Larimer County Multi-Jurisdictional Hazard Mitigation Plan Update

March 2021

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LIST OF COMMUNITY ANNEXES

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CERTIFICATION OF ANNUAL PLAN REVIEW MEETINGS

The Larimer County Hazard Mitigation Planning Team (HMPT) has agreed to review the contents of this Hazard Mitigation Plan annually. The following table hereby certifies this review.

Year	Date	Signature
2022		
2023		
2024		
2025		
2026		

Record of Changes

1 INTRODUCTION

Larimer County, Colorado, including the following participating municipalities and Title 32 Special Districts, have prepared this 2021 update of the Larimer County Hazard Mitigation Plan (HMP).

- Larimer County
- Town of Berthoud
- Berthoud Fire Protection District
- Crystal Lake Fire Protection District
- Town of Estes Park
- Estes Park Health
- Estes Valley Fire Protection District
- Estes Valley Recreation and Parks District
- City of Fort Collins
- Glacier View Fire Protection District
- Town of Johnstown
- Livermore Fire Protection District
- City of Loveland
- Loveland Fire Rescue Authority
- Northern Water Conservancy District
- Pinewood Springs Fire Protection District
- Poudre Canyon Fire Protection District
- Poudre Fire Authority
- Thompson Valley EMS District
- Town of Timnath
- Upper Thompson Sanitation District
- Town of Wellington
- Wellington Fire Protection District
- Town of Windsor
- Windsor Severance Fire Protection District

1.1 Executive Summary

The purpose of hazard mitigation is to reduce or eliminate long-term risk to people and property from disasters and hazard events. Studies have found that hazard mitigation is extremely cost-effective, with every dollar spent on mitigation saving an average of $6 in avoided future losses. Larimer County and its participating jurisdictions developed this hazard mitigation plan to reduce future losses to the County and its communities from natural and human-caused hazards, and to reduce the shocks and stressors caused by those events. This Plan is the result of the continued effort from stakeholders, partners and districts to complete a document that updates the 2016 Larimer County Hazard Mitigation Plan, which in turn built on the 2005 and 2010 Northern Colorado Regional Hazard Mitigation Plans. The Federal Emergency Management Agency (FEMA) requires that local hazard mitigation plans be updated every five years in order for the jurisdictions to be eligible for federal mitigation assistance. All sections of the 2016 plan were reviewed and updated to reflect new data changes in the hazards facing the County, as well as changes in demographics and development. The updated Plan addresses natural and human-caused hazards throughout Larimer County with the expressed purpose of saving lives and reducing future losses in anticipation of future events.

Section 1: Introduction – includes this Executive Summary and lays out the background, purpose, scope and authotities of the plan.

Section 2: Community Profile – describes the planning area, consisting of Larimer County and the participating jurisdictions listed above, and includes updated information on demographics, social vulnerability, and changes in development.

Section 3: Planning Process – describes the planning process used to conduct the 2021 update. Larimer's HMP has been completed with a high degree of public participation. A broad range of public and private stakeholders, including agencies, local businesses, nonprofits, and other interested parties were invited to participate in the development of the 2021 Plan. Stakeholder involvement was encouraged through staff and planning team invitations to agencies and individuals to actively participate in local planning meetings and to interact with the planning materials and surveys posted on the project website. Public input was sought throughout the planning process by conducting open public meetings advertised through social media networks, community bulletins, email distribution lists, and jurisdictional websites. The final plan was reviewed by the State of Colorado Division of Homeland Security and Emergency Management (DHSEM), approved by the Federal Emergency Management Agency (FEMA), and formally adopted by the governing bodies of all participating jurisdictions.

Section 4: Risk Assessment – builds on available historical data from past hazard occurrences, establishes detailed profiles for each hazard, and culminates in a hazard risk ranking based on conclusions about the frequency of occurrence, spatial extent, and potential impact of each hazard. Additional data pertaining to drought and dam failures/incidents allowed those hazards to be more fully fleshed out than they were in the previous plan. The information generated through the risk assessment serves a critical function as communities seek to determine the most appropriate mitigation actions to pursue and implement — enabling communities to prioritize and focus their efforts on those hazards of greatest concern and those structures or planning areas facing the greatest risk(s). The best available information on the impacts of climate change were taken into account for each hazard.

The following hazards are profiled in the 2021 Plan:

- Biological Hazards (including pandemics)
- Civil Disturbance
- Dam Inundation
- Drought
- Earthquake
- Flood – Flash and Riverine
- Hazardous Materials Incident
- Landslide / Rockslide
- Soil Hazards
- Spring / Summer Storms
- Tornado
- Utility Disruption
- Wildfire
- Winter Storm (Blizzard, Heavy Snow)

The overall significance of these hazards, based on their frequency of occurrrence, spatial extent affected, and severity of impacts, are shown in Table 1-1. Details about how the risk from each hazard varies by jurisdiction can be found in Section 4 and in the Community Annexes.

Section 5: Capability Assessment – evaluates programs and policies currently in use across the County to reduce hazard impacts or that could be used to implement hazard mitigation activities. The section also identifies opportunities for enhancement.

Section 6: Mitigation Strategy – describes what the County and jurisdictions will do to reduce their vulnerability to the hazards identified in Section 4, and to increase their mitigation capabilities described in Section 5. It presents the updated goals and objectives of the mitigation program, and details a broad range of targeted mitigation actions to reduce losses from hazard events.

Section 7: Plan Implementation and Maintenance – details how the plan will be implemented, monitored, evaluated, and updated, as well as how the mitigation program will be integrated into other planning mechanisms.

While the above sections focus on the risks, capabilities, and activities of the planning area as a whole, the Jurisdictional Annexes provide specific details unique to each participating jurisdiction, including variations in risk and vulnerability, and each jurisdictions' planned mitigation actions.

Table 1-1 Larimer County Hazard Significance

Hazard	Frequency	Spatial Extent	Severity	Overall Significance
Biological Hazards	Highly Likely	Extensive	Catastrophic	High
Civil Disturbance	Likely	Limited	Significant	Medium
Dam Inundation	Occasional	Significant	Critical	Medium
Drought	Likely	Significant	Significant	Medium
Earthquake	Unlikely	Significant	Catastrophic	Medium
Flood	Highly Likely	Significant	Catastrophic	High
Hazardous Materials Incident	Likely	Limited	Critical	High
Landslide/Rockslide	Likely	Limited	Critical	High
Soil Hazards	Likely	Limited	Significant	Medium
Spring/Summer Storm	Highly Likely	Extensive	Critical	High
Tornado	Likely	Limited	Critical	High
Utility Disruption	Likely	Significant	Critical	Medium
Wildfire	Highly Likely	Significant	Critical	High
Winter Storm	Highly Likely	Extensive	Critical	High

Frequency of Occurrence:
Highly Likely: Near 100% probability in next year.
Likely: Between 10 and 100% probability in next year or at least one chance in ten years.
Occasional: Between 1 and 10% probability in next year or at least one chance in next 100 years.
Unlikely: Less than 1% probability in next 100 years.

Spatial Extent:
Limited: Less than 10% of planning area
Significant: 10-50% of planning area
Extensive: 50-100% of planning area

Potential Severity:
Catastrophic: Multiple deaths, complete shutdown of facilities for 30 days or more, more than 50% of property is severely damaged
Critical: Multiple severe injuries, complete shutdown of facilities for at least 2 weeks, more than 25% of property is severely damaged
Significant: Some injuries, complete shutdown of critical facilities for more than one week, more than 10 percent of property is severely damaged
Negligible: Minor injuries, minimal quality-of-life impact, shutdown of critical facilities and services for 24 hours or less, less than 10 percent of property is severely damaged.

Significance
Low: minimal potential impact
Medium: moderate potential impact
High: widespread potential impact

1.2 Background

Emergency Management is the practice of identifying, managing, and reducing risks. It is a discipline that involves preparing for a disaster before it occurs, supporting those affected by the disaster, as well as rebuilding after the natural or human-caused disaster event, and determining solutions for increased overall resilience of the community. Emergency Management is an ever-changing process by which all individuals, groups, and communities attempt to manage hazards (and our interactions with them) in an effort to avoid or reduce the impact of disasters. One method for proactively managing hazard risks is hazard mitigation planning, which is the identification of policies, capabilities, activities, and tools to implement successful and sustainable risk reduction actions.

Mitigation planning offers many benefits, including:

- Saving lives and property
- Saving money
- Ensuring quick and effective recovery following disasters
- Reducing future vulnerability through wise development and post-disaster recovery and reconstruction
- Enhancing coordination within and across participating jurisdictions,
- Expediting the receipt of pre-disaster and post-disaster grant funding, and
- Demonstrating a firm commitment to improving community health and safety

Mitigation planning has great potential to produce long-term and recurring benefits by breaking the repetitive cycle of disaster loss. A core assumption of hazard mitigation is that pre-disaster investments will significantly reduce the demand for post-disaster assistance by lessening the need for emergency response, repair, recovery, and reconstruction. Furthermore, mitigation practices enable local residents, businesses, and industries to re-establish themselves in the wake of a disaster, getting the community economy back on track sooner and with less interruption.

The benefits of mitigation planning go beyond reducing hazard vulnerability. Measures such as the acquisition or regulation of land in known hazard areas can help achieve multiple community goals, such as preserving open space, improving water quality, maintaining environmental health, and enhancing recreational opportunities. Thus, it is vitally important that any local mitigation planning process be integrated with existing local planning efforts, and any proposed mitigation strategies must take into account broader community goals. Larimer County and its jurisdictions have embraced this approach, identifying multiple opportunities to link the Plan with pre-existing programs, policies, plans, and resilience-building initiatives.

During the last several decades, the emergency management cycle has evolved considerably. A renewed emphasis has been placed on planning for disasters before they occur as a complement to effective response and recovery. As a result, hazard mitigation has gained increasing prominence as a critical part of emergency management. By mitigating hazards through sustained action taken to reduce or eliminate the long-term risk to human life and property from hazards, risks can be proactively combated in a systematic manner, rather than being reacted to once they occur.

This 2021 Plan is the result of continuing work by the citizens of the County to update a regional pre-disaster multi-hazard mitigation plan that will not only continue to guide the County towards greater disaster resistance, but will also respect the character and needs of the community.

1.3 Purpose and Scope

Recognizing the importance of hazard mitigation planning, Larimer County, the City of Fort Collins, and the City of Loveland adopted the first Northern Colorado Regional Hazard Mitigation Plan (NCRHMP) in 2005. An updated NCRHMP was adopted in 2010 by those jurisdictions, in addition to the Towns of Berthoud, Estes Park, and Wellington. In 2016, the County and its participating municipalities and special districts chose to develop a county-scale hazard mitigation plan to better address the needs and capabilities of Larimer County.

Information in this plan will be used to help guide and coordinate mitigation activities and decisions for local land use policy in the future. Proactive mitigation planning helps reduce the cost of disaster response and recovery to communities and their residents by protecting people and critical community facilities, reducing liability exposure, and minimizing overall community impacts and disruptions. The Larimer County area has been affected by hazards in the past, and is committed to reducing future impacts from hazard events.

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

Larimer County has remained dedicated in implementing the actions and strategies defined in the 2016 Plan and its predecessors, and is committed to continuing that momentum with the 2021 Plan. It will be updated and maintained to continually address changes in hazards or vulnerabilities, and will be updated within the next five years.

1.4 Authority

This Hazard Mitigation Plan has been adopted by Larimer County and its participating jurisdictions in accordance with the authority granted to counties by the State of Colorado.

This Plan was developed in accordance with current state and federal rules and regulations governing local hazard mitigation plans. The Plan shall be monitored and updated on a routine basis to maintain compliance with the following legislation and guidance:

- Robert T. Stafford Disaster Relief and Emergency Assistance Act, 42 U.S.C., Section 322, Mitigation Planning, as enacted by Section 104 of the Disaster Mitigation Act of 2000 (P.L. 106-390) and by FEMA's Interim Final Rule published in the Federal Register on February 26, 2002, at 44 CFR Part 201

2 COMMUNITY PROFILE

Larimer County describes itself as a "thriving, friendly place where people of all ages, cultures, and economic backgrounds live, work, play and most of all, call home." The county extends to the Continental Divide and includes several mountain communities and Rocky Mountain National Park. The County encompasses 2,640 square miles that include some of the finest irrigated farmland in the state, as well as vast stretches of scenic ranch lands, forests and high mountain peaks. Over 50% of Larimer County is publicly owned, most of which is land within Roosevelt National Forest and Rocky Mountain National Park.

The Introduction to the 2016 Larimer Community Resiliency Framework states:

> Larimer County is known for its world-class outdoor recreation opportunities, a balance between thriving agriculture and growing urban communities, and Colorado State University. Like most counties in the Front Range of the Rocky Mountains, Larimer County encompasses both the mountains in the west and flat agricultural land in the east. Communities in the mountains tend to follow the canyons carved out by the main rivers and creeks, flowing on to the plains. These water courses provide resources for recreation, irrigation, and urban water needs. Unlike most Front Range counties, Larimer County has never had a large mining industry. Instead, ranching and agriculture, including cattle, hay, and sugar beets, have historically driven growth. Today, the county is considerably more diversified, with most people finding employment in government, hospitality and food industries, and retail.

The County's 2019-2023 Strategic Plan and 2019 Comprehensive Plan establish the following guiding principles:

VISION: Larimer County is a great place to be; an innovative community to live, work, and play for everyone.

MISSION: Larimer County government upholds and advances the community's health, safety, well-being and quality of life.

2.1 County History

Present-day Larimer County was originally the home of several Native American tribes, with the Utes occupying the mountainous areas and the Cheyenne and Arapaho living on the piedmont areas along the base of the foothills. French fur trappers infiltrated the area in the early decades of the 19th century, soon after the area became part of the United States with the Louisiana Purchase and was organized as part of the Missouri Territory. In 1828 William H. Ashley ascended the Cache la Poudre River on his way to the Green River in present-day Utah. The river itself received its name in the middle 1830s from an obscure incident in which French-speaking trappers hid gunpowder along its banks, somewhere near present-day Laporte or Bellvue. In 1848 a group of Cherokees crossed through the county following the North Fork of the Poudre to the Laramie Plains on their way to California along a route that became known as the Cherokee Trail.

Larimer County was established in 1861 as one of the 17 original counties of the Colorado Territory, and was named after General William Larimer. Unlike that of much of Colorado, which was founded on the mining of gold and silver, the settlement of Larimer County was based almost entirely on agriculture, an industry that few thought possible in the region during the initial days of the Colorado Gold Rush. The mining boom almost entirely passed the county by. It would take the introduction of irrigation to the region in the 1860s to bring the first widespread settlement to the area.

The first railroad finally arrived in the County in 1877 when the Colorado Central Railroad extended a line north from Golden via Longmont to Cheyenne. The town council of Fort Collins designated right-of-way through the center of town (and through the campus of the unbuilt college) for the line. A planned transcontinental line over Cameron Pass was never completed, but the line nevertheless opened up the quarrying of stone for the railroad at Stout, furnishing another industry for the region.

The early growth of agriculture, which depended highly on direct river irrigation, experienced a second boom in 1902 with the introduction of the cultivation of sugar beets, accompanied by the construction of the large processing plant of the Great Western Sugar Co. in Loveland. In the following decade, the sugar beet industry brought large numbers of German emigrants from the Russian Empire to the county. The neighborhoods of Fort Collins northeast of the Poudre were constructed largely to house these new families. Meanwhile the Estes Park area was developing into a major tourist destination, especially after the formation of Rocky Mountain National Park in 1915 and the construction of the Stanley Hotel in 1909.

A significant increase in the agricultural productivity of the region came in the 1930s with the construction of the Colorado Big Thompson Project following the Great Depression, sort of a third boom for the agricultural industry around Fort Collins. This project collected and captured Western Slope water, and carried it over to the Front Range Colorado counties of Boulder, Larimer and Weld, along with an extensive water storage and distribution system, which significantly extended the irrigable growing season and brought substantial additional land under irrigation for the first time.

2.2 Governing Body

Larimer County is governed by ten elected officials that over-see different functions of county government:

- Assessor
- Board of County Commissioners
- Clerk & Recorder
- Coroner
- District Attorney
- Sheriff
- Surveyor
- Treasurer

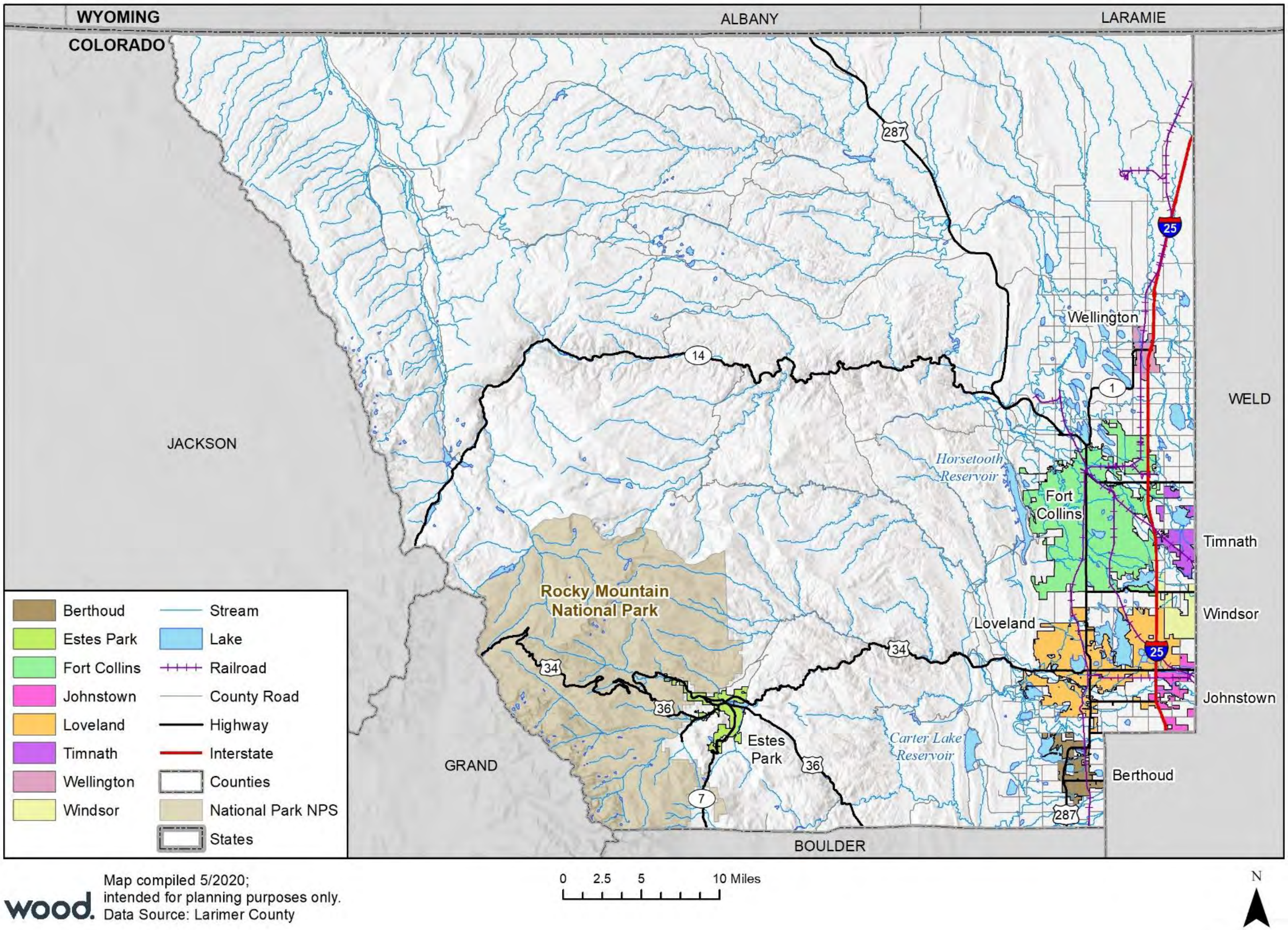
Constitutionally and statutorily independent from one another, their powers and duties are prescribed by state statute. The County Commissioners have no direct authority over the other elected officials in the County except that commissioners approve budgets for all other elected officials' departments.

2.3 Geography

Larimer County is located in north-central Colorado at the border with Wyoming. The County is bordered by Jackson, Grand, Boulder, and Weld Counties and the State of Wyoming to the north. Covering 2,631.75 square miles, it is the 9th largest Colorado County by area.

Larimer County has a rich agricultural history and the county's agricultural lands are rapidly vanishing as the County continues to develop. According to the 2017 Census of Agriculture, there are 2,043 farms in Larimer County covering 482,456 total acres. Although the number of farms in Larimer County rose steadily between 1982 and 2007, the number of acres covered by farms declined. Over the 24 year period, Larimer County saw an overall drop of 16.1% in the total acreage in farmland, compared with an increase of 56% in number of farms. The trend in Larimer County is more pronounced than it is nationally or in the state of Colorado. In Larimer County, this increase in number of farms, followed by a decrease in acreage, is due to larger farms going out of business and being resold as smaller 'ranchettes'.

Figure 2-1 Larimer County



Information on natural resources to include endangered species and areas that provide natural floodplain protections are discussed in Section 4.2.4.

2.4 Cities and Communities

Larimer County contains 9 incorporated and 19 unincorporated communities:

Cities

- Fort Collins
- Loveland

Towns

- Berthoud (partially in Weld County)
- Estes Park
- Johnstown (partially in Weld County)
- Red Feather Lakes
- Timnath
- Wellington
- Windsor (partially in Weld County)

Unincorporated communities and census-designated places

- Bellvue
- Buckeye
- Campion
- Cherokee Park
- Drake
- Glendevey
- Glen Haven
- LaPorte
- Livermore
- Kinikinik
- Masonville
- Norfolk
- Pinewood Springs
- Pingree Park
- Poudre Park
- Red Feather Lakes
- Rustic
- Teds Place
- Waverly

2.5 Transportation Systems

Major Highway corridors through the County include:

- I-25 (runs north-south through near the eastern county line)
- US 287 (runs north-south slightly west of I-25)
- US 34 (runs east-west through the southern County)
- US 36 (runs diagonally through Estes Park and Rocky Mountain National Park)
- CO 7 (runs north-south between Estes Park and Allenspark)
- CO 14 (runs east-west through the center of the County)

The principal railroads that pass through the County are the Burlington Northern Santa Fe (BNSF) and Union Pacific (UP) lines that run north-south in the eastern portion of the County. Great Western Railway also operates two Class 3 rail lines that run from Fort Collins and Loveland east to Greeley.

Northern Colorado Regional Airport in Fort Collins is primarily used for general aviation and tourism flights, scheduled commercial service to the airport having been discontinued in 2012.

2.6 Demographics

As of 2018 the population of Larimer County is estimated at 338,161. This represents a 12% increase since the 2010 Census of 300,637. Roughly 82% of this increase has come from net migration (new residents who moved in minus those who moved out), with 18% coming from natural increase (births - deaths). Larimer County has been the sixth most populated county in Colorado since 2010.

Table 2-1 Shows the County's population broken down by jurisdiction. (For municipalities that cross county lines, the numbers show estimates for the portion of that municipality that fall within Larimer County; see that jurisdiction's annex for complete population data.) Roughly 80% of the County's population lives in one of the incorporated cities or towns, with 20% in unincorporated areas. The City of Fort Collins accounts for 48% of the County's population, followed by the City of Loveland at 22%.

Table 2-1 Larimer County Population By Jurisdiction, 2018

Jurisdiction	Population	% of County
Larimer County	338,161	---
City of Fort Collins	162,511	48%
City of Loveland	75,395	22%
Unincorporated County	66,430	20%
Town of Wellington	8,571	3%
Town of Windsor	7,296	2%
Town of Berthoud	6,518	2%
Town of Estes Park	6,297	2%
Town of Timnath	2,922	1%
Town of Johnstown	2,221	1%

Source: U.S. Census Bureau, American Community Survey

The following tables break down key demographic, economic, and social characteristics based on data from the U.S. Census Bureau.

Table 2-2 Larimer County Demographic and Social Characteristics, 2014-2018

Larimer County	2014	2018	% Change
Population	311,435	338,161	8.58%
Median Age	35.5	35.9	1.1%
Total Housing Units	135,219	145,672	7.7%
Housing Occupancy Rate	90.8%	91.7%	1.0%
% of Housing Units with no Vehicles Available	4.5%	4.1%	-8.9%
Median Home Value	$251,600	$336,200	33.6%
Unemployment Rate	7.5%	5.0%	-33.3%
Mean Travel Time to Work (minutes)	22.6	23.2	2.7%
Median Household Income	$58,844	$67,664	15.0%
Per Capita Income	$31,082	$35,390	13.9%
% of Individuals Below Poverty Level	13.7%	12.0%	-12.4%
% Without Health Insurance	11.0%	6.3%	-42.7%
# of Households	122,743	133,527	8.8%
Average Household Size	2.5	2.5	0.0%
% of Population Over 25 with High School Diploma	95.1%	95.8%	0.7%
% of Population Over 25 with Bachelor's Degree or Higher	44.1%	46.3%	5.0%

Larimer County	2014	2018	% Change
% with Disability	9.4%	9.8%	4.3%
% Speak English less than "Very Well"	2.2%	2.6%	18.2%

Source: U.S. Census Bureau, American Community Survey

Table 2-3 Demographic and Social Characteristics Compared to the State and the Nation

Demographic & Social Characteristics (as of 2018)	County	Colorado	U.S.
Median Age	35.9	36.6	37.9
Housing Occupancy Rate	91.7%	89.8%	87.8%
% of Housing Units with no Vehicles Available	4.1%	5.2%	8.7%
Median Home Value	$336,200	$313,600	$204,900
Unemployment	5.0%	4.7%	5.9%
Mean Travel Time to Work (minutes)	23.2	25.5	26.6
Median Household Income	$67,664	$68,811	$60,293
Per Capita Income	$35,390	$36,415	$32,621
% of Individuals Below Poverty Level	12.0%	10.9%	14.1%
% Without Health Insurance	6.3%	8.1%	9.4%
Average Household Size	2.5	2.6	2.6
% of Population Over 25 with High School Diploma	95.8%	91.4%	87.7%
% of Population Over 25 with bachelor's degree or Higher	46.3%	40.1%	31.5%
% with Disability	9.8%	10.6%	12.6%
% Speak English less than "Very Well"	2.6%	5.9%	8.5%

Source: U.S. Census Bureau, American Community Survey

Table 2-4 Larimer County Demographics by Race and Sex

Larimer County	Population	%
Total Population	338,161	
Male	168,615	49.9%
Female	169,546	50.1%
White, not Hispanic	280,122	82.8%
Hispanic or Latino	38,323	11.3%
Black	3,275	1.0%
Asian	7,505	2.2%
American Indian and Alaska Native	2,322	0.7%
Native Hawaiian and Other Pacific Islander	309	0.1%
Some other race	4,949	1.5%
Two or more races	10,532	3.1%

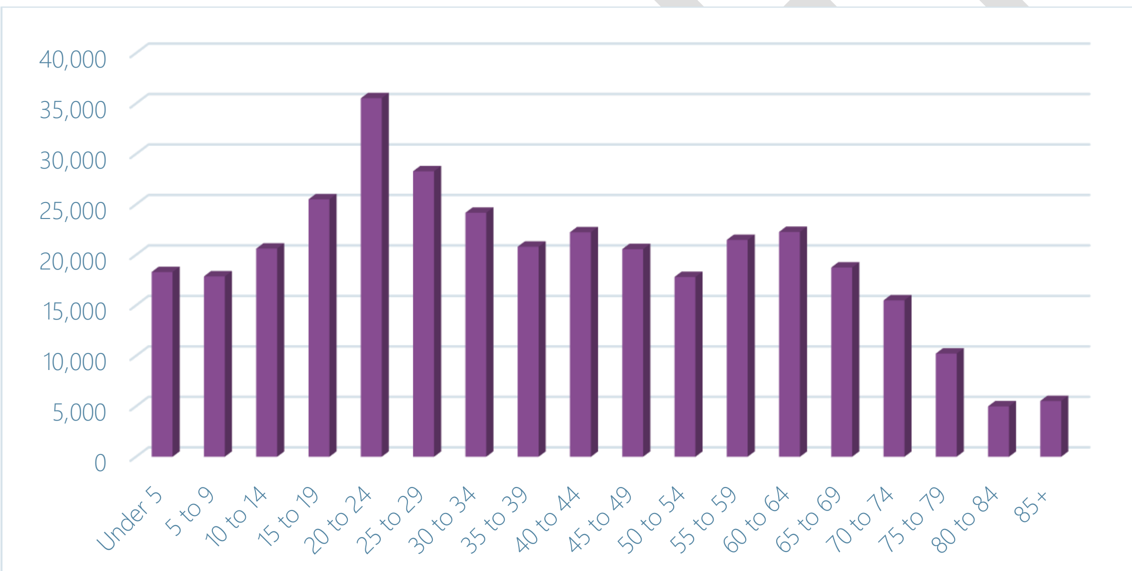
Source: U.S. Census Bureau, American Community Survey

Table 2-5 Types and Total Amounts of Housing Units in Larimer County

Type of housing units	Total	Percentage
Total housing units	145,672	
1-unit detached	96,799	66.4%
1-unit attached	10,208	7.0%
2 units	2,995	2.1%
3 or 4 units	5,716	3.9%
5 to 9 units	7,386	5.1%
10 to 19 units	7,609	5.2%
20 or more units	9,313	6.4%
Mobile home	5,600	3.8%
Boat, RV, van, etc.	46	0.03%

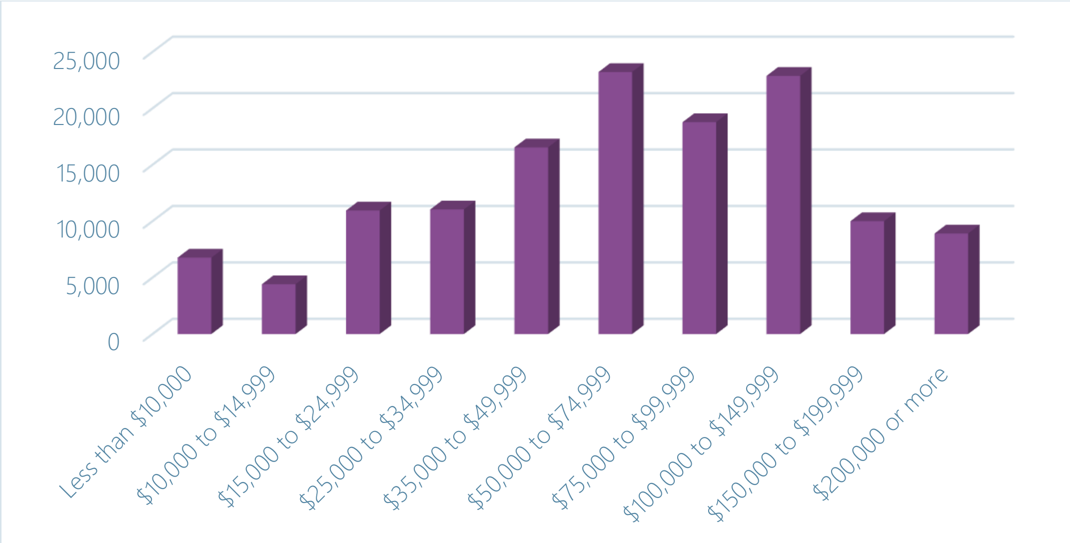
Source: U.S. Census Bureau, American Community Survey

Figure 2-2 Larimer County Demographic Breakdown by Age



Source: U.S. Census Bureau, American Community Survey

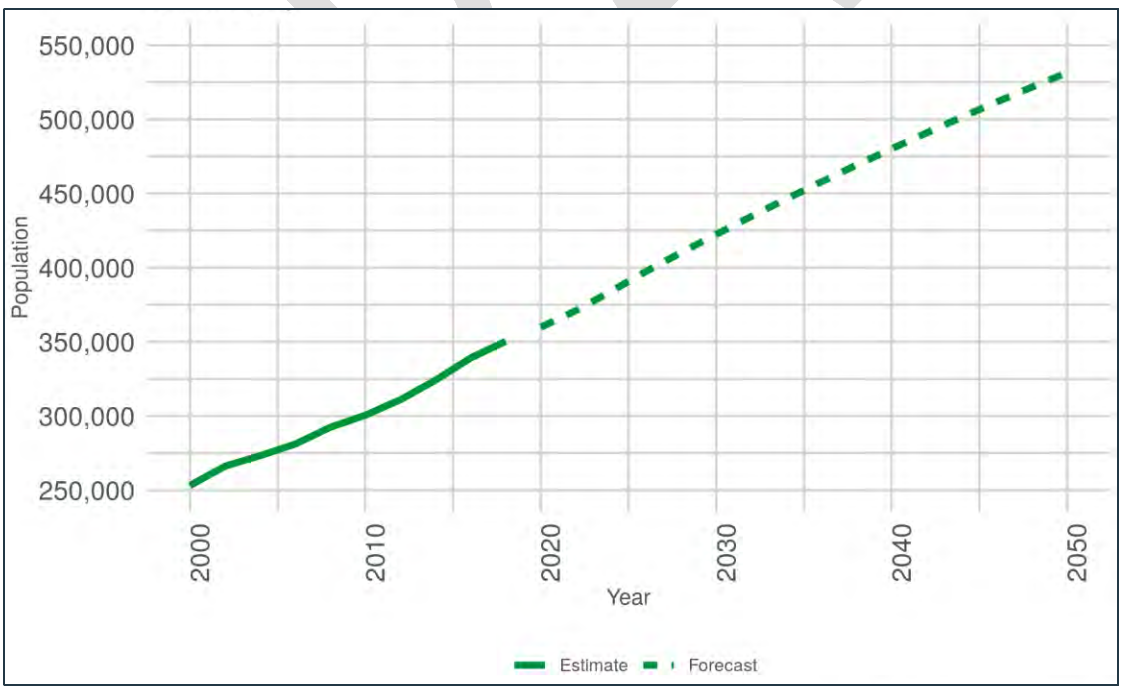
Figure 2-3 Larimer County Demographic Breakdown by Income



Source: U.S. Census Bureau, American Community Survey

The Colorado State Demography Office creates population forecasts for Colorado counties and communities. **Figure 2-4** illustrates their projections for Larimer County's population through 2050 based on "plausible courses of future population change." The population of Larimer County is forecast to reach 480,126 by 2040. Between 2010 and 2020 the County's annual growth rate was 1.8%; this is expected to decrease slightly to 1.6% annually between 2020 and 2030, and 1.3% 2030 and 2040. This decrease is due in part to population aging and changes in the proportion of the population in childbearing ages.

Figure 2-4 Larimer County Projected Population Growth, 2000-2050



Source: State Demography Office

2.7 Social Vulnerability

Local vulnerability to disasters depends on more than the relationship between a place and its exposure to hazards. Social vulnerability to disasters refers to “the characteristics and situation of a person or group that influence their capacity to anticipate, cope with, resist, or recover from the impact of a hazard”. It is determined by a number of pre-existing social and economic characteristics. Very often, the impacts of hazards fall disproportionately on the most underserved or marginalized people in a community – people with low income, children, people who are aging, people with disabilities, and minorities. During emergencies, for example, self-evacuation can be nearly impossible for individuals who are disabled or institutionalized. Additionally, the willingness of an individual/family to invest in residential mitigation actions is often limited if their home is a rental and they are averse to investing money in long-term mitigation activity. Not only do conditions like these limit the ability of some communities to get out of harm’s way, they also decrease the ability of communities to recover from and thrive in the aftermath of a disaster event.

The term vulnerability should be used to describe the communities more vulnerable to a risk or hazard, such as high vulnerability due to wildfires or floods based upon geography, topography, hydrology or weather. Referencing people themselves directly with the term vulnerability causes individual community members to be seen with a deficit lens, leaving the impression that the vulnerability is a result of the lack of responsibility and/or adequate planning of the individual. Instead, vulnerability only occurs when the system that the individual is part of fails to provide equitable accessibility to resources or services, known as access and functional needs, for the individual to survive, respond to, and recover from an event. Barriers that may be exacerbated by certain social and economic factors – including race, age, income, renter status, or institutionalized living – directly affect a community’s ability to prepare for, respond to, and recover from hazards and disasters. The concept of social vulnerability helps explain why communities often experience a hazard event differently, even when they experience the same amount of physical impacts or property loss.

The 2016 Plan integrated social vulnerability into the hazard risk analysis in order to more effectively identify hazard risk experienced by the most vulnerable residents and communities within the County; this analysis has been updated with new data for the 2021 Plan, including lessons learned from the ongoing COVID-19 pandemic. The social vulnerability assessment is designed to improve local decision making, hazard prioritization, and emergency management activities. By incorporating social vulnerability into the risk assessments of individual hazards, local communities are able to identify more vulnerable areas and tailor their mitigation actions to accommodate all members of their community, including the most sensitive groups.

The Center for Disease Control and Prevention (CDC) has developed a social vulnerability index (SoVI) as a way to measure the resilience of communities when confronted by external stresses such as natural or human-caused disasters or disease outbreaks. The SoVI is broken down to the census tract level and provides insight into particularly vulnerable populations to assist emergency planners and public health officials identify communities more likely to require additional support before, during, and after a hazardous event. The SoVI index combines four main themes of vulnerability, which are in turn broken down into subcategories for a total of 15 vulnerability factors. Table 2-6 displays those 15 factors and shows how Larimer County compares to other counties in Colorado and nationally. The rankings show the percentage of counties that Larimer County is more vulnerable than, i.e. – high numbers are worse.

During the risk assessment and mitigation strategy development phases of the 2016 planning process, participating jurisdictions reviewed the results of the social vulnerability analysis in conjunction with the multi-hazard risk assessment results. The social vulnerability information helped communities uncover unseen risks and better prioritize their local mitigation actions.

Table 2-6 Social Vulnerability in Larimer County

Theme	Variable	Ranking Compared to Colorado Counties	Ranking Compared to US Counties	Vulnerability
Socioeconomic status		37%	15%	Low
	Below poverty	49%	32%	Below Average
	Unemployment	59%	42%	Below Average
	Income	27%	8%	Low
	No high school diploma	19%	2%	Low
Household composition and disability		27%	2%	Low
	Age 65 or older	33%	19%	Low
	Age 17 or younger	41%	23%	Low
	Disability	27%	6%	Low
	Single-parent households	62%	19%	Low
Minority status and language		35%	60%	Above Average
	Minority	33%	52%	Above Average
	Speaking English "less than well"	38%	63%	Above Average
Housing and transportation		33%	36%	Below Average
	Multiunit structures	78%	91%	High
	Mobile homes	18%	16%	Low
	Crowding	18%	30%	Below Average
	No vehicle	41%	22%	Low
	Group quarters	73%	64%	Above Average
Overall Social Vulnerability		**35%**	**12%**	**Low**

Source: U.S. CDC https://svi.cdc.gov (using data from U.S. Census Bureau American Community Survey, 2014-2018)

The data shows that Larimer County's social vulnerability is low overall compared to both the State and the Nation. However, the County's vulnerability is high or above average in the following areas:

- Multi-unit housing (defined as more than 10 units per structure), which are more difficult to evacuate during emergencies.
- Institutionalized group quarters (such as college dormitories, farm workers' dormitories, psychiatric institutions, and prisons) which present special concerns during evacuation and are often highly dependent on limited staffing.
- Percentage of racial minorities, who historically are hardest hit by disasters.
- Percentage of people who speak English "less than well," complicating disaster communications.

It should be noted that even tho the County may have relatively fewer people in a SoVI category compared to other counties, those people there are still people in that category who may be disproportionately impacted by disasters.

Figure 2-5 through Figure 2-9 display the SoVI data for Larimer County broken down by census tract. Based on this data, the areas with the highest level of social vulnerability are primarily located along the metro corridor in and around the incorporated municipalities.

Additional information on the CDC's Social Vulnerability Index can be found at https://svi.cdc.gov.

Another social vulnerability not captured in the CDC data is the lack of broadband service in certain areas of the county. According to the 2019 Larimer County Comprehensive Plan 45% of private land in the county are not serviced by broadband technology. Most of these areas are in the Mountain Planning Area (Refer to Section 2.10 for additional information on Planning Areas). The lack of broadband services, or in some cases high speed services, can make it challenging to inform people in these areas of emergency situations or community outreach related to hazards in general.

For a more thorough discussion of ways to minimize the disproportionate impact of disasters on disadvantaged and marginalized communities, to include specific initiatives completed or underway in Larimer County, see the Larimer County Office of Emergency Management Equity and Inclusion Strategic Plan.

Figure 2-5 Larimer County Overall Social Vulnerability

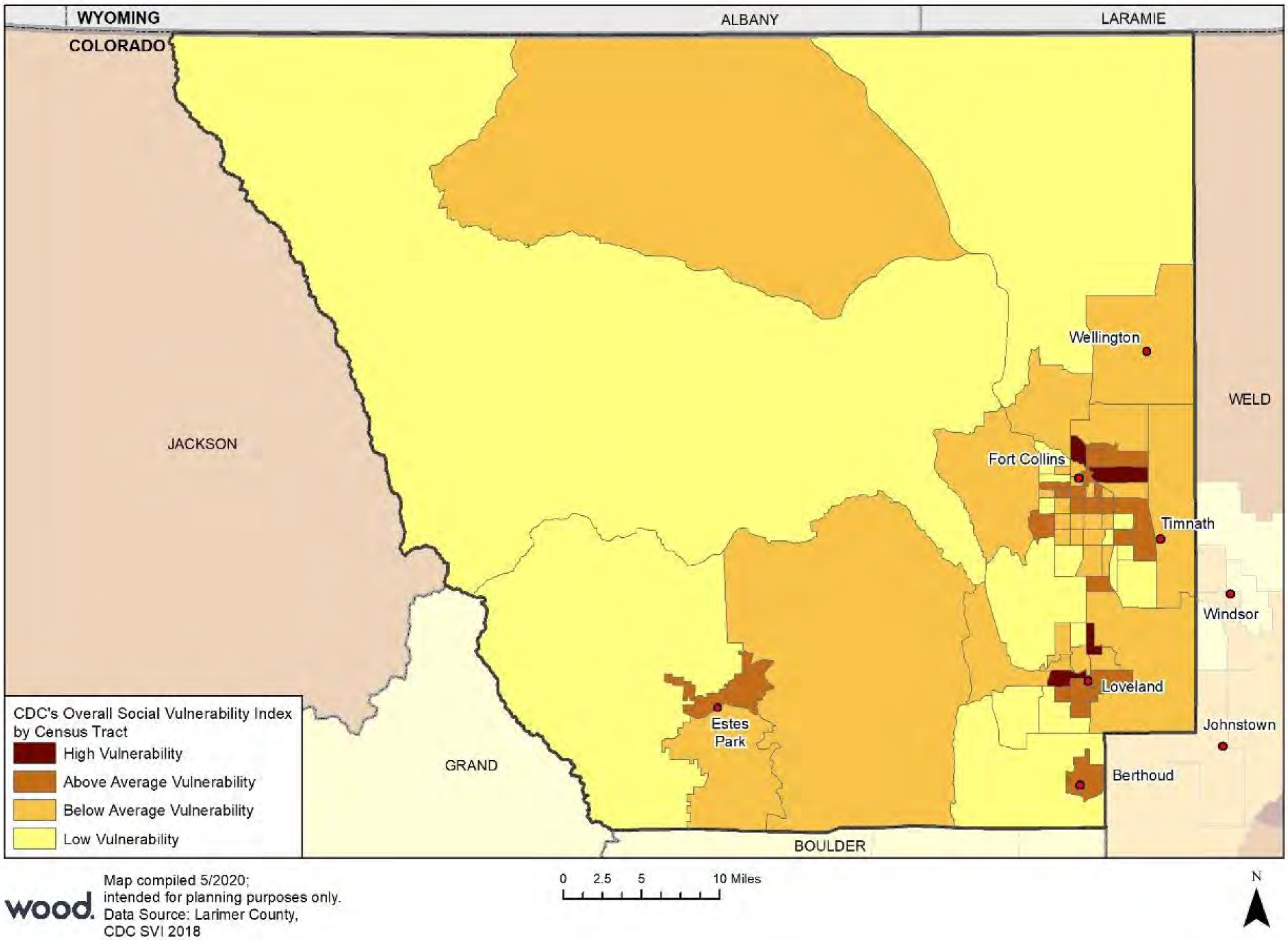


Figure 2-6 Larimer County Socioeconomic Vulnerability

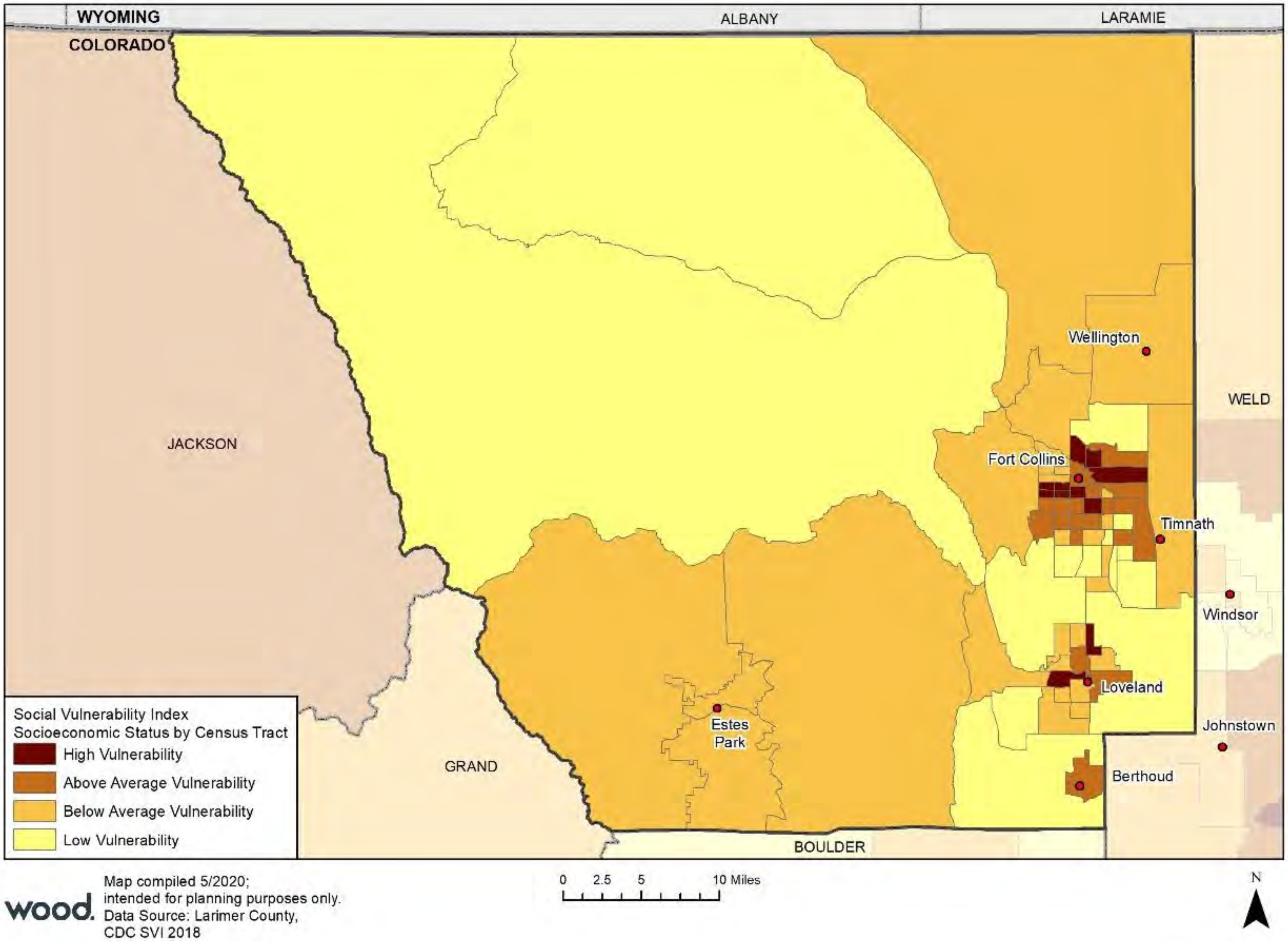


Figure 2-7 Larimer County Household Composition and Disability Vulnerability

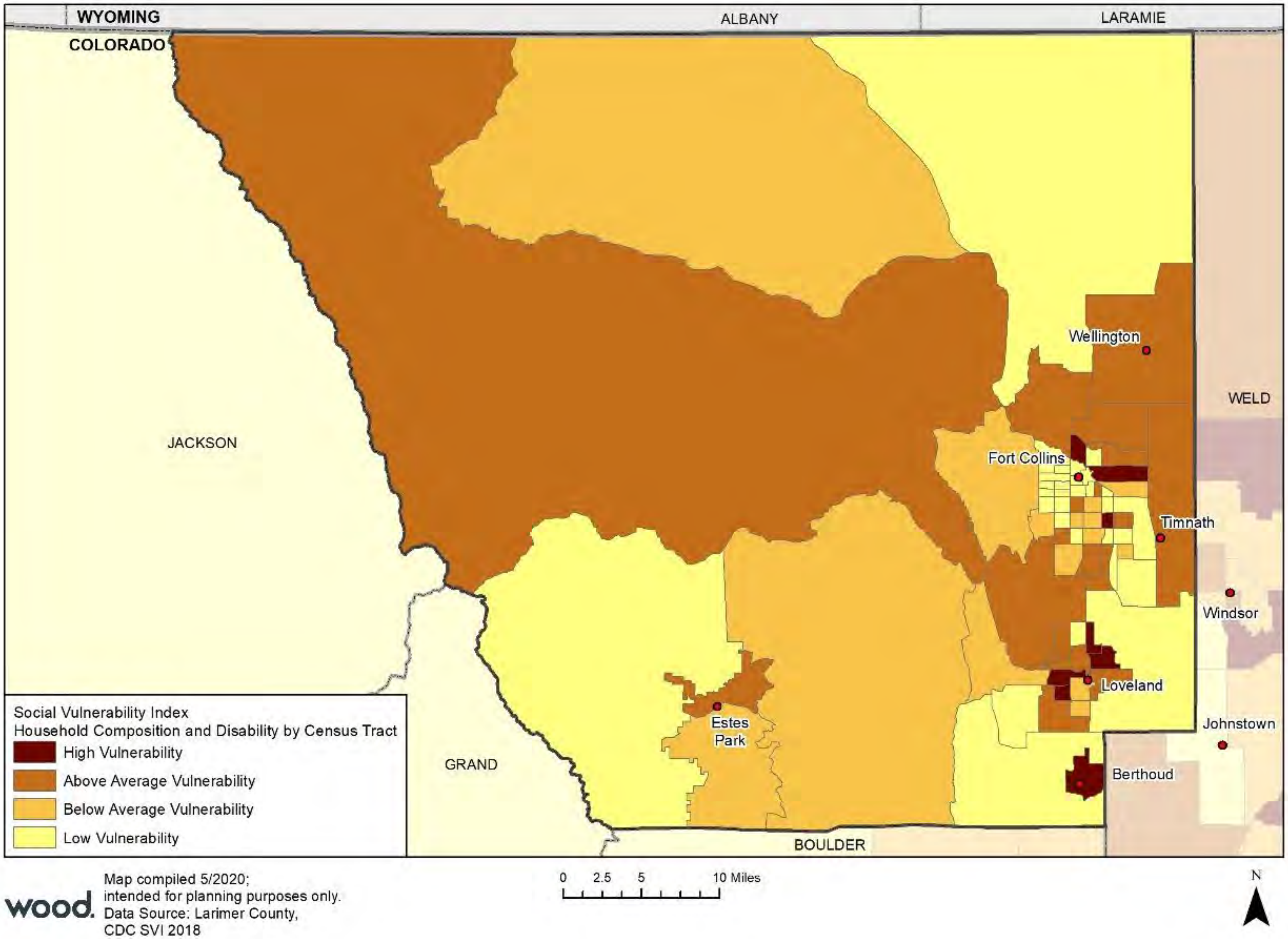


Figure 2-8 Larimer County Minority Status and Language Vulnerability

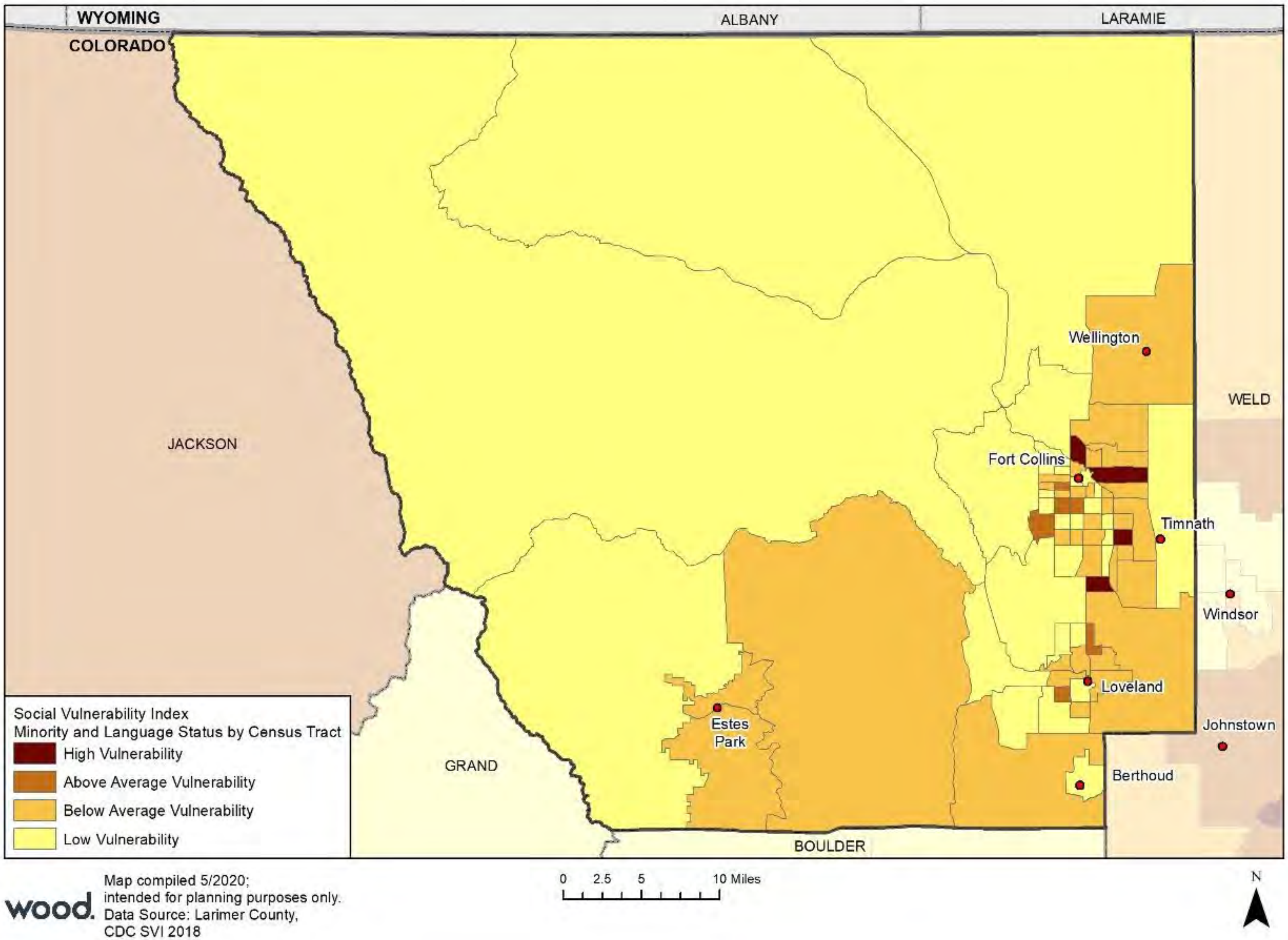
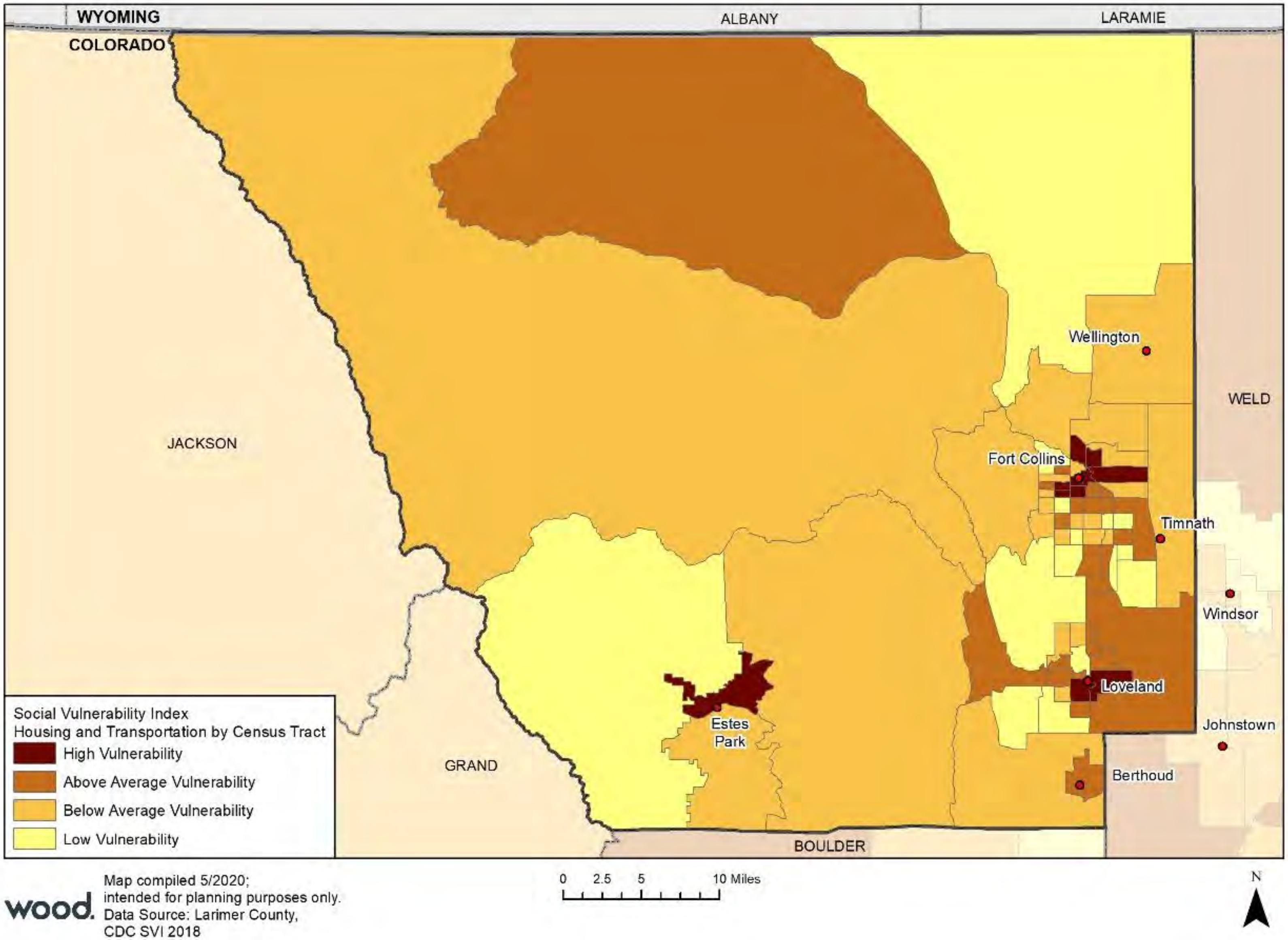


Figure 2-9 Larimer County Housing and Transportation Vulnerability



2.8 Economy

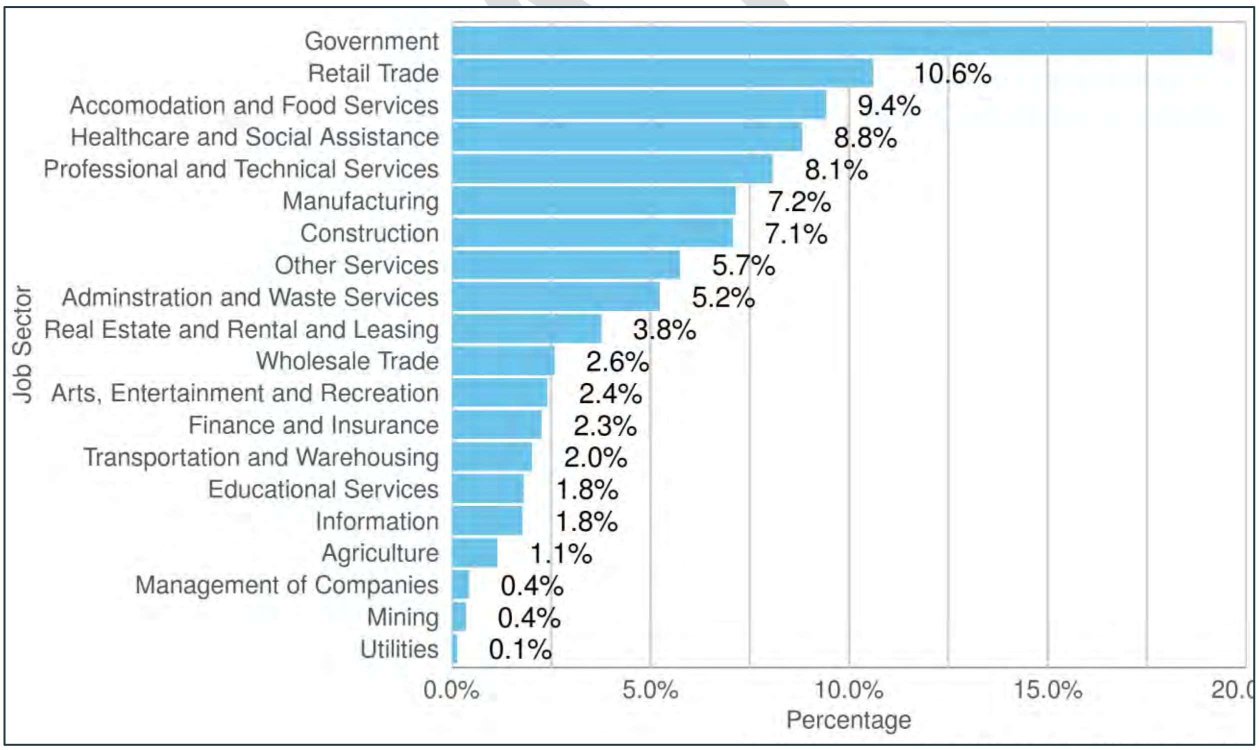
According to data from the U.S. Bureau of Economic Analysis, Larimer County's Gross Domestic Product (GDP) in 2018 was $16,793,330. This constitutes 4.9% of the State's economy and ranks Larimer 8th among Colorado Counties in terms of GDP. The County's GDP has grown by an average of 4.4% annually since 2015, which makes it the 19th fastest growing County economy in Colorado.

Based on data from the U.S. Census Bureau's County Business Patterns (CBP), the following private businesses employ the lion's share of Larimer County residents:

- Poudre Valley Health Systems
- Broadcom
- Banner Health
- Hewlett Packard
- Center Partners
- Woodward, Inc.

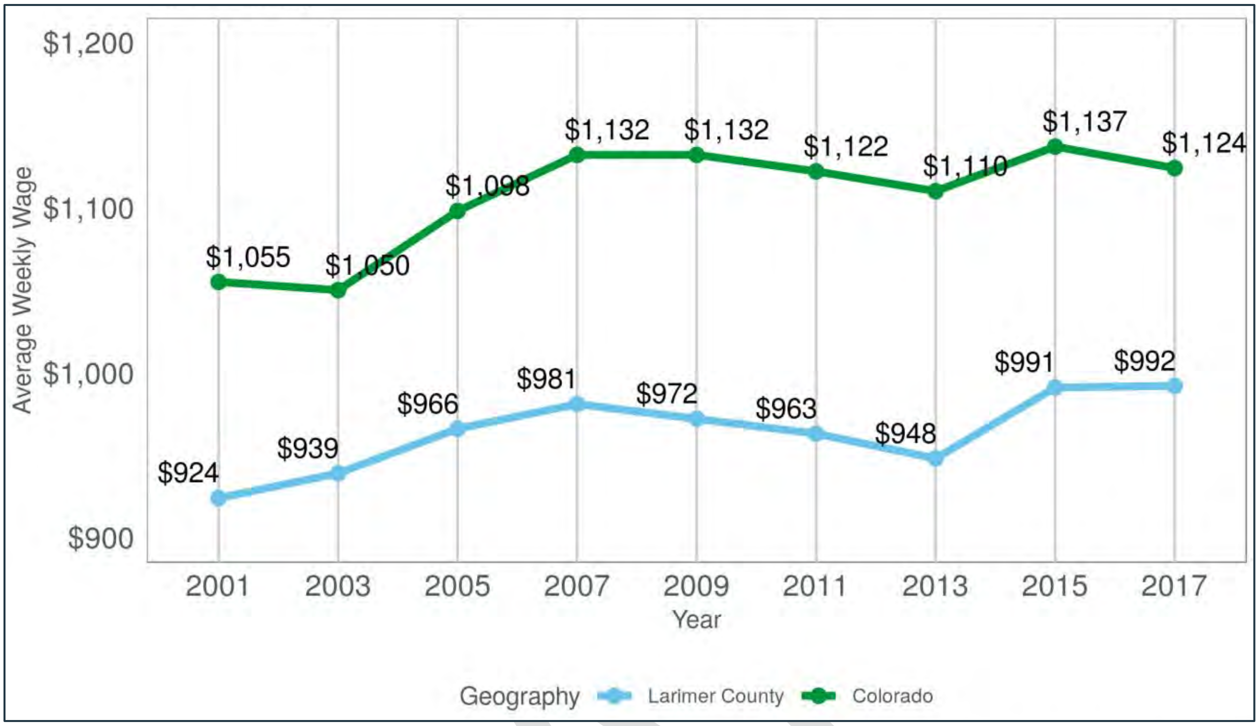
In addition to the private employers listed above, several public employers (Colorado State University, Poudre and Thompson School Districts, Larimer County and the Cities of Fort Collins and Loveland) employ more than 1,500 workers each.

Figure 2-10 Larimer County Share of Jobs by Industry, 2018



Source: State Demography Office

Figure 2-11 Larimer County Average Weekly Wage in Real (2017) Dollars



Source: Colorado Department of Labor and Employment

The U.S. Census Bureau estimates that 60,066 Larimer County residents are employed outside the County. The top 5 counties where they work are Weld, Boulder, Denver, Adams, and Jefferson Counties. Conversely, 52,553 people who live outside of Larimer County are employed in the County. The top 5 counties where those commuters live are Weld, Boulder, Jefferson, Adams, and Arapahoe Counties. As shown in Table 2-3, the average Larimer County commuter has a 23.2 minute commute, slightly below state and national averages.

According to the 2017 Census of Agriculture, there are 2,043 farms in Larimer County covering 482,456 total acres. The market value of agricultural products sold by these farms is estimated at over $150M.

2.9 Community Values, Historic, and Special Considerations

Historic resources include landmarks buildings, historic structures and sites, commercial and residential districts, historic rural resources, archaeological and cultural sites, and the historic environment in which they exist. Historic resources serve as visual reminders of a community's past, providing a link to its development. Preservation of these important resources makes it possible for them to continue to play an integral, vital role in the community. Currently, Larimer County has 107 properties and Historic Districts listed on the National Register of Historic Places, including two National Historic Landmarks. The listing of these assets can be found in Section 4.3.

Depending on the number of historic resources within a community, it can be unrealistic to assume that all of the necessary mitigation activities can be taken to protect these resources. Historic preservation and protection work must be done in a manner that retains the character-defining features of a historic property. Because this work can be costly, it is important to set priorities in terms of which resources and mitigation projects should become the point of focus. Larimer County and its jurisdictions recognize that the preservation and maintenance historic sites and structures contributes to the cultural heritage of the county and is in the long-term best interest of the community.

2.10 Land Use & Development Trends

A key strategy for reducing future losses in a community is to avoid development in known hazard areas while enforcing the development of safe structures in other areas. The purpose of this strategy is to keep people, businesses, and buildings out of harm's way before a hazard event occurs. The 2021 Larimer County Multi-Jurisdictional Hazard Mitigation Plan highlights areas where future development can be expected and areas where mitigation options can be considered in future land use decisions to ensure safe, smart growth in the county.

Larimer County has grown significantly in the past decade and is one of the fastest growing counties in the State. The amount of growth that Larimer County has seen over the past decade has been dictated by the availability of undeveloped land. Based on observed population growth trends, housing demand within Larimer County is expected to remain steady over the next decade.

Land use patterns and cover varies across the county. The Larimer County 2019 Comprehensive Plan divides the county into two planning areas, 'Mountain' and 'Front Range'. The City of Fort Collins and the City of Loveland are both located in the Front Range planning areas, which is comprised of mostly urban and suburban land uses and where most of the housing in the county is located. Most of the current development in the county is taking place in this planning areas along the I-25 corridor. Urban Growth Areas were established around the cities in 1980. The county's policy has been to locate urban development in cities and towns adjacent to these areas. There are 642 vacant residential parcels within platted subdivisions in this planning area. Complete development of these parcels in addition to the parcels greater than 35 acres would result in 1,797 new residents in the Front Range planning area (Larimer County 2019).

The Mountain planning area consists more of low density rural land uses. According to the County's Comprehensive Plan there are 2,200 vacant residential parcels from subdivisions approved in the 1970s and 1980s in the Mountain planning area. In addition, there are 3,300 parcels that are greater than 35 acres, which allows landowners to obtain a building permit without going through a formal planning process as long as access and provided and there is a buildable area. Full development of these vacant areas would result in 13,750 new residents in the Mountain planning area (Larimer County 2019).

Half of the area in the county is considered public lands, under state or federal control. Larimer County only has the ability to directly influence development on 31% of land area in the county. The remaining areas are under ad hoc informal local government channels that limits the County's ability to influence development and actions that occur in these areas. The following table shows the current breakdown of the County's zoning districts. One of the goals with the County's Land Use Code update process in the 2019-2021 is to broaden the county's zoning toolbox by revising these 23 base zone districts.

Table 2-7 Larimer County Zoning District Composition

District Label	District Name	Number of Parcels	Total Gross Acres	% of County-Zoned Land Area
FA	Farming	4,080	24,980	1.54%
FA-1	Farming	5,932	62,071	3.83%
FO	Forestry	498	9,677	0.60%
FO-1	Forestry	54	3,025	0.19%
O	Open	19,565	1,453,798	89.73%
E	Estate	2,765	10,437	0.64%

District Label	District Name	Number of Parcels	Total Gross Acres	% of County-Zoned Land Area
E-1	Estate	2,559	5,218	0.32%
RE	Rural Estate	1,117	12,833	0.79%
RE-1	Rural Estate	382	10,857	0.67%
R	Residential	3,057	2,501	0.15%
R-1	Residential	1,285	10,533	0.65%
R-2	Residential	558	226	0.01%
M	Multiple-Family	470	147	0.01%
M-1	Multiple-Family	2,509	473	0.03%
A	Accommodations	321	2,676	0.17%
T	Tourist	318	1,205	0.07%
B	Business	88	220	0.01%
C	Commercial	760	1,743	0.11%
I	Industrial	477	2,197	0.13%
I-1	Heavy Industrial	58	2,432	0.14%
AP	Airport	499	2,576	0.16%
PD	Planned Development	181	310	0.02%
RFLB	Red Feather Lakes Business	25	40	0.00%
Total		**47,558**	**1,620,175**	**100%**

Source: Clarion Associates, Larimer County Land Use Code 2020 Assessment and Annotated Outline, November 2019

3 PLANNING PROCESS

DMA Requirements §201.6(b) and §201.6(c)(1):
An open public involvement process is essential to the development of an effective plan. In order to develop a more comprehensive approach to reducing the effects of natural disasters, the planning process shall include: *An opportunity for the public to comment on the plan during the drafting stage and prior to plan approval;* *An opportunity for neighboring communities, local and regional agencies involved in hazard mitigation activities, and agencies that have the authority to regulate development, as well as businesses, academia, and other private and non-profit interests to be involved in the planning process; and* *Review and incorporation, if appropriate, of existing plans, studies, reports, and technical information.* *[The plan shall document] the planning process used to develop the plan, including how it was prepared, who was involved in the process, and how the public was involved.*

This section of the Plan describes the mitigation planning process undertaken by Larimer County and participating jurisdictions in the preparation of this Multi-Jurisdictional Hazard Mitigation Plan. This chapter consists of the following subsections:

- Background
- What's New in the 2021 Plan Update
- Local Government Participation
- The 2021 Planning Process

3.1 Background

Recognizing the importance of hazard mitigation planning, Larimer County, the City of Fort Collins, and the City of Loveland adopted the first Northern Colorado Regional Hazard Mitigation Plan (NCRHMP) in 2005. An updated NCRHMP was adopted in 2010 by those jurisdictions, in addition to the Towns of Berthoud, Estes Park, and Wellington. The 2016 Larimer County Multi-Jurisdictional Hazard Mitigation Plan expanded on the NCRHMP and included all incorporated jurisdictions in the County as well as special districts. A key focus of the 2016 Plan was the integration of hazard mitigation with ongoing land use and community development activities.

The multi-jurisdictional Hazard Mitigation Plan (HMP) underwent a comprehensive update in 2021. The planning process followed during the update was similar to what was used in the original plan development. This planning process utilized the input from a multi-jurisdictional Planning Team. The County received Hazard Mitigation Assistance grant funding from DHSEM and FEMA to procure consultant assistance during the 2021 update, and a consultant, Wood Environment & Infrastructure Solutions, Inc (Wood) was procured to assist with the update. The plan update process is described further in this section and documented in Appendix B.

It is worth noting that this update was conducted during the middle of the COVID-19 pandemic and while the largest wildfire in Colorado's history, the Cameron Peak Fire, was burning in Larimer County. The fact that the participating jurisdictions remained committed to and engaged in the update process even in the midst of these major disasters is a testament to how seriously the community takes mitigation planning.

This 2021 Plan is the result of continuing work by the citizens of the county to update a multi-jurisdictional pre-disaster multi-hazard mitigation plan that will not only continue to guide the county towards greater disaster resistance but will also respect the character and needs of the community.

3.2 What's New in the 2021 Plan Update

DMA Requirements §201.6(d)(3):
A local jurisdiction must review and revise its plan to reflect changes in development, progress in local mitigation efforts, and changes in priorities, and resubmit it for approval within 5 years in order to continue to be eligible for mitigation project grant funding.

The 2021 HMP complies with all Federal Emergency Management Agency (FEMA) guidance for local hazard mitigation plans. The update followed the requirements noted in the Disaster Mitigation Act (DMA) of 2000 and FEMA's 2013 Local Hazard Mitigation Planning Handbook.

This multi-jurisdictional, multi-hazard mitigation plan update involved a comprehensive review and update of each section of the 2016 plan and includes an assessment of Larimer County's success in evaluating, monitoring, and implementing the mitigation strategy outlined in the previous plan. The process followed to review and revise the chapters of the plan during the 2021 update is detailed in Table 3-1. All sections of the plan were reviewed and updated to reflect new data and methodologies on hazards and risk, risk analysis processes, capabilities, participating jurisdictions and stakeholders, and mitigation strategies. The plan was also revised to reflect changes in development, including using the latest version of the assessor's office data as the basis for identifying overall and hazard exposure for developed parcels by County and jurisdiction. Only the information and data still valid from the 2016 plan was carried forward as applicable to this plan update.

Table 3-1 2021 Plan Update Summary of Changes by Chapter

2016 Plan Section	Update Review and Analysis	2021 Plan Section
1 Certification of Annual Plan Review Meetings	Moved into separate section. Updated with information on past meetings. Updated for future years.	Certification of Annual Plan Review Meetings, Record of Changes, Executive Summary
2 Executive Summary	Moved into Section 1. Updated Executive Summary to reflect updated plan. Moved Background, Purpose and Scope into Planning Process Section.	1 Introduction
3 Planning Process	Described and documented the planning process for the 2021 update, including coordination among agencies and integration with other planning efforts. Updated summary of changes. Described any changes in jurisdictional priorities Described changes in participation. Described 2021 public participation process	3 Planning Process
4 County Profile	Moved to new Section 2. Updated demographic, social & economic data, including the results of any recent annexations or new development.	2 Community Profile
5 Risk Assessment	Moved into Section 4. Added new hazards: Dam Failure/Incident and Drought Reviewed hazards from current Colorado State Hazard Mitigation Plan for consistency.	4 Risk Assessment

2016 Plan Section	Update Review and Analysis	2021 Plan Section
	Updated list of disaster declarations, hazards data, and past occurrences to include 2016-2020 data. Incorporated new hazard studies since 2016 and wildfire risk mapping. Added potential consequences of climate change within each hazard profile Updated critical facilities data from the 2016 plan Updated development and land use trends Used 2020 Assessor's data to update current property values. Estimated flood losses using the latest flood hazard mapping and building counts and values. Updated NFIP data and Repetitive Loss structure data from the previous plan. Incorporated new hazard loss estimates since 2016, as applicable. Conducted a Hazus-MH Level I earthquake vulnerability analysis. Updated information regarding specific vulnerabilities to hazards, including maps and tables of specific assets at risk, specific critical facilities at risk, and specific populations at risk Updated maps where appropriate.	
5 Capability Assessment	Previously within Risk Assessment. Moved to new section 5. Updated capability assessment with information provided in Data Collection Guides Reviewed mitigation capabilities and updated to reflect current capabilities. Indicated projects that have been implemented that may reduce previously identified vulnerabilities. Described how 2016 plan was integrated into other plans and programs.	5 Capability Assessment
6 Mitigation Strategy	Updated based on the results of the updated risk assessment, completed mitigation actions, and implementation obstacles and opportunities over the last five years. Reviewed goals and objectives to determine if they are still representative of the County's mitigation strategy. If necessary, form new goals and objectives or revise existing ones. Reviewed mitigation actions from the 2016 plan and develop a status report for each; identify if action has been completed, deleted, or deferred. Added a section on Progress Made Since 2016 HMP Identified and detailed new mitigation actions not captured in the previous plan. Identified projects that have been submitted for funding and those that will be likely candidates for this funding Created consolidated mitigation actions table Moved mitigation action worksheets to an appendix	6 Mitigation Strategy

2016 Plan Section	Update Review and Analysis	2021 Plan Section
7 Plan Implementation and Maintenance	Reviewed and updated procedures for monitoring, evaluating, and updating the plan. Revised to reflect current methods. Revised to note opportunities for integration in future planning efforts. Updated the system for monitoring progress of mitigation activities by identifying additional criteria for plan monitoring and maintenance.	7 Plan Implementation and Maintenance
Community Profiles	Formerly in Appendix B, broken out as Annexes.	Annexes A through U.
Appendices	Appendix A: Meeting Minutes & Sign-In Sheets Appendix B: Community Profiles (see above) Appendix C: Local Jurisdiction Mitigation Outreach Appendix D: Additional Fort Collins CRS Documentation Appendix E: Update on Mitigation Actions from the 2010 Northern Colorado Regional Hazard Mitigation Plan Appendix F: FEMA Approval Documents & Jurisdictional Adoptions	Appendix A: Planning Team Appendix B: Planning Process Appendix C: Adoption Resolution Appendix D: Mitigation Action Worksheets Appendix E: References

3.3 Local Government Participation

DMA Requirements §201.6(a)(3):
Multi-jurisdictional plans may be accepted, as appropriate, as long as each jurisdiction has participated in the process and has officially adopted the plan.

