.4 Environment

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

10.7 FUTURE TRENDS IN DEVELOPMENT

Each municipal planning partner in this effort has an established comprehensive plan that includes policies directing land use and dealing with issues of water supply and the protection of water resources. These plans provide the capability at the local municipal level to protect future development from the impacts of drought. All planning partners reviewed their general plans under the capability assessments performed for this effort. Deficiencies identified by these reviews can be identified as mitigation initiatives to increase the capability to deal with future trends in development. Vulnerability to drought will increase as population growth increases, putting more demands on existing water supplies. Future water use planning should consider increases in population as well as potential impacts of climate change.

10.8 SCENARIO

An extreme multiyear drought could impact the region with little warning. Combinations of low precipitation and unusually high temperatures could occur over several consecutive years. Intensified by such conditions, extreme wildfires could break out throughout the planning area, increasing the need for water. Surrounding communities, also in drought conditions, could increase their demand for water supplies relied upon by the planning partnership, causing social and political conflicts. If such conditions persisted for several years, the economy of Clear Creek County could experience setbacks, especially in water dependent industries.

10.9 ISSUES

The following are extreme heat and drought-related issues:

- Identification and development of alternative water supplies
- Utilization of groundwater recharge techniques to stabilize the groundwater supply
- The probability of increased drought frequencies and durations due to climate change
- The promotion of active water conservation even during non-drought periods
- Increasing vulnerability to drought over time as demand for water from different sectors increases
- The effects of climate change may result in an increase in frequency of extreme heat events
- The effects of recent droughts have exposed the vulnerability of the planning areas economy to drought events

Chapter 11.
EARTHQUAKE

EARTHQUAKE HAZARD RANKING	
Clear Creek County	Low
City of Idaho Springs	Low
Town of Empire	Low
Town of Georgetown	No Exposure
Town of Silver Plume	Low
See Chapter 20 for more information on hazard ranking.	

DEFINITIONS

Earthquake—The shaking of the ground caused by an abrupt shift of rock along a fracture in the earth or a contact zone between tectonic plates.

Epicenter—The point on the earth's surface directly above the hypocenter of an earthquake. The location of an earthquake is commonly described by the geographic position of its epicenter and by its focal depth.

Fault—A fracture in the earth's crust along which two blocks of the crust have slipped with respect to each other.

Focal Depth—The depth from the earth's surface to the hypocenter.

Hypocenter—The region underground where an earthquake's energy originates.

Liquefaction—Loosely packed, water-logged sediments losing their strength in response to strong shaking, causing major damage during earthquakes.

11.1 GENERAL BACKGROUND

11.1.1 How Earthquakes Happen

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

Earthquakes tend to reoccur along faults, which are zones of weakness in the crust. Even if a fault zone has recently experienced an earthquake, there is no guarantee that all the stress has been relieved. Another earthquake could still occur.

Geologists classify faults by their relative hazards. Active faults, which represent the highest hazard, are those that have ruptured to the ground surface during the Holocene period (about the last 11,000 years). Potentially active faults are those that displaced layers of rock from the Quaternary period (the last 1,800,000 years). Determining if a fault is "active" or "potentially active" depends on geologic evidence, which may not be available for every fault. Although there are probably still some unrecognized active faults, nearly all the movement between the two plates, and therefore the majority of the seismic hazards, are on the well-known active faults.

Faults are more likely to have earthquakes on them if they have more rapid rates of movement, have had recent earthquakes along them, experience greater total displacements, and are aligned so that movement can relieve accumulating tectonic stresses. A direct relationship exists between a fault's length and location and its ability to generate damaging ground motion at a given site. In some areas, smaller, local faults produce lower magnitude quakes, but ground shaking can be strong, and damage can be significant as a result of the fault's proximity to the area. In contrast, large regional faults can generate great magnitudes but, because of their distance and depth, may result in only moderate shaking in the area.

11.1.2 Earthquake Classifications

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

Magnitude

Currently the most commonly used magnitude scale is the moment magnitude (M_w) scale, with the follow classifications of magnitude:

- Great—$M_w \geq 8$
- Major—$M_w = 7.0 - 7.9$
- Strong—$M_w = 6.0 - 6.9$
- Moderate—$M_w = 5.0 - 5.9$
- Light—$M_w = 4.0 - 4.9$
- Minor—$M_w = 3.0 - 3.9$
- Micro—$M_w < 3$

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

Intensity

Currently the most commonly used intensity scale is the modified Mercalli intensity scale, with ratings defined as follows (U.S. Geological Survey [USGS] 1989):

- I. Not felt except by a very few under especially favorable conditions.
- II. Felt only by a few persons at rest, especially on upper floors of buildings.
- III. Felt quite noticeably by persons indoors, especially on upper floors of buildings. Many people do not recognize it is an earthquake. Standing cars may rock slightly. Vibrations similar to the passing of a truck. Duration estimated.
- IV. Felt indoors by many, outdoors by few during the day. At night, some awakened. Dishes, windows, doors disturbed; walls make cracking sound. Sensation like a heavy truck striking building. Standing cars rocked noticeably.
- V. Felt by nearly everyone; many awakened. Some dishes, windows broken. Unstable objects overturned. Pendulum clocks may stop.
- VI. Felt by all; many frightened. Some heavy furniture moved; a few instances of fallen plaster. Damage slight.
- VII. Damage negligible in buildings of good design and construction; slight in well-built ordinary structures; considerable in poorly built or badly designed structures. Some chimneys broken.
- VIII. Damage slight in specially designed structures; considerable damage in ordinary buildings with partial collapse. Damage great in poorly built structures. Fall of chimneys, factory stacks, columns, monuments, walls. Heavy furniture overturned.

- IX. Damage considerable in specially designed structures; well-designed frame structures thrown out of plumb. Damage great in substantial buildings, with partial collapse. Buildings shifted off foundations.
- X. Some well-built wooden structures destroyed; most masonry and frame structures destroyed with foundations. Rails bent.
- XI. Few, if any (masonry) structures remain standing. Bridges destroyed. Rails bent greatly.
- XII. Damage total. Lines of sight and level are distorted. Objects thrown into the air.

11.1.3 Ground Motion

Earthquake hazard assessment is also based on expected ground motion. This involves determining the annual probability that certain ground motion accelerations will be exceeded, then summing the annual probabilities over the time period of interest. The most commonly mapped ground motion parameters are the horizontal and vertical peak ground accelerations (PGA) for a given soil or rock type. Instruments called accelerographs record levels of ground motion due to earthquakes at stations throughout a region. These readings are recorded by state and federal agencies that monitor and predict seismic activity.

Maps of PGA values form the basis of seismic zone maps that are included in building codes such as the International Building Code. Building codes that include seismic provisions specify the horizontal force due to lateral acceleration that a building should be able to withstand during an earthquake. PGA values are directly related to these lateral forces that could damage "short period structures" (e.g., single-family dwellings). Longer period response components create the lateral forces that damage larger structures with longer natural periods (apartment buildings, factories, high-rises, bridges). Table 11-1 lists damage potential and perceived shaking by PGA factors, compared to the modified Mercalli scale.

TABLE 11-1.
MERCALLI SCALE AND PEAK GROUND ACCELERATION COMPARISON

Modified Mercalli Scale	Perceived Shaking	Potential Structure Damage		Estimated PGA[a] (%g)
		Resistant Buildings	Vulnerable Buildings	
I	Not Felt	None	None	<0.17%
II-III	Weak	None	None	0.17% - 1.4%
IV	Light	None	None	1.4% - 3.9%
V	Moderate	Very Light	Light	3.9% - 9.2%
VI	Strong	Light	Moderate	9.2% - 18%
VII	Very Strong	Moderate	Moderate/Heavy	18% - 34%
VIII	Severe	Moderate/Heavy	Heavy	34% - 65%
IX	Violent	Heavy	Very Heavy	65% - 124%
X - XII	Extreme	Very Heavy	Very Heavy	>124%

PGA Peak Ground Acceleration

a. PGA measured in percent of g (%g), where g is the acceleration of gravity

Sources: USGS 2008; USGS 2010

11.1.4 Effect of Soil Types

The impact of an earthquake on structures and infrastructure is largely a function of ground shaking, distance from the source of the earthquake, and liquefaction, a secondary effect of an earthquake in which

soils lose their shear strength and flow or behave as liquid, thereby damaging structures that derive their support from the soil. Liquefaction generally occurs in soft, unconsolidated sedimentary soils. A program called the National Earthquake Hazard Reduction Program (NEHRP) creates maps based on soil characteristics to help identify locations subject to liquefaction. Table 11-2 summarizes NEHRP soil classifications. NEHRP Soils B and C typically can sustain ground shaking without much effect, dependent on the earthquake magnitude. The areas that are commonly most affected by ground shaking have NEHRP Soils D, E, and F. In general, these areas are also most susceptible to liquefaction.

TABLE 11-2.
NEHRP SOIL CLASSIFICATION SYSTEM

NEHRP Soil Type	Description	Mean Shear Velocity to 30 m (m/s)
A	Hard Rock	1,500
B	Firm to Hard Rock	760-1,500
C	Dense Soil/Soft Rock	360-760
D	Stiff Soil	180-360
E	Soft Clays	< 180
F	Special Study Soils (liquefiable soils, sensitive clays, organic soils, soft clays >36 m thick)	

Notes:
m Meters
m/s Meters per second

11.2 HAZARD PROFILE

Earthquakes can last from a few seconds to over 5 minutes; they may also occur as a series of tremors over several days. The actual movement of the ground in an earthquake is seldom the direct cause of injury or death. Casualties generally result from falling objects and debris, because the shocks shake, damage, or demolish buildings and other structures. Disruption of communications, electrical power supplies and gas, sewer, and water lines should be expected. Earthquakes may trigger fires, dam failures, landslides, or releases of hazardous material, compounding their disastrous effects.

Small, local faults produce lower magnitude quakes, but ground shaking can be strong and damage can be significant in areas close to the fault. In contrast, large regional faults can generate earthquakes of great magnitudes but, because of their distance and depth, they may result in only moderate shaking in an area.

11.2.1 Past Events

Colorado has a relatively short period of historical records for earthquakes. An earthquake and fault map developed by the Colorado Geological Survey depicts the location of historical epicenters and potentially active faults in that state. Figure 11-1 shows the faults and recorded earthquakes for Clear Creek County and vicinity. The map indicates that there are two recorded earthquake events occurred in Clear Creek County. Both events are historical events that were mentioned in a newspaper, one from 1871 and the second from 1894. Figure 11-1 also shows the location of a monitoring station located in Clear Creek County.

Source: Colorado Geological Survey (http://dnrwebmapgdev.state.co.us/cgsonline/)

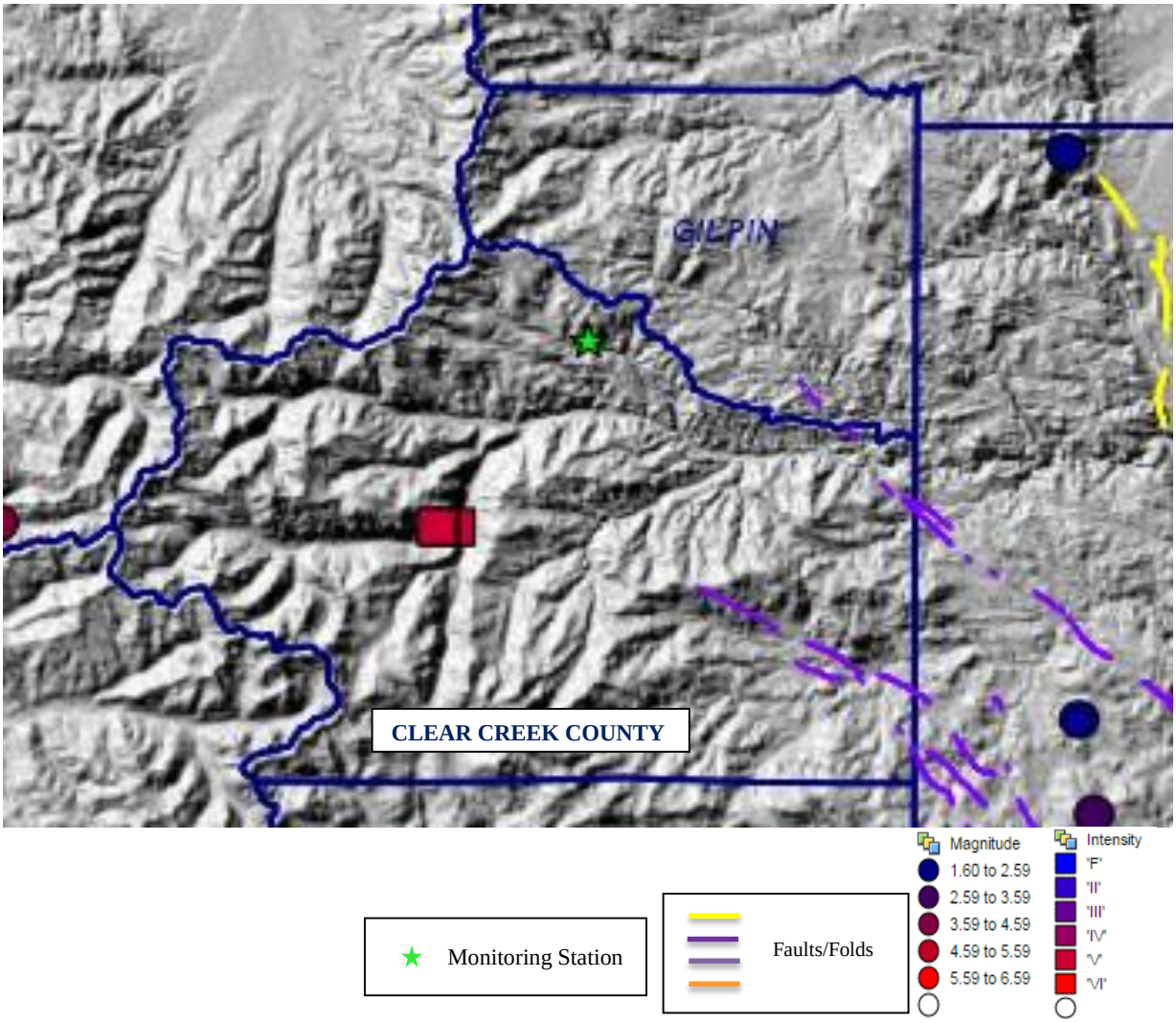


Figure 11-1. Earthquake Faults and 1870 – 2015 Recorded Epicenters Map for Clear Creek County and Vicinity

11.2.2 Location

Geological research indicates that faults capable of producing earthquakes are prevalent in Colorado. There are approximately 90 potentially active faults in Colorado with documented movement within the last 1.6 million years. Clear Creek County has two major faults that run on the eastern portion of the county. Floyd Hill Fault is the more northern fault that runs through only a small portion of the county. The Kennedy Gulch Fault is larger and runs through more of the central and eastern portion of the county. Parts of the Kennedy Gulch Fault are not represented on Figure 11-1, but portions of the fault run just southeast of Georgetown. Figure 11-2 shows other potentially active faults near Clear Creek County and in all of Colorado. More than 700 earthquake tremors of magnitude 2.5 or higher have been recorded in Colorado since 1867. This is considered relatively infrequent for a western state.

Source: Colorado Earthquake Hazard Mitigation Council 2008

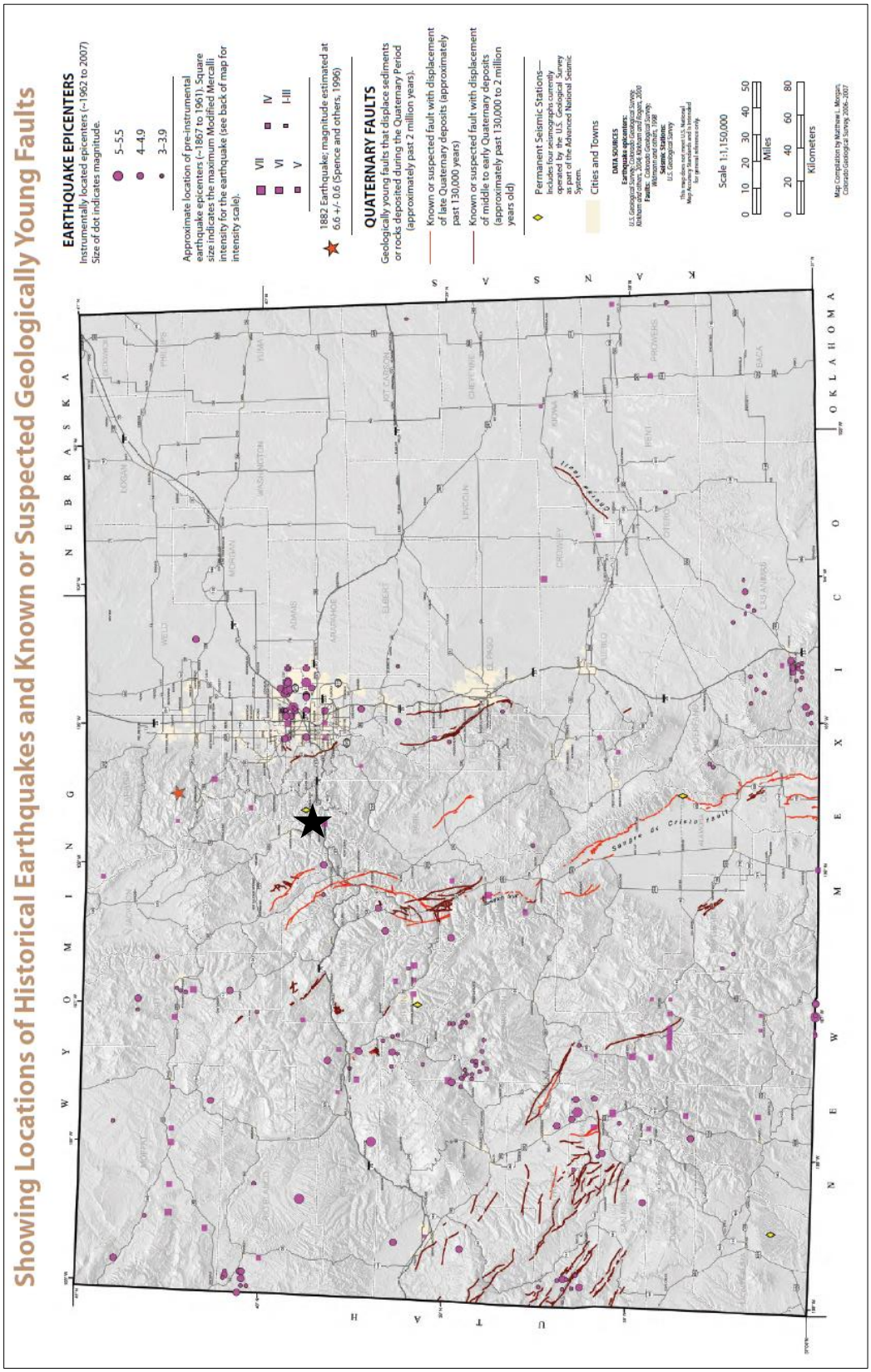


Figure 11-2. Colorado Earthquakes and Fault Map

Faults have been classified based on the geologic time frame of their latest suspected movement (in order of activity occurrence, most recent is listed first):

- H—Holocene (within past 15,000 years)
- LQ—Late Quaternary (15,000 to 130,000 years)
- MLQ—Middle to Late Quaternary (130,000 to 750,000 years)
- Q—Quaternary (approximately past 2 million years)
- LC—Late Cenozoic (approximately past 23.7 million years)

11.2.3 Frequency and Severity

Research based on Colorado's earthquake history suggests that an earthquake of magnitude 6.3 or larger has a 1% probability of occurring each year somewhere in Colorado (Charlie, Doehring, Oaks Colorado Earthquake Hazard Reduction Program Open File Report 93-01 1993).

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

The severity of an earthquake can be expressed in terms of intensity or magnitude. Intensity represents the observed effects of ground shaking on people, buildings, and natural features. According to FEMA's *2006 Homebuilder's Guide to Earthquake Resistant Design and Construction*, the International Residential Code designates the level of potential seismic hazard for dwellings by assigning a house to a Seismic Design Category based on its location. Clear Creek County is in category B and has the potential of moderate ground shaking.

Magnitude is related to the amount of seismic energy released at the hypocenter of an earthquake. It is calculated based on the amplitude of the earthquake waves recorded on instruments. Whereas intensity varies depending on location with respect to the earthquake epicenter, magnitude is represented by a single, instrumentally measured value for each earthquake event.

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

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

Mapping that shows the impacts of these components was used to assess the risk of earthquakes within the planning area. While the impacts from each of these components can build upon each other during an earthquake event, the mapping looks at each component individually. One probabilistic scenario and two earthquake scenarios were selected for this plan:

500-Year Probabilistic Scenario (see Figure 11-3)—This is a HAZUS-MH Probabilistic Event scenario, which allows the user to generate estimates of damage and loss based on the seismic hazard for a specified return period.

Golden Fault Scenario (see Figure 11-4)—A magnitude 6.5 event with an epicenter approximately 15 miles east of Clear Creek County. This is a HAZUS-MH Arbitrary-Event scenario, which is

defined by the location of its epicenter and by its magnitude. The epicenter is defined by latitude and longitude. The following user-specified parameters were used

- Magnitude – 6.5
- Depth – 10 kilometers
- Rupture orientation – 193 degrees

Mosquito Fault Scenario (see Figure 11-5)—A magnitude 7.0 event with an epicenter approximately 30 miles east of Clear Creek County. This is a HAZUS-MH Arbitrary-Event scenario, which is defined by the location of its epicenter and by its magnitude. The epicenter is defined by latitude and longitude. The following user-specified parameters were used

- Magnitude – 7.0
- Depth – 10 kilometers
- Rupture orientation – 193 degrees

According to the information in this hazard profile, a large earthquake's impact on the county would be relatively minimal. Due to the low probability of damaging earthquakes, the overall significance is considered to have a low potential impact and the Town of Georgetown has no impact to earthquake.

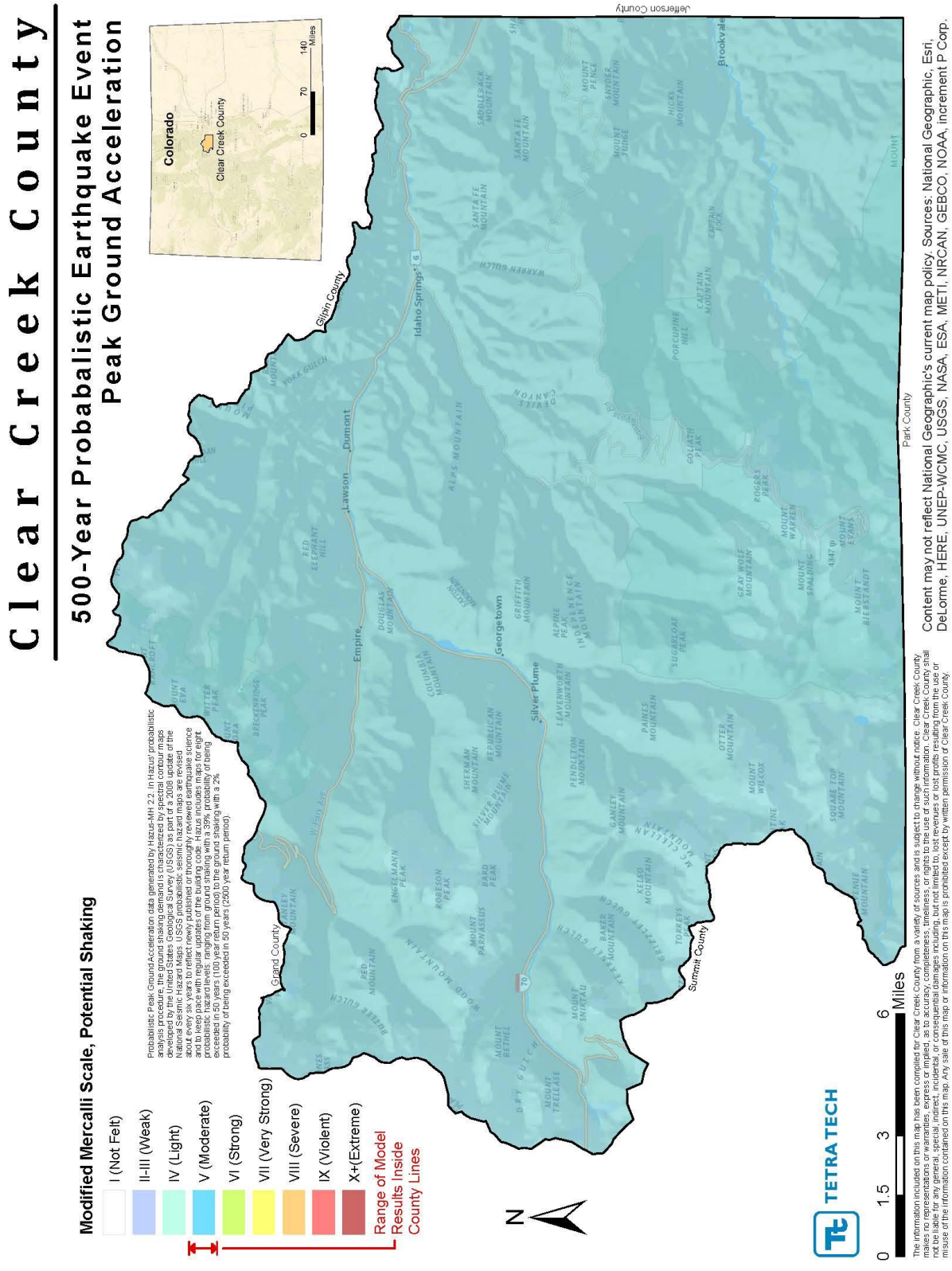


Figure 11-3. 500-Year Probabilistic Event

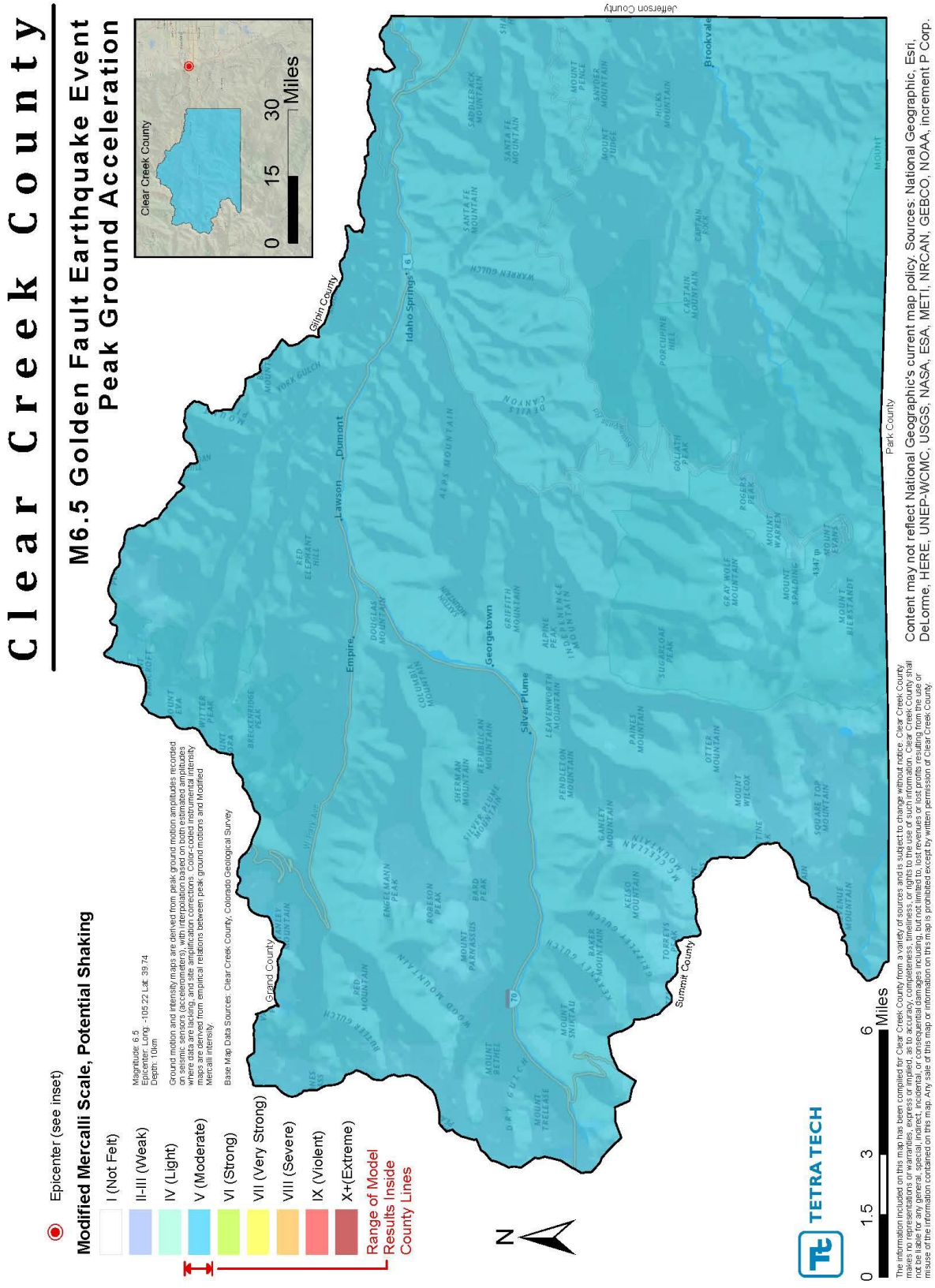


Figure 11-4. Golden Fault Magnitude 6.5 Event

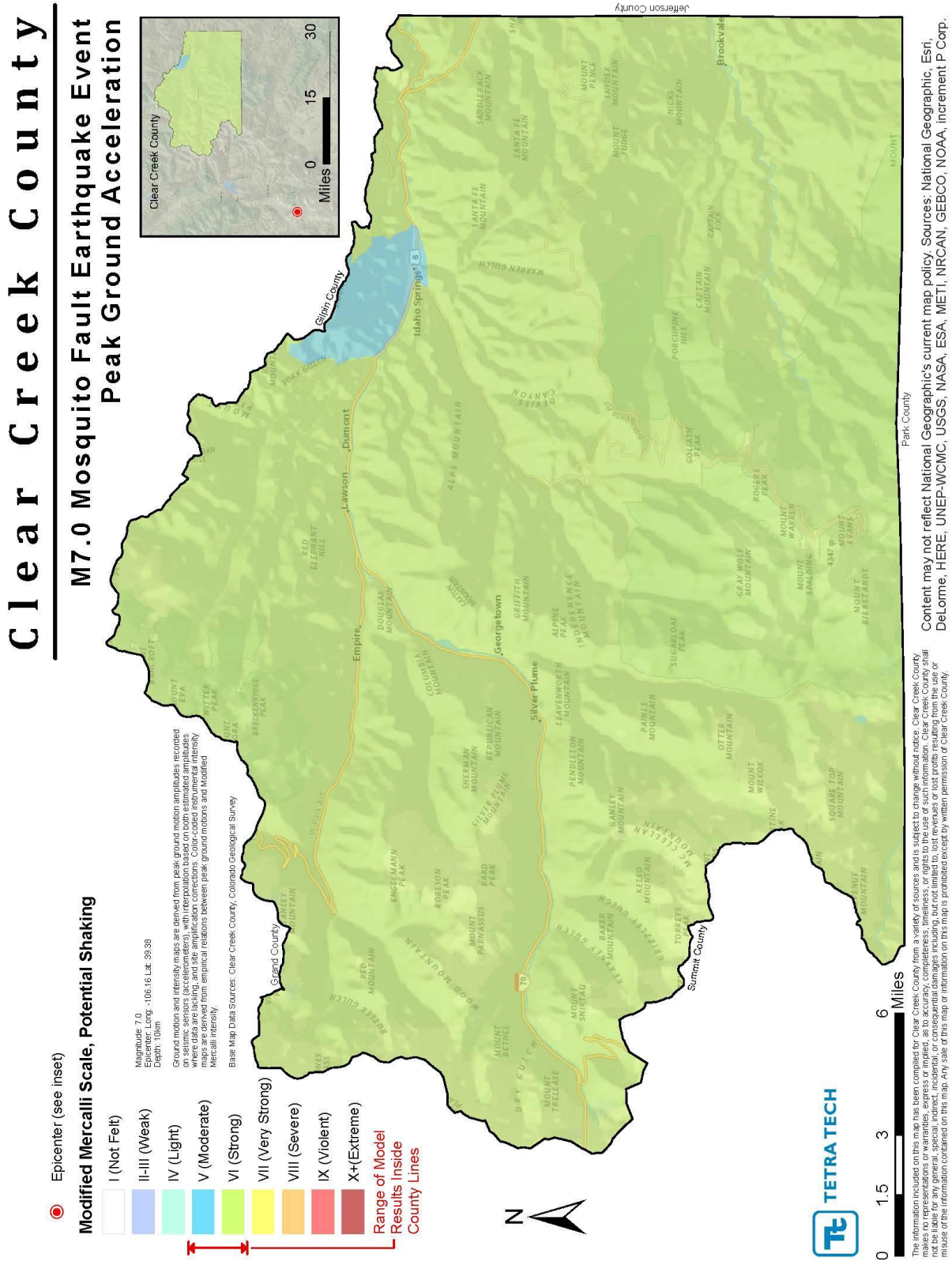


Figure 11-5. Mosquito Fault Magnitude 7.0 Event

11.2.4 Warning Time

Part of what makes earthquakes so destructive is that they generally occur without warning. The main shock of an earthquake can usually be measured in seconds, and rarely lasts for more than a minute. Aftershocks can occur within the days, weeks, and even months following a major earthquake.

By studying the geologic characteristics of faults, geoscientists can often estimate when the fault last moved and estimate the magnitude of the earthquake that produced the last movement. Because the occurrence of earthquakes is relatively infrequent in Colorado and the historical earthquake record is short, accurate estimations of magnitude, timing, or location of future dangerous earthquakes in Colorado are difficult to estimate.

There is currently no reliable way to predict the day or month that an earthquake will occur at any given location. Research is being done with warning systems that use the low energy waves that precede major earthquakes. These potential warning systems give approximately 40 seconds notice that a major earthquake is about to occur. The warning time is very short but it could allow for someone to get under a desk, step away from a hazardous material they are working with, or shut down a computer system.

11.3 SECONDARY HAZARDS

Earthquakes can cause large and sometimes disastrous landslides and mudslides. River valleys are vulnerable to slope failure, often as a result of loss of cohesion in clay-rich soils. Soil liquefaction occurs when water-saturated sands, silts, or gravelly soils are shaken so violently that the individual grains lose contact with one another and float freely in the water, turning the ground into a pudding-like liquid. Building and road foundations lose load-bearing strength and may sink into what was previously solid ground. Unless properly secured, hazardous materials can be released, causing significant damage to the environment and people. Earthen dams and levees are highly susceptible to seismic events and the impacts of their eventual failures can be considered secondary risks for earthquakes.

11.4 CLIMATE CHANGE IMPACTS

The impacts of global climate change on earthquake probability are unknown. Some scientists say that melting glaciers could induce tectonic activity. As ice melts and water runs off, tremendous amounts of weight are shifted on the earth's crust. As newly freed crust returns to its original, pre-glacier shape, it could cause seismic plates to slip and stimulate volcanic activity according to research into prehistoric earthquakes and volcanic activity. National Aeronautics and Space Administration (NASA) and USGS scientists found that retreating glaciers in southern Alaska may be opening the way for future earthquakes (NASA 2004).

Secondary impacts of earthquakes could be magnified by climate change. Soils saturated by repetitive storms could experience liquefaction during seismic activity due to the increased saturation. Dams storing increased volumes of water due to changes in the hydrograph could fail during seismic events. There are currently no models available to estimate these impacts.

11.5 EXPOSURE

11.5.1 Population

The entire population of Clear Creek County is potentially exposed to direct and indirect impacts from earthquakes. The degree of exposure is dependent on many factors, including the age and construction type of the structures people live in, the soil type their homes are constructed on, their proximity to fault location, etc. Whether impacted directly or indirectly, the entire population will have to deal with the consequences of earthquakes to some degree. Business interruption could keep people from working, road closures could isolate populations, and loss of functions of utilities could impact populations that suffered no direct damage from an event itself.

11.5.2 Property

According to Clear Creek County Assessor records, there are 5,244 buildings in the planning area, with a total assessed value of $112 billion. Because all structures in the planning area are susceptible to earthquake impacts to varying degrees, this total represents the countywide property exposure to seismic events. Most of the buildings are residential.

11.5.3 Critical Facilities and Infrastructure

All critical facilities and infrastructure in the planning area are exposed to the earthquake hazard. Table 6-4 and Table 6-5 list the number of each type of facility by jurisdiction. HAZMAT releases can occur during an earthquake from fixed facilities or transportation-related incidents. Transportation corridors can be disrupted during an earthquake, leading to the release of materials to the surrounding environment. Facilities holding HAZMAT are of particular concern because of possible isolation of neighborhoods surrounding them. During an earthquake, structures storing these materials could rupture and leak into the surrounding area or an adjacent waterway, having a disastrous effect on the environment.

11.5.4 Environment

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

11.6 VULNERABILITY

Earthquake vulnerability data was generated using a Level 2 HAZUS-MH analysis. Once the location and size of a hypothetical earthquake are identified, HAZUS-MH estimates the intensity of the ground shaking, the number of buildings damaged, the number of casualties, the damage to transportation systems and utilities, the number of people displaced from their homes, and the estimated cost of repair and clean up.

11.6.1 Population

Three population groups are particularly vulnerable to earthquake hazards:

- **Linguistically Isolated Populations**—Less than 5% of the planning area population over 5 years old speaks English “less than very well.” Problems arise when there is an urgent need to inform non-English speaking residents of an earthquake event. They are vulnerable because of difficulties in understanding hazard-related information from predominantly English-speaking media and government agencies.
- **Population below Poverty Level**—Families with incomes below the poverty level in 2013 made up 8.6% of the total county population. These families may lack the financial resources to improve their homes to prevent or mitigate earthquake damage. Poorer residents are also less likely to have insurance to compensate for losses in earthquakes.
- **Population over 65 Years Old**—Approximately 12.5% of the residents in Clear Creek County are over 65 years old. This population group is vulnerable because they are more likely to need special medical attention, which may not be available due to isolation caused by earthquakes. Elderly residents also have more difficulty leaving their homes during earthquake events and could be stranded in dangerous situations

Impacts on persons and households in the planning area were estimated for the 500-Year Probabilistic Earthquake and the Golden and Mosquito Fault scenario events through the Level 2 HAZUS-MH analysis. Table 11-3 summarizes the results.

TABLE 11-3.
ESTIMATED EARTHQUAKE IMPACT ON PERSONS AND HOUSEHOLDS

	Number of Displaced Households	Number of Persons Requiring Short-Term Shelter
500-Year Earthquake	0	0
Golden Fault Scenario	0	0
Mosquito Fault Scenario	2	1

11.6.2 Property

Building Age

Table 11-4 identifies significant milestones in building and seismic code requirements that directly affect the structural integrity of development. Using these time periods, the planning team used HAZUS-MH to identify the number of structures in the planning area by date of construction. The number of structures does not reflect the number of total housing units, as many multi-family units and attached housing units are reported as one structure. In addition, the year a structure was built was not available for all assessor records. Approximately 21% of the structures were constructed after the Uniform Building Code was amended in 1994 to include seismic safety provisions. Approximately 18% of the structures were built before 1933 when there were no building permits, inspections, or seismic standards.

TABLE 11-4.
AGE OF STRUCTURES IN CLEAR CREEK COUNTY

Time Period	Number of Current Planning Area Structures Built in Period	Significance of Time Frame
Pre-1933	947	Before 1933, there were no explicit earthquake requirements in building codes. State law did not require local governments to have building officials or issue building permits.
1933-1940	133	In 1940, the first strong motion recording was made.
1941-1960	502	In 1960, the Structural Engineers Association of California published guidelines on recommended earthquake provisions.
1961-1975	1,342	In 1975, significant improvements were made to lateral force requirements.
1976-1993	1,196	In 1994, the Uniform Building Code was amended to include provisions for seismic safety.
1994-Present	1,078	Seismic code is currently enforced in communities where there are building codes and those codes are enforced.
Total	**5,198**	

Loss Potential

Property losses were estimated through the Level 2 HAZUS-MH analysis for the 500-Year Probabilistic Earthquake and the Golden Fault scenarios. Table 11-5 through Table 11-7 show the results for two types of property loss:

- Structural loss, representing damage to building structures.

- Non-structural loss, representing the value of lost contents.

The total of the two types of losses is also shown in the tables. A summary of the property-related loss results is as follows:

- For a 500-Year Probabilistic Earthquake, the estimated damage potential is $1,820,000 or <0.1% of the total replacement value for the planning area.
- For a 6.5-magnitude Golden Fault event, the estimated damage potential is $3,641,000 or 0.2% of the total replacement value for the planning area.
- For a 6.5-magnitude Golden Fault event, the estimated damage potential is $3,641,000 or 0.2% of the total replacement value for the planning area.

TABLE 11-5.
LOSS ESTIMATES FOR 500-YEAR PROBABILISTIC EARTHQUAKE

	Estimated Loss Associated with Earthquake		
	Structure	Contents	**Total**
City of Idaho Springs	$266,000	$90,000	**$356,000**
Town of Empire	$33,000	$11,000	**$44,000**
Town of Silver Plume	$27,000	$9,000	**$36,000**
Rest of County	$1,057,000	$327,000	**$1,384,000**
Clear Creek County Total	**$1,383,000**	**$437,000**	**$1,820,000**

Note: Town of Georgetown has no exposure to earthquake.

TABLE 11-6.
LOSS ESTIMATES FOR GOLDEN FAULT SCENARIO EARTHQUAKE

	Estimated Loss Associated with Earthquake		
	Structure	Contents	**Total**
City of Idaho Springs	$818,000	$227,000	**$1,045,000**
Town of Empire	$21,000	$4,700	**$25,700**
Town of Silver Plume	$18,000	$4,000	**$22,000**
Rest of County	$2,062,000	$487,000	**$2,548,000**
Clear Creek County Total	**$2,919,000**	**$722,700**	**$3,642,700**

Note: Town of Georgetown has no exposure to earthquake.

TABLE 11-7.
LOSS ESTIMATES FOR MOSQUITO FAULT SCENARIO EARTHQUAKE

	Estimated Loss Associated with Earthquake		
	Structure	Contents	**Total**
City of Idaho Springs	$1,440,562	$378,400	**$1,818,692**
Town of Empire	$575,718	$149,221	**$724,938**
Town of Silver Plume	$471,719	$122,265	**$593,984**
Rest of County	$16,912,206	$4,366,858	**$16,211,456**
Clear Creek County Total	**$18,928,486**	**$4,894,479**	**$18,755,086**

The HAZUS-MH analysis also estimated the amount of earthquake-caused debris in the planning area for the 500-Year Probabilistic Earthquake and Golden and Mosquito Fault scenario events, as summarized in Table 11-8.

TABLE 11-8.
ESTIMATED EARTHQUAKE-CAUSED DEBRIS

	Debris to Be Removed (tons)
500-Year Earthquake	320
Golden Fault Scenario	700
Mosquito Fault Scenario	5,560

11.6.3 Critical Facilities and Infrastructure

Level of Damage

HAZUS-MH classifies the vulnerability of critical facilities to earthquake damage in five categories: no damage, slight damage, moderate damage, extensive damage, or complete damage. The model was used to assign a vulnerability category to each critical facility in the planning area except HAZMAT facilities and "other infrastructure" facilities, for which there are no established damage functions. The analysis was performed for all scenario events. Table 11-9 through Table 11-11 summarize the results.

TABLE 11-9.
ESTIMATED DAMAGE TO CRITICAL FACILITIES AND INFRASTRUCTURE FROM 500-YEAR EARTHQUAKE

Category	No Damage	Slight Damage	Moderate Damage	Extensive Damage	Complete Damage
Medical and Health	0	0	0	0	0
Protective Functions	8	0	0	0	0
Schools	6	0	0	0	0
Bridges	79	0	0	0	0
Potable Water	0	0	0	0	0

TABLE 11-9.
ESTIMATED DAMAGE TO CRITICAL FACILITIES AND INFRASTRUCTURE FROM 500-YEAR EARTHQUAKE

Wastewater	2	0	0	0	0
Power	0	0	0	0	0
Communications	3	0	0	0	0
Transportation	0	0	0	0	0
Total	**98**	**0**	**0**	**0**	**0**

TABLE 11-10.
ESTIMATED DAMAGE TO CRITICAL FACILITIES AND INFRASTRUCTURE FROM GOLDEN FAULT SCENARIO EVENT

Category	No Damage	Slight Damage	Moderate Damage	Extensive Damage	Complete Damage
Medical and Health	0	0	0	0	0
Protective Functions	8	0	0	0	0
Schools	6	0	0	0	0
Bridges	79	0	0	0	0
Potable Water	0	0	0	0	0
Wastewater	2	0	0	0	0
Power	0	0	0	0	0
Communications	3	0	0	0	0
Transportation	0	0	0	0	0
Total	**98**	**0**	**0**	**0**	**0**

TABLE 11-11.
ESTIMATED DAMAGE TO CRITICAL FACILITIES AND INFRASTRUCTURE FROM MOSQUITO FAULT SCENARIO EVENT

Category	No Damage	Slight Damage	Moderate Damage	Extensive Damage	Complete Damage
Medical and Health	0	0	0	0	0
Protective Functions	0	2	6	0	0
Schools	0	2	4	0	0
Bridges	5	4	70	0	0
Potable Water	0	0	0	0	0
Wastewater	0	0	2	0	0
Power	0	0	0	0	0
Communications	0	0	3	0	0

TABLE 11-11.
ESTIMATED DAMAGE TO CRITICAL FACILITIES AND INFRASTRUCTURE FROM MOSQUITO FAULT SCENARIO EVENT

Category	No Damage	Slight Damage	Moderate Damage	Extensive Damage	Complete Damage
Transportation	0	0	0	0	0
Total	**5**	**8**	**85**	**0**	**0**

Time to Return to Functionality

HAZUS-MH estimates the time to restore critical facilities to fully functional use. Results are presented as probability of being functional at specified time increments: 1, 3, 7, 14, 30 and 90 days after the event. For example, HAZUS-MH may estimate that a facility has 5% chance of being fully functional at Day 3, and a 95% chance of being fully functional at Day 90. The analysis of critical facilities in the planning area was performed for all scenario events. Table 11-12 through Table 11-14 summarize the results.

TABLE 11-12.
FUNCTIONALITY OF CRITICAL FACILITIES FOR 500-YEAR EVENT

Planning Unit	# of Critical Facilities	Probability of Being Fully Functional (%)					
		at Day 1	at Day 3	at Day 7	at Day 14	at Day 30	at Day 90
Medical and Health	0	-	-	-	-	-	-
Protective Functions	8	97	97	99	99	99	99
Schools	6	97	97	99	99	99	99
Bridges	79	99	99	99	99	99	99
Potable Water	0	-	-	-	-	-	-
Wastewater	2	88	98	99	99	99	99
Power	0	-	-	-	-	-	-
Communications	3	99	99	99	99	99	99
Transportation	0	-	-	-	-	-	-
Total/Average	**100**	**96**	**98**	**99**	**99**	**99**	**99**

TABLE 11-13.
FUNCTIONALITY OF CRITICAL FACILITIES FOR GOLDEN SCENARIO EVENT

Planning Unit	# of Critical Facilities	Probability of Being Fully Functional (%)					
		at Day 1	at Day 3	at Day 7	at Day 14	at Day 30	at Day 90
Medical and Health	0	-	-	-	-	-	-
Protective Functions	8	91	91	99	99	99	99
Schools	6	91	91	99	99	99	99
Bridges	79	97	98	99	99	99	99
Potable Water	0	-	-	-	-	-	-
Wastewater	2	85	97	99	99	99	99

TABLE 11-13.
FUNCTIONALITY OF CRITICAL FACILITIES FOR GOLDEN SCENARIO EVENT

Planning Unit	# of Critical Facilities	Probability of Being Fully Functional (%)					
		at Day 1	at Day 3	at Day 7	at Day 14	at Day 30	at Day 90
Power	0	-	-	-	-	-	-
Communications	3	99	99	99	99	99	99
Transportation	0	-	-	-	-	-	-
Total/Average	**98**	**93**	**95**	**99**	**99**	**99**	**99**

TABLE 11-14.
FUNCTIONALITY OF CRITICAL FACILITIES FOR MOSQUITO SCENARIO EVENT

Planning Unit	# of Critical Facilities	Probability of Being Fully Functional (%)					
		at Day 1	at Day 3	at Day 7	at Day 14	at Day 30	at Day 90
Medical and Health	0	-	-	-	-	-	-
Protective Functions	8	91	91	99	99	99	99
Schools	6	91	91	99	99	99	99
Bridges	79	97	98	99	99	99	99
Potable Water	0	-	-	-	-	-	-
Wastewater	2	85	97	99	99	99	99
Power	0	-	-	-	-	-	-
Communications	3	99	99	99	99	99	99
Transportation	0	-	-	-	-	-	-
Total/Average	**98**	**93**	**95**	**99**	**99**	**99**	**99**

11.6.4 Environment

The environment vulnerable to earthquake hazard is the same as the environment exposed to the hazard.

11.7 FUTURE TRENDS IN DEVELOPMENT

Land use in the planning area will be directed by the comprehensive plans adopted by the county and its planning partners as well as local permitting departments and zoning maps. The information in this plan provides the participating partners a tool to ensure that there is no increase in exposure in areas of high seismic risk. Development in the planning area will be regulated through building standards and performance measures so that the degree of risk will be reduced. The International Building Code also establishes provisions to address seismic risk.

11.8 SCENARIO

An earthquake does not have to occur within the planning area to have a significant impact on the people, property and economy of the county. Any seismic activity of magnitude 6.0 or greater on faults within or near the planning area would have significant impacts throughout the county. Earthquakes of this magnitude or higher would lead to massive structural failure of property on highly liquefiable soils. Levees and revetments built on these poor soils would likely fail, representing a loss of critical infrastructure. These events could cause secondary hazards, including landslides and mudslides that would further damage

structures. River valley hydraulic-fill sediment areas are also vulnerable to slope failure, often as a result of loss of cohesion in clay-rich soils.

11.9 ISSUES

Important issues associated with an earthquake include but are not limited to the following:

- Approximately half of the planning area's building stock was built prior to 1975, when seismic provisions became uniformly applied through building code applications.
- Critical facility owners should be encouraged to create or enhance continuity of operations plans using the information on risk and vulnerability contained in this plan.
- Geotechnical standards should be established that take into account the probable impacts from earthquakes in the design and construction of new or enhanced facilities.
- Earthquakes could trigger other natural hazard events such as dam failures and landslides, which could severely impact the county.
- A worst-case scenario would be the occurrence of a large seismic event during a flood or high-water event. Failures could happen at multiple locations, increasing the impacts of the individual events.
- The cost of retro-fitting buildings to meet earthquake seismicity standards may be cost-prohibitive.
- Dams located in the county may not have been engineered to withstand probable seismic events.
- Information regarding liquefaction susceptibility of soils in the planning area is lacking.