Larimer County invited every incorporated city, town, and special district in the County to participate in the 2021 Plan update. The following jurisdictions met all the participation requirements described below:

County

- Larimer County

Municipalities

- Town of Berthoud
- Town of Estes Park
- City of Fort Collins
- Town of Johnstown
- City of Loveland
- Town of Timnath
- Town of Wellington
- Town of Windsor

Special Districts

- Berthoud Fire Protection District
- Crystal Lake Fire Protection District
- Estes Park Health
- Estes Valley Fire Protection District
- Estes Valley Recreation and Parks District
- Glacier View Fire Protection District
- Livermore Fire Protection District
- Loveland Fire Rescue Authority
- Northern Water Conservancy District
- Pinewood Springs Fire Protection District
- Poudre Canyon Fire Protection District
- Poudre Fire Authority
- Thomas Valley EMS District
- Upper Thompson Sanitation District
- Wellington Fire Protection District
- Windsor Severance Fire Protection District

The only change in participation from the 2016 Plan was that Colorado State University and the Platte River Power Authority declined to participate in this update.

The Disaster Mitigation Act requires that each jurisdiction participate in the planning process and officially adopt the multi-jurisdictional plan in order to be eligible for FEMA Hazard Mitigation Assistance grants. The jurisdictions that chose to participate in the planning process were required to meet strict plan participation requirements defined at the beginning of the process, which included the following:

- Designating a representative to serve on the Planning Team
- Participating in Planning Team meetings
- Completing and returning updates on Mitigation Actions since 2016
- Identifying new mitigation actions for the plan
- Reviewing and commenting on plan drafts
- Informing the public, local officials, and other interested parties about the planning process and providing opportunity for them to comment on the plan
- Formally adopting the mitigation plan and re-adopting every 5 years

Appendix A shows the attendance of representatives at each Planning Team meeting, including the titles of individuals involved; sign-in sheets are included in Appendix B Planning Process Documentation.

3.4 The 2021 Planning Process

The Larimer County Office of Emergency Management worked with the consultant team to establish the framework and process for this planning effort using FEMA's Local Multi-Hazard Mitigation Planning Guidance (2013). The guidance and this plan are structured around FEMA's original four-phase process:

1) Organize resources
2) Assess risks
3) Develop the mitigation plan
4) Implement the plan and monitor progress

Into this four-phase process, Wood integrated the 10-step planning process used for FEMA's Community Rating System (CRS) and Flood Mitigation Assistance programs. Thus, the modified 10-step process used for this plan meets the funding eligibility requirements of the Hazard Mitigation Assistance grants (including Hazard Mitigation Grant Program, Building Resilient Infrastructure and Communities grant, High Hazard Potential Dams grant, and Flood Mitigation Assistance grant), Community Rating System, and the flood control projects authorized by the U.S. Army Corps of Engineers (USACE). Table 3-2 shows how the process followed meets all the requirements for those programs.

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

FEMA's 4-Phase DMA Process	Modified 10-Step CRS Process
1) Organize Resources	
201.6(c)(1)	1) Organize the Planning Effort
201.6(b)(1)	2) Involve the Public
201.6(b)(2) and (3)	3) Coordinate with Other Departments and Agencies
2) Assess Risks	
201.6(c)(2)(i)	4) Identify the Hazards
201.6(c)(2)(ii)	5) Assess the Risks
3) Develop the Mitigation Plan	

FEMA's 4-Phase DMA Process	Modified 10-Step CRS Process
201.6(c)(3)(i)	6) Set Goals
201.6(c)(3)(ii)	7) Review Possible Activities
201.6(c)(3)(iii)	8) Draft an Action Plan
4) Implement the Plan and Monitor Progress	
201.6(c)(5)	9) Adopt the Plan
201.6(c)(4)	10) Implement, Evaluate, and Revise the Plan

3.4.1 Phase 1 Organize Resources

Step 1: Organize the Planning Effort

This section describes the planning process used during the 2021 update. The previous planning processes for the 2010 and 2016 planning efforts is well documented and can be referenced in those plans. The Larimer County Emergency Management Coordinator took the lead on coordinating and reconvening the Planning Team and identifying the key county, municipal, and other local government and initial stakeholder representatives. Representatives from all jurisdictions listed in Section 3.3 above participated on the Planning Team and the update of the plan.

The Larimer County Office of Emergency Management emailed letters of invitation to each meeting to county, municipal, district, state, and other stakeholder representatives. This list is included in Appendix B. Stakeholder participation was significant during the 2021 update; stakeholders are listed in subsection Step 3: Coordinate with Other Departments and Agencies.

Two distinct but related groups were formed to direct and inform the update of this plan. The Disaster Mitigation Act requires that each jurisdiction participate in the planning process and officially adopt the multi-jurisdictional hazard mitigation plan. An All Hazards Planning Team was created that includes representatives from each participating jurisdiction, departments of the County, and other local, state, and federal organizations responsible for making decisions in the plan and agreeing upon the final contents. Kickoff meeting attendees discussed potential participants and made decisions about additional stakeholders to invite to participate on the Planning Team. The Planning Team contributed to this planning process by:

- Providing facilities for meetings,
- Attending meetings,
- Collecting data,
- Managing administrative details,
- Making decisions on plan process and content,
- Submitting mitigation action implementation worksheets,
- Reviewing and editing drafts, and
- Coordinating and assisting with public involvement and plan adoptions.

Within the All Hazards Planning Team, a Floodplain Management Steering Committee (FMSC) was formed to lead the floodplain management planning effort. The FMSC was composed of staff from those community departments that implement or have expertise in floodplain mitigation activities including land use and comprehensive planning, and also included members of the public and other stakeholders. All jurisdictions participating in the Community Rating System (CRS) were represented on the FMSC. All decisions pertaining to floodplain management efforts and CRS activities were made by the FMSC, with information and advice being provided by the rest of the All Hazards Planning Team and other stakeholders. All FMSC members were also members of the All Hazards Planning Team, and participated in all Planning Team meetings. The FMSC contributed to the floodplain management planning process by:

- Providing facilities for meetings,
- Attending meetings,
- Collecting data,
- Managing administrative details,
- Making decisions on plan process and content,
- Submitting mitigation action implementation worksheets,
- Reviewing and editing drafts, and
- Coordinating and assisting with public involvement and plan adoptions.

Membership and attendance of the All Hazards Planning Team and the Floodplain Management Steering Committee are listed in Appendix A. Appendix A also shows the areas of mitigation expertise of County and jurisdictional representatives participating on the FMSC, as well as additional external stakeholders contacted or coordinated with during the update process.

During the plan update process, the Planning Team and FMSC communicated with a combination of online webinars, phone interviews, and email correspondence. Four planning meetings with the Planning Team and FMSC were held during the plan's development between April 2020 and July 2020. The meeting schedule and topics are listed in the following table; all 10 planning process steps were covered in these four meetings. All meetings were held virtually as webinars due to social distancing requirements associated with the ongoing COVID-19 pandemic. The sign-in sheets and agendas for each of the meetings are included in Appendix B.

Table 3-3 Summary of Meetings

Planning Meetings	Meeting Topic	CRS Steps	Meeting Date
1 – Kickoff	1. Introduction to DMA, CRS and the planning process. 2. Organize resources: the role of the planning team, planning for public involvement, and coordinating with other agencies and stakeholders.	1, 2, 3	April 10, 2020
2 – Floodplain Management	1. Overview of the CRS floodplain management planning process. 2. Organize resources: the role of the FMSC 3. Review of CRS activities in 2016 Plan	1, 2, 3	April 10, 2020
3 – Risks and Goals	1. Review online survey and other public involvement strategies. 2. Review/discussion of Risk Assessment (Assess the Hazard) 3. Review/discussion of Vulnerability Assessment (Assess the Problem) 4. Review Capability Assessment 5. Discuss/update mitigation goals 6. Solicit comments and feedback from the Planning Team	2, 4, 5, 6	May 15, 2020
4 – Mitigation Strategy	1. Review/discussion of Risk and Vulnerability Assessment 2. Discuss/develop mitigation strategies 3. Review Draft Plan 4. Update maintenance and implementation procedures 5. Solicit comments and feedback from the Planning Team	7, 8, 9, 10	July 14, 2020

Planning Meeting #1 – Kickoff Meeting

During the kickoff meeting, Wood presented information on the scope and purpose of the plan update, participation requirements of Planning Team members, and the proposed project work plan and schedule. Plans for public involvement (Step 2) and coordination with other agencies and departments (Step 3) were discussed. Wood also introduced the hazard identification requirements and data. The Planning Team discussed past events and impacts and future probability for each of the hazards required by FEMA for consideration in a local hazard mitigation plan. Each jurisdiction provided updates through a data collection workbook created by Wood and mitigation action trackers or provided information directly to Wood for incorporation into the plan update.

Planning Meeting #2 — Floodplain Management

Following the kickoff meeting, the Floodplain Management Steering Committee (FMSC) met separately to discuss the floodplain management planning portions of the HMP update. Thirteen FMSC members participated in the discussion. Wood gave an overview of Community Rating System (CRS) planning credits and how they fit into the multi-hazard mitigation plan update. Roles and responsibilities of the FMSC were discussed, along with how the FMSC will direct the floodplain management planning process.

Planning Meeting #3 — Risk Assessment Update

On May 15, 2020, the Planning Team convened virtually to review and discuss the results of the risk and vulnerability assessment update. Fifty-three members of the Planning Team and stakeholders were present for the discussion. Wood presented preliminary risk assessment results for natural and human-caused hazards. The group went through each hazard together and discussed the results as well as shared any local insight to inform the HIRA update. The Planning Team made two additions to the hazards list from the 2016 plan, to include Dam Failure/Incidents and Drought. A survey was developed by Wood and shared with the Planning Team after the meeting, that asked the members to rank each hazard for the county as a whole and asked if any additional hazards should be considered. The survey also asked the Planning Team to review the 2016 mitigation goals and objectives and determine if they were still valid, comprehensive, and reflect current priorities and updated risk assessments. Revisions to the goals can be found in Chapter 6 Mitigation Strategy. Refer to the meeting summary in Appendix B for notes related to each hazard discussed and results from the post meeting survey.

Planning Meeting #4 — Mitigation Strategy

The Planning Team convened virtually on July 14, 2020 with forty-five people [participating to discuss goals and objectives for this planning process. The group discussed the criteria for mitigation action selection and prioritization using a worksheet provided by Wood (refer to Appendix B). The group reviewed each possible new mitigation action and additional details were provided by the Planning Team. The meeting ended with a review of the next steps and planning process schedule. Wood provided the Planning Team with a link to an online form to submit new mitigation actions. During the Planning Team review of the full plan, each member was provided a handout on prioritizing new mitigation actions and asked to focus on prioritizing each new mitigation action in their jurisdictional annex.

Step 2: Involve the Public

DMA Requirements §201.6(b):
An open public involvement process is essential to the development of an effective plan. In order to develop a more comprehensive approach to reducing the effects of natural disasters, the planning process shall include: (1) An opportunity for the public to comment on the plan during the drafting stage and prior to plan approval.

Larimer County and its participating jurisdictions were active in involving the public throughout the update process. The fact that the process was conducted during the COVID-19 pandemic, with attendant restrictions on public gatherings, made it difficult to use many traditional outreach methods such as in person public gatherings or discussion at other forums. The Planning Team adapted by leveraging virtual meetings and other online messaging, which in many cases resulted in greater public attendance and involvement than more traditional face-to-face meetings. These outreach efforts are summarized in Table 3-4 and discussed below.

Table 3-4 Summary of Public Outreach and Involvement Efforts

Event/Effort	Message	Dates	Methods Advertised
Online Public Survey	Personal experience with hazard events; public perception of hazard significance; what mitigation measures should be pursued.	May 18 to July 14, 2020	Flyer, website posting, Facebook, Twitter
Public Workshop #1 (virtual)	Overview of mitigation planning and plan update process; introduction to hazards and risk assessment; mitigation goals and objectives.	May 28, 2020	Flyer, website posting, Facebook, Twitter, YouTube
Public Workshop #2 (virtual)	Overview of draft plan; solicitation of feedback.	October 13, 2020	Flyer website posting, Facebook, Twitter, YouTube
Public Review Draft	Public review and comment on the draft plan.	February 1-22, 2021	Flyer, website posting, Facebook
Virtual Public Room	Virtual room for the public to educate the public on mitigation planning and the 2021 plan update, as well as providing opportunities to review and comment on the draft plan.	February 1-22, 2021	Flyer, website posting, Facebook
Hazard Mitigation Flyer	Public information flyer created and disseminated by multiple means.	May 2020	Email, website posting, Facebook, Twitter
YouTube.com	Videos of public workshops posted.	Ongoing	NA
Website notices	Notices of process, survey, public workshops, and public review draft posted at Larimer.org.	May – December 2020	NA
Facebook posts	Updates on process, survey, public workshops, and public review draft posted on County Facebook page.	May – December 2020	NA
Twitter posts	Updates on process, survey, public workshops, and public review draft posted on County Twitter account.	May – December 2020	NA

At the kickoff meeting, the Planning Team discussed options for soliciting public input on the mitigation plan and developed an outreach strategy by consensus. An online public survey was developed by Wood and shared with the Planning Team to share through their respective public information channels. A link to the survey was also posted on some of the participating jurisdictions' websites as well as through social media posts; screenshots from both can be found in Appendix B.

Figure 3-1 below is the flyer the County Planning Team used to advertise the first public workshop on May 28, 2020.

Figure 3-1 Larimer County's Flyer for Public Workshop #1 May 28, 2020

Online Public Survey

During the plan update's initial drafting stage, an online public survey was used to gather public input to the Planning Team. The survey provided an opportunity for public input during the planning process, prior to finalization of the plan update. The survey gathered public feedback on concerns about hazards and input on mitigation strategies to reduce their impacts. The survey was released on May 18, 2020 and closed on July 14, 2020. The Planning Team provided links to the public survey by distributing it using social media, email, and posting the link on websites. One hundred and thirty-eight people filled out the survey online. Results showed that the public perceives the most significant hazards to be wildfire, spring/summer storm, winter storm and flood. Question 4 of the survey asked the public's opinion on what mitigation actions that should have the highest priority in the updated hazard mitigation plan; wildfire fuels treatment projects improve reliability of communication systems, forest health/watershed protection, continued participation in the National Flood Insurance Program, and public education and awareness were cited as the most popular mitigation actions. This information was shared with the Planning Team during the update of the mitigation strategy to consider when evaluating hazard rankings and as a source of potential mitigation ideas. A summary of all the survey data and documentation of the public feedback can be found in Appendix B.

Public Workshops

Two online public workshops were held during the planning process to inform the public, receive input to integrate into the plan update, and keep the public updated on the progress being made in the planning process. Both workshops were held virtually as webinars due to social distancing requirements associated with the ongoing COVID-19 pandemic.

The first workshop was held on May 28, 2020 through Zoom. The workshop introduced the public to the hazard mitigation planning process for the County's Plan Update and answered any questions and gather public input to be integrated into the plan update. In addition, it was an opportunity to help staff identify risks, hazards and vulnerabilities from the public's perspective. In total eighteen individuals participated in the virtual workshop. Members of the public were able to submit comments verbally or via the chat function. The Planning Team received four comments from the meeting that helped to inform the Planning Team on the public initial thoughts on hazard mitigation and hazards in their community. A recording of the meeting was subsequently posted on Larimer County's YouTube channel, where it has been viewed an additional 51 times as of March 1, 2021.

The second virtual public workshop was held on October 13, 2020 via Zoom. Eight individuals participated in the workshop. This workshop gave an update on the planning process, reviewed the results of the public survey, and introduced the draft plan and key components. Participants were invited to comment on the public review draft (see below). A recording of the meeting was subsequently posted on Larimer County's YouTube channel, where it has been viewed an additional 19 times as of March 1, 2021.

Public Review Period

The public was also given an opportunity to provide input on a draft of the complete plan prior to its submittal to the State and FEMA. Larimer County provided the plan draft for review and comment on the County website from February 1-28, 2021. (Due to the ongoing COVID-19 pandemic at that time, hard copy plans were not made available for comment.) The jurisdictions announced the availability of the draft plan and the public comment period through social and traditional media announcements. Copies of these notices is provided in Appendix B. An online form to collect comments was posted with the plan, and is also included in Appendix B. The Planning Team received 16 comments from the public that helped to inform the Planning Team on the public's perception of hazard mitigation and hazards in their community. A section on low head dams was added to the Dam Inundation section based on public and stakeholder comments.

Step 3: Coordinate with Other Departments and Agencies

DMA Requirements §201.6(b):
[T]he planning process shall include: (2) An opportunity for neighboring communities, local and regional agencies involved in hazard mitigation activities, and agencies that have the authority to regulate development, as well as businesses, academia and other private and non-profit interests to be involved in the planning process. (3) Review and incorporation, if appropriate, of existing plans, studies, reports, and technical information.

There are numerous organizations whose goals and interests interface with hazard mitigation in Larimer County. Coordination with these organizations and other community planning efforts is vital to the success of this plan update. The Larimer County Office of Emergency Management invited other local, state, and federal agencies to the kickoff meeting to learn about and participate in the hazard mitigation planning initiative. Many of the agencies participated throughout the planning process in meetings described in Step 1: Organize the Planning Effort. In addition, the Planning Team developed a list of neighboring communities and local and regional agencies involved in hazard mitigation activities, as well as other interested parties to keep informed on the plan update process.

Stakeholders included local and regional agencies involved in hazard mitigation activities and those with the authority to regulate development. The neighboring jurisdictions of Boulder, Weld, Jackson, and

Grand Counties were also invited to participate, either by attending meetings or reviewing draft documents. Stakeholders could participate in various ways, either by contributing input at Planning Team meetings, being aware of planning activities through an email group, providing information to support the effort, or reviewing and commenting on the draft plan. Representatives from the following agencies and organizations were invited to participate as stakeholders in the process; an asterisk indicates they attended Planning Team meetings. Many of these groups found it beneficial to participate on the Planning Team and/or the FMSC. Stakeholders were also invited to review and comment on the plan prior to its submission to Colorado DHSEM and FEMA. A complete list of stakeholders contacted or invited to participate in the planning process can be found in Appendix A.

As part of the public review and comment period for the draft plan, key agencies were again specifically solicited and the incorporated jurisdictions not participating in this HMP update, to provide any final input to the draft plan document. This input was solicited by direct emails to key groups and associations to review and comment on the plan. As part of this targeted outreach, these key stakeholders were also specifically invited to attend the Planning Team meetings to discuss any outstanding issues and to provide input on the draft document and final mitigation strategies. This met the requirements of planning steps 2 and 3 in the FEMA Local Mitigation Planning Handbook.

Incorporation of Existing Plans and Other Information

The coordination and synchronization with other community planning mechanisms and efforts are vital to the success of this plan. To have a thorough evaluation of hazard mitigation practices already in place, appropriate planning procedures should also involve identifying and reviewing existing plans, policies, regulations, codes, tools, and other actions that help to reduce a community's risk and vulnerability from hazards. Larimer County uses a variety of mechanisms to guide growth and development. Integrating existing planning efforts, mitigation policies, and action strategies into this plan establishes a credible, comprehensive document that weaves the common threads of a community's values together. The development and update of this plan involved a comprehensive review of existing plans, studies, reports, and initiatives from Larimer County and each participating municipality that relate to hazards or hazard mitigation. A high-level summary of the key plans, studies and reports is summarized in the table below. Information on how they informed the update are noted and incorporated where applicable.

Table 3-5 Summary of Review of Key Plans, Studies and Reports

Plan, Study, Report Name	How Plan informed LHMP
Larimer County Comprehensive Plan (2019)	Provided background information on the County including some information related to jurisdictions. Informed the Community Profile in Chapter 2 and Chapter 4 Risk Assessment.
Larimer County Resilience Framework (2016)	Provided background information on the County and identified risks. Goals were used as a reference in the update and development of 2021 goals
Larimer County Capacity Assessment (Threat and Hazard Identification and Risk Assessment)	Informed Chapter 4 Risk Assessment including natural and cultural resources and hazardous materials section.
Colorado Front Range Gust Map ASCE 7-10 Complete (2013)	Provided background information on Wind hazard in the County.
Larimer County Land Use Code 2020 Assessment and Annotated (2020)	Provided a summary of the County's current land use code and proposed changes. Informed the Capability Assessment
Colorado State Hazard Mitigation Plan (2018)	Informed the HIRA (Chapter 4) with risk information specific to Larimer County and hazard profile information for each of

Plan, Study, Report Name	How Plan informed LHMP
	the hazards. Used as a reference in the development and review of mitigation goals.
Larimer County Strategic Plan 2019-2023	Provided background information on the County and future planning efforts. Used as a reference in the development and review of mitigation goals.
Larimer County Flood Insurance Study – Preliminary (2019)	Reviewed for information on past floods and flood problems to inform risk assessment (Chapter 4)
State Demography Office Colorado Demographic Profiles: • Larimer County • Town of Berthoud • Town of Estes Park • City of Fort Collins • Town of Johnstown • City of Loveland • Town of Timnath • Town of Wellington • Town of Windsor	Informed the demographic trends in the County and in each incorporated jurisdiction. Chapter 2 Community Profile, Chapter 4 Risk Assessment, and jurisdictional annexes.
Colorado State Drought Response and Mitigation Plan (2018)	Informed the drought hazard and dam incident profiles and vulnerability assessments in Chapter 4 risk assessment.
Fort Collins Utilities Water Supply Vulnerability Study Draft Report (2019)	Informed the drought hazard profile and vulnerability assessment in Chapter 4 risk assessment.
City of Loveland Mitigation Master Plan (2016)	Informed the Loveland Annex and mitigation strategy, including additional mitigation actions.
Technical Support Data Notebook for Big Thompson Watershed, Colorado (2016)	Informed the Flood profile including hydrologic condition of the Big Thompson Watershed, including both historical and future conditions.

Other technical data, reports and studies were reviewed and considered during the collection of data to support Planning Steps 4 and 5, which included the hazard identification, vulnerability assessment, and capability assessment. Information from the following agencies and groups were reviewed in the development and update of this plan. Specific references relied on in the development of this plan are also sourced throughout the document as appropriate. These sources are documented throughout the plan and specifically in the capability assessment sections of each jurisdictional annex.

- Colorado Department of Public Health and Environment (CDPHE)
- Colorado Department of Transportation (CDOT)
- Colorado Division of Water Resources – Dam Safety
- Colorado Earthquake Information Database
- Colorado Geological Survey
- Colorado State Demography Office
- Colorado Wildfire Risk Assessment Portal (CO-WRAP)
- Federal Wildland Fire Occurrence Database
- FEMA Community Information System
- Headwaters Economics
- National Drought Mitigation Center – Drought Impact Reporter
- National Fire Protection Association (NFPA)
- National Interagency Fire Center (NIFC)
- National Oceanic and Atmospheric Administration (NOAA)
- National Register of Historic Places
- National Weather Service (NWS)
- U.S. Army Corp of Engineers'(USACE) National Inventory of Dams (NID)

- U.S. Census Bureau
- U.S. Center for Disease Control and Prevention (CDC)
- U.S. Coast Guard's National Response Center (NRC)
- U.S. Department of Agriculture (USDA) – Farm Service Agency (FSA)
- U.S. Department of Transportation (DOT)
- U.S. Drought Monitor
- U.S. Environmental Protection Agency (EPA)
- U.S. Geological Survey
- Western Regional Climate Center

Larimer County is a participant in the National Flood Insurance Program (NFIP). Since it entered the program, the county has adopted the minimum NFIP requirements and imposed additional requirements into its Charter and County Code and Ordinances.

3.4.2 Phase 2 Assess Risk

Step 4: Identify the Hazards

Wood led the Planning Team and FMSC in an effort to review the list of hazards identified in the 2016 plan and document all the hazards that have impacted or could impact the planning area, including documenting recent events. The Planning Team refined the list of hazards to make it more relevant to Larimer County. The profile of each of these hazards was then developed and updated in 2021 with information from the Planning Team and additional sources. Web resources, existing reports and plans, and existing GIS layers were used to compile information about past hazard events and determine the location, previous occurrences, probability of future occurrences, and magnitude/severity of each hazard. Information on the methodology and resources used to identify and profile hazards is provided in Chapter 4.

Step 5: Assess the Risks

After profiling the hazards that could affect Larimer County, the Planning Team and FMSC collected information to describe the likely impacts of future hazard events on the participating jurisdictions. This step included two parts: a vulnerability assessment and a capability assessment.

Vulnerability Assessment - Participating jurisdictions inventoried their assets at risk of natural and human-caused hazards—overall and in the identified hazard areas. These assets included total number and value of structures; critical facilities and infrastructure; natural, historic, and cultural assets; and economic assets. The Planning Team and FMSC also analyzed social vulnerability measures, as well as development trends in hazard areas. The County's Digital Flood Insurance Rate Map (DFIRM) was used to refine the estimated flood losses during the update, where available for the NFIP participating communities.

Capability Assessment - This assessment consisted of identifying the existing mitigation capabilities of participating jurisdictions. This involved collecting information about existing government programs, policies, regulations, ordinances, and plans that mitigate or could be used to mitigate risk to disasters. Participating jurisdictions collected information on their regulatory, administrative, fiscal, and technical capabilities, as well as ongoing initiatives related to interagency coordination and public outreach. This information is included in the jurisdictional annexes.

A more detailed description of the risk assessment process and the results are included in Chapter 4 Risk Assessment and Chapter 5 Capabilities Assessment, as well as the jurisdictional annexes.

3.4.3 Phase 3 Develop the Mitigation Plan

Step 6: Set Goals

Wood facilitated a brainstorming and discussion session with the Planning Team and FMSC during their third meeting to review and update the goals and objectives for the overall hazard mitigation plan update. The Planning Team and FMSC discussed definitions and examples of goals, objectives, and actions and considered the goals of the state hazard mitigation plan and other relevant local plans when forming their own goals and objectives. The Planning Team and FMSC were provided a survey after the meeting to review the goals and objectives more closely and provide recommendations on revisions. The Planning Team and FMSC determined that the goals and objectives from the 2016 plan were still relevant; they remained unchanged except for a few minor edits. The group discussed the ideas and came to consensus on the final goals and objectives for the multi-jurisdictional plan update, which are further discussed in Chapter 6.

Step 7: Review Possible Activities

The Planning Team and FMSC identified mitigation actions at their fourth meeting. The group was presented with six different categories of mitigation actions and example actions for each identified hazard. Planning Team members were encouraged to brainstorm actions to address the plan's goals. The Planning Team and FMSC then reviewed potential mitigation alternatives and identified new actions by hazard and jurisdiction to ensure that all the plan's high- and medium-significance hazards were addressed, and that all participating jurisdictions had at least one new mitigation action.

The Planning Team and FMSC discussed criteria for narrowing down and prioritizing the identified actions. The group approved the STAPLEE criteria, which assesses the Social, Technical, Administrative, Political, Legal, Economic, and Environmental implications of each action. Each member used these criteria to determine their highest priority projects. Projects were then sorted into high, medium, or low priority based upon the feedback received from each Planning Team and FMSC member. This process is described in more detail in Chapter 6 Mitigation Strategy.

Each participating jurisdiction was responsible for submitting at least one new mitigation action specific to their jurisdiction, in addition to providing input on the progress made on actions identified in the 2016 plan.

Step 8: Draft the Plan

The first complete draft of the plan update, including annexes for each of the participating jurisdictions, was developed and submitted to the Planning Team and FMSC for review in September 2020. Once the Planning Team's comments were incorporated, a complete draft of the plan was made available online and in hard copy for review and comment by the public and other agencies and interested stakeholders, as discussed above under Step 2 Involve the Public. This review period was February 1-28, 2021. Methods for inviting interested parties and the public to review and comment on the plan were discussed in Steps 2 and 3, and materials are provided in Appendix B.

3.4.4 Phase 4 Implement the Plan and Monitor Progress

Step 9: Adopt the Plan

To secure buy-in and officially implement the plan, the governing bodies of each participating jurisdiction adopted the plan and their jurisdictional annex. Scanned copies of resolutions of adoption are included in Appendix C Local Plan Adoptions.

Step 10: Implement, Evaluate, and Revise the Plan

The true worth of any mitigation plan is in the effectiveness of its implementation. The Planning Team reviewed how the 2016 HMP was implemented and maintained since its adoption; this is described in Section 7.1.1.

The strategy for implementing and maintaining the 2021 plan, including a strategy for continued public involvement, was updated, and is described in Chapter 7 Plan Implementation and Maintenance.

4 Risk Assessment

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

This section of the Larimer County Multi-Jurisdictional Hazard Mitigation Plan describes the local Hazard Identification and Risk Assessment summary undertaken by the County and participating jurisdictions and special districts. The risk assessment process identifies and profiles relevant hazards and assesses the exposure of lives, property, and infrastructure to these hazards. The process allows for a better understanding of a jurisdiction's potential risk to hazards and provides a framework for developing and prioritizing mitigation actions to reduce risk from future hazard events.

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

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

A key step in preventing disaster losses in Larimer County is developing a comprehensive understanding of the hazards that pose risks to its communities. The following terms facilitate comparisons between communities and can be found throughout the Plan.

- **Hazard:** Event or physical condition that has the potential to cause fatalities, injuries, property damage, infrastructure damage, agricultural loss, damage to the environment, interruption of business, other types of harm or loss
- **Risk:** Product of a hazard's likelihood of occurrence and its consequences to society; the estimated impact that a hazard would have on people, services, facilities, and structures in a community
- **Vulnerability:** Degree of susceptibility to physical injury, harm, damage, or economic loss; depends on an asset's construction, contents, and economic value of its functions

In essence, the risk assessment evaluates potential loss from hazards by assessing the vulnerability of the County's population, built environment, critical facilities, and other assets. Environmental and social impacts are also taken into consideration wherever possible. Data collected through this process has been incorporated into the following subsections:

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

Subsection 4.2: Asset Summary - describes the methodology for inventorying assets as the basis for determining vulnerability of the planning area to the identified hazards.

Subsection 4.3: Hazard Analysis and Risk Assessment - discusses the threat to the planning area and describes previous occurrences of hazard events and the likelihood of future occurrences. It also includes a vulnerability assessment considering property, critical facilities, and historic/cultural/natural assets at risk, as well as possible effects to the economy and future development trends.

This risk assessment covers the entire geographical area of Larimer County. Since this is a multi-jurisdictional plan, the HMPC also evaluated how the hazards and risks vary from jurisdiction to jurisdiction. While these differences are noted in this section, they are expanded upon in the annexes of the participating jurisdictions. If no additional data is provided in an annex, it should be assumed that the risk and potential impacts to the affected jurisdiction are similar to those described here for the entire Larimer County planning area.

4.1 Hazard Identification

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

4.1.1 Methodology and Results

A Risk Assessment is a method for evaluating risk as defined by probability and frequency (likelihood) of occurrence of a hazard event, exposure of people and property to the hazard, and consequences of that exposure. Historical data, catastrophic potential, relevance to the jurisdiction, and the probability and potential magnitude of future occurrences were all used to reduce and prioritize the list of hazards to those most relevant to Larimer County. Hazards data was obtained from various federal, state, and local sources such as FEMA, the Colorado Geological Survey (CGS), the Colorado Dam Safety Branch (DSB), the National Oceanic and Atmospheric Administration's (NOAA) National Center for Environmental Information (NCEI), the United States Geological Survey (USGS), and others. Local and national news reports were also used to research historic events. Together, these sources were examined to assess the significance of these hazards to the County. The hazards selected for inclusion in this plan include those that have occurred historically or have the potential to cause significant human and/or economic losses in the future.

The update process included a comprehensive, parcel-level risk analysis with GIS where available data permitted. Many new maps and tables were added that capture the potential losses. Additional details on the loss analysis at the jurisdictional level, including a breakdown of hazard losses by community and property type, can be referenced in the jurisdictional annexes.

Larimer County and its communities are vulnerable to a wide range of natural and human-caused hazards that threaten life and property. The hazards identified by the HMPC for inclusion in the Plan are those determined to be of potential threat to the County and its municipalities and are consistent with the hazards identified by the State of Colorado and the Federal Emergency Management Agency for this part of the State and this region of the country.

Hazard Identification Changes from 2016 Plan

There were two changes made in the identified hazards from the 2016 Larimer County HMP, which was the addition of dam inundation and drought as hazards. The overall hazard significance ratings have generally remained the same with the exception of earthquake, which revised from high to moderate. The hazard profiles have been improved with additional data and analysis. The 2020 planning process showed that recent hazard events have increased awareness of the interconnectedness of many hazards. Another difference of this plan compared to the 2016 HMP is that climate change considerations summaries were added to each hazard profile. The maps and GIS analysis were updated with best available data, and the writing was made more concise across most sections. Table 4-1 summarizes changes in the hazards profiled in 2016 compared to the 2021 update.

Table 4-1 Larimer County Hazards Updates

2021 Hazards	When Identified	Comments
Biological Hazards	Included in 2016 HIRA	Discussion of COVID-19 global pandemic added to 2021 HIRA
Civil Disturbance	Included in 2016 HIRA	
Dam Inundation	New in 2021	Includes downstream inundation from dam failure, uncontrolled spillway releases and controlled outlet releases.
Drought	Expanded on in 2021	Drought was briefly discussed in the 2016 Plan, but is fully profiled in the 2021 update
Earthquake	Included in 2016 HIRA	
Erosion/Deposition	Included in 2016 HIRA	Renamed to Soil Hazards to better reflect inclusion of expansive/collapsible soils, etc.
Flood	Included in 2016 HIRA	
Hazardous Materials Incident	Included in 2016 HIRA	
Landslide/Rockslide	Included in 2016 HIRA	
Spring/Summer Storm	Included in 2016 HIRA	
Tornado	Included in 2016 HIRA	
Utility Disruption	Included in 2016 HIRA	
Wildfire	Included in 2016 HIRA	Renamed from "Fire-Wildland" to "Wildfire"
Winter Storm	Included in 2016 HIRA	

Source: HMPC

The HMPC also reviewed the hazards profiled in the 2018 Colorado State Hazard Mitigation Plan in their consideration of hazards to include in the 2021 Plan Update. Several of those hazards were deemed to not be a significant risk in Larimer County. For other hazards, the risk in Larimer County does not differ significantly from the State as a whole. While the HMPC decided not to include the following hazards in the Larimer County 2021 Hazard Mitigation Plan the following descriptions of these hazards have been included below to facilitate decision making and the hazard prioritization process during the next plan update:

Aircraft Accidents: Aircraft accidents can occur at any location, with significant differences in magnitude due to the size of aircraft, altitude of the incident, and population density at the crash site and/or debris field. The cities of Fort Collins and Loveland, and Larimer County, are subject to potential aircraft accidents. The cities of Loveland and Fort Collins share a municipal airport that offers limited commercial service. The Fort Collins-Loveland Municipal Airport primarily handles small aircraft and helicopters, along with various larger private and commercial aircraft. The airspace above this region is utilized and controlled by Denver Center, which also services the Denver International Airport (DIA). The City of Fort Collins operated the Fort Collins Downtown Airport until 2005, when it was permanently closed. Larimer County experienced several aircraft accidents while controlling wildland fires during 2001. Due to the overall infrequency of aircraft accidents in the County since the closure of the Fort Collins Downtown Airport, aircraft accidents were not profiled further for this plan.

Avalanche: An avalanche is a mass of snow, ice, and other debris that flows and/or slides rapidly down a steep slope. If conditions are right, an avalanche can reach speeds in excess of 150 mph. Avalanches can be triggered by either natural causes such as earthquake, thermal changes, or blizzards, or by human activities such as snowmobiling, skiing, or hiking. The greatest threat of avalanche is in the mountainous area of Larimer County. While avalanches are quite common in the mountains, the risk of personal injury or property damage from avalanche is minimal due to the remote location. There is minimal development in mountainous areas where avalanches occur. Furthermore, there is usually a small number of people in the area when avalanches occur.

Fire – Urban: Structure fires are among the costliest fires in the nation. The National Fire Protection Association (NFPA) reports that structural fires account for 37 percent of fires nationwide, 82 percent of civilian fire deaths, 83 percent of civilian fire injuries, and 72 percent of direct property loss from fire (NFPA 2017). Most structure fires in the region occur in residential occupancies. The two primary reasons for the lack of significant commercial structure fires are constantly improving business safety practices and frequent fire department inspections.

Terrorism / WMD: Terrorism is defined in the U.S.A. Patriot Act as "activities that (A) involve acts dangerous to human life that are a violation of the criminal laws of the U.S. or of any state; that (B) appear to be intended (i) to intimidate or coerce a civilian population, (ii) to influence the policy of a government by intimidation or coercion, or (iii) to affect the conduct of a government by mass destruction, assassination, or kidnapping; and (C) occur primarily within the territorial jurisdiction of the U.S." Terrorism can be domestic or international depending on its origin, base, and the objectives of the terrorist. Incidents usually involve a criminal act, often symbolic in nature and intended to influence an audience beyond the immediate victims. While Larimer County's law enforcement agencies are actively engaged in trying to prevent and protect against terrorist attacks, the sensitive nature of those planning efforts makes them difficult to discuss in an open plan like this; therefore, the HMPC decided not to profile terrorism further in this plan.

Hazard Ranking Methodology

The 2016 Larimer County HMP used a numerical Risk Factor Value system to rank the significance of the hazards that threaten the planning area, based on the following factors:

Probability: What is the likelihood of a hazard event occurring in a given year?

Impact: In terms of injuries, damage, or death, would you anticipate impacts to be minor, limited, critical, or catastrophic when a significant hazard event occurs?

Spatial Extent: How large of an area could be impacted by a hazard event? Are impacts localized or regional?

Warning Time: Is there usually some lead time associated with the hazard event? Have warning measures been implemented?

Duration: How long does the hazard event usually last?

These factors were then combined to produce an overall Risk Rating of Low (1.9 or lower), Medium (2.0-2.4), or High (2.5 or higher).

For the 2021 plan update, the HMPC agreed this methodology was still sound overall, but decided to make a few changes to simplify the analysis and make it easier to understand. The numerical rankings were eliminated in favor of their descriptive levels (Likely, Minor, Significant, etc.) to make it easier to take into account the lived experience of HMPC members, stakeholders, and the public. The term Extent, while used by FEMA, was changed to Location to be clearer to a general reader. The term Impact was replaced by Magnitude/Severity. And Warning Time and Duration were deleted as separate factors and incorporated into the Magnitude/Severity factor. The criteria used are listed and defined in Table 4-2 below.

Overall Hazard Significance Summary

Table 4-2 shows overall hazard significance, based on a combination of geographic area, probability of future occurrence and potential magnitude/severity as defined below. The individual ratings are based on or interpolated from the analysis of the hazards in the sections that follow. During the 2021 Plan update, the individual ratings and significance of the hazards was revisited and updated. Public concern was also considered via input at public meetings and an online survey.

Table 4-2 Larimer County Hazard Significance

Hazard	Frequency	Spatial Extent	Severity	Overall Significance
Biological Hazards	Highly Likely	Extensive	Catastrophic	High
Civil Disturbance	Likely	Limited	Significant	Medium
Dam Inundation	Occasional	Significant	Critical	Medium
Drought	Likely	Significant	Significant	Medium
Earthquake	Unlikely	Significant	Catastrophic	Medium
Flood	Highly Likely	Significant	Catastrophic	High
Hazardous Materials Incident	Likely	Limited	Critical	High
Landslide/Rockslide	Likely	Limited	Critical	High
Soil Hazards	Likely	Limited	Significant	Medium
Spring/Summer Storm	Highly Likely	Extensive	Critical	High
Tornado	Likely	Limited	Critical	High
Utility Disruption	Likely	Significant	Critical	Medium
Wildfire	Highly Likely	Significant	Critical	High
Winter Storm	Highly Likely	Extensive	Critical	High

Frequency of Occurrence:
Highly Likely: Near 100% probability in next year.
Likely: Between 10 and 100% probability in next year or at least one chance in ten years.
Occasional: Between 1 and 10% probability in next year or at least one chance in next 100 years.
Unlikely: Less than 1% probability in next 100 years.

Spatial Extent:
Limited: Less than 10% of planning area
Significant: 10-50% of planning area
Extensive: 50-100% of planning area

Potential Severity:
Catastrophic: Multiple deaths, complete shutdown of facilities for 30 days or more, more than 50% of property is severely damaged
Critical: Multiple severe injuries, complete shutdown of facilities for at least 2 weeks, more than 25% of property is severely damaged
Significant: Some injuries, complete shutdown of critical facilities for more than one week, more than 10 percent of property is severely damaged
Negligible: Minor injuries, minimal quality-of-life impact, shutdown of critical facilities and services for 24 hours or less, less than 10 percent of property is severely damaged.

Significance
Low: minimal potential impact
Medium: moderate potential impact
High: widespread potential impact

As noted previously, the risk from many hazards varies across the county and between jurisdictions. Table 4-3 and Table 4-4 summarize the overall risk and significance of each hazard by jurisdiction; further details can be found in the Community Annex for each participating jurisdiction.

Table 4-3 Hazard Significance by Jurisdiction – Municipalities

Hazard	Larimer County	City of Fort Collins	City of Loveland	Town of Berthoud	Town of Estes Park	Town of Johnstown	Town of Timnath	Town of Wellington	Town of Windsor
Biological Hazards	High	Medium	High	Low	Medium	High	High	High	High
Civil Disturbance	Medium	Medium	Medium	Low	Low	Low	Low	Medium	Medium
Dam Inundation	Medium	High	Medium	Medium	Low	Low	Medium	High	Medium
Drought	Medium	Medium	Medium	Medium	Medium	Medium	Medium	Medium	Medium
Earthquake	Medium	Low	Medium	Low	Medium	Low	NA	Medium	Medium
Flood	High	High	Medium	Medium	Medium	Medium	Medium	High	High
Hazardous Materials	High	Medium	High	Low	Medium	Medium	Low	Medium	Medium
Landslide/Rockslide	High	Low	Low	Low	Medium	Low	NA	Low	Low
Soil Hazards	Medium	Low	Medium	Low	Low	Low	Low	Low	Medium
Spring/Summer Storm	High	Medium	High	Medium	High	Low	Low	High	High
Tornado	High	Low	High	Medium	Low	Low	High	High	High
Utility Disruption	Medium	Low	Medium	Low	Medium	Low	Medium	Medium	Medium
Wildfire	High	Medium	Medium	Medium	High	Low	Low	Medium	Medium
Winter Storm	High	Medium	High	High	High	Low	Low	High	High

Table 4-4 Hazard Significance by Jurisdiction – Special Districts

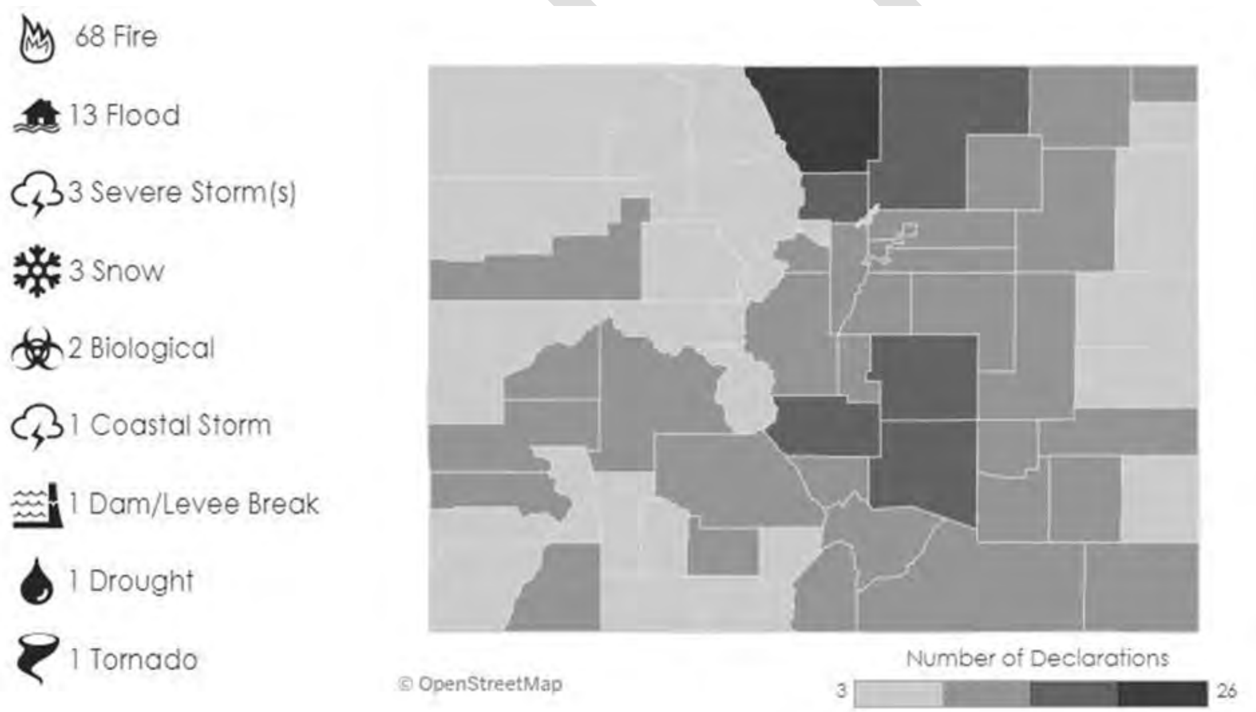
Hazard	Berthoud FPD	Crystal Lakes FPD	Estes Park Health	Estes Valley FPD	Estes Valley Rec & Park	Glacier View FPD	Livermore FPD	Northern Water	Pinewood Springs FPD	Poudre Canyon FPD	Poudre Fire Authority	Thompson Valley EMS	Upper Thompson Sanitation District	Wellington FPD	Windsor Severance Fire Rescue
Biological Hazards	Medium	High	High	High	High	High	High	Medium	High	Low	Medium	High	Medium	High	High
Civil Disturbance	Medium	Low	Low	Low	Low	Low	Low	Medium	Low	Low	Low	Medium	Low	Low	Medium
Dam Inundation	Medium	Medium	Low	Low	Medium	Low	Medium	High	Medium	Medium	Medium	Medium	Low	Medium	Medium
Drought	Medium	Medium	Medium	Medium	Medium	Medium	Medium	High	Medium	Medium	Medium	Medium	Medium	Medium	Medium
Earthquake	Low	Medium	Medium	Medium	Low	Low	Medium	Medium	Medium	Medium	Medium	Medium	Medium	High	Medium
Flood	Medium	Medium	Medium	Medium	Medium	Low	Low	Medium	Medium	Medium	High	High	High	Low	High
Hazardous Materials	Medium	Low	Low	Medium	Low	Low	Medium	Medium	Low	Low	High	High	Medium	High	Medium
Landslide/ Rockslide	Low	Low	Medium	Low	Low	Medium	Medium	Medium	Medium	Medium	Medium	Low	Low	High	Low
Soil Hazards	Low	Low	Low	Low	Low	Low	Low	Medium	Low	Low	Low	Low	Low	Low	Medium
Spring/Summer Storm	High	Medium	Low	High	Low	Medium	High	Medium	Medium	Medium	Medium	High	High	Medium	High
Tornado	Medium	Low	Low	Low	Low	Low	Low	High	Low	Low	High	High	Low	High	High
Utility Disruption	Medium	Medium	Medium	Medium	Low	Medium	Medium	Medium	Medium	Medium	Low	Medium	Medium	High	Medium
Wildfire	High	High	High	High	Medium	High	High	High	High	High	High	High	Medium	High	Medium
Winter Storm	Medium	High	Medium	High	Medium	High	High	High	High	Medium	High	High	Medium	Medium	High

4.1.2 Disaster Declaration History

To further focus on the list of identified hazards for the Plan, events were examined that triggered federal and/or state disaster declarations. Federal and/or state declarations may be granted when the severity and magnitude of an event surpasses the ability of the local government to respond and recover. Disaster assistance is supplemental and sequential. When the local government's capacity has been surpassed, a state disaster declaration may be issued, allowing for the provision of state assistance. Should the disaster be so severe that both the local and state governments' capacities are exceeded; a federal emergency or disaster declaration may be issued allowing for the provision of federal assistance.

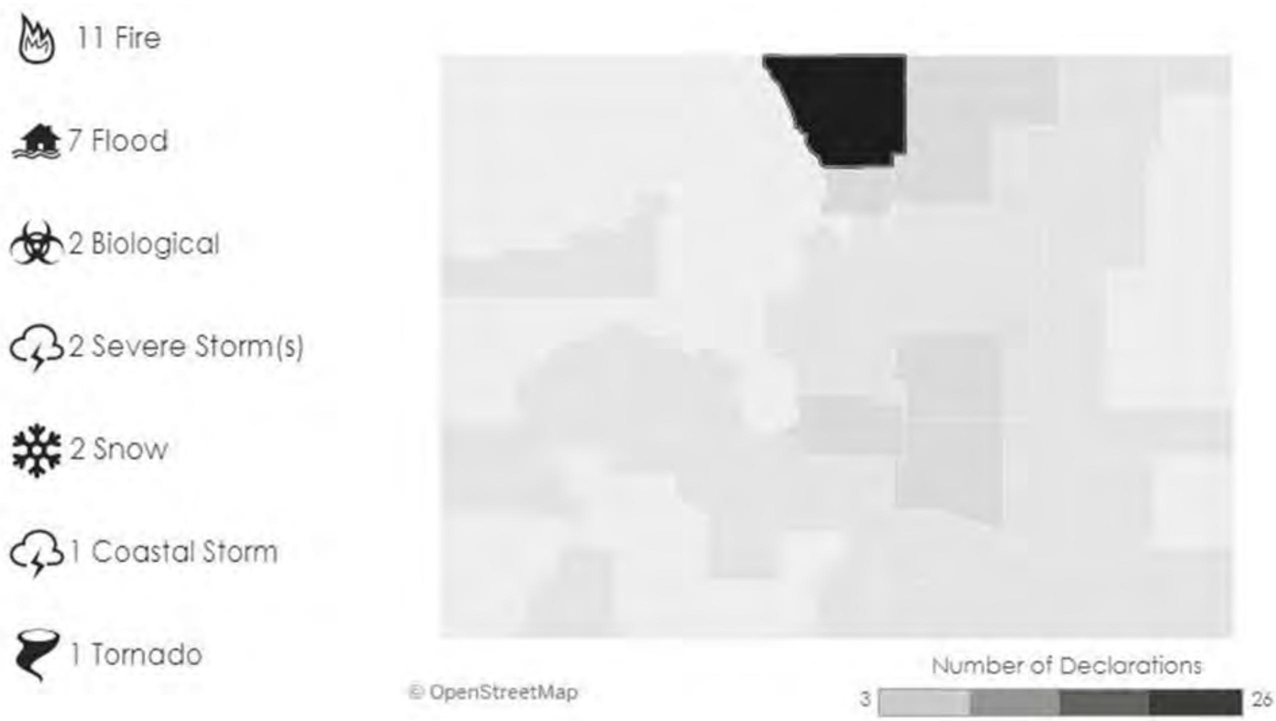
The federal government may issue a disaster declaration through FEMA, the USDA, and/or the Small Business Administration (SBA). FEMA also issues emergency declarations, which are more limited in scope and without the long-term federal recovery programs of major disaster declarations. The quantity and types of damage are the determining factors. Figure 4-1 and Figure 4-2 show the number and type of Major Disaster Declarations in Colorado and Larimer County respectively.

Figure 4-1 Summary of Disaster Declaration Events, Colorado



Source: FEMA

Figure 4-2 Summary of Disaster Declaration Events, Larimer County



Source: FEMA

Table 4-5 presents a list of all federal disaster and emergency declarations that have occurred in Larimer County since 1965, according to the Federal Emergency Management Agency. Many of the disaster events were regional or statewide; therefore, reported costs are not accurate reflections of losses to Larimer County. This list presents the foundation for identifying what hazards pose the greatest risk to the County and to its local jurisdictions.

Table 4-5 Presidential Disaster and Emergency Declarations in Larimer County

Declaration #	Date	Event Details
FM-5349-CO	9/6/2020	Cameron Peak Fire
FEMA-4498-DR	03/28/2020	Covid-19 Pandemic
FEMA-3436-EM	03/13/2020	Covid-19
FEMA-4145-DR	09/14/2013	Severe Storms, Flooding, Landslides, and Mudslides
FEMA-3365-EM	09/12/2013	Severe Storms, Flooding, Landslides, and Mudslides
FEMA-4067-DR	06/28/2012	High Park and Waldo Canyon Wildfires
FEMA-2980-FM	06/09/2012	High Park Fire
FEMA-2877-FM	04/03/2011	Crystal Fire
FEMA-2857-FM	09/12/2010	Reservoir Road Fire
FEMA-1762-DR	05/26/2008	Severe Storms and Tornadoes
FEMA-3270-EM	01/07/2007	Snow
FEMA-3224-EM	09/05/2005	Hurricane Katrina Evacuation
FEMA-2514-FM	4/1/2004	CO - PICNIC ROCK FIRE - 03/30/2004
FEMA-2511-FM	11/12/2003	CO - BUCKHORN CREEK FIRE - 11/11/2003
FEMA-2486-FM	7/25/2003	CO-CLOUDY PASS FIRE-07/25/2003
FEMA-EM-3185	04/09/2003	Snowstorm
FEMA-2447-FS	07/18/2002	Big Elk Fire
FEMA-1421-DR	6/19/2002	Wildfires

Declaration #	Date	Event Details
FEMA- 2383-FS	11/1/2001	CO – Armageddon Fire
FEMA-2308-FS	6/12/2000	Bobcat Gulch Fire
FEMA-1276-DR	05/17/1999	CO Flooding 4/30/1999
FEMA-1186-DR	08/01/1997	Severe Storms, Heavy Rain, and Flash Floods, Flooding, Mudslides
FEMA-665-DR	7/22/1982	Flash Flood Due to Dam Failure
FEMA-517-DR	08/02/1976	Severe Storms and Flash Flooding
FEMA-385-DR	05/23/1973	Heavy Rain, Snowmelt, Flooding
FEMA-261-DR	05/19/1969	Severe Storms, Flooding
FEMA-200-DR	06/19/1965	Tornadoes, Severe Storms, Flooding

Source: FEMA Disaster Declarations Summary – Open Government Dataset

Larimer County has also been included in 14 USDA disaster certifications since 2010. A USDA disaster declaration certifies that the affected county has suffered at least a 30% loss in one or more crop or livestock areas and provides affected producers with access to low-interest loans and other programs to help mitigate the impact of the disaster. In accordance with the Consolidated Farm and Rural Development Act, all counties neighboring those receiving disaster declarations are named as contiguous disaster counties and, as such, are eligible for the same assistance.

Larimer County has had the most federally-declared disasters out of all counties in the State of Colorado since 1965. This is mostly due to the three large river systems within the County and the large amount of wildland urban interface land leading to significant wildfire potential.

Table 4-6 USDA Disaster Declarations in Larimer County

Declaration #	Date Approved	Event Details
S4481	5/30/2019	Drought
S4408	10/2/2018	Drought
S4397	9/17/2018	Flood, Excessive Rain/Moisture, Hail, Wind, Tornado, Lightning
S4386	9/12/2018	Drought
S4365	8/1/2018	Hail, Wind
S4145	2/23/2017	Drought
S4087	10/26/2016	Hail
S3548	7/3/2013	Drought, Wind, Fire, Heat, Insects
S3508	4/10/2013	Drought, Wind, Fire, Heat, Insects
S3456	1/9/2013	Drought, Wind, Fire, Heat, Insects
S3347	8/15/2012	Flood, Hail, Wind
S3319	8/1/2012	Drought, Wind, Fire, Heat, Insects
S3290	7/12/2012	Drought, Wind, Fire, Heat, Insects
S3260	7/3/2012	Drought, Wind, Heat

Source: usda.gov

4.1.3 Climate Change Considerations Summary

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 Earth's average temperature is expected to increase.

In 2018, the U.S. Global Change Research Program released the Fourth National Climate Assessment (NCA4), the authoritative and comprehensive report on climate change and its impacts in the United States. Not only did the report confirm that climate change continues to affect Americans in every region of the U.S., the report identifies increased heat, drought, insect outbreaks, wildfire, and flooding as key climate-related concerns for the Southwest region of the U.S., which includes Colorado. The following is a summary of climate change impacts from the Fourth National Climate Assessment.

Recent warming in the southwest region is among the most rapid in the nation and is significantly greater than the global average, and the period since 1950 has been hotter than any comparable long period in at least 600 years. Summer temperatures across the state are expected to warm more than winter temperatures and projections suggest that typical summer months will be as warm as (or warmer than) the hottest 10% of summers that occurred between 1950 and 1999. Under the higher emissions scenario (RCP8.5) climate models predict an increase of 8.6°F in the southwest regional annual average temperature by 2100.

Projected increases in temperatures in the southwest region are also projected to increase probabilities of natural events such as wildfires, drought and summer precipitation. These temperature changes have great potential to directly affect public health through increased risk of heat stress and infrastructure through increased risk of disruptions of electric power generation. Water supplies are also vulnerable to impacts of higher temperatures. While water supplies generally change year-to-year due to variabilities in water use and precipitation, higher temperatures are projected to increase evapotranspiration, reducing the effectiveness of precipitation in replenishing surface water and soil moisture. This will have direct impacts on crop yields and productivity of key regional crops and livestock a major risk for the agricultural industry and food security nationwide.

The impacts of climate change already pose a threat to people and property in the southwest region of the United States, including Larimer County. Vulnerable populations, in particular those who are low-income, children, elderly, disabled and minorities will likely be impacted by the effects of climate change disproportionately than other populations (Refer to Chapter 2 for more information on social vulnerability in the county). Together, these impacts represent a slow-onset disaster that is likely to manifest and change over time. Current projections predict even more rapid changes in the near future, which are likely to affect many of the natural hazards that Larimer County has historically dealt with. According to HMPC the County is already experiencing some hazards with more frequency and intensity than in years past, such as drought, flooding, wildfire and extreme heat.

Larimer County's two most frequent and devastating hazards are wildfire and flood, both of which are expected to be impacted by our changing climate. The nature of erosion/land subsidence and public health hazards are also likely to evolve in intensity and character due to a changing regional climate. For these reasons, the hazard identification and risk assessment for the 2021 Larimer County Hazard Mitigation Plan update includes climate change considerations discussion on how climate change may impact the frequency, intensity, and distribution of specific hazards within the county. Because many impacts of climate-related hazards cross county boundaries, some of the discussion looks at impacts on a regional scale. As climate science evolves, future mitigation plan updates may consider including climate change projections in the risk rankings and vulnerability assessments of the hazards included in the Plan.

4.1.4 Overview of Hazard Identification and Risk Assessment

The hazards identified in Section 4.1 Hazard Identification are profiled individually in this section. The section will conclude by summarizing the probability of future occurrence and potential magnitude of each hazard for each jurisdiction, as well as assigning an overall vulnerability, or planning significance, rating of high, moderate, or low for each hazard.

The sources used to collect information for these profiles include the following:

- Disaster declaration history from FEMA
- State of Colorado Hazard Mitigation Plan (2018)
- Larimer County Comprehensive Plan (2019)
- Internet resources on past hazard events, such as the National Oceanic and Atmospheric Administration's National Centers for Environmental Information (NCEI) databases, and the National Response Center.
- Geographic information systems (GIS) data from the Larimer County GIS Department
- Statewide GIS datasets compiled by state and federal agencies (e.g., The Homeland Infrastructure Foundation-Level Data, or HIFLD dataset for critical facilities and infrastructure)
- Personal interviews with HMPC members and other stakeholders
- Larimer County Data Collection Guides completed by each participating jurisdiction
- Larimer County Resiliency Framework (2016)
- Larimer County Land Use Code Assessment (2019)
- Other existing plans and reports

Detailed profiles for each of the identified hazards include information on the following characteristics of the hazard:

Hazard Description

This section consists of a general description of the hazard and the general impacts it may have on a community.

Past Occurrences

This section includes information on historic incidents, including impacts and costs, if known. A historic incident worksheet was used to capture information from participating jurisdictions on past occurrences. Information from the HMPC was combined with other data sources, including those previously mentioned.

Location

This section describes the geographic coverage, or location, of the hazard in the planning area and assesses the affected areas as isolated, small, medium, or large.

Magnitude/Severity

This section summarizes the magnitude/severity or extent of a hazard event in terms of deaths, injuries, property damage, and interruption of essential facilities and services. Magnitude and severity are classified in the following manner:

- Catastrophic: Multiple deaths; property destroyed and severely damaged; and/or interruption of essential facilities and service for more than 72 hours
- Critical: Isolated deaths and/or multiple injuries and illnesses; major or long-term property damage that threatens structural stability; and/or interruption of essential facilities and services for 24-72 hours

- Limited: Minor injuries and illnesses; minimal property damage that does not threaten structural stability; and/or interruption of essential facilities and services for less than 24 hours
- Negligible: No or few injuries or illnesses; minor quality of life loss; little or no property damage; and/or brief interruption of essential facilities and services

Probability of Future Occurrence

The frequency of past events is used to gauge the likelihood of future occurrences. Based on historical data, the Probability of Future Occurrence is categorized as follows:

- Highly Likely: Near 100% chance of occurrence next year or happens every year
- Likely: 10-100% chance of occurrence in next year or has a recurrence interval of 10 years or less
- Occasional: 1-10% chance of occurrence in the next year or has a recurrence interval of 11 to 100 years
- Unlikely: Less than 1% chance of occurrence in next year or has a recurrence interval of greater than every 100 years

The probability, or chance of occurrence, was calculated where possible based on existing data. Probability was determined by dividing the number of events observed by the number of years and multiplying by 100. This gives the percent chance of the event happening in any given year. An example would be three wildfires occurring over a 30-year period, which suggests a 10% chance of a wildfire occurring in any given year.

Climate Change Considerations

As summarized in Section 4.1.3 above, this sub-section will discuss the known or potential impacts of climate change on the specific hazard.

Vulnerability Assessment

The vulnerability assessment further defines and quantifies populations, buildings, critical facilities and infrastructure, natural/cultural resources, and other community assets at risk to the profiled hazards, as well as the potential impacts to the economy and future development trends of the planning area. The vulnerability assessment includes these sub-sections per applicable hazard:

- People (including vulnerable populations)
- General Property
- Critical Facilities and Infrastructure
- Economy
- Historic, Cultural, and Natural Resources
- Future Development
- Risk Summary

The data and other assets inventory used in the vulnerability assessment for each hazard is described in more detail in the following Section 4.2 Asset Summary.

4.2 Asset Summary

4.2.1 People

For hazards with a geospatial component and for which data was available for GIS-based parcel analysis, population estimates were calculated. These were based on multiplying the average persons per household for Larimer County and its municipalities as of 2018, times the number of properties of Residential nature in each of the vulnerability analyses which found parcels at risk of the various hazards. Hence, if 'X' number of properties of Residential nature were found to overlap with a hazard layer, the total population exposed to that hazard would be obtained by taking 'X' times 2.46, then adding the results by jurisdiction, parcel type, and/or hazard classification. This average number of persons per household value was obtained from the Colorado Counties and Municipalities Population and Household Estimates summary, published by the Colorado Demographer's Office (under the Department of Local Affairs). For more details on Economic Assets, development trends, and other population and demographic information refer to Section 2 Community Profile.

4.2.2 General Property

General property exposure to hazards is based on Larimer County's parcel data containing assessor information such as total number of parcels, improvement values, and parcel type classification by jurisdiction. Note that only those parcels with improvement values greater than $0, or those which were classified as "exempt" or "state assessed" were accounted here; non-developed or non-improved parcels were excluded for the purposes of conducting the vulnerability assessments under Section 4.3. Vacant parcels, due to their improvement values equaling $0, were also excluded from the exposure valuation analysis.

Counts and values are based on the latest county assessor's data (as of April 4, 2020), which was provided in GIS and tabular (spreadsheet) formats. Improvement values and parcel type attributes were joined to the parcel geometries in GIS, to enable spatial analysis and mapping. Content values were estimated as a percent of the improvement value based on parcel type, specifically: 50% of the improvement value for residential structures (including mobile homes), 100% for agricultural, commercial, and exempt parcels, as well as multi-unit structures, and 150% for industrial parcels. These percentage calculations are based on standard FEMA HAZUS methodologies. Finally, Total Values were aggregated by adding the improvement and content values for each jurisdiction. Table 4-7 shows the total number of improved parcels, properties, and their improvement and content values by jurisdiction.

Table 4-7 Improved Parcel Exposure Values by Jurisdiction

Jurisdiction	Improved Parcels	Improved Values	Content Values	Total Values
Berthoud	3,656	$1,216,096,180	$692,383,141	$1,908,479,321
Estes Park	4,074	$1,591,728,771	$969,018,601	$2,560,747,372
Fort Collins	52,006	$23,665,351,379	$15,092,610,654	$38,757,962,033
Johnstown	1,227	$744,855,197	$559,614,704	$1,304,469,901
Loveland	27,708	$10,640,269,300	$6,751,873,209	$17,392,142,509
Timnath	2,213	$1,072,713,092	$579,454,731	$1,652,167,823
Wellington	3,774	$1,112,267,351	$611,266,287	$1,723,533,638
Windsor	2,879	$1,484,571,448	$821,478,128	$2,306,049,576
Unincorporated	29,325	$11,211,866,745	$6,529,948,869	$17,741,815,614
Total	**126,862**	**$52,739,719,463**	**$32,607,648,324**	**$85,347,367,787**

Source: Larimer County GIS/Assessor's Office, Wood analysis.

Table 4-8 summarizes parcels for unincorporated Larimer County by parcel type. The below information indicates that 86% of parcels in Larimer County are residential in nature, followed by 7% agricultural and 4% commercial. The Total Values of parcels available for assessment is over $85 billion including both improvement values and content values. A total of 126,862 parcels were summed up for this exposure summary.

For those vulnerability analyses to follow in Section 4.3 Hazard Analysis and Risk Assessment, the total parcels exposed to the hazards available in geospatial format were obtained by overlaying the hazard threat layers with the parcel layer in GIS. The following hazards will have vulnerability summaries at the parcel level, due to the availability of hazard data for the geospatial overlay analysis: Dam Failure/Incidents, Flood, and Wildfire. Earthquake will also include damage and loss estimates to general property based on the HAZUS-derived information (see Section 4.3.4 Earthquake for details).

Table 4-8 Improved Parcel Exposure Values by Parcel Type

Parcel Type	Improved Parcels	Improved Values	Content Values	Total Values
Agricultural	2,183	2,587	$848,882,468	$848,882,468
Commercial	1,077	1,753	$542,488,008	$542,488,008
Exempt	310	1,178	$282,034,786	$282,034,786
Industrial	91	117	$77,906,548	$116,859,834
Mobile Home	257	3,059	$242,398,985	$121,199,488
Multiple Unit	46	134	$18,812,653	$18,812,653
Residential	25,361	27,742	$9,199,343,297	$4,599,671,632
Total	**29,325**	**36,570**	**$11,211,866,745**	**$6,529,948,869**

Source: Larimer County GIS/Assessor's Office, Wood analysis.

4.2.3 Critical Facilities and Infrastructure

A critical facility may be defined as one that is essential in providing utility or direction either during the response to an emergency or during the recovery operation. Table 4-9 summarizes the inventory of critical facilities by jurisdiction (based on best available data) in Larimer County. Table 4-10 breaks down those facilities by type. The locations of these facilities are displayed in Figure 4-3.

The primary data source used was Larimer County's Cascarta system. Cascarta is an innovative web-based mapping tool of facilities and infrastructure across the County, which allows emergency managers, land use planners, and others to visualize the resiliency of the built environment, including critical lifeline utilities and social infrastructure, and the cascading effects of a disaster. By identifying and assessing the relationships and dependencies between critical utility and social infrastructure assets, users are able to pinpoint areas of vulnerability and proactively mitigate risks and build additional redundancy into community systems. Cascarta data was supplemented with Tier II hazardous materials facilities data.

FEMA Lifeline categories are the U.S. Department of Homeland Security's current recommended way to standardize the classification of critical facilities and infrastructure which provide indispensable service, operation, or function to a community. A lifeline is defined as providing indispensable service that enables the continuous operation of critical business and government functions, and is critical to human health and safety, or economic security. These categorizations are particularly useful as they:

- Enable effort consolidations between government and other organizations (e.g., infrastructure owners and operators)
- Enable integration of preparedness efforts among plans; easier identification of unmet critical facility needs

- Refine sources and products to enhance awareness, capability gaps, and progress towards stabilization
- Enhance communication amongst critical entities, while enabling complex interdependencies between government assets
- Highlight lifeline related priority areas regarding general operations as well as response efforts.

Specific information on facilities, names, and other key details by participating communities may be accessed by permission of the jurisdiction or infrastructure owner.

Table 4-9 Critical Facilities and Infrastructure in Larimer County by Jurisdiction

Jurisdiction	Total
Berthoud	16
Estes Park	21
Fort Collins	268
Johnstown	4
Loveland	115
Timnath	6
Wellington	6
Windsor	1
Unincorporated	244
Total	**681**

Source: Cascarta, Larimer County Assessor's Office, Wood analysis.

Table 4-10 Critical Facilities and Infrastructure in Larimer County by Lifeline and Type

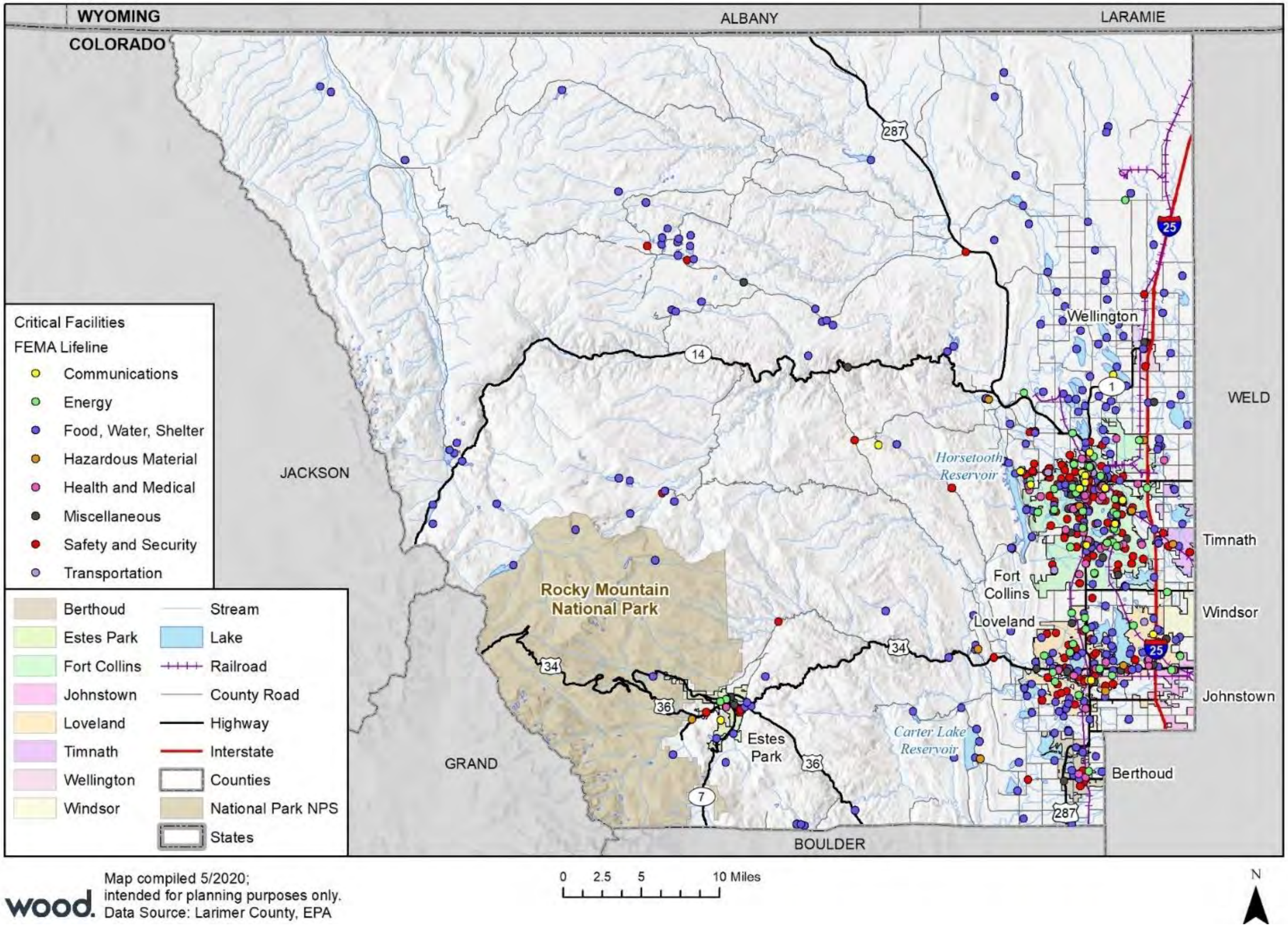
FEMA Lifeline	Critical Facility Type	Total
Communications	Commercial buildings	2
	Utility and other nonbuilding structures	24
	Total	**26**
Energy	Generators	2
	Commercial buildings	18
	Public assembly facilities	2
	Utility and other nonbuilding structures	36
	Total	**58**
Food, Water, Shelter	Agricultural facilities	1
	Commercial buildings	26
	Public assembly facilities	3
	Residential buildings	31
	Utility and other nonbuilding structures (incl. dams)	232
	Total	**293**
Hazardous Material	Commercial buildings	3
	Utility and other nonbuilding structures	9
	Total	**12**
Health and Medical	Institutional or community facilities	31
	Public assembly facilities	25
	Residential buildings	9
	Total	**65**
Safety and Security	Institutional or community facilities	182

FEMA Lifeline	Critical Facility Type	Total
	Specialized military facilities	2
	Utility and other nonbuilding structures	7
	Total	**191**
Transportation	Public assembly facilities	4
	Transportation-related facilities	4
	Total	**8**
Miscellaneous	Commercial buildings	5
	Public assembly facilities	19
	Utility and other nonbuilding structures	4
	Total	**28**
Grand Total		**681**

Source: Cascarta, Larimer County Assessor's Office, Wood analysis.

Critical facilities that are located in areas at risk of hazards are discussed in the Vulnerability Assessment section of each hazard profile.

Figure 4-3 Critical Facilities in Larimer County



4.2.4 Historic, Cultural, and Natural Resources

Assessing the vulnerability of Larimer County to disasters also involves inventorying the natural, historic, and cultural assets of the area. This step is important for the following reasons:

- The community may decide that these types of resources warrant a greater degree of protection due to their unique and irreplaceable nature and contribution to the overall economy.
- If these resources are impacted by a disaster, knowing so ahead of time allows for more prudent care in the immediate aftermath, when the potential for additional impacts are higher.
- The rules and laws for reconstruction, restoration, rehabilitation, and/or replacement are often specific for these types of designated resources (e.g., under the NEPA and Section 106 of the National Historic Preservation Act).
- Natural resources can have beneficial functions that reduce the impacts of natural hazards, such as wetlands and riparian habitat, which help absorb and attenuate floodwaters.

Historical and Cultural Resources

A historic property not only includes buildings or other types of structures such as bridges and dams but can also refer to prehistoric or Native American sites, roads, byways, historic landscapes, and such other features. Given the history of the County, these types of historic properties exist; some are inventoried and listed in this plan and used in appropriate GIS analyses to determine potential vulnerability to hazards.

Historic properties and cultural resources are also valuable economic assets that increase property values and attract businesses and tourists. Far from being at odds with economic development, preservation of these assets is often an important catalyst for economic development (e.g., historic downtown revitalization programs leading to growth in heritage tourism). Some key information on historic assets and properties in Larimer County was obtained from local sources, the HMPC, and the following two historic inventories:

- **National Register of Historic Places.** The Nation's official list of cultural resources worthy of preservation. The National Register is part of a national program to coordinate and support public and private efforts to identify, evaluate, and protect historic and archeological resources. Properties listed include districts, sites, buildings, structures, and objects that are significant in American history, architecture, archeology, engineering, and culture. The National Register is administered by the National Park Service, which is part of the U.S. Department of the Interior.
- **Colorado State Register of Historic Properties.** A listing of the state's significant cultural resources worthy of preservation for the future education and enjoyment of Colorado's residents and visitors. Properties listed in the Colorado State Register include individual buildings, structures, objects, districts, and historic and archaeological sites. The Colorado State Register program is administered by the Office of Archaeology and Historic Preservation within the Colorado Historical Society. Properties listed in the National Register of Historic Places are automatically placed in the Colorado State Register.

Based on these databases there are 135 historic resources in Larimer County. Of these resources 101 are listed on the National Register, 27 are on the State Register and 7 are listed on both Registers. Table 4-11 summarizes those cultural and historic resources throughout Larimer County.

Table 4-11 Historic and Cultural Resources in Larimer County

Property Name	Register	Jurisdiction	Date Listed
A.S. Benson House	National	Loveland	Jan. 6, 2004
Aggie "A"	State	Fort Collins	Sept. 13, 1995
Agnes Vaille Shelter	National	Rocky Mountain National Park, Estes Park	Dec. 24, 1992
Ammons Hall	National	Fort Collins	June 15, 1978
Anderson, Peter, House	National	Fort Collins	Oct. 25, 1979
Armstrong Hotel	National	Fort Collins	Aug. 31, 2000
Arrowhead Lodge	National	Bellvue	May 27, 1992
Avery House	National	Fort Collins	June 24, 1972
Baker House	National	Fort Collins	July 20, 1978
Baldpate Inn	National	Estes Park	Jan. 11, 1996
Bear Lake Comfort Station	National	Estes Park	Jan. 29, 1988
Bee Farm	National	Fort Collins	Nov. 25, 2002
Bennett House	State	Fort Collins	Sep. 25, 2019
Big Thompson River Bridge III	National	Loveland	Oct. 15, 2002
Big Thompson River Bridge IV	National	Loveland	Oct. 15, 2002
Bimson Blacksmith Shop	National	Berthoud	July 23, 1981
Bingham Homestead Rural Historic Landscape	National	Bellvue	April 16, 2013
Birch Cabin	State	Estes Park	Dec. 12, 2001
Borland, Maude Stanfield Harter, House	National	Loveland	July 6, 2004
Botanical and Horticultural Laboratory	National	Fort Collins	Sept. 18, 1978
Bouton, Jay H., House	National	Fort Collins	Dec. 18, 1978
Buckeye School	National	Wellington	June 26, 2008
Chasteen's Grove	National	Loveland	Sept. 6, 1978
Civil & Irrigation Engineering Building, Colorado Agricultural College (Statistics Building)	State	Fort Collins	Dec. 13, 1995
Clatworthy Place	National	Estes Park	July 14, 2004
Colorado and Southern Railway Depot	National	Loveland	June 14, 1982
Colorado-Big Thompson Project Administration Building	State	Estes Park	June 10, 1998
Coy Barn	State	Fort Collins	June 14, 1995
Crags Lodge	National	Estes Park	July 1, 1998
Deines Barn	State	Fort Collins	March 13, 2002
Downtown Loveland Historic District	National	Loveland	June 1, 2015
Dunraven Cottage-Camp Dunraven	National	Estes Park	April 5, 2019
East Longs Peak Trail--Longs Peak Trail--Keyhole Route--Shelf Trail	National	Rocky Mountain National Park, Allenspark	July 10, 2007

Property Name	Register	Jurisdiction	Date Listed
Edgemont	State & National	Estes Park	June 10, 1998 (State) July 15, 1998 (National)
Elkhorn Lodge	National	Estes Park	Dec. 27, 1978
Entomology Building, Colorado Agriculture College (L.L. Gibbons Building)	State	Fort Collins	Dec. 13, 1995
Estes Park Chalet	State	Estes Park	Sept. 13, 1995
Fall River Entrance Historic District	National	Estes Park	Jan. 29, 1998
Fall River Entrance Historic District (Boundary Increase and Additional Documentation)	National	Estes Park	March 5, 2018
Fall River Pass Ranger Station	National	Estes Park	Jan. 29, 1988
Fall River Pump House and Catchment Basin	National	Estes Park	Aug. 30, 2006
Fall River Road	National	Estes Park	July 20, 1987
Fall River Road (Boundary Increase and Additional Documentation)	National	Estes Park	May 21, 2018
Fansler House	State	Loveland	Dec. 13, 2000
Fern Lake Patrol Cabin	National	Estes Park	Jan. 29, 1988
Fern Lake Trail	National	Estes Park	Feb. 28, 2005
First National Bank Building	National	Wellington	Aug. 10, 2000
First United Presbyterian Church	State & National	Loveland	March 8, 2000 (State) July 7, 2004 (National)
Flattop Mountain Trail	National	Rocky Mountain National Park, Estes Park	Sept. 27, 2007
Flowers Store (Cache la Poudre Grange No. 456)	State	Bellvue	Feb. 14, 2006
Flowers' House (Jacob and Elizabeth Flowers)	National	Bellvue	March 1, 2007
Forestry Building, Colorado State College of Agriculture & Mechanical Arts (Building #81)	State	Fort Collins	Aug. 11, 1999
Fort Collins Armory	National	Fort Collins	Oct. 15, 2002
Fort Collins Masonic Temple	State	Fort Collins	Feb. 28, 2008
Fort Collins Municipal Railway Birnery Safety Streetcar No. 21	National	Fort Collins	Jan. 5, 1984
Fort Collins Post Office	National	Fort Collins	Jan. 30, 1978
Fort Collins Waterworks	State	Fort Collins	10-Mar-99
Gem Lake Trail	National	Rocky Mountain National Park, Estes Park	Jan. 29, 2008
Glacier Basin Campground Ranger Station	National	Rocky Mountain National Park, Estes Park	July 20, 1987
Graves Camp Rural Historic District	National	Wellington	Dec. 14, 2016
Great Western Sugar Company Effluent Flume and Bridge	National	Fort Collins	Nov. 19, 2014

Property Name	Register	Jurisdiction	Date Listed
Greeley, Salt Lake and Pacific Railroad--Stout Branch	National	Laporte	April 16, 2008
Guggenheim Hall, Colorado Agricultural College	State	Fort Collins	Dec. 13, 1995
Harmony Mill	National	Fort Collins	Nov. 22, 1995
Hewes--Kirkwood Inn	National	Estes Park	Oct. 28, 1994
Homestead Meadows Discontiguous District	National	Estes Park	Oct. 4, 1990
Hyatt-Spence-Pulliam Ranch	State	Loveland	Oct. 28, 2011
Kaplan-Hoover Site	State & National	Windsor	April 18, 2003 (National) March 10, 2004 (State)
Kelley House	National	Loveland	Nov. 15, 2019
Kissock Block Building	National	Fort Collins	May 16, 1985
Lake Haiyaha Trail	National	Rocky Mountain National Park, Estes Park	March 5, 2008
Laurel School Historic District	National	Fort Collins	Oct. 3, 1980
Lavatory/Entomology Laboratory, Colorado Agricultural College (Nutrition Research Laboratory)	State	Fort Collins	Dec. 13, 1995
Leiffer House	National	Estes Park	Aug. 2, 1978
Library, Colorado Agricultural College (Laurel Hall)	State	Fort Collins	Dec. 13, 1995
Lindenmeier Site	National	Fort Collins	Oct. 15, 1966
Livermore Hotel and General Store	National	Livermore	Sept. 14, 2001
Lost Lake Trail	National	Rocky Mountain National Park, Estes Park	March 5, 2008
Loveland State Amory	National	Loveland	April 12, 2001
MacGregor Ranch	National	Estes Park	July 31, 1989
Maxwell, R. G., House	National	Fort Collins	Sept. 29, 1980
McCreery House	State & National	Loveland	Feb. 14. 2001 (State) May 2, 2001 (National)
McGraw Ranch	National	Rocky Mountain National Park, Estes Park	Sept. 17, 1998
McHugh-Andrews House	National	Fort Collins	Dec. 27, 1978
Mechanical Engineering Building, Colorado Agricultural College (Industrial Sciences Building)	State	Fort Collins	Dec. 13, 1995
Mills, Enos, Homestead Cabin	National	Estes Park	May 11, 1973
Milner--Schwarz House	National	Loveland	May 19, 2014
Montezuma Fuller House	National	Fort Collins	Dec. 15, 1978
Moraine Lodge	National	Rocky Mountain National Park, Estes Park	Oct. 8, 1976
Moraine Park Museum and Amphitheater	National	Rocky Mountain National Park, Estes Park	June 15, 2005
Mosman House	National	Fort Collins	Dec. 15, 1978

Property Name	Register	Jurisdiction	Date Listed
Mountainside Lodge	State & National	Estes Park	May 14, 1997 (State) July 20, 2000 (National)
North Inlet Trail	National	Rocky Mountain National Park, Grand Lake	March 5, 2008
Old Town Fort Collins	National	Fort Collins	Aug. 2, 1978
Opera House Block/Central Block Building	National	Fort Collins	Feb. 8, 1985
Park Theatre	National	Estes Park	14-Jun-84
Patterson House	National	Fort Collins	Jan. 22, 2019
Peep O Day Park	National	Loveland	Aug. 10, 2011
Pleasant Valley School	National	Bellvue	Oct. 1, 2003
Plummer School	State & National	Fort Collins	Sep. 11, 1996 (State) April 29, 1999 (National)
Potting Shed, Colorado Agricultural College (Forensics Laboratory)	State	Fort Collins	Dec. 13, 1995
Preston Farm	National	Fort Collins	May 10, 2001
Provost Homestead--Herring Farm Rural Historic Landscape	National	Laporte	Dec. 27, 2010
Ramsey-Koening Ranch	State	Bellvue	May 14, 1997
Red Feather Lakes Post Office	State	Red Feather Lakes	Sept. 25, 2019
Rialto Theater	National	Loveland	Feb. 17, 1988
Robertson, T. H., House	National	Fort Collins	July 2, 1992
Rocky Mountain National Park Administration Building	National	Rocky Mountain National Park, Estes Park	Jan. 3, 2001
Rocky Mountain National Park Utility Area Historic District	National	Rocky Mountain National Park, Estes Park	March 18, 1982
Schlichter, E.A., House	National	Fort Collins	Nov. 22, 2016
Shaffer, Henry K. and Mary E., House	National	Loveland	Jan. 9, 2007
Snogo Snow Plow	National	Estes Park	Oct. 4, 2006
Soils Building, Colorado Agricultural College (Vocational Education/Soils Laboratory)	State	Fort Collins	Dec. 13, 1995
Soloman Batterson Ranch (Rural Historic Landscape)	National	Livermore	Oct. 28, 2010
Spruce Hall	National	Fort Collins	Jan. 9, 1977
Stanley Hotel	National	Estes Park	May 26, 1977
Stanley Hotel District	National	Estes Park	June 20, 1985
Stanley Hotel District (Stanley Power Plant Boundary Increase)	National	Estes Park	April 14, 19998
Stove Prairie School	State	Bellvue	March 11, 1998
Swanson, Gustav and Annie, Farm	National	Berthoud	Oct. 5, 2005
Trail Ridge Road	National	Rocky Mountain National Park, Estes Park	Nov. 14, 1984
Truscott Junior High School	National	Loveland	July 16, 2017

Property Name	Register	Jurisdiction	Date Listed
Twin Sisters Lookout	National	Rocky Mountain National Park, Estes Park	Dec. 24, 1992
United Brethren Church	State	Berthoud	May 16, 2001
Vaille, Agnes, Shelter	National	Rocky Mountain National Park, Estes Park	Dec. 24, 1992
Veterinary Medicine Building, Colorado State College of Agriculture & Mechanical Arts	State	Fort Collins	Aug. 11, 1999
Virginia Dale Stage Station	National	Virginia Dale	Sept. 26, 1985
Waycott, Ernest, House	National	Fort Collins	Dec. 2, 1993
White, William Allen, Cabins	National	Rocky Mountain National Park, Estes Park	Oct. 25, 1973
Willard, Beatrice, Alpine Tundra Research Plots	National	Estes Park	Oct. 25, 2007
Willow Park Patrol Cabin	National	Rocky Mountain National Park, Estes Park	July 20, 1987
Willow Park Stable	National	Rocky Mountain National Park, Estes Park	July 20, 1987
Wind Ridge	State & National	Estes Park	March 13, 2002 (State) Oct. 15, 2002 (National)
Wurl Ranch	State	Livermore	Dec. 13, 1995
Ypsilon Lake Trail	National	Rocky Mountain National Park, Estes Park	March 5, 2008

Source: National Register of Historic Places, History Colorado National & State Register Listed Properties database

Natural Resources

Natural resources are important to include in benefit-cost analyses for future projects and may be used to leverage additional funding for projects that also contribute to community goals for protecting sensitive natural resources. Awareness of natural assets can lead to opportunities for meeting multiple objectives. For instance, protecting wetland areas protects sensitive habitat as well as attenuates and stores floodwaters.

Wetlands

Wetlands are a valuable natural resource for communities due to their benefits to water quality, wildlife protection, recreation, and education, and play an important role in hazard mitigation. Wetlands provide natural floodplain protection by reducing flood peaks and slowly releasing floodwaters to downstream areas. When surface runoff is dampened, the erosive powers of the water are greatly diminished. Furthermore, the reduction in the velocity of inflowing water as it passes through a wetland helps remove sediment being transported by the water. They also provide drought relief in water-scarce areas where the relationship between water storage and streamflow regulation is vital (Wetland Functions and Values, 2016).

Endangered Species

To further understand natural resources that may be particularly vulnerable to a hazard event, as well as those that need consideration when implementing mitigation activities, it is important to identify at-risk species (endangered and threatened species) in the planning area. An endangered species is any species of fish, plant life, or wildlife that is in danger of extinction throughout all or most of its range. A threatened species is a species that is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range. Both endangered and threatened species are protected by law and any future hazard mitigation projects are subject to these laws. Candidate species are a third category of plants and animals at risk, but these have been proposed as endangered or threatened but are not currently listed.

According to the U.S. Fish and Wildlife Service (USFW) Environmental Conservation Online System (ECOS), there were 19 federally endangered, threatened, or candidate/proposed/under/other status review species in Larimer County (as of July 2020). These are listed in Table 4-12.

Table 4-12 Endangered Species in Larimer County

Group	Common Name	Scientific Name	Status
Birds	Whooping crane	*Grus americana*	Experimental Population, Non-Essential
Birds	Bald eagle	*Haliaeetus leucocephalus*	Recovery
Birds	American peregrine falcon	*Falco peregrinus anatum*	Recovery
Birds	Mexican spotted owl	*Strix occidentalis lucida*	Threatened
Birds	Southern white-tailed ptarmigan	*Lagopus leucura altipetens*	Under Review
Fishes	Humpback chub	*Gila cypha*	Endangered
Fishes	Colorado pikeminnow (squawfish)	*Ptychocheilus lucius*	Endangered
Fishes	Greenback Cutthroat trout	*Oncorhynchus clarkii stomias*	Threatened
Fishes	Bonytail	*Gila elegans*	Endangered
Fishes	Razorback sucker	*Xyrauchen texanus*	Endangered
Flowering Plants	Colorado Butterfly plant	*Gaura neomexicana var. coloradensis*	Recovery
Flowering Plants	North Park phacelia	*Phacelia formosula*	Endangered
Flowering Plants	Ute ladies'-tresses	*Spiranthes diluvialis*	Threatened
Flowering Plants	Western prairie fringed Orchid	*Platanthera praeclara*	Threatened
Mammals	Black-footed ferret	*Mustela nigripes*	Endangered
Mammals	Canada Lynx	*Lynx canadensis*	Threatened
Mammals	Preble's meadow jumping mouse	*Zapus hudsonius preblei*	Threatened
Mammals	North American wolverine	*Gulo gulo luscus*	Proposed Threatened
Mammals	Little brown bat	*Myotis lucifugus*	Under Review

Source: U.S. Fish & Wildlife Service Environmental Conservation Online System

4.3 Hazard Analysis and Risk Assessment

4.3.1 Biological Hazards

Hazard	Frequency	Spatial Extent	Severity	Overall Significance
Biological Hazards	Highly Likely	Extensive	Catastrophic	High

Description

Biological hazards and contagions, including epidemics and pandemics, have the potential to cause serious illness and death, especially among those who have compromised immune systems due to age or underlying medical conditions. There are several contagious and infectious diseases present in the State of Colorado that constitute a public health risk. Emergency Support Function 8 (ESF 8) of the Larimer County Emergency Operations Plan provides an organizational framework for public health and medical service preparedness, response, and recovery efforts for various emergency epidemics. During the 2016 planning process, pandemic flu was identified as the key public health hazard in the county. This hazard risk assessment includes an analysis of pandemic flu risk in Larimer County and an analysis of the impacts of the hazards profiled in this plan on biological hazards and contagions.

A pandemic can be defined as a disease that attacks a large population across great geographic distances. Pandemics are larger than epidemics in terms of geographic area and number of people affected. Epidemics tend to occur seasonally and affect much smaller areas. Pandemics, on the other hand, are most often caused by new subtypes of viruses or bacteria for which humans have little or no natural resistance. Consequently, pandemics typically result in more deaths, social disruption, and economic loss than epidemics.

According to data from the Colorado Reportable Disease Statistics (CDPHE) database, Influenza viruses represent the most common cause of hospitalization due to disease in Larimer County. Seasonal influenza (often referred to as the flu) is a common infection that affects large numbers of people in Colorado every year. Influenza is an acute respiratory disease caused by influenza type A or B viruses. The typical features of seasonal influenza include abrupt onset of fever and respiratory symptoms such as cough, sore throat, as well as headache, muscle ache, and fatigue. For seasonal influenza, the incubation period ranges from 1 to 4 days and the clinical severity of infection can range from asymptomatic infection to primary viral pneumonia and death. Most people experience influenza as a very-uncomfortable but ultimately benign illness. However, the influenza virus can mutate, causing it to be much more dangerous to humans. Yearly seasonal influenza remains a significant disease in the U.S. and Colorado, and seasonal epidemics can result in high morbidity and mortality, as well as create strains on the health care system and communities.

There are three conditions that must be met before an influenza pandemic begins:

1. A new virus subtype must emerge that has not previously circulated in humans (and therefore there is no pre-existing immunity),
2. This new subtype must be able to cause disease in humans, and
3. The virus must be easily transmissible from human to human.

Unlike influenza viruses that have achieved ongoing transmission in humans, the sporadic human infections with avian A (H5N1) viruses are far more severe with high mortality. Initial symptoms include high fever and other influenza-like symptoms. It also appears that the incubation period in humans may be longer for avian (H5N1) viruses, ranging from 2 to 8 days, and possibly as long as 17 days. Diarrhea, vomiting, abdominal pain, chest pain, and bleeding from the nose and gums have also been reported. The disease often manifests as a rapid progression of pneumonia with respiratory failure ensuing over several days.

Zoonotic diseases are diseases that can be spread through animals and humans. These diseases can be caused by bacteria, viruses, parasites, and fungi that are carried by animals and insects. Hantavirus is an example that may pose a higher risk to Larimer County residents in the future. Deer mice are the primary reservoir for Hantaviruses.

Past Occurrences

Public health hazards can manifest as primary events by themselves, or they may be secondary to another disaster or emergency, such as a flood, a severe storm, or a hazardous materials incident. The common characteristic of most public health emergencies is that they adversely impact, or have the potential to adversely impact, a large number of people.

The Colorado Department of Public Health and Environment releases an annual reportable disease summary for each county. The events with the highest incidences in Larimer County between 2010 and 2018 (the most recent year for which data was available) are summarized in Table 4-13.

Table 4-13 Colorado Reportable Disease Statistics for Larimer County, 2010-2018

Disease	2010	2011	2012	2013	2014	2015	2016	2017	2018	Total
Campylobacter	91	78	49	80	62	73	65	95	103	696
Carbapenem-Resistant Enterobacteriaceae (CRE)	-	-	-	-	-	-	-	12	14	26
Carbapenem-Resistant Pseudomonas Aeruginosa (CRPA)	-	-	-	-	-	-	-	86	71	157
Cryptosporidiosis	8	14	5	3	11	14	26	12	33	126
Giardiasis	21	16	15	13	16	13	16	25	39	174
Haemophilus Influenzae	5	4	7	3	4	6	5	8	2	44
Hepatitis B, Chronic	14	19	16	18	22	19	19	16	17	160
Hepatitis C, Chronic	115	104	94	80	80	145	193	277	291	1379
Influenza-Hospitalized	1	40	69	103	169	91	79	268	237	1057
Meningitis Aseptic/Viral	29	24	19	6	7	-	-	-	-	85
Pertussis	8	7	79	81	79	89	34	30	42	449
Salmonellosis	34	21	37	28	39	36	49	46	88	378
Shigellosis	2	5	11	7	3	3	4	3	12	50
STEC (Shiga Toxin Producing E. coli)	21	14	15	14	5	11	10	17	33	140
Strep Pneumo Invasive	16	20	17	15	18	28	28	25	20	187
Varicella (Chicken Pox)	22	29	43	20	41	33	36	22	30	276
West Nile Virus	14	2	-	-	-	-	-	14	17	47
Total:	**401**	**397**	**476**	**471**	**556**	**561**	**564**	**956**	**1049**	**5431**

Source: Division of Disease Control and Environmental Epidemiology, CDPHE

Chronic Hepatitis C and hospitalizations from influenza represented the largest disease incidences in Larimer County between 2010 and 2018. Note that Carbapenem (i.e., antibiotic) Resistant Enterobacteriaceae (CRE) and Pseudomonas Aeruginosa (CRPA) were only added to the CDPHE database starting in 2017.

Pandemics

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

- **1918-1919 Spanish Flu:** The Spanish Flu was the most severe pandemic in recent history. The number of deaths was estimated to be 50-100 million worldwide and 675,000 in the United States. Its primary victims were mostly young, healthy adults. At one point, more than 10 percent of the American workforce was bedridden.
- **1957-1958 Asian Flu:** The 1957 Asian Flu pandemic killed 1-2 million people worldwide, including about 70,000 people in the United States, mostly the elderly and chronically ill. Fortunately, the virus was quickly identified, and vaccine production began in May 1957.
- **1968-1969 H3N2 Hong Kong Flu:** The 1968 Hong Kong Flu pandemic killed 34,000 Americans. Again, the elderly were more severely affected. This pandemic peaked during school holidays in December, limiting student-related infections, which may have kept the number of infections down. Also, people infected by the Asian Flu ten years earlier may have gained some resistance to the new virus.
- **2009-2010 H1N1 Swine Flu:** This influenza pandemic emerged from Mexico in early 2009 and was declared a public health emergency in the U.S. on April 26. By June, approximately 18,000 cases had been reported in the U.S. and the virus had spread to 74 countries. Most cases were fairly mild, with symptoms similar to the seasonal flu, but there were cases of severe disease requiring hospitalization and a number of deaths. The CDC estimates that 43-89 million people were infected worldwide, with an estimated 8,870 to 18,300 H1N1 related deaths, including 12,469 deaths in the United States.
- **2020-Ongoing COVID-19:** The COVID-19 or coronavirus pandemic began in December 2019 and was declared a pandemic in March of 2020. As of September 15th, 2020, it has killed more than 900,000 people worldwide and more than 190,000 Americans. It is expected to last through the remainder of 2020 and possibly into 2021.

Location

Infectious disease outbreaks can occur anywhere in the planning area, especially where there are groups of people in close quarters. More highly-populated areas may be affected sooner and may experience higher infection rates.

Magnitude/Severity

The magnitude of a health-related emergency will range significantly depending on the aggressiveness of the virus in question and the ease of transmission. Pandemic influenza is easily transmitted from person-to-person but advances in medical technologies have greatly reduced the number of deaths caused by influenza over time. In terms of lives lost, the impact of various pandemic influenza outbreaks over the last century has declined globally. However, a recent trend in parents not vaccinating their children could increase the likelihood and severity of an outbreak.

Epidemics and pandemics can lead to high infection rates in the population causing isolation, quarantine, and potential mass fatalities. An especially severe influenza pandemic or other major disease outbreak could lead to high levels of illness, death, social disruption, and economic loss. Impacts could range from school and business closings to the interruption of basic services such as public transportation, health care, and the delivery of food and essential medicines.

Overall, the impacts from a pandemic outbreak in Larimer County could be critical, with 25-50% of the planning area's population affected. Depending on the specific disease, the elderly and/or the very young could be impacted the most, along with people with pre-existing medical conditions. Local medical facilities could be rapidly overwhelmed. The medical facilities of neighboring jurisdictions would most likely also be overwhelmed and unable to provide assistance.

Table 4-14 describes the World Health Organization's six main phases to a pandemic flu as part of their planning guidance.

Table 4-14 World Health Organization's Pandemic Flu Phases

Phase	Description
1	No animal influenza virus circulating among animals have been reported to cause infection in humans.
2	An animal influenza virus circulating in domesticated or wild animals is known to have caused infection in humans and is therefore considered a specific potential pandemic threat.
3	An animal or human-animal influenza reassortant virus has caused sporadic cases or small clusters of disease in people but has not resulted in human-to-human transmission sufficient to sustain community-level breakouts.
4	Human-to-human transmission of an animal or human-animal influenza reassortant virus able to sustain community-level breakouts has been verified.
5	The same identified virus has caused sustained community-level outbreaks in two or more countries in one WHO region.
6	In addition to the criteria defined in Phase 5, the same virus has caused sustained community-level outbreaks in at least one other country in another WHO region.
Post-Peak Period	Levels of pandemic influenza in most countries with adequate surveillance have dropped below peak levels.
Post-Pandemic Period	Levels of influenza activity have returned to levels seen for seasonal influenza in most countries with adequate surveillance.

Source: World Health Organization

Probability of Future Occurrences

Based on historical record of 2,308 recorded diseases in Larimer County since 2010, public health hazards have affected Larimer County residents and visitors more than once every year from 2010 through 2014. The historic frequency suggests that there is a 100% chance of some type of public health hazard will affect Larimer County every year. However, most of those will have relatively minor impacts within the capabilities of the County's public health system.

It is not possible to predict when the next pandemic will occur, or how severe it will be. Based on the five pandemics that have affected the United States in roughly the last 100 years, a pandemic occurs on average roughly every 20 years.

Today, a much larger percentage of the world's population is clustered in cities, making them ideal breeding grounds for epidemics. Additionally, the explosive growth in air travel means the virus could literally be spread around the globe within hours. Under such conditions, there may be very little warning time. Most experts believe we will have just one to six months between the time that a dangerous new influenza strain is identified and the time that outbreaks begin to occur in the United States. Outbreaks are expected to occur simultaneously throughout much of the nation, preventing shifts in human and material resources that normally occur with other natural disasters. These and many other aspects make influenza pandemic unlike any other public health emergency or community disaster. Pandemics typically last for several months to 1-2 years.

Climate Change Considerations

According to the best available data, the changing climate is expected to exacerbate future pandemics. Climate change will influence vector-borne disease prevalence, although the direction of the effects (increased or decreased incidence) will be location- and disease specific. The intensity and extent of certain diseases is projected to increase. Climate change threatens to increase the spread of infectious diseases because changing heat, rain, and humidity levels allow disease carrying vectors and pathogens to come into closer contact with humans. If Colorado's climate becomes warmer, mosquito populations could swell, making the region more favorable for disease transmission. Warmer weather could also play a role in elevated seasonal deer mouse populations. Disadvantaged populations such as people with compromised health and the economically disadvantaged are expected to bear a greater burden as a result of their current reduced access to medical care and limited resources for adaptation strategies.

Additional research is needed to determine the effects of climate change on the frequency and duration of epidemics and pandemics. Ongoing efforts to reduce Colorado's greenhouse gas emissions and adapt to a changing climate, such as the Colorado Climate Plan, may help to reduce the impacts of climate change on pandemics.

Vulnerability Assessment

The 2018 Colorado State Hazard Mitigation Plan lists several assumptions and guidelines for pandemic influenza planning. These are listed below, with notes where they have been found not to apply to the current COVID-19 pandemic:

A. Susceptibility to the virus will be universal.
B. The clinical disease attack rate will be about 30% of the overall population. The highest rates will be among school-aged children, at around 40%. About 20% of working adults will become ill.
C. Of those who become ill with the new strain, 50% will seek outpatient medical care.
D. In an infected community, a pandemic outbreak will last about six to eight weeks, with at least two waves likely. The seasonality cannot be predicted with certainty. *(Note: the COVID-19 pandemic has lasted six months as of September 2020 and is expected to last several more months.)*
E. The number of hospitalizations and death will depend on the virulence of the virus.
F. Based on an extrapolation for a severe pandemic, Colorado deaths are estimated to exceed 30,000. It is assumed that the pandemic will occur in two waves, lasting six to eight weeks each. Colorado can expect to see approximately 350 deaths per day. This factors in the 80 deaths per day that Colorado typically has per day. *(Note: Colorado has experienced 62,000 cases of COVID-19 with 2,000 deaths as of September 2020.)*
G. Risk groups for severe and fatal infections cannot be predicted with certainty. During annual fall and winter influenza season, infants and the elderly, persons with chronic illnesses, and pregnant women are usually at higher risk of complications from influenza infections.
H. In a severe pandemic, it is expected that absenteeism may reach 40% due to illness, the need to care for ill family members, and fear of infection during the peak weeks of a community outbreak. Certain public health measures (closing schools, quarantining household contacts of infected individuals, "snow days") are likely to increase rate of absenteeism.
I. The typical incubation period is two days. It is assumed this would be the same for a novel strain that is transmitted between people by respiratory secretions. *(Note: This depends on the virus; for COVID-19 the period is 2-14 days.)*
J. Persons who become ill may shed the virus and can transmit infection for up to one day before the onset of symptoms. Viral shedding and the risk of transmission will be greatest during the first two days of illness. Children shed the greatest amount of virus and are therefore the most likely to pose a risk for transmission. *(Note: patients with COVID-19 can transmit infection for a number of days while asymptomatic, and children are not the greatest infection risk.)*
K. On average, infected persons will transmit the infection to approximately two other people. Some estimates from past pandemics have been higher.

L. Outbreaks can be expected to occur simultaneously throughout much of the United States, preventing shifts in human and material resources that usually occur in response to other disasters.
M. Localities must be prepared to rely on their own resources to respond. The effect of influenza on individual communities will be relatively prolonged (weeks to months) in comparison to other types of disasters.
N. Healthcare workers, public health workers, and other responders (i.e., law enforcement and firefighters) may be at higher risk of exposure and illness than the general population, further straining the pandemic response.
O. Effective prevention and therapeutic measures, including vaccine and antiviral agents, may be delayed and, initially, in short supply or not available.
P. Substantial public education regarding the need to target priority groups for vaccination and possibly for antiviral medication, and rationing of limited supplies, is paramount to controlling public panic.
Q. Adequate security measures must be in place while distributing limited supplies of vaccine or antiviral medication.
R. All plans must account for the uncertainness of the situation.

Preparing for, responding to, and recovering from pandemic influenza will require a strategy that includes a holistic suite of public health activities designed to lessen the impact on morbidity and mortality. These activities include education, vaccination, prophylaxis, isolation/quarantine, a robust contact tracing program, and the closure of public facilities. In addition, clear, concise communication with the public and with other agencies remains a critical component, as does the ability of the involved agencies to achieve collaboration and coordination. By its very nature, an influenza pandemic, once started, will not be stopped until it has run its course. This course can be shortened and weakened by a number of factors, with vaccination being the gold standard for protecting the population. Pandemic plans describe strategies of preparedness, response, and recovery to attempt to decrease illnesses and deaths during the pandemic period to manageable levels (i.e., that do not overwhelm the critical infrastructures of the State), and to promote community resiliency and rapid recovery.

The Colorado Department of Public Health and Environment has developed a number of resources related to pandemic health hazards to supplement the State Emergency Operations Plan. Listed below are a number of pandemic response plans, health alert networks, and resources currently available for residents and planners in the State of Colorado and Larimer County.

Table 4-15 Influenza Planning Resources and Guidelines

Title	Source
Pandemic Influenza Action Plan for Schools (2009)	Colorado Department of Public Health and Environment
Infectious Diseases in Child Care and School Settings: Guidelines for Childcare Providers, School Nurses and Other Personnel (2013)	Colorado Department of Public Health and Environment
Pandemic Influenza Planning Guidelines for Hospitals (2009)	Colorado Department of Public Health and Environment
Home Care Guide: Providing Care at Home During Pandemic Flu (2009)	Colorado Department of Public Health and Environment
Guidelines for Medical Office Pandemic Readiness (2007)	Colorado Department of Public Health and Environment
Social Distancing Support Guidelines for Pandemic Readiness (2008)	Colorado Department of Public Health and Environment
Colorado Health Alert Network (HAN)	Colorado Department of Public

Title	Source
	Health and Environment
Public Health Emergency Operations Plan	Larimer County
Comprehensive Emergency Management Plan: Emergency Operations	Larimer County
Comprehensive Emergency Management Plan: Continuity of Operations	Larimer County
Comprehensive Emergency Management Plan: Recovery	Larimer County
Comprehensive Emergency Management Plan: Resiliency Framework	Larimer County
Epidemiology Plan	Larimer County
Quarantine and Isolation Plan	Larimer County
Risk Communication Plan	Larimer County
Strategic National Stockpile and Mass Prophylaxis/Vaccination Point-of-Dispensing Plan	Larimer County
Mass Fatality Plan	Larimer County
Pandemic Influenza Plan	Larimer County

Source: HMPC

Where necessary, details or public information templates unique to pandemic influenza have been included in the plans listed above. The guidelines and plans provide background information related to pandemic influenza and infectious diseases, outline concepts of operations for response, list primary and support functional areas, and outline available resources and tools to mitigate a pandemic and promote community resilience recovery.

People

Pandemics have the ability to affect large segments of the population for long periods of time. According to the 2018 Colorado State Hazard Mitigation Plan, a pandemic flu outbreak could affect approximately 30% of the state's overall population, with as much as 10% possibly needing hospitalization. The number of hospitalizations and deaths will depend on the virulence of the virus. Risk groups cannot be predicted with certainty; the elderly, people with underlying medical conditions, and young children are usually at higher risk, but as discussed above this is not always true for all influenza strains. People without health coverage or access to good medical care are also likely to be more adversely affected.

Table 4-16 highlights a number of key pandemic vulnerability factors in Larimer County jurisdictions using 2018 Census Bureau data.

Table 4-16 Biological Hazards / Contagion Vulnerability Factor Data

Jurisdiction	Age: 5 and Under (%)	Age: 65 and Over (%)	People Below Poverty Level (%)	Persons Without Health Insurance (%)
Colorado	6.1%	13.4%	10.9%	8.1%
Larimer County	5.4%	16.3%	12.0%	6.3%
Town of Berthoud	6.1%	13.6%	7.4%	10.7%
Town of Estes Park	4.1%	33.9%	13.5%	12.2%
City of Fort Collins	5.2%	10.3%	16.8%	6.2%
Town of Johnstown	9.2%	12.9%	1.3%	3.2%
City of Loveland	5.1%	18.9%	7.9%	6.5%
Town of Timnath	6.1%	13.6%	3.2%	2.1%
Town of Wellington	12.3%	7.5%	5.7%	3.8%
Town of Windsor	7.0%	14.0%	4.3%	3.3%

Source: U.S. Census Bureau

The communities of Estes Park and Loveland have significantly higher percentages of elderly residents than the average for the State of Colorado. Johnstown and Wellington have higher percentage of children. The poverty rate is higher than average for Larimer County as a whole, and particularly for Estes Park and Fort Collins. The Towns of Estes Park and Berthoud have more people without health insurance than the state average. Also, as noted in Section 2.7, Larimer County has a higher percentage of people living in multiunit housing (more than 10 units per structure) and in group quarters such as dormitories or prisons, which could potentially accelerate the spread of disease. All these demographic trends are important to monitor over time as they will present unique challenges for the management and mitigation of biological hazards/contagions.

In the event of a pandemic, medical personnel would be incredibly overtaxed. Help from the federal government and from other states would likely be limited, as other portions of the country are likely to also be affected. Communities may have to rely on their own resources for a much longer period of time as compared to other disasters. Medications may be limited to help prevent or treat the disease. It typically takes five to six months to manufacture a vaccine, but it would likely become available in small quantities at first. Health care supplies such as protective gear would also likely be in high demand, and supply-chains, including at the manufacturing level, are also likely to be significantly disrupted. National stockpiles may not be enough to resupply local health care providers.

Other responders will be impacted similarly to the general public, although the nature of their jobs may make social distancing more difficult which could potentially lead to higher infection rates, thereby reducing available responders.

General Property

For the most part, property itself would not be impacted by a human disease epidemic or pandemic. However, as concerns about contamination increase, property may be quarantined or destroyed as a precaution against spreading illness. Additionally, traditional sheltering facilities including homeless shelters or facilities stood up to support displaced persons due to an evacuation or other reason due to a simultaneous disaster occurring cannot be done in a congregate setting. This requires additional planning considerations or use of facilities that allow for non-congregate shelter settings which may require an approval of a request to FEMA for non-congregate sheltering and may have an increased cost (such as the use of individual hotel rooms) as opposed to traditional congregate sheltering facilities.

Critical Facilities and Infrastructure

Hospitals and morgues will be heavily affected and may be overwhelmed. Other critical facilities and infrastructure are not directly affected by a pandemic but may have difficulty maintaining operations and maintenance activities due to a significantly decreased workforce. Schools may be forced to close.

Government facilities may have difficulty continuing to provide services due to staffing shortages. The Larimer County Continuity of Government Plan and departmental Continuity of Operations Plans address how to continue to provide essential services during a staffing shortage.

Economy

In a normal year, lost productivity due to illness costs U.S. employers an estimated $530 billion. During a pandemic, that figure would likely be considerably high and could trigger a recession or even a depression.

FluWorkLoss 1.0 is a tool developed by the CDC to estimate the potential economic impact of pandemic influenza on a community in terms of the number of workdays lost. Days missed from work cost both employees in lost wages, and employers in work not completed. Table 4-17 shows the total estimated number of days lost from work in Larimer County due to a four-week long influenza pandemic with a 25% clinical attack rate. The available workdays are calculated as a product of the total population in the working age group (Census 2010), the employment rate of Larimer County (Census 2010), and five workdays in a week. Results are estimated based on three scenarios: a mild, best-case scenario; a most likely scenario, and a more severe worst-case scenario.

Table 4-17 Total Workdays Lost (Pandemic Influenza)

Scenario	Workdays Lost
Minimum Loss Scenario	121,312
Most Likely Scenario	144,596
Maximum Loss Scenario	180,307

Source: FluWorkLoss 1.0, CDC

The number of workdays lost includes days lost for both self-care and care of sick family members and shows the County could lose hundreds of thousands of workdays in a month. Moreover, these estimates do not include workdays lost due to secondary impacts such as social distancing and the closure of schools and businesses.

Historic, Cultural and Natural Resources

Impacts to these resources are typically minimal. However, reduced tourism could lead to additional economic impacts.

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

Risk Summary

Ongoing mitigation activities should focus on preventing infection during flu season. This includes, but is not limited to, pre-season community outreach campaigns to educate the public about risks and available support; establishing convenient vaccination centers; reaching out to vulnerable populations and care givers; and issuing advisories and warnings.

- Pandemics affecting the U.S. occur roughly once every 20 years but cannot be reliably predicted.
- Effects on people will vary, but as much as 30% of the population could become ill, and 10% may need to be hospitalized
- Effects on property are typically minimal, although quarantines could result in short-term closures. Critical facilities may have difficulty maintaining operations due to staffing shortages.
- Lost productivity due to illness and potential business closures could potentially have severe economic impacts. Social distancing requirements and fear of public gatherings could significantly reduce in-person commerce.
- Related Hazards: None

4.3.2 Civil Disturbance

Hazard	Frequency	Spatial Extent	Severity	Overall Significance
Civil Disturbance	Likely	Limited	Significant	Medium

Description

Civil disturbance refers to one or more forms of disturbance or disruption caused by a group of people. The term is typically used by law enforcement and includes acts of violence and disorder detrimental to the public law and order. Civil disturbance includes acts such as riots, acts of violence, insurrections, unlawful obstructions or assemblages, or other disorders prejudicial to public law and order. It also includes all domestic conditions requiring or likely to require the use of federal armed forces.

Incidents that have disrupted the public peace have figured prominently throughout this country's history. Constitutional guarantees allow for ample expression of protest and dissent, and in many cases can collide with the preamble's requirement of the government "to ensure domestic tranquility." Typical examples of such conflicting ideology include the protest movements for civil rights in the late 1960s and the Vietnam War protest demonstrations in the early 1970s. The balance between an individual's and group's legitimate expression of dissent and the right of the populace to live in domestic tranquility requires the diligent efforts of everyone to avoid such confrontations in the future.

In modern society, laws have evolved that govern the interaction of its members to peacefully resolve conflict. In the United States, a crowd itself is constitutionally protected under "the right of the people to peacefully assemble." However, assemblies that are not peaceable are not protected, and this is generally the dividing line between crowds and mobs. The laws that deal with disruptive conduct are generally grouped into offenses that disturb the public peace. They range from misdemeanors, such as blocking sidewalks or challenging another to fight, to felonies, such as looting and rioting. Acts of civil disturbance are often a symptom and/or form of protest against major socio-political problems, and the severity of the event can coincide with public sentiment or expressions of displeasure. These acts may be spontaneous, such as when a group of people suddenly and unexpectedly erupts into violence, or it may be a planned event, such as a demonstration, a march, or a protest designed to intentionally interfere with another's lawful business or activity. In recent years, it has become more common to see protests or disturbances in one city ignite similar protests across the country.

Until recently, the majority of the civil disturbances in Larimer County had resulted from out-of-control parties or celebrations, but in recent years the County has seen a number of protests around political or social causes. The majority of these events have been peaceful and have not caused major concern or property damage. There have however been a few protests that have turned violent when two opposing groups have engaged with one another. As political tensions increase nationally, this trend may continue or worsen.

In an article on "Understanding Riots" published in the Cato Journal (Vol. 14, No 1), David D. Haddock and Daniel D. Polsby note that a large crowd itself is not an incipient riot merely because it assembles a great many people. Haddock and Polsby explain that "starting signals" must occur for civil disorder to erupt; these starting signals include certain kinds of high profile events. In fact, incidents can become signals simply because they have been signals in the past, as has been seen with many annual recurring riots at CSU. With any conventional triggering event, such as news of an assassination or unpopular jury verdict, crowds form spontaneously in various places as word of the incident spreads, without any one person having to recruit them. But since not every crowd threatens to evolve into a riot, the authors reason that a significant number of people must expect and desire that the crowd will become riotous. In addition, "someone has to serve as a catalyst—a sort of entrepreneur to get things going." A typical action could be the breaking of a window, which can be heard by many who do not necessarily see it. Someone will throw the first stone, so to speak, when he calculates the risk of being apprehended has diminished to an acceptable level. This diminished risk is generally based on two variables—the size of the crowd relative to the police force and the probability that others will follow if someone leads. The authors conclude that once someone has taken a risk to get things started, the rioting will begin and spread until civil authorities muster enough force to make rioters believe they face a realistic prospect of arrest.

Universities, industry, government officials and buildings, research laboratories, medical facilities, and populated areas are all potential sites and targets for civil disturbances. All of the communities within the county region have the potential to experience civil disturbance events. The diverse (and rapidly growing) population of the region coupled with the presence of numerous research facilities, universities, and other outlets for active political and/or social activity contribute to the increased risk for civil disturbance.

In light of recent civil disturbances across the Country, regional fire agencies in Larimer and Weld Counties have begun a dialogue on developing a regional strategy for addressing such incidents.

Past Occurrences

Table 4-18 summarizes a number of notable instances of civil disturbance in Larimer County.

Table 4-18 Historical Civil Disturbances in Larimer County

Date	Event	Details
1987	College Daze riots	10,000-12,000 college students involved in disturbance for more than three days in Fort Collins.
1988	Baystone riots	10,000 people involved in civil disturbance over three day period.
1989	Baystone riots	10,000 people involved in civil disturbance over three day period.
1995	Football riots	CSU football team wins WAC Championship, nearly 3,000 people involved in riots over two days.
1997	Whitcomb/Howes	More than 3,000 people involved in two consecutive nights of riots on and near Colorado State University campus.
1998	Super Bowl riot	3,000 to 6,000 people involved in riots along College Ave, Mountain Ave., and Plum St. after Denver Broncos won the Super Bowl football championship
2000	Stanley Cup riot	2,000 to 3,000 people involved in riots in Old Town Fort Collins after Colorado Avalanche won Stanley Cup hockey championship
2004	CSU student riots	Fort Collins experienced two consecutive nights of out-of-control parties, which developed into riots near the CSU campus
2013	CSU riots	Fort Collins experienced riots near the CSU campus after an out-of-control party
2014	CSU riots	Fort Collins experienced riots near the CSU campus after an out-of-control party
2020	Black Lives Matter and Back the Blue protests	While most of these protests were peaceful, Fort Collins experienced violence at Black Lives Matter and Back the Blue protests when opposing groups converged

Source: HMPC

The causes and perpetrators of civil disturbance events are broad. Many of the most recent civil disturbance incidents in the County were located in Fort Collins and were related to annual CSU sporting events and/or large parties that devolved into riots. Other civil disturbance events have occurred when protesters gathered near Pineridge Reservoir in Larimer County to protest the planned removal of prairie dog colonies. Additionally, extremist groups such as the Animal Liberation Front and the Environmental Liberation Front have been known in the past to be involved in several civil disturbance incidents in

Larimer County and the surrounding region. Intelligence reports gathered by law enforcement indicate that several research facilities have been burglarized and/or vandalized, and this included having laboratory facilities destroyed and/or research animals being released.

In the past, "Right to Life" groups have participated in civil disturbance activity by obstructing sidewalks and entryways to medical facilities within the communities of Fort Collins, Loveland, and Larimer County. Since 2001, several small-scale civil disturbances involving religious groups have occurred within the City of Fort Collins and other local jurisdictions at local mosques. Since 2016, multiple protests have occurred in Estes Park, Loveland and Fort Collins on a variety of issues. Recently, in 2020, peaceful rallies and protests have broken out in violence due to opposing groups engaging with one another.

Location

Limited. Civil disturbances can arise from a number of causes for a variety of reasons. Circumstances may be spontaneous or may result from escalating tensions. Civil disorder can erupt anywhere, but the most likely locations are those areas with large population groupings or gatherings. As noted above, the majority of past civil disturbances in Larimer County have been centered on or near the CSU campus. Sites that are attractive for political or other rallies should be considered as probable locations for the epicenter of civil disorder events; arenas and stadiums are another type of venue where civil disorder can occur. Civil disorder can also occur in proximity to locations where a "trigger event" occurred.

Magnitude/Severity

Limited. The severity of a civil disturbance can be measured based on the number of people involved, how long the disturbance lasts, and the number and severity of injuries and property damage, as well as how much it disrupts the community. The more widespread an incident is, the greater the likelihood of excessive injury, loss of life and property damage; additional factors, such as the ability of law enforcement to contain the event, are also critical in minimizing damages.

Past disturbances in Larimer County have consisted of anywhere from a few hundred people to as many as 10-12,000 people. Major riots can last for a few hours or 2-3 days and can result in dozens or more than 100 arrests, 10s-100s of injuries, and thousands of dollars in damages.

Speed of Onset: While many protests are planned ahead of time, they can turn into riots with little or no notice. Social media can be leveraged to mobilize and organize crowds quickly. Additionally, social media can inspire local organizations when a trigger event occurred somewhere else in the country due to the rapid availability of information. Similarly, parties or other peaceful celebrations can quickly get out of control.

Duration: Civil disturbances can last for a few hours or a few days.

Probability of Future Occurrences

Likely. Due to the nature of the hazard, it is difficult to predict when a civil disturbance event may erupt, making the probability of Larimer County and its jurisdictions experiencing a civil disturbance event difficult to quantify. Historically, the County has experienced a significant civil disturbance once every 4-5 years. There is sometimes a tendency for disturbances to cluster together, where a disturbance one year may make it more likely for another disturbance to occur the following years on the anniversary of the event. Based on historic record of previous events, it is reasonable to assume that civil disturbance activity will be most probable during annual sporting events, holidays, or following nationwide triggering events. Keeping aware of these annual events, their anticipated size, and any history of contention between communities will help local law enforcement plan and anticipate potential risks.

Civil Disturbances have been on the rise nationwide due to social, economic and racial tensions. These activities have caused a recent influx in rallies and marches within Larimer County, typically in Fort Collins, Loveland and Estes Park. It is likely these events will continue into 2021.

Climate Change Considerations

As a human-caused hazard, changes in climate would not have a direct impact on civil disturbances. Far more relevant, though, could be the implications of future climate change as a cause for civil disorder. Climate change impact forecasts include increasingly extreme weather patterns that exacerbate issues of drought, flooding, severe weather and other weather hazards globally that could affect whole ecosystems. Incidents of civil disobedience could be a secondary result related to societal unrest as a result of other climate-impacted hazards.

Vulnerability Assessment

People

Generally, civil disturbance events have the potential to cause injuries and potentially fatalities, although the latter is extremely rare.

General Property

Rioters often destroy private, commercial, and public property, to include smashing windows, cars, and setting fires. Additional costs can stem from debris removal, maintenance, repair, and response. No specific, countywide loss estimation process exists for civil disturbance.

Critical Facilities and Infrastructure

Critical facilities such as government buildings and police stations are frequent targets for civil disturbances.

Economy

Indirect costs include loss of industrial and commercial productivity as a result of damage to infrastructure, facilities, or interruption of services.

Historic, Cultural and Natural Resources

Historic or cultural resources may be targets of civil disturbances. Environmental impacts can occur if the civil unrest occurs in an outdoor or environmentally sensitive area.

Future Land Use and Development

As Larimer County continues to experience rapid population growth, development, and diversification, it is anticipated that there will be increased exposure to potential casualties, injuries, and property damage due to civil disturbance incidents.

Risk Summary

- Historically, the County has experienced a significant civil disturbance once every 4-5 years.
- Can arise from a number of causes for a variety of reasons.
- Past disturbances in Larimer County have consisted of anywhere from a few hundred people to as many as 10-12,000 people and lasted from a few hours to 2-3 days.
- Injuries and property damage are common, although most have historically been relatively minimal.
- Related Hazards: None

4.3.3 Dam Inundation

Hazard	Frequency	Spatial Extent	Severity	Overall Significance
Dam Inundation	Occasional	Significant	Critical	Medium

Description

Dams are humanmade structures built for a variety of uses, including flood protection, power generation, agriculture, water supply, and recreation. When dams are constructed for flood protection, they usually are engineered to withstand a flood with a computed risk of occurrence. For example, a dam may be designed to contain a flood at a location on a stream that has a certain probability of occurring in any one year. If prolonged periods of rainfall and flooding occur that exceed the design requirements, that structure may be overtopped, which is when water passes over the top of the dam. Overtopping can lead to dam failure and is the primary cause of earthen dam failure in the United States. Dam failures can also result from any one or a combination of the following causes:

- Prolonged periods of rainfall and flooding, which result in overtopping
- Earthquake/seismic activity
- Inadequate spillway capacity resulting in excess overtopping flows
- Internal erosion caused by embankment or foundation leakage or piping or rodent/wildlife activity
- Improper design
- Improper maintenance
- Negligent operation
- Failure of upstream dams on the same waterway

The majority of dams in Larimer County are not flood-control dams; for these dams, the natural snow-melt or precipitation runoff that flows into the dam is released into the river systems below.

Water released by a failed dam generates tremendous energy and can cause a flood that is catastrophic to life and property. A catastrophic dam failure could challenge local response capabilities and require evacuations to save lives. Impacts to life safety will depend on the warning time and the resources available to notify and evacuate the public. Major loss of life could result as well as potentially catastrophic effects to roads, bridges, and homes. Associated water quality and health concerns could also be issues. Factors that influence the potential severity of a full or partial dam failure are the amount of water impounded; the density, type, and value of development and infrastructure located downstream; and the speed of failure.

Dam inundation can also occur from non-failure events, such as when outlet releases increase during periods of heavy rains or high inflows. Controlled releases to allow water to escape when a reservoir is overfilling actually can help prevent future overtopping or failure. When outlet releases aren’t enough, spillways are designed to allow excess water to exit the reservoir and prevent overtopping. This can protect the dam but result in flooding downstream.

The Colorado Dam Safety Branch developed a tool in recent years that can support public awareness, planning, and emergency preparedness and response involving high hazard dams across the state. This tool evaluates dams and their capabilities regarding operational and flood release functions to prevent or minimize potential future damages (Flood Hazard Mitigation Plan for Colorado 2018). The Colorado Dam Safety Branch rules and regulations require owners of High and Significant hazard dams in the state to develop and maintain Emergency Actions Plans (EAP) and file them with Larimer County Emergency Managers. EAP’s enable notification and response to dam safety emergency and contain inundation mapping that portrays the limits of flood inundation for the sunny-day (absent flooding) failure scenario.

Low Head Dams

Low head dams are engineered structures built into and across stream and river channels for a variety of purposes. Water flows over low head dams continuously, as they span from one riverbank to the other. Low head dams generally range in height from 1-15 feet. Historically, low head dams were built to divert water from streams to support industrial, municipal, and agricultural water usage. Low head dams are also engineered to prevent erosion and degradation of stream channels. More recently, low head dams have been engineered to provide recreational amenities for boating, rafting and tubing and also to improve aquatic habitat.

Low-head dams are a hazard because water flowing over low head dams produces dangerous recirculating currents that can trap recreators. Rafters, kayakers, and those floating our rivers for recreation are often unaware of these structures and the dangers resulting from them. Low head dams can be difficult to detect by uneducated river users approaching from upstream due to their height, and the fact that the relatively tranquil pool they create provides no indication of the dangers just beyond the visual horizon created by the dam and ponded water. This can limit reaction time and boaters' ability to exit the river upstream of the dam.

According to the Colorado Division of Natural Resources, public safety at low head dams is becoming an increasingly important issue as the population of Colorado increases and citizens recreate more and more on waterways within the state. Safety measures can include anything from upstream signage recommending portage, modifications to the existing structure to eliminate the recirculating current, or removal if the structure is no longer serving its original purpose.

Past Occurrences

Larimer County had one of the most devastating dam failures in Colorado’s history, which resulted in a Federal Disaster Declaration. The following is a description of the event from 2018 State of Colorado Hazard Mitigation Plan.

July 15, 1982 (DR-665): The Lawn Lake Disaster of 1982 caused three deaths and over $31 million in property damage when the privately-owned Lawn Lake Dam failed in Rocky Mountain National Park above the Town of Estes Park in Larimer County. Gradual deterioration of the earthen dam led to a sudden breech that released 220 million gallons of water on a sunny day in July of 1982. The dam failure flood also resulted in the failure of the Cascade Dam and destroyed the Fall River Hydropower plant, resulting in a delayed second peak in the flood that entered downtown Estes Park. The water and debris caused extensive damage to downtown Estes Park. A lawsuit awarded $480,000 to the family of one of the three persons killed in the disaster. Loss of life would likely have been greater if not for a timely warning relayed by a trash collector in Rocky Mountain National Park who witnessed the event.

September 11, 2013 (DR-4145): The historic flooding in Colorado in September 2013 led to widespread flooding throughout Larimer County. The Olympus Dam in Estes Park is not a flood-control dam and therefore released water as it entered Estes Lake. Due to these actions, the integrity of the dam remained intact even though the amount of rainfall in the area led to catastrophic flooding along the Big Thompson River. Five Low Hazard dams failed in the Big Elk Meadows development on the Little Thompson River in parts of Boulder and Larimer County. Four of the dams were in Larimer County. The dams were designed for the 25-50 year rainfall event and the September 2013 event had an annual recurrence internal of greater than 100 years. Forensic investigations conducted following the overtopping dam failures confirmed that damaged caused by the rain event flooding alone was not exacerbated by the failure of these small impoundments during the event. Non-failure controlled outlet works and uncontrolled spillway releases from several dams contributed to flooding damage.

Location

Significant - The geographic coverage of this hazard in Larimer County is extensive, based on the number of dams and planning area at risk to widespread inundation. The Colorado Department of Natural Resources High Hazard Dam 2020 database was queried for those dams either inside the Larimer County boundaries, or upstream of it so that they may cause inundation into the county if the structures failed. This source lists 148 dams in or upstream of the County and classifies them based on the potential hazard to the downstream areas as a result of failure or mis-operation of the dam or facilities (Refer to the Magnitude/Severity section below). According to the database there are 59 high hazard dams, 33 significant hazard dams, and 57 low hazard dams either inside of Larimer County or upstream of it so that they are considered dams of concern. (Refer to the Magnitude/Severity subsection below for a description of dam hazard classifications.) The high and significant dams are listed in Table 4-19 and illustrated in Figure 4-4 and Figure 4-5. All of the high and most of the significant hazard dams have emergency action plans (EAPs) in place, while the low hazard dams are not required to have these EAPs.

Table 4-19 Dams of Concern for Larimer County

Dam Name	Waterway*	Downstream City	Storage Capacity (Acre-Feet)	Emergency Action Plan?	Hazard Rating
Barnes Meadow	Joe Wright Creek-Tr	Fort Collins	2,329	Yes	High
Boyd Lake	Big Thompson River-Os	Loveland	48,871	Yes	High
Cache La Poudre	Cache La Poudre River-Tr	Timnath	10,070	Yes	High
Carter Lake Dam #1	Dry Creek	Berthoud	112,200	Yes	High
Carter Lake Dam #2	Dry Creek	Berthoud	112,200	Yes	High
Carter Lake Dam #3	Big Thompson River	Loveland	112,200	Yes	High
Chambers Lake	Big Thompson River Os	Fort Collins	11,400	Yes	High
Cobb Lake	Dry Creek-Tr	Windsor	28,200	Yes	High
College #3	Big Thompson River Os	Fort Collins	1,461	Yes	High
Comanche	Joe Wright Creek	Fort Collins	52	Yes	High
Crow Lane No. 1	Unnamed Trib Lt Thompson	Lyons	37	Yes	High
Dixon Canyon	Dixon Creek	Fort Collins	152,000	Yes	High
Douglas	Dry Creek	Fort Collins	8,940	Yes	High
Dry Creek	Dry Creek	Berthoud	8,900	Yes	High
East Side Detention Facility	Boxelder Creek	Timnath	1,166	Yes	High
Elder	Cache La Poudre River	Fort Collins	666	Yes	High
Equalizer	Trib Of Big T. River	Milliken	1,139	No	High
Flatiron	Dry Creek	Loveland	1,000	Yes	High
Flood Control Basin No. 1	Dry Creek	Fort Collins	0	Yes	High
Floodwater Ret. B-2	Boxelder Creek	Wellington	6,470	Yes	High
Floodwater Ret. B-3	Coal Creek	Wellington	3,839	Yes	High
Floodwater Ret. B-4	Indian Creek	Wellington	1,270	Yes	High
Fossil Creek	Fossil Creek	Windsor	11,100	Yes	High
Halligan	N Fork Cache La Poudre	Fort Collins	6,428	Yes	High
Handy	Dry Creek	Berthoud	6,747	Yes	High
Horsetooth	Cache La Poudre	Fort Collins	152,000	Yes	High
Hourglass	Beaver Creek	Fort Collins	1,729	Yes	High

Dam Name	Waterway*	Downstream City	Storage Capacity (Acre-Feet)	Emergency Action Plan?	Hazard Rating
Indian Creek	Indian Creek	Timnath	1,697	Yes	High
Ish #3 (Main Dam)	Big Thompson River	Berthoud	7,128	Yes	High
Joe Wright	Joe Wright Creek	Fort Collins	7,161	Yes	High
Kluver	Cache La Poudre River	Fort Collins	1,147	Yes	High
Lake Loveland	Big Thompson River	Loveland	12,736	Yes	High
Lon Hagler	Big Thompson River	Loveland	5,228	Yes	High
Long Draw	La Poudre Pass Creek	Fort Collins	10,900	Yes	High
Long Pond	Dry Creek	Fort Collins	3,500	Yes	High
Loveland Water Storage	Big Thompson River	Loveland	6,836	Yes	High
Mariano	Big Thompson River	Loveland	5,550	Yes	High
Milton Seaman	N Fork Cache La Poudre	Laporte	5,008	Yes	High
North Poudre # 2	Cache La Poudre River	Fort Collins	3,748	Yes	High
North Poudre # 3	Boxelder Creek	Wellington	3,080	Yes	High
North Poudre # 5	Cache La Poudre River	Fort Collins	7,704	Yes	High
North Poudre # 6	Cache La Poudre River	Fort Collins	10,969	Yes	High
North Poudre #15	Dry Creek	Fort Collins	5,560	Yes	High
Olympus	Big Thompson River	Loveland	3,100	Yes	High
Panhandle	Panhandle Creek	Fort Collins	1,018	Yes	High
Park Creek	Park Creek	Fort Collins	7,343	Yes	High
Peterson Lake	Cache La Poudre River	Fort Collins	1,183	Yes	High
Rawhide	Coal Creek	Wellington	15,400	Yes	High
Richards	Cache La Poudre River	Fort Collins	515	Yes	High
Rist - Benson	Big Thompson River	Loveland	456	Yes	High
Rocky Ridge	Cache La Poudre River	Fort Collins	4,270	Yes	High
Satanka	Cache La Poudre River	Fort Collins	152,000	Yes	High
Soldier Canyon	Cache La Poudre River	Fort Collins	152,000	Yes	High
Spring Canyon	Spring Creek	Fort Collins	152,000	Yes	High
Terry Lake	Dry Creek	Fort Collins	8,345	Yes	High
Warren Lake	Cache La Poudre	Windsor	2,185	Yes	High
Water Supply No 3	Dry Creek	Fort Collins	3,350	Yes	High
Water Supply No 4	Dry Creek	Fort Collins	1,480	Yes	High
Windsor #8	Cache La Poudre River	Fort Collins	8,993	Yes	High
Annex #8	Cache La Poudre	Fort Collins	3,724	Yes	Significant
Aspen Lodge	Tahosa Creek	Rural Development, Big Owl Rd	11	No	Significant
Berthoud	Little Thompson River	Johnstown	574	Yes	Significant
Carriage Hills #1 (Upper)	Fish Creek	Estes Park	11	Yes	Significant
Clarks Lake	North Fork Poudre	Wellington	874	Yes	Significant
Claymore	Cache La Poudre	Laporte	1,018	Yes	Significant
Curtis Lake	Poudre River	Fort Collins	1,259	Yes	Significant
Dixon Canyon	Dixon Creek	Fort Collins	335	Yes	Significant

Dam Name	Waterway*	Downstream City	Storage Capacity (Acre-Feet)	Emergency Action Plan?	Hazard Rating
Donath Lake	Big Thompson River	Loveland	1,148	Yes	Significant
Dowdy Lake	N Lone Pine Cr	Fort Collins	900	Yes	Significant
Fairport	Big Thompson River	Fort Collins	143	Yes	Significant
Fairway	Mail Creek	Windsor	32	Yes	Significant
Floodwater Ret. B-5	South Branch Boxelder Cr	Wellington	1,578	Yes	Significant
Floodwater Ret. B-6	Sand Creek	Wellington	1,496	Yes	Significant
George Rist	Big Thompson River	Loveland	337	Yes	Significant
Hertha	Dry Creek	Berthoud	1,703	Yes	Significant
Hiawatha	Columbine Cr	Fort Collins	500	Yes	Significant
High Peak Camp Dam #4	Tahosa Creek	Lyons	-	-	Significant
Horseshoe Lake (East Dam)	Big Thompson River	Loveland	8,051	Yes	Significant
Horseshoe Lake (South Dam)	Big Thompson River	Loveland	8,051	Yes	Significant
Lone Tree	Big Thompson River	Johnstown	9,268	Yes	Significant
Loveland Lake	Big Thompson River	Berthoud	2,150	Yes	Significant
Marys Lake #1	Big Thompson River	Estes Park	900	Yes	Significant
North Poudre # 4	Boxelder Creek	Wellington	1,669	Yes	Significant
North Poudre #1	Cache La Poudre River	Fort Collins	629	Yes	Significant
Parvin	South Lone Pine	Fort Collins	700	Yes	Significant
Rattlesnake	Cottonwood Creek	Loveland	2,000	Yes	Significant
Ryan Gulch	Ryan Gulch	Loveland	738	Yes	Significant
Sherwood	Cache La Poudre	Fort Collins	298	Yes	Significant
South Side	Big Thompson River	Loveland	658	Yes	Significant
Sunny Slope	Dry Creek	Berthoud	480	Yes	Significant
Twin Lakes Reservoir	S Fork Cache La Poudre	Fort Collins	278	Yes	Significant
Worster	Sheep Creek	Fort Collins	3,750	Yes	Significant

Source: State of Colorado CO-DSS (dwr.state.us/Tools/DamSafety/) queryied 9-23-2020; *Tr-tributary, Os-Off Stream

Figure 4-4 illustrates the locations of identified dams within Larimer County, or which could potentially flood into the County, including their major drainages. Figure 4-5 displays the dam inundation areas for several of the significant and high hazard dams in the county. Dam inundation extents were mapped and used in analysis throughout this chapter based on GIS layers for the significant or high hazard dams. The Colorado Dam Safety Program office provided the dam inundation maps based on latest and best available data.

During the time of this plan update the Colorado DNR mapped non-failure inundation below 40 high hazard dams in Larimer County. The mapping shows potential areas of flooding where outlet capacity exceeds the downstream channel capacity. The dams at the highest risk of non-failure inundation are shown in Table 4-20. The ranking shown in the table represents the likelihood of hazardous conditions existing below the dams during a worst case, maximum outlet release scenario. Dams are ranked as high, moderate, or low likelihood for outlet releases to cause conditions that could require an emergency response to reduce potential downstream consequences. The ranking is based on a statewide database of high hazard dams that includes 441 high hazard dams that have been analyzed by the Colorado DNR for this aspect of dam incident flooding. The high, moderate, or low designations were assigned by DNR by dividing the total number of ranked dams across the state into thirds. Should there be a need to relieve pressure on the dam (e.g. if there was excess inflow from high rains or snowmelt) releases from the dams ranked as high or moderate may result in downstream flooding.

Table 4-20 Dams with Risk of Non-Failure Inundation

Dam Name	Dam ID	Outlet Description	Max Outlet Release Capacity (cfs)	Outlet Release Ranking
Boyd Lake	040105	1. Pump station with invert at GH 0.0 2. Hillsboro transfer outlet with invert at GH 25.0 3. Greeley-Loveland Ditch inlet/outlet with invert at GH 49.25	800	HIGH
Cache la Poudre	030327	60"RCP	575	HIGH
Chambers Lake	030115	4-3' X 4' CONC*	1,700	HIGH
Cobb Lake	030119	48"R/C,U/S SUBMERGED, D/S PIPE	633	HIGH
Comanche	030121	30" X 44" ARCH*	444	HIGH
Flood Control Basin 1	030526	UNGATED 5 FOOT BY 5 FOOT OPENING	438	HIGH
Hourglass	030209	33" RCP	180	HIGH
JoeWright	030402	72" RCP	600	HIGH
Loveland Water Storage	040217	54" Steel	255	HIGH
Milton Seaman	030223	18' TUNNEL	1,680	HIGH
North Poudre #6	030303	48" RCP	280	HIGH
North Poudre 3	030238	36" HDPE & RCP	109	HIGH
Olympus	040134	18"RCP+6.25'X8*	5,767	HIGH
Panhandle	030307	33" CONC	135	HIGH
Park Creek	030308	42" SQUARE CONCRETE	335	HIGH
Terry Lake	030326	48" RCP,D/S GOES TO 60"RCP ADD	325	HIGH
Water Supply 3	030332	3' X 4' RCP	358	HIGH
Barnes Meadow	030104	3 GATES-30"X36*24"HDP LINER	89	MODERATE
Equalizer	040231	FIVE - 4' BY 4' GATES	595	MODERATE
Floodwater Retention Basin 2	030505	48" RCP	234	MODERATE
Floodwater Retention Basin 3	030415	30" RCP	80	MODERATE
Floodwater Retention Basin 4	030414	24"&30" RCP	98	MODERATE
Halligan	030204	2-33" SP	573	MODERATE
Handy	040126	Three outlets numbered 1-2-3 from west to east (right to left)	140	MODERATE
Horsetooth	030208	2-72" STL PIPES	2,500	MODERATE
Indian Creek	030210	4 FT X 4 FT CO	210	MODERATE
Ish Reservoir	040131	By-pass: 42" RCP	95	MODERATE

Dam Name	Dam ID	Outlet Description	Max Outlet Release Capacity (cfs)	Outlet Release Ranking
Long Draw	030217	54" RCP	560	MODERATE
Long Pond	030216	42" RCP	275	MODERATE
Mariano	040203	No description	155	MODERATE
North Poudre 15	030305	42" RCP	195	MODERATE
North Poudre 2	030237	36" CMP	110	MODERATE
Rawhide	030508	54" RCP	133	MODERATE
RistBenson	040208	24" CMP x 94 ft	35	MODERATE
Water Supply 4	030333	2' X 3' ROCK	150	MODERATE
College #3	030120	3 each 18" CMP w/ Insituform liner	59	LOW
East Side Detention Facility	030527	No Outlet	NA	LOW
Lily Lake	040224	8" CMP	NA	LOW
LonHagler	040137	30" concrete cylinder pipe	45	LOW
Soldier Canyon	030324	30" STEEL PIPE	90	LOW

Figure 4-4 Dams of Concern to Larimer County

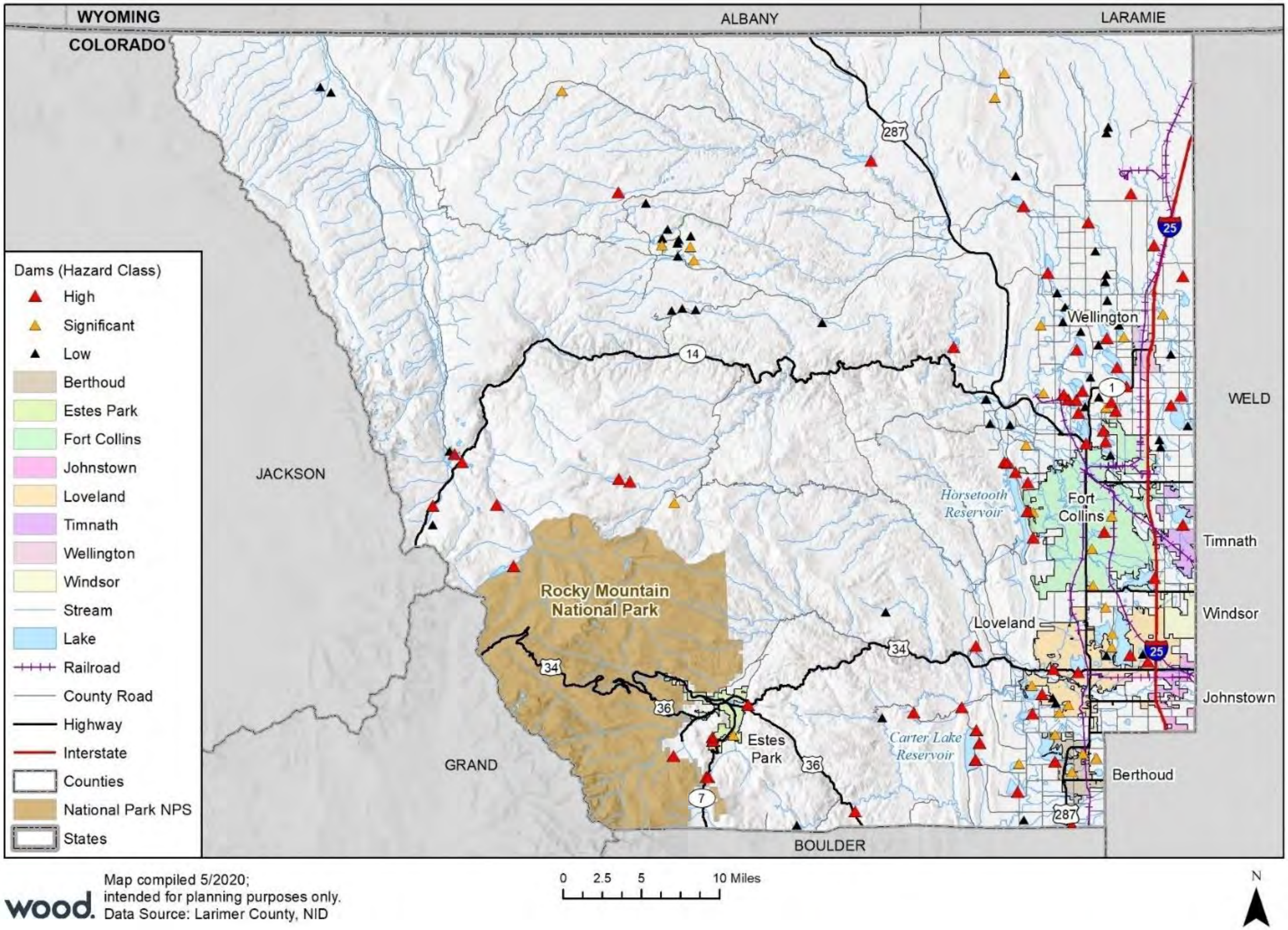
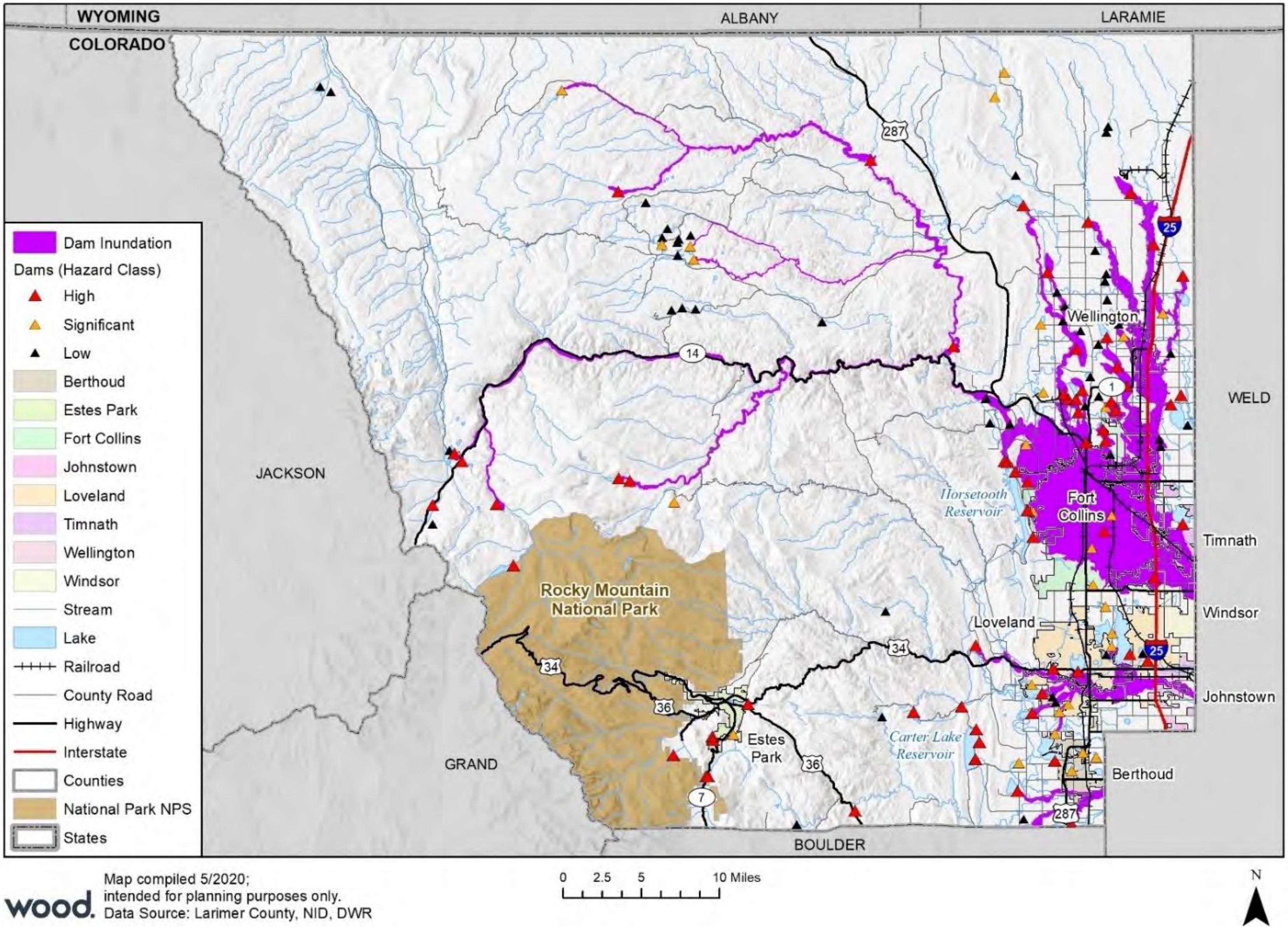


Figure 4-5 Dam Inundation Areas for Dams in Larimer County



wood. Map compiled 5/2020; intended for planning purposes only. Data Source: Larimer County, NID, DWR

Magnitude/Severity

Critical - Standard practice among federal and state dam safety offices is to classify a dam according to the potential impact a dam failure (breach) would have on downstream areas. The hazard potential classification system categorizes dams based on the probable loss of human life and the impacts on economic, environmental and lifeline facilities. Per the U.S. Army Corps of Engineers and National Inventory of Dams standards, dams are classified in three categories that identify the potential hazard to life and property, and one that indicates unknown risk:

- **High** hazard indicates that a failure has the potential to result in the loss of life.
- **Significant** hazard indicates that a failure could result in appreciable property damage and loss of life is not expected.
- **Low** hazard indicates that failure would result in only minimal property damage and loss of life is unlikely.
- **No Public Hazard (NPH)** dam failure damage is limited to the dam owners' property and has minimal impact downstream.

Larimer County has the highest number of high hazard dams in the State (State of Colorado 2018). In total there are 92 High and Significant hazard dams in the County, making the potential for loss of life and property damage likely if a failure was to occur. Both unincorporated and incorporated areas of the County are identified on dam inundation maps included in various dam Emergency Action Plans. The inundation areas for each of the dams are generally downstream and include rural and urban areas below the dams. The extent of impacts depends on the nature of failure and location of the dam. The largest population potentially at risk is in Fort Collins.

Speed of Onset: A dam failure event's speed of onset can range from sudden, with little warning time prior to the release of dangerous flood flows, to an event that gradually unfolds. The Lawn Lake Dam failure was a "worst case", sunny day event with little warning. An event with a dam in more developed parts of the County would likely be detected before failure occurred, but the proximity of many of the dams to Fort Collins in particular may lead to a rapid onset if failure occurred.

Duration: A spring or summer storm involving heavy rain can lead to a flash flood within six hours of the beginning of the event. Dam failure initiated because of extreme rainfall can occur within hours of an extreme rain event. Flooding from a non-dam failure flood event could last for several days depending on the amount of water needing to be released to relieve pressure on the dam.

Probability of Future Occurrence

Occasional - The County remains at risk to dam failures from numerous dams under a variety of ownership and control and of varying ages and conditions. Dam failures are infrequent but given the number of dams of concern and consequences within Fort Collins and other population centers in Larimer County the potential exists for future dam or reservoir failures. Uncontrolled or controlled release flooding as well as spillway flooding below dams due to excessive rain or runoff are more likely to occur than failures, while the consequences of such events are considerably less.

Climate Change Considerations

The potential for climate change to affect the likelihood of dam failure has been incorporated into the 2020 Rules and Regulations for Dam Safety and Dam Construction. The climate-change related Rule is based on a state-of-the-practice regional extreme precipitation study completed in 2018. (DWR, 2018). This study determined a very high likelihood of temperature increases, resulting in increased moisture availability to extreme storms. As such, an atmospheric moisture factor of 7% is required to be added to estimates of extreme rainfall for spillway design.

Vulnerability Analysis

A dam incident can range from a small, uncontrolled release to a catastrophic failure. Vulnerability to dam failures is confined to the areas and populations subject to inundation downstream of the structure. Secondary losses could include loss of the multi-use functions of the dam itself and associated revenues that accompany those functions, as well as damage to roads, utilities, and other infrastructure. GIS analysis was carried out using dam inundation extents from the Colorado Dam Safety Program as well as the Larimer County parcel data (from the Assessor's Office), and the critical facility/infrastructure inventory. In this process, asset data was overlaid with the dam inundation layers to arrive at total units or facilities at risk.

People

Persons located downstream of a dam are at risk of a dam failure, though the level of risk can be tempered by topography, amount of water or material in the reservoir/dam/structure, and time of day of the breach. Injuries and fatalities can occur from debris, drowning, or release of sludge or other hazardous material. People in the inundation area may need to be evacuated, cared for, and possibly permanently relocated. Impacts could include hundreds of evacuations and possibly casualties, depending on the dam involved. Specific population impacts are noted in Table 4-21 below; total people at risk were estimated by multiplying the average number of persons per household in Larimer County (based on Census estimates which equals 2.46) times the number of properties of classified as Residential within the dam inundation extents. An estimated total of 161,887 people could be at risk countywide based on the rough estimation used. This estimate does not account for non-resident or visitor population. The City of Fort Collins has the most people at risk. A total of 113,266 people reside within mapped inundation areas in Fort Collins alone, based on the calculation methodology used; this analysis does not account for transient or non-resident population at risk.

The impacts of flooding from a dam failure event can be more severe for vulnerable populations. Comparing Figures 2-4 through Figure 2-8 with the social vulnerability maps in Section 2.7 shows that many of the areas at greatest risk of dam inundation also have higher social vulnerability stemming from socioeconomic status, household composition and disabilities, minority status and language proficiency, or housing and transportation resources. Families in this area may have fewer financial resources to prepare for or recover from a flood, may not have access to a vehicle for evacuation, and may be more likely to be uninsured or underinsured. Individuals with disabilities may need more time to evacuate, so evacuation notices will need to be issued as soon as feasible, and communicated by multiple, inclusive methods.

General Property

The total properties at risk and their improvements were found by counting the number of parcels intersecting with the dam inundation extents and summing the improvement values. Content value calculations are based on FEMA HAZUS software standards based on parcel type, as described in more detail under Section 4.2 Asset Summary. Total value is the combination of improved and content values. Results are presented in Table 4-21 and Table 4-22 by jurisdiction and by parcel type, respectively.

According to the analysis of the dams with a potential to impact the planning area, the majority of the dam inundation exposed parcels are Residential, followed by the Commercial, and Agricultural categories. The largest numbers of exposed parcels are located in Fort Collins, followed by the Unincorporated County areas. Total exposed parcel values add up to over $45 billion based on the over 62,000 parcels falling within these available dam inundation areas.