Chapter 12.
EROSION AND DEPOSITION, EXPANSIVE SOIL, AND SUBSIDENCE

EROSION AND DEPOSITION, EXPANSIVE SOIL, AND SUBSIDENCE HAZARD RANKING			
	Erosion and Deposition	**Expansive Soil**	**Subsidence**
Clear Creek County	Low	Low	Low
City of Idaho Springs	Low	Low	High
Town of Empire	Medium	Low	Low
Town of Georgetown	Medium	Low	Low
Town of Silver Plume	Low	Low	Low
See Chapter 20 for more information on hazard ranking.			

12.1 GENERAL BACKGROUND

12.1.1 Erosion and Deposition

The Colorado Geological Survey defines erosion as "the removal and simultaneous transportation of earth materials from one location to another by water, wind, waves, or moving ice" (Colorado Geological Survey, 2014). Deposition is defined as "the placing of eroded material in a new location" (Colorado Geological Survey, 2014). According to the Colorado Geological Survey, all material that is eroded is later deposited in another location. Both erosion and deposition are continually occurring phenomenon, although the rate of erosion and deposition varies tremendously and can be affected by a variety of factors including rate of scour, type of material being eroded, and the presence or absence of vegetation.

DEFINITIONS

Ground Subsidence— Ground subsidence is the sinking of land over human-caused or natural underground voids and the settlement of native low density soils.

Soil Erosion— Soil erosion is the removal and simultaneous transportation of earth materials from one location to another by water, wind, waves, or moving ice.

Deposition— Deposition is the placing of eroded material in a new location.

12.1.2 Expansive Soil

Expansive and collapsible soils are some of the most widely distributed and costly geologic hazards. Collapsible soils are a group of soils that can rapidly settle or collapse the ground. They are also known as metastable soils and are unsaturated soils that undergo changes in volume and settlement in response to wetting and drying, often resulting in severe damage to structures. The sudden and usually large volume change could cause considerable structural damage.

Expansive soil and rock are characterized by clayey material that shrinks as it dries or swells as it becomes wet. In addition, trees and shrubs placed closely to a structure can lead to soil drying and subsequent shrinkage. The parent (source) rock most associated with expansive soils is shale. Figure 12-1 shows expansive soil distribution in United States.

Collapsible soils consist of loose, dry, low-density materials that collapse and compact under the addition of water or excessive loading. Soil collapse occurs when the land surface is saturated at depths greater than those reached by typical rain events. This saturation eliminates the clay bonds holding the soil grains

together. Similar to expansive soils, collapsible soils result in structural damage such as cracking of the foundation, floors, and walls in response to settlement.

12.1.3 Subsidence and Sinkholes

According to the 2013*Colorado State Hazard Mitigation Plan*, "ground subsidence is the sinking of land over human caused or natural underground voids and the settlement of native low density soils" (Colorado Division of Emergency Management 2011). Subsidence can occur gradually over time or virtually instantaneously. There are many different types of subsidence; however, in Colorado, there are three types of subsidence that warrant the most concern: settlement related to collapsing soils, sinkholes in karst areas, and the ground subsidence over abandoned mine workings.

Collapsible Soils

Collapsible soils are a group of soils that can rapidly settle or collapse the ground. The most common type of collapsible soil is hydrocompactive soil. According to the Colorado Geological Survey, "hydrocompactive soils form in semi-arid to arid climates in the western US and large parts of Colorado in specific depositional environments" (Colorado Geological Survey 2014). These soils are low in density and in moisture content and are loosely packed together. Agents that bind these loosely packed particles together, such as clay and silk buttresses, are water sensitive. When water is introduced to these soils, the binding agents may quickly break down, soften, disperse, or dissolve. This results in a reorganization of the soil particles in a more dense arrangement, which in turn results in a net volume loss indicated by resettlement or subsidence at the surface (Colorado Geological Survey 2014). Volume loss can be between 10 to 15%, which can result in several feet of surface-level displacement.

Sinkholes in Karst Areas

Most sinkholes in Colorado are related to the dissolution of evaporite minerals or limestone. Evaporite minerals dissolve in water and include gypsum and halite. Rocks containing limestone also form sinkholes based on dissolution by water. The term "karst" describes a landscape that has been shaped by the dissolution of these types of bedrock (Colorado Geological Survey 2014). According to a newsletter issued by the Colorado Geological Survey, "two characteristics of evaporative bedrock are important. One is that evaporative minerals can flow, like a hot plastic, when certain pressures and temperatures are exceeded. The second, and most important to land use and development is that evaporative minerals dissolve in the presence of freshwater. It is this dissolution of the rock that creates caverns, open fissures, streams out letting from bedrock, breccia pipes, subsidence sags and depressions, and sinkholes" (Colorado Geological Survey 2001).

Factors leading to the formation of sinkholes in these landscapes may be natural or may be induced by human activities. Natural contributing factors include the downward percolation of surface water through the rock formation or the lateral movement of water within a water table. Human activities that may contribute to such subsistence include stream channel changes, irrigation ditches, land irrigation leaking or broken pipes, temporary or permanent ponding of surface waters, and mining of soluble materials by means of forced circulation of water (Colorado Geological Survey 2014).

Abandoned Mine Workings

The underground removal of minerals and rock can undermine underground support systems and lead to void spaces. These voids can then be affected by natural and man-made processes such as caving, changes in flowage, or changes in overlying rock and soil material resulting in collapse or subsidence. Hazards from these abandoned sites are complicated by the fact that many "final mine maps" are inaccurate or incomplete (Colorado Geological Survey 2014). Mines operating after August 1997 were required by federal and state law to take potential surface subsidence into account; however, mining has been an activity in the state since the 1860s (Colorado Geological Survey 2001). There are some mapped, known mine hazard areas in

Colorado and in Clear Creek County. Three mapped road-mine sinkholes are documented in the vicinity of Idaho Springs.

12.2 HAZARD PROFILE

12.2.1 Past Events

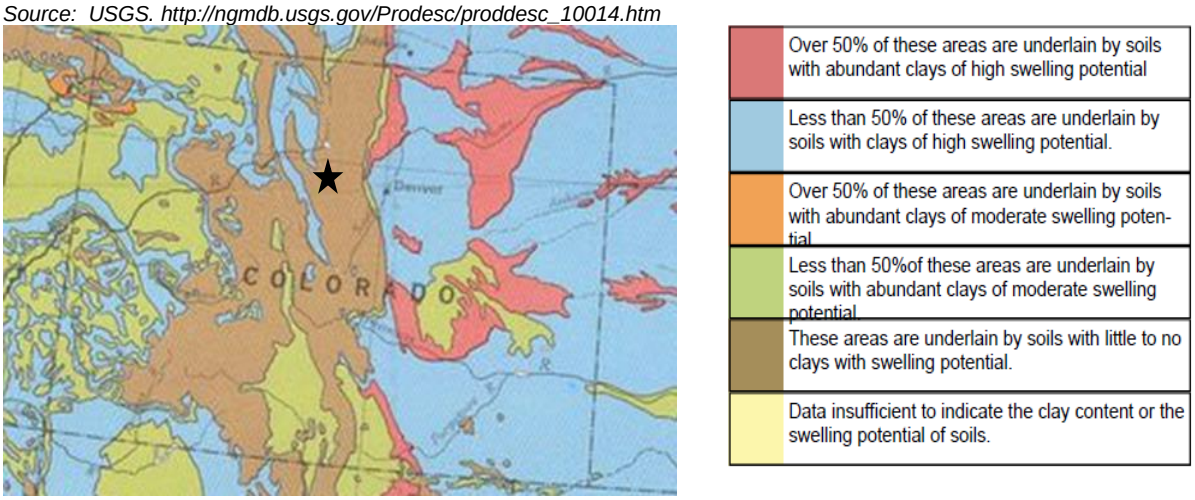
Erosion and Deposition

Soil erosion and deposition are ongoing events that can be affected by both natural and human-induced processes. Soil erosion and deposition events are continually occurring throughout the county. Portions of the county vary between highly erodible land to not highly erodible land. The majority of the highly erodible land is in higher sloped and mountainous areas.

Expansive Soil

Clear Creek County soils are mostly underlain by soils with less than 50% of clays with high swelling potential, with some areas, primarily the Front Range Mountains that are areas underlain by soils with little to no clays with swelling potential (Figure 12-1). Because the majority of the county is in mountainous terrain, there is little to no clay, resulting in minimal swelling potential.

Source: USGS. http://ngmdb.usgs.gov/Prodesc/proddesc_10014.htm



★ Clear Creek County

Figure 12-1. Expansive Soils in the State of Colorado

Subsidence and Sinkholes

The occurrence of subsidence is an on-going process resulting from natural and human induced causes. There have been three known events of subsidence and sinkhole events that have occurred within Clear Creek County and according to the USGS, primarily along the Interstate 70 corridor. Three road-mine sinkholes occurred and are mapped, one July 19, 2012, one April 14, 2006, and one August 27, 2004. Additional sinkhole details are below and two additional sinkhole occurrences.

- **March 22, 2016** – A car-size sinkhole opened up near an Interstate 70 off-ramp in Idaho Springs according to CDOT spokeswoman. CDOT crews filled the hole and then traffic was able to continue moving.
- **July 26, 2015** – A small 2 foot-wide sinkhole opened on the westbound side of Interstate 70 on the Loveland Bridge near Georgetown. There was no reported cost estimates or reported injuries associated with the sinkhole. CDOT blamed a "joint failure" for the sinkhole and it was not caused

by a mine shaft (source: CDOT news release, https://www.codot.gov/news/dailyclips/july-2015-clips/july-29-2015).

- **July 19, 2012** – CDOT was notified about a sinkhole 15 feet-deep and 14 feet-wide that opened up on Interstate 70 near Idaho Springs as shown in Figure 12-2. The sinkhole is believed to have opened up due to a couple of mine shafts weakening underneath the highway. There were no injuries and no vehicles damaged due to the sinkhole (source: CDOT news release, https://www.codot.gov/news/2012-news-releases/07-2012/i-70-sinkhole-in-idaho-springs-area).

Source: Channel 9 News, http://legacy.9news.com/story/news/local/4-pm-show/2014/02/22/1807844/, Photo KUSA

Figure 12-2. Sinkhole on Interstate 70 near Idaho Springs, Colorado, July 19, 2012

Erosion and Deposition

Soil erosion and deposition occur in all parts of the county. Point sources of erosion often occur in areas where humans interact with exposed areas of the earth's surface, such as construction sites. Waterways are continually involved in erosion and deposition processes. Erosion and deposition may be exacerbated in areas where wildfires have occurred. According to the *2013 State of Colorado Hazard Mitigation Plan*, "there is a high risk for erosion in the aftermath of a wildfire event. As a fire burns, it destroys plant material and the layers of litter that blanket the floor of an ecosystem. These materials, as well as trees, grasses, and shrubs, buffer and stabilize the soil from intense rainstorms. The plant materials slow runoff to give rainwater time to percolate into the ground. When fire destroys this protective later, rain and wind wash over the unprotected soil and erosion occurs" (Colorado Division of Emergency Management 2015). Areas in Clear Creek County that were recently burned are more susceptible to exacerbated erosion and deposition. Additionally, areas with high slopes and mountainous regions have a higher susceptibility to soil erosion.

Expansive Soil

Colorado is home to expansive soil, particularly bentonite. The leading cause of foundation damage in this type of soil is uneven moisture. Drying soil can shift and crack foundation as it shrinks. When moisture is applied the resulting swelling can crumble foundation. The entire planning area is exposed to a minimal risk from expansive soil since this mountainous county has very little underlay of clay soils.

Subsidence and Sinkholes

According to the Colorado Geological Survey, "Most catalogued sinkholes of Colorado lie on surficial deposits such as flat-lying glacial outwash terraces, recent valley side sediments, or older deposits on pediment slopes overlying the evaporite bedrock. The highest density of sinkholes that are manifested at the surface in Colorado occur in the Garfield County, Eagle County, Rio Blanco County, and Park County" (Colorado Geological Survey 2001). Figure 12-3 shows the locations of Evaporative Bedrock, Sinkholes, and Historic Gypsum Mining in the county. Figure 12-4 shows the Average Erosion Potential in tons per acre per year for the county based on based on slope, water drainage, and other factors.

There are five known sinkhole hole events that have occurred in the county. The sinkholes are a result of old, unmapped mines. Figure 12-7 shows the documented areas of road-mine sinkholes in the vicinity of the Town of Idaho Springs.

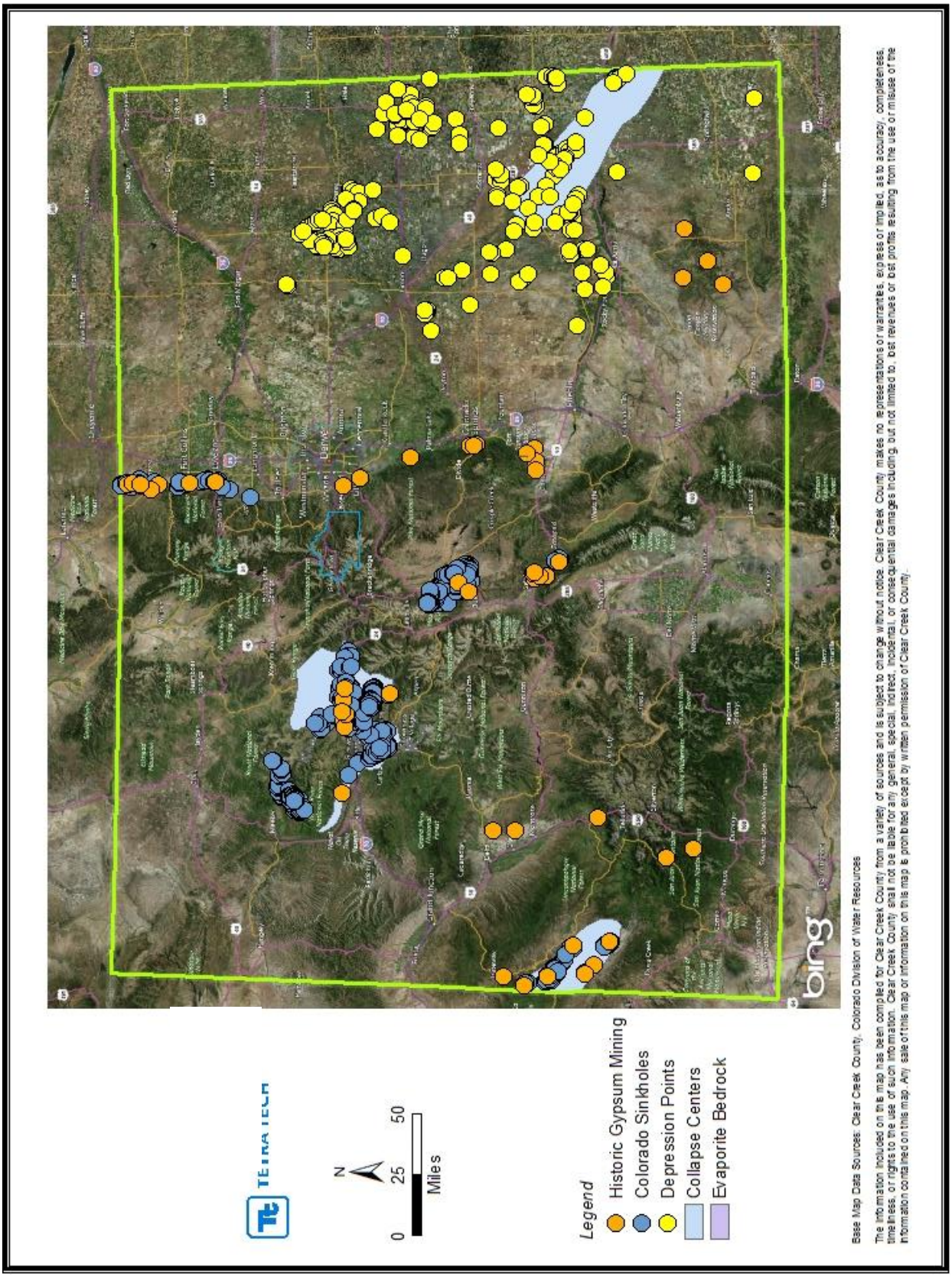


Figure 12-5. Evaporative Bedrock, Sinkholes, and Historic Gypsum Mining

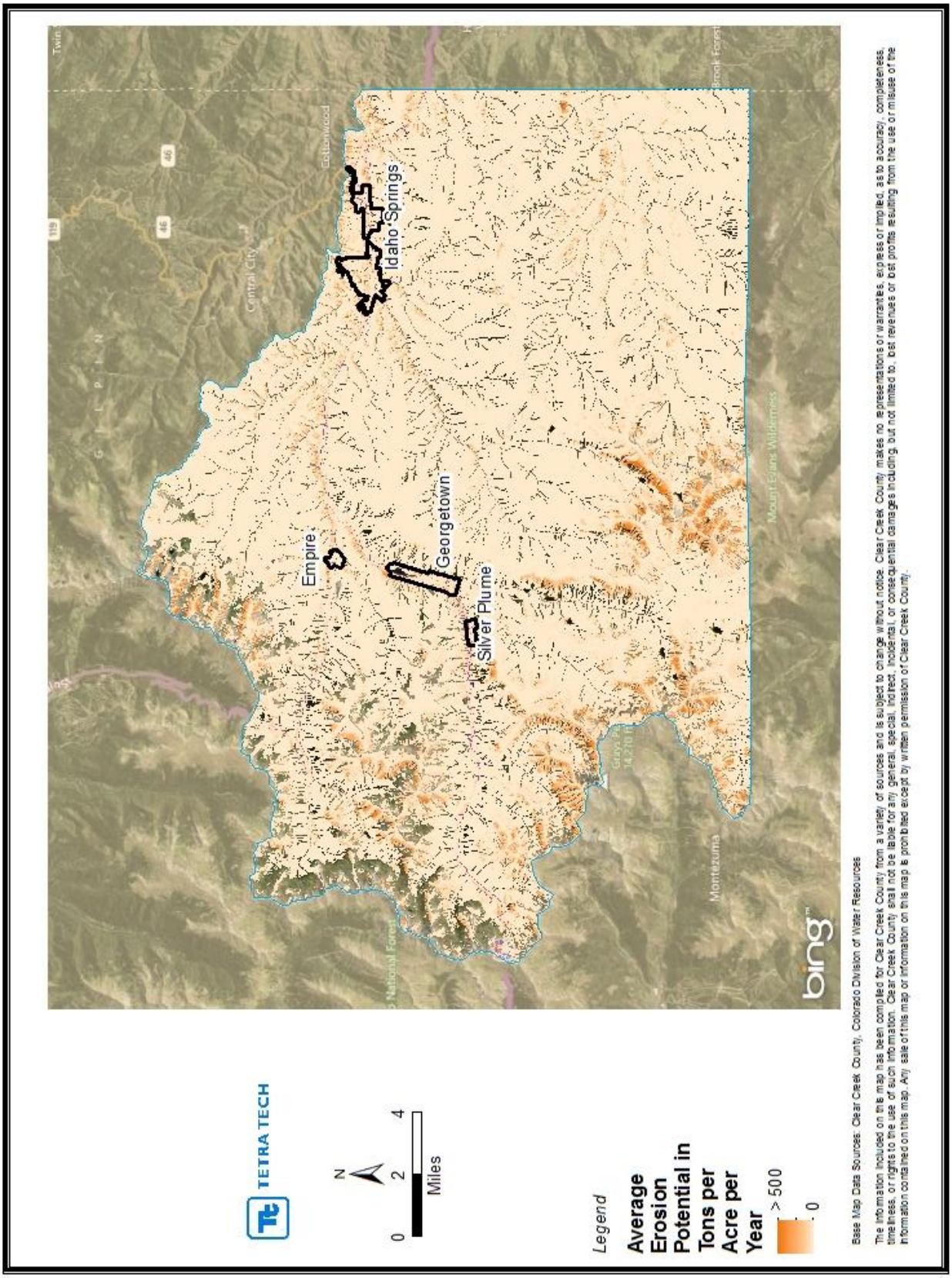


Figure 12-6. Clear Creek County Average Erosion Potential in Tons per Acre per Year

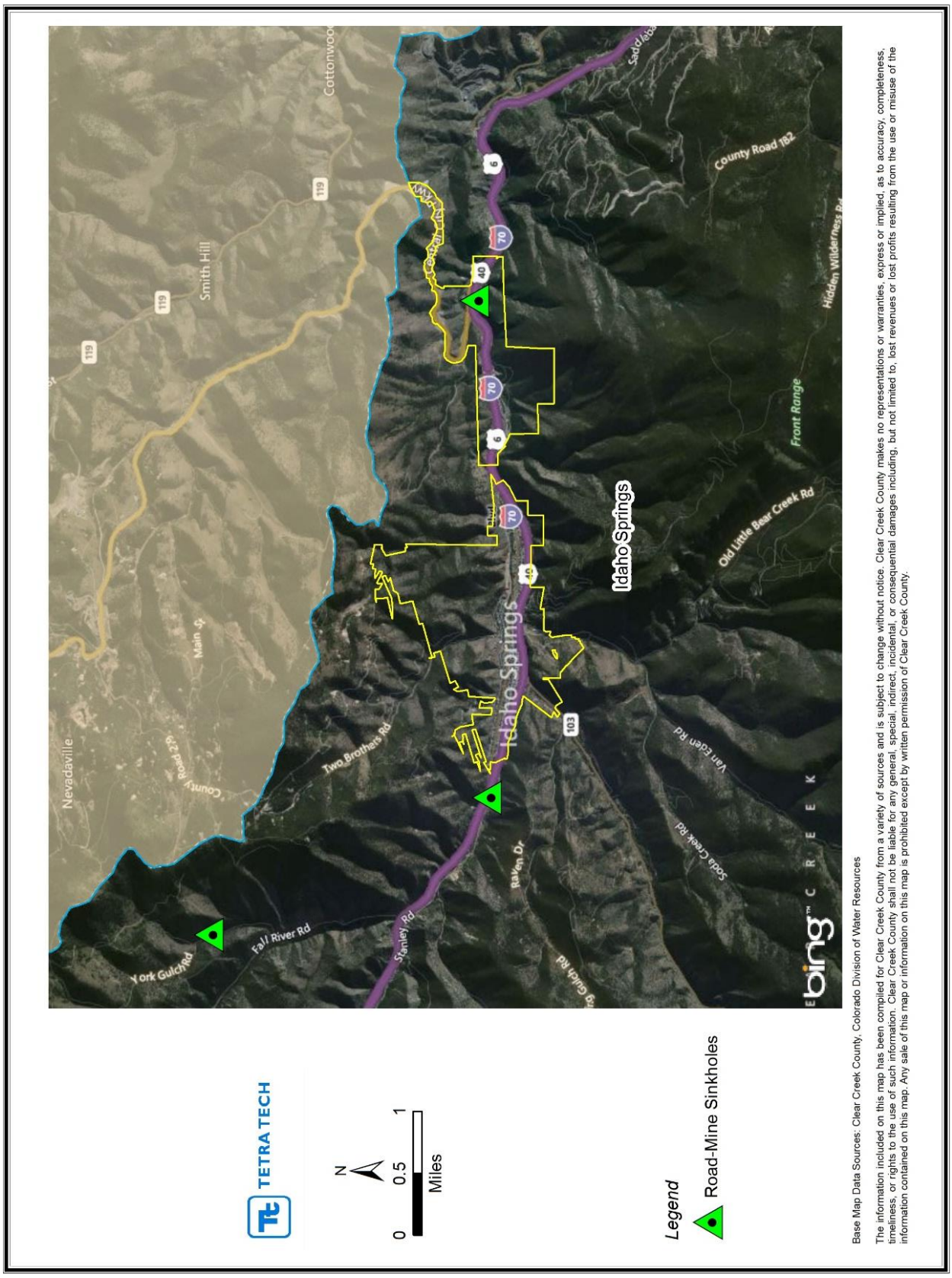


Figure 12-7. Location of Road-Mine Sinkholes, 2004-2012

12.2.2 Frequency and Severity

Erosion and deposition, subsidence, and sinkholes are occurring continuously throughout the county and the probability is likely to continue in the future. Large precipitation events as well as human activity may influence the frequency of these events. Expansive soils is not likely to occur in the county.

The severity of erosion and deposition, subsidence, and sinkholes is largely related to the extent and location of areas that are impacted. Such events can cause property damage as well as loss of life; however, events may also occur in remote areas of the county where there is little to no impact to people or property. According to the Colorado Geological Survey, "In general, the type and severity of surface subsidence is governed by the amount of ground surface and the location of removal or compression, and the geological conditions of a particular site" (Colorado Geological Survey 2014).

Based on the information in this hazard profile, the magnitude/severity of erosion and deposition, expansive soils and subsidence is considered to have a low to moderate potential impact for the county. The City of Idaho Springs is considered to have a low potential impacts for erosion and deposition and expansive soils, but a high potential impact for subsidence based on past road-mine sinkhole events. The Towns of Empire, and Georgetown is considered to have a moderate potential impact for erosion and deposition, but low potential for expansive soils and subsidence. The Town of Silver Plume is considered to have a low potential impact for erosion and deposition, expansive soils, and subsidence. Unmapped and abandoned mining locations can cause a serious issue for Clear Creek County with the threat of soil collapse. There is historically a good deal of mining that has occurred in Clear Creek County. Though there are no marked areas of immediate concern, more research is needed to identify locations of past mining locations.

12.2.3 Warning Time

Subsidence can happen suddenly and without warning or can occur gradually over time. Soil erosion and deposition generally occurs gradually over time; however, these processes may be intensified as a result of natural or human-induced activities. According to Colorado Geological Survey, there are some instances where the rate of subsidence can be calculated, particularly subsidence that occurs as a result of mining activities (Colorado Geological Survey 2001):

> *Where longwall mining is active and subsidence is a well-documented and predictable action, surface response to ongoing mining can be accurately estimated. However, in the case of room and pillar mines, especially where they are inaccessible and record-keeping may be inaccurate, predictions of when subsidence will happen are not possible.*
>
> *How much subsidence will occur and the features that will appear at the surface depend not only on the type of mining but on geology and several physical features of the voids left by mining. Some general rules of thumb are:*
>
> - *The larger the mine opening height and width, the larger the subsidence feature at the surface,*
> - *The shallower the mine below ground, the more noticeable the surface subsidence evidence; however, in Colorado pits have been found over mines as deep as 350 feet,*
> - *The strength of the rock above the coal seam influences whether subsidence will reach the surface and the kind of features that can appear.*

12.3 SECONDARY HAZARDS

Events that cause damage to improved areas can result in secondary hazards, such as explosions from natural gas lines, loss of utilities such as water and sewer due to shifting infrastructure, and potential failures of reservoir dams. Additionally, these events may occur simultaneously with other natural hazards such as flooding. Erosion can cause undercutting that can result in an increase in landslide or rockfall hazards.

Additionally erosion can result in the loss of topsoil, which can affect agricultural production in the area. Deposition can have impacts that aggravate flooding, bury crops, or reduce capacities of water reservoirs.

12.4 CLIMATE CHANGE IMPACTS

Changes in precipitation events and the hydrological cycle may result in changes in the rate of subsidence and soil erosion. According to a 2003 paper published by the Soil and Water Conservation Society (Soil and Water Conservation 2003):

> *The potential for climate change – as expressed in changed precipitation regimes – to increase the risk of soil erosion, surface runoff, and related environmental consequences is clear. The actual damage that would result from such a change is unclear. Regional, seasonal, and temporal variability in precipitation is large both in simulated climate regimes and in the existing climate record. Different landscapes vary greatly in their vulnerability to soil erosion and runoff. Timing of agricultural production practices creates even greater vulnerabilities to soil erosion and runoff during certain seasons. The effect of a particular storm event depends on the moisture content of the soil before the storm starts. These interactions between precipitation, landscape, and management mean the actual outcomes of any particular change in precipitation regime will be complex.*

12.5 EXPOSURE

12.5.1 Population

Residents of the county living or travelling in areas prone to subsidence and erosion are exposed to the hazard. Population exposure estimates are unavailable. The majority of the population is not exposed to subsidence. Interstate 70 is a major transportation route that transects Colorado and is a major national east-west highway. Disruption of transportation could cause major impacts to Clear Creek County, the State of Colorado, and potentially areas throughout the country.

12.5.2 Property

Structures and other improvements located in areas prone to subsistence or soil erosion are exposed to risk from these hazards, particularly structures located along streams and other waterways. Additionally, deposition may result in damage to structures and property.

12.5.3 Critical Facilities and Infrastructure

Any critical facilities or infrastructure that is located on or near areas prone to subsidence or soil erosion are exposed to risk from the hazard; particularly facilities located along streams and other waterways. Deposition may result in additional exposure to facilities and infrastructure, including dams, bridges, and roads. Interstate 70 is a major transportation route that transects Colorado and is a major national east-west highway. Disruption of transportation could cause major impacts to Clear Creek County, the State of Colorado, and potentially areas throughout the country.

12.5.4 Environment

Subsidence, erosion and deposition, and expansive soils are all naturally occurring processes, but can still cause damage to the natural environment. Environments located in areas prone to subsidence and deposition are exposed. Additionally, areas where sediments are deposited are also exposed.

12.6 VULNERABILITY

12.6.1 Population

The risk of injury or fatalities as a result of these hazards are limited, but possible. Spontaneous collapse and opening of voids are rare, but still may occur resulting in death or injury to any people in the area at the time. It is likely that any such injuries would be highly localized to the area directly impacted by an event. Erosion can adversely impact populations who have respiratory issues by reducing air quality, so those with existing respiratory issues are likely to be more vulnerable.

12.6.2 Property

Property exposed to subsidence and erosion can sustain minor damages or can result in complete destruction. According to Colorado Geological Survey, merely an inch of differential subsidence beneath a residential structure can cause several thousand dollars of damage. Structures may be condemned as a result of this damage resulting in large losses. FEMA estimates that there are over $125 million in losses in the U.S. annually as a result of subsidence. Structures exposed to erosion hazard areas may be undermined, resulting in damages. This may also result in the condemnation of a structure. Additionally, physical loss land area may occur as a result of erosion.

12.6.3 Critical Facilities and Infrastructure

Subsidence can result in serious structural damage to critical facilities and infrastructure such as, roads, irrigation ditches, underground utilities and pipelines. According to Colorado Geological Survey, large ground displacements caused by collapsing soils can totally destroy roads and structures and alter surface drainage. Minor cracking and distress may result as the improvements respond to small adjustments in the ground beneath them. Erosion can also impact structures such as bridges and roads by undermining their foundations. Structures and underground utilities found in areas prone to subsidence or soil erosion can suffer from distress. The shifting and settling of the structure can be seen in a number of ways:

- Settlement, cracking and tilting of concrete slabs and foundations,
- Displacement and cracking in door jams, window frames, and interior walls, or
- Offset cracking and separation in rigid walls such as brick, cinderblock, and mortared rock (Colorado Geological Survey 2001).

12.6.4 Environment

Ecosystems that are exposed to increased sedimentation as a result of erosion and deposition degrades habitat. However, some erosion and disposition is required for healthful ecosystem functioning. Ecosystems that are already exposed to other pressures, such as encroaching development, may be more vulnerable to impacts from these hazards.

12.7 FUTURE TRENDS IN DEVELOPMENT

According to the *2013 State of Colorado Hazard Mitigation Plan* (Colorado Division of Emergency Management 2015):

> *Future development will continue to intersect subsidence hazard areas based on past and projected population growth. Important identification and mitigation strategies are necessary in engineering geology and geotechnical investigations within the evaporite terrain mapped. Avoidance is generally the best mitigation solution where subsidence features are exposed at the surface and properly identified. Many older sinkholes may be hidden. Only subsurface inspections, either by investigative trenching, a series of investigative borings, geophysical means, and/or observations made during overlot grading or utility installation, can ascertain whether sinkholes exist within a*

development area. Ground-modification and structural solutions can help mitigate the threat of localized subsidence. Drainage issues and proper water management are also important. In Colorado's semi-arid climate, additional increases of fresh water may accelerate dissolution and further destabilize certain subsidence areas.

Jurisdictions in the planning area should ensure that known hazard areas are regulated under their planning and zoning programs. In areas where hazards may be present, permitting processes should require geotechnical investigations to access risk and vulnerability to hazard areas. Erosion issues generally do not impact land use except along river channels. Issues pertaining to land use in these areas are likely addressed through jurisdictional floodplain ordinances and regulations.

12.8 SCENARIO

A worst case scenario would occur if a rapidly occurring sinkhole opened up beneath a structure where many individuals lived or worked. This situation could result in a number of injuries or fatalities and would cause extensive damage to the area directly impacted.

12.9 ISSUES

The major issues for subsidence, expansive soils, erosion, and deposition are the following:

- Onset of actual or observed subsidence in many cases is related to changes in land use. Land uses permitted in known hazard areas should be carefully evaluated.
- Knowledge of hydrologic factors is critical for evaluating most types of ground subsidence.
- Abandoned mine information is incomplete. There are likely to be hazardous areas in addition to known locations.
- Some housing developments have had subsidence hazard investigations completed before development. This practice should be expanded.
- Homeowners within an undermined area that were built before 1989 are eligible to participate in the Mine Subsidence Protection Program, a federal program operated by the Mined Land Reclamation Board of the Division of Minerals and Geology. Homes built after 1989 are not covered.
- Many older sinkholes have been covered with recent soil infilling and are completely concealed at the surface
- Human activities greatly influence the rate and extent of erosion and deposition. Activities should be evaluated before proceeding with them.
- Riverine erosion can reduce water quality and impact aquatic habitat as well as impacting private property and critical infrastructure.
- More detailed analysis should be conducted for critical facilities and infrastructure exposed to hazard areas. This analysis should address how potential structural issues were addressed in facility design and construction.

Chapter 13.
FLOOD

FLOOD HAZARD RANKING	
Clear Creek County	High
City of Idaho Springs	High
Town of Empire	High
Town of Georgetown	High
Town of Silver Plume	High
See Chapter 20 for more information on hazard ranking.	

DEFINITIONS

Flood—The inundation of normally dry land resulting from the rising and overflowing of a body of water.

Floodplain—The land area along the sides of a river that becomes inundated with water during a flood.

100-Year Floodplain—The area flooded by a flood that has a 1% chance of being equaled or exceeded each year. This is a statistical average only; a 100-year flood can occur more than once in a short period of time. The 1% annual chance flood is the standard used by most federal and state agencies.

Riparian Zone—The area along the banks of a natural watercourse.

13.1 GENERAL BACKGROUND

13.1.1 Flood

The following section is excerpted from the *2013 State of Colorado Flood Mitigation Plan.*

A flood is a general and temporary condition of partial or complete inundation of normally dry land areas from:

- The overflow of stream banks,
- The unusual and rapid accumulation of runoff of surface waters from any source, or
- Mudflows or the sudden collapse of shoreline land.

Flooding results when the flow of water is greater than the normal carrying capacity of the stream channel. Rate of rise, magnitude (or peak discharge), duration, and frequency of floods are a function of specific physiographic characteristics. Generally, the rise in water surface elevation is quite rapid on 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. Floods may also be caused by structural or hydrologic failures of dams or levees. A hydrologic failure occurs when the volume of water behind the dam or levee exceeds the structure‘s capacity resulting in overtopping. Structural failure arises when the physical stability of the dam or levee is compromised due to age, poor construction and maintenance, seismic activity, rodent tunneling, or myriad other causes. For more information on floods resulting from dam and levee failure refer to Chapter 9 of this plan.

General Rain Floods

General rain floods can result from moderate to heavy rainfall occurring over a wide geographic area lasting several days. They are characterized by a slow steady rise in stream stage and a peak flood of long duration. As various minor streams empty into larger and larger channels, the peak discharge on the mainstream channel may progress upstream or downstream (or remain stationary) over a considerable length of river.

General rain floods can result in considerably large volumes of water. 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

Damaging thunderstorm floods are caused by intense rain over basins of relatively small area. They are characterized by a sudden rise in stream level, 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. The average number of thunderstorm days per year in Colorado varies from less than 40 near the western boundary to over 70 in the mountains along the Front Range. The thunderstorm flood season in Colorado is from the middle of July through October.

Snowmelt Floods

Snowmelt floods result from melting of winter snowpack in the high mountain areas. Snowmelt floods typically begin as spring runoff appears, after the first spring warming trend. If the warming trend continues up to 8 to 10 consecutive days in a basin where the snowpack has a water content more than about 150% 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. Once snowmelt floods have peaked, the daily decreases are moderate, but fairly constant. Snowmelt flooding usually occurs in May, June, and early July.

Rain on Snowmelt Floods

Rain on snow flooding occurs most often in Colorado during the month of May. It is at this time of year that large general rainstorms occur over western Colorado. These rainstorms are most often caused when warm moist air from the Gulf of Mexico begins pushing far enough north that it begins to affect western weather. In combination with this movement of air mass is the continued possibility of cold fronts moving into Colorado from the Pacific Northwest. When these weather phenomena collide, long lasting general rainstorms can often occur. Rain on snowmelt exacerbates an already tenuous situation as snowmelt waters rush down heavily incised stream channels. Any abnormal increase in flow from other sources usually causes streams to leave their banks.

During the summer months of May and June when rivers are running high, there is a potential for flooding due to rain falling on melting snow. 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. To some extent, the cloud cover associated with the rain system can slow the melting cycle and offset the compound effect. In some cases, however, rainfall may be heavy and widespread enough to noticeably affect peak flows throughout the basin.

Ice Jam Floods

Ice jam floods can occur by two phenomena. In the mountain floodplains during extended cold periods of 20 to 40 degrees below zero, the streams ice over. The channels are frozen solid and overbank flow occurs, which results in ice inundation in the floodplains. Ice jam floods can 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. An ice jam can also break up, suddenly causing a surge of water as the "reservoir" that was formed behind it is suddenly released. Ice jamming occurs in slow moving streams where prolonged periods of cold weather are experienced. Sometimes the ice jams are dynamited, allowing a controlled release of the backed up water to flow downstream.

13.1.2 Floodplain

A floodplain is the area adjacent to a river, creek, or lake that becomes inundated during a flood. Floodplains may be broad, as when a river crosses an extensive flat landscape, or narrow, as when a river is confined in a canyon.

When floodwaters recede after a flood event, they leave behind layers of rock and mud. These gradually build up to create a new floor of the floodplain. Floodplains generally contain unconsolidated sediments (accumulations of sand, gravel, loam, silt, or clay), often extending below the bed of the stream. These sediments provide a natural filtering system, with water percolating back into the ground and replenishing groundwater. These are often important aquifers, the water drawn from them being filtered compared to the water in the stream. Fertile, flat reclaimed floodplain lands are commonly used for agriculture, commerce and residential development.

Connections between a river and its floodplain are most apparent during and after major flood events. These areas form a complex physical and biological system that not only supports a variety of natural resources but also provides natural flood and erosion control. When a river is separated from its floodplain with levees and other flood control facilities, natural, built-in benefits can be lost, altered, or significantly reduced.

13.1.3 Measuring Floods and Floodplains

The frequency and severity of flooding are measured using a discharge probability, which is the probability that a certain river discharge (flow) level will be equaled or exceeded in a given year. Flood studies use historical records to estimate the probability of occurrence for the different discharge levels. The flood frequency equals 100 divided by the discharge probability. For example, the 100-year discharge has a 1% chance of being equaled or exceeded in any given year. The “annual flood” is the greatest flood event expected to occur in a typical year. These measurements reflect statistical averages only; it is possible for two or more floods with a 100-year or higher recurrence interval to occur in a short time period. The same flood can have different recurrence intervals at different points on a river.

The extent of flooding associated with a 1% annual probability of occurrence (the base flood or 100-year flood) is used as the regulatory boundary by many agencies. Also referred to as the special flood hazard area (SFHA), this boundary is a convenient tool for assessing vulnerability and risk in flood-prone communities. Many communities have maps that show the extent and likely depth of flooding for the base flood. Corresponding water-surface elevations describe the elevation of water that will result from a given discharge level, which is one of the most important factors used in estimating flood damage.

13.1.4 Floodplain Ecosystems

Floodplains can support ecosystems that are rich in plant and animal species. A floodplain can contain 100 or even 1,000 times as many species as a river. Wetting of the floodplain soil releases an immediate surge of nutrients: those left over from the last flood, and those that result from the rapid decomposition of organic matter that has accumulated since then. Microscopic organisms thrive and larger species enter a rapid breeding cycle. Opportunistic feeders (particularly birds) move in to take advantage. The production of nutrients peaks and falls away quickly, but the surge of new growth endures for some time. This makes floodplains valuable for agriculture. Species growing in floodplains are markedly different from those that grow outside floodplains. For instance, riparian trees (trees that grow in floodplains) tend to be very tolerant of root disturbance and very quick-growing compared to non-riparian trees.

13.1.5 Effects of Human Activities

Because they border water bodies, floodplains have historically been popular sites to establish settlements. Human activities tend to concentrate in floodplains for a number of reasons: water is readily available; land is fertile and suitable for farming; transportation by water is easily accessible; and land is flatter and easier to develop. But human activity in floodplains frequently interferes with the natural function of floodplains.

It can affect the distribution and timing of drainage, thereby increasing flood problems. Human development can create local flooding problems by altering or confining drainage channels. This increases flood potential in two ways: it reduces the stream's capacity to contain flows, and it increases flow rates or velocities downstream during all stages of a flood event. Human activities can interface effectively with a floodplain as long as steps are taken to mitigate the activities' adverse impacts on floodplain functions.

13.1.6 Federal Flood Programs

National Flood Insurance Program

The NFIP makes federally backed flood insurance available to homeowners, renters, and business owners in participating communities. For most participating communities, FEMA has prepared a detailed Flood Insurance Study (FIS). The study presents water surface elevations for floods of various magnitudes, including the 1% annual chance flood (the 100-year flood) and the 0.2% annual chance flood (the 500-year flood). Base flood elevations and the boundaries of the 100- and 500-year floodplains are shown on Flood Insurance Rate Map (FIRM), which are the principle tool for identifying the extent and location of the flood hazard. FIRMs are the most detailed and consistent data source available, and for many communities they represent the minimum area of oversight under their floodplain management program.

Participants in the NFIP must, at a minimum, regulate development in floodplain areas in accordance with NFIP criteria. Before issuing a permit to build in a floodplain, participating jurisdictions must ensure that three criteria are met:

- New buildings and those undergoing substantial improvements must, at a minimum, be elevated to protect against damage by the 100-year flood.
- New floodplain development must not aggravate existing flood problems or increase damage to other properties.
- New floodplain development must exercise a reasonable and prudent effort to reduce its adverse impacts on threatened salmonid species.

Clear Creek County and all of the participating jurisdictional communities participate in the NFIP program. Structures permitted or built in the county before then are called "pre-FIRM" structures, and structures built afterwards are called "post-FIRM." The insurance rate is different for the two types of structures. The effective date for the current countywide DFIRM (Digitized Flood Insurance Rate Map) is July 17, 2012. The county and participating communities are currently in good standing with the provisions of the NFIP. Compliance is monitored by FEMA regional staff. Maintaining compliance under the NFIP is an important component of flood risk reduction.

The Community Rating System

The Community Rating System (CRS) is a voluntary program within the NFIP that encourages floodplain management activities that exceed the minimum NFIP requirements. Flood insurance premiums are discounted to reflect the reduced flood risk resulting from community actions meeting the following three goals of the CRS:

- Reduce flood losses
- Facilitate accurate insurance rating
- Promote awareness of flood insurance

For participating communities, flood insurance premium rates are discounted in increments of 5%. For example, a Class 1 community would receive a 45% premium discount, and a Class 9 community would receive a 5% discount. (Class 10 communities are those that do not participate in the CRS; they receive no discount.) The CRS classes for local communities are based on 18 creditable activities in the following categories:

- Public information
- Mapping and regulations
- Flood damage reduction
- Flood preparedness

Figure 13-1 shows the number of CRS communities by class as of May 2014, there are 46 communities in the State of Colorado receiving flood insurance premium discounts under the CRS program.

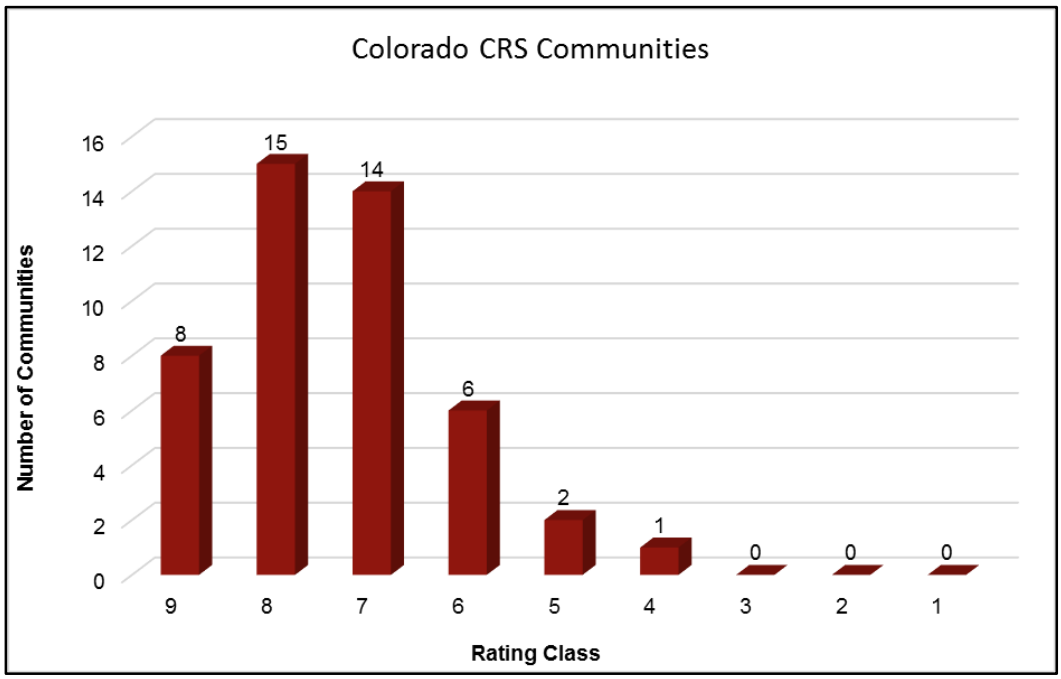


Figure 13-1. Colorado CRS Communities by Class as of May 2014

CRS activities can help to save lives and reduce property damage. Communities receiving premium discounts through the CRS range from small to large and represent a broad mixture of flood risks.

At this time neither Clear Creek County nor any of the planning partners participates in the CRS program.

13.2 HAZARD PROFILE

Clear Creek County is susceptible to flooding, particularly in the jurisdictions that are located in high mountainous valleys. Snowmelt and rainfall tend to travel off the mountains and enter the towns below. Additionally, Clear Creek and its tributaries all flow through the jurisdictions in Clear Creek County.

Flooding in the county is predominantly the result of snowmelt and cloudbursts that result in flash flooding. Severe flash flooding poses the greatest risk. These rain events are most often microbursts, which produce a large amount of rainfall in a short amount of time. Flash floods, by their nature, occur suddenly but usually dissipate within hours. Despite their sudden nature, the NWS is usually able to issue advisories, watches, and warnings in advance of a flood. In mountainous, rugged terrain, runoff can damage drainage systems or cause them to fail.

The potential for flooding can change and increase through various land use changes and changes to land surface. A change in environment can create localized flooding problems inside and outside of natural floodplains by altering or confining watersheds or natural drainage channels. These changes are commonly created by human activities (e.g., development). These changes can also be created by other events such as wildfires. Wildfires create hydrophobic soils, a hardening or “glazing” of the earth’s surface that prevents

rainfall from being absorbed into the ground, thereby increasing runoff, erosion, and downstream sedimentation of channels.

Potential flood impacts include loss of life, injuries, and property damage. Floods can also affect infrastructure (water, gas, sewer, and power utilities), transportation, jobs, tourism, the environment, and ultimately local and regional economies.

13.2.1 Past Events

The National Centers for Environmental Information Storm Events Database includes flood events that happened in Clear Creek County between 1998 and 2015, as listed in Table 13-1. Only one incident in September 2013 resulted in recorded property damage and a fatality.

TABLE 13-1.
CLEAR CREEK COUNTY FLOOD EVENTS (1998-2015)

Location	Date	Event Type	Estimated Damage Cost	
			Property	Crops
Idaho Springs	7/25/1998	Flash Flood	$0	$0
Idaho Springs	9/3/2003	Flash Flood	$0	$0
Idaho Springs	7/16/2004	Flash Flood	$0	$0
Idaho Springs	7/18/2004	Flash Flood	$0	$0
Idaho Springs	7/19/2004	Flash Flood	$0	$0
North Central Portion	8/5/2004	Flash Flood	$0	$0
Idaho Springs	9/12/2013	Flood	$0	$0
Idaho Springs	9/14/2013	Flash Flood	$256,000	$0

Source: National Centers for Environmental Information, Storm Events Database

Notable incidents causing damages from the Storm Events Database in Clear Creek County are described below:

- **July 1998** – Flooding occurred after a month of above-average precipitation and in areas where the ground was already fully saturated. In Idaho Springs, the rains caused a flash flood in Virginia Canyon and rainwater flooding in the town. At its peak, there was over 2 inches of rainfall in less than 1 hour.
- **September 2013** – FEMA-EM-3365 and FEMA-DR-4145. A deep southerly flow over Colorado, ahead of a near stationary low pressure system over the Great Basin, pumped monsoonal moisture into the area. In addition, a weak stationary front stretched along the Front Range Foothills and Palmer Divide. As a result, a prolonged period of moderate to heavy rain developed across the Front Range Foothills, Palmer Divide, and Urban Corridor. By September 14, storm totals ranged from 6 to 18 inches. Houses were flooded along Soda Creek Road south of Idaho Springs, and roads were impassable near Upper Bear Creek, stranding numerous residents. Clear Creek County schools were closed and motorists were stuck for hours at various times in traffic that moved very slowly for miles. One Idaho Springs man died when Clear Creek water levels rose above normal and the bank collapsed under his feet. The victim was an 83-year old man. The flooding was some of the worst the county has experienced (see photos in Figure 13-2 and Figure 13-3). According to FEMA, 113 households in the county were impacted by flooding. FEMA-DR-4145 approved over $61 million for individual assistance and over $354

million for public assistance aid for the affected communities of this federal disaster (Source: FEMA, https://www.fema.gov/disaster/4145).

Source: Clear Creek Office of Emergency Management

Figure 13-2. Photos of Flood Damage in Clear Creek, September 2013

Source: Clear Creek Office of Emergency Management

Figure 13-3. Photos of Flood Damage along Juno Trail in Clear Creek, September 2013

13.2.2 Location

Clear Creek County is a very mountainous county with elevations above 7,500 feet and bounded on the west by the continental divide. Clear Creek and its tributaries divide the county. Most of the towns in the county are located directly on Clear Creek and its tributaries, contributing to a high overall significance of flood hazards.

Clear Creek is a tributary of the South Platte River and is approximately 66 miles long. The Clear Creek Watershed is approximately 575 square miles and spans from 14,000-foot mountain peaks at its western edge on the Continental Divide in Clear Creek County down to the urbanized plains at its confluence with the South Platte River just north of Denver. The main stem of Clear Creek flows eastward along the Interstate 70 corridor through several mountain communities, along approximately 12 miles of the Highway 6 corridor through Clear Creek Canyon, and then back along the Interstate 70 corridor through several Denver Front Range Communities. Clear Creek converges with the South Platte River near Commerce City. The Clear Creek Watershed is shown on Figure 13-4.