Table 4-21 Parcels Exposed to Dam Inundation Extents – Estimates by Jurisdiction

Jurisdiction	Total Improved Parcels	Improved Values	Content Values	Total Values	Population
Berthoud	110	$33,361,699	$16,680,845	$50,042,544	275
Estes Park	4	$1,154,771	$577,384	$1,732,155	8
Fort Collins	46,938	$21,707,572,979	$14,057,878,625	$35,765,451,604	113,266
Johnstown	21	$6,567,126	$3,283,562	$9,850,688	60
Loveland	5,059	$1,921,542,245	$1,250,412,935	$3,171,955,180	11,419
Timnath	1,165	$500,176,513	$285,208,291	$785,384,804	3,788
Wellington	3,621	$1,064,805,211	$587,276,641	$1,652,081,852	9,855
Windsor	147	$61,985,388	$31,063,054	$93,048,442	364
Unincorporated	5,928	$2,408,767,480	$1,558,716,644	$3,967,484,124	22,852
TOTAL	**62,993**	**$27,705,933,412**	**$17,791,097,981**	**$45,497,031,393**	**161,887**

Source: USACE National Inventory of Dams 2018, Colorado Dam Safety Program, Larimer County GIS, U.S. Census Bureau, Wood analysis

Table 4-22 Parcels Exposed to Dam Inundation Extents – Estimates by Parcel Type in Unincorporated Larimer County

Parcel Type	Improved Parcels	Building Count	Improved Value	Content Value	Total Value
Agricultural	237	316	$93,800,690	$93,800,690	$187,601,380
Commercial	755	1,209	$362,977,352	$362,977,352	$725,954,704
Exempt	87	318	$96,310,700	$96,310,700	$192,621,400
Industrial	80	104	$70,713,632	$106,070,459	$176,784,091
Mobile Home	88	2,151	$165,152,616	$82,576,306	$247,728,922
Multiple Unit	25	75	$14,149,710	$14,149,710	$28,299,420
Residential	4,656	5,366	$1,605,662,780	$802,831,427	$2,408,494,207
TOTAL	**5,928**	**9,539**	**$2,408,767,480**	**$1,558,716,644**	**$3,967,484,124**

Source: USACE National Inventory of Dams 2018, Colorado Dam Safety Program, Larimer County GIS, U.S. Census Bureau, Wood analysis

Critical Facilities and Infrastructure

A total dam failure can cause catastrophic impacts to areas downstream of the water body, including critical facilities and infrastructure. In Colorado's semi-arid environment, dams and reservoirs that supply water for municipal use can also be considered critical infrastructure themselves. Any critical assets located under the dam in an inundation area would be susceptible to the impacts of a dam failure. Of particular risk would be roads and bridges that could be vulnerable to washouts, further complicating response and recovery by cutting off impacted areas. Based on the critical facility inventory considered in the updating of this plan and intersected with the dam inundation extents available, 389 county critical facilities were found to be at risk. Ten (10) of the facilities are categorized as hazardous material facilities. These at-risk facilities are listed below by jurisdiction and organized by Lifeline classification as based on the FEMA Lifeline categories.

Table 4-23 Critical Facilities in Dam Inundation Extents

Jurisdiction	FEMA Lifeline	Total Critical Facilities
Estes Park	Food, Water, Shelter	1
	Total	**1**
Fort Collins	Communications	16
	Energy	30
	Food, Water, Shelter	56

Jurisdiction	FEMA Lifeline	Total Critical Facilities
	Hazardous Material	5
	Health and Medical	40
	Miscellaneous	14
	Safety and Security	92
	Transportation	3
	Total	**256**
Loveland	Communications	2
	Energy	1
	Food, Water, Shelter	7
	Hazardous Material	1
	Health and Medical	1
	Miscellaneous	1
	Safety and Security	11
	Transportation	1
	Total	**25**
Timnath	Food, Water, Shelter	2
	Safety and Security	2
	Total	**4**
Wellington	Food, Water, Shelter	1
	Miscellaneous	1
	Safety and Security	4
	Total	**6**
Unincorporated	Communications	1
	Energy	4
	Food, Water, Shelter	68
	Hazardous Material	4
	Health and Medical	2
	Miscellaneous	2
	Safety and Security	16
	Total	**97**
Grand Total		**389**

Source: USACE National Inventory of Dams 2018, Colorado Dam Safety Program, Cascarta, Larimer County GIS, U.S. Census Bureau, Wood analysis

Economy

Extensive and long-lasting economic impacts could result from a major dam failure or inundation event, including the long-term loss of water in a reservoir, which may be critical for potable water needs, agriculture, or local wildlife. A major dam failure and loss of water from a key structure could bring about direct business and industry damages and potential indirect disruption of the local economy, and potentially affect important transportation routes enabling business and tourism into the county.

Historic, Cultural and Natural Resources

Dam or reservoir failure effects on the environment would be similar to those caused by flooding from other causes. Water could erode stream channels and topsoil and cover the environment with debris. For the most part the environment is resilient and would be able to rebound from whatever damages occurred, though this process could take years. However, historic and cultural resources could be affected just as housing or critical infrastructures would, were a dam to fail and cause downstream inundation that could further erode surfaces or cause scouring of structural foundations.

Future Land Use and Development

Flooding due to a water-related dam failure event is likely to exceed the special flood hazard areas regulated through local floodplain ordinances and usually mapped by FEMA's National Flood Hazard Layer (NFHL) dataset. The County and jurisdictions should consider dam failure and release hazards when permitting development downstream of the high hazard and significant hazard dams, in particular. In addition, there are currently 57 low hazard dams in the area of interest. Due to the phenomenon of "hazard creep," these could become significant or high hazard dams if development occurs below them and the consequences of failure increase. Regular inspection and monitoring of dams, exercising and updating of EAPs, and rapid response to problems when detected at dams are ways to mitigate the potential impacts of these rare but potentially catastrophic events.

The construction of new dams could also increase future exposure below high hazard dams. One example is Glade Reservoir, an off-channel reservoir being proposed on a tributary of the Cache La Poudre River northwest of Fort Collins, part of the Northern Integrated Supply Project (NISP).

Risk Summary

- There has been 1 recorded dam failure event in 1982 that resulted in a Disaster Declaration (DR-665). The event released 220 million gallons and caused $31 million in property damages and 3 fatalities.
- The County has the highest number of high hazard dams in the state. There are 59 High hazard dams (leading to probable loss of life if failure was to occur), 33 Significant hazard dams and 57 Low hazard dams, for a total of 149 dams.
- City of Fort Collins and the Unincorporated County areas contain the largest population at risk to a dam failure as well as the highest number of parcels and total values exposed. Loveland and Wellington also have substantial property and people in inundation zones. A total of 161,887 people are potentially at risk, over 62,000 parcels with a total exposure value of over $45 billion countywide. The majority of exposed parcels in dam inundation zones are residential.
- A total of 389 critical facilities and infrastructure are found within dam inundation extents in the county.
- Related Hazards: Civil Disturbance, Earthquake, Flood, Utility Disruption

4.3.4 Drought

Hazard	Frequency	Spatial Extent	Severity	Overall Significance
Drought	Likely	Significant	Significant	Medium

Description

Drought is a slow-onset hazard, generally defined by a long-term deficiency in precipitation resulting in water shortages causing adverse impacts on vegetation, animals, and/or people. Droughts occur gradually, which often makes it difficult to define when a drought begins and ends. Per the National Drought Mitigation Center, there are four basic approaches to defining a drought based on its effects:

- **Meteorological drought** is based on the degree and duration of dryness, usually defined by a period of below average precipitation.
- **Agricultural drought** links dryness to agricultural impacts and occurs when there is an inadequate water supply to meet the needs of crops, livestock, and other agricultural operations. It is measured by precipitation shortages, differences between actual and potential evapotranspiration, soil water deficits, reduced groundwater or reservoir levels, and other factors. Agricultural drought is dependent on the variable needs of different crops during different stages of development.
- **Hydrological drought** concerns deficiencies in surface and subsurface water supplies and is typically defined on a watershed scale. It is generally measured as streamflow, snowpack, and as lake, reservoir, and groundwater levels. Measuring drought with this approach may result in a slower recognition of drought conditions compared to meteorological and agricultural drought because the impacts of precipitation deficiencies can take a while to be seen in the hydrologic system.
- **Socioeconomic drought** is associated with the supply and demand of water or other related goods. It occurs when a drought impacts health, well-being, and quality of life, or when a drought starts to have an adverse economic impact on a region.

Each of the above definitions of drought can be measured on different scales and scopes and by a variety of metrics, such as precipitation, soil moisture, streamflow, and surface water and groundwater levels. Additionally, each definition can provide a different point of view or understanding of drought severity and impacts. Several unique indices have been developed to describe drought and measure its severity. It's important to understand that each of these indices measures drought as it occurs but does not predict future drought conditions.

The **Palmer Drought Severity Index** (PDSI) devised in 1965, was the first drought indicator to assess moisture status comprehensively. The PDSI uses temperature and precipitation data to calculate water supply and demand, incorporates soil moisture, and is considered most effective for unirrigated cropland. It primarily reflects long-term drought and has been used extensively to initiate drought relief.

The **Standardized Precipitation Index** (SPI), like the PDSI, index is negative for drought, and positive for wet conditions. However, the SPI is a probability index that considers only precipitation.

The **U.S. Drought Monitor** provides a summary of drought conditions across the United States and Puerto Rico. Often described as a blend of art and science, the Drought Monitor map is updated weekly by combining a variety of data-based drought indices and indicators as well as local expert input into a single composite drought indicator.

Colorado has a Drought Mitigation and Response Plan that encompasses drought monitoring, assessment, response, and mitigation statewide. Additionally, the Colorado Water Conservation Board (CWCB) maintains a Drought Response page that encompasses the above definitions of drought and supports both local and state drought planning as well as water supply planning. The CWCB also provides a Drought Planning Toolbox designed to assist with planning and responding to drought. The City of Fort Collins Utilities' Water Shortage Action Plan (2020) was approved by CWCB in August 2020, and is an action plan to address drought, as well as other water shortages.

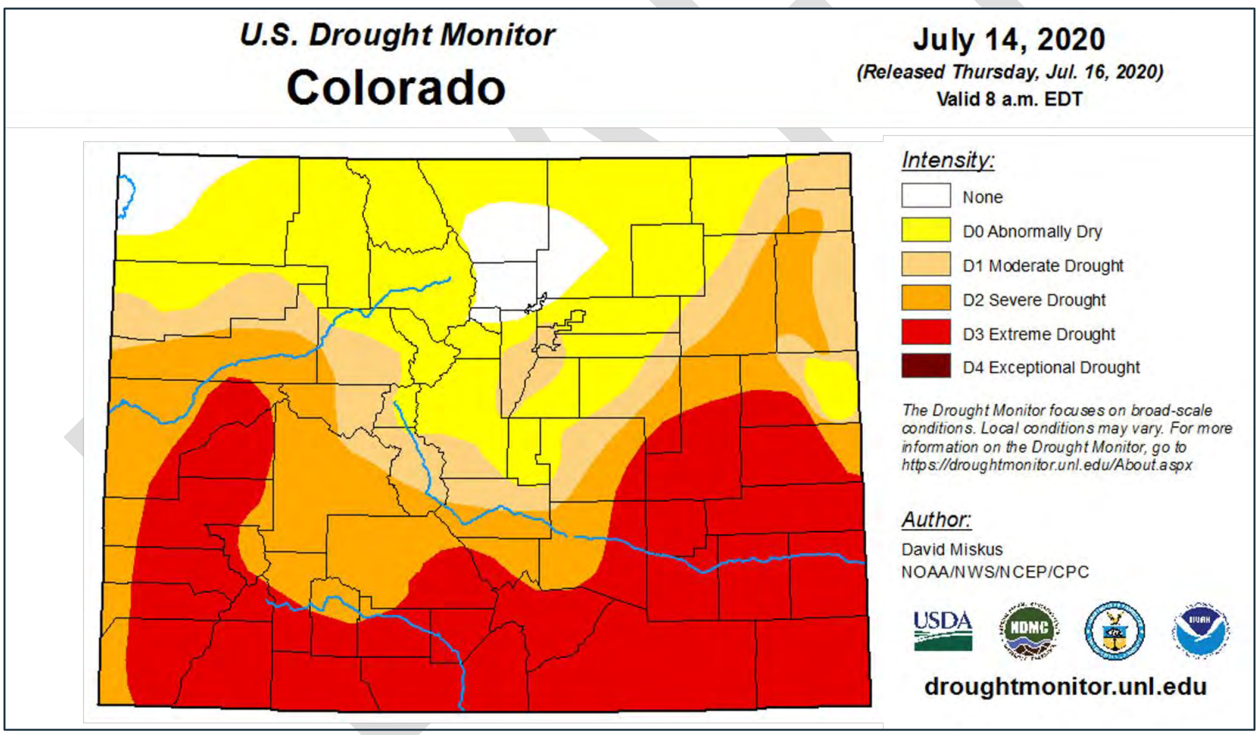
Extreme heat is defined in the State Hazard Mitigation Plan as "temperatures over 90 degrees for an extended period of time, or that hover 10 degrees or more above the average high temperature for the region and last for multiple consecutive days." It's useful to consider the extreme heat hazard in conjunction with drought because of the direct impact high temperatures can have on drought incidence. Extreme heat can occur quickly and without warning. Older adults, children, and sick or overweight individuals are more vulnerable to extreme heat.

Past Occurrences

As reported in Table 4-6, Larimer County has received ten USDA disaster declarations due to drought in the last ten years.

Figure 4-6 shows the U.S. Drought Monitor for Colorado as of July 14, 2020, illustrating the regional nature of drought.

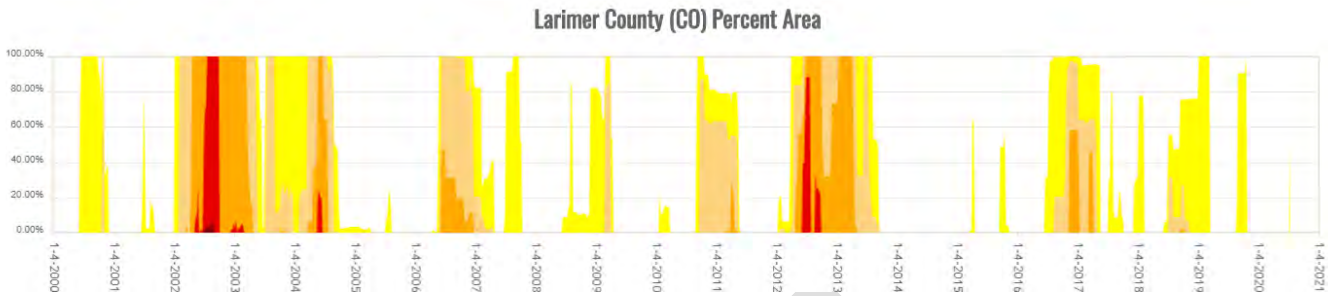
Figure 4-6 U.S. Drought Monitor



Source: U.S. Drought Monitor

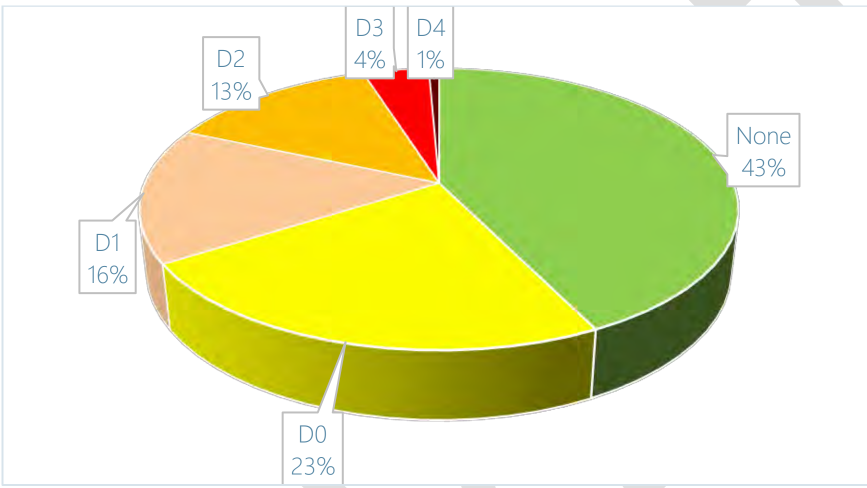
The U.S. Drought Monitor maintains weekly records of drought by county. Per these records, during the 1040-week period from January 2000 through December 2019, all or portions of Larimer County spent 596 weeks (57% of the time period) in some level of drought, defined as Abnormally Dry (D0) or worse conditions. This period includes 141 weeks of Severe Drought (D2), 44 weeks of Extreme Drought (D3), and 7 weeks of Exceptional Drought (D4). Figure 4-7 and Figure 4-8 illustrate the severity and duration of drought conditions during this time, using the same color coding for each category of drought intensity as shown in Figure 4-6 above.

Figure 4-7 U.S. Drought Monitor Drought Intensity Time Series, 2000-2020



Source: U.S. Drought Monitor

Figure 4-8 Percentage of Weeks in Drought, 2000-2020



Source: U.S. Drought Monitor

NOAA's National Centers for Environmental Information (NCEI) records 3 drought events between 1950 and 2019. Brief descriptions of each events are shown below, no damages or casualties were recorded for any of the events. NCEI does not record any severe heat events in Larimer County between 1950 and 2019.

- **April 1, 2002** – Statewide drought event. Within Larimer County the event impacted elevations below 6,000 feet, between 6,000 & 9,000 feet, and above 9,000 feet. April, normally the third snowiest month of the year with just over 9 inches, ended up being the third driest April on record for Denver. Only a trace of snow was recorded for the month with .23 inches liquid precipitation. The snowpack in the North Platte River Basin was only 44 percent of normal by the end of the month. The snowpack was much lower across some of the other Colorado river basins. The very dry conditions prompted the Governor to request a statewide emergency drought declaration from the U.S. Agricultural Secretary, making farmers and ranchers eligible for federal assistance.
- **March 1, 2011** - The month of March 2011 was the eighth least snowy March on record with 2.9 inches of snowfall at Denver International Airport. The seasonal snowfall of 20.6 inches, measured between July 1, 2010 and March 31, 2011 made it the third least snowy season to date. The combination of above normal temperatures, windy conditions and sparse precipitation resulted in very dry conditions along the Front Range Foothills, Urban Corridor and Northeast Plains. Over two dozen wildfires occurred throughout the region in March alone. Although structural damage was limited, the wildfires threatened hundreds of homes and forced the evacuation of thousands of residents and numerous road closures.

- **April 1, 2011** - The dry, warm, and windy conditions that started the month of April allowed for another large wildfire to develop in the foothills of Larimer County, west of Fort Collins. The fire spread after strong winds allowed a slash pile burn on private property get out of control. Nearly 3,000 acres were consumed by the blaze. Hundreds of residents were forced to evacuate their homes due to very strong winds. In all, thirteen homes were destroyed in addition to numerous vehicles and outbuildings. The total cost of fighting the fire alone was around $3 million. The Crystal Wildfire was expected to become the most destructive on record for Larimer County.

Location

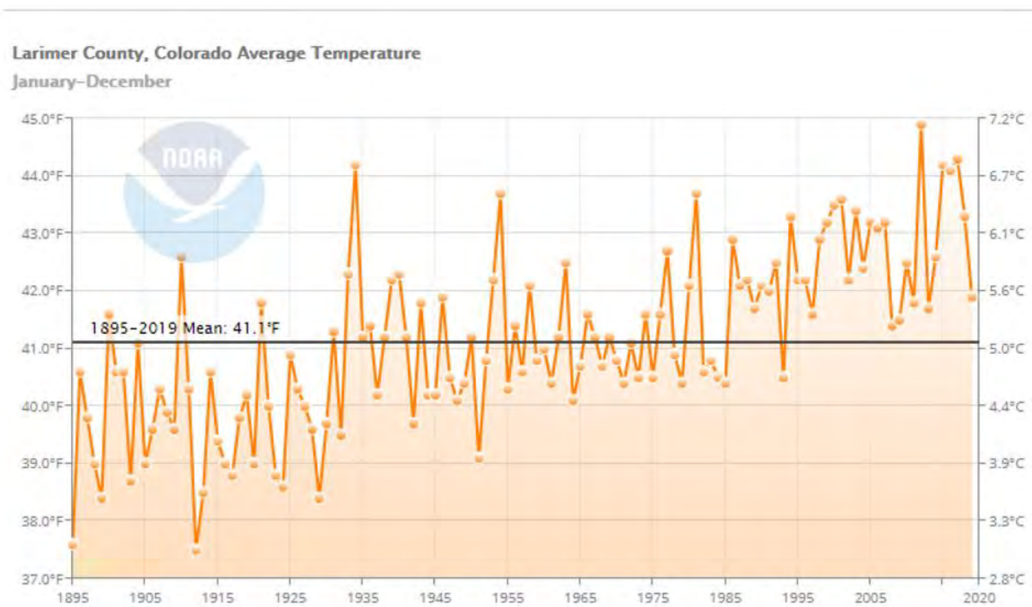
Drought is regional in nature and can occur anywhere in Larimer County, affecting all or part of the County at any given time. The eastern portion of the County may have greater exposure and vulnerability to drought due to the presence of farms and urban populations.

Extreme heat is also regional in nature; however, urbanized areas can experience pockets of heightened temperatures where surfaces such as pavement and roofs become hotter than the air temperatures, a phenomenon known as the urban heat island effect. These hot surfaces also retain heat, causing high temperatures to persist even when air temperature drops. Per the EPA, "the annual mean air temperature of a city with 1 million people or more can be 1.8–5.4°F (1–3°C) warmer than its surroundings. On a clear, calm night, however, the temperature difference can be as much as 22°F" (US EPA). Colorado's climate tends to experience large day and night temperature changes. This nighttime cooling will help alleviate heat conditions and is thought to benefit and reduce risk of extreme heat.

Magnitude/Severity

Figure 4-9 shows the average annual temperature in Larimer County going back to 1895.

Figure 4-9 Average Annual Temperature, Larimer County 1895-2020



Source: NOAA

Heat conditions are a product of ambient air temperature and relative humidity. Humidity increases the feeling of heat as measured by heat index. The Heat Index Chart in Figure 4-10 shows how ambient temperature and relative humidity impact the relative intensity of heat conditions. The shaded zone above

105°F corresponds to a heat index that may cause increasingly severe heat disorders with continued exposure and/or physical activity.

Although lower relative humidity contributes to a lower overall heat index, excessively dry and hot weather can also be dangerous. These conditions can cause dust storms and low visibility and can contribute to more severe drought as well as dangerous fire conditions.

Figure 4-10 Heat Index Chart

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

Source: National Weather Service (NWS) Note: Exposure to direct sun can increase Heat Index values by as much as 15°F.

Drought severity can be defined in terms of intensity using the U.S. Drought Monitor scale mentioned above. This scale measures drought episodes with input from the Palmer Drought Severity Index, the Standardized Precipitation Index, the Keetch-Byram Drought Index, soil moisture indicators, and other inputs as well as information on how drought is affecting people. Table 4-24 details the classifications used by the U.S. Drought Monitor. A category of D2 (severe) or higher on the U.S. Drought Monitor Scale can likely result in crop or pasture losses, water shortages, and the need to institute water restrictions. Larimer County can experience all categories.

Table 4-24 U.S. Drought Monitor Classifications

Category	Description	Possible Impacts	Ranges: Palmer Drought Severity Index (PDSI)	CPC Soil Moisture Model (Percentiles)	USGS Weekly Streamflow (Percentiles)	Standardized Precipitation Index (SPI)	Objective Drought Indicator Blends (Percentiles)
D0	Abnormally Dry	Going into drought: ▪ short-term dryness slowing planting, growth of crops or pastures Coming out of drought: ▪ some lingering water deficits ▪ pastures or crops not fully recovered	-1.0 to -1.9	21 to 30	21 to 30	-0.5 to -0.7	21 to 30
D1	Moderate Drought	▪ Some damage to crops, pastures ▪ Streams, reservoirs, or wells low, some water shortages developing or imminent ▪ Voluntary water-use restrictions requested	-2.0 to -2.9	11 to 20	11 to 20	-0.8 to -1.2	11 to 20
D2	Severe Drought	▪ Crop or pasture losses likely ▪ Water shortages common ▪ Water restrictions imposed	-3.0 to -3.9	6 to 10	6 to 10	-1.3 to -1.5	6 to 10
D3	Extreme Drought	▪ Major crop/pasture losses ▪ Widespread water shortages or restrictions	-4.0 to -4.9	3 to 5	3 to 5	-1.6 to -1.9	3 to 5
D4	Exceptional Drought	▪ Exceptional and widespread crop/pasture losses ▪ Shortages of water in reservoirs, streams, and wells creating water emergencies	-5.0 or less	0 to 2	0 to 2	-2.0 or less	0 to 2

Source: US Drought Monitor

The National Weather Service Heat Index Program provides a measure of the extent of typical health impacts of exposure to heat, summarized in Table 4-25. During these conditions, the human body has difficulties cooling through the normal method of the evaporation of perspiration, and health risks rise.

Table 4-25 Typical Health Impacts of Extreme Heat by Heat Index

Heat Index	Disorder
80-90° F	Fatigue possible with prolonged exposure and/or physical activity
90-105° F	Sunstroke, heat cramps, and heat exhaustion possible with prolonged exposure and/or physical activity
105-130° F	Heatstroke/sunstroke highly likely with continued exposure

Source: National Weather Service Heat Index Program, www.weather.gov/os/heat/index.shtml

Probability of Future Occurrence

According to information from the Colorado Drought Mitigation and Response Plan, Colorado was in drought for 50 of the past 126 years (1893-2018). Thus, there is a 39.7% chance that a drought will happen in Colorado in any given year, and a drought can be expected somewhere in the state every 2.5 years.

As noted above under past occurrences, historical drought occurrence and intensity data reported by the U.S. Drought Monitor indicates that over the 1040-week period from January 2000 through December 2019 Larimer County experienced 192 weeks of Severe Drought or worse conditions. If future occurrences continue to follow this trend, Larimer County has a 18% change of experiencing severe drought conditions in any given week. Short duration droughts are likely, but longer periods of intense drought are less common. Considered on the level of annual probability, Larimer County experienced Severe Drought or worse conditions during 8 of the 20 years during this period, which equates to a 40% annual chance of severe drought conditions.

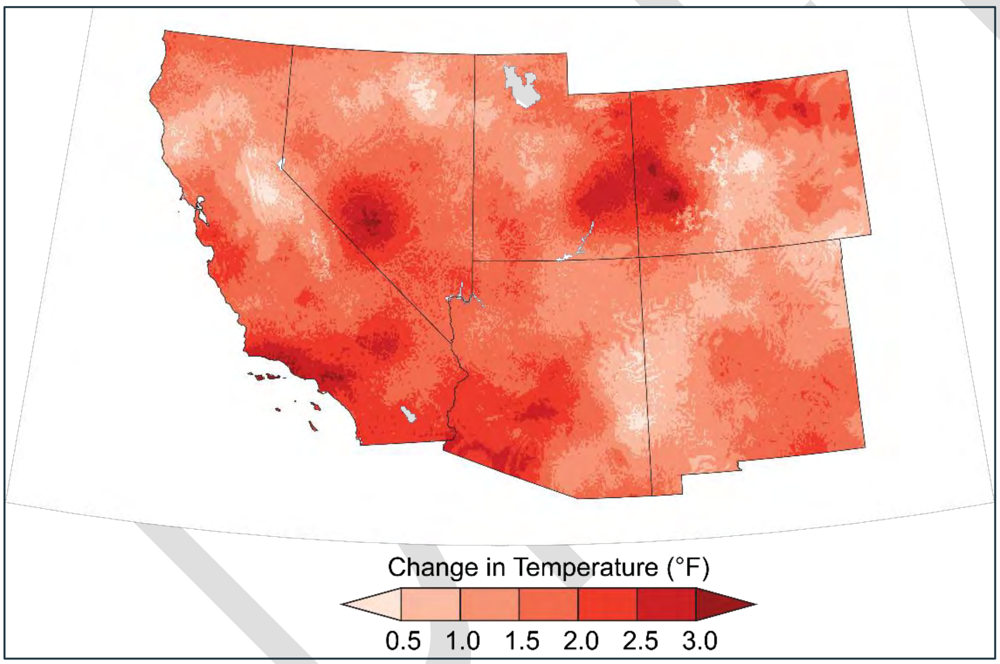
Drought and extreme heat probability may increase in the future due to climate change, discussed in greater detail below.

Climate Change Considerations

Current climate change projections suggest that drought conditions may become even more common in the future due to a variety of factors, including higher temperatures and increased evapotranspiration, reduced snowpack from less snowfall and earlier spring melt, and severe soil moisture drought.

Research cited in the Fourth National Climate Assessment indicates that average temperatures have already increased across the Southwest and will likely continue to rise. Figure 4-11 shows the difference between the 1986-2016 average temperature and the 1901-1960 average temperature. This trend toward higher temperatures is expected to continue and would cause more frequent and severe droughts in the Southwest as well as drier future conditions and an increased risk of megadroughts—dry periods lasting 10 years or more). Additionally, current models project decreases in snowpack, less snow and more rain, shorter snowfall seasons, and earlier runoff, all of which may increase the probability of future water shortages (Gonzalez et al., 2018).

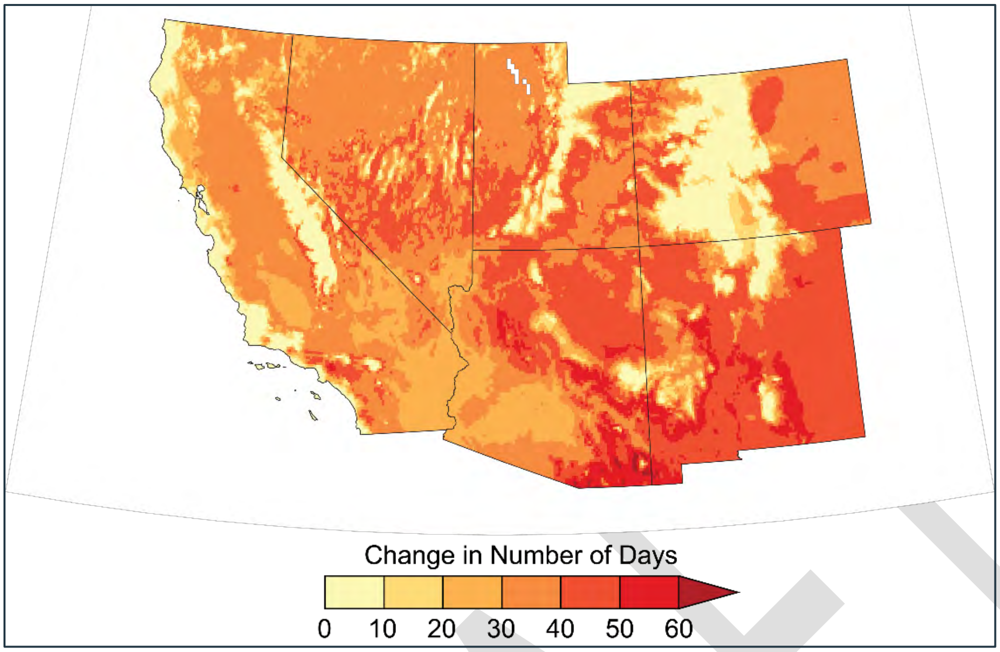
Figure 4-11 Change in Average Temperature Across the Southwest, 1901-1960 to 1986-2016



Source: Fourth National Climate Assessment

In conjunction with rising average temperatures and their projected impact on drought, extreme heat is also expected to increase in frequency. Figure 4-12 shows projected increases in extreme heat as an increase in the number of days per year when the temperature exceeds 90°F by the period 2036-2065 compared to the period 1976-2005. Under the higher emissions scenario (RCP8.5), the number of days of extreme heat would increase in Larimer County by 30 to 50 days based on the figure below.

Figure 4-12 Projected Increases in Extreme Heat



Source: Fourth National Climate Assessment *Based on higher emission scenario RCP8.5

Vulnerability Analysis

The National Drought Mitigation Center (NDMC), located at the University of Nebraska in Lincoln, provides a clearinghouse for information on the effects of drought based on reports from media, observers, impact records, and other sources.

According to the NDMC's Drought Impact Reporter, during the 20-year period from January 2000 through December 2019, 818 drought impacts were recorded for the State of Colorado, of which 71 were reported to affect Larimer County. Table 4-26 summarizes the number of impacts reported by category and the years impacts were reported for each category, where available. Note that the Drought Impact Reporter assigns multiple categories to each impact, so there is some duplication between categories.

Table 4-26 NDMC Drought Impact Reporter, 2000-2019

Impact Category	# of Impacts
Agriculture	18
Business & Industry	3
Fire	14
Plants & Wildlife	23
Relief, Response & Restrictions	26
Society & Public Health	7
Tourism & Recreation	9
Water Supply & Quality	18
Total Impacts	**71**

Source: National Drought Mitigation Center Drought Impact Reporter (https://droughtreporter.unl.edu/map/)

People

Drought can affect people's physical and mental health. For those economically dependent on a reliable water supply, drought may cause anxiety or depression about economic losses, reduced incomes, and other employment impacts. Larimer County has many agricultural workers, who can be particularly vulnerable to these impacts. Drought may also cause health problems due to poorer water quality from lower water levels.

Though physical injury or death are not typically a result of drought, extreme heat can cause heat stroke or even fatality. The most dangerous place to be during an extreme heat incident is in a permanent home, with little or no air conditioning. Those most vulnerable to heat-related illness include people 65 years of age and older, young children, people with chronic health problems such as heart disease, people who are obese, people who are socially isolated, and people who are on certain medications. Low income families are less likely to have air conditioning and may be disproportionately impacted by rising water costs. Even young and healthy individuals are susceptible if they participate in strenuous physical activities during hot weather or are not acclimated to hot weather. Those who are homeless and are limited in their ability to seek shelter from extreme temperatures are also more vulnerable to extreme heat.

Aside from direct health impacts, in extreme cases of drought, conflicts may arise over water shortages. People may be forced to pay more for water, food, and utilities affected by increased water costs. Utilities may increase water prices to cover revenue losses from water restrictions, and to incentivize customers to use less so the shortage does not result in a supply disruption. Larimer County has the greatest number of dams in the State, which infers a capability to ensure a greater amount of water resources in times of drought. However, if drought is prolonged these stored resources could be depleted, making the County more reliant on snowpack from year to year.

General Property

Drought does not typically have a direct impact on buildings, although an increase in expanding/collapsing soils could affect building foundations. Developed areas may experience damages to landscaping if water use restrictions are put in place, however these losses are not considered significant.

According to the 2017 Census of Agriculture, there are 2,043 farms in Larimer County covering 482,456 total acres. The market value of agricultural products sold by these farms is estimated at over $150M. Approximately 24,554 acres, or 5.1% of the total farm acreage, is covered by crop insurance. The United States Department of Agriculture (USDA) Risk Management Agency (RMA) maintains a database of all crop insurance claims across the country by location and cause of loss. This data helps to quantify the economic impact of drought on agriculture. In Larimer County, crop insurance claims were made as a result of drought 8 years between 2007 and 2019. In total, 2,384 acres were affected and $119,474 in losses were claimed, for an average annualized loss of $9,956 per year. An additional $375,924 (or $31,327/year) in losses were claimed due to excessive heat during the same period. Exposure of agricultural property to drought is high in Larimer County.

Table 4-27 Crop Insurance Claims Paid Due to Drought, 2007-2018

Year	Net Acres	Indemnity Amount
2007	54	$1,714
2008	187	$11,427
2009	21	$985
2011	617	$28,009
2012	86	$8,547
2013	475	$29,609
2017	937	$39,168
2018	5	$15
Total	**2,384**	**$119,474**

Source: USDA RMA

Critical Facilities and Infrastructure

Buildings and infrastructure are not vulnerable to direct impact from drought; however, critical systems related to water supply can be affected. Decreased water levels in dams can cause structural damage. Low water levels can also affect wildfire protection capability.

Secondary hazards exacerbated by drought, such as wildfire and expansive soils, can cause direct structural impacts on critical facilities and infrastructure.

Prolonged heat exposure can have devastating impacts on infrastructure. Prolonged high heat exposure increases the potential of pavement deterioration, as well as railroad warping or buckling. High heat also puts a strain on energy systems and consumption, as air conditioners are run at a higher rate and for longer. Extreme heat can also reduce transmission capacity over electric systems. While firefighting will always be a prioritized water use, a severe supply disruption could impact fire suppression both in the mountains and in urban areas.

Economy

The main industry to experience the effects of drought is agriculture. Farmers may face crop losses or increased livestock costs, and businesses that depend on farming may experience secondary impacts. Extreme drought also has the potential to impact local businesses in landscaping, recreation and tourism, and public utilities. Additionally, there are many businesses in the cities that rely on outdoor water use such as nurseries, landscapers, and car washes; these can be impacted when water restrictions are put in place. Many large facilities require water for building cooling towers, and limited supply could impact industrial processes that require cooler temperatures. Impacts from more severe restrictions could be much more far reaching and could potentially affect indoor use and industries and quality of life the rely on indoor water use.

Other industries may also face impacts from drought due to reduced water availability. Lower reservoir levels in popular recreation areas such as Horsetooth and Carter reservoirs may impede access for boats and curb recreational activities. Additionally, the rafting and kayaking industry, such as those that utilize the Cache la Poudre River, that depend on flows for business viability may face adverse impacts caused by drought and decreased water levels.

Historic, Cultural and Natural Resources

Drought can affect local wildlife by shrinking food supplies and damaging habitats. Sometimes this damage is only temporary, and other times it is irreversible. Wildlife may face increased disease rates due to limited access to food and water. Increased stress on endangered species could cause extinction. Reduced food supply can also drive wildlife into greater proximity with humans. Extreme heat can have similar direct health impacts on natural resources such as plants, wildlife, and livestock.

Drought conditions can also provide a substantial increase in wildfire risk. As plants and trees die from a lack of precipitation, increased insect infestations, and diseases – all of which are associated with drought – they become fuel for wildfire. Long periods of drought can result in more intense wildfires, which bring additional consequences for the economy, the environment, and society. Drought may also increase likelihood of wind and water erosion of soils. Wildfire and soil erosion/deposition can in turn affect water quality, further complicating drought conditions.

Future Land Use and Development

Drought vulnerability is likely to be impacted by future development. Public demand for water, which impacts water availability, can exacerbate drought. Larimer County has a semi-arid climate, which means precipitation is already limited under normal climate conditions. Per the State’s Drought Mitigation and Response Plan, all of Colorado depends on precipitation for its water supply. As the gap between water supply and water demand shrinks, departures from normal hydrologic conditions may be felt more frequently in Larimer County. Water rights issues further complicate this matter.

Risk Summary

- Larimer County has an estimated 40% chance of experiencing drought in any given year. This frequency is likely to increase with the warming climate.
- Annualized crop loss due to drought in Larimer County is estimated at $9,956
- Related hazards: Wildfire

4.3.5 Earthquake

Hazard	Frequency	Spatial Extent	Severity	Overall Significance
Earthquake	Unlikely	Significant	Catastrophic	Medium

Description

An earthquake is the motion or trembling of the ground produced by sudden displacement of rock usually within the upper 10 – 20 miles of the Earth's crust. Earthquakes can affect hundreds of thousands of square miles, cause extensive damage to property and infrastructure, result in loss of life and injury to hundreds of thousands of people, and disrupt the social and economic functioning of the affected area. Most property damage and earthquake-related deaths are caused by the failure and collapse of structures due to ground shaking which is dependent upon amplitude and duration of the earthquake (FEMA, 1997).

Earthquake Mechanics

Regardless of the source of the earthquake, the associated energy travels in waves radiating outward from the point of release. When these waves travel along the surface, the ground shakes and rolls, ground fractures can form, and water waves may be generated. Earthquakes generally last a matter of seconds, but the waves may travel for long distances and cause damage well after the initial shaking at the point of origin has subsided.

Breaks in the earth's crust associated with seismic activity are known as "faults" and are classified as either active or inactive. Faults may be expressed on the surface by sharp cliffs or scarps or may be buried below surface deposits.

"Foreshocks," minor releases of pressure or slippage, may occur months or minutes before the actual onset of the earthquake. "Aftershocks," which range from minor to major, may occur for months after the main earthquake. In some cases, strong aftershocks may cause significant additional damage, especially if the initial earthquake impacted emergency management and response functions or weakened structures.

Factors Contributing to Damage

The damage associated with each earthquake is subject to four primary variables:

- The nature of the seismic activity
- The composition of the underlying geology and soils
- The level and quality of development of the area struck by the earthquake
- The time of day

Seismic Activity: The properties of earthquakes vary greatly from event to event. Some seismic activity is localized (a small point of energy release), while other activity is widespread (e.g., a major fault shifting or slipping all at once). Earthquakes can be very brief (only a few seconds) or last for a minute or more.

The depth of release and type of seismic waves generated also play roles in the nature and location of damage; shallow quakes will hit the area close to the epicenter harder but tend to be felt across a smaller region than deep earthquakes.

Geology and Soils: The surface geology and soils of an area influence the propagation (conduction) of seismic waves and how strongly the energy is felt. Generally, stable areas (e.g., solid bedrock) experience less destructive shaking than unstable areas (e.g., fill soils). The siting of a community or even individual buildings plays a strong role in the nature and extent of damage from an event.

Development: An earthquake in a densely populated area which results in many casualties and considerable damage may have the same magnitude as a shock in a remote area that has no direct impacts. Building stock construction materials, type, age, and design all contribute to susceptibility for damage.

Time of Day: The time of day of an event controls the distribution of the population of an affected area. On workdays, the majority of the community will transition between work or school, home, and the commute between the two. The relative seismic vulnerability of each location can strongly influence the loss of life and injury resulting from an event.

Types of Damage

Often, the most dramatic evidence of an earthquake results from the vertical and/or horizontal displacement of the ground along a fault line. This displacement can sever transportation, energy, utility, and communications infrastructure potentially impacting numerous systems and persons. These ground displacements can also result in severe and complete damages to structures situated on top of the ground fault. However, most damage from earthquake events is the result of shaking. Shaking also produces a number of phenomena that can generate additional damage

- Additional ground displacement
- Landslides and avalanches
- Liquefaction and subsidence
- Seismic Seiches

Shaking: During minor earthquake events, objects often fall from shelves and dishes rattle. In major events, large structures may be torn apart by the forces of the seismic waves. Structural damage is generally limited to older structures that are poorly maintained, poorly constructed, or improperly (or not) designed for seismic events. Un-reinforced masonry buildings and wood frame homes not anchored to their foundations typically sustain the worst damage from earthquakes.

Loose or poorly secured objects also pose a significant hazard when they are loosened or dropped by shaking. These "non-structural falling hazard" objects include bookcases, heavy wall hangings, and building facades. Home water heaters pose a special risk due to their tendency to start fires when they topple over and rupture gas lines. Crumbling chimneys may also be responsible for injuries and property damage.

Dam and bridge failures are significant risks during stronger earthquake events, and due to the consequences of such failures, may result in considerable property damage and loss of life. In areas of severe seismic shaking hazard, shaking Intensity levels of VII or higher (see Table 35) can be experienced even on solid bedrock. In these areas, older buildings especially are at significant risk.

Ground Displacement: Ground displacement can also occur due to shaking, resulting in similar damages as mentioned previously.

Landslides and Avalanches: Even small earthquake events can cause landslides. Rock falls are common as unstable material on steep slopes is shaken loose, but significant landslides or even debris flows can be generated if conditions are ripe. Roads may be blocked by landslide activity, hampering response and recovery operations. Avalanches are possible when the snowpack is sufficient.

Liquefaction and Subsidence: Soils may liquefy and/or subside when impacted by the seismic waves. Fill and previously saturated soils are especially at risk. The failure of the soils has the potential to cause widespread structural damage. The oscillation and failure of the soils may result in increased water flow and/or failure of wells as the subsurface flows are disrupted and sometimes permanently altered. Increased flows may be dramatic, resulting in geyser-like waterspouts and/or flash floods. Similarly, septic systems may be damaged creating both inconvenience and health concerns.

Seiches: Seismic waves may rock an enclosed body of water (e.g., lake or reservoir), creating an oscillating wave referred to as a "seiche." Although not a common cause of damage in past Colorado earthquakes, there is a potential for large, forceful waves similar to a tsunami ("tidal waves") to be generated on the large reservoirs. Such a wave would be a hazard to shoreline development and pose a significant risk on dam-created reservoirs. A seiche could either overtop or damage a dam leading to downstream flash flooding.

Environmental impacts of earthquakes can be numerous, widespread, and devastating, particularly if indirect impacts are considered. Some examples of impacts are listed below:

- Induced flooding and landslides
- Poor water quality
- Damage to vegetation
- Breakage in sewage or toxic material containments

Past Occurrences

Earthquakes are relatively infrequent in Colorado and records of historical earthquakes in and around Larimer County are limited. Table 4-28 provides a list of Colorado's larger earthquakes recorded since 1870.

Table 4-28 Notable Earthquake Events in Colorado (1870 – 2015)

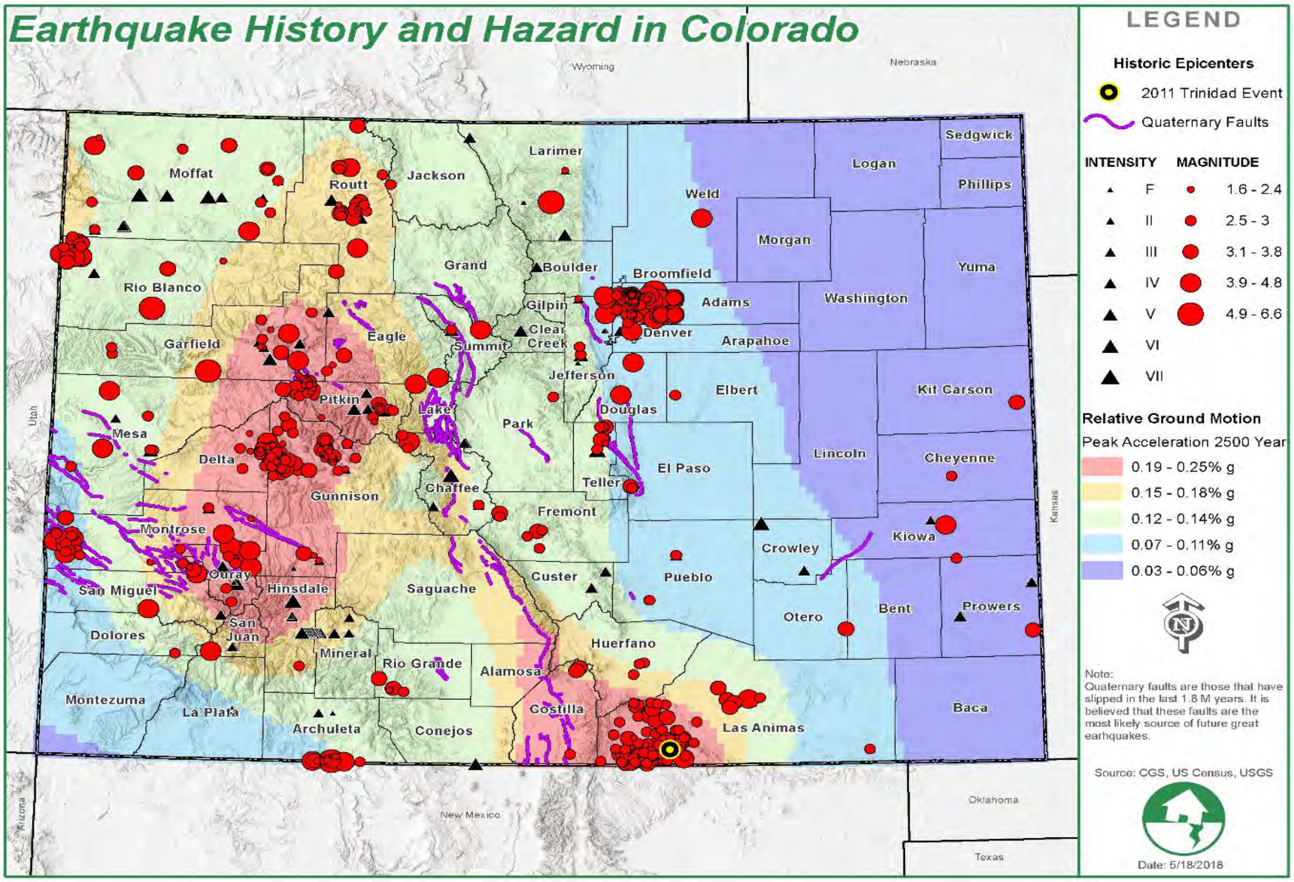
Date	Location	Magnitude	Intensity
1870	Pueblo/Ft. Reynolds	-	VI
1871	Lily Park, Moffat County	-	VI
1880	Aspen	-	VI
1882	Larimer County	6.6*	VII
1891	Axial Basin (Maybell)	-	VI
1901	Buena Vista	-	VI
1913	Ridgeway Area	-	VI
1944	Montrose/Basalt	-	VI
1955	Lake City	-	VI
1960	Montrose/Ridgeway	5.5	V
1966	NE of Denver	5.0	V
1966	CO-NM border, near Dulce, NM	5.5	VII
1967	NE Denver	5.3	VII
1967	NE Denver	5.2	VI
2011	Southwest of Trinidad	5.3	VIII

Source: Colorado Geological Survey, *Estimated, based on historical felt reports

Colorado's largest earthquake in modern history was believed to have originated in the foothills of Larimer County on November 7, 1882. The location of this earthquake has been the subject of much debate and controversy over the years, but the general scientific consensus was it occurred to the west of Fort Collins and near Estes Park. While the region was less populated and developed at the time, the earthquake was felt across Colorado into Wyoming and parts of Utah, with Intensity levels of VII.

The map below shows the location of past earthquake epicenters and Quaternary age faults in Colorado, as well as the Peak Ground Acceleration from the 2500 year (2% in 50 years) probabilistic shaking.

Figure 4-13 Colorado Seismic Hazard Map



Source: Colorado State Hazard Mitigation Plan 2018

The most economically damaging earthquake in Colorado's history occurred on August 9th, 1967 in the Denver metro area. The 5.3 magnitude earthquake caused more than a million dollars of damage in Denver and the northern suburbs. The August 1967 earthquake was followed by an earthquake of magnitude 5.2 three months later in November 1967. Although these two earthquake events cannot be classified as "major earthquakes" they are significant because of their location along the Front Range Urban Corridor, an area where nearly 75 percent of Colorado residents and many critical facilities are located. Historically, earthquake risk in Colorado has been rated lower than most subject experts consider justified. It is critically important that local emergency managers in and around Larimer County become fully aware of the size and consequences of an earthquake that could occur.

Location

Studies indicate that there are about 100 potentially active fault lines in Colorado. Over 500 earthquake tremors of magnitude 2.5 or higher have been recorded across the state since 1870. It is likely that more earthquakes of similar magnitude occurred during that time but were not recorded due to low population densities and limited coverage of sensors across most of the state. For comparison, over 20,500 similarly sized events have been recorded in the State of California since 1870.

Relative to other western states, Colorado's earthquake risk is higher than Kansas or Oklahoma, lower than Utah, and much lower than Nevada and California (Colorado OEM, 2003). Despite Colorado's lower earthquake risk, based on geologic observations and characteristics of faults located in the region, seismologists predict that Colorado will indeed experience a magnitude 6.5 earthquake at some point in the future.

Earthquakes are extremely difficult to predict, and their occurrence rate is determined in one of two ways. If geologists can find evidence of distinct, datable earthquakes in the past, the number of these ruptures is used to define an occurrence rate. If evidence of ruptures is not available, geologists estimate fault slip rates from accumulated scarp heights and estimated date for the oldest movement on the scarp. Because a certain magnitude earthquake is likely to produce a displacement (slip) of a certain size, we can estimate the rate of occurrence of earthquakes of that magnitude.

Recurrence rates are different for different assumed magnitudes thought to be "characteristic" of that fault type. Generally, a smaller magnitude quake will produce a faster recurrence rate, and for moderate levels of ground motion, a higher hazard risk. Future earthquakes are assumed to be likely to occur where earthquakes have produced faults in the geologically recent past. Quaternary faults are faults that have slipped in the last 1.8 million years and it is widely accepted that they are the most likely source of future large earthquakes. For this reason, quaternary faults are used to make fault sources for future earthquake models.

Magnitude/Severity

The impact an earthquake event has on an area is typically measured in terms of earthquake intensity. Intensity is most commonly measured using the Modified Mercalli Intensity (MMI) Scale based on direct and indirect measurements of seismic effects. A detailed description of the Modified Mercalli Intensity Scale is shown in the table below.

Table 4-29 Modified Mercalli Intensity Scale, PGA, and Richter Scale Comparison

SCALE	INTENSITY	DESCRIPTION OF EFFECTS	PGA (g)	RICHTER SCALE MAGNITUDE
I	Instrumental	Detected only on seismographs	< 0.0017	< 4.2
II	Feeble	Some people feel it	0.0018 – 0.014	
III	Slight	Felt by people resting; like a truck rumbling by		
IV	Moderate	Felt by people walking	0.015 – 0.039	
V	Slightly Strong	Sleepers awake; church bells ring	0.040 – 0.092	< 4.8
VI	Strong	Trees sway; suspended objects swing; objects fall off shelves	0.093 – 0.18	< 5.4
VII	Very Strong	Mild alarm, walls crack, plaster falls	0.19 – 0.34	< 6.1
VIII	Destructive	Moving cars uncontrollable, masonry fractures, poorly constructed buildings damaged	0.34 – 0.65	< 6.9
IX	Ruinous	Some houses collapse, ground cracks, pipes break open	0.65 – 1.24	
X	Disastrous	Ground cracks profusely, many buildings destroyed, liquefaction and landslides widespread	> 1.24	< 7.3
XI	Very Disastrous	Most buildings and bridges collapse, roads, railways, pipes and cables destroyed, general triggering of other hazards	> 1.24	< 8.1
XII	Catastrophic	Total destruction, trees fall, ground rises and falls in waves	> 1.24	> 8.1

Source: USGS

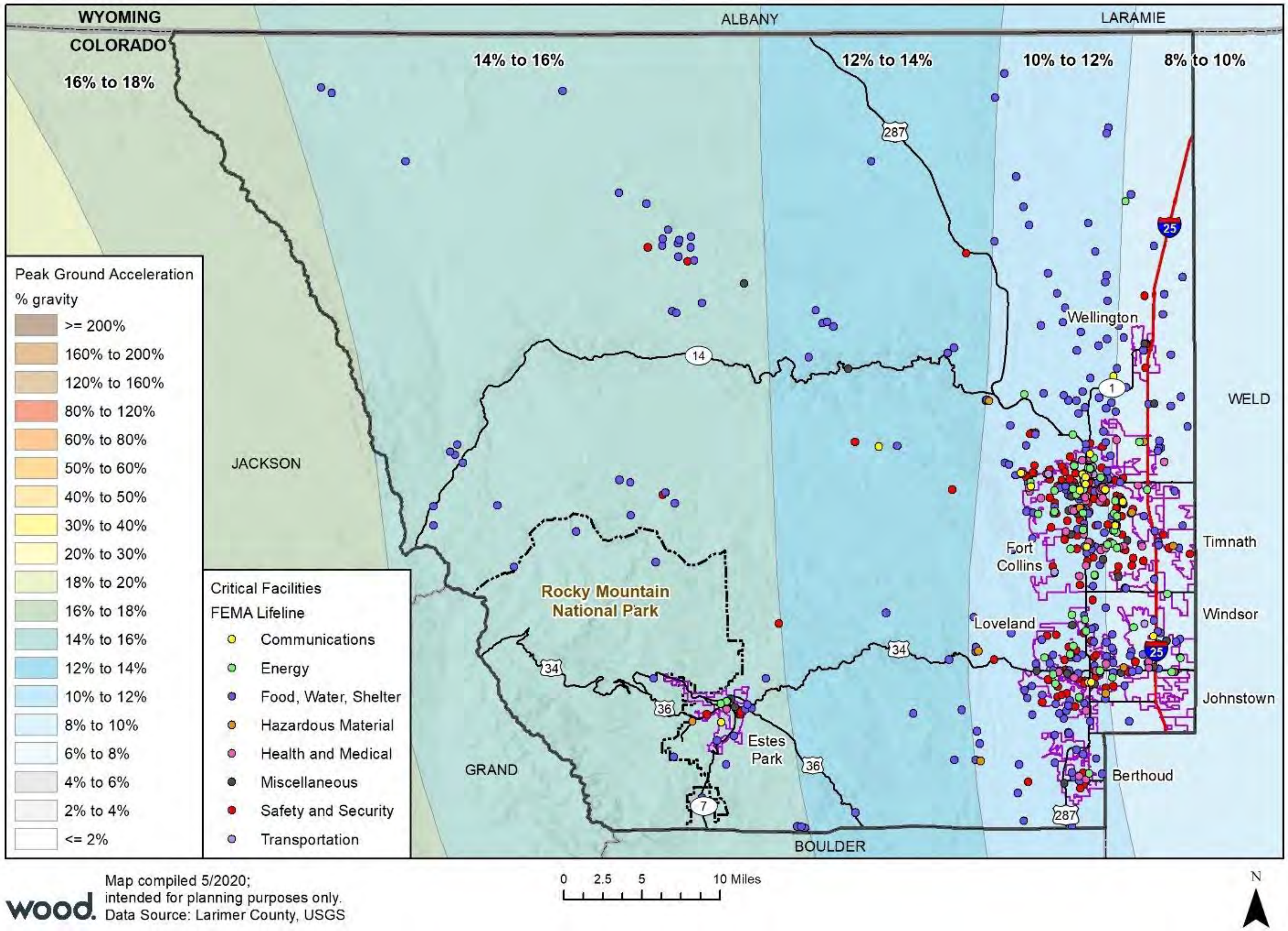
Another way to express an earthquake's severity is to compare its acceleration to the normal acceleration due to gravity. Peak ground acceleration (PGA) measures the strength of ground movements in this manner. PGA represents the rate in change of motion of the earth's surface during an earthquake as a percent of the established rate of acceleration due to gravity. PGA can be partly determined by what soils and bedrock characteristics exist in the region. Unlike the Richter scale, PGA is not a measure of the total energy released by an earthquake, but rather of how hard the earth shakes at a given geographic area (the intensity). PGA is measured by using instruments including accelerographs and correlates well with the Mercalli scale.

When the peak ground acceleration nears 0.04 – 0.092g, an earthquake can be felt by people walking outside. As PGA nears 0.19 – 0.34g the intensity is considered to be very strong. At this level, plaster can break off and fall away from structures and cracks in walls often occur. PGA magnitudes of 1.24g are considered to be very disastrous. This magnitude of ground acceleration represents an earthquake of roughly 6.9 to 8.1 on the Richter Scale. Figure 4-14 shows estimated Peak Ground Acceleration from a 2500 year earthquake.

Speed of Onset: Earthquakes typically occur quickly with little to no warning; foreshocks may be a precursor to a larger event.

Duration: Earthquakes occur quickly and suddenly, and the duration of the event is typically measured in seconds except for the larger earthquakes which may last 1-3 minutes. Aftershocks can occur in the days, weeks and months following a significant earthquake and continue to cause damage to weakened buildings and infrastructure, even though typically smaller in magnitude.

Figure 4-14 Larimer County 2500 Year Earthquake Peak Ground Acceleration



Probability of Future Occurrences

Even though the seismic hazard risk in Larimer County is low to moderate, it is likely that earthquakes will occur in the county in the future. It is reasonable to expect future earthquakes as large as magnitude 6.5, the largest event on record in Colorado. Calculations based on the historical earthquake records and geological evidence of recent fault activity suggest that an earthquake of magnitude 6 or greater may be expected somewhere in Colorado every several centuries. Earthquakes are not a seasonal hazard, and thus can be experienced year-round. This fact presents its own set of planning and preparedness concerns.

Ultimately, the probability of an earthquake occurring in Larimer County is low. Additionally, if an earthquake were to occur in the near future it is likely to be of a low magnitude, with expected damages to property and people to be minimal. History has shown, however, that Larimer County and Colorado are at risk to a larger magnitude seismic event. Should that type of event occur, major damages and losses should be expected. This fact makes these low probability, high impact hazards a challenge to deal with when planning a mitigation strategy to combat all hazards faced by a community.

Climate Change Considerations

Climate change is not expected at this time to have any impacts on geological hazards such as earthquakes. There is potential for increased heat and reduced soil moisture to contribute to the instability of regional soils. In theory, these subtle changes to the surface of the earth may affect the damage profile of local earthquake events in the future. However, it is unlikely that earthquake events in Larimer County will be affected by climate change in a measurable way.

Vulnerability Analysis

As noted above, earthquakes strike with little to no warning and can have multiple impacts on an area. After-effects from an earthquake can include impacted roadways, downed power and communication lines, fires, and damages to structures (especially poorly built, or those already in disrepair).

The most appropriate risk assessment methodology for seismic hazards involves scenario modeling using FEMA's HAZUS loss estimation software. HAZUS is a regional earthquake loss estimation model developed by FEMA and the National Institute of Building Science. The primary purpose of HAZUS is to provide a methodology and software application to develop earthquake loss at a regional scale. HAZUS is a very useful planning tool because it provides a standard method for estimating earthquake damage, loss of function of infrastructure, and casualties, among many other factors. There are three levels of HAZUS analysis, from Level 1, which uses the default FEMA-derived datasets and damage functions, to Level 3, which uses independently compiled and accurately verified structure and infrastructure inventories and damage functions.

Utilizing HAZUS 4.2, FEMA's loss estimation and hazard modeling software, a Level 1 earthquake loss analyses was conducted for Larimer County, based on an inventory database compiled at a national level aggregated to Census Tracts. As with any model there are uncertainties, and the results should be considered approximate for planning purposes.

To evaluate potential losses associated with earthquake activity in the planning area, a HAZUS 2,500-year probabilistic scenario was run for the entire County. The methodology utilizes probabilistic seismic hazard contour maps developed by the U.S. Geological Survey (USGS). The 2,500-year return period analyzes ground shaking estimates from the various seismic sources in the area with a 2 percent probability of being exceeded in 50 years.

People

Casualties: Ground movement during an earthquake is seldom the direct cause of death or injury. Most earthquake-related injuries result from collapsing walls, flying glass, and falling objects as a result of the ground shaking, or people trying to move more than a few feet during the shaking. HAZUS estimates the number of people that will be injured and killed by the earthquake. The casualties are broken down into four severity levels that describe the extent of the injuries. The levels are described as follows:

- Severity Level 1: Injuries will require medical attention, but hospitalization is not needed.
- Severity Level 2: Injuries will require hospitalization but are not considered life-threatening.
- Severity Level 3: Injuries will require hospitalization and can become life threatening if not promptly treated.
- Severity Level 4: Victims are killed by the earthquake.

The casualty estimates are provided for three times of day: 2:00 AM, 2:00 PM and 5:00 PM. These times represent the periods of the day that different sectors of the community are at their peak occupancy loads. The 2:00 AM estimate considers that the residential occupancy load is at its maximum. The 2:00 PM estimate considers that the educational, commercial, and industrial sector loads are at their maximum. The 5:00 PM represents peak commute time. The model shows that the 2:00 PM would result in the most casualties. Most of these would be minor injuries (95 Level 1 and 13 Level 2), and only 1 hospitalization (Level 3) and 2 fatalities (Level 4) are estimated.

HAZUS estimates the number of households that are expected to be displaced from their homes due to the earthquake and the number of displaced people that will require accommodations in temporary public shelters. The model estimates that approximately 199 households will be displaced due to the earthquake, and 124 people will seek temporary shelter in public shelters.

General Property

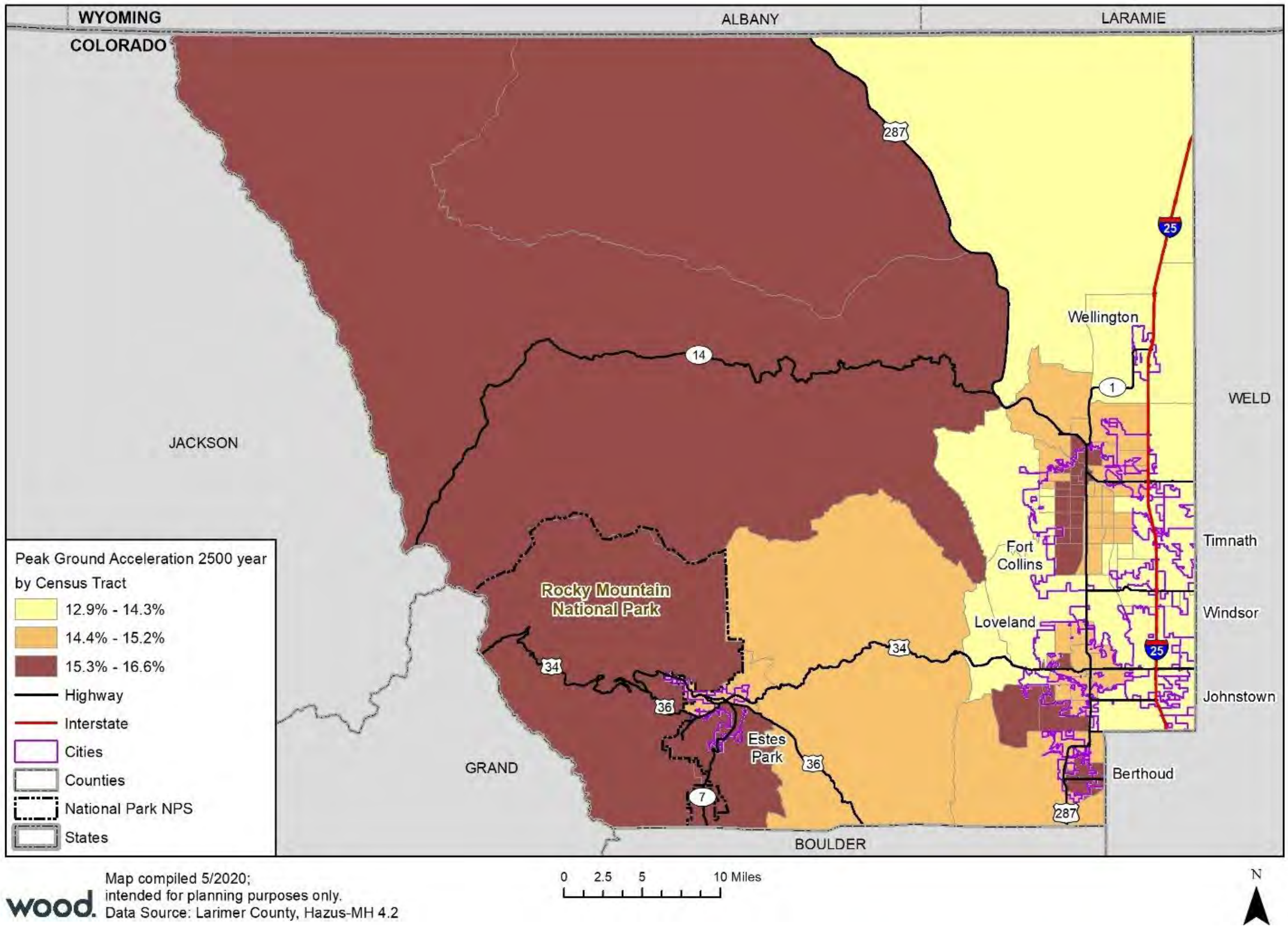
There are an estimated 119,000 buildings in Larimer County with a total building replacement value (excluding contents) of $33.6 Billion. In terms of building construction types found in the HAZUS region, wood frame construction makes up 68% of the building inventory.

The building losses are broken into two categories: direct building losses and business interruption losses. The direct building losses are the estimated costs to repair or replace the damage caused to the building and its contents.

The categories of damages defined by HAZUS are:

- **Slight** damage includes diagonal hairline fractures on most shear wall surfaces and hairline cracks on most infill walls.
- **Moderate** damage includes cracks on most walls and failure of some shear walls.
- **Extensive** damage means that most shear wall surfaces in the structure have reached or exceeded their capacity exhibited by large, through-the-wall diagonal cracks.
- **Complete** damage means that the structure has collapsed or is in danger of collapse.

Figure 4-15 Larimer County HAZUS 2500 Year Earthquake Peak Ground Acceleration



HAZUS estimates that about 4,610 buildings will be at least moderately damaged. This is over 4% of the total number of buildings in the County. There are 26 buildings that will be damaged beyond repair. Most of the damage modeled as extensive and complete is associated with unreinforced masonry buildings.

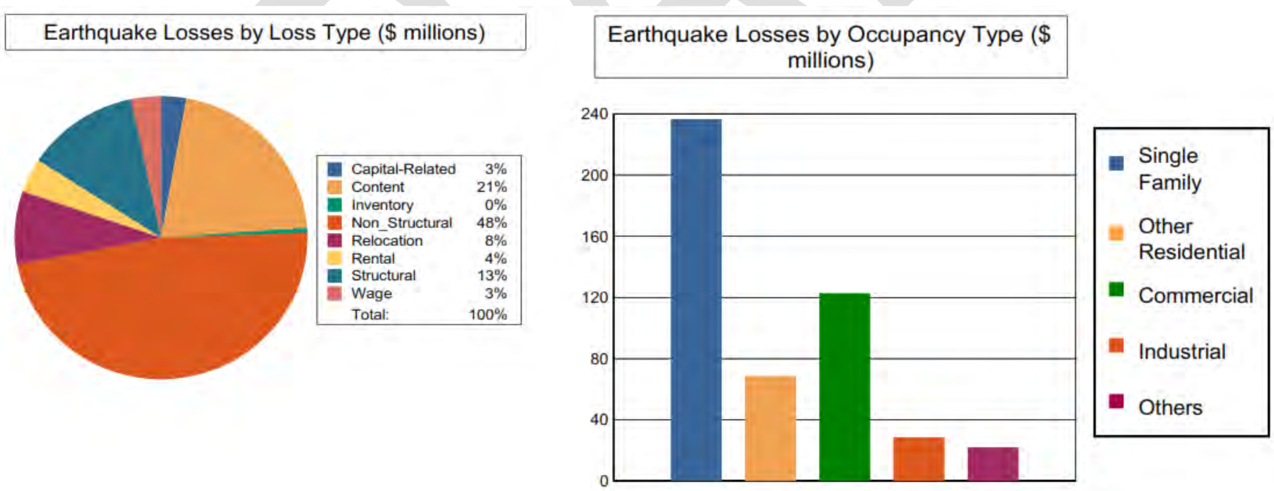
The total building-related losses were $478 million, with detail shown in Table 4-30. By far, the largest loss was sustained by the residential occupancies which made up over 64% of the total loss.

Table 4-30 Building-Related Economic Loss Estimates in Millions of Dollars

Category	Area	Single Family	Other Residential	Commercial	Industrial	Others	Total
Income Losses							
	Wage	0.0000	1.1339	13.5597	0.5605	0.7706	16.0247
	Capital-Related	0.0000	0.4824	12.1244	0.3330	0.1937	13.1335
	Rental	5.6459	4.0181	7.7680	0.2717	0.3512	18.0549
	Relocation	19.9172	3.5030	11.4236	1.6197	2.8317	39.2952
	Subtotal	**25.5631**	**9.1374**	**44.8757**	**2.7849**	**4.1472**	**86.5083**
Capital Stock Losses							
	Structural	32.2455	7.7486	13.5460	3.5483	3.2182	60.3066
	Non_Structural	127.6113	40.0686	39.2886	12.4060	8.6846	228.0591
	Content	51.0728	11.5558	24.4349	8.3652	5.7904	101.2191
	Inventory	0.0000	0.0000	0.6015	1.4282	0.1328	2.1625
	Subtotal	**210.9296**	**59.3730**	**77.8710**	**25.7477**	**17.8260**	**391.7473**
	Total	**236.49**	**68.51**	**122.75**	**28.53**	**21.97**	**478.26**

Source: HAZUS 4.2 Global Summary Report, Wood analysis

Figure 4-16 Earthquake Losses by Type



Source: HAZUS 4.2 Global Summary Report, Wood analysis

The business interruption losses are the losses associated with inability to operate a business because of the damage sustained during the earthquake. Business interruption losses also include the temporary living expenses for those people displaced from their homes because of the earthquake. 18% of the estimated losses were related to business interruption.

Critical Facilities and Infrastructure

Critical Facility Inventory: HAZUS breaks critical facilities into two groups: essential facilities and high potential loss (HPL) facilities. Essential facilities include hospitals, medical clinics, schools, fire stations, police stations and emergency operations facilities. High potential loss facilities include dams, levees, military installations, nuclear power plants and hazardous material sites.

Essential Facility Damage: The model estimates the region had 725 hospital beds total, and due to the earthquake only 621 (86%) would be available for use. After one week 95% of the beds will be back in service. The model did not predict there would be any damage to schools, police, fire stations, or EOCs.

Transportation Systems Inventory: Within HAZUS, the lifeline inventory is divided between transportation and utility lifeline systems. There are 7 transportation systems that include highways, railways, light rail, bus, ports, ferry, and airports. The transportation systems inventory includes over 339 miles of highways and 546 bridges. The model estimated approximately $3 million in damage to transportation systems, mostly to railways, bridges, and an airport facility.

Utility Lifeline Systems Inventory: There are 6 utility systems that include potable water, wastewater, natural gas, crude & refined oil, electric power, and communications. The replacement value of the utility lifeline systems combined is estimated to be $6.4 billion including 16,994 miles of pipes, and related economic losses to these systems would be around $229 million, with the largest losses to wastewater and electrical power systems.

The expected utility system facility damages in terms of Economic losses in millions of dollars are found in Table 4-31.

Table 4-31 Utility System Economic Losses in Millions of Dollars

System	Component	Inventory Value	Economic Loss	Loss Ratio (%)
Potable Water	Pipelines	0.0000	0.0000	0.00
	Facilities	64.6020	2.6443	4.09
	Distribution Lines	341.3948	0.4453	0.13
	Subtotal	**405.9968**	**3.0896**	
Waste Water	Pipelines	0.0000	0.0000	0.00
	Facilities	4288.4359	175.0048	4.08
	Distribution Lines	204.8369	0.2237	0.11
	Subtotal	**4493.2728**	**175.2285**	
Natural Gas	Pipelines	23.4846	0.0000	0.00
	Facilities	0.0000	0.0000	0.00
	Distribution Lines	136.5579	0.0766	0.06
	Subtotal	**160.0425**	**0.0766**	
Oil Systems	Pipelines	0.0000	0.0000	0.00
	Facilities	0.0000	0.0000	0.00
	Subtotal	**0.0000**	**0.0000**	
Electrical Power	Facilities	1385.6710	51.5307	3.72
	Subtotal	**1385.6710**	**51.5307**	
Communication	Facilities	0.6790	0.0265	3.90
	Subtotal	**0.6790**	**0.0265**	
	Total	**6,445.66**	**229.95**	

Source: HAZUS 4.2 Global Summary Report - analysis by Wood

Economy

The total economic loss estimated for the earthquake is $711 million, which includes building and lifeline related losses based on the County's available inventory. $86 million is estimated to result from business interruption.

Historic, Cultural and Natural Resources

Earthquake effects on the environment, natural resources, and historic and cultural assets would likely be minor. The biggest impact would likely be on the older historic properties constructed with unreinforced masonry in Estes Park, Loveland, and Fort Collins.

Future Land Use and Development

With the unpredictable nature of earthquake epicenter locations, it is not feasible to identify specific areas where development may exacerbate the risk to an earthquake. It should be assumed that all development increases the risk to the County from the threat of earthquakes. As population and development continue to expand in Larimer County, continued enforcement of the unified construction code has great potential to mitigate increasing vulnerability and development pressure.

Standard building codes have the opportunity to provide Larimer County with reasonable guidance for development throughout unincorporated and incorporated areas. Contractors and builders should be aware of applicable codes and regulations designed to reduce losses sustained by new and existing construction due to seismic hazards.

For example, the light weight of wood frame buildings results in less force from inertia, which means less damage. Wood's natural flexibility also is an advantage when seismic forces are brought to bear and the nailed joints in wood frame buildings dissipate energy and motion. Wood's inherent earthquake resistance must be accompanied by design and construction techniques that take advantage of those characteristics.

Structural wood panels nailed to wall framing add rigid bracing, help resist lateral loads and help tie framing members together. Bolted connections at the sill plate/foundation joint help keep the structure in one spot. Securely connected wall, floor, and roof framing also help tie a structure together and make it a single, solid structural unit. Proper connections will do more to hold a house together during an earthquake than any other single seismic design element.

As development grows in the County and its municipalities, it will be important for citizens to consult with local building codes as modern building codes generally require seismic design elements for new construction.

Risk Summary

Earthquakes are relatively uncommon in Larimer County and the probability is low that they will occur regularly in the future. However, if an event was to occur within the county, there is potential for significant structural damage to occur. HAZUS does not break out loss by jurisdiction, but areas in Larimer County with high population densities and large numbers of structures and critical facilities are expected to experience greater damage and loss from an earthquake event. This includes jurisdictions located primarily in the southern, central eastern and southwestern portion of the county, including:

- Fort Collins
- Loveland
- Windsor
- Berthoud
- Johnstown
- Estes Park

Communities located in the eastern part of the County, may experience differential impacts from an earthquake event if transportation or utility infrastructure is damaged and prevents communities from responding or evacuating.

- The overall significance of earthquakes is Moderate due to the potential for high economic losses.
- A large earthquake occurring in or near Larimer County could result in injuries, property damage, and disruption of normal government, community services and activities, and economic and business activity.

- The HAZUS 2,500-year probabilistic scenario modeling of worst-case ground shaking estimates approximately $711 M in total economic damages, but relatively minor casualties and sheltering needs. Economic losses to utility lifeline systems would be around $229 million, with the largest losses to wastewater and electrical power systems.
- Earthquakes can cause many cascading effects such as fires, dam incidents, hazardous materials spills, landslide and debris flows, utility disruptions, and transportation emergencies. Ground shaking may cause seiches, the rhythmic sloshing of water, in the lakes and reservoirs in the county.
- Related hazards: Landslide/Rockslide, Dam Incident.

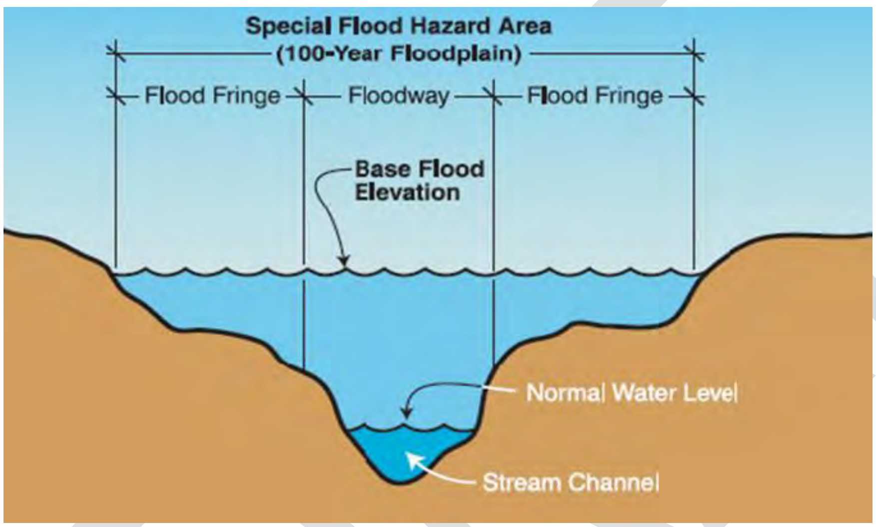
4.3.6 Flood

Hazard	Frequency	Spatial Extent	Severity	Overall Significance
Flood	Highly Likely	Significant	Catastrophic	High

Description

A flood is a naturally occurring event for rivers and streams and occurs when a normally dry area is inundated with water. Excess water from snowmelt or rainfall accumulates and overflows onto the stream banks and adjacent floodplains. As illustrated in Figure 4-17 below, floodplains are lowlands adjacent to rivers, streams, and creeks that are subject to recurring floods. Flash floods, usually resulting from heavy rains or rapid snowmelt, can flood areas not typically subject to flooding including urban areas. Additionally, extreme cold temperatures can cause streams and rivers to freeze, causing ice jams and creating flood conditions.

Figure 4-17 Floodplain Terminology



Floods are considered hazards when people and property are affected. Nationwide, hundreds of floods occur each year, making it one of the most common hazards in all 50 states and U.S. territories. Most injuries and deaths from flooding happen when people are swept away by flood currents and most property damage results from inundation by sediment-filled water. Fast-moving water can wash buildings off of their foundations and sweep vehicles downstream. Pipelines, bridges, and other infrastructure can be damaged when high water combines with flood debris. Basement flooding can also cause extensive damage. Flooding can cause extensive damage to crop lands and bring about the loss of livestock. Several factors determine the severity of floods including rainfall intensity and duration, topography, and ground cover.

Riverine flooding originates from a body of water, typically a river, creek, or stream, as water levels rise onto normally dry land. Water from snowmelt, rainfall, freezing streams, ice flows, or a combination thereof, causes the river or stream to overflow its banks into adjacent floodplains. Winter flooding usually occurs when ice in the rivers creates dams or streams freeze from the bottom up during extreme cold spells. Spring flooding is usually the direct result of melting winter snowpack, heavy spring rains, or a combination of the two.

Flash floods can occur anywhere when a large volume of water flows or melts over a short time period, usually from slow moving thunderstorms or rapid snowmelt. Because of the localized nature of flash floods, clear definitions of hazard areas do not exist. These types of floods often occur rapidly with significant impacts. Rapidly moving water, only a few inches deep, can lift people off their feet, and only a depth of a foot or two, is needed to sweep cars away. Most flood deaths result from flash floods.

Previous flash flooding events have occurred within Larimer County. Although data does not currently exist to perform robust assessments of flash flood risk within Larimer County, local jurisdictions have expressed a desire and a need for data and information specifically related to flash flooding so that appropriate mitigation strategies can be identified and implemented.

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

Stream bank erosion is measured as the rate of the change in the position or horizontal displacement of a stream bank over a period of time. It is generally associated with riverine flooding and may be exacerbated by human activities such as bank hardening and dredging.

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

Flooding that results from a dam failure or incident is covered in Section 4.4.3 **Dam Inundation**.

Flooding events are typically measured in terms of magnitude and the statistical probability that they will occur. The 1% annual chance flood event is the standard national measurement for flood mitigation and insurance. A 1% annual chance flood, also known as the '100-year flood', has a 1 in 100 chance of being equaled or exceeded in any 1 year and has an average recurrence interval of 100 years. It is important to note that this recurrence interval is an average; it does not necessarily mean that a flood of such a magnitude will happen exactly every 100 years. Sometimes, only a few years may pass between one 1% annual chance flood and another while two other 1% annual chance floods may be separated by 150 years. The 0.2% annual chance flood event, or the '500-year flood', is another measurement which represents a 0.2% chance (or 1 in 500 chance) of occurring in a given year.

Past Occurrences

Seasonally, Larimer County is confronted with the possibility of flooding and flood-related hazards. Floods have the potential to inflict tremendous damages with significant losses of life and property. They can also pose a threat to the health, safety, and welfare of Larimer County citizens. Previous flooding events have caused thousands of dollars in damage in just a few hours or days in the region and current development and population growth trends necessitate a heightened awareness that the impact of flooding may likely increase in Larimer County over time.

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

During flooding events, homes, businesses, and people face the threat of explosions and fires caused by leaking gas lines along with the possibility of being electrocuted. Domestic and wild animals forced out of their homes and brought into contact with humans by floodwaters can also pose a threat. In rural areas, property damage caused by flooding can be devastating to ranchers and farmers. When flooding occurs during the growing season, farmers can suffer widespread crop loss. Stock growers may lose livestock if they are unable to find safety from rising floodwaters. Flooding may also cause damage to pastureland, fences, barns, and outbuildings.

Publicly owned facilities are a key component of daily life for all citizens of the county. Public buildings are of particular importance during flood events because they house critical assets for government response and recovery activities. Damage to public water and sewer systems, transportation networks, flood control facilities, emergency facilities, and offices can hinder the ability of the government to deliver services. Loss of power and communications can be expected. Drinking water and wastewater treatment facilities may be temporarily out of operation.

Mitigation against flood events is accomplished through sensible floodplain management and regulations as well as identifying flood prone areas, tributary watersheds that experience instability or sediment loading problems, and channel instability hazards. This involves strategies to modify flooding and to modify infrastructure to decrease the likelihood of damage. To modify the impact of flooding, measures must be taken to decrease susceptibility to flood damage and disruptions. Natural and cultural resources must also be protected and managed. Coordination with mitigation plans by Floodplain Managers will increase effectiveness of flood mitigation projects. City and County Planners will be valuable resources to incorporate flood mitigation plans into their respective plans.

The National Centers for Environmental Information (NCEI) documents significant flood events going back to 1950. Table 4-32 provides a history of major flood events that affected Larimer County between 1996 and 2020. The database does not show any new flood events since the 2016 plan update.

Table 4-32 Larimer County Historical Flood Events (1996 – 2020)

Date	Hazard Type	Injuries	Deaths	Property Damage	Crop Damage
9/14/1996	Flood	0	0	0	0
6/2/1997	Flash Flood	0	0	$500,000	0
6/13/1997	Flood	0	0	0	0
7/28/1997	Flood	0	0	0	0
7/28/1997	Flash Flood	5	40	$190,000,000	0
8/4/1997	Flash Flood	0	0	0	0
9/1/1998	Flash Flood	0	0	0	0
4/28/1999	Flood	0	0	0	0
5/1/1999	Flood	0	0	$200,000	0
8/4/1999	Flood	0	0	0	0
8/16/2000	Flash Flood	0	0	0	0
7/12/2001	Flash Flood	0	0	0	0
6/18/2003	Flash Flood	0	0	0	0
8/18/2004	Flash Flood	0	0	0	0
6/3/2005	Flash Flood	0	0	0	0
8/2/2007	Flash Flood	0	0	$20,000	0
6/22/2009	Flash Flood	0	0	$10,000	$50,000
7/4/2010	Flash Flood	0	0	$10,000	$5,000
7/6/2012	Flash Flood	0	0	$20,000	$20,000

Date	Hazard Type	Injuries	Deaths	Property Damage	Crop Damage
7/7/2012	Flash Flood	0	0	$10,000	$25,000
7/16/2012	Flash Flood	0	0	$15,000	$10,000
7/27/2012	Flash Flood	0	0	$15,000	$10,000
7/5/2013	Flash Flood	0	0	$25,000	0
7/12/2013	Flash Flood	0	0	$10,000	$10,000
7/18/2013	Flash Flood	0	0	$10,000	$5,000
7/25/2013	Flash Flood	0	0	0	0
9/6/2013	Flash Flood	0	0	$5,000	$5,000
9/11/2013	Flash Flood	0	0	0	0
9/12/2013	Flood	2	0	$109,000,000	0
9/14/2013	Flash Flood	0	0	0	0
5/23/2014	Flash Flood	0	0	$10,000	0
5/23/2014	Flash Flood	0	0	$15,000	0
6/24/2014	Flash Flood	0	0	$10,000	$5,000
7/13/2014	Flash Flood	0	0	$10,000	$5,000
7/14/2014	Flash Flood	0	0	$10,000	$10,000
7/29/2014	Flash Flood	0	0	$25,000	$50,000
7/29/2014	Flash Flood	0	0	$10,000	$20,000
5/9/2015	Flood	0	0	$100,000	$10,000
6/4/2015	Flash Flood	0	0	$15,000	$10,000
6/11/2015	Flash Flood	0	0	$10,000	0
	TOTAL:	7	40	$300,075,000	$255,000

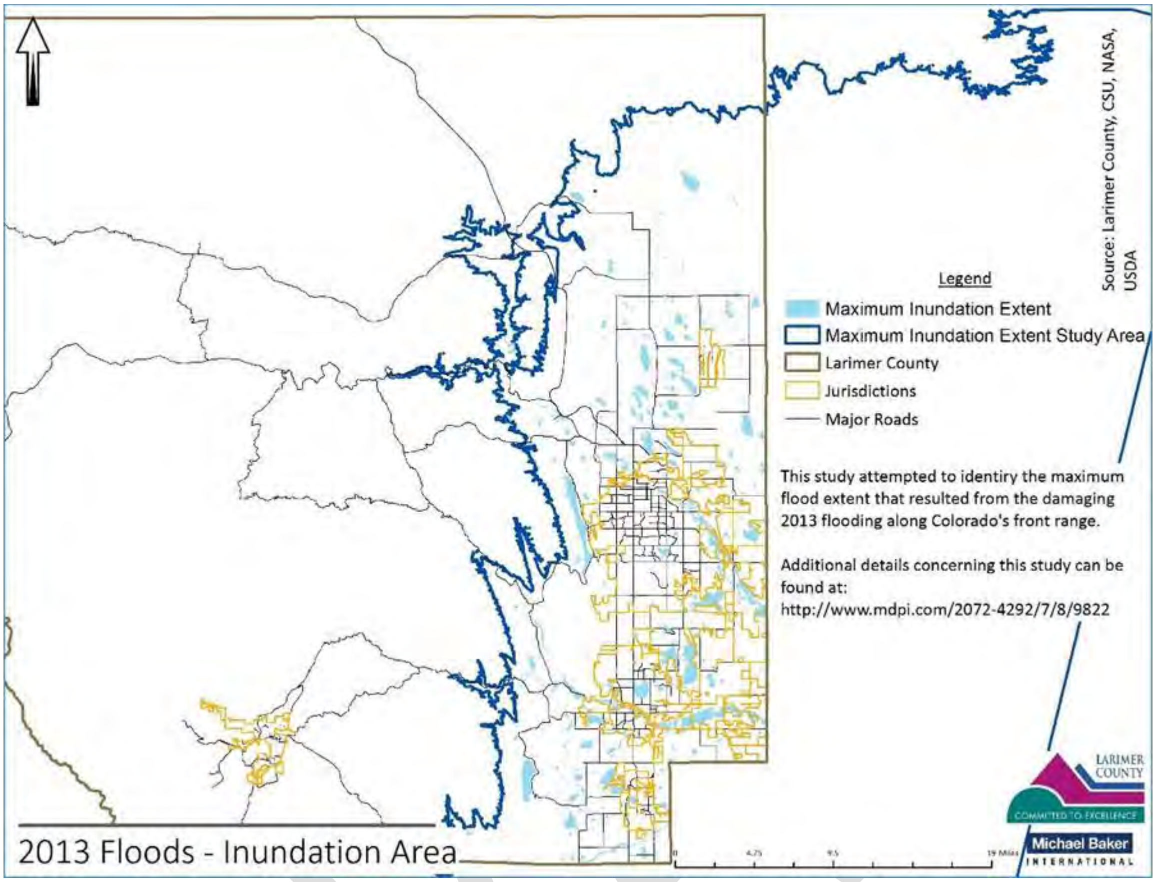
Source: NOAA (NCEI Storm Events Database)

Notable flood events from 1864 to 2013 are discussed below by the rivers and creeks that have been the sources of flood problems in the past. These events include event-related injuries, deaths, and property or crop damages as applicable.

- **2013 Colorado Floods** - The most extensive and damaging flooding event to collectively impact the State of Colorado occurred during September 2013. During the week beginning on September 9th, a slow moving cold front circulated over the state, clashing with warm, humid monsoonal air from the south. The extended storm duration escalated flooding as soils became saturated, thereby, increasing runoff potential. The flooding resulted in considerable changes to channel geometry and alignment, damage to property infrastructure, and caused 10 fatalities. Total damage was estimated at over $2 billion.
- **Big Thompson River** – One of the most significant, and deadly, flood disasters in the State's history occurred within the county occurred on the Big Thompson River, July 31 to August 1, 1976. Intense precipitation over an approximate 60-square-mile area between Lake Estes and Drake, with rainfall depths up to 12 inches, generated a flood discharge of approximately 31,200 cubic feet per second (cfs) at the mouth of the canyon. The 1976 flood claimed 144 lives and caused $35 Million in damages. Floods on the Big Thompson River caused damage in 1864 and 1894, but no discharge or damage estimates were recorded. Floods also occurred on the Big Thompson River in 1919, 1923, 1945, and 1949 with discharges of 8,000, 7,000, 7,600, and 7,750 cfs, respectively.
- **Big Thompson River, Buckhorn Creek** - On August 2 and 3, 1951, intense rains over much of the Big Thompson River basin caused a dam to break on the Buckhorn Creek on August 3.
- **Buckhorn Creek** – The largest floods were in 1923, 1938, 1948, and 1951 with discharges of 10,500, 10,200, 5,750 and 14,000 cfs, respectively.

- **Boxelder Creek** – Floods have been recorded in the Boxelder Creek watershed on 13 occasions since 1900.
- **Cooper Slough** – The Cooper Slough floodplain is predominantly flat. Channel capacity is limited in places, promoting overbank flows and divided-flow conditions. Channel flow is restricted by relatively small culverts at Vine Drive, the Colorado and Southern Railroad (C&SRR), and State Highway 14. Due to an undersized culvert at State Highway 14, a ponded area will form north of the highway, and eventually overtop the highway during storm events. In places, the width of the l00-year floodplain averages over 1,000 feet, although the depth of flooding is generally less than 3 feet, except in areas where ponding occurs.
- **Dry Creek** – In 1904, a flood occurred that resulted in the drowning death of a child when floodwaters overtopped the Eaton Ditch (which intercepts Dry Creek near Willox Road). Numerous irrigation canals cross the Dry Creek channel and directly intercept drainage flows. In the past, much of the excess drainage in the lower Dry Creek basin (below Eaton Ditch) was intercepted by irrigation canals. However, the impact of development has increased the magnitude and frequency of drainage flow, and many of the canals no longer have the capacity to intercept the increased drainage flows. Several of the canals, including the Larimer and Weld Canal (Eaton Ditch), Larimer County Canal, Terry Inlet, Poudre Valley Canal, and North Poudre Ditch, have large enough flow capacities to impact flood magnitudes on Dry Creek.
- **Dry Creek, Cache La Poudre River** – Flooding occurred, in Dry Creek, in 1924 with depths of flows several feet deep. However, it is unclear as to whether the flooding was due to overflow from the Cache La Poudre River.
- **Fish Creek, Fall River** – Fall River did overflow its banks in 1965 and cause some damage. In July 1982, extensive damage occurred throughout the Town of Estes Park because of the failure of Lawn Lake Dam located in the headwaters of the Fall River. On July 15, 1982, the Lawn Lake Dam on the Roaring River failed. The 1965 peak of 1,640 cubic feet per second (cfs) was the most damaging flow in recent history, although flows of this magnitude were also recorded in 1949, 1951, 1953, and 1957. Damage from the 1965 event was the result of continued encroachment upon the river channels and blockage of the Fall River culvert at Elkhorn Avenue that diverted flows through the center of town.
- **Redstone Creek** – An intense rainstorm on September 10, 1938, caused flooding in some of the lower areas of the floodplain.
- **Spring Creek** – A devastating flash flood occurred on July 28, 1997, on Spring Creek. Over 14.5 inches of rain fell between 4:00 PM on July 27th and 11:00 PM on July 28th, with over 10 inches of that amount occurring during a six hour time period on July 28th. There were five deaths and over $200 million in property damage. The discharge was estimated at 8,250 cfs going into the detention pond behind the Burlington Northern Railroad just west of College Avenue. This event was greater than a 0.2% annual chance flood event. Previous flooding on Spring Creek occurred in 1902, 1904, 1938, 1949, and 1951, prior to the completion of the Horsetooth Reservoir, and again in 1975 and 1977, causing flooding in several basements.

Figure 4-18 2013 Flood Inundation Area – Larimer County



The preceding figure was created utilizing data produced by a team which included Colorado State University, NASA, and USDA, who performed a study attempting to better identify areas which were inundated by the 2013 floods (note the study area, which only covers portions of Larimer County). Maximum flood extent—a key data need for disaster response and mitigation—is rarely quantified due to storm-related cloud cover and the low temporal resolution of optical sensors. While change detection approaches can circumvent these issues through the identification of inundated land and soil from post-flood imagery, their accuracy can suffer in the narrow and complex channels of increasingly developed and heterogeneous floodplains. The data depicted above is from a study that explored the utility of the Operational Land Imager (OLI) and Independent Component Analysis (ICA) for addressing these challenges in the unprecedented 2013 Flood along the Colorado Front Range, USA. The approach was able to simultaneously distinguish flood-related water and soil moisture from pre-existing water bodies and other spectrally similar classes within the narrow and braided channels of the study site. Visual assessment against aerial orthophotography showed close agreement with high water marks and scoured riverbanks, and a pixel-to-pixel validation with WorldView-2 imagery captured near peak flow yielded an overall accuracy of 87% and Kappa of 0.73. Additional tests showed a twofold increase in flood class accuracy over the commonly used modified normalized water index. Although flooding beneath moderate and sparse riparian vegetation canopy was captured, dense vegetation cover and paved regions of the floodplain were main sources of omission error, and commission errors occurred primarily in pixels of mixed land use and along the flood edge. Nevertheless, the unsupervised nature of ICA, in conjunction with the global availability of Landsat imagery, offers a straightforward, robust, and flexible approach to flood mapping that requires no ancillary data for rapid implementation. Finally, the spatial layer of flood extent and a summary of impacts were provided for use in the region's ongoing hydrologic research and mitigation planning. The analysis within the study has not updated since 2013 but it is still relevant.

Location

Floods and the damaging effects of flooding can occur wherever water or precipitation is present, and the entire county is susceptible to flooding. Some regions and residents however are more vulnerable to floods and in many areas, the risk of flooding is rare. Large streams or rivers are obvious examples of where to expect floods, though intense, short-duration storms, or high snowmelt runoff can create significant flash floods, or damaging floods even where the risk is rare. FEMA Flood Insurance Rate Maps (FIRMs) and flood risk products such as the maps presented in Figure 4-19 are available to express some of the spatial variation of risk to residents throughout the county.

The maps below depict the current special flood hazard areas (SFHA) for Larimer County. The SFHA areas span roads, infrastructure, property, and jurisdictions across the county and show areas mapped through the Colorado Hazard Mapping Program (CHAMP) and FEMA's current Risk Mapping, Analysis, and Planning Program (Risk MAP). CHAMP is a State of Colorado funded study, managed by the Colorado Water Conservation Board, to provide a mitigation and land use framework in areas likely to be affected by future flooding, erosion and debris flow events. The program was initiated by State Legislature following the statewide 2013 flooding. The data from the Study will be incorporated into the FEMA Risk Map program, a program to provide high quality flood maps and information, tools to better assess the risk from flooding, and planning and outreach support to communities to help them take action to reduce (or mitigate) flood risk.

Larimer County entirely falls within the South Platte River Basin, which has Hydrologic Unit Code 6 (HUC 6) 101900. The major sub-basins in Larimer County, which are classified as HUC 8, are listed, and briefly described in Table 4-33. The most significant sources of flooding are the Big Thompson and Cache La Poudre rivers; smaller basins and tributaries to these rivers have caused floods that are described further below.

Table 4-33 Larimer County Basin Characteristics

Sub-Basin	Primary Flooding Source	Description of Affected Area	Drainage Area (square miles)
Big Thompson	Big Thompson River	Largest watershed within Larimer County.	7,212
Cache La Poudre	Cache La Poudre River	Affects northern portion of Larimer County. Crosses Colorado and Wyoming.	1,915
Lone Tree-Owl	Lone Tree Creek	Affects small portion of northern Larimer County. Crosses Colorado and Wyoming.	578
St. Vrain	St. Vrain Creek	Small portion of watershed affecting northern Larimer County.	754
Upper Laramie	Laramie River	Small portion of watershed affecting north western Larimer County.	2,273

Source: FEMA Flood Insurance Study for Larimer County, Colorado (Preliminary 3/8/2019)

Figure 4-19 Special Flood Hazard Areas – Larimer County

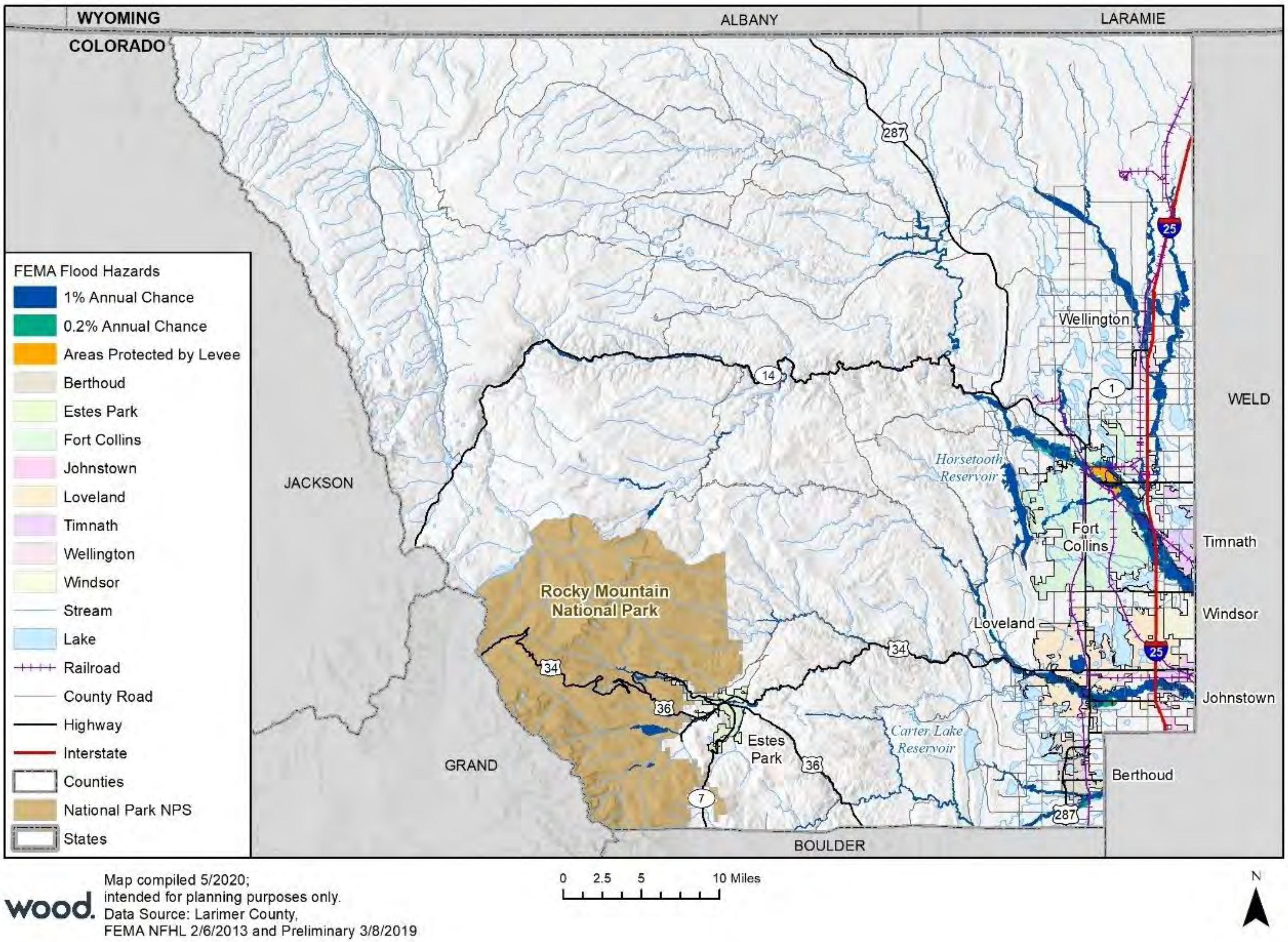


Figure 4-20 Special Flood Hazard Areas – CHAMP Studies

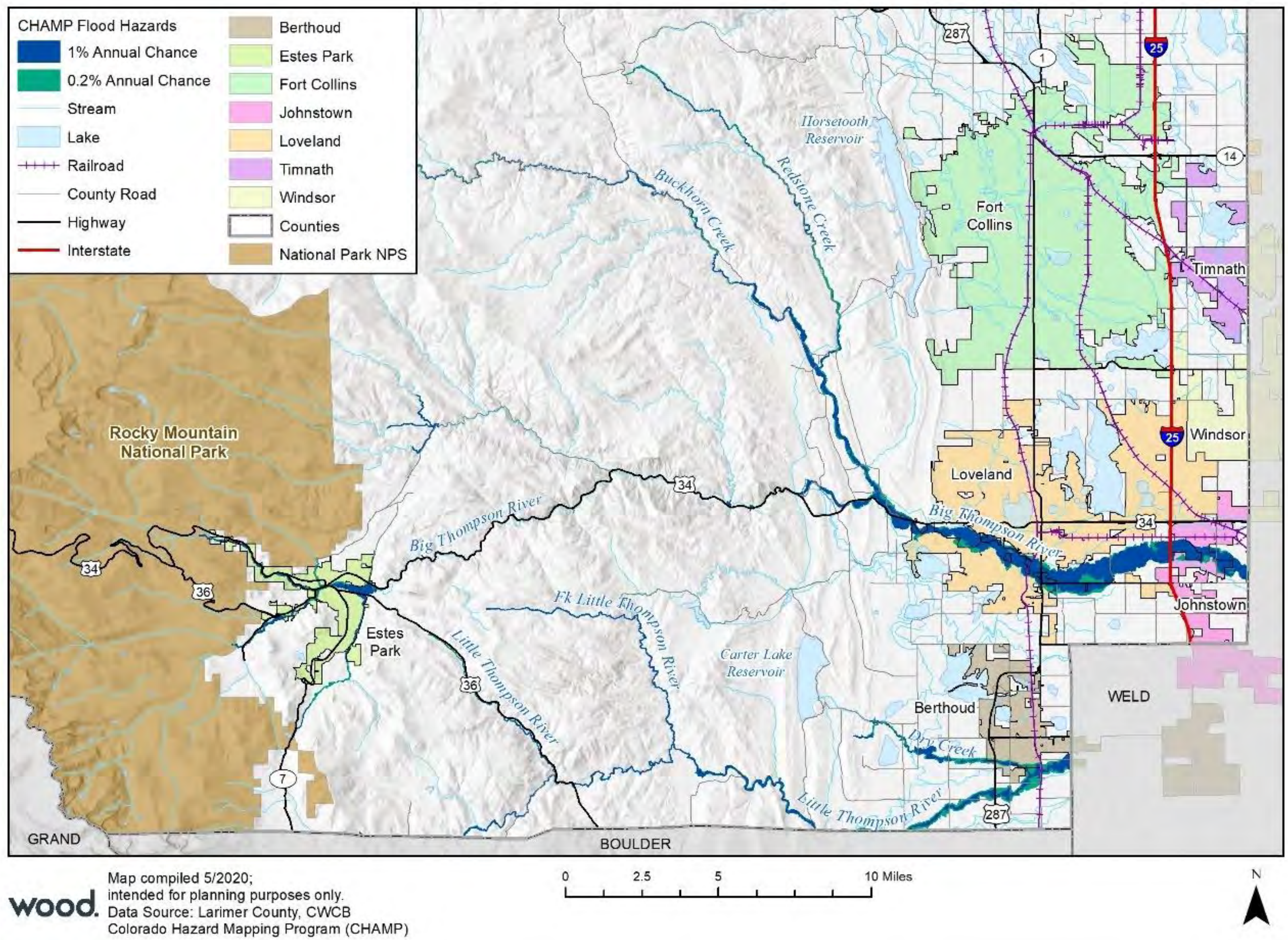


Figure 4-21 Special Flood Hazard Areas – FEMA Risk Map Projects on the Cache La Poudre River and Boxelder Creek

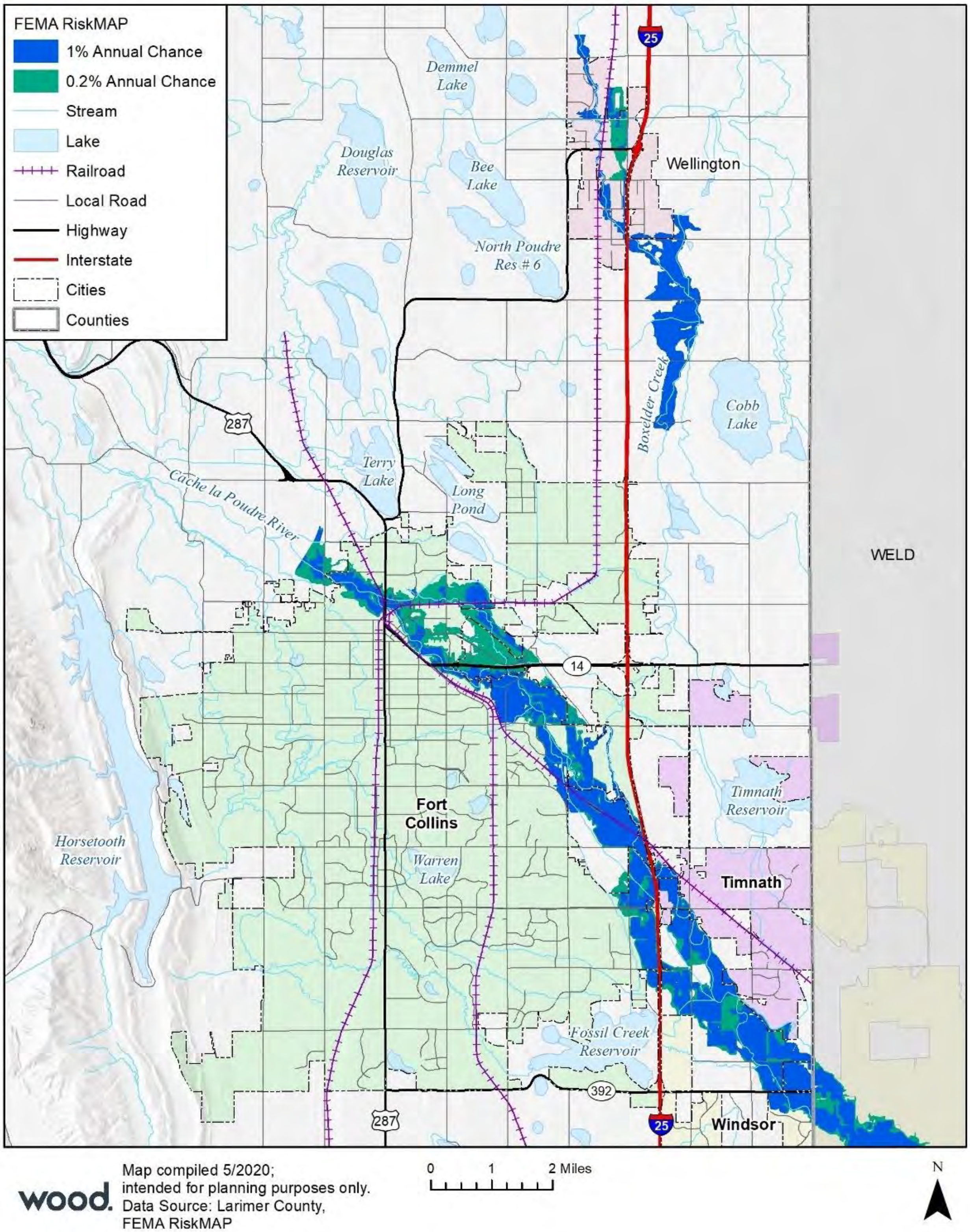
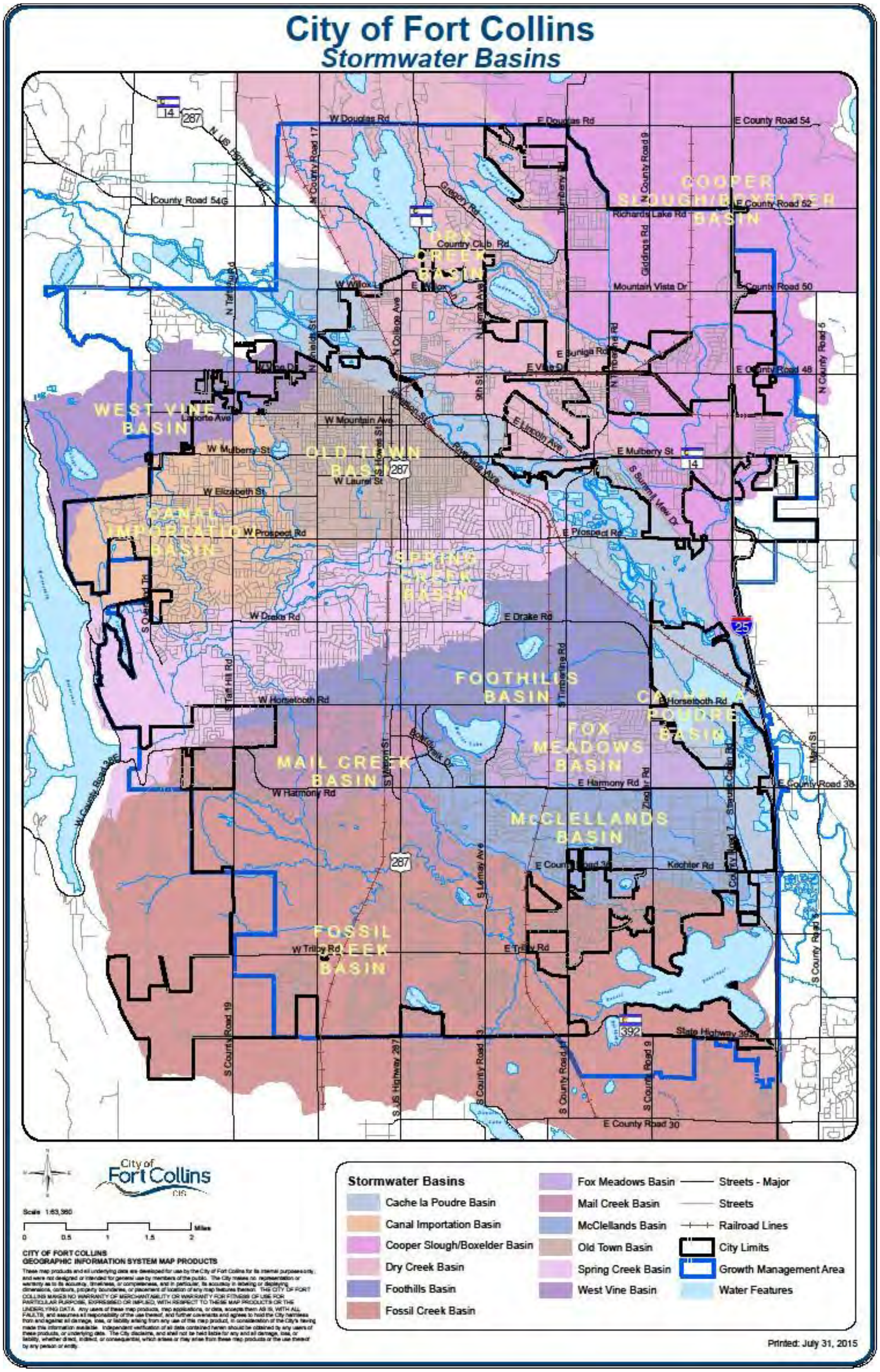


Figure 4-22 City of Fort Collins Stormwater Basins



As shown in Figure 4-22, the City of Fort Collins has 12 drainage basins: The Cache la Poudre, Dry Creek, Cooper Slough/Boxelder, West Vine, Old Town, Canal Importation, Spring Creek, Foothills, Mail Creek, Fox Meadows, McClellands and Fossil Creek. All have flooded in the past for various reasons and have different features that must be taken into account when considering safety. The Drainage Basin Master Plan, approved by City Council in June 2004, describes the flooding history of each basin, identifies potential problem areas and recommends improvements. There are continuous updates occurring for each of the plans. Maps of these drainage basins are included in Appendix E.

The water bodies, rivers, creeks, and tributaries are the primary causes of flooding in Larimer County are described previously in the Past Occurrences section; and describes who is generally impacted by that flooding by that flooding.

Magnitude/Severity

The magnitude or severity of flooding hazards in Larimer County is potentially **Catastrophic**.

The severity of a flooding event is determined by the following key aspects: 1) a combination of stream and river basin topography and physiography; 2) precipitation and weather patterns; 3) recent soil moisture conditions; 4) the degree of vegetative clearing, and 5) effects on life, property, the environment, and the economy in terms of injuries and deaths, and damages or losses to structures, crops, resources, and critical facilities.

As previously discussed, major floods can induce property damages that threaten structural integrity, result in death and injuries, and impact critical services, facilities, and infrastructure. Flooding impacts a community only to the degree that it affects the lives or property of its citizens and the community's overall ability to function. Therefore, the most vulnerable areas of a community will be those most affected by floodwaters in terms of potential losses, damages, and disruption of community services and utilities. For example, an area with large developments on the floodplain is significantly more vulnerable to the impacts of flooding than a rural or undeveloped zone where potential floodwaters would have little impact on the community due to lack of the built environment and human presence.

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

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

more susceptible to damage because the construction materials used are easily damaged when inundated with water.

Floods may also be caused by structural or hydrologic failures of dams or levees. Each of these causes results in floods that have distinct characteristics relative to flow rate, rate of rise, volume, duration, and flood season. For more information on dam and structural inundation hazards, refer to Section 4.3.3 Dam Inundation.

Probability of Future Occurrences

The probability of future occurrence of this flooding hazard in Larimer County is **Highly Likely**.

Periodic flooding of lands adjacent to rivers and streams is a natural occurrence in the County, and it can be expected to take place based upon established flood recurrence intervals. Additionally, large burn scars from the 2012 High Park Wildfire and the 2020 Cameron Peak Wildfire both increase the risk of flooding in those areas due to burn severity, charred soil and lack of vegetation in those areas.

A *100-year* flood, which has a 1% chance (1 in 100) of occurring in a given year, is a regulatory standard used by federal agencies, states, and NFIP- participating communities to administer and enforce floodplain management programs, as well as set insurance requirements nationwide.

The *500-year* flood event, which has a 0.2% chance (1 in 500) chance of occurring in a given year, is another commonly mapped and studied event by FEMA flood related programs and efforts.

For context, the main flood recurrence intervals used in planning, floodplain studies, and other regulatory contexts are summarized in Table 4-34, and more detailed descriptions of FEMA special flood hazard zones applicable to Larimer County are given in Table 4-35. The most recent FEMA special flood hazard areas mapped, which contain the 100- and 500-year events and hence where riverine flooding is expected to primarily occur in the future, are shown in

Figure 4-19 above.

Table 4-34 Annual Probability of Flooding Based on Recurrence Intervals

Flood Recurrence Interval	Annual Chance of Occurrence
10-year	10%
50-year	2%
100-year	1%
500-year	0.2%

Source: FEMA

Table 4-35 FEMA Special Flood Hazard Zones Present in Larimer County

Flood Zone	Definitions
FEMA Special Flood Hazard Areas (SFHAs) Subject to Inundation by the 100- or 500-Year Floods	
Zone A	100-year floodplain, or areas with a 1% annual chance of flooding. Because detailed analyses are not performed these areas, no depths or base flood elevations are shown in Zone A areas.
Zone AE	Detailed studies for the 100-year floodplain. The base floodplain where base flood elevations are provided. AE Zones are now used on new format FIRMs instead of A1-A30 zones.
Zone AH	Areas with a 1% annual chance of shallow flooding, usually in the form of a pond, with an average depth ranging from 1 to 3 feet. These areas have a 26% chance of flooding over the life of a 30-year mortgage. Base flood elevations derived from detailed

Flood Zone	Definitions
	analyses are shown at selected intervals within these zones.
Zone AO	River or stream flood hazard areas and areas with a 1% or greater chance of shallow flooding each year, usually in the form of sheet flow, with an average depth ranging from 1 to 3 feet. Average flood depths derived from detailed analyses.
Other Flood Areas	
Floodway	A regulatory floodway is the channel of a river or other watercourse and the adjacent land areas that must be reserved in order to discharge the base flood without cumulatively increasing the water surface elevation more than a designated height.
Area with Reduced Flood Risk due to Levee	Areas where an accredited levee, dike, or other flood control structure has reduced the flood risk from the 1% annual chance flood.
Zone X (shaded)	Areas with a 0.2% annual chance flooding (1 in 500 chance), between the limits of the 100-year and 500-year floodplains. This zone is also used to designate base floodplains of lesser hazards, such as areas protected by levees from the 100-year flood, shallow flooding areas with average depths of less than one foot, or drainage areas less than 1 square mile.
Zone X (unshaded)	500-year floodplain (0.2% annual chance). Area of minimal flood hazard.

Source: FEMA Flood Map Service Center, 2020

Based on the details provided in this chapter, flooding remains a likely occurrence throughout the identified flood hazard areas in the county. Smaller floods caused by heavy rains or inadequate drainage capacity in urbanized areas may be more frequent, but not as costly as the large-scale floods, which may occur at much less frequent intervals. In addition, dam or flood control structure failure could additionally take place and lead to flooding in an unexpected manner, in which likelihood of occurrence estimations would be more difficult to obtain.

Climate Change Considerations

The two most common and most destructive hazards in Larimer County are severe flooding and wildfires. Both of these hazards are greatly affected by a changing climate. If we look at an accelerated process of evapotranspiration, both drought and severe weather events are more likely; as more water is pulled out of the soil and plants into the atmosphere, the soil becomes drier, the water table drops, and the chance of drought will increase.

In addition to increasing drought and wildfire potential (and therefore increasing runoff), climate change has the potential to intensify rain events and storms in the Colorado region. According to the National Oceanic and Atmospheric Administration, there is generally more rain and snow falling in the Northern Hemisphere and precipitation has increased by about 5% over the last century. An increase in precipitation alone is not immediately alarming, but “factors such as precipitation intensity, soil moisture and snow conditions, and basin topography are also important in determining the occurrence and severity of flooding.” As with temperature, it is the extremes that matter most with regard to rainfall. According to Robert Hanson, author of The Thinking Person’s Guide to Climate Change, “Data shows a clear ramp up in precipitation intensity for the United States, Europe, and several other areas over the last century, especially since the 1970s. When it rains or snows in these places, it now tends to rain or snow harder, over periods ranging from a few hours to several days.” The 1997 and 2013 flood events caused widespread infrastructural damage, social instabilities and changes along the waterways throughout the County and in other areas of the state. Drought, precipitation intensity and changes in snowmelt patterns are overarching challenges Larimer County will face moving into the future.

These events can lead to increased infrastructure damage, injury, illness, and death. Additionally, warmer temperatures in the winters may cause increased precipitation to fall as rain instead of snow in mountain regions of Colorado. This may lead to elevated stream flows and increased flood risk across the state. As climate science and data evolves it will be important for communities in and around Larimer County to address how our changing climate will affect how water moves through local streams and regional landscapes.

Vulnerability Assessment

The risk of flood is prevalent within all regions of Larimer County, however not all exposed areas have equal risk, and many areas may not experience serious flooding or flood related damages. This section summaries the results of a countywide risk analysis intended to identify the vulnerability of population, property, and infrastructure. The vulnerability analysis was performed through the use of an address point layer to obtain more accurate property locations and the assessor's parcel layer to obtain different parcel types and improved values. Using GIS, this combined dataset was intersected with the effective FEMA special flood hazard area (SFHA) as well as preliminary mapping available at the time of this study to determine at risk population, infrastructure, and assets.

The type of property damage caused by flood events depends on the depths and velocity of the floodwaters. Faster moving floodwaters can wash buildings off their foundations and sweep cars downstream. Pipelines, bridges, and other infrastructure can be damaged when high waters combine with flood debris. Extensive damage can be caused by basement flooding and landslide damage related to soil saturation from flood events. Seepage into basements is common during flood events. Most flood damage is caused by water saturating materials susceptible to loss (e.g., wood, insulation, wallboard, fabric, furnishings, floor coverings, and appliances). Homes in flooded areas can also suffer damage to septic systems and drain fields. In many cases, flood damage to homes renders them uninhabitable.

Severe flooding has the potential to inflict significant damage to people and property in Larimer County. Mitigating flood damage requires that communities throughout the county remain diligent and notify local officials of potential flood (and flash flood) prone areas near infrastructure such as roads, bridges, and buildings. While the potential for flooding is always present, Larimer County has existing land-use policies and regulations for development to help lessen potential damage due to floods.

People

Population counts of those living in the flood hazard area were generated by analyzing tax assessor building locations of residential structure locations that intersect with the SFHA. Total estimates were derived by multiplying then number of residential properties exposed to the SFHA by the Average household size by the respective community, as listed in Section 2.6 and the jurisdictional annexes. Through this approach, an estimated 2,373 residents live within the 100-year floodplain, an additional 2,262 within the 500-year floodplain, and 782 within SFHA areas protected by certified levees throughout the County.

Floods can cause significant impacts to the life, safety, and health of the public and responders. Flood waters may prevent access to areas in need of response or to the critical facilities themselves which may prolong response time. The public must understand that they should never drive through flooded streets. The Centers for Disease Control and Prevention report that over half of flood-related drownings occur when a vehicle is driven into flood water, and the next highest percentage of deaths is due to people walking into or near flood waters. The National Weather Service warns that just 6 inches of fast-moving flood water can knock down an adult, 12 inches can carry away a small car, and 2 feet can carry away most vehicles. When someone drives through floodwaters, they put their life and the lives of first responders at risk. First responders are at risk when attempting to rescue people from floodwaters. They are subject to the same health hazards as the public and are more likely to be exposed to these hazards during their response efforts.

Certain health hazards are common to flood events. While such problems are often not reported, three general types of health hazards accompany floods. The first comes from the water itself. Floodwaters carry anything that was on the ground that the upstream runoff picked up, including dirt, oil, animal waste, and lawn, farm and industrial chemicals. Pastures and areas where farm animals are kept, or their wastes are stored can contribute polluted waters to the receiving streams.

Floodwaters also saturate the ground, which leads to infiltration into sanitary sewer lines. When wastewater treatment plants are flooded, there is nowhere for the sewage to flow. Infiltration and lack of treatment can lead to overloaded sewer lines that can back up into low-lying areas and homes. Even when it is diluted by flood waters, raw sewage can be a breeding ground for bacteria such as E. coli and other disease causing agents. Residents with private wells will need to have their water quality tested to ensure it is safe for use.

The second type of health problem arises after most of the water has gone. Stagnant pools can become breeding grounds for mosquitoes, and wet areas of a building that have not been properly cleaned breed mold and mildew. A building that is not thoroughly cleaned becomes a health hazard, especially for small children and the elderly.

Another health hazard occurs when heating ducts in a forced air system are not properly cleaned after inundation. When the furnace or air conditioner is turned on, the sediments left in the ducts are circulated throughout the building and breathed in by the occupants. Flooding can also cause extensive mold growth in building walls and floors, which also poses a respiratory health hazard.

If the County's water systems lose pressure, a boil order may be issued to protect people and animals from contaminated water.

The long-term psychological impact of having been through a flood and seeing one's home damaged and personal belongings destroyed must also be considered. The cost and labor needed to repair a flood-damaged home puts a severe strain on people, especially the unprepared and uninsured. There is also a long-term problem for those who know that their homes can be flooded again. The resulting stress on floodplain residents takes its toll in the form of aggravated physical and mental health problems.

Another health risk from flooding comes from animals, such as snakes and rodents, that make their way through floodwaters and come into contact with people. Animals can pose a risk of physical attack and/or spread of disease.

Debris also poses a risk both during and after a flood. During a flood, debris carried by floodwaters can cause physical injury from impact. During the recovery process, people may often need to clear debris out of their properties but may encounter dangers such as sharp materials or rusty nails that pose a risk of tetanus. People must be aware of these dangers prior to a flood so that they understand the risks and take necessary precautions before, during, and after a flood.

Timely emergency public information and warning are one of the most important measures in reducing the risk of flooding to people in at risk areas. The Emergency Notification and Warning Annex to the Larimer County Comprehensive Emergency Management Plan (CEMP) addresses procedures and methods for timely emergency information across departments, agencies, and partners, and for communicating emergency alerts and warnings to the public, to include residents and visitors. The Annex covers roles and responsibilities, and a concept of operations for notifications, along with several alert and warning tools in use such as Everbridge, Wireless Emergency Alerts, media releases, website and social media posts, and door-to-door notifications.

The Larimer County CEMP Evacuation and Re-Entry Annex contains procedures for the safe and orderly evacuation of people threatened by flood or other hazards in Larimer County, as well as providing for the safe re-entry of the affected area. The authority for evacuation in Larimer County rests with the Larimer County Sheriff's Office, who will make determinations regarding the evacuation of residents and visitors from affected areas within Larimer County. Additionally, Fire Districts have the authority to issue evacuations within their jurisdictions according to C.R.S. 24-32-2109. Evacuation orders and notifications will be issued in accordance with the Emergency Notification and Warning Annex described above. The Annex describes the designation of evacuation routes, establishment of evacuation centers, provisions for people unable to self-evacuate, and provisions for large animals and livestock. Detailed provisions for controlled re-entry into evacuated areas further help to ensure public health and safety.

The Larimer County Recovery Plan outlines policies and procedures to recover from floods and other disasters. The plan includes roles and responsibilities, the concept of operations, direction and coordination, and financial management, along with 17 Recovery Support Functions (RSFs). Post-flood recovery should focus on activities to protect public health and safety, such as providing safe drinking water, monitoring for disease and contaminants, and cleaning up debris.

General Property

Exposed structures and associated value of asses within the flood hazard areas were estimated using a similar methodology to the population estimates. Improved properties were intersected with the SFHA, and tax assessor valuations of the at-risk properties were totaled. Additionally, potential monetary loss estimates were calculated for all assets within the SFHA 25% of the total property value. In total, an estimated 1,533 buildings (0.9% of all structures) at a valuation of $712,967,464 lie within the 100-year floodplain, with a total loss estimate of 0.66% of the countywide property value. An Additional 1,844 structures (1.1% of all structures) lie within the extents of the 500-year floodplain at a valuation of $205,018,046, and with a loss estimate of 0.24% of the countywide property value.

Table 4-36 Improved Properties at Risk of 1% Annual Chance Flood Hazard in Larimer County

Jurisdiction	Parcel Type	Improved Parcels	Building Count	Improved Value	Content Value	Total Value	Loss Estimate	Population
Estes Park	Commercial	17	19	$8,257,080	$8,257,080	$16,514,160	$4,128,540	
	Exempt	2	2	$348,175	$348,175	$696,350	$174,088	
	Multiple Unit	1	8	$3,150,000	$3,150,000	$6,300,000	$1,575,000	
	Residential	31	46	$10,858,775	$5,429,386	$16,288,161	$4,072,040	90
	Total	**51**	**75**	**$22,614,030**	**$17,184,641**	**$39,798,671**	**$9,949,668**	**90**
Fort Collins	Agricultural	1	1	$7,122	$7,122	$14,244	$3,561	
	Commercial	36	57	$12,807,166	$12,807,166	$25,614,332	$6,403,583	
	Exempt	8	17	$18,703,762	$18,703,762	$37,407,524	$9,351,881	
	Industrial	1	1	$4,072,442	$6,108,663	$10,181,105	$2,545,276	
	Residential	74	88	$20,425,275	$10,212,637	$30,637,912	$7,659,478	216
	Total	**120**	**164**	**$56,015,767**	**$47,839,350**	**$103,855,117**	**$25,963,779**	**216**
Loveland	Agricultural	1	1	$4,600	$4,600	$9,200	$2,300	
	Commercial	37	58	$19,495,054	$19,495,054	$38,990,108	$9,747,527	
	Exempt	5	6	$3,244,573	$3,244,573	$6,489,146	$1,622,287	
	Industrial	2	2	$431,436	$647,154	$1,078,590	$269,648	
	Residential	19	19	$7,744,344	$3,872,172	$11,616,516	$2,904,129	45
	Total	**64**	**86**	**$30,920,007**	**$27,263,553**	**$58,183,560**	**$14,545,890**	**45**
Wellington	Commercial	5	6	$2,362,491	$2,362,491	$4,724,982	$1,181,246	
	Exempt	3	9	$11,826,911	$11,826,911	$23,653,822	$5,913,456	
	Mobile Home	1	2	$11,000	$5,500	$16,500	$4,125	6
	Residential	34	35	$7,775,575	$3,887,784	$11,663,359	$2,915,840	106
	Total	**43**	**52**	**$21,975,977**	**$18,082,686**	**$40,058,663**	**$10,014,666**	**112**
Unincorporated	Agricultural	62	73	$19,263,190	$19,263,190	$38,526,380	$9,631,595	
	Commercial	150	205	$56,256,310	$56,256,310	$112,512,620	$28,128,155	
	Exempt	15	62	$14,758,810	$14,758,810	$29,517,620	$7,379,405	
	Industrial	17	17	$3,757,848	$5,636,778	$9,394,626	$2,348,657	
	Mobile Home	10	130	$28,704,389	$14,352,195	$43,056,584	$10,764,146	320
	Multiple Unit	6	23	$2,990,089	$2,990,089	$5,980,178	$1,495,045	
	Residential	554	646	$154,722,306	$77,361,139	$232,083,445	$58,020,861	1,589

Jurisdiction	Parcel Type	Improved Parcels	Building Count	Improved Value	Content Value	Total Value	Loss Estimate	Population
	Total	**814**	**1,156**	**$280,452,942**	**$190,618,511**	**$471,071,453**	**$117,767,863**	**1,909**
	Grand Total	**1,092**	**1,533**	**$411,978,723**	**$300,988,741**	**$712,967,464**	**$178,241,866**	**2,373**

Source: FEMA NFHL Effective 2/6/2013 and Preliminary 3/8/2019, Larimer County Assessor's Office, Wood analysis.

Table 4-37 Improved Properties at Risk of 0.2% Annual Chance Flood Hazard in Larimer County

Jurisdiction	Parcel Type	Improved Parcels	Building Count	Improved Value	Content Value	Total Value	Loss Estimate	Population
Berthoud	Residential	38	38	$11,002,643	$5,501,319	$16,503,962	$4,125,991	95
	Total	**38**	**38**	**$11,002,643**	**$5,501,319**	**$16,503,962**	**$4,125,991**	**95**
Estes Park	Commercial	35	57	$16,334,775	$16,334,775	$32,669,550	$8,167,388	
	Exempt	2	2	$2,257,225	$2,257,225	$4,514,450	$1,128,613	
	Multiple Unit	1	1	$3,150,000	$3,150,000	$6,300,000	$1,575,000	
	Residential	15	15	$3,534,944	$1,767,473	$5,302,417	$1,325,604	29
	Total	**53**	**75**	**$25,276,944**	**$23,509,473**	**$48,786,417**	**$12,196,604**	**29**
Fort Collins	Commercial	11	11	$9,532,244	$9,532,244	$19,064,488	$4,766,122	
	Exempt	4	7	$8,578,537	$8,578,537	$17,157,074	$4,289,269	
	Industrial	3	4	$6,839,330	$10,258,995	$17,098,325	$4,274,581	
	Multiple Unit	1	67	$65,082,972	$65,082,972	$130,165,944	$32,541,486	
	Residential	189	203	$54,228,344	$27,114,167	$81,342,511	$20,335,628	499
	Total	**208**	**292**	**$144,261,427**	**$120,566,915**	**$264,828,342**	**$66,207,086**	**499**
Johnstown	Residential	32	32	$9,544,776	$4,772,387	$14,317,163	$3,579,291	92
	Total	**32**	**32**	**$9,544,776**	**$4,772,387**	**$14,317,163**	**$3,579,291**	**92**
Loveland	Agricultural	1	1	$10,807	$10,807	$21,614	$5,404	
	Commercial	24	29	$13,345,885	$13,345,885	$26,691,770	$6,672,943	
	Exempt	1	1	$451,501	$451,501	$903,002	$225,751	
	Multiple Unit	2	305	$34,512,254	$34,512,254	$69,024,508	$17,256,127	
	Residential	44	44	$16,523,344	$8,261,668	$24,785,012	$6,196,253	105
	Total	**72**	**380**	**$64,843,791**	**$56,582,115**	**$121,425,906**	**$30,356,477**	**105**
Timnath	Commercial	3	6	$10,761,632	$10,761,632	$21,523,264	$5,380,816	
	Total	**3**	**6**	**$10,761,632**	**$10,761,632**	**$21,523,264**	**$5,380,816**	**0**
Wellington	Commercial	4	4	$2,268,938	$2,268,938	$4,537,876	$1,134,469	
	Exempt	12	142	$23,720,373	$23,720,373	$47,440,746	$11,860,187	
	Mobile Home	4	5	$52,966	$26,483	$79,449	$19,862	15
	Multiple Unit	1	4	$575,290	$575,290	$1,150,580	$287,645	
	Residential	170	173	$39,879,890	$19,939,940	$59,819,830	$14,954,958	526
	Total	**191**	**328**	**$66,497,457**	**$46,531,024**	**$113,028,481**	**$28,257,120**	**541**
Unincorporated	Agricultural	17	19	$8,026,079	$8,026,079	$16,052,158	$4,013,040	
	Commercial	29	210	$15,276,933	$15,276,933	$30,553,866	$7,638,467	
	Exempt	10	80	$9,929,773	$9,929,773	$19,859,546	$4,964,887	
	Industrial	14	18	$3,561,289	$5,341,939	$8,903,228	$2,225,807	
	Mobile Home	6	34	$3,784,135	$1,892,068	$5,676,203	$1,419,051	84
	Residential	320	332	$92,409,094	$46,204,554	$138,613,648	$34,653,412	817
	Total	**396**	**693**	**$132,987,303**	**$86,671,346**	**$219,658,649**	**$54,914,662**	**900**
	Grand Total	**993**	**1,844**	**$465,175,973**	**$354,896,211**	**$820,072,184**	**$205,018,046**	**2,262**

Source: FEMA NFHL Effective 2/6/2013 and Preliminary 3/8/2019, Larimer County Assessor's Office, Wood analysis.

Table 4-38 Improved Properties in Protected by Certified Levees Zones Within County

Jurisdiction	Parcel Type	Improved Parcels	Building Count	Improved Value	Content Value	Total Value	Loss Estimate	Population
Fort Collins	Commercial	34	68	$54,954,548	$54,954,548	$109,909,096	$27,477,274	
	Exempt	13	17	$14,136,076	$14,136,076	$28,272,152	$7,068,038	
	Industrial	1	2	$11,588,014	$17,382,021	$28,970,035	$7,242,509	
	Multiple Unit	161	340	$53,983,967	$53,983,967	$107,967,934	$26,991,984	
	Residential	221	238	$64,449,619	$32,224,812	$96,674,431	$24,168,608	585
	Total	**430**	**665**	**$199,112,224**	**$172,681,424**	**$371,793,648**	**$92,948,412**	**585**
Unincorporated	Agricultural	1	1	$166,664	$166,664	$333,328	$83,332	
	Commercial	264	360	$138,149,055	$138,149,055	$276,298,110	$69,074,528	
	Exempt	9	9	$2,387,305	$2,387,305	$4,774,610	$1,193,653	
	Industrial	34	50	$30,299,752	$45,449,628	$75,749,380	$18,937,345	

Jurisdiction	Parcel Type	Improved Parcels	Building Count	Improved Value	Content Value	Total Value	Loss Estimate	Population
	Mobile Home	2	79	$2,422,487	$1,211,244	$3,633,731	$908,433	194
	Residential	1	1	$115,000	$57,500	$172,500	$43,125	2
	Total	**311**	**500**	**$173,540,263**	**$187,421,396**	**$360,961,659**	**$90,240,415**	**197**
	Grand Total	**741**	**1,165**	**$372,652,487**	**$360,102,820**	**$732,755,307**	**$183,188,827**	**782**

Source: FEMA NFHL Effective 2/6/2013 and Preliminary 3/8/2019, Larimer County Assessor's Office, Wood analysis.

Data from the National Flood Insurance Program shows that $14,831,750 in flood loss claims have been paid out in Larimer County and its jurisdictions since 1978. 71% of those losses ($10.5M) were in the unincorporated County, with 13% ($2M) in Estes Park, 10% ($1.5M) in Loveland, and 5% ($688K) in Fort Collins.

A Repetitive Loss (RL) property is any insurable building for which two or more claims of more than $1,000 were paid by the National Flood Insurance Program (NFIP) within any rolling ten-year period, since 1978. A RL property may or may not be currently insured by the NFIP. As of January 2021, there were a total of 6 repetitive loss properties, as shown in Table 4-39.

Table 4-39 Repetitive Loss Properties

Community	Building Type	# of Losses
Bellvue	Single Family	2
Berthoud	Single Family	2
Fort Collins	Other-Nonresidential	2
Fort Collins	Single Family	3
Fort Collins	Single Family	2
Laporte	2-4 Family	3
	TOTAL	**14**

Source: Colorado Water Conservation Board

Severe repetitive loss properties (SRL) are those for which the program has either made at least four payments for buildings and/or contents of more than $5,000 or at least two building- only payments that exceeded the value of the property. As of January 2015, there were no severe repetitive loss (SRL) structures located within the unincorporated areas Larimer County.

Critical Facilities and Infrastructure

Residential, commercial, and public buildings, as well as critical infrastructure such as transportation, water, energy, and communication systems may be damaged or destroyed by flood waters. Floods can severely disrupt normal operations, especially when there is a loss of power. This can affect the operations of critical facilities, which affects response times. Loss of power also puts the public at risk. Downed power lines pose a serious hazard and should always be treated as if they are still energized. When a building loses power during a flood, electricity should be turned off and not used until the wiring can be inspected, to avoid risk of electrocution or fire. Damage to electrical equipment can also result from exposure to flood waters contaminated with chemicals, sewage, oil, and other debris.

The critical facility exposure analysis estimates that there is a total of 44 critical facilities in Larimer County within the mapped FEMA SFHA. The tables below summarize the results of the critical facility flood exposure analysis.

Table 4-40 Critical Facilities Within the FEMA 1% Annual Chance Flood Hazard

FEMA Lifeline	Jurisdiction				
	Fort Collins	Loveland	Wellington	Unincorporated	Total
Energy	1	-	-	-	**1**
Safety and Security	1	1	1	1	**4**
Food, Water, Shelter	-	-	-	17	**17**
Miscellaneous	-	-	-	1	**1**
Total	**2**	**1**	**1**	**19**	**23**

Source: Cascarta, FEMA NFHL Effective 2/6/2013 and Preliminary 3/8/2019, Larimer County Assessor's Office, Wood analysis.

Table 4-41 Critical Facilities Within the FEMA 0.2% Annual Chance Flood Hazard

FEMA Lifeline	Fort Collins	Wellington	Unincorporated	Total
Hazardous Material	1	-	-	**1**
Safety and Security	2	1	2	**5**
Food, Water, Shelter	1	-	1	**2**
Miscellaneous	-	1	-	**1**
Total	**4**	**2**	**3**	**9**

Source: Cascarta, FEMA NFHL Effective 2/6/2013 and Preliminary 3/8/2019, Larimer County Assessor's Office, Wood analysis.

Table 4-42 Critical Facilities Within the FEMA SFHA Protected by Levee

FEMA Lifeline	Fort Collins	Unincorporated	Total
Health and Medical	1	-	**1**
Transportation	2	-	**2**
Safety and Security	3	1	**4**
Food, Water, Shelter	1	3	**4**
Miscellaneous	1	-	**1**
Total	**8**	**4**	**12**

Source: Cascarta, FEMA NFHL Effective 2/6/2013 and Preliminary 3/8/2019, Larimer County Assessor's Office, Wood analysis.

A discussion of actions completed, underway, or planned by the jurisdictions to reduce the vulnerability of critical facilities to flooding can be found in Section 6.3.1.

Economy

Flooding can have a major economic impact on the economy, including indirect losses such as business interruption, lost wages, reduced tourism and visitation, and other downtime costs. Flooding often coincides with the summer tourism months and may hence impact, directly or indirectly (such as from the negative perception of potential danger to his hazard), the revenues of tourist agencies, hotel bookings, outdoor activity companies, and other such businesses in the commercial and industrial sectors.

The 2013 Flood had a major economic impact on Larimer County, with over $100M spent on recovery as of September 2020; while much of this funding came from grants, the County provided $16M in matching funds. In addition to physical damages, Estes Park suffered severe economic losses due to reduced tourism and recreation resulting from closed roads and damages throughout the area. Many businesses were damaged or destroyed and forced to close.

Historic, Cultural and Natural Resources

There are significant historic, cultural, and natural resources and assets located throughout the County (e.g., trails and natural spaces, lakes). Natural areas within the floodplain often benefit from periodic flooding as a naturally recurring phenomenon. These natural areas often reduce flood impacts by allowing absorption and infiltration of floodwaters. Natural resources are generally resistant to flooding except where natural landscapes and soil compositions have been altered for human development or after periods of previous disasters such as drought and fire. Wetlands, for example, exist because of natural flooding incidents. Areas that are no longer wetlands may suffer from oversaturation of water, as will areas that are particularly impacted by drought. Areas which may have recently suffered from wildfire damage may erode because of flooding, which can permanently alter an ecological system.

Future Land Use and Future Development Trends

Severe flooding has the potential to inflict significant damage to people and property in Larimer County. Mitigating flood damage requires that communities throughout the County remain diligent and notify local officials of potential flood (and flash flood) prone areas near infrastructure such as roads, bridges, and buildings. While the potential for flooding is always present, Larimer County has existing land-use policies and regulations for development to help lessen potential damage due to floods.

Existing floodplain management ordinances are intended to address methods and practices to minimize flood damage to new and substantial home improvement projects as well as to address zoning and subdivision ordinances and state regulations. Additionally, Larimer County is a National Flood Insurance Program (NFIP) participant and continues to support floodplain management activity at the county and local scale.

The greatest protection against flooding is afforded by quality construction and compliance with local ordinances which exceed NFIP requirements. Code adoption by local jurisdictions, compliance by builders, and local government inspection of new homes can greatly reduce the risk of flooding. Moving forward, Larimer County will continue to support monitoring, analysis, modeling, and the development of decision-support systems and geographic information applications for floodplain management activities.

In addition to land-use planning, zoning, and codes applicable to new development, flood mitigation measures include structural and non-structural measures to address susceptibility of existing structures. Flood mitigation measures such as acquisition, relocation, elevation-in-place, wet/dry flood proofing, and enhanced storm drainage systems all have the potential to effectively reduce the impact of flood in Larimer County.

As population continues to increase in Larimer County, future development trajectories can be expected to create more impervious surfaces, which in turn can increase runoff and flood potential. While new building risk can be tempered by the implementation of floodplain management policies of the County and communities more people and property, the county as a whole should plan for the likelihood of increased exposure of humans to flood events as a factor of population growth.

Updates to flood mapping studies that are currently in progress are accounting for a more accurate depiction of the flood hazard across the County. New studies should begin to account for increased flood hazards as a result of changes in floodplain development, demographics, development in the watershed, and climate change. New mapping and analysis of flood hazards associated with releases from dams was completed by the Colorado DNR, as described in the Dam Inundation chapter.

Larimer County's floodplain management program includes mapping a "1% plus flood elevation", which is defined as a flood elevation derived by using discharges that include the average predictive error for the discharge calculation for the hydrologic analysis. This error is then added to the 1% annual chance discharge to calculate the new 1% plus discharge. It is meant to show the confidence limits of the hydrologic calculations and can be used to help identify possible future impacts.

Risk Summary

- Flash flooding that occurs with little or no warning will continue to impact the planning area, and deficiencies in radar coverage are a concern for appropriate alert and warning.

- The Town of Fort Collins and the Unincorporated Areas have significant and high flood risk; Estes Park, Loveland and Wellington have moderate risk.
- The 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.
- Continued compliance with the NFIP and the promotion of flood insurance as a means of protecting private property owners from the economic impacts of frequent flood events should continue.

4.3.7 Hazardous Materials Incident

Hazard	Frequency	Spatial Extent	Severity	Overall Significance
Hazardous Materials Incident	Likely	Limited	Critical	High

Description

A hazardous material (also known as hazmat) is defined by the U.S. Department of Transportation as “a threat that poses an unreasonable risk to health and safety of operating or emergency personnel, the public, and/or the environment if not property controlled during handling, storage, manufacturing, processing, packaging, use, disposal, or transportation.”

Hazardous materials are defined and regulated in the United States primarily by laws and regulations administered by the U.S. Environmental Protection Agency (EPA), the U.S. Occupational Safety and Health Administration (OSHA), the U.S. Department of Transportation (DOT), and the U.S. Nuclear Regulatory Commission (NRC). Each has its own definition of a "hazardous material.” For the purpose of tracking and managing hazardous materials, the DOT divides regulated hazardous materials into nine classes:

Table 4-43 Hazardous Materials -- Classes and Descriptions

Hazard Class	Description
Class 1: Explosives	1.1 mass explosion hazard 1.2 projectile hazard 1.3 minor blast/projectile/fire 1.4 minor blast 1.5 insensitive explosives 1.6 very insensitive explosives
Class 2: Compressed Gases	2.1 flammable gases 2.2 non-flammable compressed 2.3 poisonous
Class 3: Flammable Liquids	Flammable (flash point below 141°) Combustible (flash point 141°-200°
Class 4: Flammable Solids	4.1 flammable solids 4.2 spontaneously combustible 4.3 dangerous when wet
Class 5: Oxidizers and Organic Peroxides	5.1 Oxidizer 5.2 Organic Peroxide
Class 6: Toxic Materials	6.1 Material that is poisonous 6.2 Infectious Agents
Class 7: Radioactive Material	Radioactive I Radioactive II Radioactive III
Class 8: Corrosive Material	Destruction of the human skin Corrode steel at a rate of 0.25 inches per year
Class 9: Miscellaneous	A material that presents a hazard during shipment but does not meet the definition of the other classes

Hazardous materials that are being transported must have specific packaging and labeling. Specific safety regulations also apply when handling and storing hazardous materials at fixed facilities. In general, there are three recognized sources for hazmat incidents within the County: delivery lines, fixed storage facilities and use locations, and transportation routes. Once a hazmat incident occurs, the area impacted will depend on the natural of the chemical and climate conditions. All areas should be considered at risk. However, some areas, such as those close to aquifers and other water supplies can expect greater impacts if a spill occurred in the area.

Transportation of hazardous materials through Larimer County happens at all times of day by way of rail, road, and air. Roadway transport account for the largest amount of hazardous materials moving though the county. That said, rail cars are able to carry much larger quantities of hazardous materials than trucks or cars and can be associated with a greater risk.

Figure 4-23 SB I-25 closed in Fort Collins after hazardous materials spill, March 2015

Source: KWGN

Title 42, Article 20 of the Colorado Revised Statutes governs the routing of hazardous materials by motor vehicles on all public roads in the state. The required criteria that the route must meet before it is brought before the Transportation Commission are as follows:

- The route(s) under consideration are feasible, practicable, and not unreasonably expensive for such transportation.
- The route(s) is continuous within a jurisdiction and from one jurisdiction to another.
- The route(s) does not unreasonably burden interstate or intrastate commerce.
- The route(s) designation is not arbitrary or intended by the petitioner merely to divert the transportation of hazardous materials to other communities.
- The route(s) designation will not interfere with the pickup or delivery of hazardous materials.
- The route(s) designation is consistent with all applicable state and federal laws and regulations; and
- The route(s) provides greater safety to the public than other feasible routes. Considerations include but are not limited to:
    - AADT, crash and fatality rates
    - Population within a one-mile swath of each side of the highway
    - Locations of schools, hospitals, sensitive environmental areas, rivers, lakes, etc.
    - Emergency response capabilities on the route
    - Condition of the route, i.e., vertical and horizontal alignment, pavement condition, level of access to the route, etc.

Troop 8-C is the Hazardous Materials Section of the Colorado State Patrol. Their mission is to contribute to the safety of hazardous materials transportation in order to protect citizens and the environment. Twenty-eight troopers trained as Hazardous Materials Technicians are deployed throughout the state.

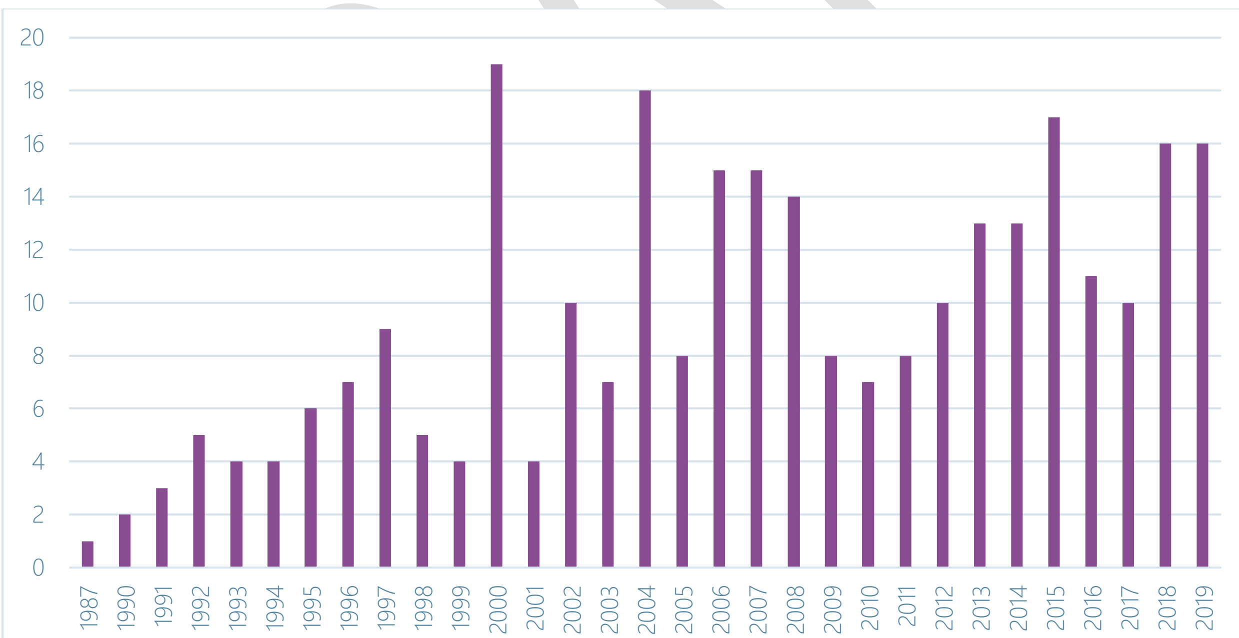
Local Hazardous Materials Response Teams (most often housed in local fire departments and fire protection districts) are the designated emergency response authority for hazardous substance incidents in all areas of Larimer County except on highways, where the State Patrol has jurisdiction.

Past Occurrences

Hazardous materials incidents occur regularly in Larimer County. The 2018 Colorado State Hazard Mitigation Plan ranks Larimer County as 8th in the top 10 of counties with the highest number of incidents in the state.

The U.S. Coast Guard's National Response Center (NRC) serves as the primary national point of contact for reporting all oil, chemical, radiological, biological, and etiological discharges into the environment anywhere in the United States and its territories. NRC data shows that between 1987 and the end of 2019, 289 hazardous materials incidents were reported in Larimer County. Roughly half of these incidents occurred at fixed sites or storage tanks, and half occurred during transportation. This number almost certainly excludes a number of very small spills that were not reported to the NRC. This translates to an average of 9.32 incidents per year. As shown in Figure 4-24, the trend over the last 32 years shows fewer incidents in the 1990s (average of 5 incidents per year), with the number of incidents more than doubling during the 2000s (average of 12 incidents per year), an average that continued during the 2010s.

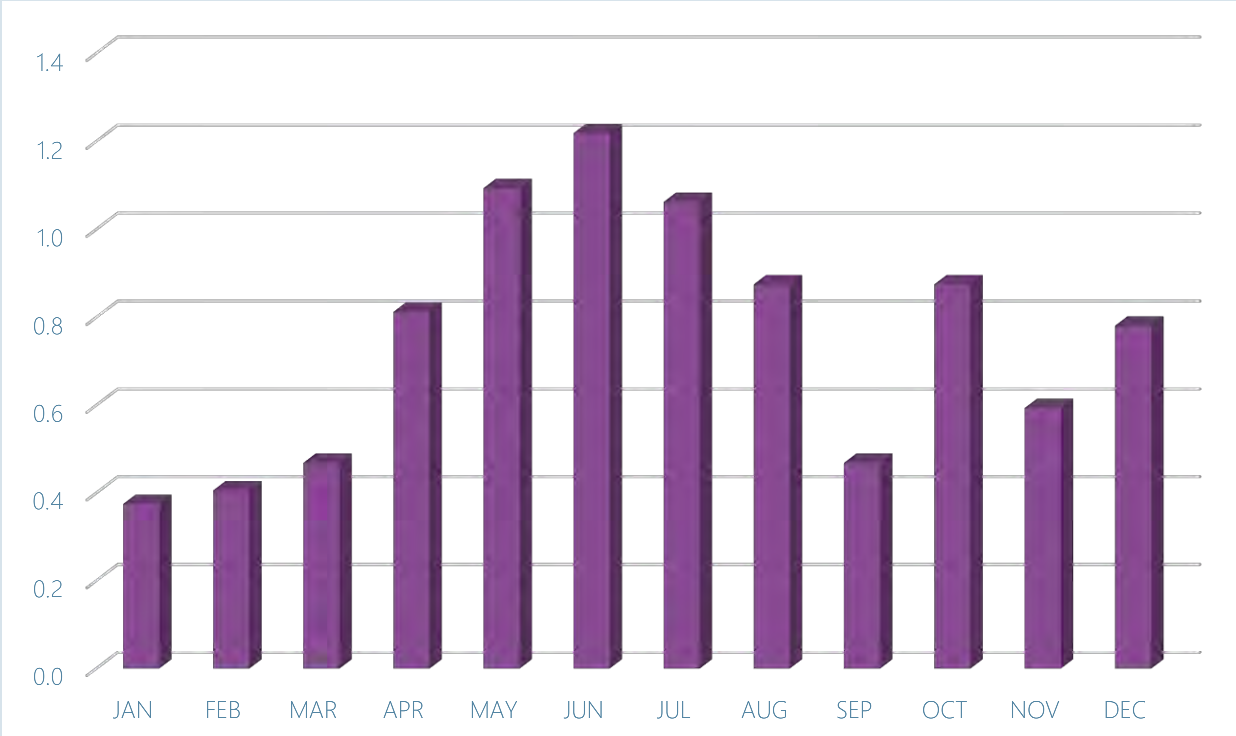
Figure 4-24 Hazardous Materials Spills in Larimer County, 1987-2019



Source: National Response Center https://nrc.uscg.mil/

Figure 4-25 shows the average number of hazmat incidents in Larimer County per month. Incidents are most common in the summer and fall.

Figure 4-25 Average Number of Hazardous Materials Spills in Larimer County by Month



Source: National Response Center https://nrc.uscg.mil/

The vast majority of these incidents resulted in little or no damage. NRC reports only 40 hazmat incidents from 1987-2019 that resulted in injuries, evacuations, or property damage. This translates to an average of 1.2 damaging hazmat incidents per year. Altogether, the NRC reports 10 fatalities, 29 injuries, 13 evacuations, and $200,000 in property damage associated with the 40 incidents. However, it is important to note that the NRC counts all injuries or damages resulting from an accident where hazardous materials were involved, whether or not the injuries or damages were caused by exposure to the hazardous substance; closer analysis shows that a majority of the injuries, fatalities, and property damages were from the physical impacts of the accident that caused the release, rather from exposure to hazardous materials themselves.