Clear Creek and its tributaries serve as the primary water supply source for several upper-watershed communities including the Towns of Silver Plume, Georgetown, Empire, and the City of Idaho Springs.

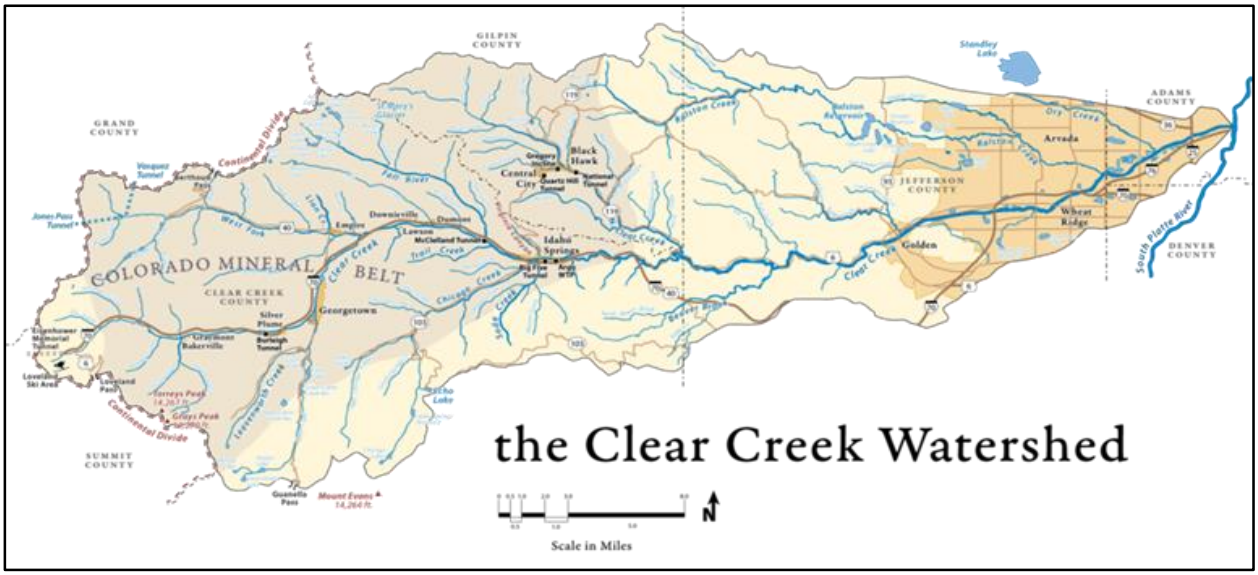


Figure 13-4. Clear Creek Watershed

Clear Creek County has 1,916 acres in the 100-year floodplain and 1,944 acres in 500-year floodplain. Table 13-2 shows the distribution of the acreage across the jurisdictions of the planning area. The SFHA of the 100-year and 500-year floodplain in Clear Creek County and in the participating communities of Idaho Springs, Empire, Georgetown, and Silver Plume are shown on Figure 13-5 and Figure 13-6.

TABLE 13-2.
ACREAGE IN 100-YEAR AND 500-YEAR FLOODPLAIN BY JURISDICTION

	Area (acres)	
Jurisdiction	100-Year	500-Year
City of Idaho Springs	69	81
Town of Empire	27	27
Town of Georgetown	112	116

TABLE 13-2.
ACREAGE IN 100-YEAR AND 500-YEAR FLOODPLAIN BY JURISDICTION

	Area (acres)	
Jurisdiction	100-Year	500-Year
Town of Silver Plume	18	22
Rest of County	1,690	1,698
Total	**1,916**	**1,944**

The SHFA in Clear Creek County and in the participating communities of Idaho Springs, Empire, Georgetown, and Silver Plume are shown on Figure 13-5 and Figure 13-6.

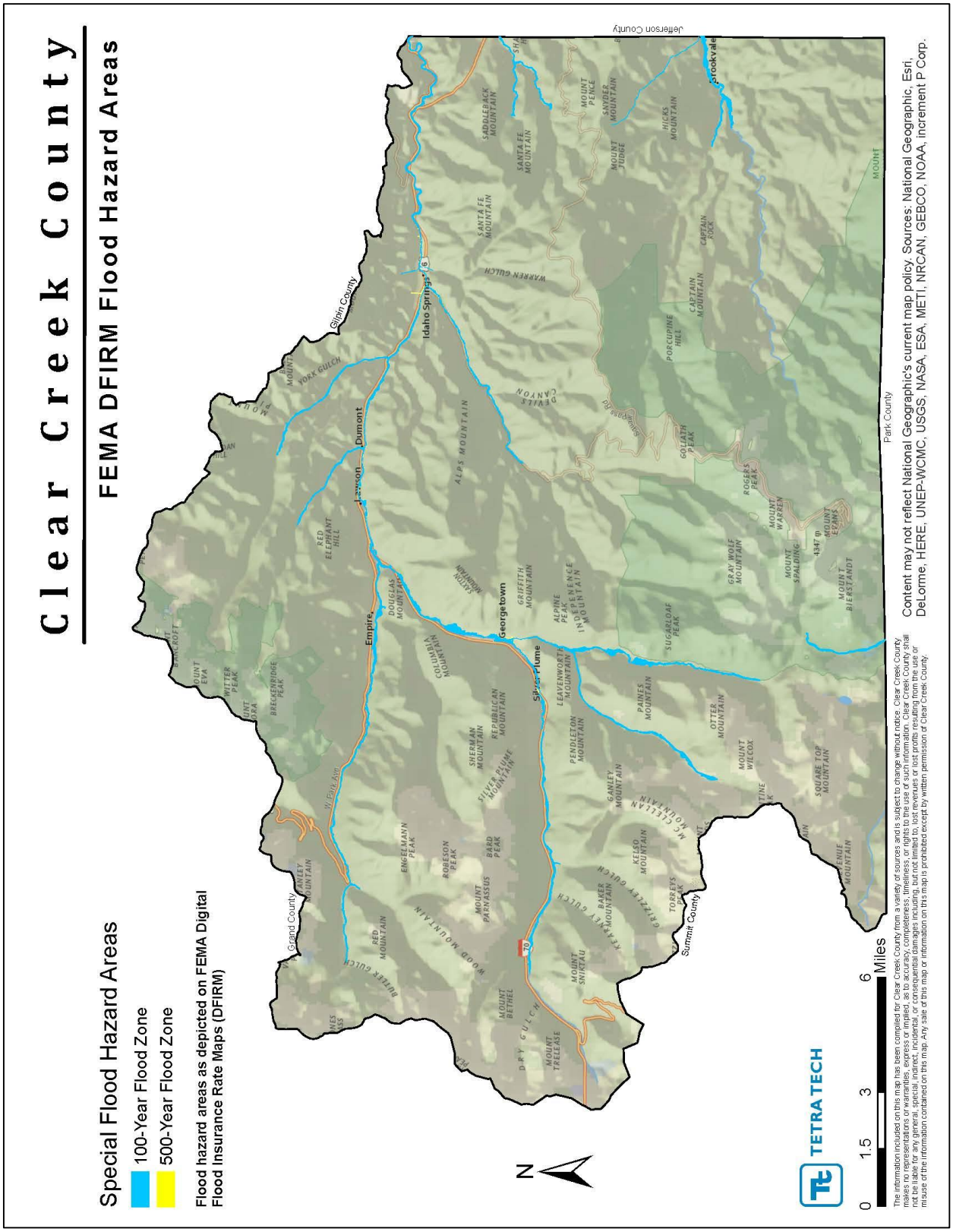


Figure 13-5. Special Flood Hazard Areas in Clear Creek County

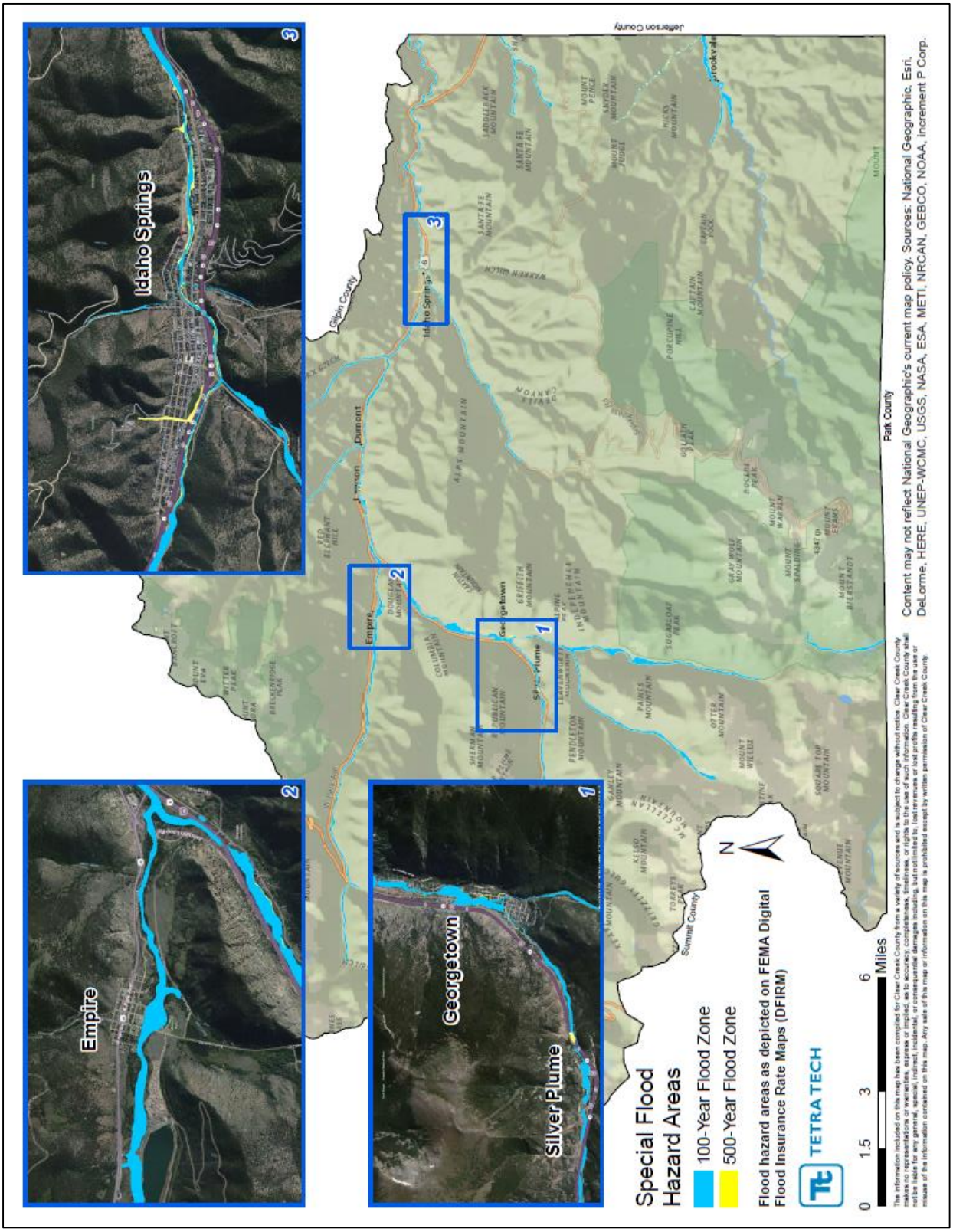


Figure 13-6. Special Flood Hazard Areas in City of Idaho Springs and Towns of Empire, Georgetown and Silver Plume

13.2.3 Frequency and Severity

Seasonal flooding in Clear Creek County has been decreasing through time due to the increased attention to water management issues. Flash floods and floods, however, are still considered to be highly likely to occur, with approximately 44% chance of occurrence in any given year. This probability is based on the 8 events occurring over the 18 years reported in the National Centers for Environmental Information Storm Events Database (Table 13-1).

Based on the information in this hazard profile, the magnitude/severity of flooding is limited for Clear Creek County; even during a 500-year event, there would be minor structural damage. Therefore, the overall significance is considered moderate for Clear Creek County, with moderate potential impact. The Towns of Empire and Georgetown and City of Idaho Springs have a high percentage of the municipality located within the floodplains. The overall significance of flooding for Towns of Empire, Georgetown, and City of Idaho Springs is considered moderate potential impact and the significance for Silver Plume is considered low, with low potential impact.

13.2.4 Warning Time

Due to the sequential pattern of meteorological conditions needed to cause serious flooding, it is unusual for a flood to occur without warning. Warning times for floods can be between 24 and 48 hours. Flash flooding can be less predictable, but potential hazard areas can be warned in advanced of potential flash flooding danger. Flood warnings are issued by radio and television media, NOAA weather radio, public address systems, emergency sirens, or emergency personnel. Police and fire officials may be on hand to direct evacuations.

The NWS has issued general flood forecasting guidance for the region. Although it can be difficult to predict how much rain will result in a flood event on any given day, there are some general principles regarding when flood events are more likely to occur (NWS 2010):

- If 1 inch or more of rain falls in an urban or mountain area in 1 hour, a flood statement should be issued. In mountain areas, a flash flood warning may be necessary.
- If 2 or more inches of rain falls in an urban or mountain area in 1 hour, a flash flood warning should be issued.
- In rural areas on the plains, if rainfall reaches 2 inches in 1 hour, a flood statement should be issued and if rainfall reaches 3 inches in 1 hour, a flash flood warning should be issued.
- If precipitable water values exceed 150% of normal, this is a good indicator that flash flood-producing rains will develop if precipitation occurs.

13.3 SECONDARY HAZARDS

The most problematic secondary hazard for flooding is bank erosion, which in some cases can be more harmful than actual flooding. This is especially true in the upper courses of rivers with steep gradients, where floodwaters may pass quickly and without much damage, but scour the banks, edging properties closer to the floodplain or causing them to fall in. Flooding is also responsible for hazards such as landslides when high flows over-saturate soils on steep slopes, causing them to fail. Hazardous materials spills are also a secondary hazard of flooding if storage tanks rupture and spill into streams, rivers or storm sewers.

13.4 CLIMATE CHANGE IMPACTS

Use of historical hydrologic data has long been the standard of practice for designing and operating water supply and flood protection projects. For example, historical data are used for flood forecasting models and to forecast snowmelt runoff for water supply. This method of forecasting assumes that the climate of the future will be similar to that of the period of historical record. However, the hydrologic record cannot be

used to predict changes in frequency and severity of extreme climate events such as floods. Going forward, model calibration or statistical relation development must happen more frequently, new forecast-based tools must be developed, and a standard of practice that explicitly considers climate change must be adopted. Climate change is already impacting water resources, and resource managers have observed the following:

- Historical hydrologic patterns can no longer be solely relied upon to forecast the water future.
- Precipitation and runoff patterns are changing, increasing the uncertainty for water supply and quality, flood management, and ecosystem functions.
- Extreme climatic events will become more frequent, necessitating improvement in flood protection, drought preparedness, and emergency response.

The amount of snow is critical for water supply and environmental needs, but so is the timing of snowmelt runoff into rivers and streams. Rising snowlines caused by climate change will allow more mountain area to contribute to peak storm runoff. High frequency flood events (e.g., 10-year floods) in particular will likely increase with a changing climate. Along with reductions in the amount of the snowpack and accelerated snowmelt, scientists project greater storm intensity, resulting in more direct runoff and flooding. Changes in watershed vegetation and soil moisture conditions will likewise change runoff and recharge patterns. As stream flows and velocities change, erosion patterns will also change, altering channel shapes and depths, possibly increasing sedimentation behind dams, and affecting habitat and water quality. With potential increases in the frequency and intensity of wildfires due to climate change, there is potential for more floods following fire, which increase sediment loads and water quality impacts.

As hydrology changes, what is currently considered a 100-year flood may strike more often, leaving many communities at greater risk. Planners will need to factor a new level of safety into the design, operation, and regulation of flood protection facilities such as dams, floodways, bypass channels, and levees, as well as the design of local sewers and storm drains.

13.5 EXPOSURE

The Level 2 HAZUS-MH protocol was used to assess the risk and vulnerability to flooding in the planning area. The model used U.S. Census data at the block level and FEMA floodplain data, which has a level of accuracy acceptable for planning purposes. Where possible, the HAZUS-MH default data was enhanced using local GIS data from county, state and federal sources.

13.5.1 Population

Population counts of those living in the floodplain in the planning area were generated by analyzing tax assessor building locations that intersect with the 100-year and 500-year floodplains identified on DFIRMs. While both floodplains are nearly identical spatially (that is, the 100-year and 500-year floodplains mostly overlap), the 500-year floodplain has increased flood acreage in developed areas, such as Idaho Springs and Georgetown. This additional area increases the exposure of the population living in the floodplain. Total population was estimated by taking the displaced population estimates from the HAZUS model (which uses 2010 U.S. Census data) and adding the difference between 2010 and 2015 estimated population from the Colorado State Demography Office. Using this approach, it was estimated that the exposed population for the entire county is 445 within the 100-year floodplain (4.87% of the total estimated county population) and 520 within the 500-year floodplain (5.70% of the total estimated unincorporated county population). For the unincorporated portions of the county, it is estimated that the exposed population is 153 within the 100-year floodplain (2.58% of the total estimated unincorporated county population) and 160 within the 500-year floodplain (2.70% of the total estimated unincorporated county population).

13.5.2 Property

Present Land Use

Table 13-3 and Table 13-4 show the present land uses in the 100-year and 500-year floodplains for the entire planning area. In the 100-year floodplain, 2% of the floodplain is agricultural land and 20.6% is developed. In the 500-year floodplain, 2.1% of the floodplain is agricultural land and 21.2% is developed. The remainder is natural vegetation and open water.

TABLE 13-3.
CLEAR CREEK COUNTY PRESENT LAND USE IN 100-YEAR FLOODPLAIN

Present Use Classification	Area (acres)	% of total
Agriculture	39	2.0
Barren Land	44	2.3
Developed, High Intensity	2	0.1
Developed, Medium Intensity	117	6.1
Developed, Low Intensity	147	7.7
Developed, Open Space	128	6.7
Forest	630	32.9
Grassland/Prairie	280	14.6
Water/Wetlands	528	27.6
Total	**1,915**	**100.0**

TABLE 13-4.
CLEAR CREEK COUNTY PRESENT LAND USE IN 500-YEAR FLOODPLAIN

Present Use Classification	Area (acres)	% of total
Agriculture	40	2.1
Barren Land	44	2.2
Developed, High Intensity	2	0.1
Developed, Medium Intensity	123	6.3
Developed, Low Intensity	157	8.1
Developed, Open Space	130	6.7
Forest	633	32.5
Grassland/Prairie	285	14.7
Water/Wetlands	530	27.3
Total	**1,944**	**100.0**

Structures in the Floodplain

Table 13-5 and Table 13-6 summarize the total number of structures in the 100-year and 500-year floodplains by municipality. While the 500-year floodplain is nearly identical to the 100-year floodplain,

the extra acreage includes several developed areas which approximately doubles the structure and exposed values. The HAZUS-MH model determined that there are approximately 143 structures within the 100-year floodplain. Approximately 39% of these structures are in unincorporated areas. Approximately 88% of the structures are residential. The HAZUS-MH model determined that there are approximately 308 structures in the 500-year floodplain. Approximately 28% of these structures are in unincorporated areas. Approximately 92% of the structures are residential.

TABLE 13-5.
STRUCTURES IN THE 100-YEAR FLOODPLAIN

	Number of Structures in Floodplain							
	Residential	Commercial	Industrial	Agriculture	Religion	Government	Education	**Total**
Empire	5	0	0	0	0	0	0	**5**
Georgetown	46	7	0	0	1	1	0	**55**
Idaho Springs	19	4	0	0	0	0	0	**23**
Silver Plume	4	0	0	0	0	0	0	**4**
Rest of County	52	2	1	0	0	1	0	**56**
Total	**126**	**13**	**1**	**0**	**1**	**2**	**0**	**143**

Note: Educational structures were classified in the Clear Creek Assessor database under Government Facilities

TABLE 13-6.
STRUCTURES IN THE 500-YEAR FLOODPLAIN

	Number of Structures in Floodplain							
	Residential	Commercial	Industrial	Agriculture	Religion	Government	Education	**Total**
Empire	5	0	0	0	0	0	0	**5**
Georgetown	121	9	0	0	2	1	0	**133**
Idaho Springs	41	6	0	0	0	1	0	**48**
Silver Plume	34	2	0	0	0	1	0	**37**
Rest of County	81	2	1	0	0	1	0	**85**
Total	**282**	**19**	**1**	**0**	**2**	**4**	**0**	**308**

Note: Educational structures were classified in the Clear Creek Assessor database under Government Facilities

Exposed Value

Table 13-7 and Table 13-8 summarize the estimated value of exposed buildings in the planning area in the 100-year and 500-year floodplain. The HAZUS-MH model estimated $53 million of building-and-contents exposure in the 100-year floodplain, representing approximately 3% of the total assessed value of the planning area. The HAZUS-MH model estimated $106 million of building-and-contents exposure in the 500-year floodplain, representing approximately 6% of the total assessed value of the planning area.

TABLE 13-7.
VALUE OF STRUCTURES IN 100-YEAR FLOODPLAIN

	Value Exposed			% of Total Assessed Value in Jurisdiction
	Structure	Contents	**Total**	
Empire	$581,000	$291,000	$872,000	2.5
Georgetown	$11,457,000	$7,203,000	$18,660,000	6.8
Idaho Springs	$8,712,000	$6,573,000	$15,285,000	4.3
Silver Plume	$664,000	$420,000	$1,084,000	3.9
Rest of County	$10,993,000	$6,452,000	$17,445,000	1.6
Total	**$32,407,000**	**$20,939,000**	**$53,346,000**	**3**

TABLE 13-8.
VALUE OF STRUCTURES IN 500-YEAR FLOODPLAIN

	Value Exposed			% of Total Assessed Value in Jurisdiction
	Structure	Contents	**Total**	
Empire	$581,000	$291,000	$872,000	2.5
Georgetown	$27,716,000	$16,924,000	$44,640,000	16.3
Idaho Springs	$15,524,000	$11,308,000	$26,832,000	7.5
Silver Plume	$5,428,000	$3,357,000	$8,786,000	31.2
Rest of County	$15,949,000	$9,110,000	$25,059,000	2.3
Total	**$65,198,000**	**$40,990,000**	**$106,189,000**	**6**

13.5.3 Critical Facilities and Infrastructure

Table 13-9, Table 13-10, Table 13-11, and Table 13-12 summarize the critical facilities and infrastructure in the 100-year and 500-year floodplain of the planning area. While the 100-year and 500-year floodplains are nearly identical, the 500-year floodplain includes a few more critical facilities located in developed areas. Details are provided in the following sections.

TABLE 13-9.
CRITICAL FACILITIES IN THE 100-YEAR FLOODPLAIN

Jurisdiction	Medical & Health	Protective Functions	Schools	**Total**
Empire	0	0	0	**0**
Georgetown	0	1	0	**1**
Idaho Springs	0	0	0	**0**
Silver Plume	0	0	0	**0**
Rest of County	0	0	0	**0**

TABLE 13-9.
CRITICAL FACILITIES IN THE 100-YEAR FLOODPLAIN

Jurisdiction	Medical & Health	Protective Functions	Schools	**Total**
Total	**0**	**1**	**0**	**1**

TABLE 13-10.
CRITICAL INFRASTRUCTURE IN THE 100-YEAR FLOODPLAIN

Jurisdiction	Bridges	Potable Water	Waste Water	Power	Communications	Transportation	Dams	**Total**
Empire	1	0	0	0	0	0	0	**1**
Georgetown	2	0	0	0	0	0	0	**2**
Idaho Springs	0	0	0	0	0	0	0	**0**
Silver Plume	0	0	0	0	0	0	0	**0**
Rest of County	5	0	0	0	0	0	0	**5**
Total	**8**	**0**	**0**	**0**	**0**	**0**	**0**	**8**

TABLE 13-11.
CRITICAL FACILITIES IN THE 500-YEAR FLOODPLAIN

Jurisdiction	Medical & Health	Protective Functions	Schools	**Total**
Empire	0	0	0	**0**
Georgetown	0	1	1	**2**
Idaho Springs	0	0	0	**0**
Silver Plume	0	0	0	**0**
Rest of County	0	0	0	**0**
Total	**0**	**1**	**1**	**2**

TABLE 13-12.
CRITICAL INFRASTRUCTURE IN THE 500-YEAR FLOODPLAIN

Jurisdiction	Bridges	Potable Water	Waste Water	Power	Communications	Transportation	Dams	**Total**
Empire	1	0	0	0	0	0	0	**1**
Georgetown	3	0	0	0	0	0	0	**3**
Idaho Springs	0	0	0	0	0	0	0	**0**
Silver Plume	0	0	0	0	0	0	0	**0**
Rest of County	6	0	0	0	0	0	0	**6**

TABLE 13-12.
CRITICAL INFRASTRUCTURE IN THE 500-YEAR FLOODPLAIN

Jurisdiction	Bridges	Potable Water	Waste Water	Power	Communications	Transportation	Dams	**Total**
Total	**10**	**0**	**0**	**0**	**0**	**0**	**0**	**10**

Utilities and Infrastructure

It is important to identify who may be at risk if infrastructure is damaged by flooding. Roads or railroads that are blocked or damaged can isolate residents and can prevent access throughout the county, including for emergency service providers needing to get to vulnerable populations or to make repairs. Bridges washed out or blocked by floods or debris also can cause isolation. Water and sewer systems can be flooded or backed up, causing health problems. Underground utilities can be damaged. Dikes can fail or be overtopped, inundating the land that they protect. The following sections describe specific types of critical infrastructure.

Roads

The major roads in the planning area that pass through the 100-year floodplain and thus are exposed to flooding are Interstate 70 and U.S. Highway 6. In severe flood events, these roads can be blocked or damaged, preventing access to some areas.

Bridges

Flooding events can significantly impact road bridges. These are important because often they provide the only ingress and egress to some neighborhoods. There are 8 bridges that are in or cross over the 100-year floodplain.

Water and Sewer Infrastructure

Water and sewer systems can be affected by flooding. Floodwaters can back up drainage systems, causing localized flooding. Culverts can be blocked by debris from flood events, also causing localized urban flooding. Floodwaters can get into drinking water supplies, causing contamination. Sewer systems can be backed up, causing wastewater to spill into homes, neighborhoods, rivers, and streams.

13.5.4 Environment

Flooding is a natural event, and floodplains provide many natural and beneficial functions. Nonetheless, with human development factored in, flooding can impact the environment in negative ways. Migrating fish can wash into roads or over dikes into flooded fields, with no possibility of escape. Pollution from roads, such as oil, and hazardous materials can wash into rivers and streams. During floods, these can settle onto normally dry soils, polluting them for agricultural uses. Human development such as bridge abutments and levees, can increase stream bank erosion, causing rivers and streams to migrate into non-natural courses.

13.6 VULNERABILITY

Many of the areas exposed to flooding may not experience serious flooding or flood damage. This section describes vulnerabilities in terms of population, property, infrastructure and environment. The vulnerability analysis was performed at the census-block level. This methodology is likely to overestimate impacts from both the modelled 100-year and 500-years flood events as it is assumed that both structures and the population are evenly spread throughout census block.

13.6.1 Population

A geographic analysis of demographics using the HAZUS-MH model identified populations vulnerable to the flood hazard as follows. These numbers are all calculated assuming that the population/households are evenly distributed over the census blocks.

- **Economically Disadvantaged Populations**—It is estimated that 21.5% of the households within the 100-year floodplain are economically disadvantaged, defined as having household incomes of $20,000 or less.
- **Population over 65 Years Old**—It is estimated that 17.9% of the population in the census blocks that intersect the 100-year floodplain are over 65 years old.
- **Population under 14 Years Old**—It is estimated that 11.5% of the population within census blocks located in or near the 100-year floodplain are under 16 years of age.

The following impacts on persons and households in the planning area were estimated for the 100-year and 500-year flood events through the Level 2 HAZUS-MH analysis:

- 100-year flood event
  - Displaced population = 443
  - Persons requiring short-term shelter = 118
- 500-year flood event
  - Displaced population = 518
  - Persons requiring short-term shelter = 151

13.6.2 Property

HAZUS-MH calculates losses to structures from flooding by looking at depth of flooding and type of structure. Using historical flood insurance claim data, HAZUS-MH estimates the percentage of damage to structures and their contents by applying established damage functions to an inventory. For this analysis, local data on facilities was used instead of the default inventory data provided with HAZUS-MH. The analysis is summarized in Table 13-13 and Table 13-14. It is estimated that there would be up to $14.4 million of flood loss from a 100-year flood event in the planning area. This represents 27% of the total exposure to the 100-year flood and 0.81% of the total replacement value for the county. For the 500-year flood scenario, it is estimated up to $16.3 million of flood loss which represents 15.3% of the total exposure to the 500-year flood and 0.92% of the total replacement for the county.

TABLE 13-13.
LOSS ESTIMATES FOR 100-YEAR FLOOD EVENT

	Estimated Loss Associated with Flood			% of Total Assessed Value of Jurisdiction
	Structure	Contents	**Total**	
Empire	$116,000	$62,000	$178,000	0.52
Georgetown	$1,840,000	$1,873,000	$3,713,000	1.35
Idaho Springs	$931,000	$2,336,000	$3,267,000	0.91
Silver Plume	$282,000	$350,000	$632,000	2.25
Rest of County	$3,465,000	$3,114,000	$6,579,000	0.61

TABLE 13-13.
LOSS ESTIMATES FOR 100-YEAR FLOOD EVENT

	Estimated Loss Associated with Flood			% of Total Assessed Value of Jurisdiction
	Structure	Contents	**Total**	
Total	**$6,634,000**	**$7,735,000**	**$14,369,000**	**0.81**

TABLE 13-14.
LOSS ESTIMATES FOR 500-YEAR FLOOD EVENT

	Estimated Loss Associated with Flood			% of Total Assessed Value of Jurisdiction
	Structure	Contents	**Total**	
Empire	$116,000	$62,000	$178,000	0.52
Georgetown	$1,968,000	$1,981,000	$3,949,000	1.44
Idaho Springs	$1,508,000	$3,013,000	$4,521,000	1.26
Silver Plume	$353,000	$430,000	$783,000	2.78
Rest of County	$3,606,000	$3,251,000	$6,857,000	0.64
Total	**$7,551,000**	**$8,737,000**	**$16,288,000**	**0.92**

National Flood Insurance Program

Table 13-15 lists flood insurance statistics that help identify vulnerability in the planning area. Clear Creek County, the City of Idaho Springs, and the Towns of Georgetown and Silver Plume all participate in the NFIP. The Town of Empire does not participate in the NFIP.

TABLE 13-15.
NATIONAL FLOOD INSURANCE PROGRAM STATISTICS

	Initial FIRM Effective Date	Claims (11/1978 to 2/29/2016)	Value of Claims Paid (11/1978 to 2/29/2016)
Georgetown	06/05/1989	8	$11,886
Idaho Springs	11/15/1978	4	$369
Silver Plume	01/17/1979	2	$1,460
Rest of County	03/11/1980	12	$28,995
Total	**--**	**26**	**$42,710**

Note:
FIRM Flood Insurance Rate Map

Properties constructed after a FIRM has been adopted are eligible for reduced flood insurance rates. Such structures are less vulnerable to flooding since they were constructed after regulations and codes were

adopted to decrease vulnerability. Properties built before a FIRM is adopted are more vulnerable to flooding because they do not meet code or are located in hazardous areas.

The following information from flood insurance statistics is relevant to reducing flood risk:

- The use of flood insurance in the planning area is below the national average.
- The average claim paid in the planning area is below the national average.

Repetitive Loss

A repetitive loss property is defined by FEMA as an NFIP-insured property that has experienced any of the following since 1978, regardless of any changes in ownership:

- Four or more paid losses in excess of $1,000
- Two paid losses in excess of $1,000 within any rolling 10-year period
- Three or more paid losses that equal or exceed the current value of the insured property.

Repetitive loss properties make up only 1% to 2% of flood insurance policies in force nationally, yet they account for 40% of the nation's flood insurance claim payments. In 1998, FEMA reported that the NFIP's 75,000 repetitive loss structures have already cost $2.8 billion in flood insurance payments and that numerous other flood-prone structures remain in the floodplain at high risk. The government has instituted programs encouraging communities to identify and mitigate the causes of repetitive losses. A recent report on repetitive losses by the National Wildlife Federation found that 20% of these properties are outside any mapped 100-year floodplain. The key identifiers for repetitive loss properties are the existence of flood insurance policies and claims paid by the policies.

FEMA-sponsored programs, such as the CRS, require participating communities to identify repetitive loss areas. A repetitive loss area is the portion of a floodplain holding structures that FEMA has identified as meeting the definition of repetitive loss. Identifying repetitive loss areas helps to identify structures that are at risk but are not on FEMA's list of repetitive loss structures because no flood insurance policy was in force at the time of loss.

Clear Creek County, the City of Idaho Springs and the Towns of Empire, Georgetown, and Silver Plume have no FEMA FY2016 Flood Mitigation Assistance-defined repetitive loss or severe repetitive loss properties according to the Biggert-Waters Act definition. For NFIP-defined repetitive losses, there is one single-family property near the community of Evergreen that has sustained two repetitive loss claims in 1979 and 1983. The property is located outside of the special flood hazard area. The property damage has resulted in $9,260 in claims.

13.6.3 Critical Facilities and Infrastructure

HAZUS-MH was used to estimate the flood loss potential to critical facilities exposed to the flood risk. Using depth/damage function curves to estimate the percent of damage to the building and contents of critical facilities, HAZUS-MH correlates these estimates into an estimate of functional down-time (the estimated time it will take to restore a facility to 100% of its functionality). This helps to gauge how long the planning area could have limited usage of facilities deemed critical to flood response and recovery.

The HAZUS critical facility analysis found that, on average, critical facilities would receive 5.13% damage to the structure and 5.87% to the contents during a 100-year flood event. For a 500-year flood event critical facilities, on average, would receive 8.4% damage to the structure and 13.5% damage to the contents.

13.6.4 Environment

The environment vulnerable to flood hazard is the same as the environment exposed to the hazard. Loss estimation platforms such as HAZUS-MH are not currently equipped to measure environmental impacts of flood hazards. The best gauge of vulnerability of the environment would be a review of damage from past

flood events. Loss data that segregates damage to the environment was not available at the time of this plan. Capturing this data from future events could be beneficial in measuring the vulnerability of the environment for future updates.

13.7 FUTURE TRENDS

Clear Creek County and its planning partners are equipped to handle future growth within flood hazard areas. All municipal planning partners have comprehensive plans that address frequently flooded areas. All partners have committed to linking their comprehensive plans to this hazard mitigation plan. This will create an opportunity for wise land use decisions as future growth impacts flood hazard areas.

Additionally, all municipal planning partners are participants in the NFIP and have adopted flood damage prevention ordinances in response to its requirements. All municipal planning partners have committed to maintaining their good standing under the NFIP through initiatives identified in this plan. Communities considering participation in the CRS program will be able to refine this commitment using CRS programs and templates as a guide.

Urban flooding issues that contribute to flash floods are also a concern in more highly developed areas in Clear Creek County. Jurisdictions in the county incorporate stormwater design requirements and rely on the State of Colorado's stormwater permitting program as mandated by the National Pollutant Discharge Elimination System. This program helps jurisdictions apply effective mitigation measures for stormwater runoff.

13.8 SCENARIO

An intense, short-duration storm could move slowly across the planning area, creating significant flash floods with little or no warning. Injuries or fatalities may result if residents are caught off guard by the flood event. Stormwater systems could be overwhelmed and significant flooding could impact a substantial portion of structures within the planning area. Transportation routes could be cut off due to floodwaters, isolating portions of the planning area. These impacts may last after the floodwater recedes as flash floods in the area have been known to cause extensive damage to roadway infrastructure. Areas that have recently experienced wildfires would contribute to the extent of flooding impacts.

13.9 ISSUES

The major issues for flooding are the following:

- Flash flooding that occurs with little or no warning will continue to impact the planning area.
- The duration and intensity of storms contributing to flooding issues may increase due to climate change.
- Flooding may be exacerbated by other hazards, such as wildfires.
- Damages resulting from flood may impact tourism, which may have significant impacts on the local economy.
- The promotion of flood insurance as a means of protecting private property owners from the economic impacts of frequent flood events should continue.

Chapter 14.
HAIL, LIGHTNING, AND SEVERE WIND

HAIL, LIGHTNING, AND SEVERE WIND HAZARD RANKING			
	Hail	**Lightning**	**Severe Wind**
Clear Creek County	Medium	Medium	Medium
City of Idaho Springs	High	High	High
Town of Empire	Low	Low	Medium
Town of Georgetown	Low	Low	High
Town of Silver Plume	Low	Low	High
See Chapter 20 for more information on hazard ranking.			

14.1 GENERAL BACKGROUND

A thunderstorm is a rain event that includes thunder and lightning. A thunderstorm is classified as "severe" when it contains one or more of the following: hail with a diameter of three-quarter inch or greater, winds gusting in excess of 50 knots (57.5 mph), or tornado.

Three factors cause thunderstorms to form: moisture, rising unstable air (air that keeps rising when disturbed), and a lifting mechanism to provide the disturbance. The sun heats the surface of the earth, which warms the air above it. If this warm surface air is forced to rise (hills or mountains can cause rising motion, as can the interaction of warm air and cold air or wet air and dry air), it will continue to rise as long as it weighs less and stays warmer than the air around it. As the air rises, it transfers heat from the surface of the earth to the upper levels of the atmosphere (the process of convection). The water vapor it contains begins to cool and it condenses into a cloud. The cloud eventually grows upward into areas where the temperature is below freezing. Some of the water vapor turns to ice and some of it turns into water droplets. Both have electrical charges. Ice particles usually have positive charges, and rain droplets usually have negative charges. When the charges build up enough, they are discharged in a bolt of lightning, which causes the sound waves we hear as thunder. Thunderstorms have three stages (see Figure 14-1):

DEFINITIONS

Severe Local Storm—Small-scale atmospheric systems, including tornadoes, thunderstorms, windstorms, ice storms, and snowstorms. These storms may cause a great deal of destruction and even death, but their impact is generally confined to a small area. Typical impacts are on transportation infrastructure and utilities.

Thunderstorm—A storm featuring heavy rains, strong winds, thunder and lightning, typically about 15 miles in diameter and lasting about 30 minutes. Hail and tornadoes are also dangers associated with thunderstorms. Lightning is a serious threat to human life. Heavy rains over a small area in a short time can lead to flash flooding.

Windstorm—A storm featuring violent winds. Windstorms tend to damage ridgelines that face into the winds.

- The *developing stage* of a thunderstorm is marked by a cumulus cloud that is being pushed upward by a rising column of air (updraft). The cumulus cloud soon looks like a tower (called towering cumulus) as the updraft continues to develop. There is little to no rain during this stage but occasional lightning. The developing stage lasts about 10 minutes.
- The thunderstorm enters the *mature stage* when the updraft continues to feed the storm, but precipitation begins to fall out of the storm, and a downdraft begins (a column of air pushing downward). When the downdraft and rain-cooled air spread out along the ground, they form a gust

front, or a line of gusty winds. The mature stage is the most likely time for hail, heavy rain, frequent lightning, strong winds, and tornadoes. The storm occasionally has a black or dark green appearance.

- Eventually, a large amount of precipitation is produced and the updraft is overcome by the downdraft beginning the *dissipating stage*. At the ground, the gust front moves out a long distance from the storm and cuts off the warm moist air that was feeding the thunderstorm. Rainfall decreases in intensity, but lightning remains a danger.

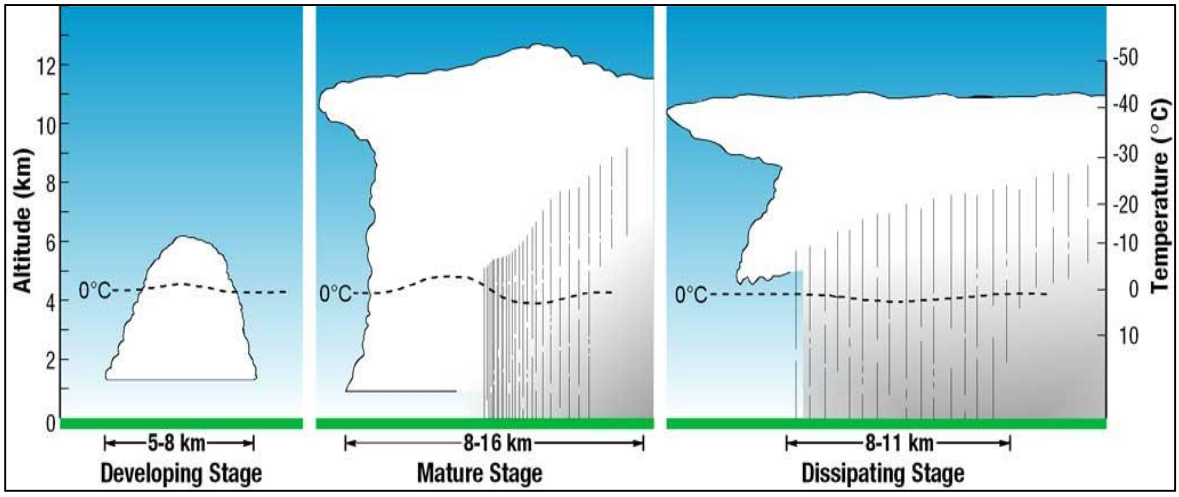


Figure 14-1. Thunderstorm Life Cycle

There are four types of thunderstorms:

- **Single-Cell Thunderstorms**—Single-cell thunderstorms usually last 20 to 30 minutes. A true single-cell storm is rare, because the gust front of one cell often triggers the growth of another. Most single-cell storms are not usually severe, but a single-cell storm can produce a brief severe weather event. When this happens, it is called a pulse severe storm.
- **Multi-Cell Cluster Storm**—A multi-cell cluster is the most common type of thunderstorm. The multi-cell cluster consists of a group of cells, moving as one unit, with each cell in a different phase of the thunderstorm life cycle. Mature cells are usually found at the center of the cluster and dissipating cells at the downwind edge. Multi-cell cluster storms can produce moderate-size hail, flash floods, and weak tornadoes. Each cell in a multi-cell cluster lasts only about 20 minutes; the multi-cell cluster itself may persist for several hours. This type of storm is usually more intense than a single cell storm.
- **Multi-Cell Squall Line**—A multi-cell line storm, or squall line, consists of a long line of storms with a continuous well-developed gust front at the leading edge. The line of storms can be solid, or there can be gaps and breaks in the line. Squall lines can produce hail up to golf-ball size, heavy rainfall, and weak tornadoes, but they are best known as the producers of strong downdrafts. Occasionally, a strong downburst will accelerate a portion of the squall line ahead of the rest of the line. This produces what is called a bow echo. Bow echoes can develop with isolated cells as well as squall lines. Bow echoes are easily detected on radar but are difficult to observe visually.
- **Super-Cell Storm**—A super-cell is a highly organized thunderstorm that poses a high threat to life and property. It is similar to a single-cell storm in that it has one main updraft, but the updraft is extremely strong, reaching speeds of 150 to 175 miles per hour. Super-cells are rare. The main characteristic that sets them apart from other thunderstorms is the presence of rotation. The rotating updraft of a super-cell (called a mesocyclone when visible on radar) helps the super-cell

to produce extreme weather events, such as giant hail (more than 2 inches in diameter), strong downbursts of 80 mph or more, and strong to violent tornadoes.

14.1.1 Hail

Hail occurs when updrafts in thunderstorms carry raindrops upward into extremely cold areas of the atmosphere where they freeze into ice. Recent studies suggest that super-cooled water may accumulate on frozen particles near the back-side of a storm as they are pushed forward across and above the updraft by the prevailing winds near the top of the storm. Eventually, the hailstones encounter downdraft air and fall to the ground.

Hailstones grow two ways: by wet growth or dry growth. In wet growth, a tiny piece of ice is in an area where the air temperature is below freezing, but not super cold. When the tiny piece of ice collides with a super-cooled drop, the water does not freeze on the ice immediately. Instead, liquid water spreads across tumbling hailstones and slowly freezes. Since the process is slow, air bubbles can escape, resulting in a layer of clear ice. Dry growth hailstones grow when the air temperature is well below freezing and the water droplet freezes immediately as it collides with the ice particle. The air bubbles are “frozen” in place, leaving cloudy ice. Hailstones can have layers like an onion if they travel up and down in an updraft, or they can have few or no layers if they are “balanced” in an updraft. One can tell how many times a hailstone traveled to the top of the storm by counting its layers. Hailstones can begin to melt and then re-freeze together, forming large and very irregularly shaped hail.

The NWS classifies hail as non-severe and severe based on hail diameter size. Descriptions and diameter sizes are provided in Table 14-1.

TABLE 14-1.
NATIONAL WEATHER SERVICE HAIL SEVERITY

Severity	Description	Hail Diameter Size (in inches)
Non-Severe Hail Does not typically cause damage and does not warrant severe thunderstorm warning from NWS.	Pea	1/4"
	Plain M&M Candy	1/2"
	Penny	3/4"
	Nickel	7/8"
Severe Hail Research has shown that damage occurs after hail reaches around 1” in diameter and larger. Hail of this size will trigger a severe thunderstorm warning from NWS.	Quarter	1" (severe)
	Half Dollar	1 1/4"
	Walnut/Ping Pong Ball	1 1/2"
	Golf Ball	1 3/4"
	Hen Egg/Lime	2"
	Tennis Ball	2 1/2"
	Baseball	2 3/4"
	Teacup/Large Apple	3"
	Grapefruit	4"
	Softball	4 1/2"
	Computer CD-DVD	4 3/4"- 5"

According to the NWS Storm Prediction Center, Clear Creek County experiences an average of 4 to 5 severe hail days a year (Figure 14-2).

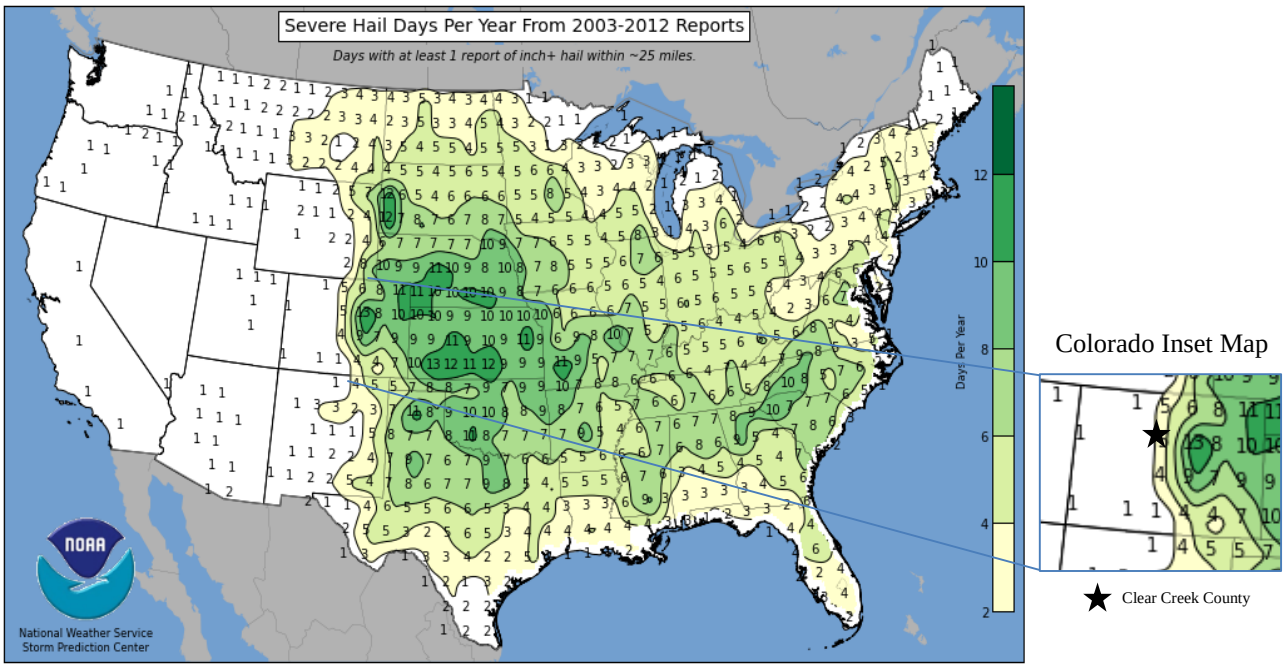


Figure 14-2. Severe Hail Days per Year (2003-2012)

14.1.2 Lightning

Lightning is an electrical discharge between positive and negative regions of a thunderstorm. A lightning flash is composed of a series of strokes with an average of about four strokes per flash. The length and duration of each lightning stroke vary, but typically average about 30 microseconds.

Lightning is one of the more dangerous and unpredictable weather hazards in the United States and in Colorado. Each year, lightning is responsible for deaths, injuries, and millions of dollars in property damage, including damage to buildings, communications systems, power lines and electrical systems. Lightning also causes forest and brush fires as well as deaths and injuries to livestock and other animals. According to the National Lightning Safety Institute, lightning strikes the U.S about 25 million times each year and causes more than 26,000 fires nationwide each year. The institute estimates property damage, increased operating costs, production delays, and lost revenue from lightning and secondary effects to be in excess of $6 billion per year. Impacts can be direct or indirect. People or objects can be directly struck, or damage can occur indirectly when the current passes through or near it.

Intra-cloud lightning is the most common type of discharge. This occurs between oppositely charged centers within the same cloud. Usually it takes place inside the cloud and looks from the outside of the cloud like a diffuse brightening that flickers. However, the flash may exit the boundary of the cloud, and a bright channel can be visible for many miles.

Although not as common, cloud-to-ground lightning is the most damaging and dangerous form of lightning. Most flashes originate near the lower-negative charge center and deliver negative charge to earth. However, a minority of flashes carry positive charge to earth. These positive flashes often occur during the dissipating stage of a thunderstorm's life. Positive flashes are also more common as a percentage of total ground strikes during the winter months. This type of lightning is particularly dangerous for several reasons. It frequently strikes away from the rain core, either ahead or behind the thunderstorm. It can strike as far as 5 or 10 miles from the storm in areas that most people do not consider to be a threat. Positive lightning also has a longer

duration, so fires are more easily ignited. And, when positive lightning strikes, it usually carries a high peak electrical current, potentially resulting in greater damage.

The ratio of cloud-to-ground and intra-cloud lightning can vary significantly from storm to storm. Depending upon cloud height above ground and changes in electric field strength between cloud and earth, the discharge stays within the cloud or makes direct contact with the earth. If the field strength is highest in the lower regions of the cloud, a downward flash may occur from cloud to earth. Using a network of lightning detection systems, NOAA monitors a yearly average of 25 million strokes of lightning from the cloud-to-ground. Figure 14-3 shows the lightning flash density for the nation.

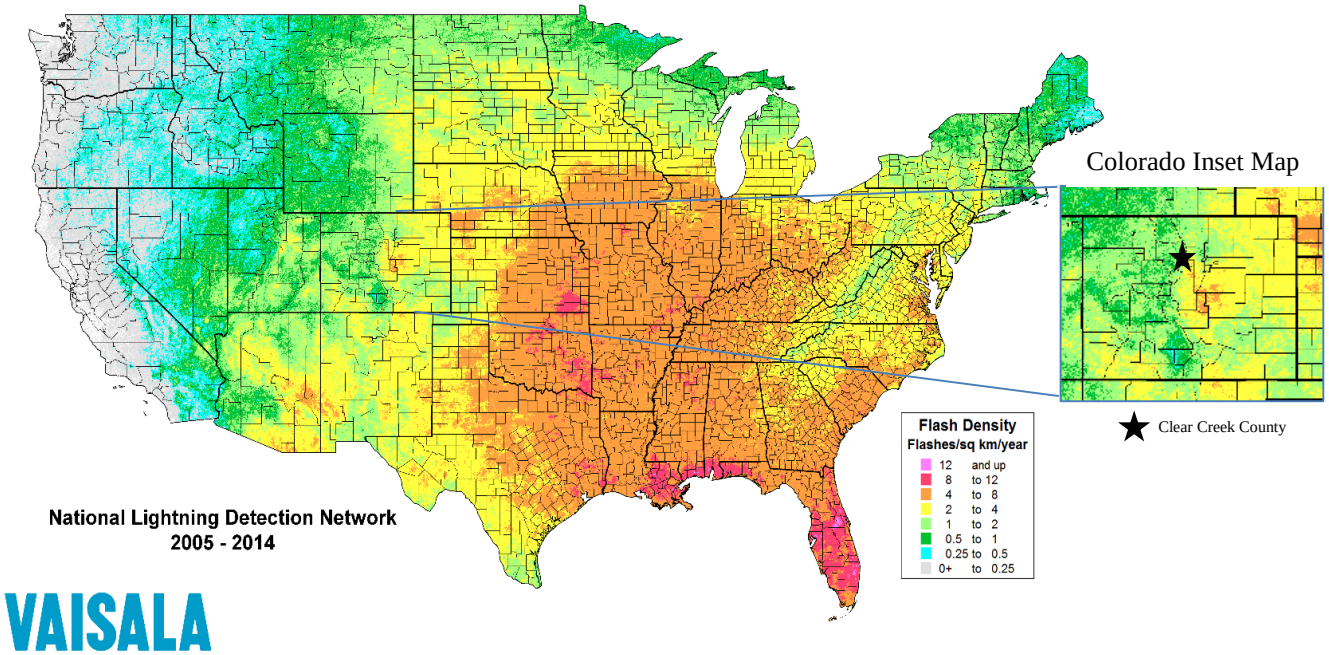


Figure 14-3. National Lightning Detection Network (2005-2014)

Data from the National Lightning Detection Network ranks Colorado 26th in the nation (excluding Alaska and Hawaii) with respect to the number of cloud-to-ground lightning flashes with an average number of more than 500,000 cloud-to-ground lightning strikes per year. According to the National Lightning Detection Network, Clear Creek County has approximately 0.5 to 4 flashes of lightning per square kilometer per year. U.S. lightning statistics compiled by NOAA between 1959 and 1994 indicate that most lightning incidents occur during the summer months of June, July, and August, and during the afternoon hours from between 2 and 6 p.m.

Figure 14-4 shows state-by-state lightning deaths from 2005 - 2014. Colorado ranks third for the number of deaths at 17 during this timeframe. Only Florida, with 47 deaths, and Texas with 20 deaths, had more. In the Rocky Mountains of Colorado, it is common for afternoon thunderstorms during the summer months to occur with lightning strikes at the higher elevations.

Source: National Weather Service, http://www.lightningsafety.noaa.gov/media.shtml

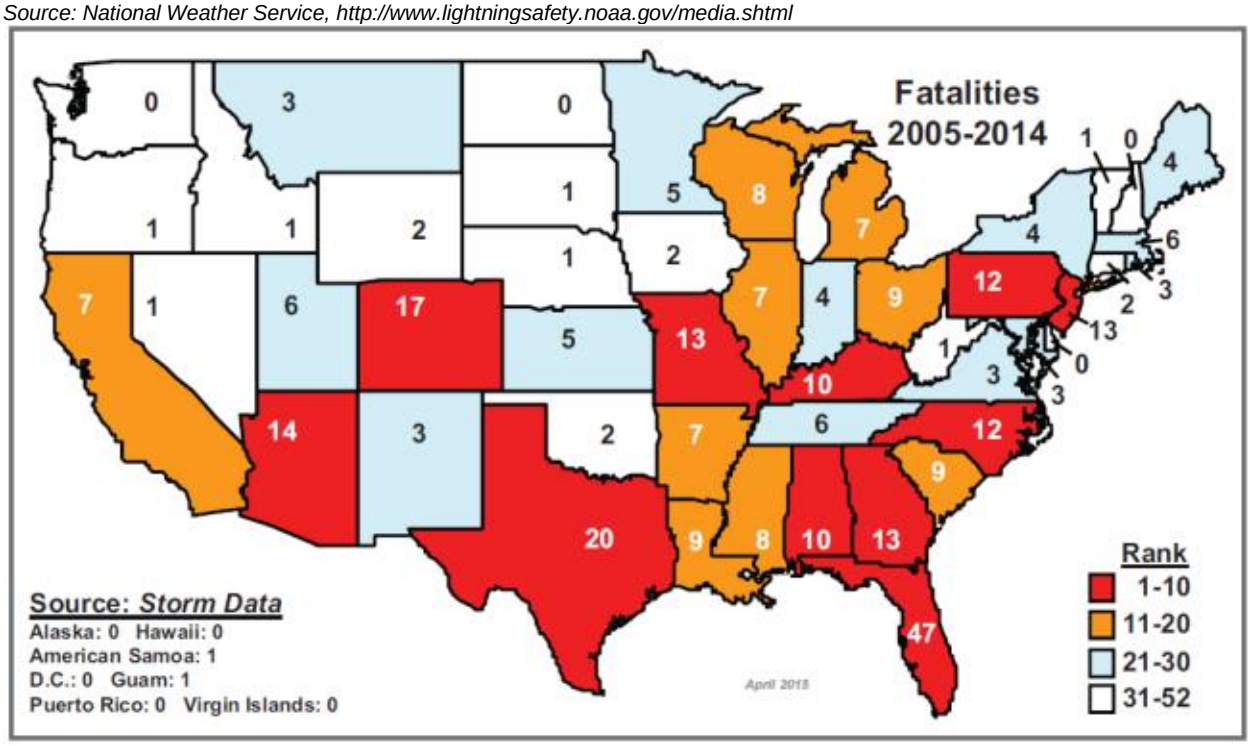


Figure 14-4. Lightning Fatalities in the United States (2005-2014)

14.1.3 Severe Winds

Damaging winds are classified as those exceeding 60 mph. Damage from such winds accounts for half of all severe weather reports in the lower 48 states and is more common than damage from tornadoes. Wind speeds can reach up to 100 mph and can produce a damage path extending for hundreds of miles. There are seven types of damaging winds:

- **Straight-line winds**—Any thunderstorm wind that is not associated with rotation; this term is used mainly to differentiate from tornado winds. Most thunderstorms produce some straight-line winds as a result of outflow generated by the thunderstorm downdraft.
- **Downdrafts**—A small-scale column of air that rapidly sinks toward the ground.
- **Downbursts**—A strong downdraft with horizontal dimensions larger than 2.5 miles resulting in an outward burst or damaging winds on or near the ground. Downburst winds may begin as a microburst and spread out over a wider area, sometimes producing damage similar to a strong tornado. Although usually associated with thunderstorms, downbursts can occur with showers too weak to produce thunder.
- **Microbursts**—A small concentrated downburst that produces an outward burst of damaging winds at the surface. Microbursts are generally less than 2.5 miles across and short-lived, lasting only 5 to 10 minutes, with maximum wind speeds up to 168 mph. There are two kinds of microbursts: wet and dry. A wet microburst is accompanied by heavy precipitation at the surface. Dry microbursts, common in places like the high plains and the intermountain west, occur with little or no precipitation reaching the ground.
- **Gust front—**A gust front is the leading edge of rain-cooled air that clashes with warmer thunderstorm inflow. Gust fronts are characterized by a wind shift, temperature drop, and gusty winds out ahead of a thunderstorm. Sometimes the winds push up air above them, forming a shelf cloud or detached roll cloud.

- **Derecho**—A derecho is a widespread thunderstorm wind caused when new thunderstorms form along the leading edge of an outflow boundary (the boundary formed by horizontal spreading of thunderstorm-cooled air). The word "derecho" is of Spanish origin and means "straight ahead." Thunderstorms feed on the boundary and continue to reproduce. Derechos typically occur in summer when complexes of thunderstorms form over plains, producing heavy rain and severe wind. The damaging winds can last a long time and cover a large area.
- **Bow Echo**—A bow echo is a linear wind front bent outward in a bow shape. Damaging straight-line winds often occur near the center of a bow echo. Bow echoes can be 200 miles long, last for several hours, and produce extensive wind damage at the ground.

14.2 HAZARD PROFILE

14.2.1 Past Events

Hail

The National Centers for Environmental Information's Storm Events Database lists 13 hail events in Clear Creek County between 1971 and 2015. These events are noted in Table 14-2.

TABLE 14-2.
CLEAR CREEK COUNTY HAIL EVENTS (1971-2015)

Location	Date	Maximum Hail Size (inches)	Location	Date	Maximum Hail Size (inches)
Clear Creek County	7/25/1971	1.75	Idaho Springs	8/29/2006	0.88
Clear Creek County	7/21/1973	0.75	Idaho Springs	7/3/2007	1.75
Clear Creek County	7/9/1988	0.75	Idaho Springs	7/3/2007	0.75
Clear Creek County	9/7/1988	1.75	Idaho Springs	6/11/2010	1.00
Clear Creek County	6/9/1991	2.00	Dumont	6/28/2013	1.75
Idaho Springs	7/31/1998	1.75	Dumont	6/28/2013	1.75

Source: National Centers for Environmental Information

Lightning

According to the National Centers for Environmental Information's Storm Events Database, 4 lightning events occurred in the Clear Creek County between 2000 and 2015. The events are noted in Table 14-3. No lightning events resulted in property damage or fatalities. On June 28, 2015, there was a reported lightning strike on Mount Bierstadt, which killed 1 and injured 8 people in an unusual pre-noon storm.

TABLE 14-3.
CLEAR CREEK COUNTY LIGHTNING EVENTS (2000-2015)

Location	Date	Deaths	Injuries	Property Damage
Idaho Springs	7/8/2000	0	2	$0
Idaho Springs	7/16/2000	0	2	$0
Georgetown	8/16/2003	0	1	$0
Guanella Pass	6/28/2015	0	8	$0

Source: National Centers for Environmental Information

Severe Winds

High winds can occur year round in Clear Creek County. In the spring and summer, high winds often accompany severe thunderstorms. The varying topography in the area has the potential for continuous and sudden gusting of high winds. According to the State of Colorado Plan, Chinook winds are a fairly common wintertime phenomena in Colorado. These winds develop in well-defined areas and can be quite strong. Atmospheric conditions are expected to continue unchanged with windstorms remaining a perennial occurrence. The areas within the county that have the highest wind potential are located in the Front Range Mountains and in the valleys that funnel the wind. The entire county is susceptible to severe wind events.

Although these high winds may not be life-threatening, they can disrupt daily activities, cause damage to building and structures, and increase the potential damage of other hazards. Wind resource information is shown in Table 14-4 as a proxy for typical wind speeds. Wind resource information is estimated by the National Renewable Energy Laboratory (NREL) to identify areas that are suitable for wind energy applications. The wind resource is expressed in terms of wind power classes, ranging from class 1 (lowest) to class 7 (highest). Each class represents a range of mean wind power density or approximate mean wind speed at specified heights above the ground (in this case, 50 meters above the ground surface).

Figure 14-5 shows the wind power class potential density for Clear Creek County classified as ranging from “Poor” to “Superb.” Table 14-4 identifies the mean wind power density and speed associated with each classification.

TABLE 14-4.
WIND POWER CLASS AND SPEED

	Wind Power Class	Wind Power Density at 50 meters (W/m^2)	Wind Speed at 50 meters (mph)
Poor	1	0-200	0-12.5
Marginal	2	200-300	12.5-14.3
Fair	3	300-400	14.3-15.7
Good	4	400-500	15.7-16.8
Excellent	5	500-600	16.8-17.9
Outstanding	6	600-800	17.9-19.7
Superb	7	800-2000	19.7-26.6

Source: National Renewable Energy Laboratory Wind Energy Resource Atlas of the United States

mph miles per hour
W/m^2 Watts per square meter

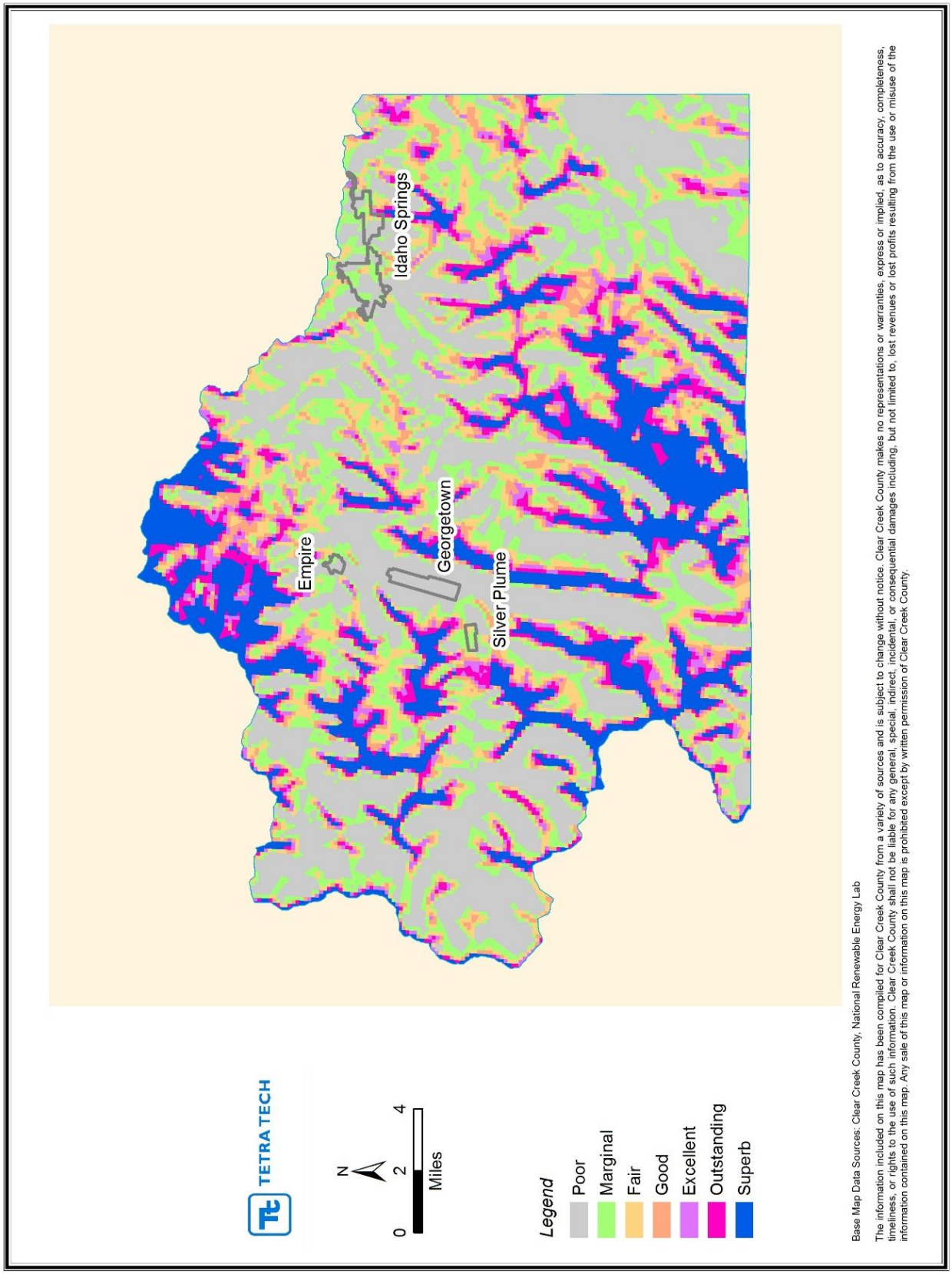


Figure 14-5. Wind Power Resource at 50 Meter Height

Historical severe weather data from the National Centers for Environmental Information Storm Events Database includes 111 high wind events and 1 thunderstorm wind events in Clear Creek County between 1996 and 2015, as shown in Table 14-5. Wind-related events caused over $16,825,000 in damages to property. There was no crop damage, but there were 10 injuries between three events.

TABLE 14-5.
CLEAR CREEK COUNTY DAMAGE OR INJURY WIND-RELATED EVENTS (1996-2015)

Location	Date	Event Type	Peak Wind Speed (knots)	Estimated Damage Cost Property	Injuries
Jefferson & W Douglas Counties above 6000 feet/Gilpin/Clear Creek/ NE Park Counties Below 9000 feet	10/29/1996	High Wind	88	$0	5
Jefferson & W Douglas Counties above 6000 feet/Gilpin/Clear Creek/ NE Park Counties Below 9000 feet	1/21/1997	High Wind	NA	$0	2
Southern Front Range Foothills/ Clear Creek Basin	2/2/1999	High Wind	110	$3,000,000	0
Southern Front Range Foothills/ Clear Creek Basin	4/9/1999	High Wind	85	$13,800,000	0
Jefferson & W Douglas Counties above 6000 feet/Gilpin/Clear Creek/ NE Park Counties Below 9000 feet	1/7/2009	High Wind	80	$25,000	0
Jefferson & W Douglas Counties above 6000 feet/Gilpin/Clear Creek/ NE Park Counties Below 9000 feet	11/12/2011	High Wind	71	$0	3

Source: National Centers for Environmental Information
NA Not Applicable

14.2.2 Location

Severe weather events have the potential to happen anywhere in the planning area. Figure 6-5 shows the distribution of average precipitation over the planning area.

Hail

While all of Clear Creek County is potentially exposed to hail, most reported hail storms occur in the eastern portion of the county, close to the City of Idaho Springs. Previous instances of hail events in the county are shown in Figure 14-6. Several of the events occurred in the same area and overlap on the map; therefore, only 9 of the 13 total hail events are represented in Figure 14-6.

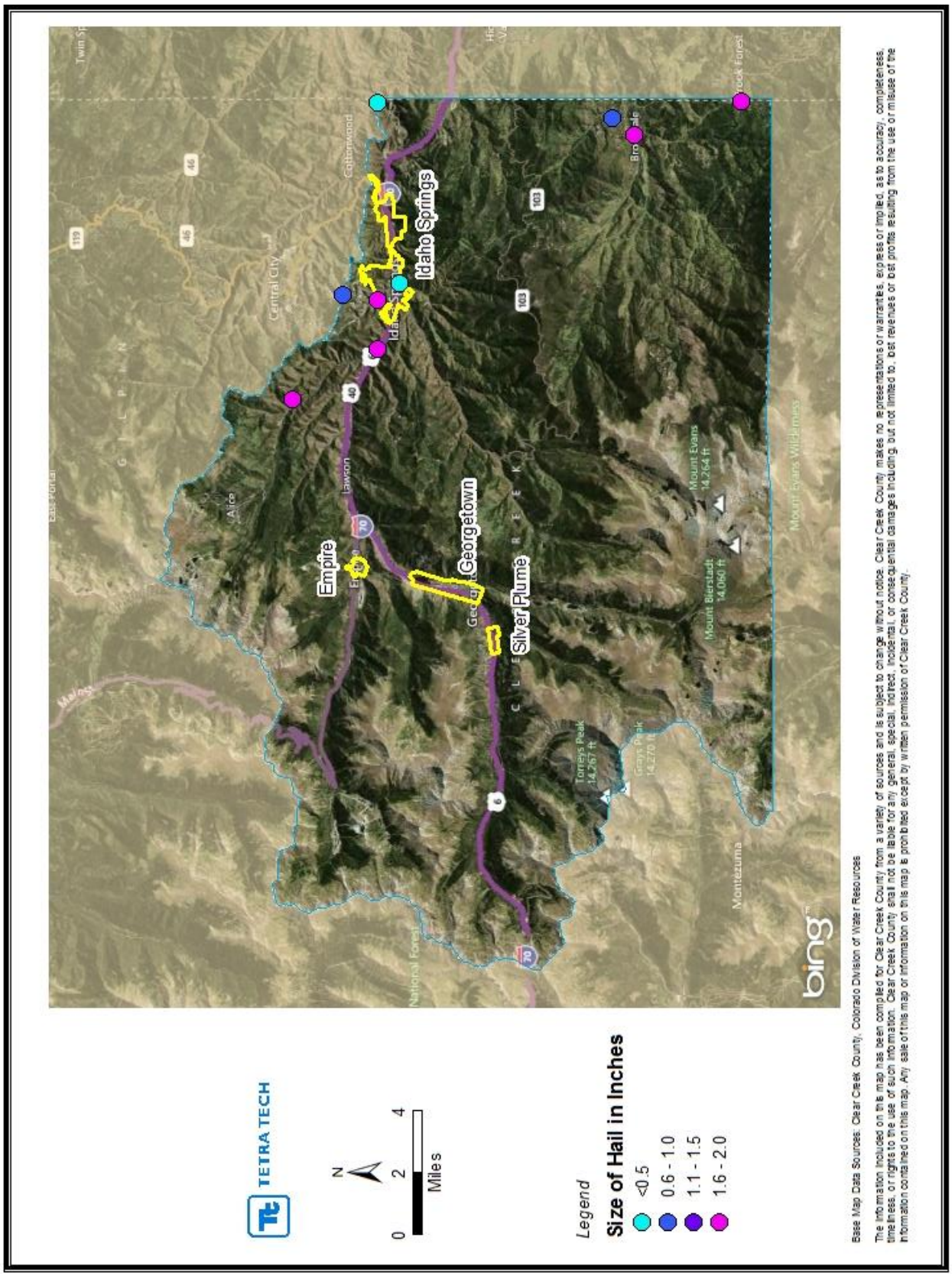


Figure 14-6. Hail Events in Clear Creek County

Lightning

The entire extent of Clear Creek County is exposed to some degree of lightning hazard, though exposed points of high elevation have significantly higher frequency of occurrence.

Severe Winds

Windstorms could occur anywhere in Clear Creek County. They have the ability to cause damage over 100 miles from the center of storm activity. Higher elevations could experience the most significant wind speeds, but these areas are generally not developed or populated. Wind events are most damaging to areas that are heavily wooded. Winds impacting walls, doors, windows, and roofs, may cause structural components to fail. The locations of previous occurrences of damaging high winds are not mapped because high wind events are likely to occur throughout the county, with high mountainous areas and valleys being the primary locations.

14.2.3 Frequency and Severity

The nation has experienced severe storms (wind, tornado, hail) that are occurring with more intensity and affecting more areas of the country. While scientists debate why these storms occur, no one argues with their effects—extensive property damage and, many times, loss of life. The property damage can be as minimal as a few broken shingles to total destruction of buildings.

Hail

Severe hailstorms can be quite destructive. Much of the damage inflicted by hail is to crops. In recent years in the United States, hail caused more than $1.3 billion in damage to property and crops each year representing 1% to 2% of the annual crop value. Even relatively small hail can shred plants to ribbons in a matter of minutes. Vehicles, roofs of buildings and homes, and landscaping are the other things most commonly damaged by hail. Hail has been known to cause injury to humans and occasionally has been fatal.

Over $2.5 billion hail damage auto and home claims were processed in 2014 at State Farm Insurance, with Colorado ranking third in overall claims. The top 5 states generating hail damage claims were Texas (51,193); Illinois (43,821); Colorado (42,365), Missouri (23,019) and Nebraska (21,326) (source: The Weather Channel, https://weather.com/storms/severe/news/top-ten-states-hail-claims-2014).

Based on the information in this hazard profile, the overall significance of hail events is moderate.

Lightning

The number of reported injuries from lightning is likely to be low, and county infrastructure losses equate to tens of thousands of dollars each year. The relationship of lightning to wildfire ignitions in the county increases the significance of this hazard. Based on the information in this hazard profile, the overall significance of lightning events is moderate for Clear Creek County but high in the City of Idaho Springs and low in the Towns of Empire, Georgetown, and Silver Plume. Caution does have to be taken on high mountainous peaks were lightning strikes are likely to occur.

Severe Winds

High winds, often accompanying severe thunderstorms, can cause significant property and crop damage, threaten public safety, and have adverse economic impacts from business closures and power loss. Wind storms in Clear Creek County are rarely life threatening, but do disrupt daily activities, cause damage to buildings, and structures, and increase the potential for other hazards, such as wildfire. Winter winds can also cause damage, close highways (blowing snow), and induce avalanches. Winds can also cause trees to fall, particularly those killed by pine beetles or wildfire, creating a hazard to property or those outdoors.

Based on the information in this hazard profile, the magnitude/severity of severe winds is considered moderate to high. Overall significance of the hazard is considered to have a moderate to high potential impact because of the high mountainous terrain found throughout the county.

14.2.4 Warning Time

Meteorologists can often predict the likelihood of a severe storm. This can give several days of warning time. However, meteorologists cannot predict the exact time of onset or severity of the storm. Some storms may come on more quickly and have only a few hours of warning time. Weather forecasts for the planning area are limited. People generally rely on weather forecasts for the City of Idaho Springs. At times warning for the onset of severe weather may be limited.

14.3 SECONDARY HAZARDS

The most significant secondary hazards associated with severe local storms are floods, falling and downed trees, landslides, and downed power lines. Rapidly melting snow combined with heavy rain can overwhelm both natural and man-made drainage systems, causing overflow and property destruction. Landslides occur when the soil on slopes becomes oversaturated and fails. Fires can occur as a result of lightning strikes. Many locations in the region have minimal vegetative ground cover and the high winds can create a large dust storm, which becomes a hazard for travelers and a disruption for local services. High winds in the winter can turn small amount of snow into a complete whiteout and create drifts in roadways. Debris carried by high winds can also result in injury or damage to property. A wildland fire can be accelerated and rendered unpredictable by high winds, which makes a dangerous environment for firefighters.

14.4 CLIMATE CHANGE IMPACTS

Climate change presents a significant challenge for risk management associated with severe weather. The frequency of severe weather events has increased steadily over the last century. The number of weather-related disasters during the 1990s was four times higher than in the 1950s, and cost 14 times as much in economic losses. Historical data shows that the probability for severe weather events increases in a warmer climate (see Figure 14-7). The changing hydrograph caused by climate change could have a significant impact on the intensity, duration and frequency of storm events. All of these impacts could have significant economic consequences.

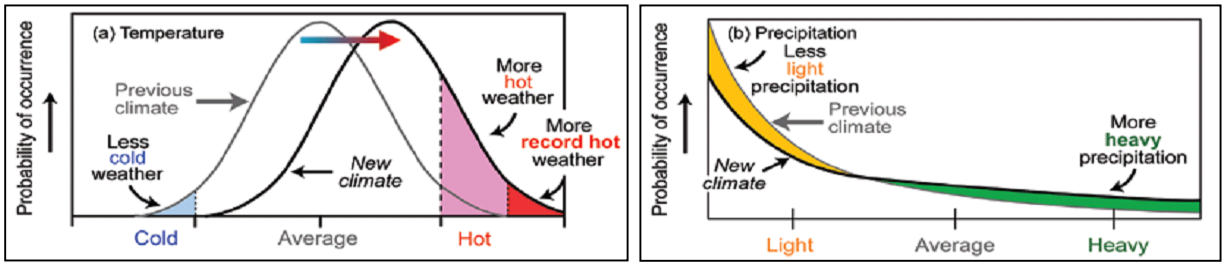


Figure 14-7. Severe Weather Probabilities in Warmer Climates

14.5 EXPOSURE

14.5.1 Population

It can be assumed that the entire planning area is exposed to some extent to thunderstorm, high wind, and hail events. Certain areas are more exposed due to geographic location and local weather patterns. Populations living at higher elevations with large stands of trees or power lines may be more susceptible to wind damage and black out, while populations in low-lying areas are at risk for possible flooding. It is not uncommon for residents living in more remote areas of the county to be isolated after such events.

14.5.2 Property

According to the Clear Creek County Assessor, there are 5,244 buildings within the census tracts that define the planning area. Most of these buildings are residential. Wind pressure can create a direct and frontal assault on a structure, pushing walls, doors, and windows inward. Conversely, passing currents can create lift and suction forces that act to pull building components and surfaces outward. The effects of winds are magnified in the upper levels of multi-story structures. As positive and negative forces impact the building's protective envelope (doors, windows, and walls), the result can be roof or building component failures and considerable structural damage.

All of these buildings are considered to be exposed to the thunderstorm, wind, and hail hazard, but structures in poor condition or in particularly vulnerable locations (located on hilltops or exposed open areas) may risk the most damage. The frequency and degree of damage will depend on specific locations.

14.5.3 Critical Facilities and Infrastructure

Facilities on higher ground may also be exposed to wind damage or damage from falling trees. The most common problems associated with these weather events are loss of utilities. Downed power lines can cause blackouts, leaving large areas isolated. Phone, water, and sewer systems may not function. Roads may become impassable due to secondary hazards such as landslides.

14.5.4 Environment

The environment is highly exposed to lightning, winds, and hail. Natural habitats such as streams and trees risk major damage and destruction. Prolonged rains can saturate soils and lead to slope failure. Flooding events can produce river channel migration or damage riparian habitat.

14.6 VULNERABILITY

14.6.1 Population

Vulnerable populations are the elderly, low income or linguistically isolated populations, people with life-threatening illnesses, and residents living in areas that are isolated from major roads. Power outages can be life threatening to those dependent on electricity for life support. Isolation of these populations is a significant concern. These populations face isolation and exposure during thunderstorm, wind, and hail events and could suffer more secondary effects of the hazard. Hikers and climbers in the area may also be more vulnerable to severe weather events. Visitors to the area may not be aware of how quickly a thunderstorm can build in the mountains.

14.6.2 Property

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

Hail

A total of 12 hail events have taken place in Clear Creek County between 1971 and 2015. Loss estimates cannot be made because the events did not result in any reported damages in the county or any of the jurisdictions.

Lightning

A total of 4 reported lightning events have taken place in Clear Creek County between 1996 and 2015. Loss estimates cannot be made because the events did not result in any reported damages in the county or any of the jurisdictions.

Severe Winds

A total of 112 severe wind events have taken place in Clear Creek County between 1996 and 2015. Only three of the events results in reported damages. The loss estimates for severe wind events in the county are listed in Table 14-6.

TABLE 14-6.
LOSS ESTIMATES FOR SEVERE WIND EVENTS IN CLEAR CREEK COUNTY

Community	Annual Rate of Occurrence	Average Loss Expectancy	Annualized Loss
Clear Creek County	6 events/year	$150,223/event	$901,338

Note: Loss estimates based on historical record of 112 wind-related events.
Source: NOAA - National Centers for Environmental Information 1996 - 2015

14.6.3 Critical Facilities and Infrastructure

Incapacity and loss of roads are the primary transportation failures resulting from thunderstorms, wind, and hail, mostly associated with secondary hazards. Landslides caused by heavy prolonged rains can block roads. High winds can cause significant damage to trees and power lines, blocking roads with debris, incapacitating transportation, isolating population, and disrupting ingress and egress. Of particular concern are roads providing access to isolated areas and to the elderly. Prolonged obstruction of major routes due to landslides, debris, or floodwaters can disrupt the shipment of goods and other commerce. Large, prolonged storms can have negative economic impacts for an entire region. Severe windstorms and downed trees can create serious impacts on power and above-ground communication lines. Loss of electricity and phone connection would leave certain populations isolated because residents would be unable to call for assistance. Lightning events in the county can have destructive effects on power and information systems. Failure of these systems would have cascading effects throughout the county and could possible disrupt critical facility functions.

14.6.4 Environment

The vulnerability of the environment to severe weather is the same as the exposure, discussed in Chapter 14.5.4.

14.7 FUTURE TRENDS IN DEVELOPMENT

All future development will be affected by severe storms. The ability to withstand impacts lies in sound land use practices and consistent enforcement of codes and regulations for new construction. The planning partners have adopted the International Building Code. This code is equipped to deal with the impacts of severe weather events. Land use policies identified in master plans and enforced through zoning code and the permitting process also address many of the secondary impacts (flood and landslide) of the severe weather hazard. With these tools, the planning partnership is well equipped to deal with future growth and the associated impacts of severe weather.

14.8 SCENARIO

Although severe local storms are infrequent, impacts can be significant, particularly when secondary hazards of flood and landslide occur. A worst-case event would involve prolonged high winds during a winter storm accompanied by thunderstorms. Such an event would have both short-term and longer-term effects. Initially, schools and roads would be closed due to power outages caused by high winds and downed tree obstructions. In more rural areas, some subdivisions could experience limited ingress and egress. Prolonged rain could produce flooding, overtopped culverts with ponded water on roads, and landslides on steep slopes. Flooding, drifting snow, and landslides could further obstruct roads and bridges, further isolating residents.

14.9 ISSUES

Important issues associated with a severe weather in the planning area include the following:

- Older building stock in the planning area is built to low code standards or none at all. These structures could be highly vulnerable to severe weather events such as windstorms.
- Redundancy of power supply must be evaluated.
- The capacity for backup power generation is limited.
- The potential for isolation after a severe storm event is high.
- There is limited information available for local weather forecasts.
- The lack of proper management of trees may exacerbate damage from high winds.

Chapter 15.
LANDSLIDE, MUD/DEBRIS FLOW, ROCKFALL

LANDSLIDE, MUD/DEBRIS FLOW, ROCKFALL HAZARD RANKING	
Clear Creek County	Medium
City of Idaho Springs	High
Town of Empire	Medium
Town of Georgetown	Medium
Town of Silver Plume	High
See Chapter 20 for more information on hazard ranking.	

DEFINITIONS

Landslide—The sliding movement of masses of loosened rock and soil down a hillside or slope. Such failures occur when the strength of the soils forming the slope is exceeded by the pressure, such as weight or saturation, acting upon them.

Mass Movement—A collective term for landslides, debris flows, falls and sinkholes.

Mudslide (or Mudflow or Debris Flow)—A river of rock, earth, organic matter and other materials saturated with water.

15.1 GENERAL BACKGROUND

15.1.1 Landslide

A landslide is a general term for a variety of mass-movement processes that generate a downslope movement of soil, rock, and vegetation under gravitational influence. Some of the natural causes of ground instability are stream and lakeshore erosion, heavy rainfall, and poor quality natural materials. In addition, many human activities tend to make the earth materials less stable and, thus, increase the chance of ground failure. Human activities contribute to soil instability through grading of steep slopes or overloading them with artificial fill, by extensive irrigation, construction of impermeable surfaces, excessive groundwater withdrawal, and removal of stabilizing vegetation. Landslides typically have a slower onset and can be predicted to some extent by monitoring soil moisture levels and ground cracking or slumping in areas of previous landslide activity.

Landslides are caused by one or a combination of the following factors: change in slope of the terrain, increased load on the land, shocks and vibrations, change in water content, groundwater movement, frost action, weathering of rocks, and removing or changing the type of vegetation covering slopes. In general, landslide hazard areas are where the land has characteristics that contribute to the risk of the downhill movement of material, such as the following:

- A slope greater than 30%.
- A history of landslide activity or movement during the last 10,000 years.
- Stream or wave activity, which has caused erosion, undercut a bank, or cut into a bank to cause the surrounding land to be unstable.
- The presence or potential for snow avalanches.
- The presence of an alluvial fan, indicating vulnerability to the flow of debris or sediments.
- The presence of impermeable soils, such as silt or clay, which are mixed with granular soils such as sand and gravel.

Flows and slides are commonly categorized by the form of initial ground failure. Figure 15-1 through Figure 15-4 show common types of slides. The most common is the shallow colluvial slide, occurring particularly in response to intense, short-duration storms. The largest and most destructive are deep-seated slides, although they are less common than other types.

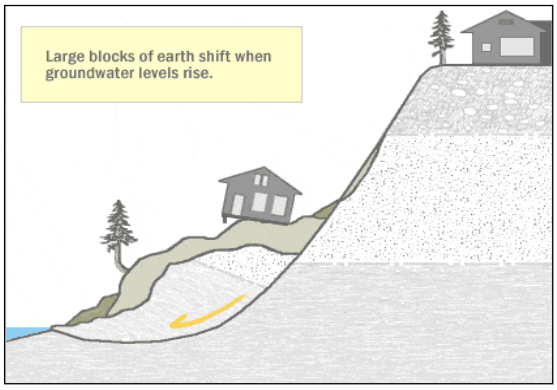


Figure 15-1. Deep Seated Slide

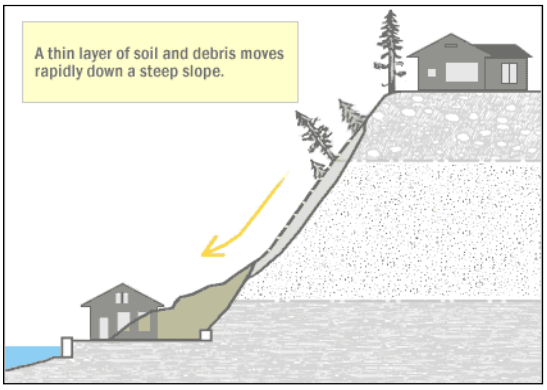


Figure 15-2. Shallow Colluvial Slide

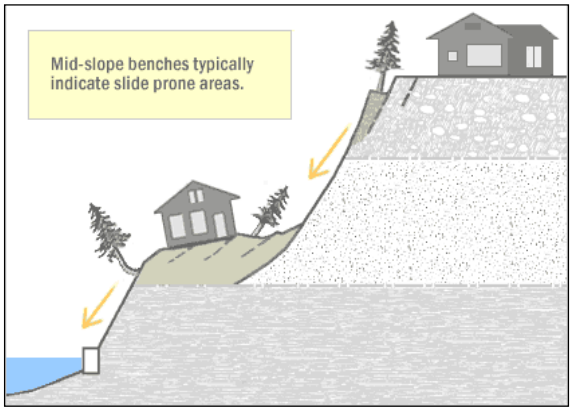


Figure 15-3. Bench Slide

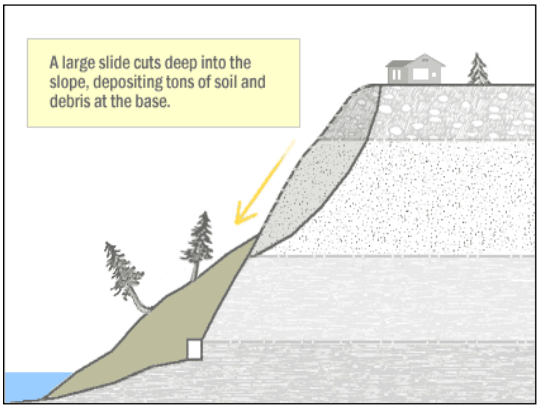


Figure 15-4. Large Slide

Slides and earth flows can pose serious hazard to property in hillside terrain. They tend to move slowly and thus rarely threaten life directly. When they move—in response to such changes as increased water content, earthquake shaking, addition of load, or removal of downslope support—they deform and tilt the ground surface. The result can be destruction of foundations, offset of roads, breaking of underground pipes, or overriding of downslope property and structures.

15.1.2 Mud and Debris Flow

According to the Colorado Geological Survey, a mudslide is a mass of water and fine-grained earth that flows down a stream, ravine, canyon, arroyo, or gulch. If more than half of the solids in the mass are larger than sand grains (rocks, stones, boulders), the event is called a debris flow. A debris fan is a conical landform produced by successive mud and debris flow deposits, and the likely spot for a future event. Mud and debris flow problems can be exacerbated by wildfires that remove vegetation that serves to stabilize soil from erosion. Heavy rains on the denuded landscape can lead to rapid development of destructive mudflows.

15.1.3 Rockfall

A rockfall is the falling of a detached mass of rock from a cliff or down a very steep slope. Weathering and decomposition of geological materials produce conditions favorable to rockfalls. Rockfalls are caused by the loss of support from underneath through erosion or triggered by ice wedging, root growth, or ground shaking. Changes to an area or slope such as cutting and filling activities can also increase the risk of a rockfall. Rocks in a rockfall can be of any dimension, from the size of baseballs to houses. Rockfalls can threaten human life, impact transportation corridors and communication systems and result in other

property damage. Spring is typically the landslide/rockfall season in Colorado as snow melts and saturates soils and temperatures enter into freeze/thaw cycles. Rockfalls and landslides are influenced by seasonal patterns, precipitation and temperature patterns. Earthquakes could trigger rockfalls and landslides too.

15.2 HAZARD PROFILE

15.2.1 Past Events

There have been 105 reported landslide events in Clear Creek County. The majority of the events are focused on high mountainous areas in the western portion of the county. Several events have occurred in Silver Plume, Georgetown, and Empire. There have been no reported landslide events in Idaho Springs. Landslides are a major issue for the Interstate 70 corridor. Landslides can cause road closures and vehicles accidents. The Interstate 70 corridor is a major east/west route across the county and provides goods and materials across the country.

15.2.2 Location

According to the *2013 State of Colorado Hazard Mitigation Plan,* "Many of Colorado's landslides occur along transportation networks because soil and rock along the transportation corridor has been disturbed by roadway construction. Construction along roads can occur with or without proper landslide hazard mitigation procedures. The cost to maintain, cleanup, monitor, and repair roads and highways from landslide activity is difficult to assess, but the best records come from CDOT, which is responsible for maintaining Colorado roads and highways" (Colorado Division of Emergency Management 2015).

The best available predictor of where movement of slides and earth flows might occur is the location of past movements. Past landslides can be recognized by their distinctive topographic shapes, which can remain in place for thousands of years. Most landslides recognizable in this fashion range from a few acres to several square miles. Most show no evidence of recent movement and are not currently active. A small proportion of them may become active in any given year, with movements concentrated within all or part of the landslide masses or around their edges.

The recognition of ancient dormant mass movement sites is important in the identification of areas susceptible to flows and slides because they can be reactivated by earthquakes or by exceptionally wet weather. Also, because they consist of broken materials and frequently involve disruption of groundwater flow, these dormant sites are vulnerable to construction-triggered sliding.

The geographic location of landslides and rockfalls throughout Clear Creek County is isolated. Figure 15-5 and Figure 15-6 show mapped landslide hazard areas within the county. Landslide events have occurred in Silver Plume, Georgetown, and Empire. There have been no reported landslide events in Idaho Springs. There is a high potential for landslides, mud/debris flows, rockfalls, and sinkholes along Interstate 70 that could severely disrupt traffic along the highway.

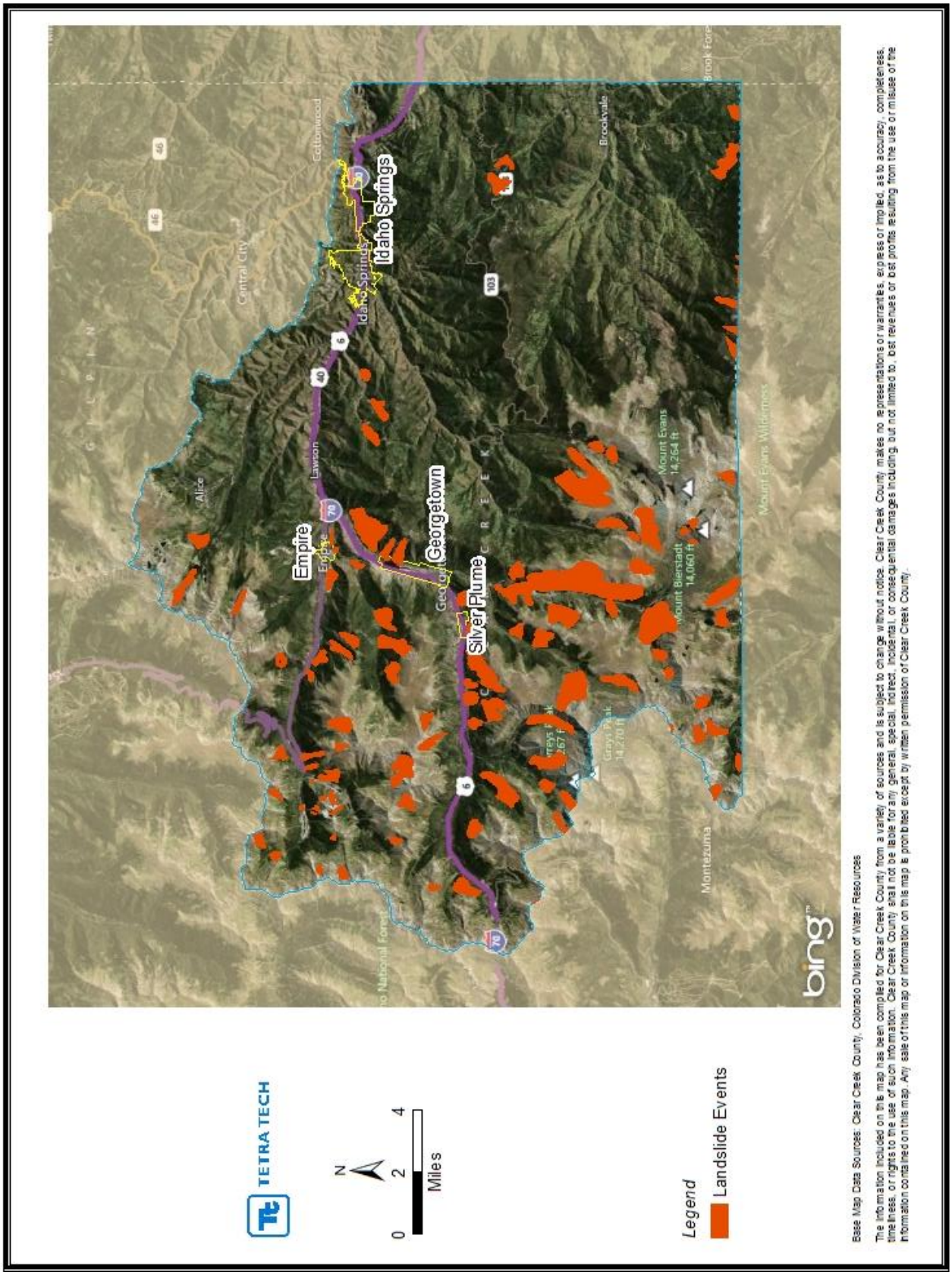


Figure 15-5. Landslide Events in Clear Creek County

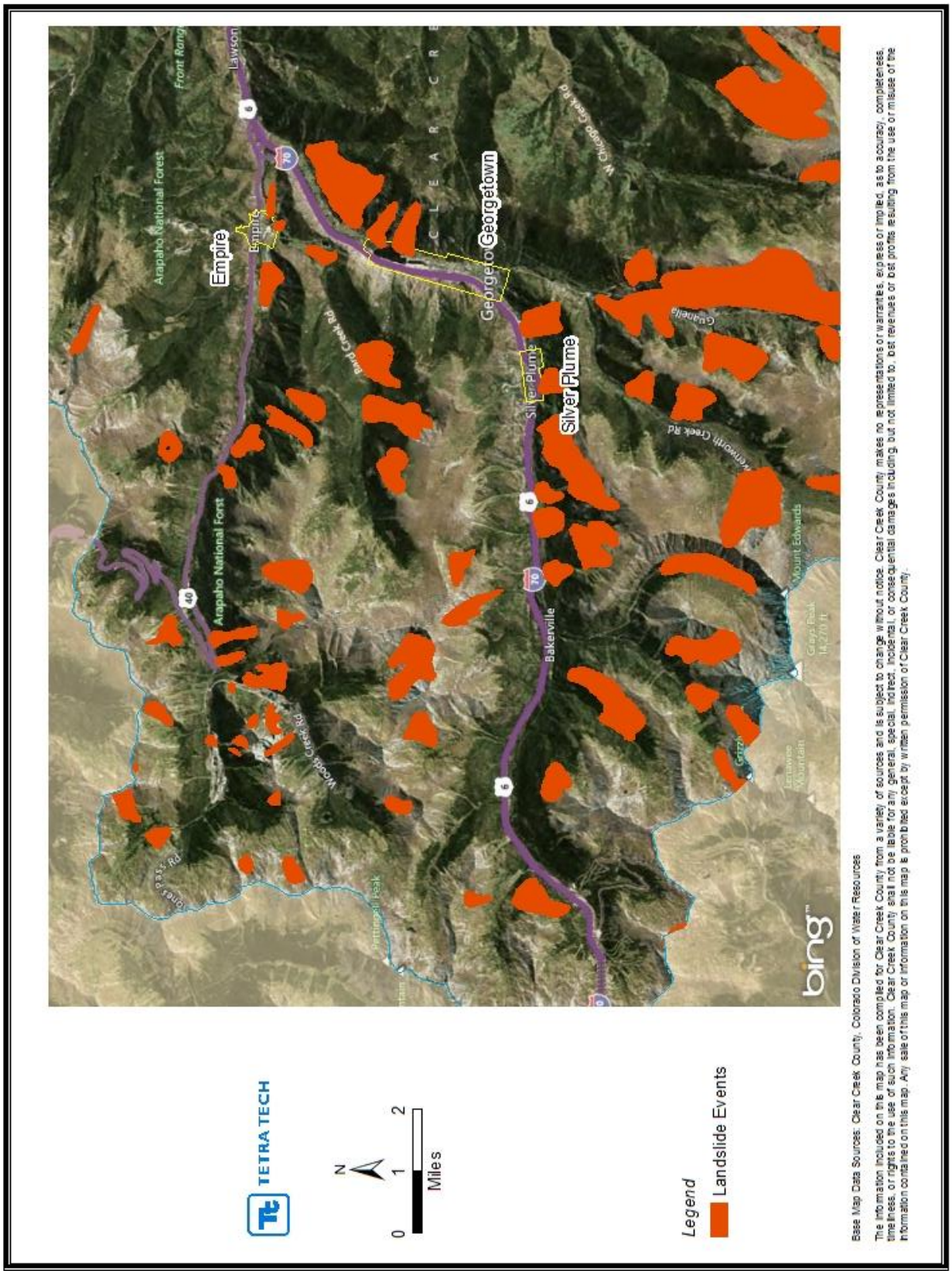


Figure 15-6. Landslide Events in the Towns of Empire, Georgetown, and Silver Plume

15.2.3 Frequency and Severity

Landslides destroy property and infrastructure and can take the lives of people. Slope failures in the United States result in an average of 25 lives lost per year and an annual cost of about $1.5 billion. Based on this hazard profile, the magnitude/severity of a landslide/rock fall event in Clear Creek County is severe, primarily because of the impact landslide/rockfall events can have on the Interstate 70 corridor.

Primarily, the area with likely landslides is in the western and high mountainous areas of the county in the Front Range Mountains. According to the USGS, the Towns of Empire, Georgetown, and Silver Plume are located within an area with high susceptibility to landslides and a moderate incidence rate.