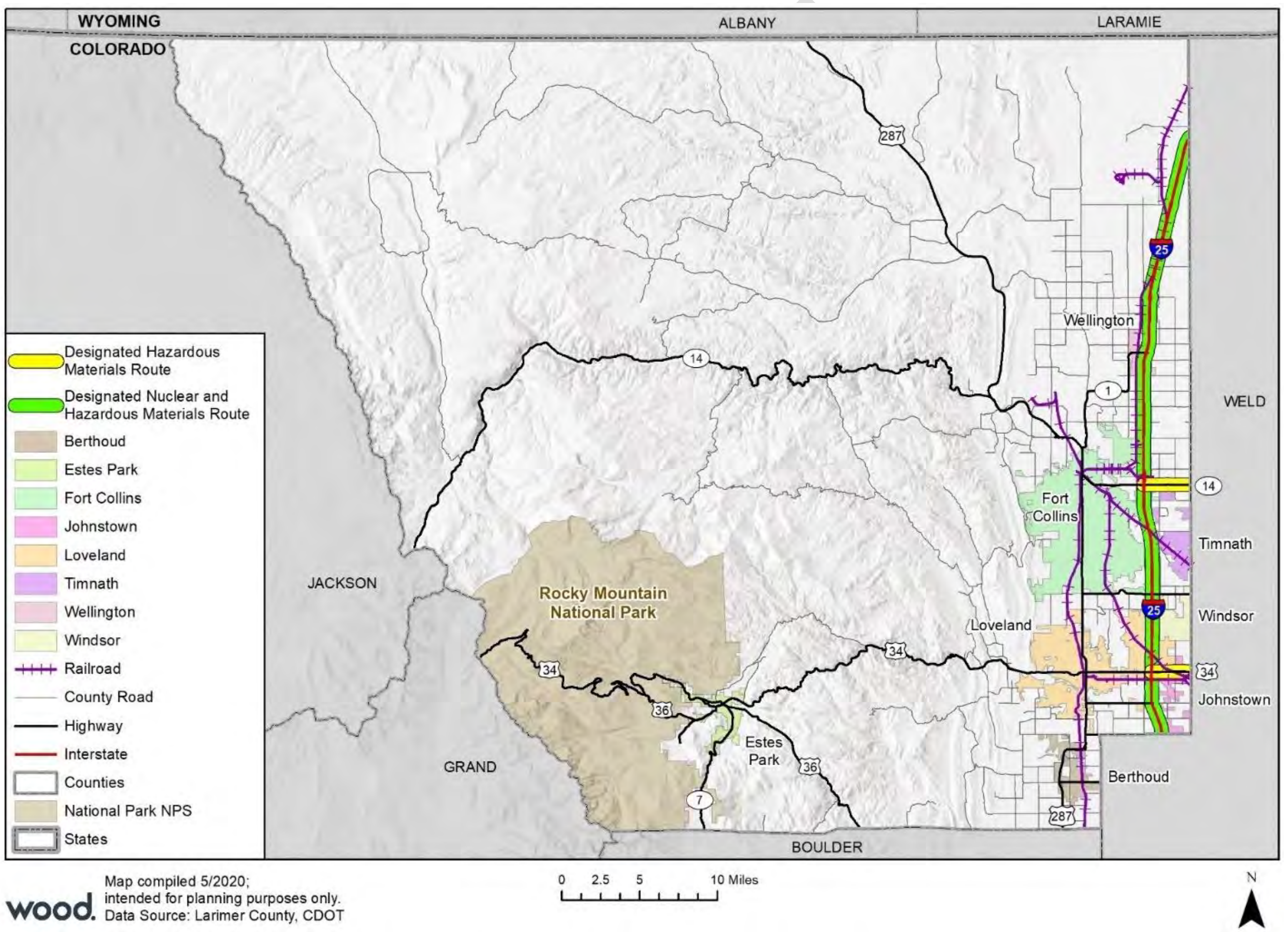
Location

Limited - Hazmat incidents can occur at fixed facilities or during transportation, as discussed below. Overall, the geographic coverage of this hazard in Larimer County is limited, with less than 10% of the planning area affected based on historical experience. However, depending on the type and quantity of spills and the medium affected, the geographic area affected by a spill could potentially become much larger, for example if the material was spilled into a waterway.

Generally, with a fixed facility, the hazards are pre-identified. The U.S. Emergency Planning and Community Right-to-Know Act (EPCRA) of 1986 requires industries to report on the storage, use, and releases of hazardous substances to federal, state, and local governments. Facilities in Colorado must submit an emergency and hazardous chemical inventory form (Tier II form) to the Colorado Department of Public Health and Environment (CDPHE) and, if required by local reporting regulations, the Local Emergency Planning Committee (LEPC) and local fire departments annually. Tier II forms provide state and local officials and the public with information on the general hazard types and locations of hazardous chemicals present at facilities during the previous calendar year. The inventory forms require basic facility identification information, employee contact information for both emergencies and non-emergencies, and information about chemicals stored or used at the facility. The EPA also requires facilities containing certain extremely hazardous substances to generate Risk Management Plans (RMPs) and resubmit these plans every five years. The Cities of Fort Collins and Loveland have the majority of the Risk Management Plan (RMP) facilities in the County.

The following map shows the state's designated nuclear, hazardous materials, and gasoline, diesel fuel, and liquid petroleum gas routes, many of which pass through the eastern portion of Larimer County.

Figure 4-26 Colorado Hazardous and Nuclear Materials Route Restrictions in Larimer County



Magnitude/Severity

A major hazardous materials incident could potentially have critical impacts, causing multiple deaths, property damage, and/or interruption of essential facilities and service for more than 72 hours. However, historically the impact of hazardous materials incidents in Larimer County have been limited.

The intensity and magnitude of these incidents depend on weather conditions, the location of the event, the time of day, and the process by which the materials are released. Was it raining when the event happened? Were the hazardous materials being transported by rail when they were released or were they at a fixed facility? Did the spill happen during rush hour traffic or in the middle of the night? All of these considerations matter when determining the risk and potential damages associated with a hazmat incident.

Hazardous materials come in the form of explosives, flammable and combustible substances, poisons, and radioactive materials. Hazards can occur during production, manufacturing, storage, transportation, use, or disposal. Impacts from hazardous materials releases can include:

- Fatalities
- Injury
- Evacuations
- Property damage
- Animal fatalities (livestock, fish & wildlife)
- Air pollution
- Surface or ground water pollution/contamination
- Interruption of commerce and transportation

Numerous factors influence the impacts of a hazardous materials release, including the type and quantity of material, location of release, method of release, weather conditions, and time of day. This makes it difficult to predict precise impacts. The impact to life and property from any given release depends primarily on:

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

Speed of Onset: Hazardous material incidents may occur quickly with little to no warning.

Duration: While the event may occur quickly and suddenly, the duration of the event lasts until it is contained, or the area is decontaminated.

Probability of Future Occurrences

Likely - As noted above, Larimer County experiences 12 hazardous materials incidents per year on average, roughly one of which will cause damages or injuries. The probability is higher in the urban areas and along major transportation routes, but incidents are possible in the entirety of the county area.

As development continues to encroach into existing industrial areas and becomes denser along high-risk designated hazardous materials transportation routes, the risk of future occurrences becomes greater. Even if the frequency of hazmat spills remains the same over time, population growth will increase the probability of a disaster event.

Climate Change Considerations

There are no known effects of climate change on human-caused hazards such as hazardous materials incidents.

Vulnerability Assessment

When hazardous materials are being transported, they are particularly vulnerable to transportation related accidents, misuse, or terrorist threats. Most hazardous materials are transported in large quantities in order to reduce costs and security is difficult to maintain around moving vehicles that cross jurisdictional boundaries. When transported close to populated areas or critical infrastructure, hazmat releases can have serious consequences. The inventory that is most often exposed to hazmat risks are railways, roadways, and fixed facilities that contain hazardous materials, and all assets that lie within a mile of the potential release areas. Due to the location of designated hazardous materials and nuclear material routes, communities on the Front Range and eastern plains are more vulnerable to the transportation of hazardous materials in comparison to the communities in the western portion of county. These communities are also vulnerable to impacts of incident at fixed facilities. All 10 RMP facilities are located on the eastern portion of the County, including 5 in the City of Fort Collins.

People

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

Vulnerable populations can be more severely impacted by hazardous materials incidents. People with existing health risks or compromised immune systems could be severely affected by releases of even relatively low-impact materials. Low income families may be more likely to live in industrial areas or near hazardous materials routes. Individuals with disabilities may need more time to evacuate, so evacuation notices will need to be issued as soon as feasible, and communicated by multiple, inclusive methods.

General Property

The impacts of major hazardous materials incidents are potentially catastrophic, causing multiple deaths, property damage, and/or interruption of essential facilities and service for more than 72 hours. However, historically the impact of hazardous materials incidents in Larimer County have been limited. The impact of most fixed facility incidents is typically localized to the property where the incident occurs. The impact of small spills during transportation may also be limited to the extent of the spill and remediated if needed. While cleanup costs from major spills can be significant, they do not typically cause significant long-term impacts to property.

Critical Facilities and Infrastructure

Impacts of hazardous material incidents on critical facilities are most often limited to the area or facility where they occurred, such as at a transit station, airport, fire station, hospital, or railroad. However, they can cause long-term traffic delays and road closures resulting in major delays in the movement of goods and services. These impacts can spread beyond the planning area to affect neighboring counties, or vice-versa. While cleanup costs from major spills can be significant, they do not typically cause significant long-term impacts to critical facilities.

Table 4-44 shows the results of GIS analysis that was overlaid hazard layers with the location of hazardous materials facilities as defined by FEMA Lifelines in the County.

Table 4-44 Hazardous Material Facilities and Potential Hazard Risk

Jurisdiction	Hazard	# of Hazardous Material Facilities*
Unincorporated	Dam Inundation	4
	Geologic	6
	Wildfire (Low Risk)	3
	Wildfire (Lowest Risk)	1
	Total	**14**
Fort Collins	Dam Inundation	5

Jurisdiction	Hazard	# of Hazardous Material Facilities*
	Flood (0.2% chance)	1
	Geologic**	17
	Expansive Soil	2
	Wildfire (Low Risk)	1
	Total	**26**
Loveland	Dam Inundation	1
	Geologic	1
	Total	**2**
Grand Total		**84**

Source: Larimer County GIS, Wood analysis
*As defined by FEMA Lifelines **Includes 1 facility within severe potential of hazard area

Economy

The primary economic impact of hazardous material incidents results from lost business, delayed deliveries, property damage, and cleanup costs. Large and publicized hazardous material-related events can deter tourists and recreationists and could potentially discourage residents and businesses. Even small incidents have cleanup and disposal costs, and for a larger scale incident these could be extensive and protracted. Evacuations can disrupt home and business activities. Large-scale incidents can easily reach $1 million or more in direct damages, with clean-ups that can last for years.

Historic, Cultural and Natural Resources

Hazmat incidents can cause serious environmental contamination to natural resources such as air, ground, and water sources. Hazardous material incidents may affect a small area at a regulated facility or cover a large area outside such a facility. Widespread effects occur when hazards contaminate the groundwater and eventually the municipal water supply, or they migrate to a major waterway or aquifer. Impacts on wildlife and natural resources can also be significant.

Future Land Use and Development

As Larimer County continues to experience population growth and development over time, it is anticipated that there will be increased exposure to potential life loss, injuries, and environmental damage resulting from a hazardous materials incident. Serious considerations must be made concerning land use and regulations as increasing development pressures push residential and commercial investment closer to railways and identified hazardous and nuclear materials routes.

Risk Summary

- There were 289 hazardous materials incidents reported between 1987-2019, an average of 9.32 incidents per year. Roughly half these incidents took place at fixed facility sites and half took place during transport.
- Only 40 of those incidents resulted in reported injuries, fatalities, evacuations or damages, an average of 1.2 per year.
- Only 3% of incidents were caused by a natural hazard event; most of the rest were due to accidents.
- There are 707 Tier II facilities and 14 Risk Management Plan facilities in Larimer County.
- Related Hazards: Dam Incident, Earthquake, Erosion/Deposition, Flood, Landslide/Rockslide, Spring/Summer Storm, Tornado, Utility Disruption, Wildfire and Winter Storm.

4.3.8 Landslide/Rockslide

Hazard	Frequency	Spatial Extent	Severity	Overall Significance
Landslide / Rockslide	Likely	Limited	Critical	High

Description

Landslides are one of the most common geologic hazards in Colorado and are characterized by the downward and outward movement of loose material on slopes. They include a wide range of ground movement, such as rock falls, deep failure of slopes, and shallow debris flows. Although gravity acting on and over steep slopes is the primary reason for a landslide, landslides are often prompted by the occurrence of other disasters such as seismic activity of heavy rain fall. Other contributing factors include the following:

- Erosion by rivers creating over-steepened slopes
- Rock and soil slopes weakened through saturation by snowmelt or heavy rains
- Earthquakes creating stresses that make weak slopes fail
- Excess weight from accumulation of rain or snow, stockpiling of rock or ore, from waste piles, or from manmade structures stressing weak slopes
- Floods or long duration precipitation events creating saturated, unstable soils that are more susceptible to failure

Slope material often becomes saturated with water and may develop a debris or mudflow. If the ground is saturated, the water weakens the soil and rock by reducing cohesion and friction between particles. Cohesion, which is the tendency of soil particles to "stick" to each other, and friction affect the strength of the material in the slope and contribute to a slope's ability to resist down slope movement. Saturation also increases the weight of the slope materials and, like the addition of material on the upper portion of a slope, increases the gravitational force on the slope. Undercutting of a slope reduces the slope's resistance to the force of gravity by removing much-needed support at the base of the slope. Alternating cycles of freeze and thaw can result in a slow, virtually imperceptible loosening of rock, thereby weakening the rock and making it susceptible to slope failure. The resulting slurry of rock and mud can pick up trees, houses, and cars, and block bridges and tributaries, causing flooding along its path. Additionally, removal of vegetation can leave a slope much more susceptible to superficial landslides because of the loss of the stabilizing root systems.

Geologists identify active landslides and areas subject to slope instability so that they may be avoided or mitigated. Together, geologists and civil engineers develop and implement measures to improve the stability of slopes, repair existing landslides, and prevent damage from future landslides. Slope stability can be improved by removing material from the top of the slope, adding material or retaining structures to the base of the slope, and reducing the degree of saturation by improving drainage within the slope.

Past Occurrences

There are a couple of data sources for landslide events in the last 30 years. Table 4-45 lists landslide incidents that blocked major transportation routes in Larimer County between 1989 and 2004 according to the Northern Colorado Regional Hazard Mitigation Plan. Highways 14 and 34 provide routes for essential services for communities in the Poudre Canyon, Big Thompson Canyon, Estes Park, Rocky Mountain National Park, and Towns of Granby and Grand Lake.

Table 4-45 Landslide/Rockslide Incidents That Blocked Roadways Between 1989 and 2004 in Larimer County

Date	Location	Length of Incident	Description
7/25/2004	Highway 14	closed – 24 hours	rockslide
7/14/2004	Highway 14	closed – 24 hours	rockslide
4/5/2002	Highway 34	closed – 24 hours	rockslide
6/19/1999	Highway 14	closed – 21 days	large rock/landslide
2/23/1993	Highway 14	closed – 72 hours	avalanche/rockslide
8/1/1989	Highway 34	closed – 8 hours	rockslide

Source: 2010 Northern Colorado Regional Hazard Mitigation Plan

Table 4-46 shows landslide/rockslide data from the NASA Global Landslide Catalog, and lists 13 landslide incidents in Larimer County between 2012 and 2017 (NASA 2019). Like most landslides, these were all triggered by heavy rain events.

Table 4-46 Landslides in Larimer County between 2012 and 2017

Year	Month	Event Description	Location
2012	July	Colorado Highway 14 in Poudre Canyon is closed from Ted's Place at U.S. Highway 287 to Poudre Park due to mudslides in the area.	Hwy 14, High, park, Poudre Canyon
2012	September	A roughly 100-foot mudslide was reported in Buckhorn Canyon.	Buckhorn Canyon, Larimer county, CO
2012	September	More rain in an area that burned in the High Park wildfire in Larimer County has led to at least two mudslides. One slide left about 50 yards of debris and rushing water on Colorado Highway 14, leaving that part of the road impassable Thursday afternoon. The Colorado Department of Transportation was working to clear the road.	Colorado Hwy, Larimer County, CO
2013	June	Highway officials have reopened Colorado 14 northwest of Fort Collins after clearing a mudslide that partially covered the road. The highway was closed west of Ted's Place to Stove Prairie at about 8:45 p.m. Friday as thunderstorms and hail pummeled northern Colorado. It was reopened at about 12:45 a.m. Saturday. Kari Bowen, a meteorologist for the National Weather Service in Boulder, tells The Denver Post that rain fell at the rate of 2.29 inches an hour in the Fort Collins area Friday night with thunderstorms and hail.	Colorado Highway 14, West of Fort Collins, Denver, Colorado
2013	July	About 4 p.m., the Sheriff's Office also reported "minor debris" on County Road 27 -- the Stove Prairie Road -- between County Road 52E and Colorado 14.	On County Road 27 -- Between County Road 52E And Colorado 14.
2013	July	Residents temporarily evacuated from their Rist Canyon homes were allowed to return home Sunday night after rains gave way to flooding, washing fine sediment down the roads and sweeping out parts of driveways. Authorities started receiving reports of mudslides and flooding in areas of Colorado 14 and Davis Ranch Road at about 5:15 p.m. An evacuation notice went out to more than 40 people in the Falls Creek Drive area just before 7 p.m., the Larimer County Sheriff's Office tweeted. It wasn't known whether there were any injuries or damage to structures reported, as of Sunday night.	Colorado 14, Roosevelt National Forest, Bellvue, Co

Year	Month	Event Description	Location
2013	July	One lane of Colorado Highway 14 has opened in the Poudre Canyon approximately 7 miles west of Ted's Place, after a mudslide. The road was closed at about 3:25 p.m. The lane was opened around the mudslide about 25 mins later. A flash flood warning is in effect for the area until 5 p.m. Doppler radar indicated heavy rain across the High Park burn scar just before 3 p.m. and said flash flooding was expected shortly. Some locations that will experience flooding include Poudre Park; the National Weather Service warned.	Colorado Highway 14 Has Opened in The Poudre Canyon
2013	July	Two mudslides in the Poudre Canyon trapped motorists and closed Colorado Highway 14 northwest of Fort Collins on Friday. Large rocks and logs were swept into the canyon after an afternoon thunderstorm dumped more than 2 inches of rain on slopes charred by last summer's High Park Fire. The afternoon deluge left travelers stranded as road crews worked into the evening to clear tons of debris. The two road-clogging mudslides were located about a mile west of the Mishawaka Amphitheatre and trapped vehicles between them.	Colorado Highway 14, Poudre Canyon, Co
2013	July	Thursday afternoon thunderstorm resulted in localized damage to the lower Fern Lake Trail, located on the east side of Rocky Mountain National Park, according to a park release. The debris flow originated on the slope to the north of the trail in an area burned by the Fern Lake Fire. The debris, consisting primarily of mud, rocks and trees, covered more than 150 yards of trail and in places is estimated to be 4 feet deep. The 2 mile section of the Lower Fern Lake Trail remains closed from the trailhead to The Pool until a damage assessment is complete.	Lower Fern Lake Trail, Rocky Mountain National Park, Co
2013	September	It's an amazing, but little-known September storm rescue story. A draft horse mired in a mudslide at an Estes Park resort was rescued by an excavator operator who "very gently" used a big metal bucket to scoop up the mud and the horse and move it to solid ground. The rescue happened on Sunday, Sept. 15, after torrential rains that unleashed flooding caused a massive mudslide that engulfed parts of the horse stables and parking lot at Aspen Lodge Resort & Spa on Highway 7, employee Kristina Naldjian told 7NEWS. Some parked cars were buried in a several feet of mud. There were 25 horses in the stable area, and all were unharmed, except for Rosie, a draft horse who became mired in several feet of watery mud. Employees tried unsuccessfully to help free the exhausted horse, which was buried up to its hips in mud, Naldjian said. "Rosie was basically giving up, she was a goner," Naldjian said. "The mud was very deep, and she totally was sucked into it. Fortunately, an excavator boom was used to scoop the mud under the horse, lifting Rosie with it. After the mudslide, 25 employees and six guests had to sleep in the lodge's restaurant until they could be evacuated, Naldjian said. The 25 horses were evacuated to an area ranch and later moved down to the Fort Collins area, she said. The lodge will be closed for several months because the mudslide damaged its water infrastructure and water treatment plant.	Aspen Lodge Resort, Estes Park, Co
2013	July	River rafters are still feeling the effects of 2012's High Park fire. Mudslides and debris in the Cache la Poudre River due to heavy rains in the High Park fire burn area have made for interesting rafting conditions, according to area outdoor adventure companies.	Cache La Poudre River Near High Park Fire Burn Area, Co

Year	Month	Event Description	Location
		A mudslide Friday stranded motorists for a brief time at highway marker 104 and blocked the river at "Three Way" rapids. "It went across the street and pretty much destroyed that rapid," said Sam LaBarre, a rafting guide with A1 Wildwater Rafting. "This whole thing that jetties out right here was all water. (The mudslide) came down the mountain and this whole road was covered with about three feet of silt, rock, leaves. Not even a kayak can get through there," said Branden Gunn on Monday at the site of the mudslide.	
2017	May	Rockslide blocks highway.	CR 43, near Drake CO
2017	May	Many small rockslides along Estes Park stretch of Route 36 due to storms.	80517, Estes Park, Colorado

Source: NASA Global Landslide Catalog

Location

Figure 4-27 shows historical and potential landslide and rockslide areas in Larimer County. The western mountainous portion of Larimer County are more susceptible to Landslides and Rockslides.

Figure 4-27 Larimer County Landslide Deposits

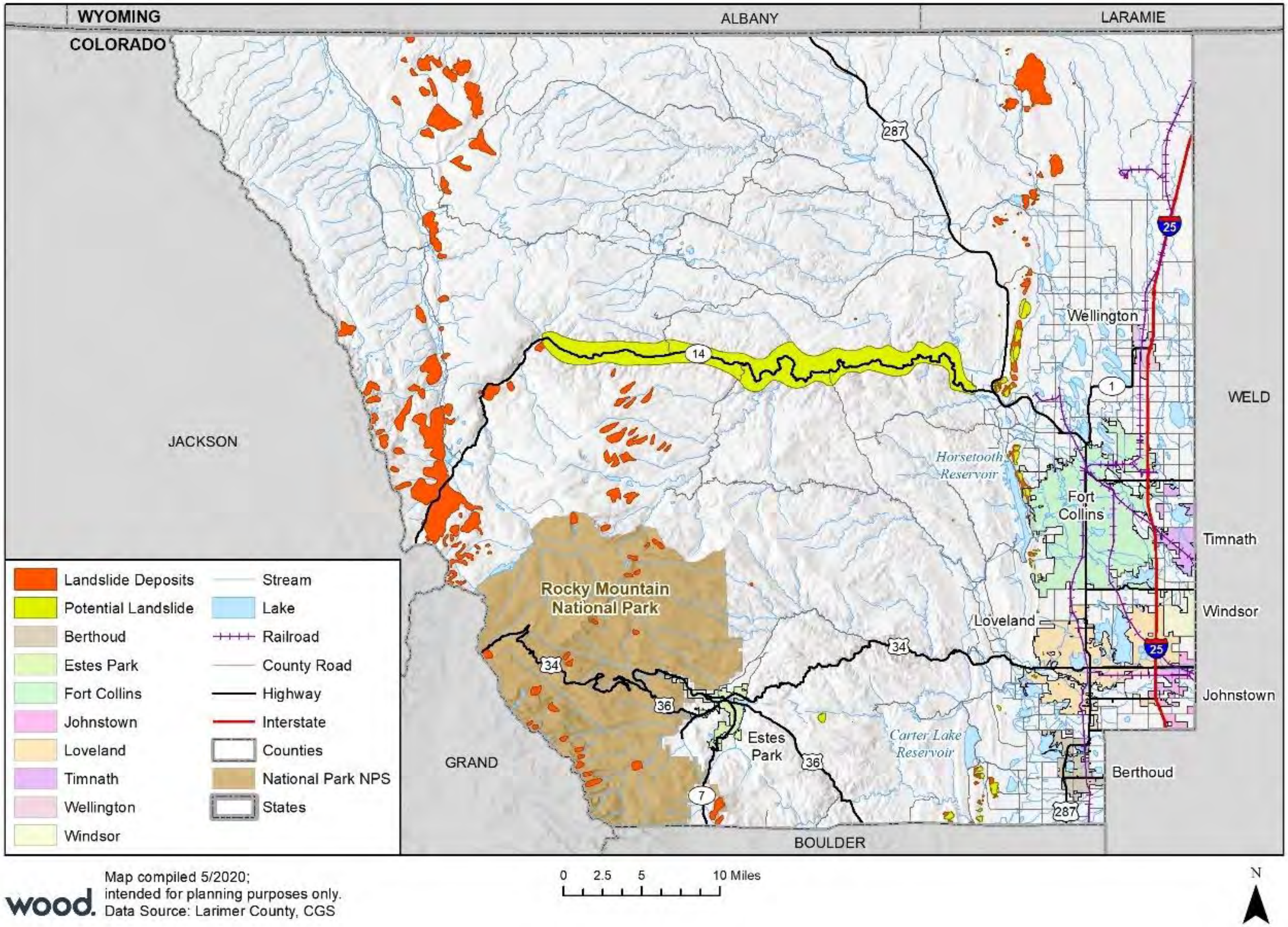
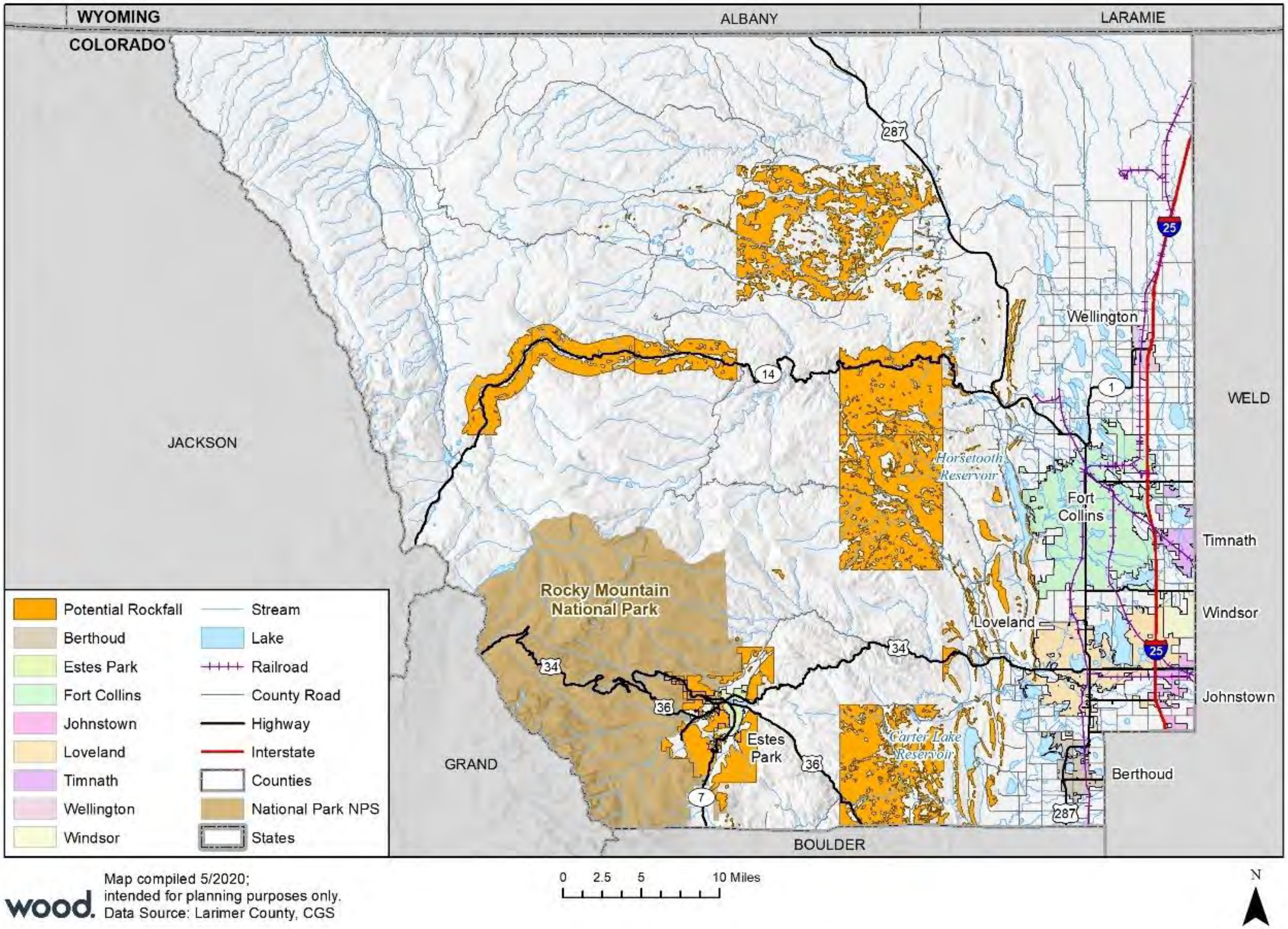


Figure 4-28 Larimer County Potential Rockslide Areas



Magnitude/Severity

Landslides and rockslides often come with minimal to no warning. The duration of an event is quick, in the range of seconds to minutes, but the effects can last up to a day or two if blocking a roadway or knocking out power. Common problems associated with landslides and rockslides include the loss of utilities or immobility. Loss of life is rare but could occur during landslides or rockfalls. Immobility can occur when roads become impassable due to landslides or rockslides. Interruption or loss of power lines or transportation pathways can occur due to landslides or rockslides.

The severity of landslides or rockslides depends on the amount of material (soil, debris, or rocks) moves and where it stops moving (e.g., on roadway).

Probability of Future Occurrences

Based on the NASA landslide inventory, there were 13 reported landslide/rockslide events between 2012 and 2017 in Larimer County which produces an annual average of just over two landslides. It should be noted that some landslides may not be reported due to smaller size or remote location. This data range also included the 2013 heavy precipitation events and floods, which likely increased landslide activity with 8 of the 13 reported landslides occurring in 2013.

Also, according to the Northern Colorado Regional Hazard Mitigation Plan, there were six events that blocked Highways 14 or 34 over 16 years. This comes to an average of about a landslide/rockslide event that closes Highway 14 or 34 in Larimer County every three years. The most recent wildfire in Larimer County, the 2020 Cameron Peak Fire, has increased the potential for landslides or rockslides along the Highway 14 corridor or along County Road 103 due to burn severity in that area.

Overall, the probability of future occurrences of rockslide and landslide events in Larimer County is likely with an occurrence likely in the next year. Many areas in the western portion of the county are prone to these types of hazard events due to their proximity to previous landslide events, their location at the base or top of steep slopes and drainage basins, or their location on infill or steep slope cuts. Moreover, as development and population increase in the county, increasing numbers of structures (and people) will be exposed to future landslide and rockslide events.

Climate Change Considerations

Average annual temperatures have increased since the 1970s in Larimer County (Doerr 2019). This has contributed to more water evaporation making drought more common, which would increase the probability of wildfire, reducing the vegetation that helps to support steep slopes. Wildfires and earthquakes destabilize soil on steep slopes increasing landslide risk. Erosion caused by development on steep hillsides increases risk of landslides. Since the 1950s, snow precipitation and duration of snowpack have both decreased while rising temperatures have increase rate of water evaporating into the air, creating drier soil conditions in Colorado (EPA 2016).

Vulnerability Assessment

People

Exposure is the greatest danger to people in remote locations in areas of steep slopes and higher precipitation areas in the western to central portion of the county. People who travel along these roadways or highways that are susceptible to landslides and rockslides are also exposed. Past landslides in Larimer County have not caused loss of life, injuries, or major property damage. Landslides have closed down highways for hours to days, which can affect essential services for rural populations. As population, tourism, and development increases in landslide prone areas, landslide occurrence interacting with people and development will also increase.

While not technically a landslide or rockslide, a backcountry skier was caught in an avalanche and died near Cameron Pass on Highway 14 in December of 2019. According to the History of Colorado Avalanche accidents, there have been eight fatalities due to avalanches between 1950 and 2006 (Atkins 2006).

General Property

Landslides and rockslides affect the entire planning area of Larimer County and affected jurisdictions that have steep slopes near roadways or critical infrastructure. Although damage or losses to transportation corridors and structures are typically minimal, there can be impacts with lost time, maintenance costs, and tourism.

Table 4-47 Improved Properties at Risk to Landslide by Parcel Type within Larimer County.

Jurisdiction	Parcel Type	Improved Parcels	Building Count	Improved Value	Content Value	Total Value	Population
Fort Collins	Residential	26	30	$13,845,739	$6,922,868	$20,768,607	74
	Total	**26**	**30**	**$13,845,739**	**$6,922,868**	**$20,768,607**	**74**
Loveland	Exempt	1	3	$850,320	$850,320	$1,700,640	
	Residential	5	5	$1,760,795	$880,398	$2,641,193	12
	Total	**6**	**8**	**$2,611,115**	**$1,730,718**	**$4,341,833**	**12**
Unincorporated	Agricultural	20	23	$7,001,251	$7,001,251	$14,002,502	
	Commercial	8	15	$1,745,554	$1,745,554	$3,491,108	
	Exempt	11	30	$25,835,857	$25,835,857	$51,671,714	
	Mobile Home	3	8	$861,396	$430,698	$1,292,094	20
	Residential	409	545	$91,184,540	$45,592,260	$136,776,800	1,341
	Total	**451**	**621**	**$126,628,598**	**$80,605,620**	**$207,234,218**	**1,360**
	Grand Total	**483**	**659**	**$143,085,452**	**$89,259,206**	**$232,344,658**	**1,446**

Source: CGS, Larimer County Assessor's Office, Wood analysis.

There were 659 buildings throughout 483 parcels in Fort Collins, Loveland, and Unincorporated jurisdictions that were at risk to landslide and improved. The improved value of the buildings is over $143 million dollars with the total value over $232 million dollars.

Table 4-48 Improved Properties at Risk to Rockslides by Parcel Type within Larimer County

Jurisdiction	Parcel Type	Improved Parcels	Building Count	Improved Value	Content Value	Total Value	Population
Estes Park	Commercial	35	50	$40,710,265	$40,710,265	$81,420,530	
	Exempt	7	7	$2,690,293	$2,690,293	$5,380,586	
	Multiple Unit	3	10	$3,825,000	$3,825,000	$7,650,000	
	Residential	568	597	$224,991,221	$112,495,614	$337,486,835	1,164
	Total	**613**	**664**	**$272,216,779**	**$159,721,172**	**$431,937,951**	**1,164**
Loveland	Residential	10	10	$4,555,168	$2,277,583	$6,832,751	24
	Total	**10**	**10**	**$4,555,168**	**$2,277,583**	**$6,832,751**	**24**
Unincorporated	Agricultural	109	128	$38,008,320	$38,008,320	$76,016,640	
	Commercial	12	18	$8,941,681	$8,941,681	$17,883,362	
	Exempt	15	57	$64,660,836	$64,660,836	$129,321,672	
	Mobile Home	1	1	$26,400	$13,200	$39,600	2

Jurisdiction	Parcel Type	Improved Parcels	Building Count	Improved Value	Content Value	Total Value	Population
	Residential	1,391	1,545	$511,586,652	$255,793,329	$767,379,981	3,801
	Total	**1,528**	**1,749**	**$623,223,889**	**$367,417,366**	**$990,641,255**	**3,803**
	Grand Total	**2,151**	**2,423**	**$899,995,836**	**$529,416,121**	**$1,429,411,957**	**4,991**

Source: CGS, Larimer County Assessor's Office, Wood analysis.

There were 2,423 buildings throughout 2,151 parcels in Estes Park, Loveland, and Unincorporated jurisdictions that were at risk to rockfall and improved. The improved value of the buildings is over $899 million dollars with the total value over $1.4 billion dollars.

Most structures, including the County's critical facilities, should be able to provide adequate protection from smaller landslides or rockslides with mesh or cable nets, barriers, and fences, or catchment areas. These designed structures can stop, control, reduce or provide a safe location for landslides/rockslides (FHWA 2011).

Critical Facilities and Infrastructure

The critical facility exposure analysis estimates that there are seven critical facilities with potential landslide hazards and three facilities with potential rockslide hazards. These facilities consist of a health and medical facility in Fort Collins as well as nine other facilities for food/water/shelter, communications, and safety/security facilities in unincorporated areas. These facilities do not include miles roadway that are susceptible to landslides and rockslides.

Table 4-49 Critical Facilities with Potential Landslide Hazards

Jurisdiction	FEMA Lifeline	Count
Fort Collins	Health and Medical	1
Unincorporated County	Food, Water, Shelter	5
	Miscellaneous	1
	Safety and Security	1
Total		**7**

Source: CGS, Cascarta, Larimer County, Wood analysis.

Table 4-50 Critical Facilities with Potential Rockslide Hazards

Jurisdiction	FEMA Lifeline	Count
Unincorporated County	Communications	1
	Food, Water, Shelter	2
Total		**3**

Source: CGS, Cascarta, Larimer County, Wood analysis.

Economy

Economic impact of landslides/rockslides is typically short term, although it can be significant. Landslide/rockslide events can cause road closures and structural damage. As noted in the Past Occurrences subsection above, landslides and rockslides in Larimer County have led to 13 events that have closed, damaged, or impacted roadways between 2012 and 2017. There were also 6 closures of Highways 14 and 34 between 1989 and 2004.

Historic, Cultural and Natural Resources

Landslides/rockslides are a natural environmental process. Environmental impacts include the removal of vegetation, soil, and rock.

Future Land Use and Development

As population growth brings new development into available land in the county, more inventory assets may become exposed to landslides and rockslides hazards.

Rapid and sustained population growth across Colorado and the Front Range has contributed to increasing trends in landslide/rockslide hazard risk, exposure, and vulnerability across Larimer County. There have been property and infrastructure damages associated with these hazards within the county and landslides and rockslides have been categorized as a high risk hazard. Based on historical data, the natural process of landslides and rockslides will continue over time occurring between once every three years and as many two times per year.

As of 2018, more than 87% of Larimer County's population lives in jurisdictions that are not in landslide/rockslide prone areas. Based on past and projected population growth, it is very likely that future development will lead to the intersection of landslides and rockslides-prone areas. As development pressures continue in undeveloped areas of the county, vulnerability to landslides and rockslides may increase across Larimer County.

Typically, the process of landslides and rockslides do not limit land use, especially if efforts are made to minimize it. Landslide and rockslide impacts can be reduced and controlled by road bank slope design, surface drainage management, and re-vegetation or disturbed lands. Ground modification and structural solutions can help mitigate the threats of localized landslides and rockslides. Proper drainage and water management are also important to prevent increasing vulnerability to landslide and rockslide hazards.

Risk Summary

- The central to western portion of the county is susceptible to the impacts of landslides and rockslides, especially in areas of steep slopes during high precipitation events in spring or summer.
- There have been 13 landslide/rockslide events between 2012 and 2017 resulting in road closures, road repairs, travel delays, and some home evacuations.
- There were six landslide/rockslide events that closed Highways 14 and 34 between 1989 and 2004.
- The total value of properties at risk to landslides and rockslides within Larimer County is over $1.6 billion, not including utilities or roadways.
- Related hazards: spring/summer storms, earthquakes, wildfires.

4.3.9 Soil Hazards

Hazard	Frequency	Spatial Extent	Severity	Overall Significance
Soil Hazards	Likely	Limited	Limited	Medium

Description

Erosion / Deposition

Erosion and deposition are the removal and transportation of earth materials from one location to another by water, wind, waves, or moving ice. Erosion occurs when soil is removed at a greater rate than it is formed. Deposition is the placing of the eroded earth in another location, typically by wind or water. The natural geologic process of erosion has occurred since the Earth's formation and continues at a very slow and uniform rate. Soil erosion hazard is the term used to describe how likely it is for soil in a given area to erode rapidly. It depends on the inherent properties of the soil, the topography, vegetative cover, soil disturbance (including over-grazing, drought, flooding, wind, etc.), and rainfall intensity.

Although soil erosion is a natural process, rapid erosion can lead to a serious loss of topsoil and a reduction of cropland productivity. It can also contribute to the pollution of adjacent watercourses, wetlands, and lakes. During the processes of wind and water erosion, infrastructure and mechanical equipment can be damaged by soil build-up and dust. Additionally, blowing soils can affect human and animal health and create public safety hazards.

Soil erosion and deposition have the potential to cause substantial losses to Larimer County assets. Erosion and deposition alone pose little harm to the county; however, when assets are placed in close proximity to erosion and deposition-prone environments such as a valley near a stream or riverbed, hazard vulnerability increases significantly. For example, when heavy rain and snowmelt result in increased stream flow, the erosion of riverbanks can pose significant risks to transportation infrastructure, including roads and bridges. Severe erosion can remove earth from beneath bridges, roads, and foundations of structures adjacent to streams. The deposition of material can block culverts, aggravate flooding, destroy crops and lawns, and reduce capacity in water reservoirs.

Land Subsidence

Land subsidence describes any depressions, cracks, and/or sinkholes in the earth's surface which can threaten people and property. Causes of subsidence include, but are not limited to, the removal or reduction of sub-surface fluids (water, oil, gas, etc.), mine subsidence, and hydro compaction. Of these causes, hydro-compaction and mine subsidence usually manifest as localized events, while fluid removal may occur either locally or regionally.

Collapsible Soils

Collapsible soils can quickly settle or collapse the ground. This settling of the ground can cause damage to manmade structures. The most common type of collapsible soil is Hydrocompactive soil. This type of soil occurs in semi-arid to arid climates and consist of low density and low moisture content soil. The soil grains in these areas are not compact tightly together but rather stacked loosely. These soils are considered strong while in a dry state. However, when moisture is introduced the stacked soil grains can collapse causing ground surface subsidence or settlement.

Expansive Soils

Expansive soils contain minerals that are capable of absorbing water. As the soil absorbs water it expands and increases in volume. The change in soil volume can cause damage to man- made structures such as foundations. As the soils begin to dry, they will then shrink. The shrinking of the soils can deplete the structural support of soil and cause damaging subsidence.

Past Occurrences

There are no good historical data available for erosion/deposition, subsidence, or expansive soil events in Larimer County.

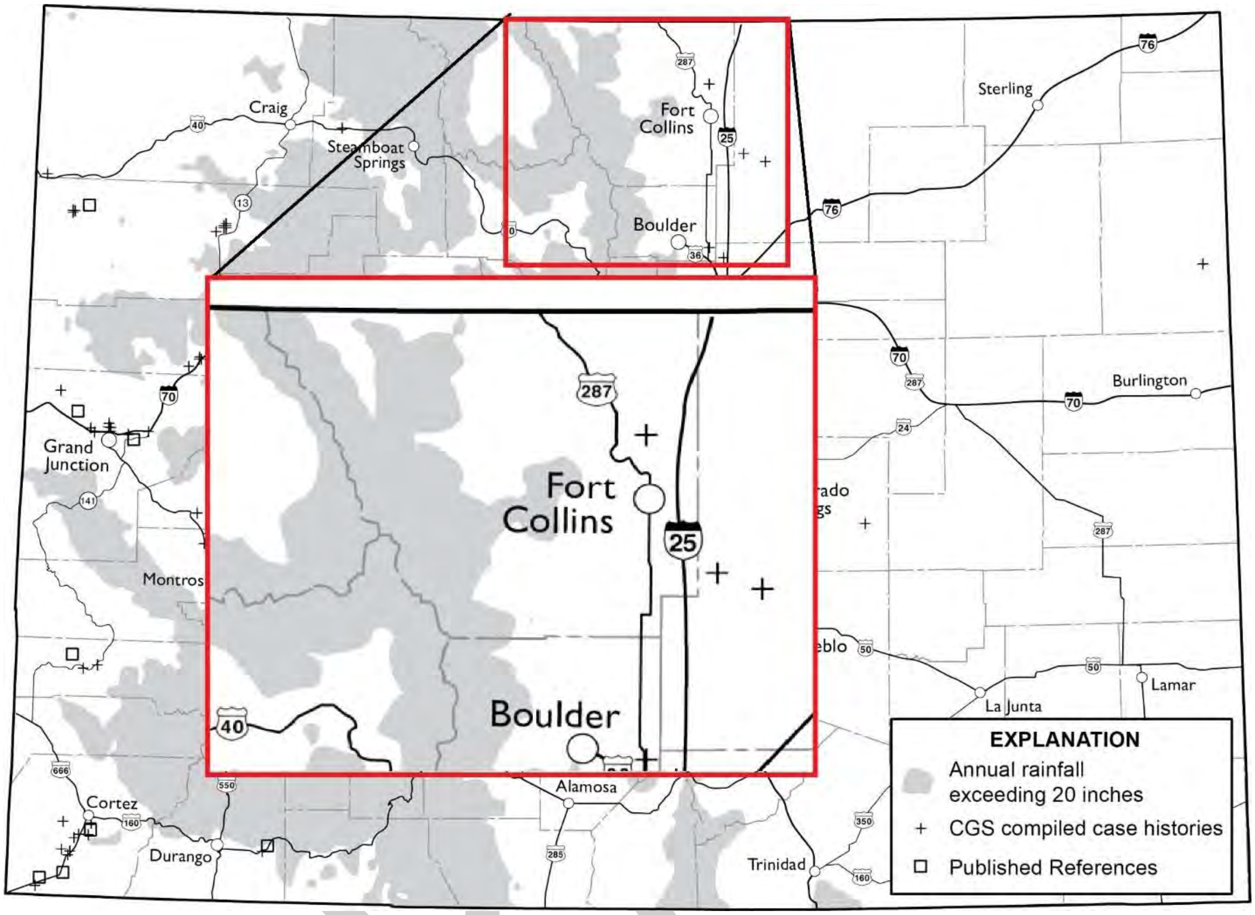
The erosion and deposition of soil by storm events, flooding, wildfires, irrigation, runoff, and traffic/snow removal operations is a regular occurrence in Larimer County. The deposited sediments in ditches and culverts require ongoing maintenance and routine cleaning.

In the 2013 flood events, material was eroded, moved, and deposited along riverbanks and riverbeds throughout Larimer County, including the Cache la Poudre River, Big Thompson, Little Thompson, and Fossil Creek. Mud and silt deposited during the 2013 floods presented numerous public health hazards to public and private property. In addition, the deposited material was likely covering hazardous waste and contaminated material from leach-fields and septic tanks (Board of Commissioners of Larimer County 2014).

Historically undermined areas are shown below in Figure 4-30. Historically undermined areas are prone to subsidence.

There is one collapsible soil event history north of Fort Collins as shown in Figure 4-29.

Figure 4-29 Collapsible Soil Case Histories in Larimer County



Source: Colorado Geological Survey

Location

A Significant portion of Larimer County is at risk from soil hazards, including the most populated jurisdictions in the southeastern portion of Larimer County. Additionally, due to the number of river and stream systems, soil erosion is likely throughout the County from runoff, flooding and wildfire events.

Figure 4-30 shows areas of historic (pre-1970s) coal and clay mining activity and potentially undermined areas throughout Colorado. This map reflects the extent of mining outlines. The dataset does not include hard rock mineral mines, prospects, etc. Due to incomplete historic mine records and survey errors, the dataset should NOT be considered complete or perfectly accurate. The dataset was developed from multiple sources and digitized by the Colorado Geological Survey in 2008.

There are hundreds of abandoned underground coal mines scattered throughout Colorado that present potential subsidence hazards to structures and surface improvements. The Colorado Geological Society (CGS) operates the Colorado Mine Subsidence Information Center (MSIC) which is the repository for all the known existing maps of inactive or abandoned coal mines in the state.

Where there are historic underground mines, special hazards exist such as subsidence because material has removed that supports the ground above. The overburden material above these underground mined areas change over time causing the underground mined areas to give out and fill in causing a surface level subsidence.

Figure 4-30 Historically Undermined Areas – Larimer County

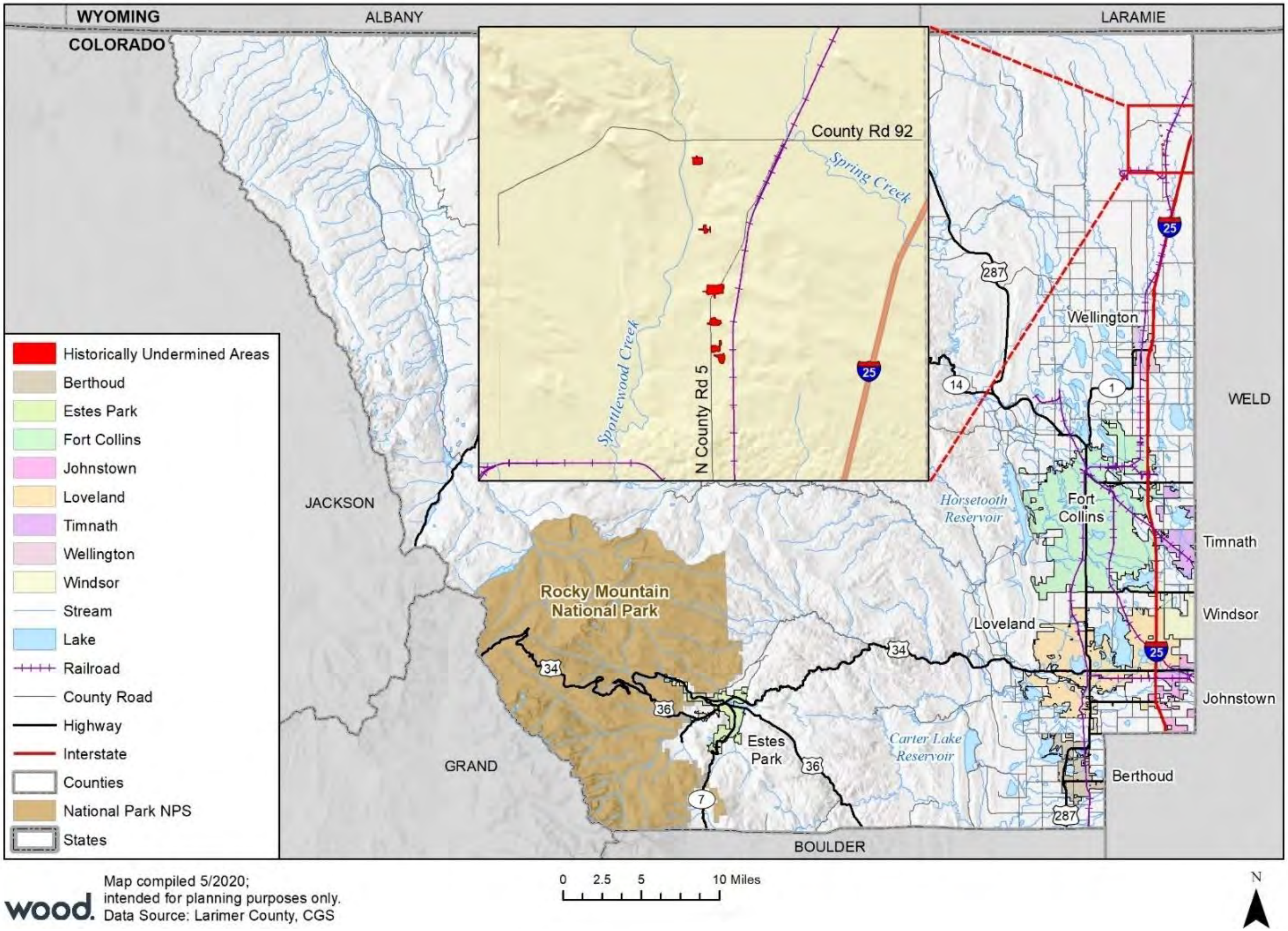
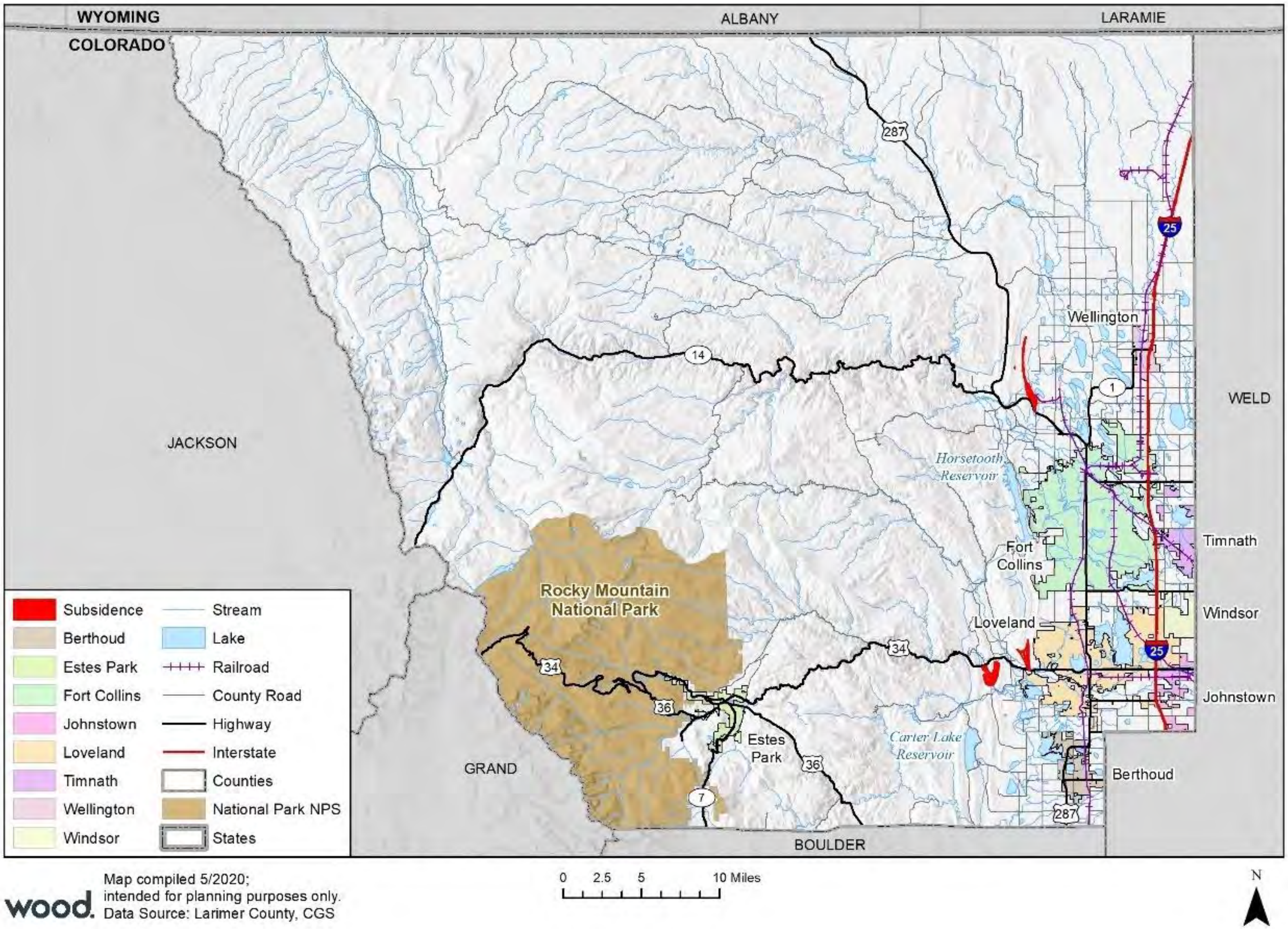


Figure 4-31 Potential Land Subsidence Areas – Larimer County



Undermined areas are areas of potential subsidence. In addition to the undermined areas, the Colorado Geological Survey has mapped out other potential subsidence areas based on geologic and soil composition and history as well as hydrologic features (Colorado Geological Survey 2020).

Subsidence tends to be most problematic along the Colorado Front Range, Western Slope, and in the central mountains near Eagle and Garfield Counties. Figure 4-31 presents a map identifying the locations within Larimer County that have potential for subsidence. The highest potential for land subsidence is in the eastern region of the County west of the urban area.

Collapsible Soils

Collapsible soils underly most of the populated jurisdictions in the County.

Figure 4-30 presents a map identifying the locations within Larimer County that have potential for collapsible soil. The highest potential for collapsible soil is in the southeastern region of the County including areas in and around Loveland, Fort Collins, and Berthoud.

Expansive Soils

Expansive soils underly most of the highest populated jurisdictions in the county in the southeast. Figure 4-33 presents a map identifying the locations within Larimer County that have potential for expansive soil. The highest potential areas for moderately expansive soil are in the eastern region of the County including areas in and around Loveland, Fort Collins, and Berthoud.

Figure 4-32 Potential Collapsible Soils Areas – Larimer County

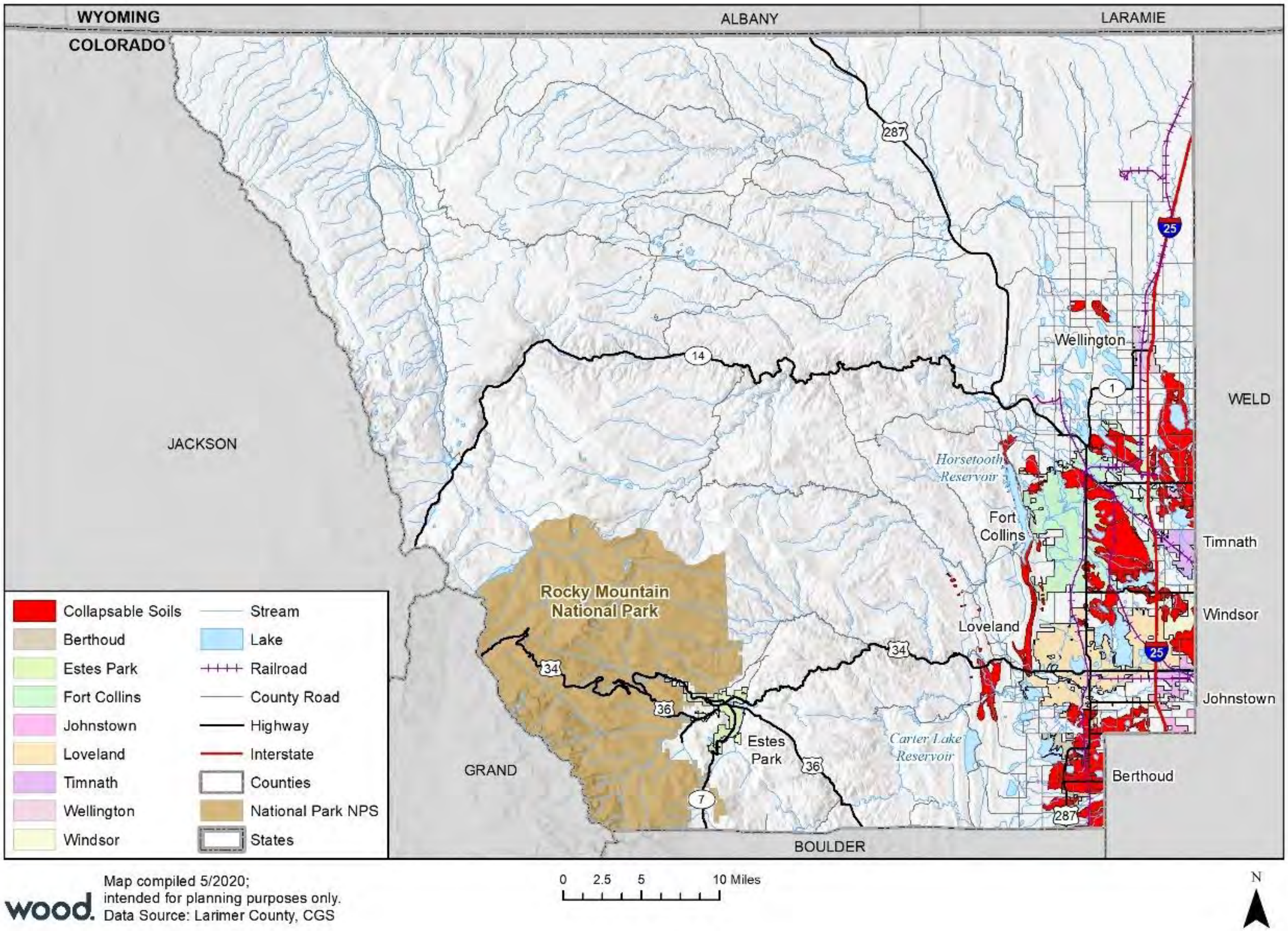
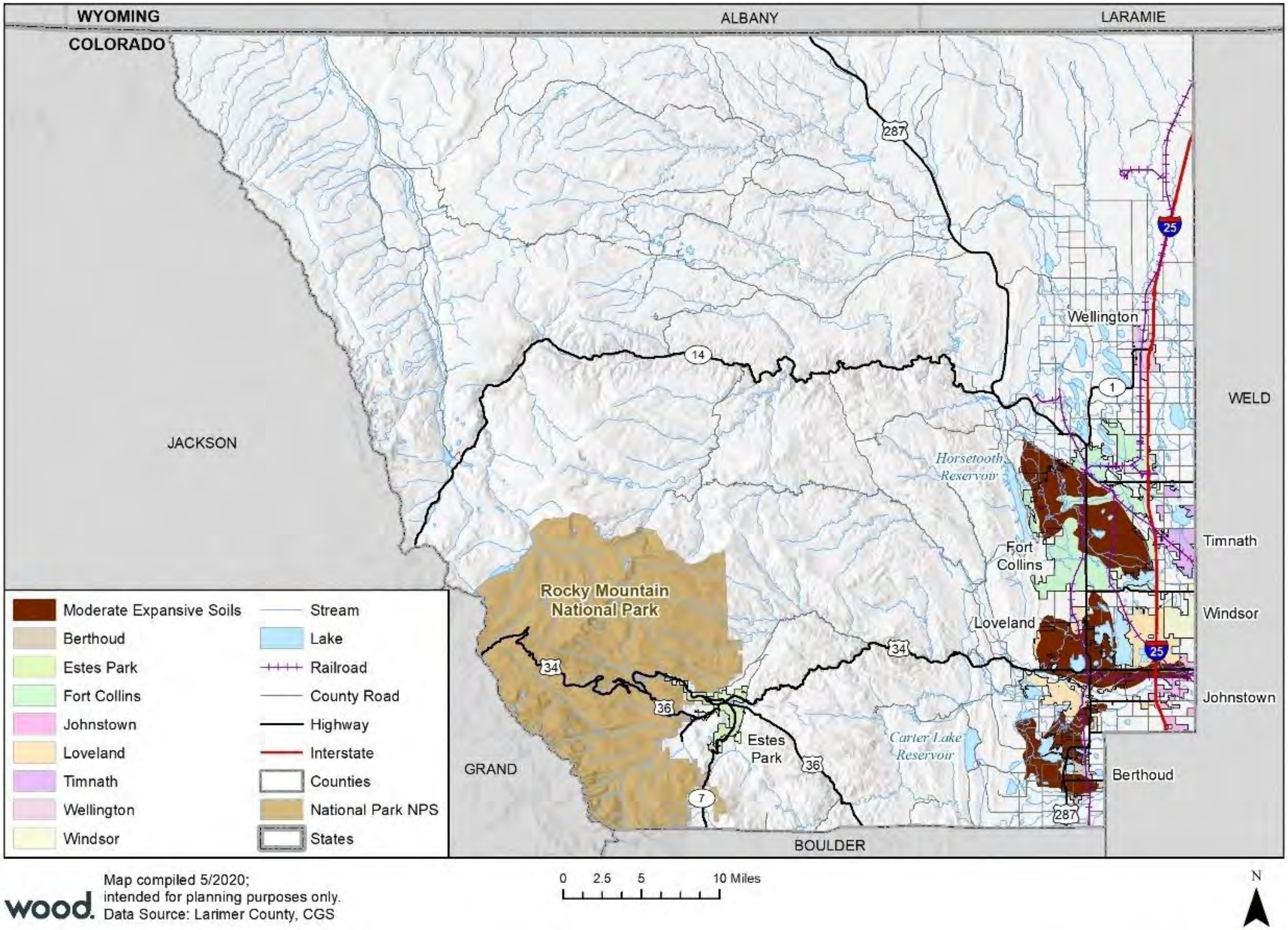


Figure 4-33 Potential Expansive Soils Areas – Larimer County



Magnitude/Severity

Damages from soil hazards can be classified as cosmetic, functional, or structural. Cosmetic damages refer to slight problems where only the physical appearance of a structure is affected (e.g., cracking in plaster or drywall). Functional damage refers to situations where the use of a structure has been impacted due to subsidence. Structural damages include situations where entire foundations require replacement due to subsidence-caused cracking of supporting walls and footings.

Most soil hazards have weeks to months of warning time. Subsidence has a shorter warning time (i.e., hours to days). However, these events can be ongoing over months or years, continuing to cause damage until mitigated.

Erosion / Deposition

The warning time for erosion and deposition is weeks to years, unless it is associated with a severe storm event such as the 2013 floods, then it would be days. The duration of the erosion and deposition are long lasting and often permanent changes to the landscape, unless intervention involves movement of deposited material and reclamation of eroded areas.

Land Subsidence

Land subsidence affects localized areas but can affect the region if it affects transportation corridors. Land subsidence can occur rapidly with only an hour or two of warning due to sinkholes, the collapse of underground mines, or during an earthquake. Subsidence can also take place slowly, becoming evident over the time span of many years. Subsidence events can pose significant risks to health, safety, and local agricultural economies and interruption to transportation, and other services.

Collapsible Soils

Collapsible soil, like land subsidence, affects localized areas but can affect the region if it affects transportation corridors such as a highway or roadway. Soils that tend to collapse and settle are those characterized by low-density materials that shrink in volume when they become wet and/or are subjected to weight from development. Collapsible soil events can occur rapidly with only an hour or two of warning. The effects of collapsible soil can last months to years for the small area of collapse. Collapsible soil events can occur in a remote field or near a residential community or roadway. The location of the event determines its effects and can pose significant risks to health, safety, and local agricultural economies and interruption to transportation, and other services.

Expansive Soils

Expansive soil occurs slowly over time, typically over months to years. Expansive soils affect localized areas such as foundations of a building or a section of a roadway. If expansive soils affect a transportation corridor, then it would affect the region to a greater extent. The effects are long lasting, often years, unless human intervention corrects or compensates for expansive soil properties.

Probability of Future Occurrences

Due to a lack of data, it is difficult to accurately estimate the likelihood of future soil events. Anecdotally, these events tend to occur every few years overall.

Erosion / Deposition

It is likely that erosion and deposition will continue to slowly alter the landscape of Larimer County in the coming years. In the last 10 years major erosion and deposition of material in riverbanks and roadways along waterways only occurred during the 2013 floods. If another storm event of that magnitude happens, major erosion and deposition of material on roadways along waterways will occur again. In the semi-arid climate of Colorado, increases in seasonal precipitation, coupled with periods of prolonged drought, may accelerate processes of erosion.

Land Subsidence

It is probable that the eastern region of Larimer County will experience more frequent land subsidence hazards over time as a result of local climate change and expansion of development. It is important that Larimer County consider future mitigation actions that will address this hazard, particularly in rapidly growing areas west of Loveland and northwest of Fort Collins. In the past, major land subsidence has occurred in agricultural settings where ground-water has been pumped for irrigation.

Collapsible Soils

Although there is only one documented case of a damaging collapsible soil event in Larimer County, based on the potential collapsible soils data from the Colorado Geological Survey it is likely that minor cases will continue to occur. With local climate and changes and increased development, the probability of a collapsible soil event will increase.

Expansive Soils

The damaging effects of expansive soils over time will occur to a higher degree with local climate changes and increased development in these highly populated jurisdictions.

Climate Change Considerations

Changing climate conditions are expected to affect soil resources in many ways. During hot, dry years annual grasses that stabilize and protect topsoil often fail to germinate or do not grow well. This leaves soil surfaces highly vulnerable to erosion from wind and precipitation runoff. Without the availability of nutrient- rich topsoil, crops struggle to survive and flourish. As discussed previously, higher rates of erosion can have a profound effect on agricultural production and on the economies of rural areas of the county.

In areas where climate change results in decreased precipitation in the summer months and reduced surface-water supplies, communities are often forced to pump more ground water to meet their needs. In Colorado, the major aquifers are composed primarily of compressed clay and silt, soil types that are prone to compact when ground-water is pumped, increasing the chances of collapsing or subsidence.

Many soils and rocks have the potential to swell or expand based on a combination of its mineralogy and water content. The actual swelling of expansive soils will be caused by a change in the environment (e.g., water content, stress, chemistry, or temperature) in which the material exists. Since the 1950s, snow precipitation and duration of snowpack have both decreased while rising temperatures have increase rate of water evaporating into the air and earlier runoff, creating drier soil conditions in Colorado (EPA 2016). More extremes in climate conditions (e.g., wet-dry conditions), could potentially exacerbate the swelling of expansive soil issues in the future.

Vulnerability Assessment

People

There are no reported injuries or deaths to these soil hazards in Larimer County, and direct impacts on people are likely to be very minimal.

General Property

Buildings and infrastructure across the county may be vulnerable to the impacts of erosion and deposition. Although damage or losses to structures are typically minimal, there can be impacts with mitigation and maintenance costs, lost time, and minor structural damage.

Table 4-51 Improved Properties at Risk to Potential Land Subsidence within Larimer County

Jurisdiction	Property Type	Improved Parcels	Building Count	Improved Value	Contents Value	Total Value	Population
Unincorporated County	Agricultural	3	4	$1,619,160	$1,619,160	$3,238,320	
	Commercial	1	1	$84,100	$84,100	$168,200	
	Exempt	1	3	$898,976	$898,976	$1,797,952	
	Residential	41	43	$21,104,288	$10,552,143	$31,656,431	131
	Total	**46**	**51**	**$23,706,524**	**$13,154,379**	**$36,860,903**	**131**

Source: CGS, Larimer County Assessor's Office, Wood analysis.

There were 51 buildings throughout 46 parcels at risk to land subsidence within the County. The improved value of the buildings at risk is over $23 million dollars with the total value over $36 million dollars. The Land Subsidence hazard is only mapped in the Unincorporated County, no jurisdictions are at risk.

Table 4-52 Improved Properties at Risk to Potential Collapsible Soil within Larimer County

Jurisdiction	Property Type	Improved Parcels	Building Count	Improved Value	Content Value	Total Value	Population
Berthoud	Agricultural	7	9	$2,177,570	$2,177,570	$4,355,140	
	Commercial	187	218	$64,659,447	$64,659,447	$129,318,894	
	Exempt	24	156	$46,225,920	$46,225,920	$92,451,840	
	Industrial	11	11	$10,360,100	$15,540,150	$25,900,250	
	Mobile Home	8	193	$11,195,282	$5,597,642	$16,792,924	483
	Multiple Unit	17	39	$9,385,600	$9,385,600	$18,771,200	
	Residential	2,722	2,798	$834,403,320	$417,201,663	$1,251,604,983	6,995
	Total	**2,976**	**3,424**	**$978,407,239**	**$560,787,992**	**$1,539,195,231**	**7,478**
Fort Collins	Agricultural	13	18	$3,865,281	$3,865,281	$7,730,562	
	Commercial	1,038	2,374	$1,122,346,966	$1,122,346,966	$2,244,693,932	
	Exempt	263	1,413	$1,052,873,595	$1,052,873,595	$2,105,747,190	
	Industrial	13	22	$107,811,855	$161,717,782	$269,529,637	
	Mobile Home	8	567	$52,582,225	$26,291,112	$78,873,337	1,395
	Multiple Unit	228	2,864	$828,929,415	$828,929,415	$1,657,858,830	
	Residential	21,504	22,244	$8,209,609,790	$4,104,804,969	$12,314,414,759	54,720
	Total	**23,067**	**29,502**	**$11,378,019,127**	**$7,300,829,120**	**$18,678,848,247**	**56,115**
Loveland	Agricultural	1	1	$6,660	$6,660	$13,320	
	Commercial	9	18	$37,127,444	$37,127,444	$74,254,888	
	Exempt	3	100	$9,873,091	$9,873,091	$19,746,182	
	Mobile Home	2	277	$22,378,807	$11,189,404	$33,568,211	662

Jurisdiction	Property Type	Improved Parcels	Building Count	Improved Value	Content Value	Total Value	Population
	Multiple Unit	2	243	$63,599,996	$63,599,996	$127,199,992	
	Residential	998	1,001	$299,489,955	$149,744,974	$449,234,929	2,392
	Total	**1,015**	**1,640**	**$432,475,953**	**$271,541,569**	**$704,017,522**	**3,054**
Timnath	Agricultural	1	1	$20,956	$20,956	$41,912	
	Exempt	2	2	$704,246	$704,246	$1,408,492	
	Residential	324	325	$170,144,636	$85,072,313	$255,216,949	1,079
	Total	**327**	**328**	**$170,869,838**	**$85,797,515**	**$256,667,353**	**1,079**
Windsor	Commercial	89	99	$47,874,331	$47,874,331	$95,748,662	
	Exempt	5	5	$8,054,765	$8,054,765	$16,109,530	
	Industrial	1	1	$954,200	$1,431,300	$2,385,500	
	Residential	924	927	$441,890,614	$220,945,315	$662,835,929	2,605
	Total	**1,019**	**1,032**	**$498,773,910**	**$278,305,711**	**$777,079,621**	**2,605**
Unincorporated	Agricultural	226	265	$105,480,470	$105,480,470	$210,960,940	
	Commercial	25	31	$31,296,671	$31,296,671	$62,593,342	
	Exempt	21	88	$63,442,500	$63,442,500	$126,885,000	
	Industrial	4	4	$3,688,448	$5,532,672	$9,221,120	
	Mobile Home	31	436	$47,643,730	$23,821,864	$71,465,594	1,073
	Multiple Unit	3	19	$1,140,000	$1,140,000	$2,280,000	
	Residential	3,162	3,288	$1,402,014,166	$701,007,087	$2,103,021,253	8,088
	Total	**3,472**	**4,131**	**$1,654,705,985**	**$931,721,264**	**$2,586,427,249**	**9,161**
Grand Total		**31,876**	**40,057**	**$15,113,252,052**	**$9,428,983,171**	**$24,542,235,223**	**79,492**

Source: CGS, Larimer County Assessor's Office, Wood analysis.

There were 40,057 buildings throughout 31,876 parcels at risk to collapsible soil within the County. The improved value of the buildings at risk is over $15 billion dollars with the total value over $24 billion dollars. Fort Collins has the highest risk of all the jurisdictions with over $18 billion in total value.

Table 4-53 Improved Properties at Risk to Potential Expansive Soil within Larimer County

Jurisdiction	Property Type	Improved Parcels	Building Count	Improved Value	Content Value	Total Value	Population
Berthoud	Agricultural	3	4	$821,162	$821,162	$1,642,324	
	Commercial	95	118	$30,597,319	$30,597,319	$61,194,638	
	Exempt	23	119	$39,717,272	$39,717,272	$79,434,544	
	Industrial	1	1	$310,600	$465,900	$776,500	
	Mobile Home	6	189	$12,324,747	$6,162,374	$18,487,121	473
	Multiple Unit	10	31	$24,977,995	$24,977,995	$49,955,990	
	Residential	2,617	2,676	$803,591,127	$401,795,566	$1,205,386,693	6,690
	Total	**2,755**	**3,138**	**$912,340,222**	**$504,537,588**	**$1,416,877,810**	**7,163**

Jurisdiction	Property Type	Improved Parcels	Building Count	Improved Value	Content Value	Total Value	Population
Fort Collins	Agricultural	8	11	$3,880,055	$3,880,055	$7,760,110	
	Commercial	1,241	3,016	$1,581,987,128	$1,581,987,128	$3,163,974,256	
	Exempt	395	3,082	$1,329,824,514	$1,329,824,514	$2,659,649,028	
	Industrial	14	24	$124,354,664	$186,531,996	$310,886,660	
	Mobile Home	8	713	$61,804,881	$30,902,441	$92,707,322	1,754
	Multiple Unit	550	6,799	$1,577,356,935	$1,577,356,935	$3,154,713,870	
	Residential	30,104	31,128	$10,939,460,732	$5,469,730,460	$16,409,191,192	76,575
	Total	**32,320**	**44,773**	**$15,618,668,909**	**$10,180,213,529**	**$25,798,882,438**	**78,329**
Johnstown	Commercial	68	80	$185,195,377	$185,195,377	$370,390,754	
	Exempt	1	1	$1,239,800	$1,239,800	$2,479,600	
	Multiple Unit	3	13	$139,044,525	$139,044,525	$278,089,050	
	Total	**72**	**94**	**$325,479,702**	**$325,479,702**	**$650,959,404**	**0**
Loveland	Agricultural	4	7	$778,541	$778,541	$1,557,082	
	Commercial	917	1,773	$801,682,878	$801,682,878	$1,603,365,756	
	Exempt	162	1,580	$379,633,347	$379,633,347	$759,266,694	
	Industrial	19	30	$31,115,244	$46,672,865	$77,788,109	
	Mobile Home	12	625	$61,563,930	$30,781,965	$92,345,895	1,494
	Multiple Unit	281	1,744	$338,196,778	$338,196,778	$676,393,556	
	Residential	16,566	17,217	$4,936,521,147	$2,468,260,580	$7,404,781,727	41,149
	Total	**17,961**	**22,976**	**$6,549,491,865**	**$4,066,006,954**	**$10,615,498,819**	**42,642**
Unincorporated	Agricultural	93	107	$42,512,256	$42,512,256	$85,024,512	
	Commercial	56	78	$38,714,649	$38,714,649	$77,429,298	
	Exempt	25	186	$69,428,115	$69,428,115	$138,856,230	
	Industrial	2	2	$443,621	$665,432	$1,109,053	
	Mobile Home	25	1,091	$93,444,714	$46,722,357	$140,167,071	2,684
	Multiple Unit	4	11	$1,583,596	$1,583,596	$3,167,192	
	Residential	3,605	3,761	$1,333,944,705	$666,972,364	$2,000,917,069	9,252
	Total	**3,810**	**5,236**	**$1,580,071,656**	**$866,598,769**	**$2,446,670,425**	**11,936**
Grand Total		**56,918**	**76,217**	**$24,986,052,354**	**$15,942,836,542**	**$40,928,888,896**	**140,070**

Source: CGS, Larimer County Assessor's Office, Wood analysis.

There were 76,217 buildings throughout 56,918 parcels at risk to expansive soil within the County. The improved value of the buildings at risk is over $24 billion dollars with the total value over $40 billion dollars. Fort Collins has the highest risk of all the jurisdictions with over $25 billion in total value.

Critical Facilities and Infrastructure

There are several critical assets across Larimer County are vulnerable to erosion and deposition. As population growth brings new development into available land in the county, more inventory assets may become exposed to erosion and deposition, subsidence, and collapsible and expansive soil hazards.

The critical facility exposure analysis estimates that there are no critical facilities within subsidence risk areas. The critical facility exposure analysis estimates that there 151 critical facilities with potential collapsible soil hazards, as shown in Table 4-54. This includes 15 facilities in Berthoud, 99 in Fort Collins, 5 in Loveland, 1 in Windsor, and the remaining 31 in unincorporated areas.

Table 4-54 Critical Facilities with Potential Collapsible Soil Hazards

Jurisdiction	FEMA Lifeline	Count
Berthoud	Energy	1
	Food, Water, Shelter	5
	Health and Medical	2
	Miscellaneous	1
	Safety and Security	6
	Total	**15**
Fort Collins	Communications	9
	Energy	12
	Food, Water, Shelter	13
	Health and Medical	20
	Miscellaneous	3
	Safety and Security	41
	Transportation	1
	Total	**99**
Loveland	Energy	1
	Food, Water, Shelter	2
	Health and Medical	1
	Safety and Security	1
	Total	**5**
Windsor	Energy	1
	Total	**1**
Unincorporated	Communications	1
	Food, Water, Shelter	19
	Health and Medical	3
	Safety and Security	8
	Total	**31**
	Grand Total	**151**

Source: CGS, Cascarta, Larimer County, Wood analysis.