15.2.4 Warning Time

Mass movements can occur suddenly or slowly. The velocity of movement may range from a slow creep of inches per year to many feet per second, depending on slope angle, material and water content. Some methods used to monitor mass movements can provide an idea of the type of movement and the amount of time prior to failure. It is also possible to identify what areas are at risk during general time periods. Assessing the geology, vegetation, and amount of predicted precipitation for an area can help in these predictions. However, there is no practical warning system for individual landslides. The current standard operating procedure is to monitor situations on a case-by-case basis, and respond after the event has occurred. Generally accepted warning signs for landslide activity include:

- Springs, seeps, or saturated ground in areas that have not typically been wet before
- New cracks or unusual bulges in the ground, street pavements, or sidewalks
- Soil moving away from foundations
- Ancillary structures such as decks and patios tilting or moving relative to the main house
- Tilting or cracking of concrete floors and foundations
- Broken water lines and other underground utilities
- Leaning telephone poles, trees, retaining walls, or fences
- Offset fence lines
- Sunken or down-dropped road beds
- Rapid increase in creek water levels, possibly accompanied by increased soil content
- Sudden decrease in creek water levels though rain is still falling or just recently stopped
- Sticking doors and windows and visible gaps indicating jambs and frames out of plumb
- A faint rumbling sound that increases in volume as the landslide nears
- Unusual sounds, such as trees cracking or boulders knocking together

15.3 SECONDARY HAZARDS

Landslides can cause several types of secondary effects, such as blocking access to roads, which can isolate residents and businesses and delay commercial, public, and private transportation. This could result in economic losses for businesses. More significantly, landslides can limit the ability of emergency response services to access and serve portions of the county and Interstate 70. Additionally, rockfalls to rivers can cause blockages causing flooding, damage rivers or streams, potentially harming water quality, fisheries, and spawning habitat. Other potential problems resulting from landslides are power and communication failures. Vegetation or poles on slopes can be knocked over, resulting in possible losses to power and

communication lines. Landslides also have the potential of destabilizing the foundation of structures, which may result in monetary loss for residents.

15.4 CLIMATE CHANGE IMPACTS

Climate change may impact storm patterns, increasing the probability of more frequent, intense storms with varying duration. Increases in global temperature could affect the snowpack and its ability to hold and store water. Warming temperatures also could increase the occurrence and duration of droughts, which would increase the probability of wildfire, reducing the vegetation that helps to support steep slopes. All of these factors would increase the probability for landslide occurrences.

15.5 EXPOSURE

Exposure and vulnerability estimates for the landslide hazard were assessed using a methodology based on past events. Landslide risk areas are found throughout the county, including areas around the City of Idaho Springs and the Towns of Empire, Georgetown, and Silver Plume.

15.5.1 Population

Population exposure to landslide hazard areas is likely moderate. Known landslide events have occurred in the Towns of Silver Plume and Georgetown along Interstate 70 and near the Town of Empire. It is most likely that individuals exposed to landslide, mud/debris flow, and rockfall hazards would be in recreation areas or driving on roadways.

15.5.2 Property

Property exposure to landslide hazard areas are likely to be moderate. As stated previously, the Towns of Empire, Georgetown, and Silver Plume all have known occurrences of landslide events. The City of Idaho Springs has known occurrences of sinkholes from old/unmapped mines as mentioned in Chapter 12. Interstate 70 is most likely to be at risk of damage.

15.5.3 Critical Facilities and Infrastructure

No loss estimation of these facilities was performed due to the lack of established damage functions for the landslide hazard. A significant amount of infrastructure can be exposed to mass movements:

- **Roads**—Landslides, mud/debris flow, or rockfalls can block egress and ingress on roads, causing isolation for neighborhoods, traffic problems and delays for public and private transportation. This can result in economic losses for businesses.
- **Bridges**—Landslides can significantly impact road bridges. Mass movements can knock out bridge abutments or significantly weaken the soil supporting them, making them hazardous for use.
- **Power Lines**—Power lines are generally elevated above steep slopes; the towers supporting them can be subject to landslides. A landslide could trigger failure of the soil underneath a tower, causing it to collapse and ripping down the lines. Power and communication failures due to landslides can create problems for vulnerable populations and businesses.

15.5.4 Environment

Environmental problems as a result of mass movements can be numerous. Landslides that fall into streams may significantly impact fish and wildlife habitat, as well as affecting water quality. Hillsides that provide wildlife habitat can be lost for prolonged periods of time.

15.6 VULNERABILITY

15.6.1 Population

In general, all person exposed to landslide hazard areas are considered to be vulnerable. Increasing population and the fact that many homes are built on view property atop or below bluffs and on steep slopes subject to mass movement, increases the number of lives endangered by this hazard.

15.6.2 Property

Loss estimations for the landslide hazards are not based on modeling using damage functions, because no such damage functions have been generated. There are no reports of property damage or injury in association with landslides, mud/debris flows, and rockfalls in Clear Creek County. Areas of higher susceptibility are mainly located away from population centers in the western portions of the county.

15.6.3 Critical Facilities and Infrastructure

Critical facilities are found throughout the highest landslide prone areas because most of the county is in a high landslide prone area. Several critical facilities are in areas that have the potential for landslides, mud/debris flows, and rockfalls. A more in-depth analysis of the mitigation measures taken by these facilities to prevent damage from mass movements should be done to evaluate whether they could withstand impacts of a mass movement.

Several types of infrastructure are exposed to mass movements, including transportation, water and sewer and power infrastructure. Highly susceptible areas of the county include mountain roads and transportation infrastructure. At this time, all infrastructure and transportation corridors identified as exposed to the landslide hazard are considered vulnerable.

15.6.4 Environment

The environment vulnerable to landslide hazard is the same as the environment exposed to the hazard, discussed in Section 15.5.4.

15.7 FUTURE TRENDS IN DEVELOPMENT

The severity of landslide problems is directly related to the extent of human activity in hazard areas. Adverse effects can be mitigated by early recognition and avoiding incompatible land uses in these areas or by corrective engineering. The mountainous topography of the county presents considerable constraints to development, most commonly in the form of steeply sloped areas. These areas are vulnerable to disturbance and can become unstable. Most of these areas are adjacent to roadway systems that are heavily used.

Continued adherence to the land development codes and regulations in the planning area will decrease the risk of future development to landslide hazard areas. Development of lands within identified hazard areas are limited to meet the requirements set forth by the Planning and Zoning Offices or the Building Departments of the jurisdiction at the time of construction. Most construction has been limited to areas that are not in these hazard areas.

15.8 SCENARIO

Major landslides in the planning area occur as a result of soil conditions that have been affected by wildfire, natural erosion, severe storms, groundwater, or human development. The worst-case scenario for landslide hazards in the planning area would generally correspond to a severe storm that had heavy rain and caused flooding in burn scar areas. Landslides are most likely during late spring and summer months. After heavy spring and summer rains, soils become saturated with water. As water seeps downward through upper soils that may consist of permeable sands and gravels and accumulates on impermeable silt, it will cause

weakness and destabilization in the slope. A short intense storm could cause saturated soil to move, resulting in landslides. As rains continue, the groundwater table rises, adding to the weakening of the slope. Burn scars, gravity, poor drainage, a rising groundwater table, and poor soil exacerbate hazardous conditions.

Mass movements are becoming more of a concern as development moves outside of town centers and into areas less developed in terms of infrastructure. Most mass movements would be isolated events affecting specific areas. It is probable that private and public property, including infrastructure, will be affected. Mass movements could affect bridges that pass over landslide prone ravines and knock out transportation corridors through the county. Road obstructions caused by mass movements would create isolation problems for residents and businesses in sparsely developed areas. Property owners exposed to steep slopes may suffer damage to property or structures. Landslides carrying vegetation such as shrubs and trees may cause a break in utility lines, cutting off power, and communication access to residents.

15.9 ISSUES

Important issues associated with landslides in the planning area include the following:

- There are most likely existing homes in landslide risk areas throughout the county. The degree of vulnerability of these structures depends on the codes and standards the structures were constructed to. Information to this level of detail is not currently available.
- As incidents of wildfires increase and hillsides are void of vegetation, rain-soaked hillsides are more likely to slide resulting in increased damage countywide.
- Future development could lead to more homes in landslide risk areas.
- Mapping and assessment of landslide hazards are constantly evolving. As new data and science become available, assessments of landslide risk should be reevaluated.
- The impact of climate change on landslides is uncertain. If climate change impacts atmospheric conditions, then exposure to landslide risks is likely to increase.
- Landslides may cause negative environmental consequences, including water quality degradation.
- The risk associated with the landslide hazard overlaps the risk associated with other hazards such as earthquake, flood, and wildfire. This provides an opportunity to seek mitigation alternatives with multiple objectives that can reduce risk for multiple hazards.

Chapter 16.
SPACE WEATHER

SPACE WEATHER RANKING	
Clear Creek County	Low
City of Idaho Springs	Low
Town of Empire	Low
Town of Georgetown	Low
Town of Silver Plume	Low
See Chapter 20 for more information on hazard ranking.	

DEFINITIONS

Space Weather—FEMA's Ready.gov site defines space weather as the variable conditions on the sun and in space that can influence the performance of technology used on Earth.

16.1 GENERAL BACKGROUND

The NOAA Space Weather Prediction Center states: All weather on Earth, from the surface of the planet out into space, begins with the Sun. Space weather and terrestrial weather (the weather we feel at the surface) are influenced by the small changes the Sun undergoes during its solar cycle. Extreme space weather could potentially cause damage to critical infrastructure – especially the electric grid – highlighting the importance of being prepared.

The sun is the main source of space weather. Sudden bursts of plasma and magnetic field structures from the Sun's atmosphere called coronal mass ejections (CME) together with sudden bursts of radiation, or solar flares, all cause space weather effects here on Earth.

Space weather can produce electromagnetic fields that induce extreme currents in wires, disrupting power lines, and even causing wide-spread blackouts. Severe space weather also produces solar energetic particles, which can damage satellites used for commercial communications, global positioning, intelligence gathering, and weather forecasting.

The most important impact the Sun has on Earth is from the brightness or irradiance of the Sun itself. The Sun produces energy in the form of photons of light. The variability of the Sun's output is wavelength dependent; different wavelengths have higher variability than others. Most of the energy from the Sun is emitted in the visible wavelengths (approximately 400 – 800 nanometers [nm]). The output from the Sun in these wavelengths is nearly constant and changes by only one part in a thousand (0.1%) over the course of the 11-year solar cycle.

At ultraviolet or UV wavelengths (120 – 400 nm), the solar irradiance variability is larger over the course of the solar cycle, with changes up to 15%. This has a significant impact on the absorption of energy by ozone and in the stratosphere. At shorter wavelengths, like the extreme ultraviolet (EUV), the Sun changes by 30% to 300% over very short timescales (i.e. minutes). These wavelengths are absorbed in the upper atmosphere so they have minimal impact on the climate of Earth. At the other end of the light spectrum, at infrared (IR) wavelengths (800 to 10,000 nm), the Sun is very stable and only changes by a percent or less over the solar cycle.

There are other types of space weather that can impact the atmosphere. Energetic particles penetrate into the atmosphere and change the chemical constituents. These changes in minor species such as nitrous oxide (NO) can have long lasting consequences in the upper and middle atmosphere, however it has not been determined if these have a major impact on the Earth's climate.

Data from NOAA's Space Weather Prediction Center has developed Space Weather Scales. It should be noted that NOAA studies have determined that different types of space weather may occur separately. Descriptions of all three general classifications of space weather as documented by NOAA are included in the Figure 16-1. These include: geomagnetic storms, solar radiation storms and radio blackouts.

NOAA Space Weather Scales

NOTE: Each type of space weather may occur separately. Descriptions of all three types of space weather warnings are here combined into one table merely to conserve space.

HF means high frequency (radio waves), but other radio frequencies may also be affected by these events. LF means low frequency (radio waves). F: refers to event frequency.

Category Labels	Geomagnetic Storms (effect & frequency)	Solar Radiation Storms (effect & frequency)	Radio Blackouts (effect & frequency)
Minor G1 S1 R1	G1 events can cause weak power grid fluctuations, minor impacts on satellite operations, effects on migratory animals, and widely visible auroras seen in Northern Michigan. F: about 900 days per solar cycle.	S1 events result in minor impacts on HF radio in polar regions. F: about 50 such events per solar cycle, each of which can last more than 1 day.	R1 events cause weak or minor degradation of HF radio communication on the sunlit side of Earth, and occasional loss of radio contact. LF navigation signals used by maritime and general aviation systems may be degraded for brief intervals. F: about 950 days per solar cycle.
Moderate G2 S2 R2	G2 events can cause high-latitude power systems to experience voltage alarms. Long-duration storms may cause transformer damage. Corrections to satellite orientation and orbital drag prediction may be required. HF radio propagation can fade at higher latitudes. Auroras may be visible throughout Michigan. F: about 360 days per solar cycle.	S2 events may expose persons in high-flying aircraft to an elevated radiation risk* in areas of high latitude. Infrequent single-event upsets of satellite operations are possible. Possible effects on HF propagation and navigation through polar regions. F: about 25 events per solar cycle, each of which can last more than 1 day.	R2 events cause a limited blackout of HF radio communications on the sunlit side of Earth, and loss of radio contact for tens of minutes. LF navigation signals may also be degraded for tens of minutes. F: about 300 days per solar cycle.
Strong G3 S3 R3	G3 events may require voltage corrections at power systems and may trigger false alarms on their protection devices. Satellite orientation problems may need correction. Increased atmospheric drag and component surface charging may occur. Intermittent LF radio navigation problems may occur. F: 130 days per solar cycle.	S3 events can expose persons in high-flying aircraft to a radiation risk* in areas of high latitude. Satellite operations may experience single-event upsets, imaging system noise, and slight solar panel inefficiencies. Degraded HF radio propagation in polar regions. Navigation position errors are likely. F: about 10 events per cycle (each can exceed 1 day).	R3 events cause a wide area blackout of HF radio communication and loss of radio contact for about an hour on the sunlit side of Earth. LF navigation signals may be degraded for about an hour. F: about 140 days per solar cycle.
Severe G4 S4 R4	G4 events may cause widespread voltage control problems for power systems, and mistaken exclusion of key assets from a power grid by some protective systems. Satellites may experience surface charging, tracking and orientation problems that may need correction. Pipelines may experience induced currents. HF radio propagation sporadic. LF radio disrupted. Satellite-based navigation may be degraded for hours. F: about 60 days per solar cycle.	S4 events can expose persons in high-flying aircraft to a radiation risk* in areas of high latitude. Satellites may experience memory device problems, imaging systems noise, orientation problems, and degraded solar panel efficiency. A blackout of HF radio communications is likely through the polar regions. Increased navigation errors over several days are likely. F: about 3 events per solar cycle (each can exceed 1 day).	R4 events cause an HF radio communication blackout on most of the sunlit side of Earth for 1 to 2 hours, with HF radio contact lost during this time. LF navigation signals cause increased errors in positioning for 1 to 2 hours. Minor disruptions of satellite navigation are possible on the sunlit side of Earth. F: about 8 days per solar cycle.
Extreme G5 S5 R5	G5 events may cause widespread voltage control and protective system problems in power systems, with some grid systems completely blacking out or collapsing, and possible damage to transformers. Satellites may experience extensive surface charging, orientation, tracking, and linkage problems. Pipelines may receive induced currents reaching hundreds of amps. HF radio may be out for 1 to 2 days in many areas. LF may be out for hours. Satellite-based navigation may be degraded for days. Bright auroral lights visible at night. F: about 4 days per solar cycle.	S5 events can expose persons in high-flying aircraft to a radiation risk* in areas of high latitude. Satellites may be rendered useless, may receive permanent solar panel damage, or may experience memory problems, loss of control, serious imaging data noise, and navigation problems. Complete HF radio communications blackouts are possible throughout the polar regions. Navigation operations will be extremely difficult and error-laden. F: less than 1 event per solar cycle should occur, although an event may exceed 1 day in duration.	R5 events cause a complete HF radio blackout on the entire sunlit side of Earth for a number of hours. No HF radio contact with mariners and aviators in this sector. LF navigation signals experience outages for many hours on the sunlit side of Earth, causing loss in positioning. Satellite navigation errors in positioning increase for several hours on the sunlit side and may spread into the night side of the Earth. F: fewer than 1 event per cycle.

*** Pregnant women are particularly susceptible to radiation risk.**

Figure 16-1. NOAA Space Weather Scales

16.2 HAZARD PROFILE

16.2.1 Past Events

Table 16-1lists documented events associated with Space Weather worldwide since the 1700s. No events have been documented as impacting Colorado including Clear Creek County.

TABLE 16-1.
GLOBAL SPACE WEATHER EVENTS SINCE 1700

Date	Event	Location	Impacts to Clear Creek County
July 1, 1770	Lexell's comet	International	None
September 1, 1859	Solar Flare	International	None
February 5, 1905	Meteorite	The Arabian Penninsula	None
June 30, 1908	Meteorite	Russia	None
May 1, 1921	Geomagnetic storm	International	None
February 12,1947	Bolide Event	Russia	None
September 17, 1966	Bolide Event	Lake Huron	None
February 8, 1969	Meteorites	Pueblito de Allende, Mexico	None
August 4, 1972	Solar Flare	Illinois	None
August 10, 1972	Meteorites	Western US and Canada	None
January 1, 1978	Soviet Satellite, Cosmos 954	International	None
July 11, 1979	Skylab Space Station	International	None
March 13, 1989	Geomagnetic Storms	Canada and Eastern US	None
October 9, 1992	Peekskill Meteorite	New York	None
January 1, 1994	Space Weather	Canada	None
July 15 - 24, 1994	Comet Schoemaker	International	None
March 19, 1996	Asteroid	International	None
January 11, 1997	Satellite Failure	International	None
September 1, 1997	Meteorite Explosions	Michigan	None
April-May 1998	Satellite Failure	International	None
June 14, 2002	Asteroid	International	None
February 1, 2003	Space Shuttle Columbia	United States	None
March 26, 2003	Meteorite Shower	Park Forest, Suburban Chicago	None
December 1, 2005	Geomagnetic storms	International	None

TABLE 16-1.
GLOBAL SPACE WEATHER EVENTS SINCE 1700

Date	Event	Location	Impacts to Clear Creek County
December 6, 2006	Solar Burst	International	None
September 20, 2007	Meteorite Impact	Southern Peru	None
February 4, 2011	Asteroid	International	None
June 27, 2011	Asteroid	International	None
October 31, 2015	Halloween Asteroid	International	None
January 5, 2016	Geomagnetic storms	International	None

16.2.2 Location

There is no documentation of space weather events occurring in Clear Creek County or the State of Colorado. The northeast United States and Eastern Canada however have several documented occurrences.

16.2.3 Frequency and Severity

No space weather events have been documented as having occurred in Colorado nor more specifically in Clear Creek County. Thus the probability of future events affecting the planning area is minimal.

16.2.4 Warning Time

Space weather prediction services in the United States are provided primarily by NOAA's Space Weather Prediction Center and the U.S. Air Force's Weather Agency, which work closely together to address the needs of their civilian and military user communities. The Space Weather Prediction Center draws on a variety of data sources, both space and ground-based, to provide forecasts, watches, warnings, alerts, and summaries as well as operational space weather products to civilian and commercial users.

16.3 SECONDARY HAZARDS

Possibly the most likely secondary impacts of Space Weather to residents and visitors to Clear Creek County could be impacts to the electric power grid, and consequently the power to homes and businesses which could be disrupted by space weather. To date there are no reports or documentation of space weather events having affected Clear Creek County or areas proximate to the County.

Space weather can have an impact on advanced technologies which has a direct impact on daily life. The main area of concern is most likely the nation's electric power grid. Northern territories are more vulnerable to these effects than areas farther south. Generally, power outages due to space weather are very rare events, but evidence suggests that significant effects could occur. These power outages may have cascading effects, causing:

- Loss of water and wastewater distribution systems
- Loss of perishable foods and medications
- Loss of heating/air conditioning and electrical lighting systems
- Loss of computer systems, telephone systems, and communications systems (including disruptions in airline flights, satellite networks and global positioning system services)

- Loss of public transportation systems
- Loss of fuel distribution systems and fuel pipelines
- Loss of all electrical systems that do not have back-up power

16.4 CLIMATE CHANGE IMPACTS

NOAA states that the duration of solar minimum may also have an impact on Earth's climate. During solar minimum the cosmic rays are at a maximum. Cosmic rays are high energy particles whose source is outside our solar system, reaching Earth. There is a theory that cosmic rays can create nucleation sites in the atmosphere which seed cloud formation and create cloudier conditions. If this were true, then there would be a significant impact on climate, which would be modulated by the 11-year solar cycle.

16.4.1 Population

It can be assumed that the entire planning area is exposed to some extent to space weather. Certain areas are more exposed due to geographic location and local weather patterns.

16.4.2 Property

According to the Clear Creek County Assessor, there are 5,244 buildings within the census tracts that define the planning area. Most of these buildings are residential. Property across the county could likely be equally exposed and impacted by space weather.

16.4.3 Critical Facilities and Infrastructure

All critical facilities and infrastructure (see Table 6-4 and Table 6-5) are likely exposed to be equally impacted by space weather. The most common problems associated with this hazard are utility losses leaving large areas isolated. Phone, water, and sewer systems may not function.

16.4.4 Environment

Predominant environmental concerns are exposure to spoiled and tainted food and possibly water without electricity for a period of time.

16.5 VULNERABILITY

16.5.1 Population

Vulnerable populations are the elderly, low income or linguistically isolated populations, people with life-threatening illnesses, and residents living in areas that are isolated from major population centers. Power outages can be life threatening to those dependent on electricity for life support. Isolation of these populations is a significant concern.

16.5.2 Property

All property would be equally vulnerable to space weather. According to the Clear Creek County Assessor, there are 5,244 buildings within the census tracts that define the planning area. Most of these buildings are residential. It is unlikely that the impacts of space weather would have a negative impact on the structures themselves.

16.5.3 Critical Facilities and Infrastructure

Space weather occurrences could cause disruption in power and communications potentially incapacitating transportation, isolating population, and disrupting ingress and egress. Of particular concern are critical facilities.

16.5.4 Environment

Environmental vulnerability will typically be the same as exposure.

16.6 FUTURE TRENDS IN DEVELOPMENT

All future development of communications and power systems should consider redundancy. All critical facilities should consider the inclusion of backup power and communication systems.

16.7 SCENARIO

In the event that a space weather occurrence should happen, FEMA's Ready.gov website states that residents should:

- Follow energy conservation measures to keep the use of electricity as low as possible, which can help power companies avoid imposing rolling blackouts during periods when the power grid is compromised.
- Follow the Emergency Alert System instructions carefully.
- Disconnect electrical appliances if instructed to do so by local officials.
- Do not use the telephone unless absolutely necessary. During emergency situations keeping lines open for emergency personnel can improve response.

Such an event would likely have substantial negative effects on the local economy.

16.8 ISSUES

The October 2015 National Space Weather Action Plan developed by the National Science and Technology Council includes a goal to "Improve Space-Weather Services through Advancing Understanding and Forecasting." The objectives of this goal are to:

- Improve understanding of user needs for space-weather forecasting to establish lead-time and accuracy goals
- Ensure that space-weather products are intelligible and actionable to inform decision-making
- Establish and sustain a baseline observational capability for space-weather operations
- Improve forecasting lead-time and accuracy
- Enhance fundamental understanding of space weather and its drivers to develop and continually improve predictive models
- Improve effectiveness and timeliness of the process that transitions research to operations

It should be noted that these actions and challenges are for the most part, outside the control of Clear Creek County and its leaders. Important issues associated with a space weather in the planning area include the following:

- Electrical outages
- Telephone and communications outages
- Lack of Refrigeration Food Spoilage

- Redundancy of power supply must be evaluated
- The capacity for backup power generation is limited

Chapter 17.
TORNADO

TORNADO RANKING	
Clear Creek County	Low
City of Idaho Springs	Low
Town of Empire	Low
Town of Georgetown	No Exposure
Town of Silver Plume	Low
See Chapter 20 for more information on hazard ranking.	

DEFINITIONS

Tornado—Funnel clouds that generate winds up to 500 miles per hour. They can affect an area up to three-quarters of a mile wide, with a path of varying length. Tornadoes can come from lines of cumulonimbus clouds or from a single storm cloud. They are measured using the Fujita Scale, ranging from F0 to F5, or the Enhanced Fujita Scale.

17.1 GENERAL BACKGROUND

A tornado is a narrow, violently rotating column of air that extends from the base of a cumulonimbus cloud to the ground. The visible sign of a tornado is the dust and debris that is caught in the rotating column made up of water droplets. Tornadoes are the most violent of all atmospheric storms. The following are common ingredients for tornado formation:

- Very strong winds in the mid and upper levels of the atmosphere
- Clockwise turning of the wind with height (i.e., from southeast at the surface to west aloft)
- Increasing wind speed in the lowest 10,000 feet of the atmosphere (i.e., 20 mph at the surface and 50 mph at 7,000 feet)
- Very warm, moist air near the ground with unusually cooler air aloft
- A forcing mechanism such as a cold front or leftover weather boundary from previous shower or thunderstorm activity

Tornadoes can form from individual cells within severe thunderstorm squall lines. They also can form from an isolated super-cell thunderstorm. Weak tornadoes can sometimes occur from air that is converging and spinning upward, with little more than a rain shower occurring in the vicinity.

In 2007, the NWS began rating tornadoes using the Enhanced Fujita Scale (EF-scale). The EF-scale is a set of wind estimates (not measurements) based on damage. Its uses three-second gusts estimated at the point of damage based on a judgment of 8 levels of damage to the 28 indicators listed in Table 17-1. These estimates vary with height and exposure. Standard measurements are taken by weather stations in open exposures. Table 17-2 describes the EF-scale ratings versus the previous Fujita Scale used prior to 2007 (NOAA 2007).

The U.S. experiences more tornadoes than any other country. In a typical year, approximately 1,000 tornadoes affect the U.S. The peak of the tornado season is April through June, with the highest concentration of tornadoes in the central U.S.

Table 17-1 shows the annual average number of tornadoes between 1991 and 2010. Colorado experienced an average of 53 tornado events annually in that period. Colorado ranks 9th among the 50 states in frequency of tornadoes, but 38th for the number of deaths. Colorado ranks 31st for injuries and 30th for the cost of repairing the damages due to tornadoes. When these statistics are compared to other states by the frequency per square mile, Colorado ranks 28th for injuries per area and 37th for costs per area.

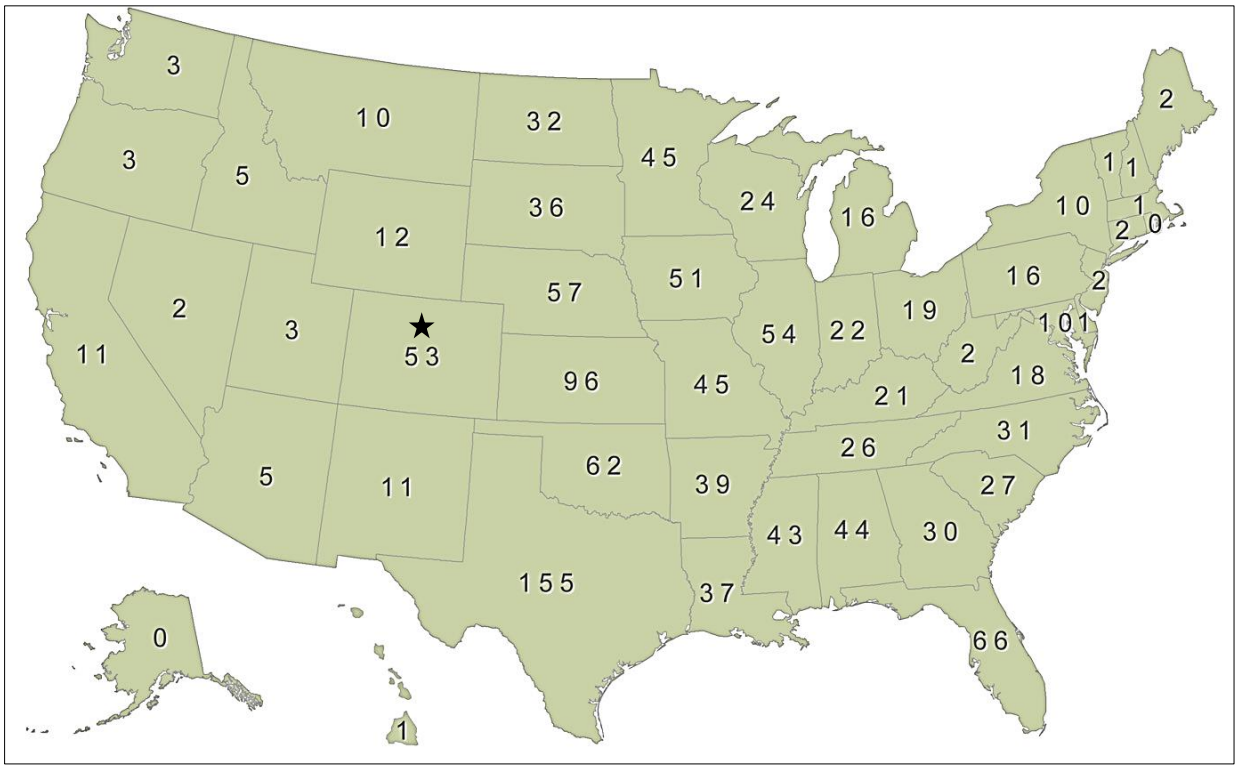
TABLE 17-1.
ENHANCED FUJITA SCALE DAMAGE INDICATORS

No.	Damage Indicator	No.	Damage Indicator
1	Small barns, farm outbuildings	15	School – 1-story elementary (interior or exterior halls)
2	One or two-family residences	16	School – junior or senior high school
3	Single-wide mobile home	17	Low-rise (1-4 story) building
4	Double-wide mobile home	18	Mid-rise (5-20) building
5	Apt, condo, townhouse (3 stories or less)	19	High-rise (over 20 stories) building
6	Motel	20	Institutional bldg. (hospital, govt. or university)
7	Masonry apt. or motel	21	Metal building system
8	Small retail building (fast food)	22	Service station canopy
9	Small professional (doctor office, bank)	23	Warehouse (tilt-up walls or heavy timber)
10	Strip mall	24	Transmission line tower
11	Large shopping mall	25	Free-standing tower
12	Large, isolated (big box) retail building	26	Free standing pole (light, flag, luminary)
13	Automobile showroom	27	Tree – hardwood
14	Automobile service building	28	Tree – softwood

TABLE 17-2.
THE FUJITA SCALE AND ENHANCED FUJITA SCALE

Fujita Scale			Derived		Operational EF Scale	
F Number	Fastest ¼ mile (mph)	3-second gust (mph)	EF Number	3-second gust (mph)	EF Number	3-second gusts (mph)
0	40-72	45-78	0	65-85	0	65-85
1	73-112	79-117	1	86-109	1	86-110
2	113-157	118-161	2	110-137	2	111-135
3	158-207	162-209	3	138-167	3	136-165
4	208-260	210-261	4	168-199	4	166-200
5	261-318	262-317	5	200-234	5	Over 200

Notes:
EF Enhanced Fujita
F Fujita
mph Miles per Hour



★ Clear Creek County

Figure 17-1. Annual Average Number of Tornadoes in the U.S. (1991-2010)

17.2 HAZARD PROFILE

17.2.1 Past Events

There are no recorded tornado events that have occurred in Clear Creek County that have caused property damage. There are two recorded tornadoes in the county (in 2007 and 2012), each rated an F0. There were no known injuries, fatalities, or property damage from these two tornadoes.

17.2.2 Location

Recorded tornadoes in the planning area are typically small and short-lived. They are more likely in flatter parts of the county, though they are generally unlikely to occur because of the mountainous terrain in the county. Figure 17-2 shows the location of previous tornado events in the county.

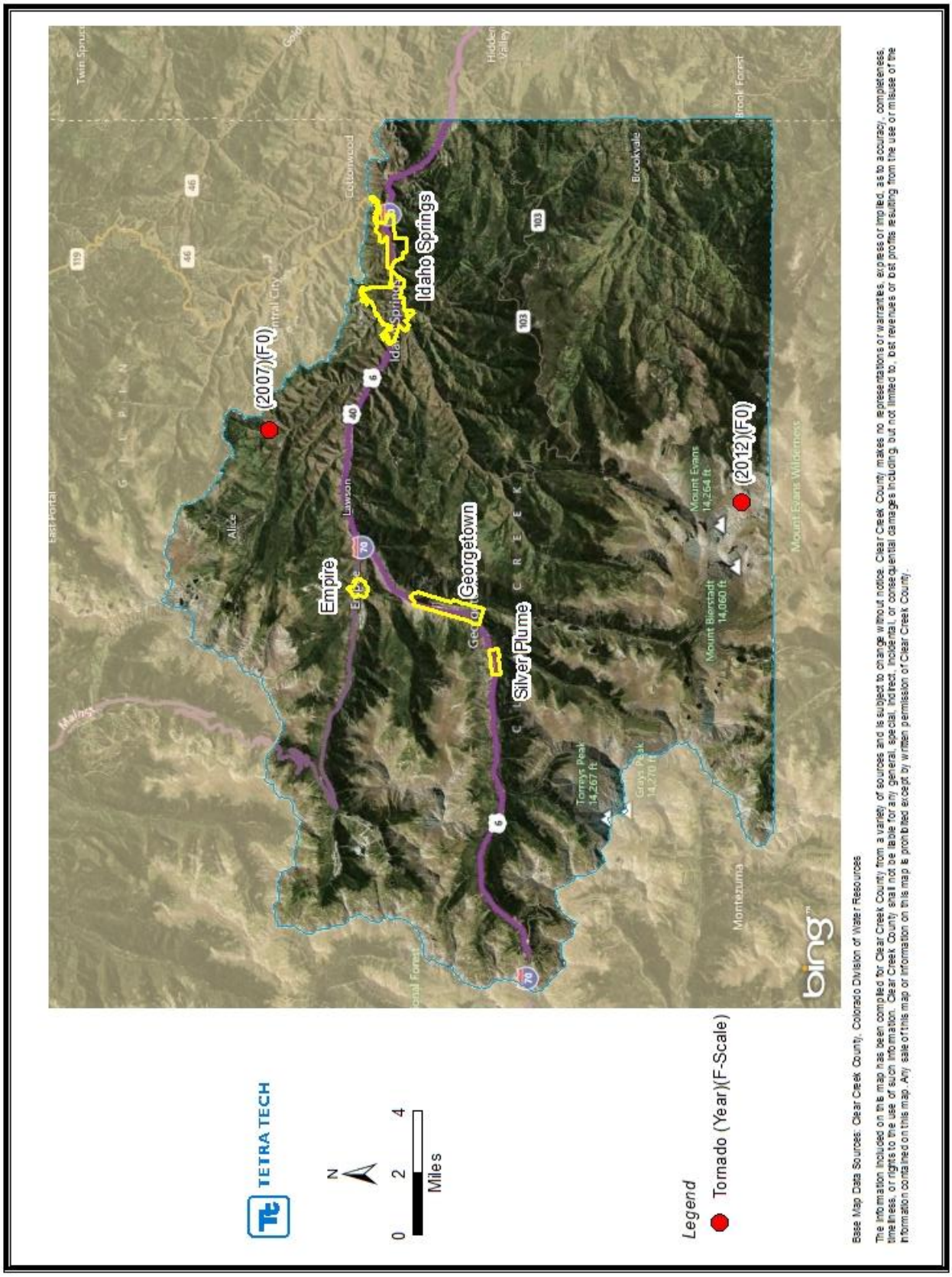


Figure 17-2. Tornado Locations in Clear Creek County

17.2.3 Frequency and Severity

Tornadoes have been reported 9 months of the year in Colorado, with peak occurrences between mid-May through mid-August. State-wide, June is by far the month with the most recorded tornadoes. There have been two recorded tornadoes between 1970 and 2014, therefore, an average of 0.05 tornadoes occur each year in Clear Creek County.

Tornadoes are potentially the most dangerous of local storms. If a major tornado were to strike within the populated areas of Clear Creek County, damage could be widespread. Businesses could be forced to close for an extended period or permanently, fatalities could be high, many people could be homeless for an extended period, and routine services such as telephone or power could be disrupted. Buildings may be damaged or destroyed. Historically, tornadoes have not typically been severe or caused damage in the planning area. The reported tornadoes have only been listed as F0s, the lowest rating for a tornado.

Based on the information in this hazard profile, the overall significance of tornadoes in Clear Creek County is minimal.

17.2.4 Warning Time

The NOAA's storm prediction center issues tornado watches and warnings for Clear Creek County:

- **Tornado Watch**—Tornadoes are possible. Remain alert for approaching storms. Watch the sky and stay tuned to NOAA Weather Radio, commercial radio, or television for information.
- **Tornado Warning**—A tornado has been sighted or indicated by weather radar. Take shelter immediately.

Once a warning has been issued, residents may have only a matter of seconds or minutes to seek shelter.

17.3 SECONDARY HAZARDS

Tornadoes may cause loss of power if utility service is disrupted. Additionally, fires may result from damages to natural gas infrastructure. Hazardous materials may be released if a structure is damaged that houses such materials or if such a material is in transport.

17.4 CLIMATE CHANGE IMPACTS

Climate change impacts on the frequency and severity of tornadoes are unclear. According to the Center for Climate Change and Energy Solutions, "Researchers are working to better understand how the building blocks for tornadoes—atmospheric instability and wind shear—will respond to global warming. It is likely that a warmer, moister world would allow for more frequent instability. However, it is also likely that a warmer world would lessen chances for wind shear. Recent trends for these quantities in the Midwest during the spring are inconclusive. It is also possible that these changes could shift the timing of tornadoes or regions that are most likely to be hit" (Center for Climate and Energy Solutions no date).

17.5 EXPOSURE

17.5.1 Population

It can be assumed that the entire planning area is exposed to some extent to tornadoes. Certain areas are more exposed due to geographic location and local weather patterns.

17.5.2 Property

According to the Clear Creek County Assessor, there are 5,244 buildings within the census tracts that define the planning area. Most of these buildings are residential. Property located at lower elevations are more likely to be exposed to tornadoes.

17.5.3 Critical Facilities and Infrastructure

All critical facilities and infrastructure (see Figure 6-7 and Figure 6-8) are likely exposed to tornadoes, though the likelihood of damage to any critical facilities or infrastructures from a tornado is extremely limited. The most common problems associated with this hazard are utility losses. Downed power lines can cause blackouts, leaving large areas isolated. Phone, water, and sewer systems may not function. Roads may become impassable due to downed trees or other debris.

17.5.4 Environment

Environmental features are exposed to tornado risk, although damages are generally localized to the path of the tornado.

17.6 VULNERABILITY

17.6.1 Population

Vulnerable populations are the elderly, low income or linguistically isolated populations, people with life-threatening illnesses, and residents living in areas that are isolated from major roads. Power outages can be life threatening to those dependent on electricity for life support. Isolation of these populations is a significant concern. These populations face isolation and exposure after tornado events and could suffer more secondary effects of the hazard.

Individuals caught in the path of a tornado who are unable to seek appropriate shelter are especially vulnerable. This may include individuals who are out in the open, in cars, or who do not have access to basements, cellars, or safe rooms.

17.6.2 Property

All property is vulnerable during tornado events, but properties in poor condition or in particularly vulnerable locations may risk the most damage. There are a total of 5,244 buildings in Clear Creek County, but it is unlikely many of these structures will be affected.

Tornadoes occur very infrequently in Clear Creek County. The two reported events occurred outside the jurisdiction areas. There is no loss expectancy from a tornado in the county based on the lack of property damage from the previous reported tornadoes.

17.6.3 Critical Facilities and Infrastructure

Tornadoes can cause significant damage to trees and power lines, blocking roads with debris, incapacitating transportation, isolating population, and disrupting ingress and egress. Of particular concern are roads providing access to isolated areas and to the elderly. Any facility that is in the path of a tornado is likely to sustain damage.

17.6.4 Environment

Environmental vulnerability will typically be the same as exposure (discussed in Chapter 17.5.4); however, if tornadoes impact facilities that store HAZMAT areas impacted by material releases may be especially vulnerable.

17.7 FUTURE TRENDS IN DEVELOPMENT

All future development will be affected by tornadoes, particularly development that occurs at lower elevations. Development regulations that require safe rooms, basements, or other structures that reduce risk to people would decrease vulnerability. Tornadoes that cause damage are uncommon in the county, so mandatory regulations may not be cost-effective.

17.8 SCENARIO

If an EF3 or higher tornado were to hit populated areas of the county, such as the City of Idaho Springs, substantial damage to property and loss of life could result. Likelihood of injuries and fatalities would increase if warning time was limited before the event or if residents were unable to find adequate shelter. Damage to critical facilities and infrastructure would likely include loss of power, water, sewer, gas and communications. Roads and bridges could be blocked by debris or otherwise damaged. The most serious damage would be seen in the direct path of the tornado, but secondary effects could impact the rest of the county through loss of government services and interruptions in the transportation network. Debris from the tornado would need to be collected and properly disposed. Such an event would likely have substantial negative effects on the local economy. However, it is extremely unlikely for an EF3 tornado to occur anywhere in Clear Creek County.

17.9 ISSUES

Important issues associated with a tornado in the planning area include the following:

- Older building stock in the planning area is built to low code standards or none at all. These structures could be highly vulnerable to tornadoes.
- Redundancy of power supply must be evaluated.
- The capacity for backup power generation is limited.
- Roads and bridges blocked by debris or otherwise damaged might isolate populations.
- Warning time may not be adequate for residents to seek appropriate shelter or such shelter may not be widespread throughout the planning area.
- The impacts of climate change on the frequency and severity of tornadoes are not well understood.

Chapter 18.
WILDFIRE

WILDFIRE HAZARD RANKING	
Clear Creek County	High
City of Idaho Springs	High
Town of Empire	High
Town of Georgetown	High
Town of Silver Plume	High
See Chapter 20 for more information on hazard ranking.	

DEFINITIONS

Conflagration—A fire that grows beyond its original source area to engulf adjoining regions. Wind, extremely dry or hazardous weather conditions, excessive fuel buildup, and explosions are usually the elements behind a wildfire conflagration.

Interface Area—An area susceptible to wildfires and where wildland vegetation and urban or suburban development occur together. An example would be smaller urban areas and dispersed rural housing in forested areas.

Wildfire—Fires that result in uncontrolled destruction of forests, brush, field crops, grasslands, and real and personal property in non-urban areas. Because of their distance from firefighting resources, they can be difficult to contain and can cause a great deal of destruction.

18.1 GENERAL BACKGROUND

A wildfire is any uncontrolled fire occurring on undeveloped land that requires fire suppression. Wildfires can be ignited by lightning or by human activity such as smoking, campfires, equipment use, and arson.

Fire hazards present a considerable risk to vegetation and wildlife habitats. Short-term loss caused by a wildfire can include the destruction of timber, wildlife habitat, scenic vistas, and watersheds. Long-term effects include smaller timber harvests, reduced access to affected recreational areas, and destruction of cultural and economic resources and community infrastructure. Vulnerability to flooding increases due to the destruction of watersheds. The potential for significant damage to life and property exists in areas designated as wildland urban interface (WUI) areas, where development is adjacent to densely vegetated areas.

Wildfires are of significant concern throughout Colorado. According to the Colorado State Forest Service, vegetation fires occur on an annual basis; most are controlled and contained early with limited damage. For those ignitions that are not readily contained and become wildfires, damage can be extensive. According to the *2013 State of Colorado Hazards Mitigation Plan*, a century of aggressive fire suppression combined with cycles of drought and changing land management practices has left many of Colorado's forests, including those in Clear Creek County, unnaturally dense and ready to burn. Further, the threat of wildfire and potential losses is constantly increasing as human development and population increases and the WUI expands. Another contributing factor to fuel loads in the forest are standing trees killed by pine bark beetles, which have been affecting the forests of Colorado since 2002, becoming more widespread and a serious concern. According to the 2015 Clear Creek County Hazard Mitigation Community Survey (see Appendix C), Clear Creek County residents believe that wildfire is the greatest threat to their safety.

Fire Protection in Clear Creek County

Fire protection in Clear Creek County is divided between the Clear Creek Fire Authority (CCFA), volunteer fire districts, and the USDA Forest Service. Multiple community wildfire protection plans are in place under the umbrella of the *2008 Community Wildfire Protection Plan for Clear Creek County*, as discussed in Chapter 6.9.

Vegetation Classes in Clear Creek County

General vegetation for Clear Creek County is described in Table 18-1. The most common landcover classes in the county are Open Water, Spruce-Fir, and Ponderosa Pine comprising over 65% of the acreage in the county.

TABLE 18-1.
VEGETATION CLASSES IN CLEAR CREEK COUNTY

Class	Acres	Percent (%)
Grassland	593	0.2
Shrubland	40,899	11.1
Aspen	46,473	12.6
Lodgepole Pine	0	0.0
Ponderosa Pine	52,577	14.2
Spruce-Fir	65,640	17.8
Mixed Conifer	339	0.1
Oak Shrubland	887	0.2
Pinyon-Juniper	268	0.1
Riparian	14,783	4.0
Introduced Riparian	2,820	0.8
Agriculture	14,895	4.0
Open Water	127,592	34.5
Urban and Community	1,900	0.5
Total	**2,185,797**	**100.0**

Source: Clear Creek County Wildfire Risk Summary Report

18.2 HAZARD PROFILE

18.2.1 Past Events

According to the *2008 Community Wildfire Protection Plan for Clear Creek County*, the following wildfires have occurred between 2002 and 2007 (see Table 18-2). Most of the wildfires had an acre or less burned.

TABLE 18-2.
CLEAR CREEK COUNTY OEM FIRE RECORDS

Fire	Month/Year	Acres Burned	Comments
North Spring Fire	06/06/02	9	
Fox Gulch Fire	05/22/04	1.5	
Benchmark 263 Fire	06/06/04	5	USFS Lands
Closet Fire	08/01/04	<1	
Hidden Valley Fire	08/02/04	<1	
Naylor Lake Fire	07/12/05	1	
Three Valley Tree Fire	08/25/05	<1	

TABLE 18-2.
CLEAR CREEK COUNTY OEM FIRE RECORDS

Fire	Month/Year	Acres Burned	Comments
Dumont East Fire	09/26/05	<1	
Devil's Gate Fire	06/09/06	<1	
Hwy 103 MM 12 Fire	06/19/06	<1	
York Gulch Road Fire	06/21/06	<1	
Devil's Tongue Fire	07/19/06	<1	
Standley 236 Fire	09/27/07	<1	
Alvarado Fire	11/07/07	25	

Note: OEM - Office of Emergency Management

Source: *2008 Community Wildfire Protection Plan for* Clear Creek County

According to NOAA, two wildfire events occurred outside the county in 2012 (March 26 and April 1). The two wildfires were identified as the Lower North Fork Fire (in Jefferson County), which resulted in three deaths and over $20 million in damages.

18.2.2 Location

Colorado overall is one of the fastest growing states in the nation. Much of this growth is occurring in the WUI area, where structures and other human improvements meet and mix with undeveloped wildland or vegetative fuels. Population growth within the WUI substantially increases the risk from wildfires. Figure 18-1 shows the Clear Creek County housing density within the WUI.

The Colorado State Forest Service's Colorado Wildfire Risk Assessment Portal (CO-WRAP) report for Clear Creek County maps the WUI Risk Index, which is a rating of the potential impact of a wildfire on people and their homes. The key input reflects housing density (Figure 18-1). The CO-WRAP report states that the location of people living in the WUI and rural areas is essential for defining potential wildfire impacts to people and homes. Figure 18-2 shows the WUI Risk Index for Clear Creek County. Figure 18-3 shows the more general wildfire risks for areas within Clear Creek County, not specifically incorporating WUI locations.

Finally, as stated in the CO-WRAP report, wildfire threat is the likelihood of an acre burning. Threat is calculated by combining multiple landscape characteristics including surface and canopy fuels, fire behavior, historical fire occurrences, weather observations, terrain conditions, etc. The measure of wildfire threat used in CO-WRAP is called the threat index. Figure 18-4 maps the threat index for Clear Creek County as identified in the CO-WRAP report. The wildfire threat index combines the probability of an acre igniting and the expected final fire size based on rate of spread in four weather percentile categories. This allows for comparison and ordination of areas across the state.

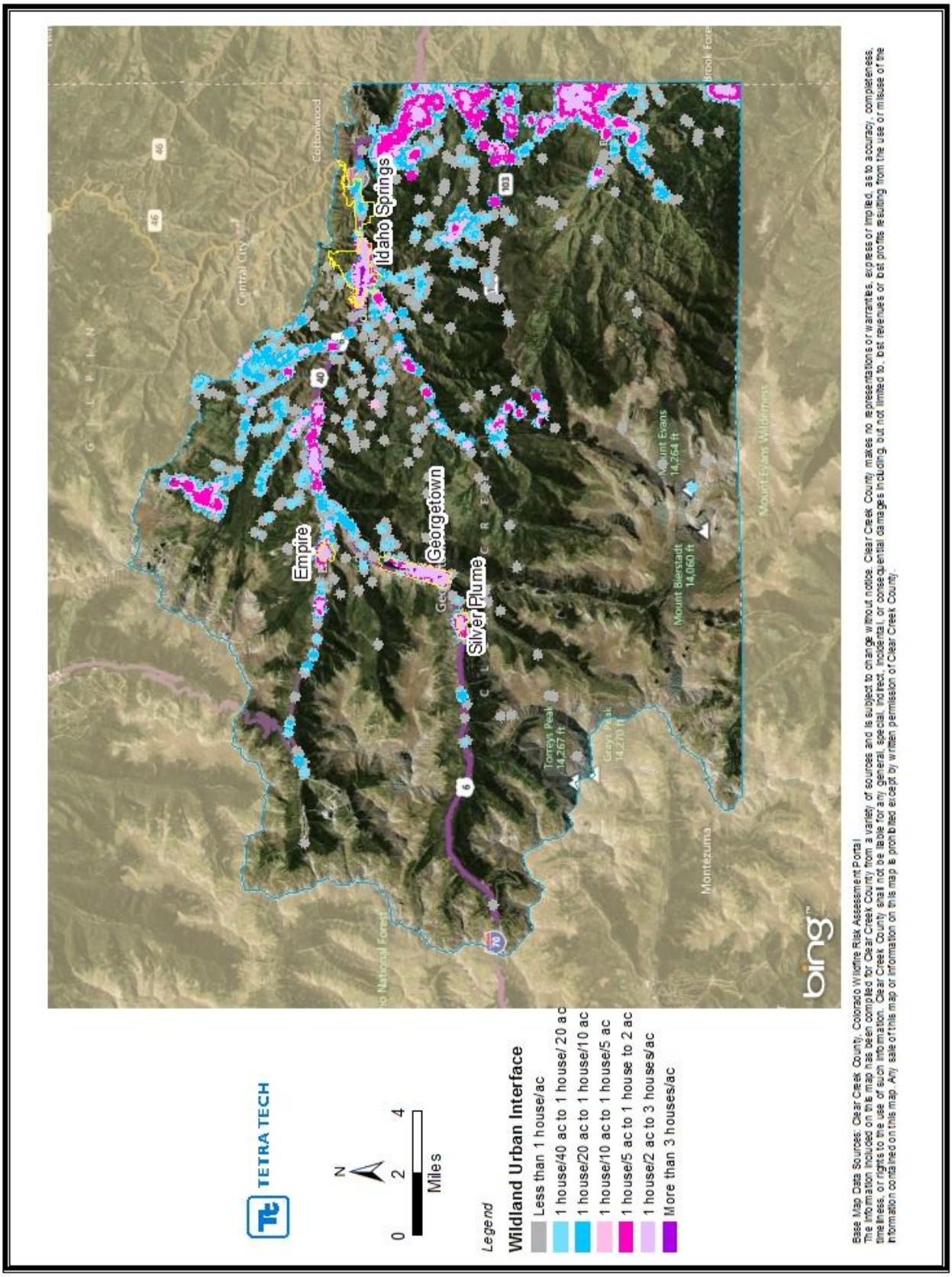


Figure 18-1. Clear Creek County Housing Density within the Wildland Urban Interface

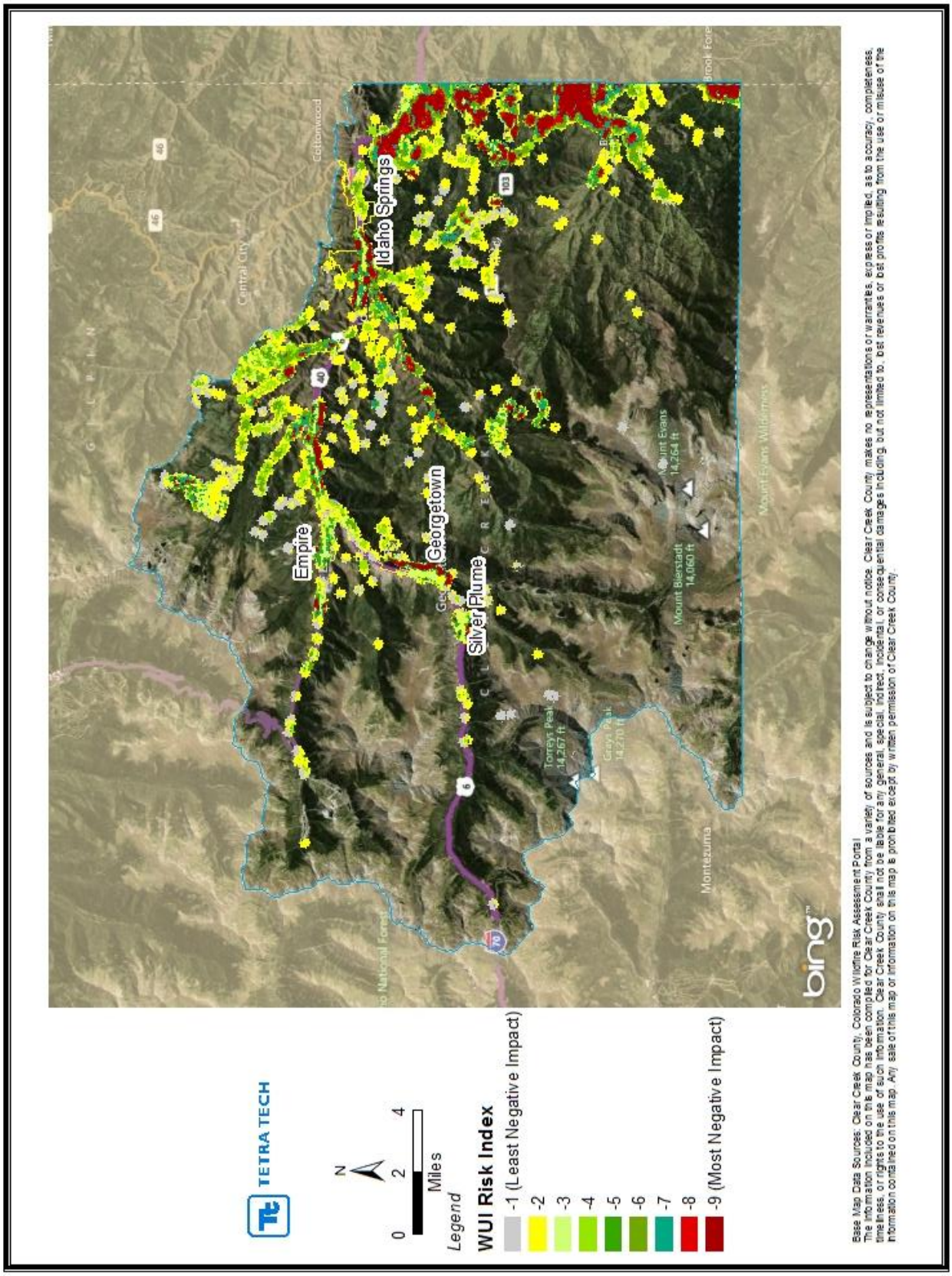


Figure 18-2. Wildland Urban Interface Risk Index for Clear Creek County

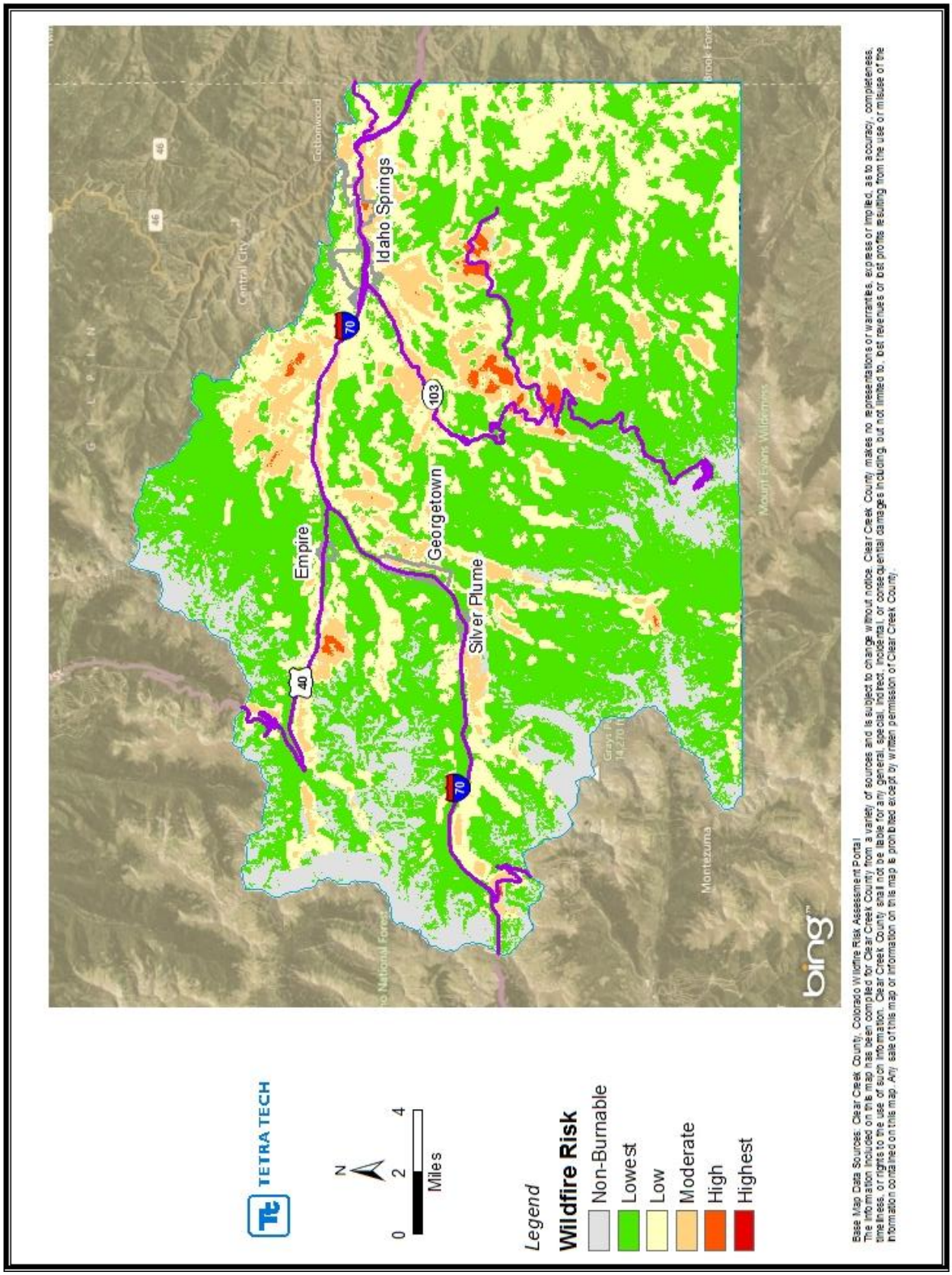


Figure 18-3. Wildfire Risks for Areas in Clear Creek County

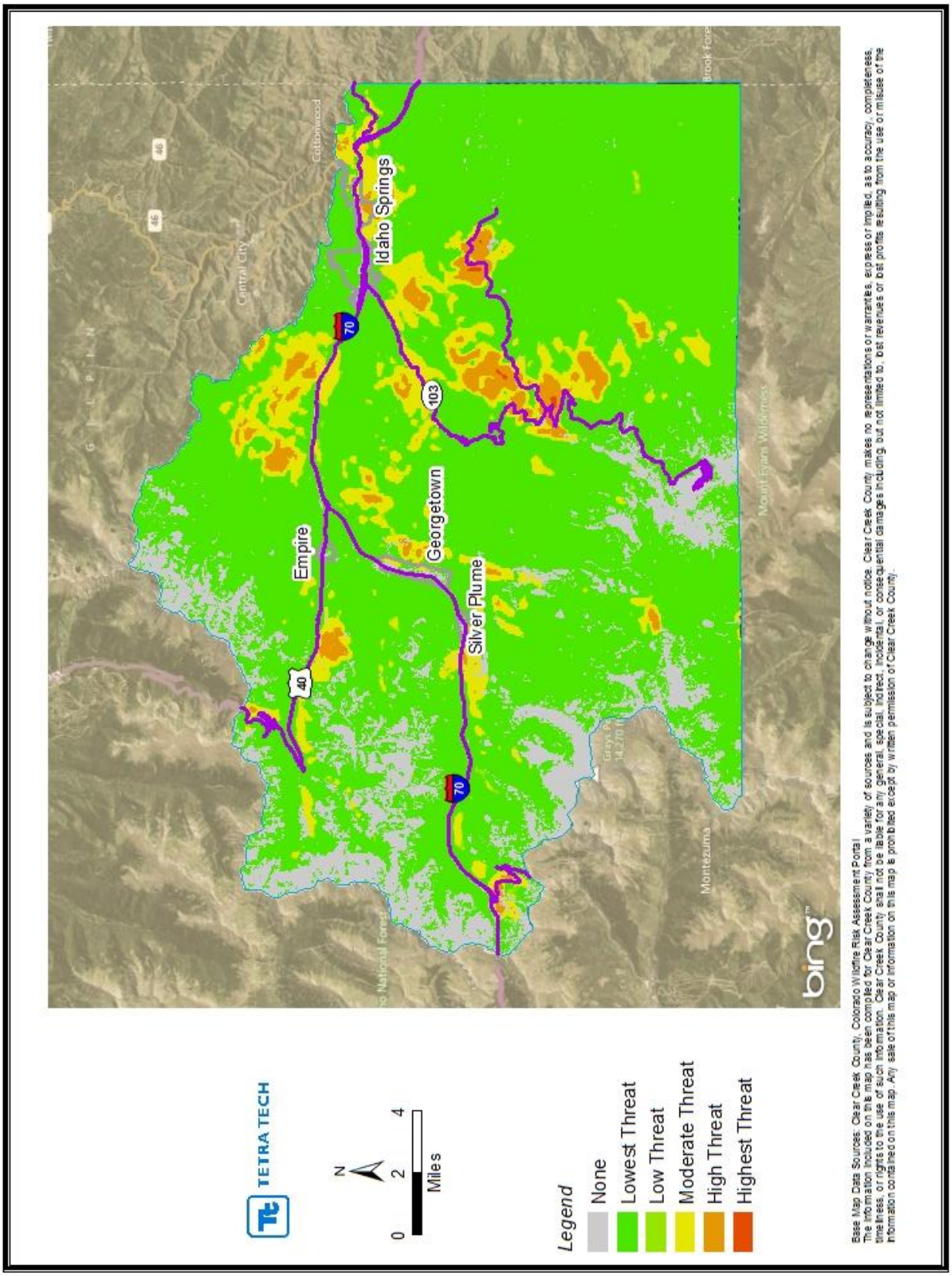


Figure 18-4. Threat Index for Clear Creek County

18.2.3 Frequency and Severity

According to the *2008 Community Wildfire Protection Plan for Clear Creek County*, wildfires occur naturally and are an important component of the Montane and Subalpine ecosystems that dominate much of Clear Creek County. The county is in the middle of Colorado's Redone Interface which is aggregated by CSFS. The typical fire season of the study area is defined as June through September when 84% of the fires occur. While only 36% of fires in these districts were caused by lightning, over 64% were caused by non-natural ignitions. However, it should be noted that while lightning strikes do occur and start fires, many do not get reported.

Based on the information in this hazard profile and the potential widespread impacts, the magnitude/severity of severe wildfires is considered critical, causing isolated deaths and multiple injuries; major or long-term property damage that threatens structural stability; or interruption of essential facilities and services for 24 to 72 hours—as well as longer duration economic impact due to interrupted tourism, which plays a major part in the economy of Clear Creek and the planning partners. Overall significance of the hazard is considered severe.

18.2.4 Warning Time

Wildfires are often caused by humans, intentionally or accidentally. There is no way to predict when one might break out. Because fireworks often cause brush fires, extra diligence is warranted around the Fourth of July when the use of fireworks is highest. Dry seasons and droughts are factors that greatly increase fire likelihood. Dry lightning may trigger wildfires. Severe weather can be predicted, so special attention can be paid during weather events that may include lightning. Reliable NWS lightning warnings are available on average 24 to 48 hours before a significant electrical storm.

If a fire does break out and spreads rapidly, residents may need to evacuate within days or hours. A fire's peak burning period generally is between 1 p.m. and 6 p.m. Once a fire has started, fire alerting is reasonably rapid in most cases. The rapid expansion of cellular and two-way radio communications in recent years has further contributed to a significant improvement in warning time.

18.3 SECONDARY HAZARDS

Wildfires can generate a range of secondary effects, which in some cases may cause more widespread and prolonged damage than the fire itself. Fires can cause direct economic losses in the reduction of harvestable timber and indirect economic losses in reduced tourism. Wildfires cause the contamination of reservoirs, destroy transmission lines, and contribute to flooding. They strip slopes of vegetation, exposing them to greater amounts of runoff. This in turn can weaken soils and cause failures on slopes. Major landslides can occur several years after a wildfire. Most wildfires burn hot and for long durations that can bake soils, especially those high in clay content, thus increasing the imperviousness of the ground. This increases the runoff generated by storm events, thus increasing the chance of flooding.

18.4 CLIMATE CHANGE IMPACTS

Fire in western ecosystems is affected by climate variability, local topography, and human intervention. Climate change has the potential to affect multiple elements of the wildfire system: fire behavior, ignitions, fire management, and vegetation fuels. Hot, dry spells create the highest fire risk. Increased temperatures may intensify wildfire danger by warming and drying out vegetation. When climate alters fuel loads and fuel moisture, forest susceptibility to wildfires changes. Climate change also may increase winds that spread fires. Faster fires are harder to contain, and thus are more likely to expand into residential neighborhoods.

Historically, drought patterns in the West are related to large-scale climate patterns in the Pacific and Atlantic Oceans. The El Niño–Southern Oscillation in the Pacific varies on a 5- to 7-year cycle, the Pacific Decadal Oscillation varies on a 20- to 30-year cycle, and the Atlantic Multidecadal Oscillation varies on a

65- to 80-year cycle. As these large-scale ocean climate patterns vary in relation to each other, drought conditions in the U.S. shift from region to region.

Climate scenarios project summer temperature increases between 2 degrees Celsius (ºC) and 5°C and precipitation decreases up to 15%. Such conditions would exacerbate summer drought and further promote high-elevation wildfires, releasing stores of carbon and further contributing to the buildup of greenhouse gases. Forest response to increased atmospheric carbon dioxide—the so-called "fertilization effect"—could also contribute to more tree growth and thus more fuel for fires, but the effects of carbon dioxide on mature forests are still largely unknown. High carbon dioxide levels should enhance tree recovery after fire and young forest regrowth, as long as sufficient nutrients and soil moisture are available, although the latter is in question for many parts of the western United States because of climate change.

18.5 EXPOSURE

Information for the exposure analyses provided in the sections below was downloaded from the CO-WRAP Wildfire Risk theme from the CO-WRAP website in October 2015. The distribution of risk areas in the planning area are shown in Figure 18-5 and Figure 18-6. The data for the figures incorporates CO-WRAP data for the county in conjunction with Clear Creek's CWPP. Wildfire threat is examined as the best option for wildfire exposure in the county. It examines the likelihood of an acre burning by combining a number of landscape characteristics including surface fuels and canopy fuels, resultant fire behavior, historical fire occurrence, percentile weather derived from historical weather observations, and terrain conditions.

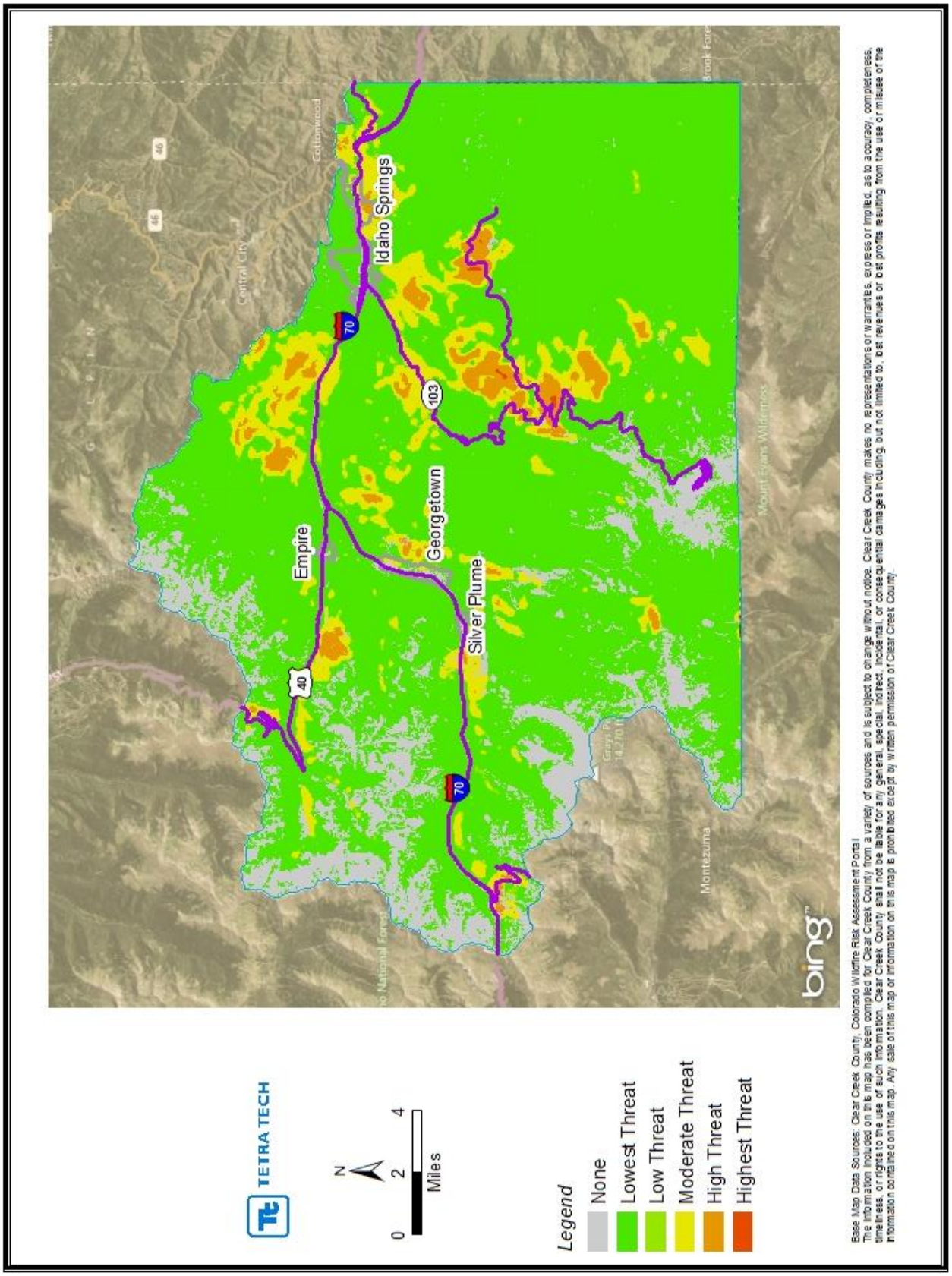


Figure 18-5. Wildfire Threat in Clear Creek County

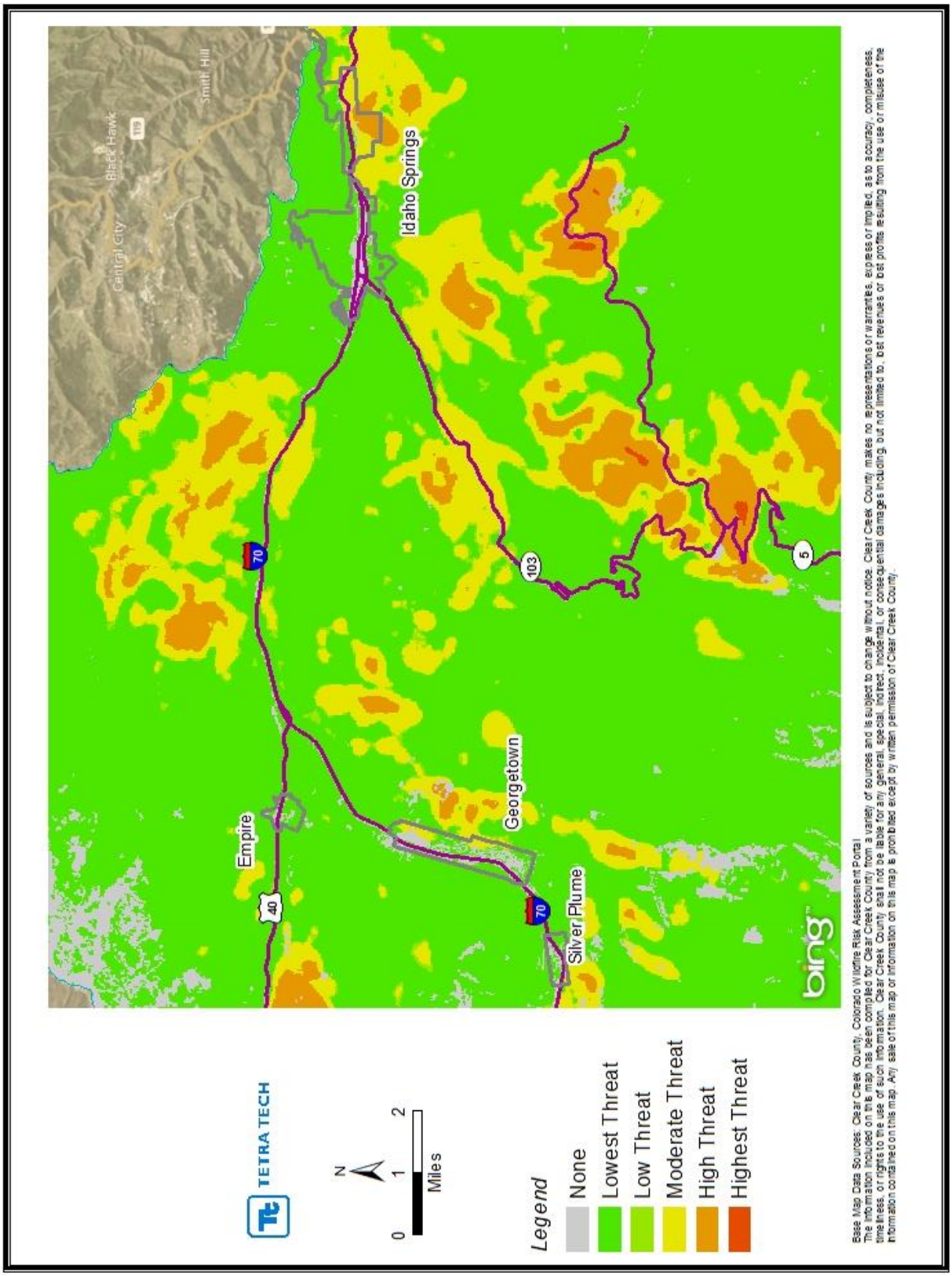


Figure 18-6. Wildfire Threat in the City of Idaho Springs, and the Towns of Empire, Georgetown, and Silver Plume

18.5.1 Population

Population could not be examined by WUI area because census block group areas do not coincide with the fire risk areas. However, population was estimated using the structure count of buildings in the WUI area and applying the census value of 2.21 persons per household for Clear Creek County. These estimates are shown in Table 18-3.

TABLE 18-3.
POPULATION WITHIN WILDFIRE THREAT AREAS

	Lowest and Low Risk		Moderate Risk		High Risk	
	Population	% of Total	Population	% of Total	Population	% of Total
City of Idaho Springs	1,995	24.3	369	56.9	68	84
Town of Empire	375	4.6	6	0.9	0	0.0
Town of Georgetown	1,423	17.4	64	9.8	0	0.0
Town of Silver Plume	231	2.8	0	0	0	0.0
Unincorporated	4,179	50.9	210	32.4	13	16
Total	**8,203**	**100.0**	**649**	**100.0**	**81**	**100.0**

18.5.2 Property

Property damage from wildfires can be severe and can significantly alter entire communities. Table 18-4 through Table 18-6 display the number of structures in the various wildfire hazard zones within the planning area and their values. For all tables, population data are from the 2012 Colorado State Demography Office estimated populations, exposure numbers are based on Clear Creek County tax assessor data, and value is calculated as the number of buildings exposed multiplied by the household average for Clear Creek County of 2.21 people per building.

TABLE 18-4.
EXPOSURE AND VALUE OF STRUCTURES IN HIGH WILDFIRE THREAT AREAS

	Buildings Exposed	Value Exposed	
		Structure and Content	Acres
City of Idaho Springs	38	$6,000,000	154
Town of Empire	0	$0	0
Town of Georgetown	0	$0	0
Town of Silver Plume	0	$0	0
Total	**38**	**$6,000,000**	**154**

TABLE 18-5.
EXPOSURE AND VALUE OF STRUCTURES IN MODERATE WILDFIRE THREAT AREAS

	Buildings Exposed	Value Exposed Structure and Content	Acres
City of Idaho Springs	167	$28,000,000	300
Town of Empire	0	0	0
Town of Georgetown	29	$6,000,000	146
Town of Silver Plume	0	0	0
Total	**199**	**$34,000,000**	**446**

TABLE 18-6.
EXPOSURE AND VALUE OF STRUCTURES IN LOWEST AND LOW WILDFIRE THREAT AREAS

	Buildings Exposed	Value Exposed Structure and Content	Acres
City of Idaho Springs	903	$153,000,000	1,768
Town of Empire	170	$22,000,000	186
Town of Georgetown	644	$48,000,000	557
Town of Silver Plume	105	$132,000,000	159
Total	**1,822**	**$355,000,000**	**2,670**

Present Land Use

Present land use for each wildfire risk area is described in Table 18-7and Table 18-8.

TABLE 18-7.
PRESENT LAND USE IN HIGH AND MODERATE WILDFIRE RISK AREAS

	High		Moderate	
Present Use Classification	Area (acres)	% of total	Area (acres)	% of total
Agriculture	0	0.0	0	0.0
Barren Land	36	0.2	168	0.4
Developed, High Intensity	0	0.0	1	<0.1
Developed, Medium Intensity	1	<0.1	14	<0.1
Developed, Low Intensity	10	<0.1	121	0.3
Developed, Open Space	158	1.4	344	0.9

TABLE 18-7.
PRESENT LAND USE IN HIGH AND MODERATE WILDFIRE RISK AREAS

	High		Moderate	
Present Use Classification	Area (acres)	% of total	Area (acres)	% of total
Forest	10,788	93.8	33,007	87.7
Grassland/Prairie	467	4.1	1,827	4.8
Shrub/Scrub	0	0.0	1,946	5.2
Water/Wetlands	39	0.3	183	0.5
Total	**11,499**	**100.0**	**37,611**	**100.0**

Note: Acreage covers only mapped parcels and thus excludes many rights of way and major water features.

TABLE 18-8.
PRESENT LAND USE IN LOWEST AND LOW WILDFIRE RISK AREAS

	Low		Lowest	
Present Use Classification	Area (acres)	% of total	Area (acres)	% of total
Agriculture	0	0.0	347	0.1
Barren Land	34	0.5	2,479	0.8
Developed, High Intensity	0	0.0	7	<0.1
Developed, Medium Intensity	4	<0.1	132	<0.1
Developed, Low Intensity	20	0.3	1,219	0.4
Developed, Open Space	50	0.8	2,226	0.7
Forest	5,419	84.8	210,085	66.7
Grassland/Prairie	461	7.2	79,539	25.2
Shrub/Scrub	360	5.7	11,817	3.7
Water/Wetlands	39	0.6	7,279	2.3
Total	**6,387**	**100.0**	**315,127**	**100.0**

Note: Acreage covers only mapped parcels and thus excludes many rights of way and major water features.

18.5.3 Critical Facilities and Infrastructure

Table 18-9 identifies critical facilities exposed to the wildfire hazard in the county.

TABLE 18-9.
CRITICAL FACILITIES AND INFRASTRUCTURE IN WILDFIRE RISK AREAS

	Number of Critical Facilities in Hazard Zone			
	Lowest Threat	Low Threat	Moderate Threat	High Threat
Medical and Health	0	0	0	0
Protective Functions	2	0	0	0
Schools	6	0	0	0
Bridges	15	8	4	4
Potable Water	0	0	0	0
Wastewater	2	1	0	0
Power	0	0	0	0
Communications	4	1	0	3
Transportation	0	0	0	0
Dams	12	10	0	0
Hazardous Materials	7	8	14	0
Total	**48**	**28**	**18**	**7**

In the event of wildfire, there would likely be little damage to the majority of infrastructure. Most roads and railroads would be without damage except in the worst scenarios. Power lines are the most at risk to wildfire because most power poles are made of wood and susceptible to burning. In the event of a wildfire, pipelines could provide a source of fuel and lead to a catastrophic explosion.

18.5.4 Environment

Fire is a natural and critical ecosystem process in most terrestrial ecosystems, dictating in part the types, structure, and spatial extent of native vegetation. However, wildfires can cause severe environmental impacts:

- **Damaged Fisheries**—Critical fisheries can suffer from increased water temperatures, sedimentation, and changes in water quality.
- **Soil Erosion**—The protective covering provided by foliage and dead organic matter is removed, leaving the soil fully exposed to wind and water erosion. Accelerated soil erosion occurs, causing landslides and threatening aquatic habitats.
- **Spread of Invasive Plant Species**—Non-native woody plant species frequently invade burned areas. When weeds become established, they can dominate the plant cover over broad landscapes, and become difficult and costly to control.
- **Disease and Insect Infestations**—Unless diseased or insect-infested trees are swiftly removed, infestations and disease can spread to healthy forests and private lands. Timely active management actions are needed to remove diseased or infested trees.
- **Destroyed Endangered Species Habitat**—Catastrophic fires can have devastating consequences for endangered species.
- **Soil Sterilization**—Topsoil exposed to extreme heat can become water repellant, and soil nutrients may be lost. It can take decades or even centuries for ecosystems to recover from a fire. Some fires burn so hot that they can sterilize the soil.

Many ecosystems are adapted to historical patterns of fire occurrence. These patterns, called "fire regimes," include temporal attributes (e.g., frequency and seasonality), spatial attributes (e.g., size and spatial complexity), and magnitude attributes (e.g., intensity and severity), each of which have ranges of natural variability. Ecosystem stability is threatened when any of the attributes for a given fire regime diverge from its range of natural variability.

18.6 VULNERABILITY

Structures, aboveground infrastructure, critical facilities, and natural environments are all vulnerable to the wildfire hazard. There is currently no validated damage function available to support wildfire mitigation planning. Except as discussed in this section, vulnerable populations, property, infrastructure, and environment are assumed to be the same as described in the section on exposure.

18.6.1 Population

Smoke and air pollution from wildfires can be a severe health hazard, especially for sensitive populations, including children, the elderly, and those with respiratory and cardiovascular diseases. Smoke generated by wildfire consists of visible and invisible emissions that contain particulate matter (soot, tar, water vapor, and minerals), gases (carbon monoxide, carbon dioxide, nitrogen oxides), and toxics (formaldehyde, benzene). Emissions from wildfires depend on the type of fuel, the moisture content of the fuel, the efficiency (or temperature) of combustion, and the weather. Public health impacts associated with wildfire include difficulty in breathing, odor, and reduction in visibility.

Wildfire may also threaten the health and safety of those fighting the fires. First responders are exposed to the dangers from the initial incident and after-effects from smoke inhalation and heat stroke.

18.6.2 Property

Loss estimations for the wildfire hazard are not based on damage functions, because no such damage functions have been generated. Instead, damage estimates have been made by intersecting the CO-WRAP data with 2015 county tax assessor data. Table 18-4 through Table 18-6 summarizes the estimated exposed value in each wildfire risk category.

18.6.3 Critical Facilities and Infrastructure

Critical facilities of wood frame construction are especially vulnerable during wildfire events. In the event of wildfire, there would likely be little damage to most infrastructure. Most roads and railroads would be without damage except in the worst scenarios. Power lines are the most at risk from wildfire because most poles are made of wood and susceptible to burning. Fires can create conditions that block or prevent access and can isolate residents and emergency service providers. Wildfire typically does not have a major direct impact on bridges, but it can create conditions in which bridges are obstructed. Many bridges in areas of high to moderate fire risk are important because they provide the only ingress and egress to large areas and in some cases to isolated neighborhoods.

18.7 FUTURE TRENDS IN DEVELOPMENT

Clear Creek County has a *2008 Community Wildfire Protection Plan*. The plan was established to assist the county with wildfire preparation and provide effective techniques to combat wildfires while protecting property and persons. The expansion of the WUI can be managed with strong land use and building codes.

18.8 SCENARIO

A major conflagration in the planning area might begin with a wet spring, adding to fuels already present on the forest floor. Flash fuels would build throughout the spring. The summer could see the onset of insect infestation. A dry summer could follow the wet spring, exacerbated by dry hot winds. Carelessness with

combustible materials or a tossed lit cigarette, or a sudden lightning storm could trigger a multitude of small isolated fires.

The embers from these smaller fires could be carried miles by hot, dry winds. The deposition zone for these embers would be deep in the forests and interface zones. Fires that start in flat areas move slower, but wind still pushes them. It is not unusual for a wildfire pushed by wind to burn the ground fuel and later climb into the crown and reverse its track. This is one of many ways that fires can escape containment, typically during periods when response capabilities are overwhelmed. These new small fires would most likely merge. Suppression resources would be redirected from protecting the natural resources to saving more remote subdivisions.

The worst-case scenario would include an active fire season throughout the American West, spreading resources thin. Firefighting teams would be exhausted or unavailable. Many federal assets would be responding to other fires that started earlier in the season. While local fire districts would be extremely useful in the urban interface areas, they have limited wildfire capabilities or experience, and they would have a difficult time responding to the ignition zones. Even though the existence and spread of the fire is known, it may not be possible to respond to it adequately, so an initially manageable fire can become out of control before resources are dispatched.

To further complicate the problem, heavy rains could follow, causing flooding and landslides and releasing tons of sediment into Clear Creek, permanently changing floodplains and damaging sensitive habitat and riparian areas. Such a fire followed by rain could release millions of cubic yards of sediment into streams for years, creating new floodplains and changing existing ones. With the forests removed from the watershed, stream flows could easily double. Floods that could be expected every 50 years may occur every couple of years. With the streambeds unable to carry the increased discharge because of increased sediment, the floodplains and floodplain elevations would increase.

18.9 ISSUES

The major issues for wildfire are the following:

- Public education and outreach to people living in or near the fire hazard zones should include information about and assistance with mitigation activities such as defensible space, and advance identification of evacuation routes and safe zones.
- Wildfires could cause landslides as a secondary natural hazard.
- Climate change could affect the wildfire hazard.
- Future growth into interface areas should continue to be managed.
- Area fire districts need to continue to train on WUI events.
- Vegetation management activities should be enhanced.
- Regional consistency of higher building code standards such as residential sprinkler requirements and prohibitive combustible roof standards.
- Fire department water supply in high risk wildfire areas.
- Expand certifications and qualifications for fire department personnel. Ensure that all firefighters are trained in basic wildfire behavior, basic fire weather, and that all company officers and chief level officers are trained in the wildland command and strike team leader level.
- Both the natural and human-caused conditions that contribute to the wildland fire hazard are tending to exacerbate through time.
- Conservative forestry management practices have resulted in congested forests prone to fire and disease.

- The continued migration of inhabitants to remote areas of the county increases the probability of human-caused ignitions from vehicles, grills, campfires, and electrical devices.
- Non-native species have become invasive in the area, specifically, Tamarisk and Russian Olive. These species burn readily and pose a threat to homes and other structures in the lower reaches of the county and into municipalities.
- Revisions to the Colorado Revised Statutes exempted properties divided into parcels of 35 acres or more from the statutory definition of a subdivision restricting the county's ability to enforce county regulations and mitigation.

Chapter 19.
WINTER STORM

WINTER STORM HAZARD RANKING	
Clear Creek County	High
City of Idaho Springs	High
Town of Empire	High
Town of Georgetown	Medium
Town of Silver Plume	High
See Chapter 20 for more information on hazard ranking.	

DEFINITIONS

Freezing Rain—The result of rain occurring when the temperature is below the freezing point. The rain freezes on impact, resulting in a layer of glaze ice up to an inch thick. In a severe ice storm, an evergreen tree 60 feet high and 30 feet wide can be burdened with up to 6 tons of ice, creating a threat to power and telephone lines and transportation routes.

Severe Local Storm—Small-scale atmospheric systems, including tornadoes, thunderstorms, windstorms, ice storms, and snowstorms. These storms may cause a great deal of destruction and even death, but their impact is generally confined to a small area. Typical impacts are on transportation infrastructure and utilities.

Winter Storm—A storm having significant snowfall, ice, or freezing rain; the quantity of precipitation varies by elevation.

19.1 GENERAL BACKGROUND

Winter storms can include heavy snow, ice, and blizzard conditions. Heavy snow can immobilize a region, stranding commuters, stopping the flow of supplies, and disrupting emergency and medical services. Accumulations of snow can collapse roofs and knock down trees and power lines. In rural areas, homes and farms may be isolated for days, and unprotected livestock may be lost. The cost of snow removal, damage repair, and business losses can have a tremendous impact on cities and towns.

Heavy accumulations of ice can bring down trees, electrical wires, telephone poles and lines, and communication towers. Communications and power can be disrupted for days until damage can be repaired. Even small accumulations of ice may cause extreme hazards to motorists and pedestrians.

Some winter storms are accompanied by strong winds, creating blizzard conditions with blinding wind-driven snow, severe drifting, and dangerous wind chills. Strong winds with these intense storms and cold fronts can knock down trees, utility poles, and power lines. Blowing snow can reduce visibilities to only a few feet in areas where there are no trees or buildings. Serious vehicle accidents can result in injuries and deaths.

Winter storms in Clear Creek County, including strong winds and blizzard conditions, can result in property damage, localized power and phone outages and closures of streets, highways, schools, businesses, and non-essential government operations. People can also become isolated from essential services in their homes and vehicles. A winter storm can escalate, creating life threatening situations when emergency response is limited by severe winter conditions. Other issues associated with severe winter weather include hypothermia and the threat of physical overexertion that may lead to heart attacks or strokes. Snow removal costs can also impact budgets significantly. Heavy snowfall during winter can also lead to flooding or landslides during the spring if the area snowpack melts too quickly.

19.1.1 Extreme Cold

Extreme cold often accompanies a winter storm or is left in its wake. It is most likely to occur in the winter months of December, January, and February. Prolonged exposure to the cold can cause frostbite or hypothermia and can become life-threatening. Infants and the elderly are most susceptible. Pipes may freeze and burst in homes or buildings that are poorly insulated or without heat. Extreme cold can disrupt or impair communications facilities.

In 2001, the NWS implemented an updated wind chill temperature index (see Figure 19-1). This index describes the relative discomfort or danger resulting from the combination of wind and temperature. Wind chill is based on the rate of heat loss from exposed skin caused by wind and cold. As the wind increases, it draws heat from the body, driving down skin temperature and eventually the internal body temperature.

Source: National Weather Service, www.nws.noaa.gov/om/windchill/index.shtml

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

Frostbite Times: 30 minutes, 10 minutes, 5 minutes

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

Where, T= Air Temperature (°F) V= Wind Speed (mph) *Effective 11/01/01*

Figure 19-1. National Weather Service Wind Chill Chart

A wind chill watch is issued by the NWS when wind chill warning criteria are possible in the next 12 to 36 hours. A wind chill warning is issued for wind chills of at least -25°F on the plains and -35°F in the mountains and foothills.

The Western Regional Climate Center reports data summaries from a station in the Town of Georgetown. Table 19-1 contains temperature summaries related to extreme cold for the station.

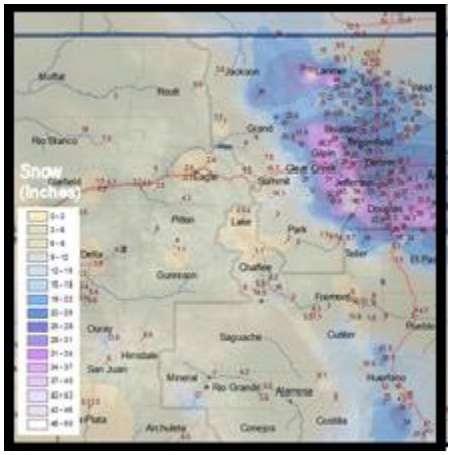
TABLE 19-1.
TEMPERATURE DATA FROM GEORGETOWN (1893-2015)

	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Temperature (degrees Fahrenheit)												
Average Maximum Temperature	36.4	37.8	42.7	50.6	60.9	72.1	77.9	75.2	68.6	57.8	44.9	36.6
Average Minimum Temperature	15.6	15.9	19.6	26.4	34.6	42.1	48.7	46.8	39.7	31.5	22.6	16.3
Average Temperature	26.0	26.8	31.2	38.4	47.8	57.1	63.4	61.0	54.2	44.6	33.9	26.6
Extreme Temperatures (degrees Fahrenheit)												
Extreme Minimum Temperature	--28	-25	-15	-8	12	24	31	29	8	-4	-12	-17
Average Number of Days												
Minimum Temperature below 32 degrees Fahrenheit	30.1	27.3	29.3	23.8	11.2	1.1	0.0	0.1	4.3	16.3	26.1	29.8
Minimum Temperature below 0 degrees Fahrenheit	2.4	2.1	0.9	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.6	2.0

Clear Creek County receives varying amounts of snow throughout the area. Winter weather affects the entire County, but primarily in the high mountainous areas in the western portion of the county. Snow typically remains on the ground throughout winter, but is more likely to melt in valley areas and in jurisdictions were snow plowing is frequent. The county receives approximately 93 inches of snow per year. March and April are on average the snowiest months in the county.

19.2 HAZARD PROFILE

19.2.1 Past Events



A total of 372 winter weather events occurred in Clear Creek County between 1996 and 2015. The event types include a combination of "Blizzard," "Heavy Snow," "Winter Weather," and "Winter Storm." Locations for the records are limited to one of four National Climate Data Center's-defined zones: "Jefferson & W Douglas Counties above 6,000 feet/Gilpin/Clear Creek/NE Park Counties below 9,000 feet," "South & Southeast Grand/W Central & SW Boulder/Gilpin/Clear Creek/Summit/ N & W Park Counties above 9,000 feet," "Southern Front Range Foothills/Clear Creek Basin," and "Summit County/Mosquito Range/Indian Peaks." Table 19-2 shows the distribution of weather events throughout the county. Only one of the winter weather events resulted in property damage in the National Centers for Environmental Information and addition details are below.

- March 17, 2003 – FEMA-EM-3185. A very moist, intense and slow moving Pacific storm system made its way across the four corners area and into southeastern Colorado from March 17 to the 19, allowing for a deep easterly upslope flow to form along the Front Range. The storm dumped heavy wet snow that caused roofs of homes and businesses to collapse as well as downed trees, branches, and power lines. Up to 135,000 people lost power at some point during the storms and it took several days, in some areas, to restore power. The areas hardest hit by heavy snow were the northern mountains east of the Continental Divide, the Front Range Foothills and Palmer Divide, where snowfall totals ranged from 3 feet to over 7 feet. The storm totals included 70 inches at Georgetown and 66 inches at Idaho Springs. FEMA obligated over $6.1 million public assistance funds to help with emergency snow removal with this event.

  Insert photo of event

TABLE 19-2.
CLEAR CREEK COUNTY WINTER WEATHER EVENTS (1996-2015)

Location	Event Type	Number of Events
Jefferson & W Douglas Counties above 6,000 feet/Gilpin/Clear Creek/NE Park Counties below 9,000 feet	Heavy Snow	36
	Winter Storm	54
	Winter Weather	22
South & Southeast Grand/W Central & SW Boulder/Gilpin/Clear Creek/Summit/ N & W Park Counties above 9,000 feet	Heavy Snow	42
	Winter Storm	74
	Blizzard	1
	Winter Weather	51
Southern Front Range Foothills/Clear Creek Basin	Blizzard	1
	Heavy Snow	35
	Winter Storm	11
Summit County/Mosquito Range/Indian Peaks	Heavy Snow	23
	Blizzard	3
	Winter Storm	19

Source: National Centers for Environmental Information

19.2.2 Location

The entire county is susceptible to severe winter storms; although severe winter weather is primarily found in the higher elevations of the county and in the high mountainous areas of the Front Range Mountains in the north and western portions of the county. Interstate 70 runs east/west across the county and could have hazardous conditions to motorists if blizzard or severe winter weather conditions occur, which is frequent in winter. Interstate 70 runs through Idaho Springs, Georgetown, and Silver Plume. It also is a major access road to Empire. If there are winter issues on Interstate 70, it can cause a major disruption in the flow of goods and services in and out of the county and state.

19.2.3 Frequency and Severity

Severe winter storms happen nearly every year in Clear Creek County and are thus considered highly likely, with nearly 100% chance of occurrence in any given year. Severe winter weather occurs most frequently in March and April.

The magnitude and severity of severe winter weather is considered severe in Clear Creek County. The annual rate of occurrence for the county is 20 events per year, with an average loss expectancy of $41,667 per event for all 372 events that have occurred in Clear Creek County between 1996 and 2015. Therefore, the annualized loss for winter weather is $815,790. It is important to note that there has only been one reported winter storm event that has resulted in damages so the annualized loss is based only on one loss event. However, Clear Creek County is a major transport center for Interstate 70 commuters. Interstate 70 through Clear Creek sees daily commuters from Denver, ski traffic in the winter, and is a major east/west route across the U.S. Winter storm events are considered a severe threat to the county because of possible disruption along the Interstate 70 corridor.

19.2.4 Warning Time

Meteorologists can often predict the likelihood of a severe winter storm; and forecasts usually come from Idaho Springs and Georgetown. When forecast are available they can give several days of warning time. However, meteorologists cannot predict the exact time of onset or severity of the storm. Some storms may come on more quickly and have only a few hours of warning time.

19.3 SECONDARY HAZARDS

The most significant secondary hazards associated with severe winter storms are falling and downed trees, landslides, and downed power lines. Rapidly melting snow combined with heavy rain can overwhelm both natural and constructed drainage systems, causing overflow and property destruction. Landslides occur when the soil on slopes becomes oversaturated and fails. Additionally the storms may result in closed highways and blocked roads. It is not unusual for motorists and residents to become stranded. Annually, heavy snow loads and frozen pipes cause damage to residences and businesses. Late season heavy snows will typically cause some plant and crop damage.

19.4 CLIMATE CHANGE IMPACTS

Climate change presents a significant challenge for risk management associated with severe weather. The frequency of severe weather events has increased steadily over the last century. Nationally, the number of weather-related disasters during the 1990s was four times that of the 1950s, and cost 14 times as much in economic losses. Historical data shows that the probability for severe weather events increases in a warmer climate (see Figure 14-7). The changing hydrograph caused by climate change could have a significant impact on the intensity, duration, and frequency of storm events. All of these impacts could have significant economic consequences.

19.5 EXPOSURE

19.5.1 Population

It can be assumed that the entire planning area is exposed to some extent to severe winter weather events. Certain areas are more exposed due to geographic location and local weather patterns.

19.5.2 Property

According to the Clear Creek County Assessor, there are 5,244 buildings within the census tracts that define the planning area. Most of these buildings are residential. All of these buildings are considered to be exposed to severe winter weather, but structures in poor condition or in particularly vulnerable locations

(located on hilltops or exposed open areas) may risk the most damage. The frequency and degree of damage will depend on specific locations.

19.5.3 Critical Facilities and Infrastructure

All critical facilities and infrastructure (see Table 6-4 and Table 6-5) are likely exposed to severe winter weather. The most common problems associated with this hazard are utility losses. Downed power lines can cause blackouts, leaving large areas isolated. Phone, water, and sewer systems may not function. Roads may become impassable due to ice or snow. Ice accumulation on roadways can create dangerous driving conditions. There are limited county roads that are available to move people and supplies throughout the region. Many of the small side roads are narrow and curved. Interstate 70 is a major east/east highway that transports goods throughout Colorado and the rest of the country.

19.5.4 Environment

The environment is highly exposed to severe weather events. Natural habitats such as streams and trees risk major damage and destruction. Flooding events caused by snowmelt can produce river channel migration or damage riparian habitat.

19.6 VULNERABILITY

19.6.1 Population

Vulnerable populations are the elderly, low income or linguistically isolated populations, people with life-threatening illnesses, and residents living in areas that are isolated from major roads. Power outages can be life threatening to those dependent on electricity for life support. Isolation of these populations is a significant concern. These populations face isolation and exposure during severe winter weather events and could suffer more secondary effects of the hazard. Commuters who are caught in storms may be particularly vulnerable. Stranded commuters may be vulnerable to carbon monoxide poisoning or hypothermia. Additionally, individuals engaged in outdoor recreation during a severe winter event may be difficult to locate and rescue.

19.6.2 Property

All property is vulnerable during severe winter weather events, but properties in poor condition or in particularly vulnerable locations may risk the most damage. Those that are located under or near overhead lines or near large trees may be vulnerable to falling ice or may be damaged in the event of a collapse.

The annual rate of occurrence for a severe winter weather event in Clear Creek County is approximately 19 winter weather events per year. The average loss expectancy for each winter weather event is approximately $42,000, with an annualized loss of approximately $815,800 for winter weather events in the county. This is based on the 372 total winter weather events that have occurred in the county between 1996 and 2015. Only one of the 372 reported events in Clear Creek County resulted in property damage. The winter storm event occurred on March 17, 2003, and resulted in $15,500,000 worth of damages.

19.6.3 Critical Facilities and Infrastructure

Incapacity and loss of roads are the primary transportation failures resulting from severe winter weather, mostly associated with secondary hazards. Snowstorms can significantly impact the transportation system and the availability of public safety services. Of particular concern are roads providing access to isolated areas and to the elderly. Prolonged obstruction of major routes can disrupt the shipment of goods and other commerce. Large, prolonged storms can have negative economic impacts for an entire region.

Severe windstorms, downed trees, and ice can create serious impacts on power and above-ground communication lines. Freezing of power and communication lines can cause them to break, disrupting

electricity and communication. Loss of electricity and phone connection would leave certain populations isolated because residents would be unable to call for assistance.

19.6.4 Environment

The vulnerability of the environment to severe weather is the same as the exposure, discussed in Section 19.5.4.