The critical facility exposure analysis estimates that there 283 critical facilities with potential expansive soil hazards, as shown in Table 4-55. This includes 14 facilities in Berthoud, 171 in Fort Collins, 3 in Johnstown, 71 in Loveland, and the remaining 24 in unincorporated areas.

Table 4-55 Critical Facilities with Potential Expansive Soil Hazards

Jurisdiction	FEMA Lifeline	Count
Berthoud	Food, Water, Shelter	6
	Health and Medical	2
	Miscellaneous	1
	Safety and Security	5
	Total	**14**
Fort Collins	Communications	11
	Energy	20
	Food, Water, Shelter	46
	Hazardous Material	2
	Health and Medical	23
	Miscellaneous	9
	Safety and Security	59
	Transportation	1
	Total	**171**
Johnstown	Energy	1
	Health and Medical	2
	Total	**3**
Loveland	Communications	2
	Energy	6
	Food, Water, Shelter	23
	Health and Medical	8
	Miscellaneous	5
	Safety and Security	27
	Total	**71**
Unincorporated	Communications	3
	Energy	3
	Food, Water, Shelter	7
	Safety and Security	11
	Total	**24**
	Grand Total	**283**

Source: CGS, Cascarta, Larimer County, Wood analysis.

Economy

The economic cost of soil hazards is typically minor in the short term, although over time they can add up to significant impacts.

Historic, Cultural and Natural Resources

Erosion and deposition and associated collapsible and expansive soils are a natural environmental process. Nonetheless they have the potential to alter the landscape and cause damages to historic and cultural resources.

Land Use and Development Trends

Rapid and sustained population growth across Colorado and the Front Range has contributed to increasing trends in erosion/deposition hazard risk, exposure, and vulnerability across Larimer County. Larimer County and the surrounding areas are rich in natural resources and the continued development of industries related to these natural resources is a distinct possibility.

As of 2018, more than 87% of Larimer County's population lives in jurisdictions that have either moderately expansive soils or collapsible soils. Based on past and projected population growth, it is very likely that future development will take place on erosion-prone soils. As development pressures continue in un-developed areas of the County, vulnerability to soil hazards in those areas is likely to increase.

Typically, the process of erosion does not limit land use, especially if efforts are made to minimize it. Erosion impacts can be reduced and controlled by surface drainage management, re-vegetation or disturbed lands, controlling stream-carried eroded materials in sediment catchment basins, and riprapping of erosion-prone stream banks (especially adjacent to structures). Ground modification and structural solutions can help mitigate the threats of localize erosion and deposition. Proper drainage and water management are also important to prevent increasing vulnerability to erosion and deposition hazards.

Continued water and mineral resource extraction have the potential to exacerbate erosion/deposition and geologic hazards such as subsidence, collapsible soils, and expansive soils further and planning efforts should remain pro-active towards assessing changing geologic hazard risks.

In developments since 1999, engineered footing and foundation systems are used in areas of shrink/swell or expansive soils (Larimer County 1999).

Risk Summary

- Significant erosion and deposition of material resulted from the 2013 floods. The deposited mud and silt damaged public and private property including roadways and bridges.
- There is one collapsible soil event north of Fort Collins.
- There are known areas of undermined areas with potential subsidence in northeastern Larimer County north of Wellington near N County Rd 5 and County Rd 92.
- There are areas of potential subsidence west of Loveland and northwest of Fort Collins that would increase in risk as more development reaches these areas.
- The more densely populated southeastern portion of the county is more susceptible to the impacts of collapsible soils and moderately expansive soils.
- Related hazards: earthquake, wildfire, spring/summer storms, floods.

4.3.10 Spring/Summer Storm

Hazard	Frequency	Spatial Extent	Severity	Overall Significance
Thunderstorm, Hail, Windstorm, Lightning	Highly Likely	Extensive	Critical	High

Description

Spring is the season of the year that involves the transition period from winter to summer. As a result of this transition period, temperatures can swing back and forth causing extreme weather changes. Severe weather events occurring in the spring include heavy snow, thunderstorms, lightning, hail, strong winds, tornadoes and flooding. Summer storms consist typically of thunderstorms, lightning, and hail.

Lightning strikes can be hazardous under the right conditions and locations. Large hail can damage crops, dent vehicles, break windows, and injure or kill livestock, pets, and people. Strong winds can take down trees and damage property and infrastructure.

The typical thunderstorm is 15 miles in diameter and lasts an average of 30 minutes. Of the estimated 100,000 thunderstorms that occur each year in the United States, about 10 percent are classified as severe. The National Weather Service considers a thunderstorm severe if it produces hail at least 3/4 inch in diameter, winds of 58 MPH or stronger, or a tornado. Every thunderstorm needs three basic components: (1) moisture to form clouds and rain, (2) unstable air which is warm air that rises rapidly, and (3) lift, which is a cold or warm front capable of lifting air to help form thunderstorms.

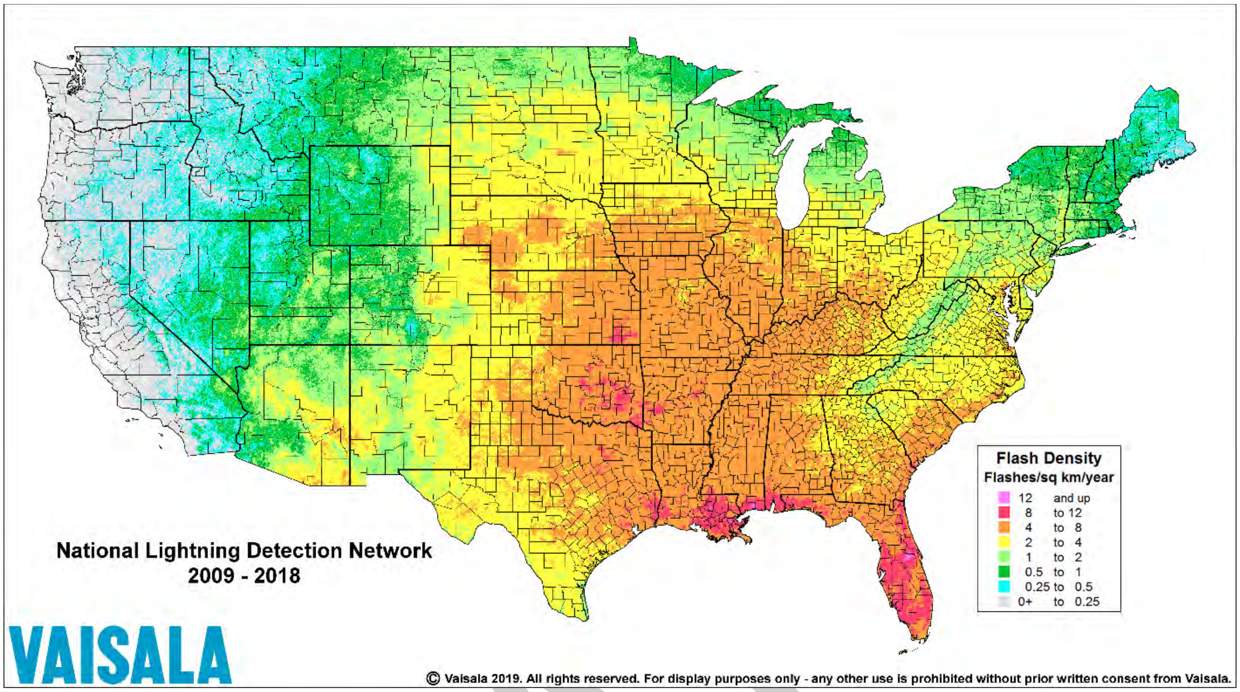
Thunderstorms can occur during strong winds, heavy rains, sleet, hail, snow, or even no precipitation at all. Thunderstorms are characterized by the presence of lightning and its audio effect on the Earth's atmosphere. Thunderstorms experience fast upward movement of warm air that contains moisture. When the air moves upwards it begins to cool and condense forming cumulonimbus clouds. Once the air cools enough to reach saturation water droplets and ice form and begin to fall. These falling droplets and ice create a downdraft of cold air, in turn causing rain, strong winds, and occasionally fog.

There are four types of thunderstorms: supercell, multicell lines, multicell cluster, and single cell. The strongest type of thunderstorm is the super cell and is associated with severe weather. Supercells are deep constantly rotating current of rising air called a mesocyclone.

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

Figure 4-34 depicts average cloud-to-ground lightning incidence in the US (or lightning flash densities) between 2009 and 2018.

Figure 4-34 Average Lightning Flash Density in the U.S.

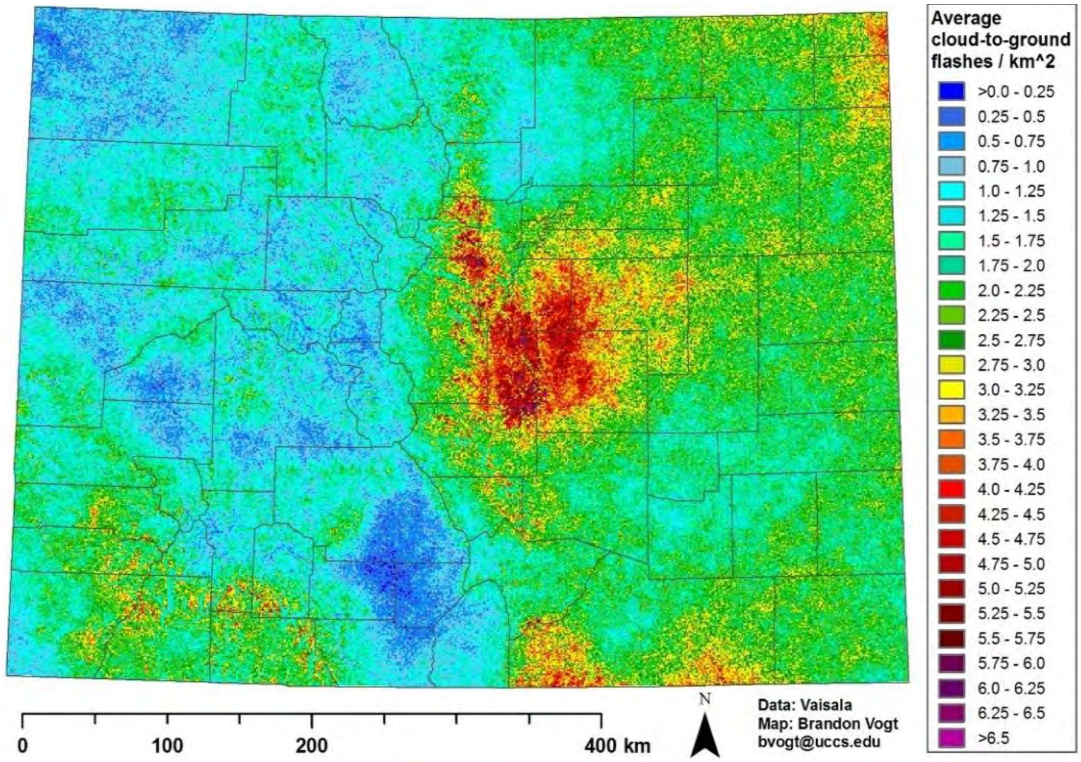


Source: https://www.weather.gov/pub/lightningFlashDensityMaps

Although the state of Colorado ranks 32nd in terms of its cloud-to-ground lightning flash densities between 1997-2012, the state 7th in the U.S. for lightning fatalities between 2008 and 2018. Between 1959 and 2019 Colorado ranks 4th in the Nation.

Figure 4-35 shows lightning flash densities for the State of Colorado for the years 1996 through 2016. Produced by Dr. Bandon Vogt from the University of Colorado, Colorado Springs using data from Vaisala, the image is the result of contouring over 8 million cloud-to-ground lightning flashes for the State of Colorado and averaging annually. The result of the analysis is a picture of average lightning flashes/km2 per year from 1996 through 2016 (the year 2000 was not included in the dataset).

Figure 4-35 Colorado Lightning Flash Density Map



Source: NWS Denver/Boulder Weather Forecast Office

In general, the flash density map shows a wide range of values across the State of Colorado, ranging from less than 0.5 flashes/year/km2 over the south central portion of the state to over 6.5 flashes/year/km2 over the east central part of the state. The higher density of lightning flashes located in the central area of the state is driven by the topography of the area. Where the higher terrain of the Plains intersects with the Rocky Mountains conditions are ripe for lightning events. Here, moist air from lower altitudes initiates and sustains convection systems as they move off of the mountain slopes, generating thunderstorms.

Hail is precipitation that is formed when updrafts in thunderstorms carry raindrops upward into extremely cold areas of the atmosphere. The super cooled raindrops grow into balls of ice, which pose a hazard to property, people, livestock, and crops when they fall back to the earth.

Severe Wind events typically develop with strong pressure gradients and gusty frontal passages. The closer and stronger two systems (one high pressure, one low pressure) are, the stronger the pressure gradient, and therefore, the stronger the winds are.

Although severe wind events often garner less attention in the local media than tornadoes do, damaging straight line winds (or downbursts) can injure and kill animals and humans. Straight-line winds, which can cause more widespread damage than a tornado, occur when air is carried into a storm's updraft, cools rapidly, and comes rushing to the ground. Cold air is denser than warm air, and therefore, wants to fall to the surface. On warm summer days, when the cold air can no longer be supported up by the storm's updraft, or when an exceptional downdraft develops, the air crashes to the ground in the form of strong winds. These winds are forced horizontally when they reach the ground and can cause significant damage. These types of strong winds can also be referred to as straight-line winds. Downbursts with a diameter of less than 2.5 miles are called microbursts and those with a diameter of 2.5 miles or greater are called macrobursts. A "derecho" is a series of downbursts associated with a line of thunderstorms.

Past Occurrences

Hail

There have been 554 hail events reported in Larimer County between 1955 and 2019. Of the 554 incidents, 5 reported property damages totaling $1,455,000 and 5 reported events of crop damages totaling $1,580,000 A review of USDA Risk Management Agency Crop Indemnity Reports shows in the past 12 years (2007-2019), the county has lost 15,857.35 acres of insured crop due to hail and $4,483,790.48 in indemnity payments.

The largest hail size recorded in the Database is 4.5 inches taking place on July 30, 1979 in the City of Fort Collins but does not include a narrative or impacts. According to the HMPC, this event did result in impacts including property damages estimated to be $30 million (1979 dollars), as well as several injuries and one causality of a 3 month baby while her mom was looking for shelter from the storm.

The events with damages to property and crops in Larimer County are only recorded for 1994 and 2009 in the Storm Events Database, these events are summarized in Table 4-56. All hail events between 1955 and 2018 are shown in Figure 4-36. Based on the historic data showing hazardous impacts on the county, there is a great potential for hail events to occur at any given time during the spring and summer seasons.

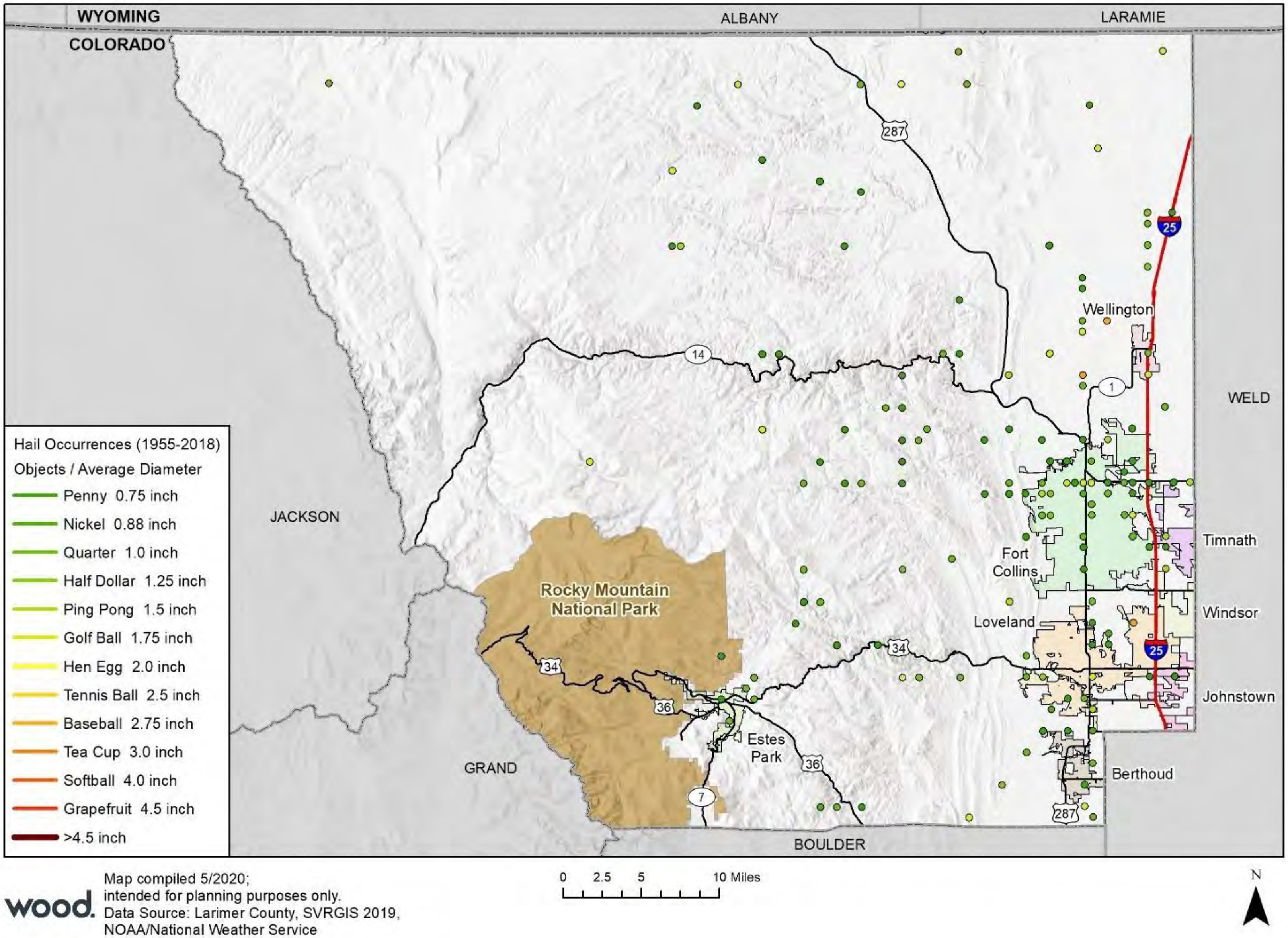
Note, the July 1994 event took place across jurisdictions. The damages listed represent the impacts specific to that location and the event overall.

Table 4-56 Damaging Hail Events Recorded in Larimer County, 1955-2019

Date	Location	Hail Size Diameter (in)	Damage to Property	Damage to Crops
7/16/1994	Virginia Dale	2	$500,000	$50,000
	Wellington	2.75	$500,000	$500,000
	Fort Collins	1.5	$50,000	$5,000
	Loveland	1.75	$5,000	$0
8/10/1994	Laporte	2	$400,000	$0
6/22/2009	Wellington	1	$0	$25,000
7/20/2009	DRAKES	2	$0	$1,000,000
Total:			**$1,455,000**	**$1,580,000**

Source: NOAA; NCEI Storm Events Database

Figure 4-36 Historical Hail Events (1955 – 2018) – Larimer County



Thunderstorm Wind

According to NOAA's Storm Events Database there have been 17 injuries and 2 deaths in Larimer County due to thunderstorm wind. There have been 117 thunderstorm wind events reported in Larimer County between 1960 and 2018. Of the 117 incidents, only ten reported any injuries or damages, totaling 2 deaths, 17 injuries, and $51,500 in property damage; no crop losses were reported. Based on the historic data showing hazardous impacts on the county, there is a great potential for wind events to occur at any given time.

Table 4-57 Damaging Historical Thunderstorm Wind Events in Larimer County

Date	Location	Deaths	Injuries	Property Damage
5/28/1993	Punkin Center	0	0	$50,000
8/15/1993	Fort Collins	0	0	0
9/7/1993	Loveland	0	0	0
5/28/1994	Not available	0	8	$500
5/28/1994	Loveland	0	1	$500
6/6/1994	Loveland	0	0	$500
7/28/1996	Ft Collins	0	2	0
8/28/2001	Loveland	0	2	0
7/2/2005	Loveland	2	4	0
6/26/2009	Ft Collins/Loveland	0	0	$25,000
Total		**2**	**17**	**$76,500**

Source: NOAA; NCEI Storm Events Database

Windstorm

Data from NOAA's NCEI Storm Events Database was used to complete the risk assessment for straight-line wind events in Larimer County. These events are defined as winds with speeds of at least fifty knots (58 mph), or winds of any speed (non-severe winds under fifty knots) that result in a fatality, injury and/or damage. The database shows 262 such events in Larimer County from 1996 through 2019. The average windspeed of these events (where known) was 73 knots; nine events had windspeeds recorded at 100-110 knots. Only 18 events during that time period resulted in any reported damage or injuries, totaling 11 injuries, over $13 million in property damage, and $50,000 in crop damage. Table 4-58 summarizes those 18 damaging severe wind events.

Table 4-58 Damaging Severe Wind Events in Larimer County (1996 – 2019)

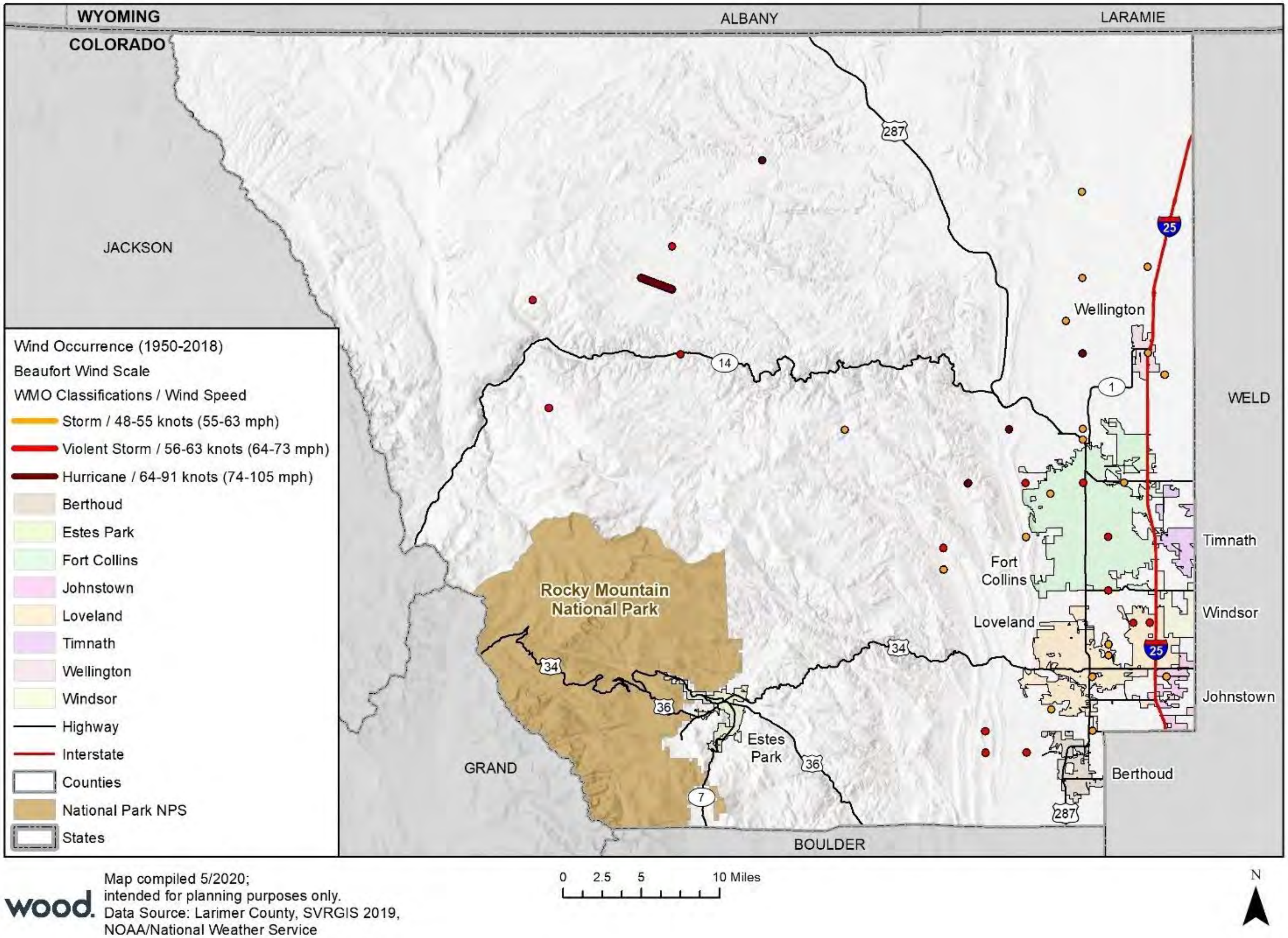
Date	Magnitude (Knots)	Deaths	Injuries	Property Damage	Crop Damage
10/29/1996	87	0	0	$5,200,000	0
4/8/1999	100	0	0	$7,200,000	0
12/17/2000	52	0	1	0	0
5/20/2001	61	0	0	$36,000	0
10/29/2003	62	0	0	$979,000	0
11/27/2007	69	0	1	0	0
8/2/2008	52	0	6	0	0
12/25/2008	70	0	0	$50,000	0
12/31/2008	77	0	0	$25,000	0
1/1/2009	77	0	0	$25,000	0
1/7/2009	65	0	0	$5,000	0
1/27/2009	87	0	0	$25,000	0
5/11/2009	65	0	1	0	0

Date	Magnitude (Knots)	Deaths	Injuries	Property Damage	Crop Damage
5/4/2010	58	0	0	$10,000	$50,000
6/16/2011	43	0	1	0	0
11/12/2011	45	0	1	0	0
11/17/2013	67	0	0	$10,000	0
2/21/2017	61	0	0	$200,000	0
TOTAL		**0**	**11**	**$13,765,000**	**$50,000**

Source: NOAA; NCEI Storm Events Database

Based on data provided by NCEI's Storm Events Database, 262 severe wind events have occurred in Larimer County between 1996 and 2019. There have been no deaths, 11 injuries, $13,765,000 in property damage, and $50,000 in crop damage. Figure 4-37 provides a geospatial view of these historical severe wind events in Larimer County between 1950 and 2018. Severe winds affect all portions of the County.

Figure 4-37 Larimer County – Historical High Wind Events



Lightning

According to the NCEI Storm Events Database there have been 46 lightning events in Larimer County between 1996 and 2019. Note that these are only events reported to NCEI and should not be considered to be comprehensive. There have been 56 reported injuries, 9 deaths, $217,000 worth of property damage, and $15,000 worth of crop damage. On July 11th and 12th, 2014 two people were killed by separate lightning strikes in Rocky Mountain National park along Trail Ridge Road. In addition to the two deaths, 21 people were taken to the hospital because of lightning strikes. The national park outside of the Town of Estes Park attracts about 3 million visitors per year. Due to its high elevations and frequent thunderstorms in the summer, there is a high risk of lightning strikes. The events are summarized in Table 4-59. Based on the historic data showing hazardous impacts on the county, there is a great potential for lightning events to occur at any given time, especially during the summer months when county residents are likely to be working and playing outdoors.

Table 4-59 Lightning Strikes in Larimer County

Date	Location	Deaths	Injuries	Property Damage	Crop Damage
5/9/1996	Loveland	0	0	0	0
6/4/1996	Fort Collins	0	1	0	0
6/10/1996	Fort Collins	0	0	$10,000	0
7/23/1996	Loveland	0	2	0	0
8/2/1996	Fort Collins	0	0	$50,000	0
8/15/1996	Red Feather Lakes	0	0	0	0
8/16/1996	Rustic	0	0	0	0
10/16/1996	Fort Collins	0	3	0	0
6/2/1997	Ft Collins	0	0	0	0
6/14/1997	Loveland	0	0	$4,000	0
5/22/1998	Loveland	0	0	0	0
8/9/1998	Estes Park	0	6	0	0
6/19/1999	Livermore	0	1	0	0
7/21/1999	Estes Park	1	2	0	0
8/7/1999	Estes Park	1	2	0	0
9/1/1999	Ft Collins	0	0	0	0
5/17/2000	Ft Collins	0	0	0	0
10/3/2000	Estes Park	0	2	0	0
8/15/2001	Loveland	1	0	0	0
4/17/2003	Ft Collins	0	0	0	0
5/31/2003	Loveland	1	1	0	0
7/26/2003	Poudre Park	0	1	0	0
8/3/2003	Red Feather Lakes	0	1	0	0
8/18/2003	Ft Collins/Loveland	0	0	0	0
4/19/2005	Ft Collins	0	0	0	0
7/3/2005	Loveland	0	0	0	0
7/3/2005	Loveland	0	9	0	0
5/29/2007	Ft Collins	0	0	$2,000	0
5/29/2007	Ft Collins	0	0	$35,000	0
10/13/2007	Ft Collins	0	0	$1,000	0
6/3/2008	Ft Collins	0	0	$4,000	0

Date	Location	Deaths	Injuries	Property Damage	Crop Damage
7/8/2008	Deer Ridge	0	3	0	0
7/24/2008	Ft Collins	2	0	0	0
7/20/2010	Berthoud	0	0	0	$10,000
7/22/2010	Loveland	0	0	$100,000	0
5/20/2011	Ft Collins	0	0	$1,000	0
6/16/2011	Ft Collins	0	0	$5,000	0
7/6/2011	Estes Park	0	0	$5,000	0
7/5/2013	Ft Collins	0	0	0	$5,000
7/18/2013	Deer Ridge	0	1	0	0
7/18/2013	Wellington	0	9	0	0
7/11/2014	Deer Ridge	1	7	0	0
7/12/2014	Deer Ridge	1	4	0	0
5/7/2016	Ft Collins	0	0	0	0
8/19/2016	Red Feather Lakes	1	0	0	0
8/17/2019	Estes Park	0	1	0	0
Total:		**9**	**56**	**$217,500**	**$15,000**

Source: NOAA; NCEI Storm Events Database

The National Weather Service (NWS) also records lightning events in Colorado. According to NWS records 76 total injuries and 10 deaths due to lightning events between 1982 and 2019.

Table 4-60 Larimer County Lightning Causalities

Date	Deaths	Injuries
8/17/1982	0	1
6/13/1988	0	1
6/22/1988	0	2
7/4/1988	0	1
8/11/1989	0	1
9/19/1989	0	1
6/16/1991	0	2
8/9/1991	0	1
6/24/1992	0	1
6/28/1992	1	1
5/19/1994	0	1
8/2/1994	0	1
8/2/1994	0	3
8/13/1994	0	2
6/4/1996	0	1
7/23/1996	0	2
10/16/1996	0	3
8/9/1998	0	6
6/19/1999	0	1
7/21/1999	1	2
8/7/1999	1	2
10/3/2000	0	2
8/15/2001	1	0
5/31/2003	1	1

Date	Deaths	Injuries
7/26/2003	0	1
8/3/2003	0	1
7/3/2005	0	9
7/8/2008	0	3
7/24/2008	2	0
7/18/2013	0	1
7/18/2013	0	9
7/11/2014	1	7
7/12/2014	1	4
5/7/2016	0	1
8/19/2016	1	0
8/17/2019	0	1
Total	**10**	**76**

Source: National Weather Service, Pueblo Office

Location

Extensive - Thunderstorms are generally expansive in size. The entire county is susceptible to any of the effects of a severe thunderstorms, including hail, lightning, and severe winds. Figure 4-36 and Figure 4-37 shows the reported locations of hailstorms from 1955 to 2018 and severe wind events from 1950 to 2018, including the event magnitudes.

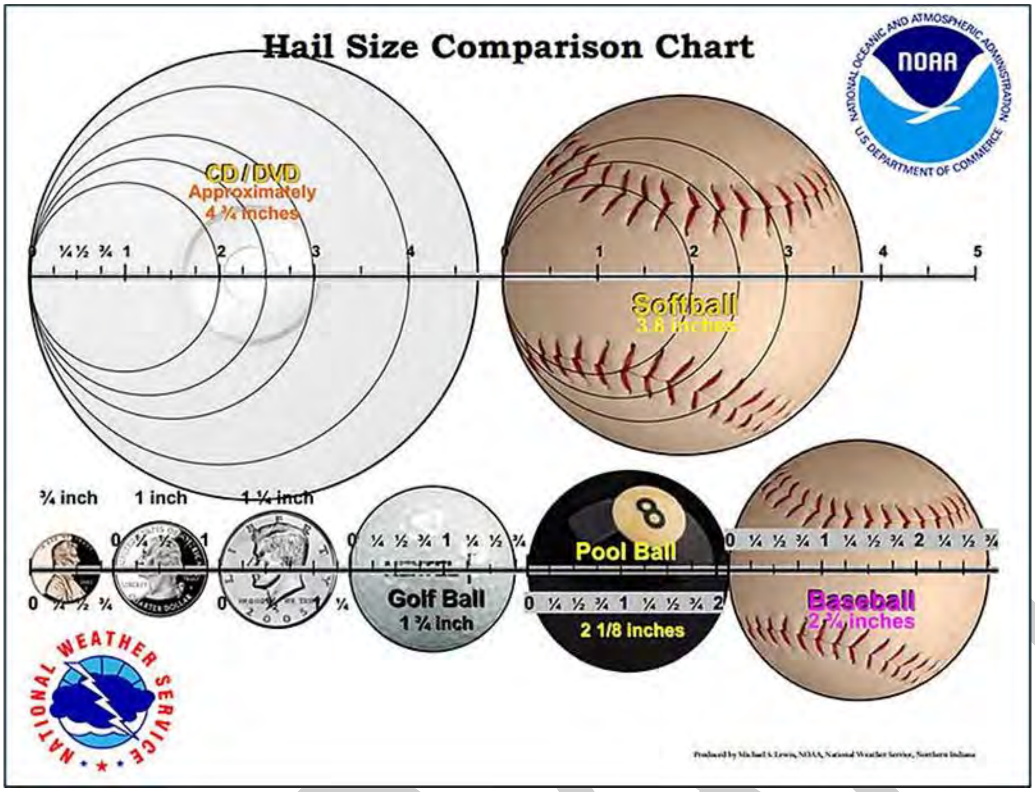
Magnitude/Severity

Critical - Common problems associated with severe storms include the loss of utilities or immobility. Loss of life is uncommon but can occur during severe storms. Immobility can occur when roads become impassable due to heavy rains causing flooding, erosion issues, or downed trees. Loss of power lines can occur due to downed trees from high winds or lighting.

The severity of severe thunderstorms that involve heavy rain, high wind, or hail can be measured according to hail by diameter sizes and wind speed. The NWS classifies hail by diameter size, and corresponding everyday objects to help relay scope and severity to the population. Figure 4-38 below shows the hailstone measurements utilized by the NWS.

There is no clear distinction between storms that do and do not produce hailstones. Nearly all severe thunderstorms probably produce hail aloft, though it may melt before reaching the ground. Multi-cell thunderstorms produce many hailstones, but not usually the largest hailstones. In the life cycle of the multi-cell thunderstorm, the mature stage is relatively short so there is not much time for growth of the hailstone. Supercell thunderstorms have sustained updrafts that support large hail formation by repeatedly lifting the hailstones into the very cold air at the top of the thunderstorm cloud. In general, golf ball sized hail or larger is associated with supercells, but non-supercell storms are also capable of producing golf ball size hail.

Figure 4-38 Hail Measurements



Source: National Weather Service

The most common hail size recorded in the Storm Event Database is 1-inch or hail the size of a quarter. Table 4-61 shows the breakdown of the various sizes of hail that have fallen in Larimer County between 1955 and 2019.

Table 4-61 Recorded Hail Stones

Hail Stone Size	Count
0.75	147
0.88	27
1	210
1.25	43
1.5	42
1.75	60
2	11
2.25	1
2.5	5
2.75	6
4	1
4.5	1

Source: NOAA; NCEI Storm Events Database

Damaging wind is measured using the Beaufort Wind Scale as shown in Table 4-62. This scale only reflects land-based effects and does not take into consideration the effects of wind over water.

Table 4-62 Beaufort Wind Scale

Beaufort Number	Description	Windspeed (MPH)	Land Conditions
0	Calm	<1	Calm. Smoke rises vertically.
1	Light air	1 – 3	Wind motion visible in smoke.
2	Light breeze	3 – 7	Wind felt on exposed skin. Leaves rustle.
3	Gentle breeze	8 – 12	Leaves and smaller twigs in constant motion.
4	Moderate breeze	13 – 17	Dust and loose paper raised. Small branches begin to move.
5	Fresh breeze	18 – 24	Branches of a moderate size move. Small trees begin to sway.
6	Strong breeze	25 – 30	Large branches in motion. Whistling heard in overhead wires. Umbrella use becomes difficult. Empty plastic garbage cans tip over.
7	High wind, Moderate gale, Near gale	31 – 38	Whole trees in motion. Effort needed to walk against the wind. Swaying of skyscrapers may be felt, especially by people on upper floors.
8	Gale, Fresh gale	39 – 46	Some twigs broken from trees. Cars veer on road. Progress on foot is seriously impeded.
9	Strong gale	47 – 54	Some branches break off trees, and some small trees blow over. Construction/temporary signs and barricades blow over. Damage to circus tents and canopies.
10	Storm, Whole gale	55 – 63	Trees are broken off or uprooted, saplings bent and deformed. Poorly attached asphalt shingles and shingles in poor condition peel off roofs.
11	Violent storm	64 – 72	Widespread vegetation damage. Many roofing surfaces are damaged; asphalt tiles that have curled up and/or fractured due to age may break away completely.
12	Hurricane	≥ 73	Very widespread damage to vegetation. Some windows may break; mobile homes and poorly constructed sheds and barns are damaged. Debris may be hurled about.

Source: National Oceanographic and Atmospheric Association, http://www.spc.noaa.gov/faq/tornado/beaufort.html

Lightning is measured by the Lightning Activity Level (LAL) scale, created by the NWS to define lightning activity into a specific categorical scale. The LAL is a common parameter that is part of fire weather forecasts nationwide. Larimer County is at risk to experience lightning in any of these categories. The LAL is reproduced in Table 4-63.

Table 4-63 Lightning Activity Level Scale

Lightning Activity Level	
LAL 1	No thunderstorms
LAL 2	Isolated thunderstorms. Light rain will occasionally reach the ground. Lightning is very infrequent, 1 to 5 cloud to ground strikes in a five-minute period.
LAL 3	Widely scattered thunderstorms. Light to moderate rain will reach the ground. Lightning is infrequent, 6 to 10 cloud to ground strikes in a five-minute period.

Lightning Activity Level	
LAL 4	Scattered thunderstorms. Moderate rain is commonly produced. Lightning is frequent, 11 to 15 cloud to ground strikes in a five-minute period.
LAL 5	Numerous thunderstorms. Rainfall is moderate to heavy. Lightning is frequent and intense, greater than 15 cloud to ground strikes in a five-minute period.
LAL 6	Dry lightning (same as LAL 3 but without rain). This type of lightning has the potential for extreme fire activity and is normally highlighted in fire weather forecasts with a Red Flag warning.

Source: National Weather Service

Isolated deaths and/or multiple injuries and illnesses; major or long-term property damage that threatens structural stability; and/or interruption of essential facilities and services for 24-72 hours.

Lightning can occur anywhere in Larimer County, and it is not possible to identify specific hazard areas. Data was not available to identify specific structures at risk. Data on average annual losses was limited but based on NCEI records $10,087 in lightning-related damages occurred between 1996 and 2018. One of the most serious risks associated with lightning is its potential to cause wildland fires, which is most significant in the western, mountainous parts of the County. For specific details on loss and vulnerability associated with wildfires, please see the wildfire vulnerability discussion. Table 4-64 shows a breakdown of reported impacts caused by past recorded lightning events. Note that these are only impacts reported to NCEI and should not be considered to be comprehensive; in particular, the Planning Team noted there have been far more than four wildfires and one power outage resulting from lightning strikes in the County.

Table 4-64 Impacts Caused by Lightning Events

Impact	Count
Casualty of Outdoor Enthusiast	12
Structural Fire	6
Wildfire	4
Casualty of Outdoor Worker	4
Tree Damage	3
Damage to Electrical Equipment	2
Power Outages	1

Source: NOAA; NCEI Storm Events Database

Speed of Onset

Spring and summer storms can be predicted with a reasonable level of certainty. Through the identification of various indicators of weather systems, and by tracking these indicators, warning time for spring snowstorms can be as much as a week in advance. 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.

Using radar technology, the National Weather Service Denver/Boulder Forecast Office issues thunderstorm watches and warnings to warn communities of impending severe weather.

Severe Thunderstorm Watch - A severe thunderstorm watch indicates that conditions are favorable for the formation of severe thunderstorms in and near the watch area. Conditions may be nice and sunny for the area at the time it is issued. The watch area is typically large (National Weather Service).

Severe Thunderstorm Warning: A thunderstorm warning indicates imminent danger to life and property. Warnings typically encompass a much smaller area (around the size of a city or small county) that may be impacted by a large hail or damaging wind identified by an NWS forecaster on radar or by a trained spotter/law enforcement who is watching the storm. The area is experiencing or will be shortly experiencing severe thunderstorm conditions. Those conditions include wind speeds of 58 miles per hour or greater and/or hail that is one inch in diameter or larger. It should be noted that lightning or rainfall are not included in the warning criteria for a severe thunderstorm. If a tornado is spotted or indicated on radar, the severe thunderstorm warning will be upgraded to a tornado warning (National Weather Service).

Duration

Thunderstorms have a lifecycle of three stages: developing stage, mature stage, and the dissipating stage. The lifecycle can last between 30 minutes and 1 hour.

Probability of Future Occurrences

Highly Likely - Spring and summer storms can be predicted with a reasonable level of certainty. Through the identification of various indicators of weather systems, and by tracking these indicators, warning time for snowstorms can be as much as a week in advance. Understanding the historical frequency, duration, and spatial extent of severe winter weather assists in determining the likelihood and potential severity of future occurrences. The characteristics of past spring and summer events provide benchmarks for projecting similar conditions into the future. The probability that Larimer County will experience a spring or summer storm event can be difficult to quantify. However, based on historical records and frequencies there is nearly a 100% chance of this type of event will occur somewhere in Larimer County at least once every year.

Reported straight-line wind events over the past nineteen years provide an acceptable framework for determining the future occurrence in terms of event. The probability of Larimer County and its municipalities experiencing a severe wind event associated with damages or injuries can be difficult to quantify but based on historical record of 231 severe wind events since 1996, there is a high chance of this type of event occurring each year.

Climate Change Considerations

As average temperatures increase over time, this generally will result in higher extreme temperatures and more warming in the atmosphere can trigger climate changes, which could result in more frequent extreme weather events. Climate change models are estimating an increase in temperature by the end of the century. Lightning specifically tends to occur with warmer temperatures as heat energy fuels storm clouds. A study published in the Journal of Science in November of 2014 showed the possibility of a 12% increase of lighting events for every degree of warming. On average the United States experiences 20 million lightning strikes with the possibility of 30 million lightning strikes over the continental U.S. by 2100 (Scientific American 2014). Some studies show a potential for a decrease in wind shear in mid-latitude areas. Because of uncertainty with the influence of climate change on tornadoes, future updates to the mitigation plan should include the latest research on how the tornado hazard frequency and severity could change. The level of significance of this hazard should be revisited over time.

Vulnerability Assessment

All assets located in Larimer County can be considered at risk from spring and summer storms. This includes 100% of the County's population, and all buildings and infrastructure within the County. Damages primarily occur as a result of high winds, lightning strikes, hail, and flooding.

People

Exposure is the greatest danger to people from severe thunderstorms. People can be hit by lightning, pelted by hail, caught in rising waters due to heavy rain and become vulnerable if recreating on waterbodies such as Boyd Lake, Red Feather Lakes, or Horsetooth Reservoir.

Aspects of the population who rely on constant, uninterrupted electrical supplies may have a greater, indirect vulnerability to lightning. Elderly or disabled people, especially those with home health care services, often rely heavily on an uninterrupted source of electricity. Resident populations in nursing homes, residential facilities, or other special needs housing may also be vulnerable if electrical outages are prolonged. If they do not have a back-up power source, rural residents and agricultural operations reliant on electricity for heating, cooling, and water supplies are also especially vulnerable to power outages. According to the data obtained from emPOWER.com, a website maintained by the U.S. Department of Health and Human Services, 8% of the Medicare beneficiaries in the County, or 4,318 of the 57,432 of beneficiaries rely on medical equipment that is dependent on electricity in order to live independently.

The impacts of thunderstorms on vulnerable populations can be more severe. Low income families are more likely to live in poorly constructed homes that are more likely to be damaged, and are more likely to be uninsured or underinsured, making it more difficult for them to recover from hail or lightning events. Individuals with disabilities may need more assistance after a major storm, especially if transportation or utility services are disrupted. Severe weather warnings must use methods that reach vision or hearing-impaired people and those with limited English proficiency.

General Property

Spring and summer storms affect the entire planning area of Larimer County and its jurisdictions including all above-ground structures and infrastructure. Although losses to structures are typically minimal and covered by insurance, there can be impacts with lost time, maintenance costs, and contents within structures. A timely forecast may not be able to mitigate the property loss but could reduce the casualties and associated injury.

Generally, straight-line wind events destroy private, commercial, and public property. Additional costs stem from debris removal, maintenance, repair, and response. Indirect costs include loss of industrial and commercial productivity as a result of damage to infrastructure, facilities, or interruption of services. Because no specific, countywide loss estimation exists for wind, potential losses are related to historical property damage and injuries/deaths.

Critical Facilities and Infrastructure

Most structures, including the County's critical facilities, should be able to provide adequate protection from hail but the structures could suffer broken windows and dented exteriors. Those facilities with back-up generators are better equipped to handle a severe weather situation should the power go out.

Inventory assets exposed to severe wind is dependent on the age of the building, type, construction material used, and condition of the structure. Possible losses to critical infrastructure include:

- Electric power disruption
- Communication disruption
- Water and fuel shortages
- Road closures
- Damaged infrastructure components, such as sewer lift stations and treatment plants
- Damage to homes, structures, and shelters

Because of the unpredictability of severe thunderstorm events strength and path, most critical infrastructure that is above ground is equally exposed to the storm's impacts.

Economy

Economic impact of a severe thunderstorm is typically short term, although it can be significant. Lightning events can cause power outages and fires. Generally, long-term economic impacts center more around hazards that cascade from a severe thunderstorm, such as flooding, or wildfires ignited by lightning. In general, all severe thunderstorms pose a risk to the agricultural economy in the County. As noted in the Past Occurrences subsection above, spring and summer storms in Larimer County have led to $18,494,000 in total damages between 1955 and 2019.

Historic, Cultural and Natural Resources

Severe thunderstorms are a natural environmental process. Environmental impacts include the sparking of potentially destructive wildfires by lightning and localized flattening of plants by thunderstorm wind. Some cultural and historic properties are potentially at risk of damage from hail, wind and lightning.

Future Land Use and Development

All future structures built in Larimer County will likely be exposed to spring and summer extremes and damage. Since the previous statement is assumed to be uniform countywide, the location of development does not increase or reduce the risk necessarily. Larimer County and its jurisdictions must adhere to building codes, and therefore, new development can be built to current standards to account for adverse weather. Additionally, as homes go up in more remote parts of the county, accessing those rural residents may become impossible should sheltering or emergency services be needed in an extreme event.

All future structures built in Larimer County will likely be exposed to severe wind damage. As with other large extent hazards, increased development trends within Planning Reserve Areas and along the I-25 corridors will increase the vulnerability of these areas. Larimer County and its jurisdictions must continue to adhere to building codes and to facilitate new development that is built to the highest design standards to account for heavy winds.

Due to the nature of severe wind events, not all jurisdictions within Larimer County are expected to be impacted equally. For example, older homes, which are often subject to less advanced building codes, suffer increased vulnerability to wind over time. Mobile homes, which are most often occupied by low-income, socially vulnerable residents, are the most dangerous places during a windstorm. As communities across Larimer County continue to grow, it is important that local agencies monitor the inventory and locations of mobile homes, particularly in areas of high wind risk. Moreover, when discussing mitigation actions for straight-line winds, communities or geographic locations with large numbers of mobile homes deserve added attention.

Risk Summary

- The entire county is susceptible to the impacts of spring/summer storm events.
- There have been 899 spring/summer storm events (hail, damaging wind, lightning) resulting in $18,494,000 in property and crop damages between 1950 and 2019.
- Severe wind and lightning events between 1950 and 2019 resulted in 115 casualties.
- USDA Risk Management Agency records show 19,429.55 acres of crops and $5,039,813.67 of indemnity payments due to hail and excess wind events.
- Largest hailstone recorded in the county was 4.5 inches on July 30, 1979. 1-inch hailstones are most commonly recorded.
- Lightning events can lead to fires; 6 lightning events have caused structural fires and 4 lead to wildfires.
- Outdoor enthusiasts, in particular tourists, are vulnerable to spring/summer storm events. Recreational waterbodies such as Boyd Lake, Horsetooth Reservoir, and Red Feather Lakes each have had events of wind, lightning, and hail recorded.

- Vulnerable populations are at risk of losing electricity due to a severe spring or summer storm events. 8% of Medicare Beneficiaries in the County rely on equipment that is electricity-dependent to be able to live independently in their homes.
- Related Hazards: Wildfire, Flood, Landslide/Rockslide, Erosion/Deposition, Tornado, and Utility Disruption

4.3.11 Tornado

Hazard	Frequency	Spatial Extent	Severity	Overall Significance
Tornado	Likely	Limited	Critical	High

Description

Tornadoes in Colorado are most often generated by thunderstorm activity when cool, dry air intersects and overrides a layer of warm, moist air forcing the warm air to rise rapidly. The damage caused by a tornado is a result of high wind velocities and wind-blown debris. According to the National Weather Service, tornado wind speeds can range between 30 to more than 300 miles per hour. They are more likely to occur during the spring and early summer months of March through June and are most likely to form in the late afternoon and early evening. Most tornadoes are a few dozen yards wide and touchdown briefly, but even small, short-lived tornadoes can inflict tremendous damage. Destruction ranges from minor to catastrophic depending on the intensity, size, and duration of the storm. Structures made of light materials such as mobile homes are most susceptible to damage. In the Colorado Front Range, tornadoes have been reported in nine months out of the year, with the peak season for tornados extending from mid-May through mid-August. June is by far the month with the most recorded tornadoes. Tornadoes have occurred every time of the day, with over half of them developing between 3 p.m. and 6 p.m., and 88% occurring between 1 p.m. and 9 p.m. MDT. They occur statewide, but by far the greatest number develops in eastern Colorado east of I-25.

Past Occurrences

Colorado, lying just west of "tornado alley," is fortunate to experience less frequent and intense tornadoes than its neighboring states to the east. However, tornadoes remain a significant hazard in the region. Tornado season typically is March through August; however, a tornado can occur in any month. Tornadoes are the most intense storm on earth having been recorded at velocities exceeding 315 mph. The phenomena results in a destructive rotating column of air ranging in diameter from a few yards to greater than a mile, usually associated with a downward extension of cumulonimbus clouds.

All portions of Larimer County have the potential to be affected by tornadoes, but they are more common in the eastern portions of the County. Historically, tornadoes have been relatively small on the EF Scale, but F1 tornadoes can still produce dangerous winds up to 112 mph. High winds can cause damage to buildings (tearing shingles from roofs, tearing awnings, collapsing structures, etc.).

Table 4-65 summarizes tornado history and damage data for Larimer County from 1954 – 2018 recorded in the NCEI Storm Events Database.

Table 4-65 Tornado History in Larimer County (1954-2018)

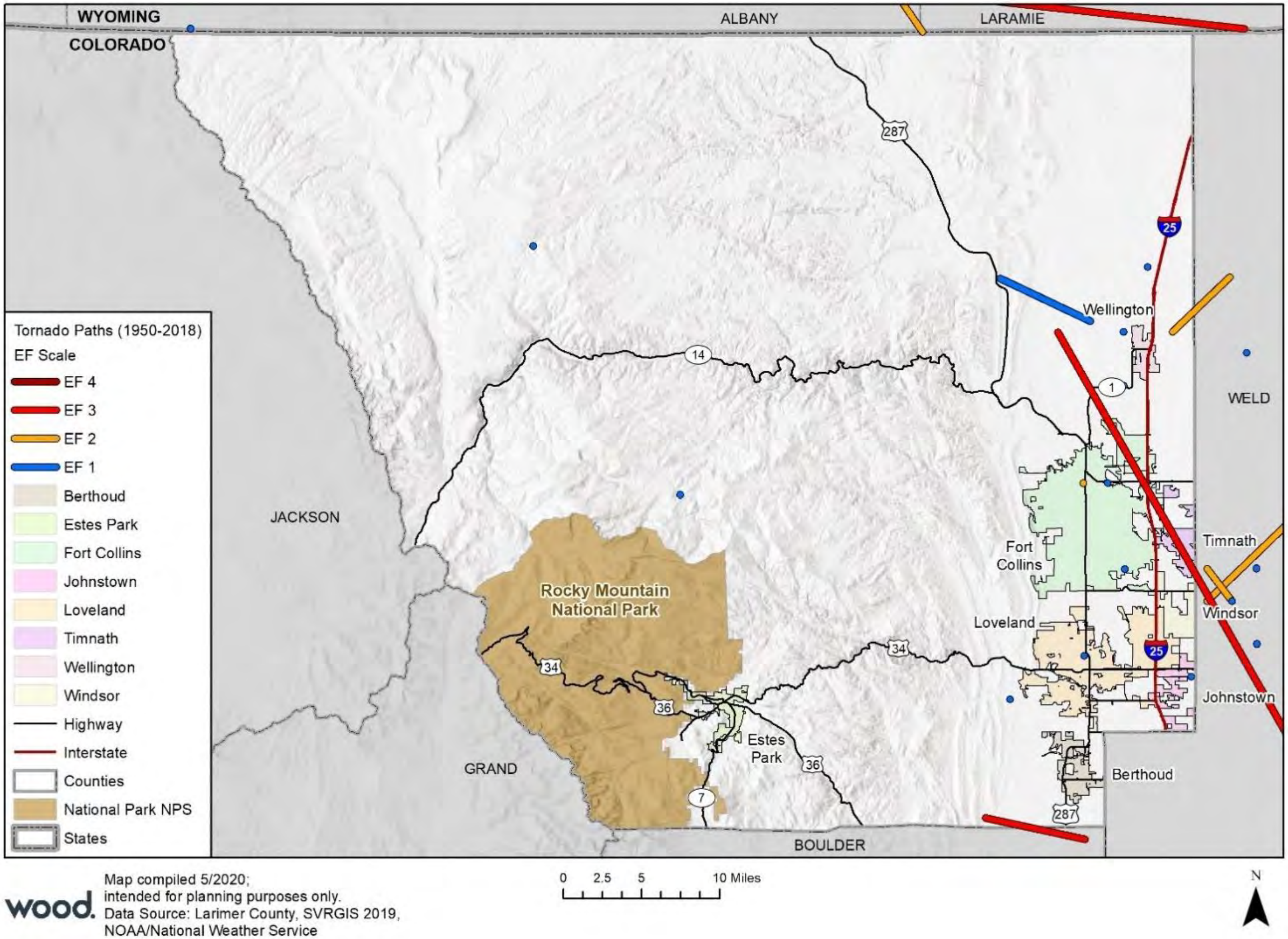
Date	Begin Location	EF Scale	Injuries	Deaths	Estimated Property Damage	Estimated Crop Damage
3/7/1954	unknown	unknown	0	0	$2,500	unknown
5/29/1957	unknown	F1	0	0	$250	unknown
5/30/1957	unknown	F2	0	0	$2,500	unknown
7/7/1963	unknown	F1	0	0	$2,500	unknown
6/23/1965	unknown	F0	0	0	unknown	unknown
6/4/1976	unknown	F2	0	0	unknown	unknown
7/22/1979	unknown	F0	0	0	unknown	unknown

Date	Begin Location	EF Scale	Injuries	Deaths	Estimated Property Damage	Estimated Crop Damage
5/24/1980	unknown	F1	0	0	$2,500	unknown
6/25/1982	unknown	F1	0	0	$30	unknown
7/7/1983	unknown	F1	0	0	$30	unknown
8/2/1985	unknown	F1	0	0	unknown	unknown
6/18/1987	unknown	F1	0	0	$25,000	unknown
8/7/1987	unknown	F1	0	0	unknown	unknown
6/15/1988	unknown	F1	0	0	$2,500	unknown
6/25/1988	unknown	F1	0	0	unknown	unknown
8/7/1988	unknown	F0	0	0	unknown	unknown
5/31/1989	unknown	F0	0	0	unknown	unknown
6/6/1990	unknown	F0	0	0	$2,500	unknown
6/9/1990	unknown	F1	0	0	unknown	unknown
6/9/1990	unknown	F2	0	0	$25,000	unknown
7/8/1990	unknown	F0	0	0	unknown	unknown
6/22/1991	unknown	F0	0	0	unknown	unknown
5/28/1993	Loveland	F0	0	0	unknown	unknown
8/5/1993	Wellington	F0	0	0	unknown	unknown
7/16/1994	Wellington	F0	0	0	unknown	unknown
7/16/1994	Wellington	F0	0	0	unknown	unknown
7/16/1994	Fort Collins	F0	0	0	unknown	unknown
5/6/1995	unknown	F0	0	0	unknown	unknown
5/9/2002	Fort Collins	F0	0	0	unknown	unknown
7/25/2005	Buckeye	F0	0	0	unknown	unknown
5/22/2008	Timnath	EF1	0	0	unknown	unknown
6/4/2015	Berthoud	EF3	0	0	unknown	unknown
5/18/2018	Estes Park	EF0	0	0	Unknown	unknown
TOTALS:			**0**	**0**	**$65,300**	**unknown**

*Source: NOAA; NCEI Storm Events Database

NCEI's Storm Events Database estimates that 33 tornadoes have touched down in or moved through Larimer County between 1954 and 2018. Figure 4-39 depicts historical tornado tracks and events in and around Larimer County between 1954 and 2018, showing where tornadoes have touched down and traveled.

Figure 4-39 Map of Tornado Events in Larimer County (1950 – 2018)



Not recorded in the NCEI Database are two EF3 tornadoes that have impacted communities in Larimer County. The most significant tornado event in the past decade in Larimer County was an EF3 on June 4, 2015 directly impacting the Town of Berthoud. According to an NWS event description, wind speeds were estimated to be up to 140 mph and a quarter mile wide. Twenty-eight homes were damaged and three destroyed. This is the strongest recorded tornado in Larimer or Boulder counties. The May 22, 2008 event was recorded as an EF3 tornado that direct damages to the Town of Windsor. Refer to Annex U Town of Windsor for a full description of the event.

Location

Limited - While the entire county is susceptible to any of the effects of severe tornadoes, the communities on the Front Range and eastern plains, to include the Town of Wellington, Town of Windsor, Town of Johnstown, Town of Berthoud, City of Loveland and the City of Fort Collins, are more likely to experience a tornado event.

Magnitude/Severity

Critical - Tornadoes can cause damage to property and loss of life. While most tornado property damage is caused by violent winds, the majority of injuries and deaths generally result from flying debris. Property damage can include damage to buildings, fallen trees and power lines, broken gas lines, broken sewer and water mains, and the outbreak of fires. Agricultural crops and industries may also be damaged or destroyed. Access roads and streets may be blocked by debris, delaying necessary emergency response.

Prior to 2007, tornadoes were previously classified by their intensity using the Fujita (F) Scale, with F0 being the least intense and F6 being the most intense. The Fujita Scale (seen in the table below) is used to rate the intensity of a tornado by examining the damage caused by the tornado after it has passed over a man- made structure.

Table 4-66 Fujita Tornado Damage Scale

Fujita Scale			
F-Scale Number	**Intensity Phrase**	**Wind Speed**	**Type of Damage**
F0	Gale tornado	40-72 mph	Some damage to chimneys; breaks branches off trees; pushes over shallow-rooted trees; damages signboards.
F1	Moderate tornado	73-112 mph	The lower limit is the beginning of hurricane wind speed; peels surface off roofs; mobile homes pushed off foundations or overturned; moving autos pushed off the roads; attached garages may be destroyed.
F2	Significant tornado	113-157 mph	Considerable damage. Roofs torn off frame houses; mobile homes demolished; boxcars pushed over; large trees snapped or uprooted; light object missiles generated.
F3	Severe tornado	158-206 mph	Roof and some walls torn off well-constructed houses; trains overturned; most trees in forest uprooted
F4	Devastating tornado	207-260 mph	Well-constructed houses leveled; structures with weak foundations blown off some distance; cars thrown and large missiles generated.

Fujita Scale			
F-Scale Number	**Intensity Phrase**	**Wind Speed**	**Type of Damage**
F5	Incredible tornado	261-318 mph	Strong frame houses lifted off foundations and carried considerable distances to disintegrate; automobile sized missiles fly through the air in excess of 100 meters; trees debarked; steel reinforced concrete structures badly damaged.
F6	Inconceivable tornado	319-379 mph	These winds are very unlikely. The small area of damage they might produce would probably not be recognizable along with the mess produced by F4 and F5 wind that would surround the F6 winds. Missiles, such as cars and refrigerators would do serious secondary damage that could not be directly identified as F6 damage. If this level is ever achieved, evidence for it might only be found in some manner of ground swirl pattern, for it may never be identifiable through engineering studies

Source: NOAA

On February 1, 2007, the Fujita scale was decommissioned in favor of the more accurate Enhanced Fujita Scale (aka the EF Scale). The EF-Scale measures tornado strength and associated damages and classifies tornadoes into six intensity categories, as shown in the following table. The scale was revised to reflect better examinations of tornado damage surveys, so as to align wind speeds more closely with associated storm damage. The new scale takes into account how most structures are designed and is thought to be a much more accurate representation of the surface wind speeds in the most violent tornadoes.

Table 4-67 Enhanced Fujita (EF) Scale

Enhanced Fujita (EF) Scale		
Enhanced Fujita Category	**Wind Speed (mph)**	**Potential Damage**
EF0	65-85	**Light damage**: Peels surface off some roofs; some damage to gutters or siding; branches broken off trees; shallow-rooted trees pushed over.
EF1	86-110	**Moderate damage**: Roofs severely stripped; mobile homes overturned or badly damaged; loss of exterior doors; windows and other glass broken.
EF2	111-135	**Considerable damage**: Roofs torn off well-constructed houses; foundations of frame homes shifted; mobile homes completely destroyed; large trees snapped or uprooted; light-object missiles generated; cars lifted off ground.
EF3	136-165	**Severe damage**: Entire stories of well-constructed houses destroyed; severe damage to large buildings such as shopping malls; trains overturned; trees debarked; heavy cars lifted off the ground and thrown; structures with weak foundations blown away some distance.

Enhanced Fujita (EF) Scale		
Enhanced Fujita Category	**Wind Speed (mph)**	**Potential Damage**
EF4	166-200	**Devastating damage**: Well-constructed houses and whole frame houses completely leveled; cars thrown and small missiles generated.
EF5	>200	**Incredible damage**: Strong frame houses leveled off foundations and swept away; automobile-sized missiles fly through the air in excess of 100 m (109 yds.); high-rise buildings have significant structural deformation; incredible phenomena will occur.

Source: NOAA

The Storm Prediction Center has developed damage indicators to be used with the Enhanced Fujita Scale for different types of buildings. These indicators can also be used to classify any high wind event. Indicators for different building types are shown in the following tables.

Table 4-68 Institutional Buildings

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

Source: Storm Prediction Center, 2009

Table 4-69 Educational Institutions (Elementary Schools, High Schools)

Damage Description	Wind Speed Range (Expected in Parentheses)
Threshold of visible damage	55-83 MPH (68 MPH)
Loss of roof covering (<20%)	66-99 MPH (79 MPH)
Broken windows	71-106 MPH (87 MPH)
Exterior door failures	83-121 MPH (101 MPH)
Uplift of metal roof decking; significant loss of roofing material (>20%); loss of rooftop HVAC	85-119 MPH (101 MPH)
Damage to or loss of wall cladding	92-127 MPH (108 MPH)
Collapse of tall masonry walls at gym, cafeteria, or	94-136 MPH (114 MPH)

Damage Description	Wind Speed Range (Expected in Parentheses)
auditorium	
Uplift or collapse of light steel roof structure	108-148 MPH (125 MPH)
Collapse of exterior walls in top floor	121-153 MPH (139 MPH)
Most interior walls of top floor collapsed	133-186 MPH (158 MPH)
Total destruction of a large section of building envelope	163-224 MPH (192 MPH)

Source: Storm Prediction Center, 2009

Table 4-70 Metal Building Systems

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

Source: Storm Prediction Center, 2009

Table 4-71 Electric Transmission Lines

Damage Description	Wind Speed Range (Expected in Parentheses)
Threshold of visible damage	70-98 MPH (83 MPH)
Broken wood cross member	80-114 MPH (99 MPH)
Wood poles leaning	85-130 MPH (108 MPH)
Broken wood poles	98-142 MPH (118 MPH)

Source: Storm Prediction Center, 2009

Table 4-72 summarizes the magnitude of past tornado events as recorded in the NCEI Storm Events Database. There have been 33 tornado events with a recorded magnitude since 1950 in Larimer County. The greatest magnitude tornado recorded in the county is an EF3. The most commonly recorded tornado events in the Storm Events Database are F0 and F1 tornadoes.

Table 4-72 Summary of Magnitudes of Past Tornado Events in Larimer County

Magnitude	# of Events	Magnitude	# of Events
Blank	1		
F0	15	EF0	1
F1	11	EF1	1
F2	3	EF2	0
F3	0	EF3	1
F4	0	EF4	0
F5	0	EF5	0
		Total	**33**

Source: NOAA; NCEI Storm Events Database

Speed of Onset

The NOAA's storm prediction center issues tornado watches and warnings for Larimer 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.

Duration
According to NOAA's National Severe Storms Laboratory, detailed statistics on the duration of tornadoes on the ground are not available at this time. The duration can range from seconds to several hours. The average duration is about 5 minutes.

Probability of Future Occurrences

Likely - Reported tornadoes over the past 64 years provide an acceptable framework for determining the future occurrence in terms of frequency for such events. The probability of the County and its municipalities experiencing a tornado associated with damages or injuries can be difficult to quantify. Historic tornado frequencies suggest that there is roughly a 52% chance of this type of event occurring somewhere within the County boundaries each year.

Climate Change Considerations

There presently is not enough data or research to quantify the magnitude of change that climate change may have related to tornado frequency and intensity. NASA's Earth Observatory has conducted studies which aim to understand the interaction between climate change and tornadoes. Based on these studies meteorologists are unsure why some thunderstorms generate tornadoes and others don't, beyond knowing that they require a certain type of wind shear. Tornadoes spawn from approximately one percent of thunderstorms, usually supercell thunderstorms that are in a wind shear environment that promotes rotation. Some studies show a potential for a decrease in wind shear in mid-latitude areas. Because of uncertainty with the influence of climate change on tornadoes, future updates to the mitigation plan should include the latest research on how the tornado hazard frequency and severity could change. The level of significance of this hazard should be revisited over time.

Vulnerability Assessment

All assets located in Larimer County can be considered at risk from severe wind and tornadoes although based on historic tornado paths, the risk for communities in the eastern portion is higher compared to those in western portion of the county. Most structures, including the County's critical facilities, should be able to withstand and provide adequate protection from tornadoes rated up to EF4. Those facilities with back-up generators should be fully equipped to handle tornado events should the power go out.

People
Community members are the most vulnerable to damaging wind and tornado events. Over the last 64 years there have been no deaths reported in Larimer County due to a tornado event. During the same time period, there have been no reported injuries from tornadoes. The availability of sheltered locations such as basements, buildings constructed using tornado-resistant materials and methods, and public storm shelters, all reduce the exposure of the population. However, there are also segments of the population that are especially exposed to the indirect impacts of damaging winds and tornadoes,

particularly the loss of electrical power. According to the data obtained from emPOWER.com, a website maintained by the U.S. Department of Health and Human Services, 8% of the Medicare beneficiaries in the County rely, or 4,318 of the 57,432 of beneficiaries on medical equipment that is dependent on electricity in order to live independently. These populations include the elderly or disabled, especially those with medical needs and treatments dependent on electricity. Nursing homes, community-based residential facilities, and other special needs housing facilities are also vulnerable if electrical outages are prolonged, since backup power generally operates only minimal functions for a short time.

General Property

Monetary losses to property from tornado events in Larimer County are largely unknown. Because no specific, countywide loss estimation exists for tornado hazards, potential losses are related to historical property damage and injuries/deaths.

General damages can be both direct and indirect. Direct damage refers to what the wind event physically destroys. Indirect damage focuses on additional costs, damages and losses from secondary hazards spawned by the event. Depending on the magnitude of the wind events as well as the size of the tornado and its path, a tornado is capable of damaging and eventually destroying almost anything. Construction practices and building codes can help maximize the resistance of the structures to damage. The County's current building code (2018 International Building l Code) requires structures to be built to withstand a 90-mph wind event (EF1). Mobile homes, which are most often occupied by low-income, socially vulnerable residents, are the most dangerous places during a tornado. Studies indicate that 45% of all fatalities during tornadoes occur in mobile homes, compared to 26% in traditional site-built homes (Ashley 2008). Countywide mobile homes make up 3.8% of total housing; most of these homes are on the eastern plains around the Cities of Fort Collins and Loveland.

Secondary impacts of damage caused by wind events often result from damage to infrastructure. Downed power and communications transmission lines, coupled with disruptions to transportation, create difficulties in reporting and responding to emergencies. These indirect impacts of a wind event put tremendous strain on a community. In the immediate aftermath, the focus is on emergency services.

Critical Facilities and Infrastructure

Inventory assets exposed to severe wind is dependent on the age of the building, type, construction material used, and condition of the structure. Possible losses to critical infrastructure include:

- Electric power disruption
- Communication disruption
- Water and fuel shortages
- Road closures
- Damaged infrastructure components, such as sewer lift stations and treatment plants
- Damage to homes, structures, and shelters

Because of the unpredictability of wind events' strength and path, most critical infrastructure that is above ground is equally exposed to the storm's impacts.

Economy

Tornadoes can impact exposed critical infrastructure; depending on the impact and the function, this could cause a short-term economic disruption. The most common problems associated with tornadoes and damaging winds are loss of utilities. Downed power lines can cause power outages, leaving large parts of the County isolated, and without electricity, water, and communication. Damage may also limit timely emergency response and the number of evacuation routes. Downed electrical lines following a storm can also increase the potential for lethal electrical shock and can also lead to other hazard events such as wildfires.

Historic, Cultural and Natural Resources

Damaging winds and tornadoes can cause massive damage to the built and natural environment, uprooting trees and other debris. There are 107 historic properties listed on the National Register and 34 properties on the State Register in Larimer County. Many of these properties including 54 in the City of Fort Collins and 17 in the City of Loveland are located in the eastern portion of the county where a majority of the past tornado events have occurred.

Future Land Use and Development

All future structures built in Larimer County could likely be exposed to tornado damage. As with other large extent hazards, increased development trends within Planning Reserve Areas and along the I-25 corridor will increase the vulnerability of these areas. Larimer County and its jurisdictions must continue to adhere to building codes and to facilitate new development that is built to the highest design standards to account for tornadoes.

Due to the nature of tornadoes, not all jurisdictions within Larimer County are expected to be impacted equally. For example, older homes, which are often subject to less advanced building codes, suffer increased vulnerability to wind and tornadoes over time.

Risk Summary

- Tornadoes are possible in all areas of the county, although the communities along the Front Range and eastern plains of the county are more likely to experience a Tornado event.
- There have been 33 recorded tornado events in the county since 1954.
- The greatest magnitude tornado event was an EF3 on June 4, 2015 in the Town of Berthoud. F0/EF0 is the most commonly recorded magnitude.
- Mobile homes are the most vulnerable housing type. Mobile homes represent 3.8% of total housing in the county.
- Vulnerable populations are at risk of losing electricity due to a tornado events. 8% of Medicare Beneficiaries in the County rely on equipment that is electricity dependent to be able to live independently in their homes
- Related Hazards: Spring/Summer Storm, Utility Disruption

4.3.12 Utility Disruption

Hazard	Frequency	Spatial Extent	Severity	Overall Significance
Utility Disruption	Likely	Significant	Critical	Medium

Description

Utility disruption is defined as the interruption or loss of electricity, gas, communications, or water to a facility of a community for a period of time that compromises the integrity of the location, threatens human life, safety, and health, or interferes with vital services. Utility disruption may occur as a secondary effect of another hazard, or as the result of severe weather, an accident, system overloading, or terrorism. Severe summer and winter storms, and tornadoes and floods can bring trees and tree limbs down onto power lines. These events also cause serious safety hazards to the general public and emergency responders. For the purpose of the 2016 plan, attention has been given to the following utility sources:

- Electricity
- Natural Gas
- Communications
- Water

Extended electrical outages can directly impact other utility systems, particularly water and wastewater systems. In areas where telephone service is provided by above-ground lines that share poles with electrical distribution lines, telecommunications providers may not be able to make repairs to the telephone system until electrical utilities restore power lines to a safe condition. Electrical outages can also adversely affect the availability of fueling facilities that require electrical power to physically move the fuel. The impacts of electric utility disruptions are felt most significantly by the general public during the winter and the summer due to heating and cooling demands. However, any extended electric disruption can lead to local economic losses when computers, lighting, refrigeration, gas pumps, and other equipment are without power during business hours.

The majority of homes in Larimer County are heated with natural gas. However, propane is a common heating fuel in the rural parts of the county. A large diameter natural gas pipeline travels through Larimer County along the Interstate 25 corridor. The distribution of natural gas through this pipeline could potentially be disrupted by an earthquake, construction accident, transportation accident, or serious fire along the corridor. The impacts of gas utility disruption can be severe in rural areas where a single-source heating is the norm.

According to the 2018 Colorado State Hazard Mitigation Plan, the most common causes of power outages in Colorado are human error, equipment failure (to include excavation and vehicle accidents), and natural causes (to include weather events and wildlife disruptions). Disruptions of communication systems happen frequently, especially now that society is more dependent on multiple means of communication. For example, when telephone lines are out of service, credit card and many internet transactions cannot be made. The potential loss of cellular phone communication has occurred in localized events, but it has not yet been regionally experienced. Severe storms or atmospheric/solar activity have the potential to impact radio communications. Typically, local and regional communications plans address the need for redundancy within the local, regional, and state-wide communication systems.

Finally, the disruption of water utilities and systems often requires notification of the public and businesses in order to: curtail usage; boil available water; use bottled water; etc. This may also impact local firefighting activities.

Past Occurrences

The County does not track incidences of utility disruption. According to the 2018 Colorado State Hazard Mitigation Plan (based on data from the US Department of Energy), during the years 2000-2016 Colorado experienced 15 electrical transmission outages, affecting more than 677,000 customers. The duration of these outages ranged from one minute, to nearly 67 hours. Only two of those outages appear to have affected Larimer County. Note however these numbers only include outages reported to the DOE, and certainly exclude many smaller outages.

Additional recent power failures impacting Colorado include:

2008 Windsor Tornado: The Windsor tornado damaged at least three power transmission lines, including a pair of 230,000-volt lines at the Fort St. Vrain power plant near Platteville. Additionally, 200 power poles and a half-dozen transmission poles were damaged or destroyed. At least 60,000 citizens lost power as the storm passed through the region.

2013 Colorado Floods: These severe floods resulted in a loss of electric and natural gas service to several flooded or threatened areas. In many cases, gas service was deliberately turned off as a protective measure; however, the fact that gas valves must be physically turned on by technicians makes restoration a slow and meticulous process. The floods also had a severe impact on Colorado’s oil & gas industry, shutting down 1000 wells and spilling thousands of gallons of fuel.

2019 Elk Fire: This fire resulted in large utility outages that also affected all landline phones due to the infrastructure in the area of the fire and a lack of redundancy in the utility systems for that area.

Location

Utility Disruptions can occur in any populated area of the County. They have the potential to be more severe or long-lasting in rural areas, where there may be fewer alternatives or alternative systems and where cold temperatures are more common.

Magnitude/Severity

A natural or human-caused disaster could disable key utility facilities, resulting in local, statewide, or possibly regional outages. A widespread electricity outage could cause shortages in generation of fuel supplies and vice versa. Utility disruption events of most concern include those large-scale disruption events that could potentially last for more than three days. Events of this magnitude could cause major disruptions to vital services, some of which would include hospitals, fuel suppliers, food suppliers, and the agricultural community.

Most critical infrastructure sectors rely heavily on communications systems to control and monitor their operations; for many businesses, losing communications is as serious an interruption as losing power. Emergency Services in particular rely heavily on communications systems, both internally-owned and commercial, to coordinate their operations, as well as to send information to and from the public. According to Ernst & Young's Global Information Security Survey 2002, the top causes of business interruption failures are hardware or software failure (56%) and telecommunications failure (49%). The information technology sector is almost entirely reliant on communications systems; indeed, as more communications systems transition to digital and Internet-based services, the line between “communications” and “data” has become increasingly blurred. Additionally, cell phones and Voice Over Internet Protocol (VOIP) services are more vulnerable to power outages than traditional “landline” phones.

A drinking water contamination incident or the denial of drinking water services could severely impact manufacturing facilities, food and agricultural operations, healthcare services, and the operation of government and emergency services. A major, prolonged loss of clean water could have far-reaching public health, economic, environmental, and psychological impacts. Disruption of wastewater treatment facilities or services can cause loss of life, economic impacts, and severe public health and environmental impacts. If wastewater infrastructure were to be severely damaged or destroyed, the lack of redundancy in the sector might cause a loss of service potentially affecting the habitability of homes and workspaces in all sectors.

Speed of Onset

Some outages can occur with little-to-no advance warning, such as with an equipment failure or a cyber-attack. In other cases, advance indications such as a prolonged heat wave or a disruption in out-of-state fuel supply may provide some warning hours or days ahead of time.

Duration

Depending upon the cause, outages can last a few seconds, a few hours, or in extreme cases several days. The average duration of power interruption in the United States is seven minutes, and the vast majority of interruptions are less than 24 hours in duration.

Probability of Future Occurrences

In Colorado, utility outages result more often from failures in the distribution system rather than shortages of supply. Distribution systems are most susceptible to failure during extreme hot and cold temperatures as well as during violent weather conditions. The 2018 Colorado State Hazard Mitigation Plan list the following natural and human-caused hazards as most likely to lead to severe power disruptions:

- Cyber Attack
- Winter Weather
- Thunderstorm
- Tornado
- Wildfire
- Flood
- Explosive Attack
- Major Transport Disruption
- Dam Failure

As both population and climate variability increase across the State of Colorado, and put more pressure on aging distribution systems, it is likely that utility disturbance events will become more frequent in and around Larimer County.

Climate Change Considerations

Climate change projections show an increase in the frequency and severity of many of the hazards that impact the energy sector, thus potentially leading to an increase in the frequency of power failures. Higher average temperatures can be expected to put increased demand on the energy sector during summer months, while colder-than-normal temperatures can increase load during winter months. Higher average temperatures could also place increased load on Colorado's water supply. Additional large-scale wildfires can lead to overheating transmission lines which can also cause power outages in disaster areas.