19.7 FUTURE TRENDS IN DEVELOPMENT

All future development will be affected by severe storms. The vulnerability of community assets to severe winter storms is increasing through time as more people enter the planning area. The ability to withstand impacts lies in sound land use practices and consistent enforcement of codes and regulations for new construction. The planning partners have adopted the International Building Code. This code is equipped to deal with the impacts of severe weather events. Land use policies identified in general plans within the planning area also address many of the secondary impacts (flood and landslide) of the severe weather hazard. With these tools, the planning partnership is well equipped to deal with future growth and the associated impacts of severe weather.

19.8 SCENARIO

Although severe winter local storms are infrequent, impacts can be significant, particularly when secondary hazards of flood occur. A worst-case event would involve prolonged high winds during a winter storm accompanied by thunderstorms. Such an event would have both short-term and longer-term effects. Initially, schools and roads would be closed due to power outages caused by high winds, snow, ice, and downed trees. Some subdivisions could experience limited ingress and egress. Prolonged rain and snow melt could produce flooding, and overtopped culverts with ponded water on roads. Flooding and debris could further obstruct roads and bridges further isolating residents. Extreme cold temperatures would stress heating systems and expose residents to hypothermia.

19.9 ISSUES

Important issues associated with a severe weather in the planning area include the following:

- Older building stock in the planning area is built to low code standards or none at all. These structures could be highly vulnerable to severe weather events such as heavy snow or windstorms.
- Redundancy of power supply must be evaluated.
- The capacity for backup power generation is limited.
- The high altitudes and rugged terrain in the planning area exacerbates emergency situations caused by winter storm events.
- Future efforts should be made to identify populations at risk and determine special needs during winter storm events.

Chapter 20.
PLANNING AREA RISK RANKING

A risk ranking was performed for the hazards of concern described in this plan. This risk ranking assesses the probability of each hazard's occurrence as well as its likely impact on the people, property, and economy of the planning area. The risk ranking was conducted by the Steering Committee based on the hazard risk assessment presented during the second Steering Committee meeting, community survey results, and personal and professional experience with hazards in the planning area. The results are used in establishing mitigation priorities.

20.1 PROBABILITY OF OCCURRENCE

The probability of occurrence of a hazard is indicated by a probability factor based on likelihood of annual occurrence:

- High—Hazard event is likely to occur within 25 years (Probability Factor = 3)
- Medium—Hazard event is likely to occur within 100 years (Probability Factor = 2)
- Low—Hazard event is not likely to occur within 100 years (Probability Factor = 1)
- No exposure—There is no probability of occurrence (Probability Factor = 0)

The assessment of hazard frequency is generally based on past hazard events in the area. The Steering Committee assigned the probabilities of occurrence for each hazard, as shown on Table 20-1.

TABLE 20-1.
HAZARD PROBABILITY OF OCCURRENCE

	Clear Creek County		City of Idaho Springs		Town of Empire		Town of Georgetown		Town of Silver Plume	
Hazard	High/Med /Low/No	Probability Factor	High/Med /Low/No	Probability Factor	High/Med /Low/No	Probability Factor	High/Med /Low/No	Probability Factor	High/Med /Low/No	Probability Factor
Avalanche	High	3	Low	1	Low	1	No	0	High	3
Dam/Levee Failure	Medium	2	Low	1	Medium	2	Low	1	Low	1
Drought	Medium	2	Low	1	High	3	Medium	2	Medium	2
Earthquake	Low	1	Low	1	Low	1	No	0	Low	1
Erosion and Deposition	Medium	2	Medium	2	High	3	Medium	2	Low	1
Expansive Soils	Low	1	Low	1	Low	1	Low	1	Medium	2
Extreme Heat	Low	1	Low	1	Low	1	No	0	Low	1
Flood	High	3	High	3	High	3	High	3	High	3
Hail	High	3	High	3	Medium	2	Low	1	Low	1
Landslide, Mud/Debris Flow, Rockfall	High	3	High	3	High	3	Medium	2	High	3
Lightning	High	3	High	3	Medium	2	Low	1	High	3
Severe Wind	High	3	High	3	High	3	High	3	High	3
Space Weather	Low	1	Low	1	Low	1	High	3	Low	1
Subsidence	Medium	2	High	3	Low	1	Low	1	Low	1
Tornado	Low	1	Low	1	Low	1	No	0	Low	1
Wildfire	High	3	High	3	High	3	High	3	High	3
Winter Storm	High	3	High	3	High	3	Medium	2	High	3

20.2 IMPACT

Hazard impacts were assessed in three categories: impacts on people, impacts on property, and impacts on the local economy. Numerical impact factors were assigned as follows:

- **People**—Values were assigned based on the percentage of the total ***population exposed*** to the hazard event. The degree of impact on individuals will vary and is not measurable, so the calculation assumes for simplicity and consistency that all people who live in a hazard zone will be equally impacted when a hazard event occurs. It should be noted that planners can use an element of subjectivity when assigning values for impacts on people. Impact factors were assigned as follows:
  - High – 50% or more of the population is exposed to a hazard (Impact Factor = 3)
  - Medium – 25% to 49% of the population is exposed to a hazard (Impact Factor = 2)
  - Low – 24% or less of the population is exposed to the hazard (Impact Factor = 1)
  - No impact – None of the population is exposed to a hazard (Impact Factor = 0)
- **Property**—Values were assigned based on the percentage of the total ***assessed property value*** exposed to the hazard event:
  - High – 30% or more of the total assessed property value is exposed to a hazard (Impact Factor = 3)
  - Medium – 15% to 29% of the total assessed property value is exposed to a hazard (Impact Factor = 2)
  - Low – 14% or less of the total assessed property value is exposed to the hazard (Impact Factor = 1)
  - No impact – None of the total assessed property value is exposed to a hazard (Impact Factor = 0)
- **Economy**—Values were assigned based on total impact to the economy from the hazard event and activities conducted after the even to restore the community to previous functions. Values were assigned based on the number of days the hazard impacts the community, including impacts on tourism, businesses, road closures, or government response agencies.
  - High – Community impacted for more than 7 days (Impact Factor = 3)
  - Medium – Community impacted for 1 to 7 days (Impact Factor = 2)
  - Low – Community impacted for less than 1 day (Impact Factor = 1)
  - No impact – No community impacts estimated from the hazard event (Impact Factor = 0)

The impacts of each hazard category were assigned a weighting factor to reflect the significance of the impact. These weighting factors are consistent with those typically used for measuring the benefits of hazard mitigation actions: impact on people was given a weighting factor of 3; impact on property was given a weighting factor of 2; and impact on the economy was given a weighting factor of 1. The impacts for each hazard are summarized in Table 20-2 through Table 20-4. The total impact factor shown on the tables equals the impact factor multiplied by the weighting factor.

TABLE 20-2.
IMPACT ON PEOPLE FROM HAZARDS

	Clear Creek County		City of Idaho Springs		Town of Empire		Town of Georgetown		Town of Silver Plume	
Hazard	High/Med /Low/No	Total Impact Factor	High/Med /Low/No	Total Impact Factor	High/Med /Low/No	Total Impact Factor	High/Med /Low/No	Total Impact Factor	High/Med /Low/No	Total Impact Factor
Avalanche	High	9	Low	3	Low	3	No	0	High	9
Dam/Levee Failure	High	9	Medium	6	Medium	6	Low	3	Low	3
Drought	Low	3	Medium	6	High	9	Medium	6	Medium	6
Earthquake	Medium	6	High	9	Low	3	No	0	Low	3
Erosion and Deposition	Low	3	Low	3	Low	3	Medium	6	Low	3
Expansive Soils	No	0	Low	3	Low	3	Low	3	Low	3
Extreme Heat	Medium	6	Low	3	High	9	No	0	Low	3
Flood	Medium	6	High	9	Medium	6	High	9	High	9
Hail	Medium	6	High	9	Low	3	Low	3	Low	3
Landslide, Mud/Debris Flow, Rockfall	Medium	6	High	9	Low	3	Medium	6	High	9
Lightning	Medium	6	High	9	Low	3	Low	3	Low	3
Severe Wind	Medium	6	High	9	Low	3	High	9	High	9
Space Weather	Low	3	Low	3	Low	3	Medium	6	Low	3
Subsidence	Low	3	High	9	Low	3	Low	3	Low	3
Tornado	Medium	6	Low	3	Low	3	No	0	Low	3
Wildfire	High	9	High	9	High	9	Medium	6	High	9
Winter Storm	High	9	High	9	High	9	High	9	High	9

TABLE 20-3.
IMPACT ON PROPERTY FROM HAZARDS

	Clear Creek County		City of Idaho Springs		Town of Empire		Town of Georgetown		Town of Silver Plume	
Hazard	High/Med /Low/No	Total Impact Factor	High/Med /Low/No	Total Impact Factor	High/Med /Low/No	Total Impact Factor	High/Med /Low/No	Total Impact Factor	High/Med /Low/No	Total Impact Factor
Avalanche	Low	2	Low	2	Low	2	No	0	High	6
Dam/Levee Failure	High	6	Medium	4	Low	2	Low	2	Low	2
Drought	Low	2	High	6	Low	2	Medium	4	Medium	4
Earthquake	Medium	4	High	6	High	6	No	0	Low	2
Erosion and Deposition	Low	2	Low	2	Medium	4	Medium	4	Low	2
Expansive Soils	Low	2	Low	2	Low	2	Low	2	Low	2
Extreme Heat	Low	2	Low	2	Low	2	No	0	Low	2
Flood	High	6	High	6	Medium	4	High	6	High	6
Hail	Medium	4	High	6	Medium	4	Low	2	Low	2
Landslide, Mud/Debris Flow, Rockfall	Medium	4	High	6	High	6	Medium	4	High	6
Lightning	Medium	4	High	6	Low	2	Low	2	Low	2
Severe Wind	Medium	4	High	6	Medium	4	High	6	High	6
Space Weather	Low	2	Low	2	Low	2	Low	2	No	0
Subsidence	Low	2	High	6	Low	2	Low	2	Low	2
Tornado	Medium	4	Low	2	Low	2	No	0	Low	2
Wildfire	High	6	High	6	High	6	High	6	High	6
Winter Storm	Medium	4	High	6	Low	2	Medium	4	High	6

TABLE 20-4.
IMPACT ON ECONOMY FROM HAZARDS

	Clear Creek County		City of Idaho Springs		Town of Empire		Town of Georgetown		Town of Silver Plume	
Hazard	High/Med /Low/No	Total Impact Factor	High/Med /Low/No	Total Impact Factor	High/Med /Low/No	Total Impact Factor	High/Med /Low/No	Total Impact Factor	High/Med /Low/No	Total Impact Factor
Avalanche	Low	2	Low	1	High	3	Low	1	High	3
Dam/Levee Failure	High	3	High	3	Medium	2	Low	1	Low	1
Drought	Medium	2	High	3	High	3	Medium	2	Medium	2
Earthquake	Medium	2	High	3	High	3	No	0	Low	1
Erosion and Deposition	Medium	2	High	3	Low	1	Medium	2	Low	1
Expansive Soils	Medium	2	Low	1	Low	1	Low	1	Low	1
Extreme Heat	Low	1	Low	1	Low	1	No	0	Medium	2
Flood	High	3	High	3	High	3	High	3	High	3
Hail	Low	1	Low	1	Low	1	Low	1	Low	1
Landslide, Mud/Debris Flow, Rockfall	Medium	2	High	3	High	3	Medium	2	High	3
Lightning	Low	1	Low	1	Low	1	Low	1	Low	1
Severe Wind	Low	1	Medium	2	Low	1	High	3	Low	1
Space Weather	Low	1	Low	1	Low	1	High	3	Low	1
Subsidence	Low	1	High	3	Low	1	Low	1	Low	1
Tornado	Medium	2	Low	1	Low	1	No	0	Low	1
Wildfire	High	3	High	3	High	3	High	3	High	3
Winter Storm	Medium	2	High	3	High	3	High	3	High	3

20.3 RISK RATING AND RANKING

The risk rating for each hazard was calculated by multiplying the probability factor by the sum of the weighted impact factors for people, property and operations, as summarized in Table 20-5. Based on these ratings, a priority of high, medium, or low was assigned to each hazard. The hazards ranked as being of highest concern vary by jurisdiction but generally include drought, flood, landslide, mud/debris flow, rockfall, severe wind, wildfire, and winter storm. Other hazards ranked as being of high or medium concern include avalanche, dam/levee failure, erosion and deposition, hail, lightning, and subsidence. The hazards ranked as being of lowest concern are earthquake, expansive soils, extreme heat, space weather, and tornado. Table 20-6 summarizes the hazard risk ranking.

TABLE 20-5.
HAZARD RISK RANKING CALCULATIONS

	Clear Creek County			City of Idaho Springs			Town of Empire			Town of Georgetown			Town of Silver Plume		
Hazard	**Probability Factor**	**Impact Weighted Sum**	**Total**	**Probability Factor**	**Impact Weighted Sum**	**Total**	**Probability Factor**	**Impact Weighted Sum**	**Total**	**Probability Factor**	**Impact Weighted Sum**	**Total**	**Probability Factor**	**Impact Weighted Sum**	**Total**
Avalanche	3	13	39	1	6	6	1	8	8	0	1	0	3	18	54
Dam/Levee Failure	2	18	36	1	13	13	2	10	20	1	6	6	1	6	6
Drought	2	7	14	1	15	15	3	14	42	2	12	24	2	12	24
Earthquake	1	12	12	1	18	18	1	12	12	0	0	0	1	6	6
Erosion and Deposition	2	7	14	2	8	16	3	8	24	2	12	24	1	6	6
Expansive Soils	1	4	4	1	6	6	1	6	6	1	6	6	2	6	12
Extreme Heat	1	9	9	1	6	6	1	12	12	0	0	0	1	7	7
Flood	3	15	45	3	18	54	3	13	39	3	18	54	3	18	54
Hail	3	11	33	3	16	48	2	8	16	1	6	6	1	6	6
Landslide, Mud/Debris Flow, Rockfall	3	12	36	3	18	54	3	12	36	2	12	24	3	18	54
Lightning	3	11	33	3	16	48	2	6	12	1	6	6	3	6	18
Severe Wind	3	11	33	3	17	51	3	8	24	3	18	54	3	16	48
Space Weather	1	6	6	1	6	6	1	6	6	1	9	9	1	4	4
Subsidence	2	6	12	3	18	54	1	6	6	1	6	6	1	6	6
Tornado	1	12	12	1	6	6	1	6	6	0	0	0	1	6	6
Wildfire	3	18	54	3	18	54	3	18	54	3	15	45	3	18	54
Winter Storm	3	15	45	3	18	54	3	14	42	2	16	32	3	18	54

Notes:
Impact Weighted Sum = Total Impact Factor People + Total Impact Factor Property + Total Impact Factor Economy
Total = Probability x Impact Weighted Sum

TABLE 20-6.
HAZARD RISK SUMMARY

Hazard	Clear Creek County	City of Idaho Springs	Town of Empire	Town of Georgetown	Town of Silver Plume
Avalanche	Low	Low	Low	No Exposure	High
Dam/Levee Failure	Medium	Low	Medium	Low	Low
Drought	Low	Low	High	Medium	Medium
Earthquake	Low	Low	Low	No Exposure	Low
Erosion and Deposition	Low	Low	Medium	Medium	Low
Expansive Soils	Low	Low	Low	Low	Low
Extreme Heat	Low	Low	Low	No Exposure	Low
Flood	High	High	High	High	High
Hail	Medium	High	Low	Low	Low
Landslide, Mud/Debris Flow, Rockfall	Medium	High	Medium	Medium	High
Lightning	Medium	High	Low	Low	Low
Severe Wind	Medium	High	Medium	High	High
Space Weather	Low	Low	Low	Low	Low
Subsidence	Low	High	Low	Low	Low
Tornado	Low	Low	Low	No Exposure	Low
Wildfire	High	High	High	High	High
Winter Storm	High	High	High	Medium	High

PART 3—
MITIGATION AND PLAN MAINTENANCE STRATEGY

Chapter 21.
MITIGATION ACTIONS AND IMPLEMENTATION

The Steering Committee reviewed a menu of hazard mitigation alternatives that present a broad range of alternatives to be considered for use in the planning area, in compliance with Title 44 Code of Federal Regulations (44 CFR) (Section 201.6(c)(3)(ii)). The menu reviewed for this plan is presented in Appendix D. The menu provided a baseline of mitigation alternatives that are backed by a planning process, are consistent with the planning partners' goals and objectives, and are within the capabilities of the partners to implement. The Steering Committee reviewed the full range of actions as well as the county's ability to implement the variety of mitigation actions. Hazard mitigation actions recommended in this plan were selected from among the alternatives presented in the menu as well as other projects known to be necessary.

21.1 RECOMMENDED MITIGATION ACTIONS

The planning partners and the Steering Committee identified actions that could be implemented to provide hazard mitigation benefits. Table 21-1 lists the recommended mitigation actions and the hazards addressed by the action. All of the hazards profiled in this plan are addressed by more than one mitigation action. Individual worksheets for each recommended action are provided in Appendix E.

Table 21-2 provides more details on the mitigation actions, including the mitigation action description, action type, estimated cost, potential funding sources, timeline, and benefit to the community (high, medium or low). Mitigation types used for this categorization are as follows:

- Local Plans and Regulations (LPR) – These actions include government authorities, policies, or codes that influence the way land and buildings are being developed and built.
- Structure and Infrastructure Projects (SIP) – These actions involve modifying existing structures and infrastructure to protect them from a hazard or remove them from a hazard area. This could apply to public or private structures as well as critical facilities and infrastructure. This type of action also involves projects to construct structures to reduce the impact of hazards.
- Natural Systems Protection (NSP) – These are actions that minimize damage and losses, and also preserve or restore the functions of natural systems.
- Education and Awareness Programs (EAP) – These are actions to inform and educate citizens, elected officials, and property owners about hazards and potential ways to mitigate them. These initiatives may also include participation in national programs, such as StormReady and FireWise Communities.

The parameters for the timeline are as follows:

- Short-Term – To be completed in 1 to 5 years
- Long-Term – To be completed in greater than 5 years
- Ongoing – Currently being funded and implemented under existing programs

Mitigation action worksheets were developed to provide more information for each recommended mitigation action, including the specific problem being mitigated, alternative actions considered, whether the action applies to existing or future development, the benefits or losses avoided, the department or agency responsible for implementing the action, the local planning mechanism, and potential funding sources. These worksheets were developed to provide a tool for the planning partners to apply for grants or general funds to complete the mitigation action. An example worksheet for Clear Creek County is shown in Figure 21-1.

Clear Creek County
Mitigation Action Worksheet

Please complete one worksheet per action with as much detail as possible, using the instructions provided and FEMA examples.

Name of Jurisdiction: _____ **Mitigation Action #:** _____

Mitigation Action Title: _____

Assessing the Risk	
Hazard(s) addressed: (check all that apply)	☐All Hazards ☐Avalanche ☐Dam/Levee Failure ☐Drought ☐Earthquake ☐Erosion and Deposition ☐Expansive Soils ☐Extreme Heat ☐Flood ☐Hail ☐Landslide. Mud/Debris Flow, Rockfall ☐Lightning ☐Severe Wind ☐Space Weather ☐Subsidence ☐Tornado ☐Wildfire ☐Winter Storm
Specific problem being Mitigated (describe why action is needed)	
Evaluation of Potential Alternatives	
Alternatives Considered (name of project and reason for not selecting)	1.
	2.
	3.
Action/Project Intended for Implementation	
Describe how action will be implemented (main steps involved)	
Action/Project Type	☐Local Plans and Regulations ☐Structure and Infrastructure Project ☐Natural Systems Protection ☐Education and Awareness Programs
Applicable Goals/Objectives (refer to list of goals/objectives)	☐Goal #1 ☐Goal #2 ☐Goal #3 Objective:
Applies to existing or future development	☐ Existing Development ☐Future Development ☐ Both Existing and Future Development ☐Not Applicable
Describe benefits (losses avoided)	☐Life Safety ☐Damage Reduction ☐Other Describe:
Estimated Cost	☐ < $10,000; ☐$10,000 to $100,000; ☐>$100,000 Other Amount: $
Plan for Implementation	
Responsible Department	
Local Planning Mechanism (check all that apply)	☐Capital Improvement Plan ☐Comprehensive Plan ☐Building Code ☐Ordinance ☐Other:
Potential Funding Sources	
Timeline for Completion	☐ Short Term (1-5 yrs.) ☐ Long Term (>5 yrs.) ☐ Ongoing
Reporting on Progress	
Status/Comment	☐Not Started ☐In-progress ☐Delayed ☐Completed ☐No Longer Required Comment:
Completed by: (name, title, phone #)	**Date:**

Figure 21-1. Example Mitigation Action Worksheet

21.2 BENEFIT/COST REVIEW AND PRIORITIZATION

The action plan must be prioritized according to a benefit/cost analysis of the proposed projects and their associated costs (44 CFR, Section 201.6(c)(3)(iii)). The benefits of proposed projects were weighed against estimated costs as part of the project prioritization process. The benefit/cost analysis was not of the detailed variety required by the Federal Emergency Management Agency (FEMA) for project grant eligibility under the Hazard Mitigation Grant Program (HMGP) and Pre-Disaster Mitigation (PDM) Grant Program. A less formal approach was used because some projects may not be implemented for up to 10 years, and associated costs and benefits could change dramatically in that time. Therefore, a review of the apparent benefits versus the apparent cost of each project was performed. Parameters were established for assigning subjective ratings (high, medium, and low) to the costs and benefits of these projects.

Fourteen criteria were used to assist in evaluating and prioritizing the mitigation initiatives. For each mitigation action, a numeric rank (0, 1, 2, 3, 4) was assigned for each of the 14 evaluation criteria defined as follows:

- Definitely Yes - 4
- Maybe Yes - 3
- Unknown/Neutral - 2
- Probably No - 1
- Definitely No - 0

The 14 evaluation/prioritization criteria are:

1. Life Safety—How effective will the action be at protecting lives and preventing injuries? The numeric rank for this criterion is multiplied by 2 to emphasize the importance of life safety when evaluating the benefit of the action.
2. Property Protection—How significant will the action be at eliminating or reducing damage to structures and infrastructure? The numeric rank for this criterion is multiplied by 2 to emphasize the importance of property protection when evaluating the benefit of the action.
3. Cost-Effectiveness—Will the future benefits achieved by implementing the action, exceed the cost to implement the action?
4. Technical—Is the mitigation action technically feasible? Will it solve the problem independently and is it a long-term solution? Eliminate actions that, from a technical standpoint, will not meet the goals.
5. Political—Is there overall public support for the mitigation action? Is there the political will to support it?
6. Legal—Does the jurisdiction have the authority to implement the action?
7. Fiscal—Can the project be funded under existing program budgets (i.e., is this action currently budgeted for)? Or would it require a new budget authorization or funding from another source such as grants?
8. Environmental—What are the potential environmental impacts of the action? Will it comply with environmental regulations?
9. Social—Will the proposed action adversely affect one segment of the population? Will the action disrupt established neighborhoods, break up voting districts, or cause the relocation of lower income people?

10. Administrative—Does the jurisdiction have the personnel and administrative capabilities to implement the action and maintain it or will outside help be necessary?
11. Multi-hazard—Does the action reduce the risk to multiple hazards?
12. Timeline—Can the action be completed in less than 5 years (within our planning horizon)?
13. Local Champion—Is there a strong advocate for the action or project among the jurisdiction's staff, governing body, or committees that will support the action's implementation?
14. Other Local Objectives—Does the action advance other local objectives, such as capital improvements, economic development, environmental quality, or open space preservation? Does it support the policies of other plans and programs?

The numeric results of this exercise are shown on the mitigation action worksheets in Appendix E. An example worksheet for is shown in Figure 21-2. The results were used to identify the benefit of the action to the community as low, medium, or high priority. Table 21-2 shows the priority of each mitigation action.

The Steering Committee used the results of the prioritization exercise to rank the mitigation actions in order of priority, with 1 being the highest priority. The highest priority mitigation actions are shown in red on Table 21-2, medium priority actions are shown in yellow and low priority actions are shown in green.

Prioritization Worksheet

Mitigation Action #: _____

Mitigation Action Title: _____

Criteria	Numeric Rank: Definitely Yes = 4 Maybe Yes = 3 Unknown/Neutral = 2 Probably No = 1 Definitely No = 0		Provide brief rationale for numeric rank when appropriate
1. Will the action result in Life Safety?		x 2 =	
2. Will the action result in Property Protection?		x 2 =	
3. Will the action be Cost-Effective? (future benefits exceed cost)			
4. Is the action Technically feasible			
5. Is the action Politically acceptable?			
6. Does the jurisdiction have the Legal authority to implement?			
7. Is Funding available for the action?			
8. Will the action have a positive impact on the natural Environment?			
9. Is the action Socially acceptable?			
10. Does the jurisdiction have the Administrative capability to execute the action?			
11. Will the action reduce risk to more than one hazard (Multi-Hazard)?			
12. Can the action be implemented Quickly?			
13. Is there an Agency/Department Champion for the action?			
14. Will the action meet other Community Objectives?			
Total			
Priority: Low = <35 Medium = 35-49 High = >50	☐Low ☐Medium ☐High		

Figure 21-2. Example Benefit/Cost Review and Prioritization Worksheet

TABLE 21-1.
MITIGATION ACTIONS TO ADDRESS HAZARDS

Action Reference Number	Title	Avalanche	Dam/Levee Failure	Drought	Earthquake	Erosion and Deposition	Expansive Soils	Extreme Heat	Flood	Hail	Landslide, Mud/Debris Flow, Rockfall	Lightning	Severe Wind	Space Weather	Subsidence	Tornado	Wildfire	Winter Storm
CLEAR CREEK COUNTY																		
1	Wildfire Risk Reduction Public Education Program																X	
2	Wildfire Fuels Reduction																X	
3	Wildfire Fuel's Reduction - DSpace																X	
4	Improve Access / Egress for Evacuation	X							X		X					X	X	X
5	Identification of Flood Mitigation Projects in High Flood Risk Areas								X									
6	NFIP Floodplain and Stormwater Management Practices								X		X				X			
7	Floodplain Mapping								X									
8	Development of a Debris Management Plan	X	X		X	X	X		X	X	X		X	X	X	X	X	X
9	Slope Stabilization Projects					X	X				X				X			
10	Mapping of Geological Hazard Areas	X			X	X	X				X				X			
11	Integration of HMP Components into Master Plans	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X

TABLE 21-1.
MITIGATION ACTIONS TO ADDRESS HAZARDS

Action Reference Number	Title	Avalanche	Dam/Levee Failure	Drought	Earthquake	Erosion and Deposition	Expansive Soils	Extreme Heat	Flood	Hail	Landslide, Mud/Debris Flow, Rockfall	Lightning	Severe Wind	Space Weather	Subsidence	Tornado	Wildfire	Winter Storm
12	Identifying Functional & Access Needs Population												X				X	X
13	Public Education to Mitigate Hazards	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
14	Development of Memorandums of Understanding and Intergovernmental Agreements	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
15	Portable Back-up Generator for Critical Infrastructure	X	X		X				X	X	X	X	X			X	X	X
16	Identify Mitigation Projects for Critical Facilities in Floodways and Floodplains								X									
17	Expand storage capacity at Upper Beaver Brook Reservoir		X															
18	Repair Lower Beaver Brook Dam		X															
IDAHO SPRINGS																		
1	Maintaining Secondary Water Supply		X						X						X		X	
2	Soda Creek Flood Mitigation					X	X		X		X				X			
3	Update Building Codes	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
4	Assess Surge Protectors on City Critical Facilities											X		X				

TABLE 21-1.
MITIGATION ACTIONS TO ADDRESS HAZARDS

Action Reference Number	Title	Avalanche	Dam/Levee Failure	Drought	Earthquake	Erosion and Deposition	Expansive Soils	Extreme Heat	Flood	Hail	Landslide, Mud/Debris Flow, Rockfall	Lightning	Severe Wind	Space Weather	Subsidence	Tornado	Wildfire	Winter Storm
5	Assess Sheltering Capabilities																	X
6	Natural Hazard Education	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
7	Create MOUs for Equipment Assistance	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
8	Community Wildfire Protection Implementation Plan – Route 103 Corridor												X				X	
9	Community Wildfire Protection Implementation Plan – Virginia Canyon												X				X	
1	Publicize Town Hall as Emergency Shelter	X	X		X				X		X		X		X	X	X	X
2	Publicize Communications Center	X	X		X				X		X		X		X	X	X	X
3	Water conservation techniques			X														
4	Ordinance on water usage during drought emergencies			X														
5	Identify & map old mining areas														X			
6	Secure known mining areas and post proper signage														X			
7	Public Education - Tornado safe room												X			X		

TABLE 21-1.
MITIGATION ACTIONS TO ADDRESS HAZARDS

Action Reference Number	Title	Avalanche	Dam/Levee Failure	Drought	Earthquake	Erosion and Deposition	Expansive Soils	Extreme Heat	Flood	Hail	Landslide, Mud/Debris Flow, Rockfall	Lightning	Severe Wind	Space Weather	Subsidence	Tornado	Wildfire	Winter Storm
8	Reduce flammable vegetation and clearance of trees												X				X	
9	Adopt construction standards for strong wind ratings												X			X		
10	Community Awareness of Hazards	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
11	Acquire town volunteers to assist the functional and access needs residents during extreme winter storms																	X
GEORGETOWN																		
1	Vegetation Thinning Program	N/A			N/A			N/A								N/A	X	
2	NFIP Floodplain Practices	N/A	X		N/A			N/A	X							N/A		
3	Adopt Newer IBC	N/A			N/A			N/A	X				X			N/A		X
4	Water Conservation Measures	N/A		X	N/A			N/A								N/A		
5	Replace Floodwall along Clear Creek and South Clear Creek	N/A			N/A	X		N/A	X		X				X	N/A		
6	Public education and outreach	N/A	X	X	N/A	X	X	N/A	X	X	X	X	X	X	X	N/A	X	X

TABLE 21-1.
MITIGATION ACTIONS TO ADDRESS HAZARDS

Action Reference Number	Title	Avalanche	Dam/Levee Failure	Drought	Earthquake	Erosion and Deposition	Expansive Soils	Extreme Heat	Flood	Hail	Landslide, Mud/Debris Flow, Rockfall	Lightning	Severe Wind	Space Weather	Subsidence	Tornado	Wildfire	Winter Storm
7	Identify slope stabilization projects	N/A			N/A	X	X	N/A	X		X				X	N/A		
8	Organizing outreach to functional & access needs population	N/A			N/A			N/A					X			N/A	X	X
SILVER PLUME																		
1	Identify projects in high risk flood prone areas		X						X		X							
2	Continue to participate in NFIP								X									
3	Community Outreach and Education for Winter Storms																	X
4	Improve Access / Egress for Evacuation	X							X		X						X	X
5	Community Outreach for Severe Wind Events												X					
6	Wildfire Fuels Reduction												X				X	
7	Water Restriction Ordinance			X														
8	Water Saving Techniques			X														

TABLE 21-2.
RECOMMENDED MITIGATION ACTIONS

Action Number	Title	Description	Mitigation Action Ranking	Action Type	Applicable Goals and Objectives	Responsible Department	Estimated Cost	Potential Funding Sources	Timeline	Mitigation Action Worksheet Priority
CLEAR CREEK COUNTY										
1	Wildfire Risk Reduction Public Education Program	Conduct public education program to encourage property owners to manage fuel loads on their own properties and use landscaping materials for existing and older homes built prior to current fire mitigation ordinance.	2	EAP	Goal: 1,2,3 Objective: 1.1; 1.2; 1.3; 1.5; 2.1; 2.3; 3.1; 3.4	Emergency Management	< $10,000	General Budget, FEMA Hazard Mitigation Funding, State Wildfire Risk Reduction Grants, "Ready-Set-Go" and "Firewise Communities" Programs	Short Term	High
2	Wildfire Fuels Reduction	Identify and prioritize areas with heavy fuel loads along county road right-of-ways throughout the county; Implement fuels reduction wildfire mitigation projects following assessments.	4	NSP	Goal: 1,2,3 Objective: 1.1; 1.2; 2.1; 2.3; 3.1; 3.3; 3.4	Public Works Department	$10,000 to $100,000	General Budget, FEMA Hazard Mitigation Funding, State Wildfire Risk Reduction Grants	Short Term	High

TABLE 21-2.
RECOMMENDED MITIGATION ACTIONS

Action Number	Title	Description	Mitigation Action Ranking	Action Type	Applicable Goals and Objectives	Responsible Department	Estimated Cost	Potential Funding Sources	Timeline	Mitigation Action Worksheet Priority
3	Wildfire Fuel's Reduction - DSpace	Work with private landowners to educate and find funding/grants to accomplish defensive space wildfire mitigation.	13	EAP NSP	Goal: 1,2,3 Objective: 1.1; 1.2; 1.3; 1.5; 2.1; 2.3; 3.1; 3.4	Emergency Management	< $10,000	General Budget, FEMA Hazard Mitigation Funding, State Wildfire Risk Reduction Grants, USDA, and CSFS	Short Term	High
4	Improve Access / Egress for Evacuation	Work with public and private landowners and developers to find funding/grants to create/identify safe secondary means of egress/access. There are communities within Clear Creek County that have limited access/egress with only "one way in – one way out".	6	LPR EAP	Goal: 1,2,3 Objective: 1.1; 1.2; 1.3; 1.4; 2.1; 2.3; 3.1; 3.3; 3.4	Emergency Management	>$100,000	General Budget	Long Term	Medium

TABLE 21-2.
RECOMMENDED MITIGATION ACTIONS

Action Number	Title	Description	Mitigation Action Ranking	Action Type	Applicable Goals and Objectives	Responsible Department	Estimated Cost	Potential Funding Sources	Timeline	Mitigation Action Worksheet Priority
5	Identification of Flood Mitigation Projects in High Flood Risk Areas	Work with Urban Drainage, Flood Plain Manager and Public Works Department to identify potential projects within the high-risk flood prone areas. Projects may include channel stabilization, increasing drainage or absorption capacities with detention and retention basins, relief drains, spillways, drain widening/dredging or rerouting, logjam and debris removal, extra culverts, bridge modification, dike setbacks, flood gates and pumps, or channel redirection.	1	NSP SIP	Goal: 1,2,3 Objective: 1.1; 1.2; 1.3; 1.4; 1.5; 2.2; 3.1; 3.3; 3.4	County Manager	$10,000 to $100,000	General Budget, FEMA Hazard Mitigation Funding	Short Term	Medium
6	NFIP Floodplain and Stormwater Management Practices	Continue to participate, implement and improve upon the NFIP Floodplain and Stormwater Management Practices	10	LPR EAP	Goal: 1,2,3 Objective: 1.1; 1.2; 1.3; 1.4; 1.5; 2.1; 2.2, 3.1; 3.3; 3.4	Community Development Department	< $10,000	General County Budget	Long Term	High
7	Floodplain Mapping	Create/Update/Enhance floodplain mapping/GIS database	8	LPR EAP	Goal:1, 2, 3 Objective: 1.1, 1.2, 1.3, 1.4, 2.1, 2.2, 3.1, 3.3, 3.4	County Manager	$10,000 to $100,000	General Budget, FEMA	Short Term	High

TABLE 21-2.
RECOMMENDED MITIGATION ACTIONS

Action Number	Title	Description	Mitigation Action Ranking	Action Type	Applicable Goals and Objectives	Responsible Department	Estimated Cost	Potential Funding Sources	Timeline	Mitigation Action Worksheet Priority
8	Development of a Debris Management Plan	Develop a Debris Management Plan that addresses all aspects of debris management by utilizing the knowledge, skills, and abilities of a consulting firm.	14	LPR	Goal: 1,2,3 Objective: 1.1; 1.2; 1.3; 1.4; 2.2, 3.2; 3.3; 3.4	Emergency Management	$10,000 to $100,000	General Budget	Short Term	Medium
9	Slope Stabilization Projects	Identify slope stabilization projects, and funding for implementation of project(s), to protect homes, buildings, businesses and infrastructure.	11	LPR SIP	Goal: 1,2,3 Objective: 1.1; 1.2; 1.5; 2.2, 3.1; 3.3; 3.4	Community Development Department	>$100,000	FEMA Hazard Mitigation Funding, CDOT project funding	Long Term	High
10	Mapping of Geological Hazard Areas	Create a Geological Hazard mapping/GIS database by coordinating with USGS, CGS and CDOT to further study and map vulnerable geologic hazard areas.	12	LPR	Goal: 1,2,3 Objective: 1.1; 1.2; 2.1; 2.2, 3.1; 3.4	County Manager	$10,000 to $100,000	General Budget	Short Term	High
11	Integration of HMP Components into Master Plans	Coordination between the county's HMP consultant and the county's Master Plan consultant team to ensure that hazard mitigation topics are included in the scope for the public outreach process and plan development for all relevant plan elements.	9	LPR EAP	Goal: 1,2,3 Objective: 1.1; 1.2; 1.3; 1.4; 2.2; 2.3, 3.1; 3.3, 3.4	Community Development	< $10,000	General Budget	Short Term	High

TABLE 21-2.
RECOMMENDED MITIGATION ACTIONS

Action Number	Title	Description	Mitigation Action Ranking	Action Type	Applicable Goals and Objectives	Responsible Department	Estimated Cost	Potential Funding Sources	Timeline	Mitigation Action Worksheet Priority
12	Identifying Functional & Access Needs Population	Identify specific functional & access needs populations that may be exceptionally vulnerable in winter storm, severe wind, or wildfire events that cause long-term power outages	18	EAP	Goal: 1,2,3 Objective: 1.1; 1.2; 1.4; 2.1; 3.1; 3.2; 3.3, 3.4	County Department of Health and Human Services	< $10,000	General Budget	Short Term	Medium
13	Public Education to Mitigate Hazards	Develop an emergency preparedness campaign that includes handouts, brochures, Emergency Preparedness Guide, community meetings, social media, newspapers, radio, etc. to disseminate information to the public, businesses, and tourist regarding best practices on being personally prepared during disasters.	3	EAP	Goal: 1,2,3 Objective: 1.1; 2.1; 3.1; 3.2	Emergency Management	< $10,000	General Budget, FEMA, State, and local Partners	Long Term	High
14	Development of Memorandums of Understanding and Intergovernmental Agreements	Develop and execute MOU's with applicable partners for obtaining needed resources in an event that exceeds local capabilities and resources during and after an incident, event, emergency and/or disaster.	5	LPR	Goal: 1, 3 Objective: 1.2; 1.4; 3.1; 3.2; 3.3, 3.4	Emergency Management	< $10,000	General Budget	Long Term	High
15	Portable Back-up Generator for Critical Infrastructure	Purchase of a portable back-up large capacity generator	15	SIP	Goal: 1, 3 Objective: 1.1, 1.2; 1.4; 3.1; 3.2; 3.4	Public Works Department	$10,000 to $100,000	General Budget	Long Term	High

TABLE 21-2.
RECOMMENDED MITIGATION ACTIONS

Action Number	Title	Description	Mitigation Action Ranking	Action Type	Applicable Goals and Objectives	Responsible Department	Estimated Cost	Potential Funding Sources	Timeline	Mitigation Action Worksheet Priority
16	Identify Mitigation Projects for Critical Facilities in Floodways and Floodplains	Projects may include relocation, elevation, floodproofing, channel stabilization, increasing drainage or absorption capacities with detention and retention basins, relief drains, spillways, drain widening/dredging or rerouting, logjam and debris removal, extra culverts, bridge modification, dike setbacks, flood gates and pumps, or channel redirection.	17	SIP EAP	Goal: 1,2,3 Objective: 1.1, 1.2, 1.4, 1.5, 2.2, 3.1, 3.2, 3.4	County Commissioners, County Manager, County Public Works	$10,000 to $100,000	County General Fund, Hazard Mitigation Assistance Funds	Short Term	High
17	Expand storage capacity at Upper Beaver Brook Reservoir	Current water storage capabilities of the District limit its ability to supply water throughout a long term drought	16	SIP	Goal: 1 Objective: 1.1	Lookout Mountain Water District	>$100,000	CWCB	Short Term	High
18	Repair Lower Beaver Brook Dam	Following the flooding of 2013, the Colorado State Engineer determined that upgrades to the Lower Beaver Brook dam would be necessary.	7	SIP	Goal: 1 Objective: 1.1	Lookout Mountain Water District	>$100,001	CWCB	Long Term	High
CITY OF IDAHO SPRINGS										
1	Maintaining Secondary Water Supply	Maintaining the Idaho Springs Reservoir Dam by getting the dam inspected on a yearly basis and making any repairs as needed. Then exercising the Dam Emergency Action Plan. The City has a lot of future growth potential and it is important to maintain the secondary water supply.	3	LPR	Goal: 1,2,3 Objective: 1.1; 1.2; 1.3; 1.5; 2.2; 3.1;3.4	Water/ Wastewater	$10,000 to $100,000	CRWA, CDPHE, CDLA, FEMA	Ongoing	High

TABLE 21-2.
RECOMMENDED MITIGATION ACTIONS

Action Number	Title	Description	Mitigation Action Ranking	Action Type	Applicable Goals and Objectives	Responsible Department	Estimated Cost	Potential Funding Sources	Timeline	Mitigation Action Worksheet Priority
2	Soda Creek Flood Mitigation	Coordinate with Clear Creek County regarding flood mitigation measures and improvements to portions of Soda Creek Road in the City of Idaho Springs and in Clear Creek County; retain a consultant to perform engineering and design of stormwater, water, sewer, and road improvements	2	NSP SIP	Goal: 1,2,3 Objective: 1.1; 1.2; 1.3; 1.5; 2.2; 3.4	Public Works	>$100,000	CDLA, FEMA	Short Term	High
3	Update Building Codes	Update to the 2015 IBC and IRC. This will be coordinated with Clear Creek County and the other municipalities to try to get all updated at the same time.	1	LPR	Goal: 1, 3 Objective: 1.5; 3.3	City Administrator	< $10,000	General funds	Short Term	High
4	Assess Surge Protectors on City Critical Facilities	The city will assess what critical facilities need surge protectors from lightning strikes and then purchase the necessary protectors and install.	4	LPR	Goal: 1,3 Objective: 1.2; 3.1; 3.4	Public Works	< $10,000	General funds	Short Term	High
5	Assess Sheltering Capabilities	The city will coordinator with the county and American Red Cross to assess public shelter capabilities in the city and create MOUs on shelter operations. Then the city will educate residents and visitors about available shelters.	5	LPR EAP	Goal: 1,2,3 Objective: 1.4; 2.1; 3.1; 3.2	City Administrator	< $10,000	General funds	Short Term	High

TABLE 21-2.
RECOMMENDED MITIGATION ACTIONS

Action Number	Title	Description	Mitigation Action Ranking	Action Type	Applicable Goals and Objectives	Responsible Department	Estimated Cost	Potential Funding Sources	Timeline	Mitigation Action Worksheet Priority
6	Natural Hazard Education	The city will educate homeowners concerning how to mitigate hazard damages to their homes, such as surge protector on electronics, carbon monoxide detectors, proper roofs for high wind and snow load, etc. The city will post information on the city website and use the quarterly newsletters.	7	EAP	Goal: 2 Objective: 2.1; 2.2; 2.3	City Administrator	< $10,000	General funds	Ongoing	High
7	Create MOUs for Equipment Assistance	The city will update/create MOUs with neighboring jurisdictions in the event of needing equipment to assist with a hazard response.	6	LPR	Goal: 1,3 Objective: 1.1; 3.1, 3.2, 3.4	City Administrator, Public Works	< $10,000	General funds	Long Term	High
8	Community Wildfire Protection Implementation Plan – Route 103 Corridor	Work with officials and neighborhoods to facilitate creation of Defensible Space; perform roadside mitigation/hazard tree removal and create fuel breaks south of Interstate 70, along the Route 103 corridor.	9	LPR NSP	Goal: 1,2, 3 Objective: 1.2, 1.3, 1.5, 2.1, 2.3, 3.1, 3.4	Police	$10,000 to $100,000	CDHSEM, CDFPC, CSFS, FEMA	Ongoing	High
9	Community Wildfire Protection Implementation Plan – Virginia Canyon	Work with officials and neighborhoods to facilitate creation of Defensible Space; perform roadside mitigation/hazard tree removal and create fuel breaks south of Interstate 70, in Virginia Canyon	8	LPR NSP	Goal: 1,2, 3 Objective: 1.2, 1.3, 1.5, 2.1, 2.3, 3.1, 3.5	Police	$10,000 to $100,000	CDHSEM, CDFPC, CSFS, FEMA	Ongoing	High

TABLE 21-2.
RECOMMENDED MITIGATION ACTIONS

Action Number	Title	Description	Mitigation Action Ranking	Action Type	Applicable Goals and Objectives	Responsible Department	Estimated Cost	Potential Funding Sources	Timeline	Mitigation Action Worksheet Priority
TOWN OF EMPIRE										
1	Publicize Town Hall as Emergency Shelter	Informing the stranded motorist that shelter can be provided at the Empire Town Hall. New letters will be generated for the residents of Empire informing them in the disaster of an avalanche, winter storm or other natural hazard, and their home is compromised or they are stranded tourists, there will be emergency shelter at the Town Hall.	4	EAP	Goal: 3 Objective: 3.1; 3.2	Mayor's Office	< $10,000	Town funds, ARC	Short Term	Medium
2	Publicize Communications Center	Empire will turn the local fire house into the local communications center to coordinate with red cross for emergency services.	10	EAP	Goal: 3 Objective: 3.1; 3.2; 3.3	Mayor's Office	< $10,000	Town funds, ARC	Short Term	Medium
3	Water conservation techniques	Educate residents on water saving techniques in our monthly newsletter as well as in Board Meetings on measures, including but not limited to, water efficient appliances; low-flow water saving showerheads and toilets; adjusting sprinklers to water lawn only; xeriscaping and the use of recycled water where feasible	5	EAP	Goal: 1,2 Objective: 1.3; 2.1	Mayor's Office	< $10,000	General funds	Short Term	Medium

TABLE 21-2.
RECOMMENDED MITIGATION ACTIONS

Action Number	Title	Description	Mitigation Action Ranking	Action Type	Applicable Goals and Objectives	Responsible Department	Estimated Cost	Potential Funding Sources	Timeline	Mitigation Action Worksheet Priority
4	Ordinance on water usage during drought emergencies	The Town of Empire will write and adopt an Ordinance mandating residence to control and prioritize their water use particularly during firefighting.	6	LPR	Goal: 1,3 Objective: 1.2; 1.3; 3.2; 3.3; 3.4	Mayor's Office	< $10,000	General funds	Long Term	Medium
5	Identify & map old mining areas	Identify and map old mining operations or geologically unstable terrain so that development can be prevented or eliminated.	7	LPR EAP	Goal: 2,3 Objective: 2.1; 3.3	Mayor's Office	< $10,000	General funds, state & federal grants	Long Term	Medium
6	Secure known mining areas and post proper signage	Once old mines are located, secure the site and educate the public with signage of the hazard.	9	EAP	Goal: 2 Objective: 2.1;	Mayor's Office	< $10,000	General funds, state & federal grants	Long Term	Medium
7	Public Education - Tornado safe room	Encouraging home owners to locate a safe room either within their home or nearby will significantly reduce the risk of personal injury and/or death.	11	EAP	Goal: 2 Objective: 2.1;	Mayor's Office	< $10,000	General funds, state & federal grants	Long Term	Medium
8	Reduce flammable vegetation and clearance of trees	Encourage homeowners to reduce flammable vegetation on their property, keep tree limbs trimmed, dead tree removal, and debris cleared from around home to minimize high wind and wildfire damages.	1	EAP NSP	Goal: 1,2 Objective: 1.1; 2.1; 2.3	Mayor's Office	< $10,000	General funds, state & federal grants	Long Term	High

TABLE 21-2.
RECOMMENDED MITIGATION ACTIONS

Action Number	Title	Description	Mitigation Action Ranking	Action Type	Applicable Goals and Objectives	Responsible Department	Estimated Cost	Potential Funding Sources	Timeline	Mitigation Action Worksheet Priority
9	Adopt construction standards for strong wind ratings	Work with the planning department to adopt construction design standards to meet the standards for strong wind ratings.	8	LPR	Goal: 1,3 Objective: 1.1; 3.1	Mayor's Office	< $10,000	General funds, state & federal grants	Long Term	High
10	Community Awareness of Hazards	Educating homeowners on safety techniques to mitigate homes from all hazards	2	EAP	Goal: 2 Objective: 2.1	Mayor's Office	< $10,000	General funds	Long Term	Medium
11	Acquire town volunteers to assist the functional and access needs residents during extreme winter storms	The town will supply volunteers with a list of specific duties and expectations to assist the functional & access needs residents.	3	EAP	Goal: 1,2 Objective: 1.4; 2.1	Mayor's Office	< $10,000	General funds	Long Term	High
TOWN OF GEORGETOWN										
1	Vegetation Thinning Program	Implement vegetation thinning program in and around the Town of Georgetown to create both defensible space and reduce the overall potential impacts of wildfire to residents, the National Historic Landmark District, and the Town.	1	NSP	Goal: 1,2 Objective: 1.1; 1.3; 2.3	Town Administrator	>$100,000	EIAF – DoLA, State and federal grants, local match	Short Term	High

TABLE 21-2.
RECOMMENDED MITIGATION ACTIONS

Action Number	Title	Description	Mitigation Action Ranking	Action Type	Applicable Goals and Objectives	Responsible Department	Estimated Cost	Potential Funding Sources	Timeline	Mitigation Action Worksheet Priority
2	NFIP Floodplain Practices	Continue to participate, implement and improve upon the NFIP Floodplain Practices. This regulates development on South Clear Cleek and Clear Creek within the Town.	2	LPR SIP	Goal: 1 Objective: 1.1; 1.3	Town Administrator	< $10,000	Town funds, CWCB	Long Term	High
3	Adopt Newer IBC	Town of Georgetown plans to update IBC & IRC regulations to address severe wind, winter storm, and flood. It currently uses the 2003 IBC.	8	LPR	Goal: 1, 3 Objective: 1.5; 3.3	Town Administrator	< $10,000	Town funds	Short Term	High
4	Water Conservation Measures	Coordinate with water department to continually identify and promote water conservation measures, including but not limited to, water efficient appliances, xeriscaping, the use of recycled water where feasible and install water meters.	7	EAP	Goal: 1,2 Objective: 1.1; 1.2; 1.3; 2.1	Town Administrator	< $10,000	State and federal grants, local funds	Long Term	High
5	Replace Floodwall along Clear Creek and South Clear Creek	Town of Georgetown has updated flood ordinance and needs funding to replace the flood prone, landslide, mud/debris flow, rockslide floodwall protection along Clear Creek and South Clear Creek through the historic area.	3	SIP	Goal: 1,3 Objective: 1.1; 1.2; 1.5; 3.4	Town Administrator	>$100,000	EIAF – DoLA, State and federal grants, local match	Short Term	Medium
6	Public Education and Outreach	Promote public education of all hazards and how to mitigate damage to homes.	4	EAP	Goal: 2 Objective: 2.1; 2.2; 2.3	Town Administrator	< $10,000	State and federal grants	Short Term	High

TABLE 21-2.
RECOMMENDED MITIGATION ACTIONS

Action Number	Title	Description	Mitigation Action Ranking	Action Type	Applicable Goals and Objectives	Responsible Department	Estimated Cost	Potential Funding Sources	Timeline	Mitigation Action Worksheet Priority
7	Identify slope stabilization projects	Georgetown is vulnerable unstable slopes including damage to private property, historic buildings and infrastructure, bridges and road closures, service disruption and fatalities.	5	NSP SIP	Goal: 1,2,3 Objective: 1.1; 1.2; 1.5; 2.2; 3.1; 3.3; 3.4	Town Administrator	$10,000 to $100,000	FEMA HMA grants	Long Term	Medium
8	Organizing outreach to functional & access needs population	Organize outreach to functional & access needs populations that may be exceptionally vulnerable in winter storm, severe wind, or wildfire events that cause long-term power outages. Maintain public information and awareness programs for the functional & access needs population and create policies and procedures to ensure that needs are met during long-term power outages.	6	EAP	Goal: 1,2 Objective: 1.1; 1.3; 2.9	Town Administrator	< $10,000	Town funds	Short Term	Medium
TOWN OF SILVER PLUME										
1	Identify projects in high risk flood prone areas	Work with the Floodplain Manager to identify potential projects within the high risk flood prone areas within the town of Silver Plume.	2	NSP SIP	Goal: 1,2,3 Objective: 1.5; 2.1; 3.4	Town Board	$10,000 to $100,000	General Fund, state and federal grants	Short Term	Medium
2	Continue to participate in NFIP	Continue to participate, implement and improve upon the NFIP Floodplain Practices.	4	LPR SIP	Goal: 1 Objective: 1.1; 1.3	Town Board	< $10,000	General Fund, CWCB	Long Term	High
3	Community Outreach and Education for Winter Storms	Community Outreach and Education to work with residents and business owners on proactive mitigation measures to reduce the impacts of winter storms on the community	5	EAP	Goal: 1,2,3 Objective: 1.5; 2.1; 3.6	Town Board	< $10,000	General Fund	Ongoing	Medium

TABLE 21-2.
RECOMMENDED MITIGATION ACTIONS

Action Number	Title	Description	Mitigation Action Ranking	Action Type	Applicable Goals and Objectives	Responsible Department	Estimated Cost	Potential Funding Sources	Timeline	Mitigation Action Worksheet Priority
4	Improve Access / Egress for Evacuation	Work with homeowners to improve access/ egress for evacuations and preventative forest maintenance.	3	EAP NSP	Goal: 1 Objective: 1.1; 1.2; 1.3; 1.4; 1.5	Planning/Zoning	< $10,000	General Fund	Short Term	Medium
5	Community Outreach for Severe Wind Events	Encourage homeowners and business owners to implement mitigation measures to reduce the impacts of fallen and blowing debris on homes and businesses during high wind events.	6	EAP	Goal: 1,2,3 Objective: 1.1; 2.1; 3.1	Town Board	< $10,000	General Fund and homeowners	Ongoing	Medium
6	Wildfire Fuels Reduction	Encourage work parties to reduce fuel loads on homeowner property and the impact of wildfires and high wind damage.	1	EAP NSP	Goal: 1,2,3 Objective: 1.1; 1.2; 1.3; 2.1; 2.3; 3.1; 3.4	Town Board	< $10,000	General Fund and grants	Short Term	High
7	Water Restriction Ordinance	Drought events can potentially effect or reduce the availability of water for residents and businesses in the community	7	LPR	Goal: 1,2,3 Objective: 1.2; 2.1; 3.3	Town Board	< $10,000	General Fund	Short Term	Low
8	Water Saving Techniques	Encourage residents to take water-saving measures, including but not limited to, water efficient appliances, adjusting sprinklers to water lawn and not the sidewalk, xeriscaping, checking for leaks in plumping.	8	EAP	Goal: 1,2 Objective: 1.1; 1.2; 1.3; 2.1	Town Board	< $10,000	State and federal grants, local funds	Long Term	Medium

TABLE 21-2.
RECOMMENDED MITIGATION ACTIONS

Action Number	Title	Description	Mitigation Action Ranking	Action Type	Applicable Goals and Objectives	Responsible Department	Estimated Cost	Potential Funding Sources	Timeline	Mitigation Action Worksheet Priority

Notes:

ARC	American Red Cross	FEMA	Federal Emergency Management Agency
CDFPC	Colorado Division of Fire Prevention and Control	IBC	International Building Code
CDHSEM	Colorado Division of Homeland Security and Emergency Management	IRC	International Residential Code
		LPR	Local Plans and Regulations
CDOT	Colorado Department of Transportation	MOU	Memorandum of Understanding
CDPHE	Colorado Department of Public Health and Environment	N/A	Not Applicable
CRWA	Colorado Rural Water Association	NFIP	National Flood Insurance Program
CSFS	Colorado State Forest Service	NSP	Natural System Protection
CWCB	Colorado Water Conservation Board	SIP	Structure and Infrastructure Project
DOLA	Colorado Department of Local Affairs	USDA	U.S. Department of Agriculture
EAP	Education and Awareness Programs		
EIAF	Energy and Mineral Impact Assistance Fund		

Chapter 22.
PLAN ADOPTION AND MAINTENANCE

22.1 PLAN ADOPTION

A hazard mitigation plan must document that it has been formally adopted by the governing body of the jurisdiction requesting federal approval of the plan (44 CFR Section 201.6(c)(5)). For multi-jurisdictional plans, each jurisdiction requesting approval must document that is has been formally adopted. All planning partners fully met the participation requirements specified by the Steering Committee and will seek DMA compliance under this plan. The plan will be submitted for a pre-adoption review to Colorado Office of Emergency Management and FEMA Region VIII prior to adoption. Once pre-adoption approval has been provided, all planning partners will formally adopt the plan. All partners understand that DMA compliance and its benefits cannot be achieved until the plan is adopted. Copies of the resolutions adopting this plan for all planning partners can be found in Appendix F.

22.2 PLAN MAINTENANCE STRATEGY

A hazard mitigation plan must present a plan maintenance process that includes the following (44 CFR Section 201.6(c)(4)):

- A section describing the method and schedule of monitoring, evaluating, and updating the mitigation plan over a 5-year cycle.
- A process by which local governments incorporate the requirements of the mitigation plan into other planning mechanisms, such as comprehensive or capital improvement plans, when appropriate.
- A discussion on how the community will continue public participation in the plan maintenance process.

This chapter details the formal process that will ensure that the *Clear Creek County Hazard Mitigation Plan* remains an active and relevant document and that the planning partners maintain their eligibility for applicable funding sources. The plan maintenance process includes a schedule for monitoring and evaluating the plan annually and producing an updated plan every 5 years. This chapter also describes how public participation will be integrated throughout the plan maintenance and implementation process. It also explains how the mitigation strategies outlined in this plan will be incorporated into existing planning mechanisms and programs, such as comprehensive land-use planning processes, capital improvement planning, and building code enforcement and implementation. The plan's format allows sections to be reviewed and updated when new data become available, resulting in a plan that will remain current and relevant.

22.2.1 Plan Implementation

The effectiveness of the hazard mitigation plan depends on its implementation and incorporation of its action items into partner jurisdictions' existing plans, policies, and programs. Together, the action items in the plan provide a framework for activities that the partnership can implement over the next 5 years. The planning team and the Steering Committee have established goals and objectives and have prioritized mitigation actions that will be implemented through existing plans, policies, and programs.

The Clear Creek County Office of Emergency Management (CCCOEM) will have lead responsibility for overseeing the plan implementation and maintenance strategy. Plan implementation and evaluation will be a shared responsibility among all planning partnership members and agencies identified as lead agencies in the mitigation action plans.

22.2.2 Steering Committee

The Steering Committee is a total volunteer body that oversaw the development of the plan and made recommendations on key elements of the plan, including the maintenance strategy. It was the Steering Committee's position that an implementation committee with representation similar to the initial Steering Committee should have an active role in the plan maintenance strategy. Therefore, it is recommended that a Steering Committee remain a viable body involved in key elements of the plan maintenance strategy. The new Steering Committee should strive to include representation from the planning partners, as well as other stakeholders in the planning area.

The principal role of the new implementation committee in this plan maintenance strategy will be to review the annual progress report and provide input to the Clear Creek County Emergency Manager on possible enhancements to be considered at the next update. Future plan updates will be overseen by a Steering Committee similar to the one that participated in this plan development process, so keeping an interim Steering Committee intact will provide a head start on future updates. Completion of the progress report is the responsibility of each planning partner, not the responsibility of the Steering Committee. It will simply be the Steering Committee's role to review the progress report in an effort to identify issues needing to be addressed by future plan updates.

22.2.3 Annual Progress Report

The minimum task of each planning partner will be the evaluation of the progress of its individual action plan during a 12-month performance period. This review will include the following:

- Summary of any hazard events that occurred during the performance period and the impact these events had on the planning area
- Review of mitigation success stories
- Review of continuing public involvement
- Brief discussion about why targeted strategies were not completed
- Re-evaluation of the action plan to evaluate whether the timeline for identified projects needs to be amended (such as changing a long-term project to a short-term one because of new funding)
- Recommendations for new projects
- Changes in or potential for new funding options (grant opportunities)
- Impact of any other planning programs or initiatives that involve hazard mitigation

The planning team has created a template to guide the planning partners in preparing a progress report (see Appendix G). The plan maintenance Steering Committee will provide feedback to the planning team on items included in the template. The planning team will then prepare a formal annual report on the progress of the plan. This report should be used as follows:

- Posted on the CCCOEM's website page dedicated to the hazard mitigation plan
- Provided to the local media through a press release
- Presented to planning partner governing bodies to inform them of the progress of initiatives implemented during the reporting period

The county and the planning partners do not currently participate in the Community Rating System (CRS). However, if any of the planning partners decide to participate in CRS in the future, the report can be provided as part of the CRS annual re-certification package. The CRS requires an annual recertification to be submitted by October 1 of every calendar year for which the community has not received a formal audit.

To meet this recertification timeline, the planning team will strive to complete progress reports between June and September each year.

Uses of the progress report will be at the discretion of each planning partner. Annual progress reporting is not a requirement specified under 44 CFR. However, it may enhance the planning partnership's opportunities for funding. While failure to implement this component of the plan maintenance strategy will not jeopardize a planning partner's compliance under the DMA, it may jeopardize its opportunity to partner and leverage funding opportunities with the other partners.

22.2.4 Plan Update

Local hazard mitigation plans must be reviewed, revised if appropriate, and resubmitted for approval in order to remain eligible for benefits under the DMA (44 CFR, Section 201.6(d)(3)). The Clear Creek County partnership intends to update the hazard mitigation plan on a 5-year cycle from the date of initial plan adoption. This cycle may be accelerated to less than 5 years based on the following triggers:

- A Presidential Disaster Declaration that impacts the planning area
- A hazard event that causes loss of life
- A comprehensive update of the county or participating city/town's comprehensive plan

It will not be the intent of future updates to develop a complete new hazard mitigation plan for the planning area. The update will, at a minimum, include the following elements:

- The update process will be convened through a Steering Committee.
- The hazard risk assessment will be reviewed and, if necessary, updated using best available information and technologies.
- The action plans will be reviewed and revised to account for any actions completed, dropped, or changed and to account for changes in the risk assessment or new partnership policies identified under other planning mechanisms (such as the comprehensive plan).
- The draft update will be sent to appropriate agencies and organizations for comment.
- The public will be given an opportunity to comment on the update prior to adoption.
- The partnership governing bodies will adopt their respective portions of the updated plan.

22.2.5 Continuing Public Involvement

The public will continue to be apprised of the plan's progress through the CCCOEM's website and by providing copies of annual progress reports to the media. The CCCOEM will maintain the hazard mitigation plan website. This site will not only house the final plan, it will become the one-stop shop for information regarding the plan, the partnership and plan implementation. Copies of the plan will be distributed to the public library system in Clear Creek County Library. Upon initiation of future update processes, a new public involvement strategy will be initiated based on guidance from a new Steering Committee. This strategy will be based on the needs and capabilities of the planning partnership at the time of the update. At a minimum, this strategy will include the use of local media outlets within the planning area.

22.2.6 Incorporation into Other Planning Mechanisms

The information on hazard, risk, vulnerability, and mitigation contained in this plan is based on the best science and technology available at the time this plan was prepared. The comprehensive plans, zoning and subdivision regulations, and ordinances of Clear Creek County and the partner cities/towns are considered to be integral parts of this plan. The county and partner municipalities, through adoption of comprehensive plans and zoning ordinances, have planned for the impact of natural hazards. The plan development process provided the county and the cities/towns with the opportunity to review and expand on policies contained

within these planning mechanisms. The planning partners used their comprehensive plans and the hazard mitigation plan as complementary documents that work together to achieve the goal of reducing risk exposure to the citizens of the planning area. An update to a comprehensive plan may trigger an update to the hazard mitigation plan.

All municipal planning partners are committed to creating a linkage between the hazard mitigation plan and their individual comprehensive plans. Other planning processes and programs to be coordinated with the recommendations of the hazard mitigation plan include the following:

- Municipal codes
- Community design guidelines
- Water-efficient landscape design guidelines
- Stormwater management programs
- Water system vulnerability assessments
- Community wildfire protection plans

Some action items do not need to be implemented through regulation. Instead, these items can be implemented through the creation of new educational programs, continued interagency coordination, or improved public participation. As information becomes available from other planning mechanisms that can enhance this plan, that information will be incorporated via the update process.

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APPENDIX A.
ACRONYMS AND DEFINITIONS

APPENDIX A.
ACRONYMS AND DEFINITIONS

ACRONYMS

°F	Degrees Fahrenheit
°C	Degrees Celsius
%g	Percentage of gravity
BLM	Bureau of Land Management
BOCC	Board of County Commissioners
CAIC	Colorado Avalanche Information Center
CCCOEM	Clear Creek County Office of Emergency Management
CCFA	Clear Creek Fire Authority
CCR	Code of Colorado Regulations
CDOT	Colorado Department of Transportation
CFR	Code of Federal Regulations
CME	Coronal Mass Ejections
CO-WRAP	Colorado Wildfire Risk Assessment Program
CRS	Community Rating System
CWA	Clean Water Act
CWCB	Colorado Water Conservation Board
CWPP	Community Wildfire Protection Plan
DEM	Digital Elevation Model
DFIRM	Digital Flood Insurance Rate Maps
DHS	Department of Homeland Security
DMA	Disaster Mitigation Act
DNR	Colorado Department of Natural Resources
EAP	Emergency Action Plan
EF	Enhanced Fujita
EMS	Emergency Medical Service
EMT	Emergency Medical Technician
EPA	U.S. Environmental Protection Agency
ESA	Endangered Species Act
ESD	Emergency Services District
EUV	Extreme Ultraviolet
FEMA	Federal Emergency Management Agency

FERC	Federal Energy Regulatory Commission
FIRM	Flood Insurance Rate Map
FIS	Flood Insurance Study
FMA	Flood Mitigation Assistance
FoCAIC	Friends of the Colorado Avalanche Information Center
GIS	Geographic Information System
HAZMAT	Hazardous Materials
HAZUS-MH	Hazards, United States-Multi Hazard
HFRA	Healthy Forest Restoration Act
HMA	Hazard Mitigation Assistance
HMGP	Hazard Mitigation Grant Program
HOA	Homeowners Association
IGA	Intergovernmental Agreement
IR	Infrared
LPR	Local Plans and Regulations
ML	Local Magnitude Scale
Mph	Miles per Hour
M_W	Moment Magnitude
NASA	National Aeronautics and Space Administration
NEHRP	National Earthquake Hazards Reduction Program
NFIP	National Flood Insurance Program
NM	Nanometer
NO	Nitrous Oxide
NOAA	National Oceanic and Atmospheric Administration
NREL	National Renewable Energy Laboratory
NSP	Natural System Protection
NSSA	National Storm Shelter Association
NWS	National Weather Service
OTA	Congressional Office of Technology Assessment
PDM	Pre-Disaster Mitigation
PDI	Palmer Drought Index
PGA	Peak Ground Acceleration
PHDI	Palmer Hydrological Drought Index
POA	Property Owners Association
SIP	Structure and Infrastructure Project

SFHA	Special Flood Hazard Area
SPI	Standardized Precipitation Index
USACE	U.S. Army Corps of Engineers
USDA	U.S. Department of Agriculture
USFS	U.S. Forest Service
USGS	U.S. Geological Survey
UV	Ultraviolet
WUI	Wildland Urban Interface

DEFINITIONS

100-Year Flood: The term "100-year flood" can be misleading. The 100-year flood does not necessarily occur once every 100 years. Rather, it is the flood that has a 1% chance of being equaled or exceeded in any given year. Thus, the 100-year flood could occur more than once in a relatively short period of time. The Federal Emergency Management Agency (FEMA) defines it as the 1% annual chance flood, which is now the standard definition used by most federal and state agencies and by the National Flood Insurance Program (NFIP).

Acre-Foot: An acre-foot is the amount of water it takes to cover 1 acre to a depth of 1 foot. This measure is used to describe the quantity of storage in a water reservoir. An acre-foot is a unit of volume. One acre foot equals 7,758 barrels; 325,829 gallons; or 43,560 cubic feet. An average household of four will use approximately 1 acre-foot of water per year.

Asset: An asset is any man-made or natural feature that has value, including, but not limited to, people; buildings; infrastructure, such as bridges, roads, sewers, and water systems; lifelines, such as electricity and communication resources; and environmental, cultural, or recreational features such as parks, wetlands, and landmarks.

Base Flood: The flood having a 1% chance of being equaled or exceeded in any given year, also known as the "100-year" or "1% chance" flood. The base flood is a statistical concept used to ensure that all properties subject to the NFIP are protected to the same degree against flooding.

Basin: A basin is the area within which all surface water—whether from rainfall, snowmelt, springs, or other sources—flows to a single water body or watercourse. The boundary of a river basin is defined by natural topography, such as hills, mountains, and ridges. Basins are also referred to as "watersheds" and "drainage basins."

Benefit: A benefit is a net project outcome and is usually defined in monetary terms. Benefits may include direct and indirect effects. For the purposes of benefit/cost analysis of proposed mitigation measures, benefits are limited to specific, measurable risk reduction factors, including reduction in expected property losses (buildings, contents, and functions) and protection of human life.

Benefit/Cost Analysis: A benefit/cost analysis is a systematic, quantitative method of comparing projected benefits to projected costs of a project or policy. It is used as a measure of cost effectiveness.

Building: A building is defined as a structure that is walled and roofed, principally aboveground, and permanently fixed to a site. The term includes manufactured homes on permanent foundations on which the wheels and axles carry no weight.

Capability Assessment: A capability assessment provides a description and analysis of a community's current capacity to address threats associated with hazards. The assessment includes two components: an

inventory of an agency's mission, programs, and policies, and an analysis of its capacity to carry them out. A capability assessment is an integral part of the planning process in which a community's actions to reduce losses are identified, reviewed, and analyzed, and the framework for implementation is identified. The following capabilities were reviewed under this assessment:

- Legal and regulatory capability
- Administrative and technical capability
- Fiscal capability

Community Rating System (CRS): The CRS is a voluntary program under the NFIP that rewards participating communities (provides incentives) for exceeding the minimum requirements of the NFIP and completing activities that reduce flood hazard risk by providing flood insurance premium discounts.

Critical Area: An area defined by state or local regulations as deserving special protection because of unique natural features or its value as habitat for a wide range of species of flora and fauna. A sensitive/critical area is usually subject to more restrictive development regulations.

Critical Facility: Facilities and infrastructure that are critical to the health and welfare of the population. These become especially important after any hazard event occurs. For the purposes of this plan, critical facilities include:

- Structures or facilities that produce, use, or store highly volatile, flammable, explosive, toxic or water reactive materials.
- Hospitals, nursing homes, and housing likely to contain occupants who may not be sufficiently mobile to avoid death or injury during a hazard event.
- Police stations, fire stations, vehicle and equipment storage facilities, and emergency operations centers that are needed for disaster response before, during, and after hazard events.
- Public and private utilities, facilities and infrastructure that are vital to maintaining or restoring normal services to areas damaged by hazard events.
- Government facilities.

Dam: Any artificial barrier or controlling mechanism that can or does impound 10 acre-feet or more of water.

Dam Failure: Dam failure refers to a partial or complete breach in a dam (or levee) that impacts its integrity. Dam failures occur for a number of reasons, such as flash flooding, inadequate spillway size, mechanical failure of valves or other equipment, freezing and thawing cycles, earthquakes, and intentional destruction.

Debris Flow: Dense mixtures of water-saturated debris that move down-valley; looking and behaving much like flowing concrete. They form when loose masses of unconsolidated material are saturated, become unstable, and move down slope. The source of water varies but includes rainfall, melting snow or ice, and glacial outburst floods.

Debris Slide: Debris slides consist of unconsolidated rock or soil that has moved rapidly down slope. They occur on slopes greater than 65%.

Disaster Mitigation Act of 2000 (DMA): The DMA is Public Law 106-390 and is the latest federal legislation enacted to encourage and promote proactive, pre-disaster planning as a condition of receiving financial assistance under the Robert T. Stafford Act. The DMA emphasizes planning for disasters before they occur. Under the DMA, a pre-disaster hazard mitigation program and new requirements for the national post-disaster Hazard Mitigation Grant Program (HMGP) were established.

Drainage Basin: A basin is the area within which all surface water—whether from rainfall, snowmelt, springs or other sources—flows to a single water body or watercourse. The boundary of a river basin is

defined by natural topography, such as hills, mountains and ridges. Drainage basins are also referred to as **watersheds** or **basins**.

Drought: Drought is a period of time without substantial rainfall or snowfall from one year to the next. Drought can also be defined as the cumulative impacts of several dry years or a deficiency of precipitation over an extended period of time, which in turn results in water shortages for some activity, group, or environmental function. A hydrological drought is caused by deficiencies in surface and subsurface water supplies. A socioeconomic drought impacts the health, well-being, and quality of life or starts to have an adverse impact on a region. Drought is a normal, recurrent feature of climate and occurs almost everywhere.

Earthquake: An earthquake is defined as a sudden slip on a fault, volcanic or magmatic activity, and sudden stress changes in the earth that result in ground shaking and radiated seismic energy. Earthquakes can last from a few seconds to over 5 minutes, and have been known to occur as a series of tremors over a period of several days. The actual movement of the ground in an earthquake is seldom the direct cause of injury or death. Casualties may result from falling objects and debris as shocks shake, damage, or demolish buildings and other structures.

Exposure: Exposure is defined as the number and dollar value of assets considered to be at risk during the occurrence of a specific hazard.

Extent: The extent is the size of an area affected by a hazard.

Fire Behavior: Fire behavior refers to the physical characteristics of a fire and is a function of the interaction between the fuel characteristics (such as type of vegetation and structures that could burn), topography, and weather. Variables that affect fire behavior include the rate of spread, intensity, fuel consumption, and fire type (such as underbrush versus crown fire).

Fire Frequency: Fire frequency is the broad measure of the rate of fire occurrence in a particular area. An estimate of the areas most likely to burn is based on past fire history or fire rotation in the area, fuel conditions, weather, ignition sources (such as human or lightning), fire suppression response, and other factors.

Flash Flood: A flash flood occurs with little or no warning when water levels rise at an extremely fast rate

Flood Insurance Rate Map (FIRM): FIRMs are the official maps on which the Federal Emergency Management Agency (FEMA) has delineated the Special Flood Hazard Area (SFHA).

Flood Insurance Study: A report published by the Federal Insurance and Mitigation Administration for a community in conjunction with the community's FIRM. The study contains such background data as the base flood discharges and water surface elevations that were used to prepare the FIRM. In most cases, a community FIRM with detailed mapping will have a corresponding flood insurance study.

Floodplain: Any land area susceptible to being inundated by flood waters from any source. A FIRM identifies most, but not necessarily all, of a community's floodplain as the SFHA.

Floodway: Floodways are areas within a floodplain that are reserved for the purpose of conveying flood discharge without increasing the base flood elevation more than 1 foot. Generally speaking, no development is allowed in floodways, as any structures located there would block the flow of floodwaters.

Floodway Fringe: Floodway fringe areas are located in the floodplain but outside of the floodway. Some development is generally allowed in these areas, with a variety of restrictions. On maps that have identified and delineated a floodway, this would be the area beyond the floodway boundary that can be subject to different regulations.

Fog: Fog refers to a cloud (or condensed water droplets) near the ground. Fog forms when air close to the ground can no longer hold all the moisture it contains. Fog occurs either when air is cooled to its dew point or the amount of moisture in the air increases. Heavy fog is particularly hazardous because it can restrict surface visibility. Severe fog incidents can close roads, cause vehicle accidents, cause airport delays, and

impair the effectiveness of emergency response. Financial losses associated with transportation delays caused by fog have not been calculated in the United States but are known to be substantial.

Freeboard: Freeboard is the margin of safety added to the base flood elevation.

Frequency: For the purposes of this plan, frequency refers to how often a hazard of specific magnitude, duration, or extent is expected to occur on average. Statistically, a hazard with a 100-year frequency is expected to occur about once every 100 years on average and has a 1% chance of occurring any given year. Frequency reliability varies depending on the type of hazard considered.

Fujita Scale of Tornado Intensity: Tornado wind speeds are sometimes estimated on the basis of wind speed and damage sustained using the Fujita Scale. The scale rates the intensity or severity of tornado events using numeric values from F0 to F5 based on tornado wind speed and damage. An F0 tornado (wind speed less than 73 miles per hour [mph]) indicates minimal damage (such as broken tree limbs), and an F5 tornado (wind speeds of 261 to 318 mph) indicates severe damage.

Goal: A goal is a general guideline that explains what is to be achieved. Goals are usually broad-based, long-term, policy-type statements and represent global visions. Goals help define the benefits that a plan is trying to achieve. The success of a hazard mitigation plan is measured by the degree to which its goals have been met (that is, by the actual benefits in terms of actual hazard mitigation).

Geographic Information System (GIS): GIS is a computer software application that relates data regarding physical and other features on the earth to a database for mapping and analysis.

Hazard: A hazard is a source of potential danger or adverse condition that could harm people or cause property damage.

Hazard Mitigation Grant Program (HMGP): Authorized under Section 202 of the Robert T. Stafford Disaster Relief and Emergency Assistance Act, the HMGP is administered by FEMA and provides grants to states, tribes, and local governments to implement hazard mitigation actions after a major disaster declaration. The purpose of the program is to reduce the loss of life and property due to disasters and to enable mitigation activities to be implemented as a community recovers from a disaster

Hazards U.S. Multi-Hazard (HAZUS-MH) Loss Estimation Program: HAZUS-MH is a GIS-based program used to support the development of risk assessments as required under the DMA. The HAZUS-MH software program assesses risk in a quantitative manner to estimate damages and losses associated with natural hazards. HAZUS-MH is FEMA's nationally applicable, standardized methodology and software program and contains modules for estimating potential losses from earthquakes, floods, and wind hazards. HAZUS-MH has also been used to assess vulnerability (exposure) for other hazards.

Hydraulics: Hydraulics is the branch of science or engineering that addresses fluids (especially water) in motion in rivers or canals, works and machinery for conducting or raising water, the use of water as a prime mover, and other fluid-related areas.

Hydrology: Hydrology is the analysis of waters of the earth. For example, a flood discharge estimate is developed by conducting a hydrologic study.

Intensity: For the purposes of this plan, intensity refers to the measure of the effects of a hazard.

Inventory: The assets identified in a study region comprise an inventory. Inventories include assets that could be lost when a disaster occurs and community resources are at risk. Assets include people, buildings, transportation, and other valued community resources.

Landslide: Landslides can be described as the sliding movement of masses of loosened rock and soil down a hillside or slope. Fundamentally, slope failures occur when the strength of the soils forming the slope exceeds the pressure, such as weight or saturation, acting upon them.

Lightning: Lightning is an electrical discharge resulting from the buildup of positive and negative charges within a thunderstorm. When the buildup becomes strong enough, lightning appears as a "bolt," usually within or between clouds and the ground. A bolt of lightning instantaneously reaches temperatures approaching 50,000ºF. The rapid heating and cooling of air near lightning causes thunder. Lightning is a major threat during thunderstorms. In the United States, 75 to 100 Americans are struck and killed by lightning each year (see http://www.fema.gov/hazard/thunderstorms/thunder.shtm).

Liquefaction: Liquefaction is the complete failure of soils, occurring when soils lose shear strength and flow horizontally. It is most likely to occur in fine grain sands and silts, which behave like viscous fluids when liquefaction occurs. This situation is extremely hazardous to development on the soils that liquefy, and generally results in extreme property damage and threats to life and safety.

Local Government: Any county, municipality, city, town, township, public authority, school district, special district, intrastate district, council of governments (regardless of whether the council of governments is incorporated as a nonprofit corporation under State law), regional or interstate government entity, or agency or instrumentality of a local government; any Indian tribe or authorized tribal organization, or Alaska Native village or organization; and any rural community, unincorporated town or village, or other public entity.

Magnitude: Magnitude is the measure of the strength of an earthquake, and is typically measured by the Richter scale. As an estimate of energy, each whole number step in the magnitude scale corresponds to the release of about 31 times more energy than the amount associated with the preceding whole number value.

Mass movement: A collective term for landslides, mudflows, debris flows, sinkholes, and lahars.

Mitigation: A preventive action that can be taken in advance of an event that will reduce or eliminate the risk to life or property.

Mitigation Initiatives (or Mitigation Actions): Mitigation initiatives are specific actions to achieve goals and objectives that minimize the effects from a disaster and reduce the loss of life and property.

Objective: For the purposes of this plan, an objective is defined as a short-term aim that, when combined with other objectives, forms a strategy or course of action to meet a goal.

Peak Ground Acceleration: Peak Ground Acceleration (PGA) is a measure of the highest amplitude of ground shaking that accompanies an earthquake, based on a percentage of the force of gravity.

Preparedness: Preparedness refers to actions that strengthen the capability of government, citizens, and communities to respond to disasters.

Presidential Disaster Declaration: These declarations are typically made for events that cause more damage than state and local governments and resources can handle without federal government assistance. Generally, no specific dollar loss threshold has been established for such declarations. A Presidential Disaster Declaration puts into motion long-term federal recovery programs, some of which are matched by state programs, designed to help disaster victims, businesses, and public entities.

Probability of Occurrence: The probability of occurrence is a statistical measure or estimate of the likelihood that a hazard will occur. This probability is generally based on past hazard events in the area and a forecast of events that could occur in the future. A probability factor based on yearly values of occurrence is used to estimate probability of occurrence.

Repetitive Loss Property: Any NFIP-insured property that, since 1978 and regardless of any changes of ownership during that period, has experienced:

- Four or more paid flood losses in excess of $1000.00; or
- Two paid flood losses in excess of $1000.00 within any 10-year period since 1978 or
- Three or more paid losses that equal or exceed the current value of the insured property.

Return Period (or Mean Return Period): This term refers to the average period of time in years between occurrences of a particular hazard (equal to the inverse of the annual frequency of occurrence).

Riverine: Of or produced by a river. Riverine floodplains have readily identifiable channels. Floodway maps can only be prepared for riverine floodplains.

Risk: Risk is the estimated impact that a hazard would have on people, services, facilities, and structures in a community. Risk measures the likelihood of a hazard occurring and resulting in an adverse condition that causes injury or damage. Risk is often expressed in relative terms such as a high, moderate, or low likelihood of sustaining damage above a particular threshold due to occurrence of a specific type of hazard. Risk also can be expressed in terms of potential monetary losses associated with the intensity of the hazard.

Risk Assessment: Risk assessment is the process of measuring potential loss of life, personal injury, economic injury, and property damage resulting from hazards. This process assesses the vulnerability of people, buildings, and infrastructure to hazards and focuses on (1) hazard identification; (2) impacts of hazards on physical, social, and economic assets; (3) vulnerability identification; and (4) estimates of the cost of damage or costs that could be avoided through mitigation.

Risk Ranking: This ranking serves two purposes, first to describe the probability that a hazard will occur, and second to describe the impact a hazard will have on people, property, and the economy. Risk estimates for the City are based on the methodology that the City used to prepare the risk assessment for this plan. The following equation shows the risk ranking calculation:

Risk Ranking = Probability + Impact (people + property + economy)

Robert T. Stafford Act: The Robert T. Stafford Disaster Relief and Emergency Assistance Act, Public Law 100-107, was signed into law on November 23, 1988. This law amended the Disaster Relief Act of 1974, Public Law 93-288. The Stafford Act is the statutory authority for most federal disaster response activities, especially as they pertain to FEMA and its programs.

Sinkhole: A collapse depression in the ground with no visible outlet. Its drainage is subterranean. It is commonly vertical-sided or funnel-shaped.

Special Flood Hazard Area: The base floodplain delineated on a FIRM. The SFHA is mapped as a Zone A in riverine situations. The SFHA may or may not encompass all of a community's flood problems

Stakeholder: Business leaders, civic groups, academia, non-profit organizations, major employers, managers of critical facilities, farmers, developers, special purpose districts, and others whose actions could impact hazard mitigation.

Stream Bank Erosion: Stream bank erosion is common along rivers, streams, and drains where banks have been eroded, sloughed, or undercut. However, it is important to remember that a stream is a dynamic and constantly changing system. It is natural for a stream to want to meander, so not all eroding banks are "bad" and in need of repair. Generally, stream bank erosion becomes a problem where development has limited the meandering nature of streams, where streams have been channelized, or where stream bank structures (like bridges, culverts, etc.) are located in places where they can actually cause damage to downstream areas. Stabilizing these areas can help protect watercourses from continued sedimentation, damage to adjacent land uses, control unwanted meander, and improvement of habitat for fish and wildlife.

Steep Slope: Different communities and agencies define it differently, depending on what it is being applied to, but generally a steep slope is a slope in which the percent slope equals or exceeds 25%. For this study, steep slope is defined as slopes greater than 33%.

Sustainable Hazard Mitigation: This concept includes the sound management of natural resources, local economic and social resiliency, and the recognition that hazards and mitigation must be understood in the largest possible social and economic context.

Thunderstorm: A thunderstorm is a storm with lightning and thunder produced by cumulonimbus clouds. Thunderstorms usually produce gusty winds, heavy rains, and sometimes hail. Thunderstorms are usually short in duration (seldom more than 2 hours). Heavy rains associated with thunderstorms can lead to flash flooding during the wet or dry seasons.

Tornado: A tornado is a violently rotating column of air extending between and in contact with a cloud and the surface of the earth. Tornadoes are often (but not always) visible as funnel clouds. On a local scale, tornadoes are the most intense of all atmospheric circulations, and winds can reach destructive speeds of more than 300 mph. A tornado's vortex is typically a few hundred meters in diameter, and damage paths can be up to 1 mile wide and 50 miles long.

Vulnerability: Vulnerability describes how exposed or susceptible an asset is to damage. Vulnerability depends on an asset's construction, contents, and the economic value of its functions. Like indirect damages, the vulnerability of one element of the community is often related to the vulnerability of another. For example, many businesses depend on uninterrupted electrical power. Flooding of an electric substation would affect not only the substation itself but businesses as well. Often, indirect effects can be much more widespread and damaging than direct effects.

Watershed: A watershed is an area that drains downgradient from areas of higher land to areas of lower land to the lowest point, a common drainage basin.

Wildfire: Wildfire refers to any uncontrolled fire occurring on undeveloped land that requires fire suppression. The potential for wildfire is influenced by three factors: the presence of fuel, topography, and air mass. Fuel can include living and dead vegetation on the ground, along the surface as brush and small trees, and in the air such as tree canopies. Topography includes both slope and elevation. Air mass includes temperature, relative humidity, wind speed and direction, cloud cover, precipitation amount, duration, and the stability of the atmosphere at the time of the fire. Wildfires can be ignited by lightning and, most frequently, by human activity including smoking, campfires, equipment use, and arson.

Windstorm: Windstorms are generally short-duration events involving straight-line winds or gusts exceeding 50 mph. These gusts can produce winds of sufficient strength to cause property damage. Windstorms are especially dangerous in areas with significant tree stands, exposed property, poorly constructed buildings, mobile homes (manufactured housing units), major infrastructure, and aboveground utility lines. A windstorm can topple trees and power lines; cause damage to residential, commercial, critical facilities; and leave tons of debris in its wake.

Zoning Ordinance: The zoning ordinance designates allowable land use and intensities for a local jurisdiction. Zoning ordinances consist of two components: a zoning text and a zoning map.

Clear Creek County
Hazard Mitigation Plan

APPENDIX B.
LOCAL MITIGATION PLAN REVIEW TOOL

APPENDIX B.
LOCAL MITIGATION PLAN REVIEW TOOL

This appendix presents the local mitigation action review tool for the *Clear Creek County Hazard Mitigation Plan*. The review tool demonstrates how the plan meets federal regulations and offers state and FEMA planners an opportunity to provide feedback on the plan to the community.

Clear Creek County
Hazard Mitigation Plan

APPENDIX C.
PUBLIC OUTREACH

APPENDIX C.
PUBLIC OUTREACH

This appendix includes the agenda, sign-in sheets, and meeting notes from the three Steering Committee Meetings conducted in 2015. This appendix also include the results of the *Clear Creek County Hazard Mitigation Plan* questionnaire, as described in Chapter 3.7.2. The press releases announcing the development of the *Clear Creek County Hazard Mitigation Plan* are shown in Chapter 3.7.4.

Clear Creek County
Hazard Mitigation Plan

APPENDIX D.
MENU OF MITIGATION ALTERNATIVES

APPENDIX D.
MENU OF MITIGATION ALTERNATIVES

Mitigation Categories

The measures that communities and individuals can use to protect themselves from, or mitigate the impacts of, natural and man-made hazards fall into six categories:

1. Life Safety
2. Public Education and Awareness
3. Preventive Measures
4. Structural Projects
5. Property Protection
6. Natural Resource Protection

SAMPLE MITIGATION INITIATIVES:

Hazard: **All Hazards**

- Incorporate an Emergency Telephone Notification System (ETNS) into the County Emergency Communications Center
- Construct a new Emergency Operations Center
- Develop a Master Generator Plan for the County
- Public Education & Information Program Development
- Develop a Special Needs registry through the 9-1-1 databases to assist with educating, alerting, evacuating, or responding to vulnerable populations during disaster
- Provide for back-up power sources for County essential services facilities to avoid water shortages during extended power outages
- Provide backup power generators to additional County fueling facilities
- Develop enhanced Emergency Planning for Special Needs populations in the County Emergency Operations Plan and other planning documents
- Work with County Businesses to develop a Disaster Resistant Business Program
- Develop a comprehensive public education program on the dangers of carbon monoxide during extended power outages
- Develop multi-lingual disaster education PSA's and educational videos
- Develop a separate "public safety" information area in all public libraries and public recreation facilities to disseminate disaster safety information appropriate to the area and the season
- Train/educate builders, developers, architects and engineers in techniques of disaster-resistant homebuilding
- Develop and begin to implement a systematic process to evaluate and upgrade aging infrastructure such as transportation, drainage, utilities, and others that could be affected during a major natural disaster.
- Collaborate with other stakeholders (public, businesses, non-profit organizations, government, regulatory agencies, and others) for public outreach efforts.
- Continue the public outreach strategy to share responsibilities amongst the citizens, federal, state, and local governments.
- Develop and maintain the County's Office of Emergency Management natural hazards website.
- Continue to pursue additional grants to implement risk reduction projects.
- Develop preparedness guides for County residents and businesses.
- Continue to improve the communication of severe weather warnings, flood warning, and related information.

- Distribute NOAA weather radios to residents that are most vulnerable to severe weather.
- Determine which critical facilities currently have weather radios and feasibility of hard-wiring.
- Develop an improved critical facilities dataset to use in emergency planning efforts and in future mitigation plan update.
- Promote structural mitigation to assure redundancy of critical facilities, to include but not limited to roof structure improvement, to meet or exceed building code standards, upgrade of electrical panels to accept generators, etc.

Hazard: Floods, Dam/Levee Failure

- Evaluate repetitive loss properties and potential solutions to mitigate existing conditions.
- Continue National Flood Insurance Program (NFIP) and improve the county's Community Rating System (CRS) classification. Examine criteria and establish roles and responsibilities for completion.
- Acquire and remove repetitive loss properties and repeatedly flooded properties acquisition will be the most cost effective and desirable mitigation measure
- Implement structural and non-structural flood mitigation measures for flood-prone properties, as recommended in the basin-wide master drainage plans
- Develop a Dam/Levee Public Education and Evacuation Plan for targeted areas of the community
- Continue to update and revise Basin-wide Master Drainage Plans where changed conditions warrant revisions.
- Develop an outreach program aimed at identifying and assisting private dam owners with repairing or decommissioning at-risk dams.
- Provide stricter floodplain regulations along the stream and river corridors.
- Consider establishing an administrative procedure or change in City and County codes for requiring builders to develop a site drainage plan ensuring "no adverse impact" when they apply for permits for new residential construction.
- Complete GIS and other automated inventories for stormwater, problem drainage areas, DFIRM and other assets.
- Review compliance with the National Flood Insurance Program with an annual review of the Floodplain Ordinances and any newly permitted activities in the 100-year floodplain.

Hazard: Tornadoes, High Winds

- Develop a model SafeRoom project for [Mobile Home Park] in the County
- Develop a SafeRoom plan for County facilities
- Evaluate individual SafeRoom rebate program
- Educate residents, building professionals and SafeRoom vendors on the ICC/NSSA "Standard for the Design and Construction of Storm Shelters" and consider incorporating into current regulatory measures

Hazard: Lightning

- Install Lightning Warning & Alert Systems in public recreation areas

Hazard: Expansive Soils

- Research the applicability of establishing an administrative procedure or change in County codes for requiring builders to check for expansive soils when they apply for permits for new residential construction and for using foundations that mitigate expansive soil damages when in a moderate or high-risk area.

Hazard: Extreme Heat

- Review the safety of playground materials during extreme heat events
- Identify shelters or facilities for vulnerable populations to congregate during extreme weather events.

Hazard: Wildfire

- Implement a Firewise Community Education and Information Program
- Continue to develop partnerships with other organizations to implement wildfire mitigation plans and other hazard reduction programs.

- Complete and maintain a Community Wildfire Protection Plan including the assessment of parcels identified in the wildland urban interface.
- Work with Colorado Forestry Association and Department of Natural Resources to review zoning and ordinances to identify areas to include wildfire mitigation principles.

***Hazard:* Earthquake**

- Incorporate earthquakes in the Office of Emergency Management public outreach strategy.
- Work with Colorado Geological to continue the study and analyze earthquakes related to appropriate levels of seismic safety in building codes and practices.

***Hazard:* Avalanche**

- Ensure hazard maps are current and updated on a regular basis
- Enact tools to help manage development in hazard areas: better land controls, tax incentives, information
- Develop strategy to take advantage of post-disaster opportunities as they arise
- Continue to educate the public on the avalanche hazard and appropriate risk reduction alternatives.

***Hazard:* Drought**

- Develop a public education on drought resistance
- Identify alternative water supplies for time of drought. Mutual aid agreements with alternative suppliers.
- Consider providing incentives to property owners that utilize drought resistant landscapes in the design of their homes.
- Develop standards that require drought resistant landscapes on County and community owned facilities
- Implement storm water retention in regions ideally suited for groundwater recharges.
  Develop a residential and local business program to modify plumbing systems – i.e. water saving kits

APPENDIX E.
WORKSHEETS FOR RECOMMENDED MITIGATION ACTIONS

APPENDIX E.
WORKSHEETS FOR RECOMMENDED MITIGATION ACTIONS

The planning partners and the Steering Committee determined that some actions could be implemented to provide hazard mitigation benefits. The individual worksheets for each recommended action are provided in this appendix.

APPENDIX F.
PLAN ADOPTION RESOLUTIONS FROM PLANNING PARTNERS

APPENDIX F.
PLAN ADOPTION RESOLUTIONS FROM PLANNING PARTNERS

To Be Provided With Final Release

Clear Creek County
Hazard Mitigation Plan

APPENDIX G.
EXAMPLE PROGRESS REPORT

APPENDIX G.
EXAMPLE PROGRESS REPORT

Clear Creek County
Hazard Mitigation Plan
Annual Progress Report

Reporting Period: 2016-2017

Background: Clear Creek County and participating communities in the county developed a hazard mitigation plan to reduce risk from all hazards by identifying resources, information, and strategies for risk reduction. The federal Disaster Mitigation Act of 2000 requires state and local governments to develop hazard mitigation plans as a condition for federal disaster grant assistance. To prepare the plan, the participating partners organized resources, assessed risks from natural hazards within the county, developed planning goals and objectives, reviewed mitigation alternatives, and developed an action plan to address probable impacts from natural hazards. By completing this process, these jurisdictions maintained compliance with the Disaster Mitigation Act, achieving eligibility for mitigation grant funding opportunities afforded under the Robert T. Stafford Act. The plan can be viewed on-line at:

http://www.co.clear-creek.co.us/

Summary Overview of the Plan's Progress: The performance period for the Hazard Mitigation Plan became effective on ____, 2016, with the final approval of the plan by FEMA. The initial performance period for this plan will be 5 years, with an anticipated update to the plan to occur before _____, 2021. As of this reporting period, the performance period for this plan is considered to be __% complete. The *Clear Creek County Hazard Mitigation Plan* has targeted 54 hazard mitigation actions to be pursued during the 5-year performance period. As of the reporting period, the following overall progress can be reported:

- __ out of __ initiatives (__%) reported ongoing action toward completion.
- __ out of __ initiatives (__%) were reported as being complete.
- __ out of __ initiatives (___%) reported no action taken.

Purpose: The purpose of this report is to provide an annual update on the implementation of the action plan identified in the *Clear Creek County Hazard Mitigation Plan*. The objective is to ensure that there is a continuing and responsive planning process that will keep the hazard mitigation plan dynamic and responsive to the needs and capabilities of the partner jurisdictions. This report discusses the following:

- Natural hazard events that have occurred within the last year
- Changes in risk exposure within the planning area (all of Clear Creek County)
- Mitigation success stories
- Review of the action plan
- Changes in capabilities that could impact plan implementation
- Recommendations for changes/enhancement

The Hazard Mitigation Plan Steering Committee: The Hazard Mitigation Plan Steering Committee, made up of planning partners and stakeholders within the planning area, reviewed and approved this progress report at its annual meeting held on _____, 201_. It was determined through the plan's development process that a Steering Committee would remain in service to oversee maintenance of the plan. At a minimum, the Steering Committee will provide technical review and oversight on the

development of the annual progress report. It is anticipated that there will be turnover in the membership annually, which will be documented in the progress reports. For this reporting period, the Steering Committee membership is as indicated in Table 1.

TABLE 1.
STEERING COMMITTEE MEMBERS

Name	Title	Jurisdiction/Agency

Natural Hazard Events within the Planning Area: During the reporting period, there were __ natural hazard events in the planning area that had a measurable impact on people or property. A summary of these events is as follows:

- _____
- _____
- _____

Changes in Risk Exposure in the Planning Area: *(Insert brief overview of any natural hazard event in the planning area that changed the probability of occurrence or ranking of risk for the hazards addressed in the hazard mitigation plan)*

Mitigation Success Stories: *(Insert brief overview of mitigation accomplishments during the reporting period)*

Review of the Action Plan: Table 2 reviews the action plan, reporting the status of each initiative. Reviewers of this report should refer to the *Clear Creek County Hazard Mitigation Plan* for more detailed descriptions of each initiative and the prioritization process.

Address the following in the "status" column of the following table:

- *Was any element of the initiative carried out during the reporting period?*
- *If no action was completed, why?*
- *Is the timeline for implementation for the initiative still appropriate?*
- *If the initiative was completed, does it need to be changed or removed from the action plan?*

TABLE 2.
ACTION PLAN MATRIX

Action No.	Title	Action Taken? (Yes or No)	Timeline	Priority	Status	Status (√, O, X)
CLEAR CREEK COUNTY						
1	Wildfire Risk Reduction Public Education Program					
2	Wildfire Fuels Reduction					
3	Wildfire Fuel's Reduction - DSpace					
4	Improve Access / Egress for Evacuation					
5	Identification of Flood Mitigation Projects in High Flood Risk Areas					
6	NFIP Floodplain and Stormwater Management Practices					
7	Floodplain Mapping					
8	Development of a Debris Management Plan					
9	Slope Stabilization Projects					
10	Mapping of Geological Hazard Areas					
11	Integration of HMP Components into Master Plans					
12	Identifying Functional & Access Needs Population					
13	Public Education to Mitigate Hazards					
14	Development of Memorandums of Understanding and Intergovernmental Agreements					
15	Portable Back-up Generator for Critical Infrastructure					
16	Identify Mitigation Projects for Critical Facilities in Floodways and Floodplains					
17	Expand storage capacity at Upper Beaver Brook Reservoir					
18	Repair Lower Beaver Brook Dam					

TABLE 2.
ACTION PLAN MATRIX

Action No.	Title	Action Taken? (Yes or No)	Timeline	Priority	Status	Status (√, O, X)
CITY OF IDAHO SPRINGS						
1	Maintaining Secondary Water Supply					
2	Soda Creek Flood Mitigation					
3	Update Building Codes					
4	Assess Surge Protectors on City Critical Facilities					
5	Assess Sheltering Capabilities					
6	Natural Hazard Education					
7	Create MOUs for Equipment Assistance					
8	Community Wildfire Protection Implementation Plan – Route 103 Corridor					
9	Community Wildfire Protection Implementation Plan – Virginia Canyon					
TOWN OF EMPIRE						
1	Publicize Town Hall as Emergency Shelter					
2	Publicize Communications Center					
3	Water conservation techniques					
4	Ordinance on water usage during drought emergencies					
5	Identify & map old mining areas					
6	Secure known mining areas and post proper signage					
7	Public Education - Tornado safe room					
8	Reduce flammable vegetation and clearance of trees					

TABLE 2.
ACTION PLAN MATRIX

Action No.	Title	Action Taken? (Yes or No)	Timeline	Priority	Status	Status (√, O, X)
9	Adopt construction standards for strong wind ratings					
10	Community Awareness of Hazards					
11	Acquire town volunteers to assist the functional and access needs residents during extreme winter storms					
TOWN OF GEORGETOWN						
1	Vegetation Thinning Program					
2	NFIP Floodplain Practices					
3	Adopt Newer IBC					
4	Water Conservation Measures					
5	Replace Floodwall along Clear Creek and South Clear Creek					
6	Public education and outreach					
7	Identify slope stabilization projects					
8	Organizing outreach to functional & access needs population					
TOWN OF SILVER PLUME						
1	Identify projects in high risk flood prone areas					
2	Continue to participate in NFIP					
3	Community Outreach and Education for Winter Storms					
4	Improve Access / Egress for Evacuation					
5	Community Outreach for Severe Wind Events					
6	Wildfire Fuels Reduction					
7	Water Restriction Ordinance					

TABLE 2.
ACTION PLAN MATRIX

Action No.	Title	Action Taken? (Yes or No)	Timeline	Priority	Status	Status (√, O, X)
8	Water Saving Techniques					

Completion status legend:

✓= Project Completed

O = Action ongoing toward completion

X = No progress at this time

Changes That May Impact Implementation of the Plan: *(Insert brief overview of any significant changes in the planning area that would have a profound impact on the implementation of the plan. Specify any changes in technical, regulatory and financial capabilities identified during the plan's development)*

Recommendations for Changes or Enhancements: Based on the review of this report by the Hazard Mitigation Plan Steering Committee, the following recommendations will be noted for future updates or revisions to the plan:

- _____
- _____
- _____
- _____
- _____

Public review notice: *The contents of this report are considered to be public knowledge and have been prepared for total public disclosure. Copies of the report have been provided to the governing boards of all planning partners and to local media outlets and the report is posted on the Clear Creek County Hazard Mitigation Plan website. Any questions or comments regarding the contents of this report should be directed to:*

Insert Contact Info Here

TETRA TECH

CLEAR CREEK COUNTY