Vulnerability Assessment

People

Much of our modern way of life is built around an assumption of easily-accessible and uninterrupted power supply. Utility failures can severely impact the health and safety of the public, particularly for children or elderly residents. An outage at any time poses risks to vulnerable populations who cannot be without water and electricity for medical treatments or refrigerated medications. Loss of water and electricity also poses a large risk to hospitals and health systems. During periods of extreme heat or cold, loss of electricity can pose a safety hazard. In the planning area, 36% of homes are heated by utility gas and 55% by electricity. This can be particularly dangerous to people who rely on electricity dependent medical equipment.

General Property

Utility outages rarely cause direct property damage. Downed power lines might directly fall on houses or indirectly cause fires. Water or sewer pipe breaks or backups might cause flooding to property.

Critical Facilities and Infrastructure

Virtually every critical infrastructure sector is heavily energy-dependent. Maintaining commercial, government, and even basic intra-organizational disaster response capabilities during a long-term and large-scale energy disruption becomes increasingly difficult over time.

Power failures are particularly critical at sites where the environment and public safety are at risk. Many critical facilities such as hospitals, telecommunications sites, and water treatment plants typically have backup power sources such as standby generators; however, it is not uncommon to have such generators fail just when they're needed most. And some facilities such as shelter sites, and even some local Emergency Operations Centers (EOCs) may not have generators at all. Furthermore, resupplying generators with diesel fuel becomes an additional logistical issue.

Economy

The costs associated with energy-sector disruptions are known to be significant. According to a 2005 study, losses due to power interruption across all business sectors are estimated at between $104-164 billion annually, and costs associated with power quality problems are estimated at $15-24 billion annually. Industrial, tech, and digital business firms lose an estimated $5.7 billion annually due to power interruption, and among high-tech business firms, the costs of downtime due to power interruption can exceed $1 million per minute. In 2009, the US Department of Energy estimated that power outages cost an average of $150 billion annually, or about $500 for every US citizen per year.

Though residential consumers are heavily impacted by electrical disruptions, the commercial and industrial sectors account for most financial losses. Even short-term interruptions can incur significant costs, due to the nature of industrial and information technology processes: a momentary interruption or transient fault may produce substantial waste of industrial resources and business time, as production lines must be halted and restarted. Likewise, in the information technology and financial sectors, the costs of data loss and operational downtime can be substantial. For vulnerable public agencies and private-sector businesses, the costs of data loss may remain constant regardless of total downtime. Similarly, even short outages can have a great effect on refineries, as evidenced by an outage at Suncor's Commerce City refinery in 2007. The power disruption was brief, but it caused the refinery to take much of its machinery offline to perform damage check before restarting. This shutdown ultimately resulted in a production loss of 50,000 barrels of gasoline and 30,000 barrels of diesel and jet fuel.

Historic, Cultural and Natural Resources

Utility outages rarely have significant impacts on historic, cultural or natural resources

Future Land Use and Development

Future development can increase vulnerability to infrastructure failure by placing additional strains on existing infrastructure, as well as by increasing the size and thus the exposure of infrastructure networks. As development expands into undeveloped areas, Larimer County may face higher risks of utility disruption. Sprawling development and the subsequent extension of utilities may increase the vulnerability of the county and its communities to utility disruption due to increased demand and increased exposure of utility lines. In developed areas, increased population densities and economic activity over time has potential to put additional stress on already overtaxed utility systems.

Risk Summary

- May occur as a secondary effect of severe weather or another hazard, or as the result of an accident, system overloading, or terrorism.
- Small outages affecting a few people for a short time are commonplace; larger, longer-lasting outages occur less often but are not unknown.
- Greatest impacts are during periods of extreme heat or extreme cold.
- Impacts are more significant on people who rely on electricity for their health or independence.
- Related Hazards: Dam Inundation, Earthquake, Flood, Landslide/Rockslide, Spring/Summer Storm, Tornado, Wildfire, Winter Storm.

4.3.13 Wildfire

Hazard	Frequency	Spatial Extent	Severity	Overall Significance
Fire – Wildland	Highly Likely	Significant	Critical	High

Description

Wildfires are defined as unwanted or unplanned wildland fires. They include unauthorized human caused fires, escaped prescribed burn projects, and all other wildland fires where the objective is to put the fire out.

Wildfires are fueled by natural ground cover, including native and non-native species of trees, brush and grasses, and crops along with weather conditions and topography. While available fuel, topography, and weather provide the conditions that allow wildfires to spread, the majority of wildfires in Colorado are caused by people through criminal or accidental misuse of fire.

Wildfires pose serious threats to human safety and property in Larimer County. They can destroy crops, timber resources, recreation areas, and critical wildlife habitat. Wildfires are commonly perceived as hazards in the western part of the state; however, wildfires are a growing problem in the wildland-urban interfaces of eastern Colorado, including communities within Larimer County.

Figure 4-40 Fire in Larimer County, CO.

Source: Poudre Fire Authority

Wildfire behavior is dictated in part by the quantity and quality of available fuels. Fuel quantity is the mass of material per unit area. Fuel quality is determined by a number of factors, including fuel density, chemistry, and arrangement. Arrangement influences the availability of oxygen surrounding the fuel source. Another important aspect of fuel quality is the total surface area of the material that is exposed to heat and air. Fuels with large area-to-volume ratios, such as grasses, leaves, bark and twigs, are easily ignited when dry.

Climatic and meteorological conditions that influence wildfires include solar insolation, atmospheric humidity, and precipitation, all of which determine the moisture content of wood and leaf litter. Dry spells, heat, low humidity, and wind increase the susceptibility of vegetation to fire. Additional natural agents can be responsible for igniting wildfires, including lightning, sparks generated by rocks rolling down a slope, friction produced by branches rubbing together in the wind, and spontaneous combustion. According to the 2018 Colorado State Hazard Mitigation Plan, over the past two decades Colorado has experienced an increase in insect infestations that have left vast areas of forest vulnerable to wildfire.

Arson and accidents, including sparks from equipment and vehicles, can also cause wildfires. Arson and accidental fires usually start along roads, trails, streams, or at dwellings that are generally on lower slopes or bottoms of hills and valleys. Nurtured by updrafts, these fires can spread quickly uphill. Arson fires are often set deliberately at times when factors such as wind, temperature, and dryness contribute to the spread of flames.

Predicting the intensity of a wildfire, its rate of spread, and its duration are important for wildfire mitigation activity, response, and firefighter safety. Three key factors affect wildfire behavior in the WUI:

1. Fuels: The type, density, and continuity of surrounding vegetation and, sometimes, flammable structures, that provide fuel to keep a wildfire burning. Fuels consist of combustible materials and vegetation (including grasses, leaves, ground litter, plants, shrubs, and trees) that feed a fire.
2. Weather: Relative humidity, wind, and temperatures all affect wildfire threat and behavior.
3. Topography: The steepness and aspect (direction) of slopes, as well as building-site locations, are features that affect fire behavior.

Very often the only factor that a community can mitigate is fuel.

Wildfires are often rated based on their ability of their fuels to ignite. Descriptions for the commonly used "Fire Danger Rating" system are listed below:

- Low: Fuels do not ignite readily from small firebrands. However, an intense heat source, such as lightning, may start fires in duff or rotted wood. Fires in open grasslands may burn freely for a few hours after rain, but wood fires spread slowly by creeping or smoldering, and burn in irregular fingers. There is little danger of spotting.
- Moderate: Fires can start from most accidental causes, with the exception of lightning. Fires in open grasslands will burn briskly and rapidly on windy days. Timber fires spread slowly to moderately fast. The average fire is of moderate intensity, although heavy concentrations of fuel may burn hot. Short-distance spotting may occur. Fires are not likely to become serious and control is relatively easy.
- High: All fine dead fuels ignite readily, and fires start easily from most causes. Unattended brush and campfires are likely to escape. Fires spread rapidly and short-distance spotting is common. High-intensity burning may develop on slopes or in concentrations of fine fuels. Fires may become serious and their control difficult unless they are attacked successfully while small.
- Extreme/Very High: Fires start easily from all causes and immediately after ignition, spread rapidly and increase quickly in intensity. Spot fires are a constant danger. Fires burning in light fuels may quickly develop intensity characteristics such as long-distance spotting and fire whirlwinds when they burn into heavier fuels.

Past Occurrences

According to the best available data compiled by USGS and CO-WRAP, there have been 874 wildfire events in Larimer County from 1980 to 2018. While as noted above, most wildfires in Colorado result from human action, of the 874 wildfires in Larimer County 65% were natural and 35% were human-caused.

These events are detailed in Table 4-74. Figure 4-42 shows the burned areas for all events from 2000-2018 that burned 10 or more acres.

Figure 4-41 High Park Fire Northwest of Horsetooth Reservoir Near Fort Collins, June 11, 2012

Source: RJ Sangosti, The Denver Post

Per the data on past wildfire events compiled by USGS and CO-WRAP, 125,749 acres burned as a result of the 874 recorded wildfires that occurred from 1980 to 2018. This averages to 143.9 acres per wildfire event, 22 wildfires per year, and 3,224.3 acres per year. Of these events, 59 burned at least 10 acres. These larger fires accounted for 125,242.5 acres burned, which is over 99% of the total acreage burned during the period of record. Fires of 10 acres or more occurred in 26 of the 39 years on record. Table 4-73 summarizes past wildfire occurrences by year from 1980 through 2018 (the last year for which complete data is available).

Figure 4-42 Larimer County Wildfire History, 2000-2018

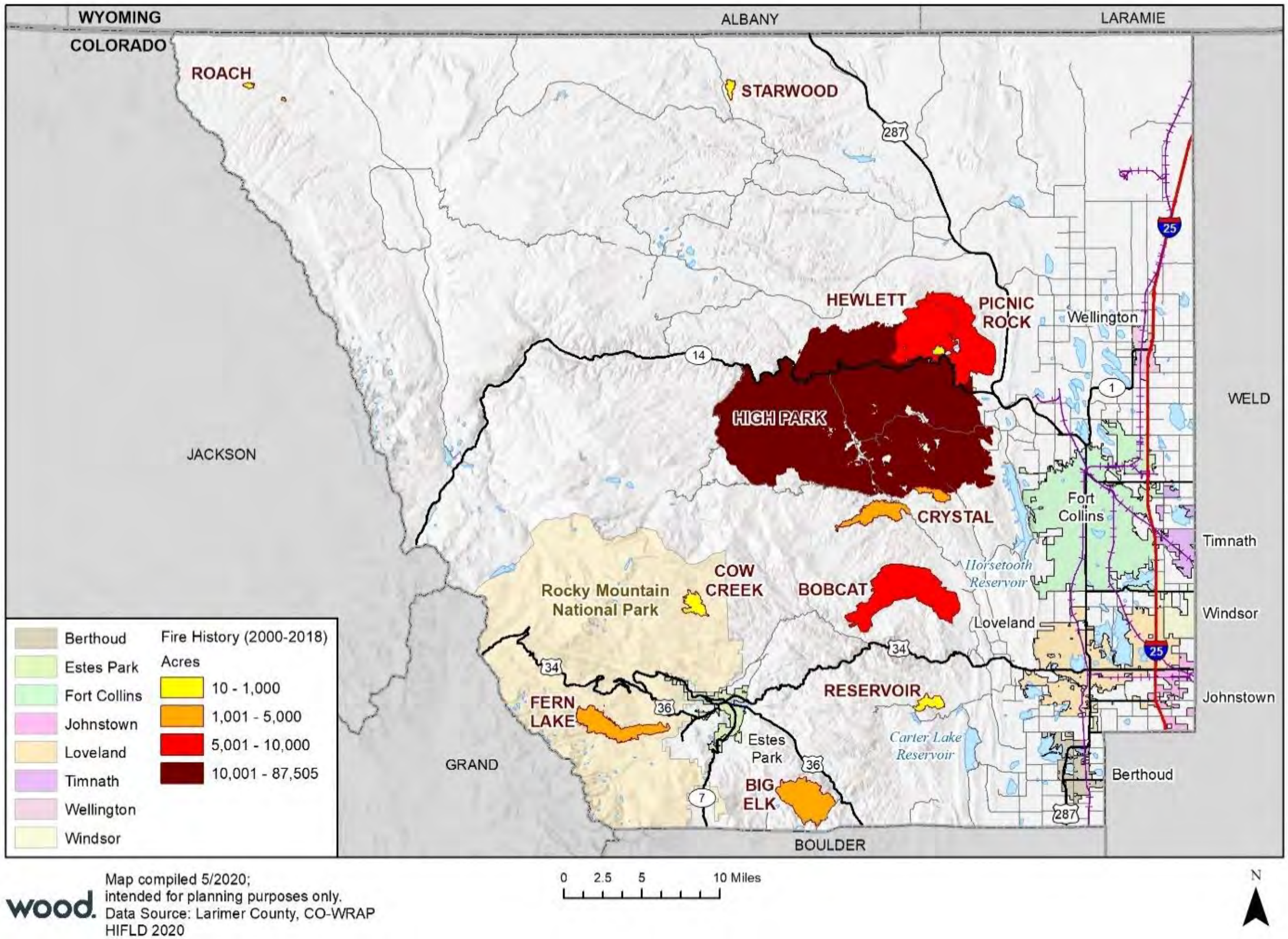


Table 4-73 Summary of Wildfires in Larimer County by Year

Year	Count of Wildfire Events	Total Acres Burned	Year	Count of Wildfire Events	Total Acres Burned
1980	3	0.3	2000	38	10,908.2
1981	2	0.2	2001	45	20.8
1982	2	1.1	2002	40	4,918.4
1983	1	0.1	2003	33	31.7
1984	1	0.1	2004	10	35.55
1985	1	0.1	2005	40	124.25
1986	27	67.4	2006	33	88
1987	28	150.6	2007	26	21.31
1988	46	3057.1	2008	34	108.63
1989	30	482.3	2009	22	90.56
1990	30	162.1	2010	17	1,218.15
1991	29	22.2	2011	28	2,984.19
1992	23	3.5	2012	29	98,605.81
1993	19	307.6	2013	18	36.98
1994	49	483.7	2014	13	7.4
1995	19	36.6	2015	28	1,033.18
1996	22	233.7	2016	17	10.39
1997	26	23.7	2017	0	0.0
1998	22	227.8	2018	1	230.3
1999	22	15			
			Total	**874**	**125,749**

Source: USFS, CO-WRAP

Table 4-74 Historical Wildfires – Larimer County, 1980-2018

Fire Name	Cause	Year	Start Date	Out Date	Total Acres
Thompson	Human	1980	6/18/1980	6/18/1980	0.1
Fall River	Human	1980	9/11/1980	9/18/1980	0.1
Wind River	Human	1980	10/6/1980	10/8/1980	0.1
Handicamp	Human	1981	6/24/1981	6/24/1981	0.1
Alberta Fl	Human	1981	10/1/1981	10/1/1981	0.1
Bone Yard	Human	1982	3/11/1982	3/12/1982	1
Upper Mora	Human	1982	11/8/1982	11/8/1982	0.1
Hubcap	Natural	1983	7/8/1983	7/10/1983	0.1
Hollowell	Human	1984	5/23/1984	5/23/1984	0.1
Iron Dike	Human	1985	9/6/1985	9/6/1985	0.1
	Natural	1986	3/8/1986	3/10/1986	1
	Natural	1986	5/23/1986	5/23/1986	0.4
	Natural	1986	6/14/1986	6/17/1986	1
	Human	1986	6/19/1986	6/21/1986	2
	Human	1986	7/13/1986	7/16/1986	1
	Human	1986	7/17/1986	7/20/1986	1
	Natural	1986	8/2/1986	8/5/1986	0.3
	Natural	1986	8/3/1986	8/5/1986	0.3

Fire Name	Cause	Year	Start Date	Out Date	Total Acres
	Natural	1986	8/3/1986	8/3/1986	0.1
	Human	1986	8/5/1986	8/8/1986	3
	Human	1986	8/5/1986	8/10/1986	48
	Natural	1986	8/5/1986	8/8/1986	4
	Natural	1986	8/6/1986	8/7/1986	0.3
	Human	1986	8/8/1986	8/10/1986	0.1
	Natural	1986	8/8/1986	8/9/1986	0.1
	Natural	1986	8/9/1986	8/10/1986	0.1
	Natural	1986	8/9/1986	8/10/1986	0.1
	Natural	1986	8/11/1986	8/12/1986	0.1
Estes Cone	Natural	1986	8/11/1986	8/11/1986	0.1
	Natural	1986	8/16/1986	8/17/1986	0.1
	Human	1986	8/17/1986	8/18/1986	0.1
	Natural	1986	8/18/1986	8/19/1986	0.2
	Human	1986	8/18/1986	8/19/1986	0.8
	Natural	1986	8/18/1986	8/20/1986	2.5
	Natural	1986	8/18/1986	8/20/1986	0.1
	Human	1986	9/16/1986	9/16/1986	0.1
	Natural	1986	10/15/1986	10/15/1986	0.5
	Human	1987	6/6/1987	6/8/1987	1
	Human	1987	6/13/1987	6/13/1987	0.1
	Natural	1987	6/25/1987	6/28/1987	0.1
	Natural	1987	6/27/1987	6/30/1987	1.5
	Natural	1987	7/5/1987	7/6/1987	0.1
	Natural	1987	7/7/1987	7/8/1987	0.3
	Natural	1987	7/8/1987	7/10/1987	0.3
	Natural	1987	7/9/1987	7/12/1987	0.2
	Human	1987	7/21/1987	7/27/1987	20
Eagle Cliff	Natural	1987	7/21/1987	7/21/1987	0.1
	Human	1987	7/24/1987	7/31/1987	0.3
	Human	1987	7/26/1987	7/28/1987	0.1
Johnston	Natural	1987	7/27/1987	7/27/1987	0.1
	Human	1987	7/29/1987	8/2/1987	1.7
	Human	1987	8/6/1987	8/7/1987	0.3
	Natural	1987	8/14/1987	8/16/1987	0.1
	Natural	1987	8/16/1987	8/19/1987	1.5
Wind River	Human	1987	8/19/1987	8/20/1987	0.8
	Natural	1987	9/2/1987	9/5/1987	100
Knife’s Edge	Natural	1987	9/12/1987	9/14/1987	0.1
	Natural	1987	9/21/1987	9/23/1987	10
	Natural	1987	9/25/1987	9/26/1987	0.1
Aspenglen	Human	1987	10/10/1987	10/10/1987	0.1
	Natural	1987	10/11/1987	10/13/1987	0.3
	Human	1987	10/11/1987	10/17/1987	6
	Natural	1987	10/20/1987	10/24/1987	0.1
	Natural	1987	10/23/1987	10/25/1987	0.3
	Natural	1987	10/26/1987	10/28/1987	5
	Human	1988	6/8/1988	6/16/1988	0.1
	Natural	1988	6/8/1988	6/11/1988	0.1
	Human	1988	6/13/1988	6/16/1988	3

Fire Name	Cause	Year	Start Date	Out Date	Total Acres
	Natural	1988	6/13/1988	6/13/1988	0.1
	Natural	1988	6/15/1988	6/16/1988	0.1
	Natural	1988	6/17/1988	6/25/1988	20
Fallriver	Natural	1988	6/19/1988	6/19/1988	0.1
	Natural	1988	6/21/1988	6/22/1988	0.1
Cublake	Natural	1988	6/21/1988	6/22/1988	0.2
	Human	1988	6/22/1988	6/23/1988	0.2
	Natural	1988	6/29/1988	6/30/1988	0.1
	Natural	1988	7/2/1988	7/3/1988	0.2
	Human	1988	7/3/1988	7/3/1988	0.1
	Natural	1988	7/5/1988	7/8/1988	0.2
	Human	1988	7/6/1988	7/7/1988	0.1
	Natural	1988	7/10/1988	7/13/1988	0.1
	Natural	1988	7/11/1988	7/11/1988	0.1
	Natural	1988	7/13/1988	7/15/1988	0.2
	Human	1988	7/14/1988	7/27/1988	200
	Human	1988	7/17/1988	7/18/1988	0.2
	Natural	1988	7/17/1988	7/19/1988	0.1
	Natural	1988	7/25/1988	7/28/1988	3
	Natural	1988	7/25/1988	7/27/1988	1
	Human	1988	7/31/1988	8/1/1988	0.2
	Natural	1988	7/31/1988	8/4/1988	0.2
	Natural	1988	8/1/1988	8/7/1988	0.1
	Human	1988	8/7/1988	8/9/1988	0.1
	Human	1988	8/18/1988	8/20/1988	0.3
	Natural	1988	8/23/1988	8/28/1988	20
	Natural	1988	8/23/1988	8/25/1988	0.1
	Natural	1988	8/25/1988	8/25/1988	0.1
	Natural	1988	8/27/1988	8/29/1988	0.1
Switchback	Natural	1988	8/27/1988	8/28/1988	0.1
	Natural	1988	8/30/1988	9/1/1988	0.3
	Natural	1988	8/31/1988	9/5/1988	0.2
	Natural	1988	8/31/1988	9/1/1988	0.5
	Natural	1988	9/4/1988	9/5/1988	0.1
Grace Creek	Natural	1988	9/6/1988	10/26/1988	2800
Willowpark	Human	1988	9/7/1988	9/7/1988	0.1
	Natural	1988	9/8/1988	9/11/1988	2
	Natural	1988	9/10/1988	9/13/1988	2
	Natural	1988	9/17/1988	9/19/1988	0.1
	Natural	1988	9/19/1988	9/21/1988	0.8
Bierstadt	Natural	1988	10/9/1988	10/9/1988	0.1
	Natural	1988	10/22/1988	10/22/1988	0.1
	Natural	1988	11/1/1988	11/1/1988	0.1
	Natural	1989	4/22/1989	4/25/1989	1.5
	Natural	1989	5/23/1989	5/24/1989	0.3
	Natural	1989	5/31/1989	5/31/1989	0.1
	Natural	1989	6/1/1989	6/2/1989	0.1
	Natural	1989	6/11/1989	6/13/1989	0.1
	Natural	1989	6/29/1989	6/30/1989	0.1
	Natural	1989	6/29/1989	7/30/1989	364

Fire Name	Cause	Year	Start Date	Out Date	Total Acres
	Human	1989	7/6/1989	7/7/1989	0.1
	Human	1989	7/7/1989	7/8/1989	0.1
	Human	1989	7/8/1989	7/9/1989	0.1
	Natural	1989	7/10/1989	7/10/1989	0.1
	Human	1989	7/14/1989	7/15/1989	0.1
	Natural	1989	7/29/1989	7/30/1989	0.1
McCullough	Human	1989	8/1/1989	8/1/1989	0.1
	Human	1989	8/6/1989	8/6/1989	0.1
	Natural	1989	8/7/1989	8/7/1989	0.1
	Human	1989	8/8/1989	8/9/1989	0.1
Vts Lot	Natural	1989	8/9/1989	8/9/1989	0.1
Cub Lake	Human	1989	8/11/1989	8/11/1989	0.1
	Natural	1989	8/12/1989	8/13/1989	0.1
	Natural	1989	8/14/1989	8/15/1989	0.1
	Human	1989	8/14/1989	8/14/1989	0.1
	Natural	1989	8/29/1989	8/31/1989	0.1
	Human	1989	9/3/1989	9/3/1989	0.1
	Human	1989	9/4/1989	9/10/1989	100.1
	Natural	1989	9/21/1989	9/27/1989	10
	Human	1989	10/1/1989	10/3/1989	3
	Natural	1989	10/7/1989	10/9/1989	0.2
Over Hill	Human	1989	10/14/1989	10/16/1989	1
	Natural	1989	10/20/1989	10/21/1989	0.1
	Natural	1990	1/11/1990	1/14/1990	1
	Human	1990	6/19/1990	6/22/1990	6
	Natural	1990	6/24/1990	6/26/1990	0.5
	Natural	1990	6/25/1990	6/27/1990	5
	Natural	1990	6/25/1990	7/5/1990	141
	Human	1990	6/25/1990	6/26/1990	0.1
	Natural	1990	6/25/1990	6/28/1990	2.5
	Natural	1990	6/25/1990	6/28/1990	1
	Natural	1990	6/26/1990	6/26/1990	0.2
	Natural	1990	6/26/1990	6/27/1990	0.1
	Natural	1990	6/26/1990	6/26/1990	0.1
	Natural	1990	6/26/1990	6/27/1990	0.1
	Natural	1990	6/26/1990	6/27/1990	0.1
	Human	1990	6/27/1990	6/30/1990	1
	Natural	1990	6/30/1990	6/30/1990	0.1
	Natural	1990	7/3/1990	7/3/1990	0.2
Moraine Pk	Natural	1990	7/3/1990	7/4/1990	0.1
	Natural	1990	7/6/1990	7/6/1990	0.1
	Natural	1990	7/16/1990	7/18/1990	0.3
	Natural	1990	7/17/1990	7/18/1990	0.1
	Natural	1990	7/28/1990	7/30/1990	0.1
Steep	Natural	1990	7/29/1990	7/30/1990	0.1
	Human	1990	8/11/1990	8/12/1990	0.1
	Natural	1990	8/27/1990	8/29/1990	1
	Human	1990	8/30/1990	9/1/1990	0.2
	Natural	1990	8/30/1990	8/31/1990	0.1
	Natural	1990	9/2/1990	9/3/1990	0.1

Fire Name	Cause	Year	Start Date	Out Date	Total Acres
	Natural	1990	9/2/1990	9/3/1990	0.1
Chaos	Natural	1990	9/11/1990	9/12/1990	0.4
Many Parks	Natural	1990	9/26/1990	9/27/1990	0.3
	Natural	1991	3/30/1991	3/31/1991	0.1
	Human	1991	4/29/1991	5/1/1991	0.1
	Natural	1991	5/14/1991	5/16/1991	1
	Natural	1991	6/24/1991	6/25/1991	0.1
	Natural	1991	6/28/1991	6/29/1991	0.1
	Human	1991	6/28/1991	6/30/1991	5
Pumphouse	Natural	1991	6/29/1991	6/29/1991	0.1
Flat Top	Human	1991	7/4/1991	7/4/1991	0.1
	Natural	1991	7/5/1991	7/8/1991	0.8
	Natural	1991	7/5/1991	7/6/1991	0.1
	Natural	1991	7/5/1991	7/6/1991	0.1
	Natural	1991	7/6/1991	7/6/1991	0.1
	Natural	1991	7/12/1991	7/13/1991	0.3
	Natural	1991	7/15/1991	7/16/1991	0.8
	Natural	1991	7/15/1991	7/18/1991	0.1
	Natural	1991	7/16/1991	7/21/1991	11
	Natural	1991	7/18/1991	7/20/1991	0.1
	Natural	1991	7/19/1991	7/20/1991	0.3
	Natural	1991	7/19/1991	7/19/1991	0.1
	Natural	1991	7/19/1991	7/21/1991	0.1
	Natural	1991	8/23/1991	8/24/1991	0.1
	Natural	1991	8/23/1991	8/28/1991	0.1
	Natural	1991	9/3/1991	9/5/1991	0.1
	Human	1991	9/8/1991	9/9/1991	0.1
Moraine Pk	Natural	1991	9/21/1991	9/22/1991	0.1
	Natural	1991	9/28/1991	9/29/1991	0.1
Bear Lake	Human	1991	9/29/1991	9/30/1991	0.1
	Natural	1991	10/11/1991	10/13/1991	0.5
Ute Trail	Human	1991	10/17/1991	10/19/1991	0.5
	Human	1992	2/6/1992	2/6/1992	0.1
	Natural	1992	5/8/1992	5/11/1992	0.1
	Natural	1992	5/19/1992	5/20/1992	0.5
	Natural	1992	5/20/1992	5/20/1992	0.1
	Natural	1992	5/25/1992	5/26/1992	0.1
	Natural	1992	6/12/1992	6/13/1992	0.1
	Natural	1992	6/12/1992	6/13/1992	0.1
	Human	1992	6/17/1992	6/17/1992	0.1
	Natural	1992	8/4/1992	8/4/1992	0.1
	Natural	1992	8/9/1992	8/10/1992	0.1
	Natural	1992	8/10/1992	8/10/1992	0.1
	Natural	1992	8/11/1992	8/11/1992	0.1
	Natural	1992	8/14/1992	8/15/1992	0.1
	Natural	1992	8/20/1992	8/22/1992	0.2
	Natural	1992	8/21/1992	8/21/1992	0.1
Steep Mt	Natural	1992	8/23/1992	8/24/1992	0.1
	Human	1992	9/8/1992	9/8/1992	0.1
	Natural	1992	9/15/1992	9/16/1992	0.1

Fire Name	Cause	Year	Start Date	Out Date	Total Acres
	Natural	1992	9/20/1992	9/20/1992	0.1
	Natural	1992	10/7/1992	10/9/1992	0.1
	Natural	1992	10/11/1992	10/19/1992	0.8
	Human	1992	10/18/1992	10/18/1992	0.1
	Natural	1992	10/26/1992	10/26/1992	0.1
	Human	1993	5/6/1993	5/7/1993	1
	Natural	1993	5/14/1993	5/15/1993	0.1
	Natural	1993	6/10/1993	6/11/1993	0.1
	Natural	1993	6/22/1993	6/24/1993	0.1
	Natural	1993	6/27/1993	6/30/1993	30
Snowtop	Natural	1993	7/9/1993	7/19/1993	275
	Human	1993	7/11/1993	7/14/1993	0.1
	Human	1993	7/16/1993	7/18/1993	0.1
	Natural	1993	7/20/1993	7/24/1993	0.1
	Natural	1993	7/29/1993	7/29/1993	0.1
	Natural	1993	7/30/1993	8/1/1993	0.1
	Human	1993	7/31/1993	8/5/1993	0.1
	Human	1993	8/5/1993	8/5/1993	0.1
Twin Sister	Human	1993	8/14/1993	8/15/1993	0.1
	Natural	1993	8/17/1993	8/25/1993	0.1
	Natural	1993	8/24/1993	8/25/1993	0.1
	Natural	1993	9/2/1993	9/5/1993	0.1
	Natural	1993	9/3/1993	9/5/1993	0.1
	Natural	1993	9/11/1993	9/15/1993	0.1
Hood Incident	Natural	1994	1/19/1994	1/19/1994	3
Twin Cabin Gulch	Natural	1994	4/3/1994	4/10/1994	3
Swamp Creek	Human	1994	5/12/1994	5/12/1994	0.1
Lily Lake	Human	1994	6/14/1994	6/14/1994	0.5
Tuxedo	Natural	1994	6/18/1994	6/18/1994	0.1
Bierstadt	Natural	1994	6/19/1994	6/19/1994	0.1
Lonetree	Natural	1994	6/23/1994	6/24/1994	0.1
Derby	Natural	1994	6/25/1994	6/25/1994	0.1
Lady Moon	Natural	1994	6/29/1994	6/30/1994	1
Alexander 3	Natural	1994	7/1/1994	7/2/1994	0.1
Devil's Creek	Natural	1994	7/4/1994	7/6/1994	0.7
Eggers	Natural	1994	7/10/1994	7/30/1994	370
Hells Canyon	Natural	1994	7/11/1994	7/15/1994	50
Pole Hill	Natural	1994	7/11/1994	7/15/1994	3.5
Palisade	Natural	1994	7/11/1994	7/16/1994	1
Lone Pine	Natural	1994	7/11/1994	7/12/1994	0.3
Creedmore	Natural	1994	7/11/1994	7/12/1994	0.1
McGraw	Natural	1994	7/11/1994	7/13/1994	0.1
Jug Gulch	Natural	1994	7/12/1994	7/18/1994	30
White Pine	Natural	1994	7/12/1994	7/13/1994	0.1
Countyline	Natural	1994	7/13/1994	7/14/1994	0.1
Fish Creek	Natural	1994	7/15/1994	7/15/1994	0.2
Long Draw	Natural	1994	7/15/1994	7/17/1994	1
Eaton	Natural	1994	7/15/1994	7/16/1994	0.5
Indian Meadows I	Natural	1994	7/16/1994	7/16/1994	0.1
Nunn Creek	Natural	1994	7/16/1994	7/16/1994	0.1

Fire Name	Cause	Year	Start Date	Out Date	Total Acres
Mount Olympus	Natural	1994	7/18/1994	7/19/1994	1
Cameron	Natural	1994	7/19/1994	9/4/1994	3
Power Plant	Natural	1994	7/22/1994	7/24/1994	0.1
Grey Rock	Natural	1994	7/22/1994	7/24/1994	0.5
Ansel	Natural	1994	7/23/1994	7/24/1994	0.1
Nicomas	Natural	1994	7/23/1994	7/24/1994	0.1
Rockpile	Natural	1994	7/27/1994	7/28/1994	0.7
Gem Lake	Natural	1994	7/29/1994	7/30/1994	0.1
Indian Meadows 2	Natural	1994	7/30/1994	8/3/1994	0.1
Seam Rock	Natural	1994	8/1/1994	8/2/1994	1
South Cow	Natural	1994	8/2/1994	8/4/1994	0.1
South Cow	Natural	1994	8/2/1994	8/4/1994	0.1
Salt Cabin	Natural	1994	8/5/1994	8/8/1994	0.1
Elkhoof	Natural	1994	8/5/1994	8/8/1994	0.1
Hewlett Gulch	Natural	1994	8/5/1994	8/8/1994	7
Grey Rock	Natural	1994	8/5/1994	8/7/1994	0.1
Ski Slope	Natural	1994	8/7/1994	8/8/1994	0.1
Fall River	Natural	1994	8/10/1994	8/11/1994	0.1
Link Creek	Natural	1994	8/15/1994	8/18/1994	0.1
	Natural	1994	8/16/1994	8/18/1994	3
Little	Natural	1994	8/27/1994	8/28/1994	0.1
Roach	Natural	1994	9/8/1994	9/10/1994	0.1
Roaring Creek	Natural	1994	9/9/1994	9/10/1994	0.1
Grey Rock	Human	1995	4/5/1995	4/8/1995	0.1
Bennett	Natural	1995	6/21/1995	6/23/1995	14
California Gulch	Natural	1995	7/14/1995	7/15/1995	0.1
Eagle Cliff	Natural	1995	7/23/1995	7/30/1995	0.1
Stratton	Natural	1995	7/29/1995	8/2/1995	12
Grey Rock North	Natural	1995	8/1/1995	8/3/1995	1
Poverty Flats	Natural	1995	8/2/1995	8/3/1995	5
Hyatt Hill	Natural	1995	8/3/1995	8/5/1995	0.1
Hodge	Natural	1995	8/4/1995	8/6/1995	0.1
Palisade Mtn	Natural	1995	8/5/1995	8/5/1995	0.5
Big South Trail	Human	1995	8/9/1995	8/13/1995	0.3
North Bald	Natural	1995	8/13/1995	8/14/1995	0.1
Bald	Natural	1995	8/17/1995	8/18/1995	0.1
Shakedown	Natural	1995	8/18/1995	8/19/1995	1.5
Almost	Natural	1995	8/18/1995	8/19/1995	0.1
Pierson Park	Natural	1995	8/20/1995	8/22/1995	0.1
Ballard	Natural	1995	8/31/1995	9/3/1995	1
Cedar Gulch	Natural	1995	9/3/1995	9/3/1995	0.1
Devils Gulch	Natural	1995	9/14/1995	9/15/1995	0.3
Eggers	Natural	1996	5/9/1996	5/10/1996	0.1
Stove Prairie	Human	1996	5/12/1996	5/13/1996	1
Crystal	Human	1996	5/17/1996	5/29/1996	178.1
McGregor	Natural	1996	5/23/1996	5/23/1996	0.1
Storm	Natural	1996	6/10/1996	6/15/1996	8
Indianhead	Natural	1996	6/10/1996	6/10/1996	0.1
Bennett Creek	Natural	1996	6/11/1996	6/15/1996	1.3
North Fork	Natural	1996	7/7/1996	7/8/1996	0.1

Fire Name	Cause	Year	Start Date	Out Date	Total Acres
Drake	Natural	1996	7/23/1996	7/26/1996	0.3
Lone Pine I	Natural	1996	7/23/1996	7/25/1996	0.1
Cottontail	Natural	1996	7/24/1996	7/25/1996	0.1
Diversion	Natural	1996	8/2/1996	8/4/1996	0.1
Mosquito	Natural	1996	8/8/1996	8/9/1996	0.1
Rustic	Human	1996	8/11/1996	8/13/1996	33
Prospect	Natural	1996	8/15/1996	8/21/1996	2.5
Waltonia	Natural	1996	8/18/1996	8/26/1996	8
Cirque Meadow	Human	1996	8/20/1996	8/24/1996	0.1
Mineral Springs	Natural	1996	8/24/1996	8/25/1996	0.2
Duck Lake	Natural	1996	8/28/1996	8/29/1996	0.1
Roaring Creek	Human	1996	9/10/1996	9/12/1996	0.1
Sheep Creek	Human	1996	9/10/1996	9/12/1996	0.1
Stone Mountain	Natural	1996	10/3/1996	10/6/1996	0.1
Fish Creek	Natural	1997	5/20/1997	5/21/1997	0.3
Palisade	Natural	1997	6/21/1997	6/24/1997	0.1
Bierstadt	Natural	1997	6/25/1997	6/26/1997	0.1
Falls Gulch	Natural	1997	7/5/1997	7/17/1997	0.3
Many Thunders	Natural	1997	7/5/1997	7/10/1997	0.1
Kiowa Road	Human	1997	7/11/1997	7/12/1997	0.1
Lost Lake	Human	1997	7/12/1997	7/21/1997	0.3
Hondius	Human	1997	7/13/1997	7/13/1997	0.1
Sylvan Dale	Natural	1997	7/16/1997	7/18/1997	0.1
Bear Gulch	Natural	1997	7/16/1997	7/21/1997	0.1
Prairie Gulch	Natural	1997	7/16/1997	7/20/1997	0.1
Livermore	Natural	1997	7/16/1997	7/31/1997	3.5
Bighorn	Natural	1997	7/16/1997	7/22/1997	0.5
Deadman	Natural	1997	7/17/1997	7/31/1997	0.1
Crosier 2	Natural	1997	7/18/1997	7/24/1997	0.1
Crosier 1	Natural	1997	7/18/1997	7/18/1997	0.1
Big South	Human	1997	7/18/1997	7/20/1997	0.1
Deer Ridge	Natural	1997	7/18/1997	7/21/1997	0.1
North Fork	Natural	1997	7/21/1997	7/23/1997	0.8
Buck Gulch	Natural	1997	7/23/1997	7/28/1997	15
Beaver	Natural	1997	7/23/1997	7/24/1997	0.1
Mirror Lake	Human	1997	8/14/1997	8/16/1997	0.1
North Cow Creek	Natural	1997	8/23/1997	8/28/1997	0.1
Zimmerman	Human	1997	9/3/1997	9/3/1997	0.1
Buckhorn	Human	1997	9/14/1997	9/17/1997	1.2
Roaring Bone	Human	1997	9/26/1997	9/29/1997	0.1
Grey Rock	Human	1998	2/28/1998	3/18/1998	142
Snowy Owls	Human	1998	3/30/1998	4/10/1998	0.1
Mineral Springs	Natural	1998	6/30/1998	8/14/1998	0.8
Tom Bennett	Human	1998	7/2/1998	7/2/1998	0.1
Maxwell	Natural	1998	7/3/1998	7/5/1998	0.1
Sheep Mtn	Natural	1998	7/3/1998	7/8/1998	0.1
Pierson Park	Human	1998	7/13/1998	7/14/1998	0.1
Lost Lake	Human	1998	7/15/1998	7/19/1998	0.1
Pinewood	Natural	1998	7/20/1998	7/25/1998	0.1
Greenwood	Natural	1998	7/27/1998	7/29/1998	0.1

Fire Name	Cause	Year	Start Date	Out Date	Total Acres
Sheep	Natural	1998	8/10/1998	8/13/1998	0.3
Home Moraine	Natural	1998	8/10/1998	8/15/1998	0.1
Highdrive	Natural	1998	8/14/1998	8/18/1998	0.1
Crosier Lightning	Natural	1998	8/16/1998	8/20/1998	0.2
Stone Mountain #2	Natural	1998	9/8/1998	9/21/1998	80
Spruce Mountain	Human	1998	9/8/1998	9/11/1998	1
Jug Gulch	Natural	1998	9/8/1998	9/14/1998	2
Comanche	Natural	1998	9/8/1998	9/25/1998	0.1
Pingree Hill	Natural	1998	9/8/1998	9/14/1998	0.1
Parrott	Natural	1998	9/8/1998	9/9/1998	0.1
Sundance	Natural	1998	9/8/1998	9/10/1998	0.1
Surprise	Human	1998	10/14/1998	10/15/1998	0.1
Narrows	Human	1999	3/29/1999	3/29/1999	0.1
Castle Mtn	Natural	1999	5/24/1999	5/25/1999	0.1
Hummingbird	Natural	1999	6/19/1999	6/20/1999	0.1
Arrow	Natural	1999	6/21/1999	6/23/1999	0.2
Palisade	Human	1999	6/26/1999	6/29/1999	0.2
Beaver Fire	Human	1999	7/2/1999	7/8/1999	0.1
Bighorn Mt	Natural	1999	7/2/1999	7/26/1999	1.5
Deer Fire	Natural	1999	7/2/1999	7/26/1999	1.5
Button Rock	Natural	1999	7/8/1999	7/14/1999	2
Fish Creek	Natural	1999	7/13/1999	7/14/1999	4.2
Leprechaun	Natural	1999	8/3/1999	8/5/1999	0
Green Ridge	Natural	1999	8/18/1999	8/21/1999	1
Pingree Hill	Natural	1999	8/22/1999	8/22/1999	0.1
Honey Do	Natural	1999	8/26/1999	8/28/1999	0.5
Seaman	Natural	1999	8/26/1999	8/29/1999	2.4
Mitchell Ditch	Natural	1999	9/2/1999	9/3/1999	0.1
Lone Palm	Natural	1999	9/13/1999	9/15/1999	0.1
Killpecker	Human	1999	10/9/1999	10/10/1999	0.2
Lost Lake	Human	1999	10/9/1999	10/9/1999	0.1
Nunn Creek	Human	1999	10/25/1999	11/3/1999	0.2
Salt Cabin Fire	Human	1999	11/5/1999	11/6/1999	0.1
Piper Meadows Fire	Human	1999	12/4/1999	12/13/1999	0.2
Cr 47	Human	2000	9/12/2000	9/12/2000	0.1
Pinewood	Natural	2000	9/1/2000	9/3/2000	0.1
Drummer Flats	Natural	2000	8/2/2000	8/4/2000	0.1
Waltonia	Natural	2000	9/6/2000	9/8/2000	0.1
Piper Meadows	Natural	2000	9/9/2000	9/11/2000	0.1
Palisade 2k	Natural	2000	5/28/2000	5/30/2000	0.5
Crosier Mtn	Natural	2000	8/15/2000	8/16/2000	0.1
Bobcat	Human	2000	6/12/2000	7/19/2000	10599
Palisade	Human	2000	1/22/2000	1/28/2000	15
Signal	Human	2000	7/22/2000	7/23/2000	0.1
Greer	Human	2000	4/8/2000	4/10/2000	1
Twin Cabin	Natural	2000	7/25/2000	7/25/2000	0.1
Stratton Park	Human	2000	7/26/2000	7/31/2000	0.2
Prairie Gulch	Natural	2000	5/29/2000	6/1/2000	2.5
Grey Rock	Natural	2000	8/4/2000	8/6/2000	15
Arrowhead	Natural	2000	8/13/2000	8/16/2000	0.1

Fire Name	Cause	Year	Start Date	Out Date	Total Acres
Cache La Poudre	Natural	2000	4/29/2000	5/1/2000	0.1
Frozen River	Human	2000	2/8/2000	2/9/2000	0.1
Seaman	Natural	2000	8/26/2000	8/29/2000	3
Long Draw	Natural	2000	7/11/2000	7/19/2000	61
Englebert	Natural	2000	6/7/2000	6/7/2000	0.1
Swamp Creek	Natural	2000	8/3/2000	8/4/2000	0.1
Elkhorn	Natural	2000	9/5/2000	9/6/2000	0.1
Lady Moon	Natural	2000	7/26/2000	7/28/2000	0.1
Maxwell Ranch	Natural	2000	7/17/2000	7/27/2000	18
Sheep Mtn	Natural	2000	8/11/2000	8/13/2000	0.5
North Fork	Human	2000	8/7/2000	8/22/2000	180
Killpecker	Natural	2000	6/8/2000	6/8/2000	0.1
Home To Roost	Natural	2000	8/13/2000	8/15/2000	2
Lower Latitude	Natural	2000	7/26/2000	7/28/2000	0.1
Chicken Park	Natural	2000	9/5/2000	9/8/2000	0.2
Chicken Leg	Natural	2000	9/5/2000	9/5/2000	0.1
Grace Creek	Natural	2000	9/6/2000	9/8/2000	0.1
Beaver Creek	Natural	2000	6/5/2000	6/10/2000	4
Turkey Roost	Natural	2000	7/26/2000	7/28/2000	4
Boswell	Natural	2000	6/25/2000	6/27/2000	0.2
McGregor	Natural	2000	7/8/2000	7/9/2000	0.1
Marmot	Natural	2000	7/9/2000	7/10/2000	0.1
Pierson Park	Human	2001	2/2/2001	2/2/2001	0.1
Hermit Park	Natural	2001	7/7/2001	7/9/2001	0.1
Dunraven	Natural	2001	7/5/2001	7/6/2001	0.1
Bell Rock	Natural	2001	7/12/2001	7/12/2001	0.1
Glen Comfort	Natural	2001	7/27/2001	7/29/2001	0.1
Glen Haven	Natural	2001	7/5/2001	7/8/2001	0.2
Big Thompson	Natural	2001	7/5/2001	7/7/2001	0.1
Bear	Natural	2001	8/28/2001	8/29/2001	0.2
Devil's Gulch	Human	2001	6/2/2001	6/3/2001	0.3
Killer Bee	Natural	2001	8/11/2001	8/11/2001	0.1
Sylvan Dale	Natural	2001	7/7/2001	7/15/2001	1.7
Bulwark	Human	2001	1/6/2001	1/6/2001	0.1
Green Ridge	Natural	2001	7/6/2001	7/11/2001	2.3
South Stringtown	Natural	2001	7/2/2001	7/4/2001	0.1
Fish Creek	Natural	2001	7/2/2001	7/5/2001	0.1
Pole Hill	Human	2001	8/25/2001	8/26/2001	0.1
Bronco	Human	2001	8/26/2001	8/26/2001	0.1
Wishful Thinking	Human	2001	6/18/2001	6/19/2001	0.1
Black Mountain	Natural	2001	7/4/2001	7/16/2001	1
Lost Lake Fire	Human	2001	8/2/2001	8/3/2001	0.1
Pendergrass	Natural	2001	6/22/2001	6/24/2001	1
Kim	Natural	2001	9/1/2001	9/6/2001	0.1
Bennett Creek 2	Human	2001	6/23/2001	6/24/2001	0.1
South Fork	Natural	2001	6/24/2001	6/28/2001	0.2
Bennett Creek	Natural	2001	6/23/2001	6/28/2001	2.5
Spencer Heights	Human	2001	10/1/2001	10/3/2001	0.1
Poudre	Natural	2001	6/25/2001	6/28/2001	0.1
Kelly Flats	Natural	2001	6/24/2001	6/25/2001	0.1

Fire Name	Cause	Year	Start Date	Out Date	Total Acres
Young Gulch	Human	2001	6/23/2001	6/24/2001	0.1
Belay	Natural	2001	7/13/2001	7/21/2001	0.1
Brinker Creek	Natural	2001	6/25/2001	6/26/2001	0.5
Fish Stick	Natural	2001	8/6/2001	8/8/2001	4
Seaman	Natural	2001	7/7/2001	7/8/2001	2.7
Pingree Hill Fire	Human	2001	9/21/2001	9/22/2001	0.1
Bonner Peak	Natural	2001	8/6/2001	8/9/2001	0.2
Swamp Creek	Human	2001	8/4/2001	8/4/2001	0.1
South Lone Pine	Natural	2001	6/22/2001	6/22/2001	0.1
Roaring Creek	Natural	2001	6/22/2001	6/24/2001	0.1
Evelyn	Natural	2001	7/6/2001	7/7/2001	0.1
Independence	Natural	2001	7/3/2001	7/5/2001	0.5
Mill Creek	Natural	2001	7/14/2001	7/17/2001	0.1
Dark	Natural	2001	6/30/2001	8/6/2001	0.5
Wuh	Natural	2001	7/8/2001	8/6/2001	0.1
Powerline2	Human	2001	10/1/2001	10/1/2001	0.1
Lily Lake	Human	2001	6/14/2001	6/18/2001	0.1
Powell Hill	Human	2002	7/9/2002	7/10/2002	0.1
Big Elk Meadows	Natural	2002	6/19/2002	6/22/2002	0.1
Big Elk	Human	2002	7/17/2002	8/20/2002	4348
Thompson	Natural	2002	5/31/2002	6/1/2002	0.1
Rocky	Natural	2002	7/24/2002	8/30/2002	1
Kiowa	Natural	2002	7/28/2002	7/28/2002	0.1
Tanker 123 Crash	Human	2002	7/18/2002	7/25/2002	1
Pierson Park	Human	2002	5/2/2002	5/3/2002	0.1
Darkside	Natural	2002	8/24/2002	8/26/2002	0.2
East McGraw	Natural	2002	8/29/2002	9/2/2002	0.6
Cedar Creek	Natural	2002	6/22/2002	6/24/2002	0.3
Triangle Mountain 2	Natural	2002	9/28/2002	9/29/2002	0.1
Triangle	Natural	2002	6/1/2002	6/6/2002	0.2
Matterhorn	Natural	2002	8/23/2002	8/26/2002	0.1
Pennock Creek	Natural	2002	6/19/2002	6/23/2002	1
Fish Creek	Natural	2002	6/28/2002	7/26/2002	48
Youngs Gulch	Natural	2002	8/29/2002	9/2/2002	0.1
Pre-Turkey	Human	2002	11/23/2002	11/24/2002	2
Hewlett Gulch	Human	2002	4/17/2002	5/21/2002	500
Double Spot	Natural	2002	6/19/2002	6/20/2002	0.1
Sevenmile	Natural	2002	8/30/2002	9/9/2002	7
Wintersteen	Natural	2002	6/15/2002	6/18/2002	0.1
Pingree Hill	Natural	2002	7/26/2002	7/27/2002	0.1
Power Line	Human	2002	7/12/2002	7/14/2002	0.3
Bald Mountain	Human	2002	6/1/2002	6/1/2002	0.1
Mary Beth	Natural	2002	8/29/2002	9/2/2002	0.1
South Lone Pine	Natural	2002	8/29/2002	9/2/2002	0.1
North Bald Mountain	Natural	2002	6/30/2002	7/14/2002	5
Killpecker	Natural	2002	6/27/2002	6/28/2002	0.1
Gap	Natural	2002	6/7/2002	6/8/2002	0.1
Gps	Natural	2002	7/20/2002	7/22/2002	0.1
Bull Creek	Natural	2002	7/23/2002	7/25/2002	0.2
Chicken Park	Natural	2002	8/29/2002	9/2/2002	0.1

Fire Name	Cause	Year	Start Date	Out Date	Total Acres
Acme Creek	Natural	2002	8/29/2002	8/30/2002	0.1
Green Mountain	Natural	2002	6/5/2002	6/9/2002	1
Boswell	Natural	2002	9/20/2002	9/22/2002	0.3
Chiq'ta Ck	Natural	2002	6/20/2002	9/5/2002	0.1
Ute Trail	Natural	2002	6/23/2002	9/5/2002	0.1
Glacier	Natural	2002	6/27/2002	9/5/2002	0.1
Tuxedo Park	Human	2002	7/25/2002	7/27/2002	0.1
Big Elk Park	Human	2003	12/16/2003	12/18/2003	0.1
Spring Gulch	Natural	2003	7/22/2003	7/25/2003	2.5
Elk Ridge	Natural	2003	7/16/2003	7/19/2003	5
Hells Canyon	Natural	2003	8/25/2003	8/29/2003	2
Chelsea	Natural	2003	6/13/2003	6/18/2003	1
Round Mountain	Human	2003	12/2/2003	12/4/2003	1
Pallisade	Natural	2003	5/30/2003	6/1/2003	10.8
Drake	Natural	2003	7/19/2003	7/21/2003	0.1
Alexander	Natural	2003	7/25/2003	8/2/2003	1
Moody Hill	Human	2003	8/15/2003	8/17/2003	0.1
Comanche	Natural	2003	7/18/2003	7/22/2003	0.1
Pingree	Natural	2003	6/13/2003	6/16/2003	0.2
Lazy D	Natural	2003	8/8/2003	8/10/2003	0.1
Monument	Natural	2003	7/30/2003	8/2/2003	0.5
Chambers Lake	Human	2003	8/16/2003	8/18/2003	0.1
Buck Ridge #1	Natural	2003	7/29/2003	7/30/2003	0.1
Bennett	Natural	2003	7/26/2003	8/1/2003	0.2
Buck Ridge #2	Natural	2003	7/29/2003	7/30/2003	0.1
Cascade	Natural	2003	8/16/2003	8/19/2003	0.1
Narrows	Human	2003	5/14/2003	5/22/2003	0.2
Keg Meadow	Human	2003	7/13/2003	7/13/2003	0.1
Pingree Hill	Natural	2003	8/3/2003	8/6/2003	0.3
Long	Natural	2003	8/6/2003	8/9/2003	1
North Fork	Natural	2003	8/18/2003	8/23/2003	2
Mount Margaret	Human	2003	7/5/2003	7/9/2003	1
Nunn	Human	2003	7/17/2003	7/19/2003	1
Green Ridge	Natural	2003	9/6/2003	9/7/2003	0.1
Creedmore Ridge	Natural	2003	7/6/2003	7/9/2003	0.1
Allotment	Natural	2003	8/2/2003	8/6/2003	0.3
Willow Creek	Natural	2003	8/7/2003	8/8/2003	0.2
Trail Creek	Natural	2003	7/5/2003	7/8/2003	0.1
Bull Rock	Natural	2003	7/17/2003	7/18/2003	0.1
Lost Falls	Natural	2003	7/29/2003	8/7/2003	0.1
Saint Vrain	Natural	2004	6/24/2004	6/25/2004	0.1
Big Elk	Natural	2004	3/29/2004	4/6/2004	0.1
West Creek	Human	2004	1/11/2004	1/13/2004	0.2
Moody	Natural	2004	3/24/2004	3/29/2004	1.2
Arrowhead	Natural	2004	6/9/2004	6/11/2004	0.1
Grey Rock	Natural	2004	6/4/2004	6/11/2004	0.25
Grey Rock 2	Human	2004	7/12/2004	8/5/2004	28.4
Yonder	Natural	2004	6/4/2004	6/13/2004	1
Lake Field	Human	2004	3/18/2004	3/22/2004	4
Lefthand Spur Road	Human	2004	3/21/2004	3/30/2004	0.2

Fire Name	Cause	Year	Start Date	Out Date	Total Acres
Pierson	Human	2005	7/10/2005	7/11/2005	0.1
Hell's Canyon	Natural	2005	7/16/2005	7/24/2005	5.9
Drake	Natural	2005	7/16/2005	7/25/2005	14
Alexander 2	Natural	2005	7/20/2005	7/25/2005	4.4
Crosier	Human	2005	12/12/2005	12/19/2005	0.25
Alexander	Natural	2005	6/28/2005	6/30/2005	0.3
Bobcat Gulch	Natural	2005	7/7/2005	7/8/2005	0.1
Bright	Natural	2005	6/28/2005	7/3/2005	0.1
Greer 19	Human	2005	5/21/2005	5/21/2005	0.1
Moody Hill	Human	2005	6/20/2005	6/25/2005	0.4
Old Flowers	Human	2005	7/31/2005	8/1/2005	0.2
Rist Canyon	Human	2005	6/16/2005	6/16/2005	0.1
Trell	Natural	2005	7/31/2005	8/2/2005	0.1
Kelly Flats	Human	2005	8/12/2005	8/12/2005	0.1
Eggers	Human	2005	8/29/2005	8/29/2005	0.1
Deer Meadow	Human	2005	10/1/2005	10/3/2005	0.1
North Rim	Natural	2005	8/16/2005	8/20/2005	0.1
Wet Saddle	Natural	2005	8/9/2005	8/13/2005	0.1
Swamp Lady	Human	2005	9/25/2005	9/28/2005	1.9
South Lone Pine	Natural	2005	7/23/2005	7/24/2005	0.1
Blue Sock	Human	2005	7/6/2005	7/7/2005	0.1
North Bald	Natural	2005	7/20/2005	8/5/2005	45
Scott	Natural	2005	7/28/2005	7/30/2005	0.25
Rabbit Creek	Natural	2005	7/2/2005	7/4/2005	0.1
S.Panhandle Ck	Human	2005	9/5/2005	9/9/2005	0.1
Lost Lake	Natural	2005	7/18/2005	7/21/2005	2
No Bull	Human	2005	9/15/2005	9/17/2005	0.1
Bull Creek	Natural	2005	8/1/2005	8/3/2005	0.25
Black Mountain	Natural	2005	7/2/2005	7/9/2005	1.4
Turkey Roost	Natural	2005	7/4/2005	7/9/2005	4.1
Devils Creek	Natural	2005	9/4/2005	9/15/2005	11
Sheep Creek Complex	Natural	2005	9/27/2005	10/15/2005	30.5
Cow Ridge	Natural	2005	7/22/2005	7/22/2005	0.1
Willow Creek	Natural	2005	6/22/2005	8/28/2005	0.1
Moraine130	Natural	2005	6/30/2005	7/1/2005	0.1
Chasm Fall	Human	2005	7/21/2005	7/21/2005	0.1
Black Canyon	Human	2005	9/23/2005	9/26/2005	0.1
Dark Vale	Natural	2005	10/8/2005	10/9/2005	0.1
Dream	Human	2005	10/15/2005	10/15/2005	0.1
Sock	Human	2005	10/23/2005	10/23/2005	0.1
Pinewood Springs	Natural	2006	5/26/2006	5/30/2006	3
Thompson	Natural	2006	7/20/2006	7/24/2006	0.2
Lily Mtn.	Human	2006	8/11/2006	8/21/2006	0.1
Pole Hill	Natural	2006	5/24/2006	5/27/2006	0.5
Bell Rock	Natural	2006	8/23/2006	9/24/2006	1.2
Rabbit Gulch	Natural	2006	9/12/2006	9/22/2006	0.3
Terry	Natural	2006	5/22/2006	5/23/2006	0.2
Cedar Creek	Natural	2006	8/15/2006	8/31/2006	4.6
Jug Gulch	Natural	2006	8/15/2006	9/1/2006	15.4
Switchback	Human	2006	3/3/2006	3/13/2006	9

Fire Name	Cause	Year	Start Date	Out Date	Total Acres
Green Ridge	Natural	2006	8/30/2006	8/31/2006	0.1
Spruce Gulch	Natural	2006	8/17/2006	8/19/2006	0.1
Mummy	Human	2006	8/8/2006	8/10/2006	0.1
Pingree Park	Human	2006	8/6/2006	8/8/2007	0.1
Quigley Mountain	Natural	2006	5/21/2006	5/28/2006	5
Cammon Fire	Natural	2006	5/21/2006	5/30/2006	0.1
Salt	Natural	2006	8/18/2006	8/18/2006	0.1
Crown Point	Natural	2006	5/17/2006	5/30/2006	3
Grey Rock	Natural	2006	5/22/2006	5/25/2006	0.1
Fox Acres	Natural	2006	5/21/2006	5/24/2006	0.1
Prickly Pear	Natural	2006	6/18/2006	6/24/2006	0.8
Podunk	Natural	2006	7/24/2006	7/27/2006	0.2
Mill Creek	Natural	2006	6/29/2006	7/5/2006	8
Trail Creek	Natural	2006	7/17/2006	7/21/2006	0.4
Mill Creek 2	Natural	2006	7/6/2006	7/9/2006	1.1
Fish Creek Ii	Human	2006	8/7/2006	8/12/2006	1.3
Bull Rock	Natural	2006	8/17/2006	8/20/2006	2.2
Halligan	Natural	2006	6/20/2006	6/25/2006	30
Hoffmeister	Human	2006	4/20/2006	4/24/2006	0.3
Abandoned Campfire	Human	2006	5/29/2006	5/29/2006	0.1
Beaver Mountain	Natural	2006	6/8/2006	6/22/2006	0.1
Eagle North	Natural	2006	7/3/2006	7/6/2006	0.1
Bighorn	Natural	2006	8/14/2006	8/21/2006	0.1
Jellystone Fire	Natural	2007	8/3/2007	8/4/2007	0.01
Crosier Mtn.	Natural	2007	7/22/2007	7/29/2007	8
West Creek	Natural	2007	7/17/2007	7/20/2007	0.2
Hyatt Mine	Human	2007	6/22/2007	6/25/2007	0.1
Black Creek	Natural	2007	7/17/2007	7/19/2007	0.1
Comanche Fish	Natural	2007	6/16/2007	6/20/2007	0.7
Pendergrass	Natural	2007	7/21/2007	7/30/2007	0
Pingree Hill	Human	2007	6/21/2007	6/24/2007	0.9
Rustic	Natural	2007	7/17/2007	7/18/2007	0.1
Grey Rock Meadow	Natural	2007	6/21/2007	7/2/2007	3.5
Grey Rock	Human	2007	11/3/2007	11/7/2007	1.1
North Rim	Natural	2007	7/17/2007	7/19/2007	0.1
Josephine	Natural	2007	8/15/2007	8/17/2007	0.1
Manhead Mountain	Natural	2007	6/28/2007	6/29/2007	0.1
Todd	Human	2007	6/15/2007	6/17/2007	0.1
Lost Lake	Human	2007	7/1/2007	7/5/2007	1
Diamond Tail	Human	2007	9/20/2007	9/23/2007	0.8
Pearl Beaver	Natural	2007	6/22/2007	6/25/2007	0.1
Stuck	Natural	2007	7/19/2007	7/22/2007	0.1
Deadhorse Mountain	Natural	2007	5/17/2007	5/21/2007	3.6
Dump Fire	Human	2007	5/18/2007	5/19/2007	0.1
Glacier Basin Dump	Human	2007	6/13/2007	6/15/2007	0.1
Deer Ridge Fire	Natural	2007	6/26/2007	6/27/2007	0.1
Moraine 115	Natural	2007	7/4/2007	7/5/2007	0.1
Twin Owls	Natural	2007	9/3/2007	9/4/2007	0.1
Endovalley Fire	Human	2007	11/15/2007	11/19/2007	0.1
Big Elk	Human	2008	10/25/2008	10/31/2008	7

Fire Name	Cause	Year	Start Date	Out Date	Total Acres
Hells Canyon	Natural	2008	7/7/2008	7/15/2008	0.4
Quillan Gulch	Natural	2008	9/28/2008	11/17/2008	10
Soul Shine	Human	2008	7/21/2008	7/24/2008	0.61
River Crossing	Natural	2008	10/2/2008	10/6/2008	0.1
Sheep	Human	2008	9/22/2008	9/23/2008	0.01
Summit Trail	Human	2008	11/20/2008	11/28/2008	0.01
Riverbend	Natural	2008	7/1/2008	7/19/2008	0.1
Sulzer	Natural	2008	9/20/2008	9/22/2008	0.1
Sulzer 2	Natural	2008	10/2/2008	10/5/2008	0.3
Crosier Mountain	Human	2008	1/24/2008	1/29/2008	0.34
Grouse Creek	Natural	2008	11/1/2008	11/18/2008	0.1
Paradise	Human	2008	11/24/2008	12/7/2008	83
Pennock Creek	Natural	2008	7/31/2008	9/9/2008	1.2
Dumpster	Human	2008	6/22/2008	6/23/2008	0.1
Burnt Car	Human	2008	5/10/2008	5/14/2008	0.34
63e	Human	2008	10/30/2008	10/31/2008	0.05
Diane	Natural	2008	8/2/2008	8/9/2008	0.1
Young	Natural	2008	7/5/2008	7/19/2008	0.25
Ansel Watrous	Human	2008	6/8/2008	6/8/2008	0.01
Forrest	Natural	2008	8/14/2008	9/7/2008	0.1
Hesselbarth	Natural	2008	8/14/2008	9/7/2008	0.1
Greyrock	Natural	2008	8/2/2008	8/3/2008	0.1
Starview	Natural	2008	6/22/2008	6/24/2008	0.3
Greyrock Camp	Human	2008	5/8/2008	5/12/2008	0.01
Wintersteen	Natural	2008	7/26/2008	7/28/2008	0.1
Hewlett Gulch	Natural	2008	9/26/2008		0.1
Swamp Lady	Human	2008	6/14/2008	6/15/2008	0.1
Creek	Natural	2008	9/17/2008	9/26/2008	0.1
Margaret	Natural	2008	10/2/2008	10/5/2008	0.2
Mill Creek	Human	2008	9/29/2008	10/4/2008	3
Endo	Human	2008	7/1/2008	7/1/2008	0.1
Bier Fire	Natural	2008	7/8/2008	9/12/2008	0.1
Longs Fire	Human	2008	7/13/2008	7/27/2008	0.1
Sullivan	Human	2009	1/13/2009	1/22/2009	0.15
Combat	Human	2009	1/20/2009	1/21/2009	0.01
Fox Creek	Natural	2009	8/31/2009	9/3/2009	0.25
West Creek	Natural	2009	8/31/2009	9/6/2009	1
Dunraven	Human	2009	9/8/2009		44.4
Lost Lake	Human	2009	11/9/2009	11/9/2009	0.1
Laramie	Natural	2009	9/5/2009	9/10/2009	0.1
Elk	Human	2009		7/19/2009	0.1
Cayman	Human	2009	9/6/2009	9/6/2009	0.1
Bennet	Human	2009	8/9/2009	8/9/2009	0.1
Pingree Park Rd	Human	2009	7/5/2009	7/5/2009	0.1
Zimmerman	Human	2009	9/3/2009	9/6/2009	0.35
Gateway Fire	Natural	2009	7/19/2009	7/21/2009	0.1
Wintersteen	Natural	2009	7/23/2009	7/28/2009	8.8
Greyrock Meadow	Human	2009		2/13/2009	28
Lone Tree Iii	Human	2009	4/5/2009	4/15/2009	6.1
Badge	Natural	2009		6/30/2009	0.1

Fire Name	Cause	Year	Start Date	Out Date	Total Acres
Tent Pole	Human	2009	8/7/2009	8/7/2009	0.1
Coon	Natural	2009	9/16/2009	9/19/2009	0.1
Rabbit Ears	Natural	2009	7/22/2009	9/5/2009	0.3
Fall River Fire	Natural	2009	9/9/2009	9/12/2009	0.1
Cub Lake	Human	2009	11/7/2009	11/8/2009	0.1
North St Vrain Fire	Natural	2010	7/29/2010	7/31/2010	0.1
Lyon's Gulch	Human	2010	6/29/2010	6/29/2010	0.1
Sullivan Park	Human	2010	4/11/2010	4/20/2010	6.3
Galuchie 2	Natural	2010	7/10/2010	7/12/2010	0.1
Galuchie	Natural	2010	7/10/2010	7/12/2010	0.1
West White Pine	Human	2010	9/26/2010	10/13/2010	0.35
Dutch George	Human	2010	4/28/2010	4/29/2010	0.3
Fort	Human	2010		9/1/2010	0.1
Lakefield 2	Human	2010	9/8/2010	9/13/2010	0.1
Swamp Pol	Human	2010	7/10/2010	7/12/2010	0
Site 9	Human	2010	6/19/2010	6/20/2010	0
Boswell	Natural	2010	8/7/2010		10.2
Dump Fire	Human	2010	8/27/2010	8/27/2010	0.1
Eagle Cliff	Human	2010	1/31/2010	2/1/2010	0.1
Forest Canyon	Human	2010	7/9/2010	7/16/2010	0.1
Cow Creek	Natural	2010	6/24/2010	12/8/2010	1200
Castle Mountain Fire	Natural	2010	7/29/2010	9/3/2010	0.1
Spring Gulch	Natural	2011	8/22/2011		0.01
Overlook	Natural	2011		8/1/2011	6.5
Crystal	Human	2011	4/1/2011	5/10/2011	2939
Monument Gulch	Human	2011	9/5/2011	9/5/2011	0.1
Pingree	Human	2011		11/18/2011	3.5
White Rock	Natural	2011	8/19/2011	8/21/2011	0.1
Camman Springs	Human	2011	8/27/2011	8/28/2011	0.01
Jack's Gulch	Human	2011		5/28/2011	2.6
Cayman Springs	Human	2011	7/29/2011	7/31/2011	0.01
Stratton	Natural	2011	8/16/2011	8/21/2011	1.82
Mm 114	Human	2011	3/23/2011	3/23/2011	0.01
Mm 111	Human	2011	3/23/2011	3/23/2011	0.1
Comanche	Natural	2011	7/18/2011	7/27/2011	0.1
Grey Rock	Human	2011	3/14/2011	3/29/2011	17
Lightning Bust	Natural	2011	7/2/2011	7/3/2011	0.1
Elkhorn	Human	2011		8/23/2011	0.25
Eagles Nest	Natural	2011	7/11/2011	7/13/2011	8.3
Manhattan 16	Human	2011	7/31/2011	7/31/2011	0.01
Lady Moon	Natural	2011		6/29/2011	0.3
Middle Bald	Human	2011	8/9/2011	8/13/2011	1
Old School	Natural	2011		6/29/2011	2.1
Green Ridge	Human	2011	9/5/2011	9/5/2011	0.01
Lost	Natural	2011	8/1/2011	8/4/2011	0.1
Creedmore Lakes	Human	2011	9/3/2011	9/5/2011	0.01
North Fork	Natural	2011	6/24/2011	6/26/2011	0.75
Forrester Creek	Natural	2011	8/16/2011	8/21/2011	0.1
Black Lily	Human	2011	6/25/2011	6/26/2011	0.1
West Creek	Natural	2011	10/1/2011	11/2/2011	0.2

Fire Name	Cause	Year	Start Date	Out Date	Total Acres
Husted	Human	2012	11/6/2012	11/11/2012	1.9
Narrows	Human	2012	9/5/2012	9/14/2012	2.7
Galuchie	Human	2012	3/26/2012	3/31/2012	14
High Park	Natural	2012	6/9/2012	8/14/2012	87275
Comanche	Natural	2012	7/2/2012	7/12/2012	0.1
Flower	Human	2012	4/29/2012	5/15/2012	0.1
Bennett Creek	Natural	2012	8/10/2012	8/19/2012	0.75
Salt Cabin Park	Human	2012	6/3/2012	6/5/2012	0.8
Seven Mile	Natural	2012	8/10/2012	8/11/2012	0.1
Dadd Gulch	Natural	2012		8/11/2012	0.1
Hewlett	Human	2012	5/14/2012	8/13/2012	7685
Swamp Creek	Human	2012	5/27/2012	5/27/2012	0.1
Middle Bald	Natural	2012	9/5/2012	9/10/2012	0.2
Molly	Human	2012	9/22/2012	9/23/2012	0.1
Columbine Canyon	Human	2012	6/10/2012	6/19/2012	0.01
Chetco	Natural	2012	6/15/2012	6/16/2012	0.1
Lost Lake	Human	2012	5/26/2012	5/26/2012	0.1
Lost Lake	Human	2012	9/16/2012	9/20/2012	0.1
Goat Mountain	Natural	2012	4/24/2012	5/2/2012	8.5
Haystack Rock	Natural	2012	7/24/2012	7/27/2012	0.35
Iron Mountain Fire	Human	2012	9/21/2012	9/22/2012	0.1
Roach	Human	2012	8/27/2012	9/20/2012	117
Book	Natural	2012	6/17/2012	6/18/2012	0.1
Glacier Basin	Natural	2012	6/28/2012	8/21/2012	0.1
Sundance	Natural	2012	7/30/2012	7/31/2012	0.1
Bighorn Mountain	Natural	2012	8/10/2012	8/21/2012	0.1
Lily	Human	2012	8/28/2012	8/29/2012	0.1
West Alluvial	Human	2012	6/8/2012	6/8/2012	0.1
Fern Lake	Human	2012	10/9/2012	6/13/2013	3498
Little Deer	Natural	2013	5/18/2013	5/22/2013	0.1
Hell Canyon	Natural	2013	7/10/2013	7/19/2013	5.7
Alexander	Human	2013	2/5/2013	2/28/2013	1.1
Cedar Creek	Natural	2013	9/3/2013	9/4/2013	0.01
Sulzer Gulch	Natural	2013	9/3/2013	9/4/2013	0.01
Moody	Natural	2013	8/28/2013	9/3/2013	0.2
Chambers	Human	2013	8/5/2013	8/10/2013	0.01
Crown Point	Natural	2013	9/1/2013	9/2/2013	0.01
Zimmerman	Natural	2013	8/12/2013	8/14/2013	0.1
Manhattan	Human	2013	5/26/2013	5/26/2013	0.01
Manhattan 2	Human	2013	5/26/2013	5/26/2013	0.01
Sheep Mountain	Natural	2013	9/5/2013	9/7/2013	0.1
Bear Trap	Natural	2013	8/7/2013	8/8/2013	0.01
Lost	Natural	2013	9/6/2013	9/7/2013	0.01
Hohnholz	Human	2013	6/2/2013	6/14/2013	29.3
Beaver Ponds	Human	2013	5/16/2013	5/20/2013	0.1
Moraine	Human	2013	5/17/2013	5/17/2013	0.1
Many Parks	Human	2013	6/2/2013	6/2/2013	0.1
Pole 14	Human	2014	6/26/2014	6/27/2014	0.1
Emhaw Gulch	Human	2014	8/6/2014	8/7/2014	0.1
Granite Gulch	Natural	2014	6/18/2014	6/30/2014	3.2

Fire Name	Cause	Year	Start Date	Out Date	Total Acres
Jacks Gulch	Human	2014	5/30/2014	5/30/2014	0.1
Laramie Lake	Human	2014	10/2/2014	10/3/2014	0.1
Dispersed 17	Human	2014	7/31/2014	8/1/2014	0.1
Lady Moon	Natural	2014	8/30/2014	9/3/2014	0.1
Turkey Knob	Natural	2014	9/21/2014	9/29/2014	2.8
Echo	Human	2014	8/16/2014	8/16/2014	0.1
Endo Valley	Human	2014	5/2/2014	5/2/2014	0.1
Sundance	Human	2014	5/29/2014	5/29/2014	0.1
Spruce	Human	2014	6/30/2014	9/8/2014	0.4
Bear Lake Road	Human	2014	10/24/2014	10/24/2014	0.1
Lyons Gulch Fire	Human	2015	9/15/2015	9/16/2015	6.12
Christy Meadows	Human	2015	9/14/2015	9/14/2015	0.1
Soulshine	Human	2015	9/9/2015	9/9/2015	0.1
Palisade	Natural	2015	8/9/2015	8/16/2015	0.1
Storm Mountain	Human	2015	9/19/2015	9/19/2015	0.1
Bobcat Ridge	Natural	2015	8/13/2015	8/15/2015	0.71
Stormy Peaks	Human	2015	9/8/2015	9/12/2015	0.1
Mummy	Natural	2015	10/10/2015	10/21/2015	558
Buckhorn	Human	2015	8/9/2015	8/11/2015	0.55
513	Human	2015	8/29/2015	9/1/2015	0.1
Fish	Human	2015	8/12/2015	8/16/2015	0.1
Skin Gulch	Human	2015	7/5/2015	7/5/2015	0.1
Three Way	Human	2015	9/22/2015	9/22/2015	0.1
Kelly Flats Fire	Human	2015	9/13/2015	9/13/2015	0.1
Mineral Springs	Natural	2015	6/29/2015	7/2/2015	462
Grassy Pass	Human	2015	9/24/2015	9/25/2015	0.1
Ouzel	Human	2015	7/26/2015	7/26/2015	3.6
Mt. Margaret	Human	2015	10/12/2015	10/12/2015	0.1
Stock Fire	Human	2015	6/20/2015	6/20/2015	0.1
North Fork	Natural	2015	6/29/2015	8/14/2015	0.1
Lumpy	Human	2015	7/4/2015	7/5/2015	0.1
Ute Meadow Fire	Human	2015	7/26/2015	7/26/2015	0.1
Alpine Circle	Human	2015	10/10/2015	10/10/2015	0.1
Sprague Lake	Human	2015	2/1/2015	2/2/2015	0.1
Fall River	Human	2015	8/30/2015	8/31/2015	0.1
Bandit	Human	2015	10/12/2015	10/15/2015	0.1
Beaver Ponds Camp Fire	Human	2015	11/2/2015	11/2/2015	0.1
953	Human	2015	10/17/2015	10/17/2015	0.1
North Rim	Human	2016	12/25/2016	12/30/2016	7
Red Deer	Human	2016	10/30/2016	11/29/2016	0.1
517	Human	2016	9/11/2016	9/12/2016	0.1
Elkhorn	Human	2016	7/11/2016	7/13/2016	0.25
Mill Creek	Natural	2016	7/23/2016	7/25/2016	0.33
Soul Shine	Human	2016	7/24/2016	7/25/2016	0.1
Stub	Human	2016	7/26/2016	8/21/2016	1.2
South Fork	Natural	2016	8/10/2016	8/17/2016	0.01
Muggins	Human	2016	6/21/2016	6/22/2016	0.1
Pratt Creek	Natural	2016	7/5/2016	7/7/2016	0.3
#522	Human	2016	7/13/2016	7/14/2016	0.1
515	Human	2016	7/23/2016	7/28/2016	0.1

Fire Name	Cause	Year	Start Date	Out Date	Total Acres
Chambers	Human	2016	8/1/2016	8/1/2016	0.1
Crosier	Natural	2016	5/30/2016	6/23/2016	0.1
Bellaire	Natural	2016	6/16/2016	6/28/2016	0.3
Lost Lake	Human	2016	3/1/2016	3/2/2016	0.1
County Road 47	Human	2016	4/9/2016	4/9/2016	0.1
Seaman	Unknown	2018	9/14/2018	9/17/2018	230.3

Source: Historical wildland fire occurrence data compiled by USFS from 1980 - 2016, from BIA, BLM, BOR, USFS, FWS, and NPS; CO-WRAP 2018

The following event narratives detail past impacts of wildfires in Larimer County and illustrate the potential magnitude of future events:

- **August 13, 2020 (Cameron Peak Fire)** – This wildfire began August 13, 2020 on U.S. Forest Service Property near Chambers Lake and burned nearly 209,000 acres before it was finally 100% contained on December 2, 2020. Due to the steep and rugged terrain, heavy timber, and beetle kill trees causing snags, an indirect approach was necessary to contain the fire. According to the Larimer County Assessor's Office, the fire destroyed 243 structures for an estimated market value loss of $6,385,058. CR 14 and CR 103 were closed for an extended period and over 130 residents were evacuated for several weeks, leading to the need for shelter operations. Due to COVID-19, however, non-congregate sheltering was used for this fire. A cold front with freezing temperatures and snow in early September stalled fire growth temporarily but did not extinguish the fire. Due to the size of this fire, long-term impacts are expected in the area, including impacts to the Cache la Poudre watershed.
- **October 16, 2019 (Elk Wildfire)** – This wildfire was a result of a prescribed burn that jumped the boundary line. The fire ended up burning approximately 622 acres near Ben Delatour Scout Ranch. The fire destroyed one storage shed and damaged some utility line poles that were quickly restored. CR 68 C and CR 74 E were closed for the duration of the incident, resulting in the need to open a shelter in Livermore as residents were unable to return home. The initial estimate of losses totaled over $87,400. (Source: Larimer County HMPC, 2016).
- **September 17, 2019 (McNay Wildfire)** – This fire burned 560 acres near MM 10 on W CR 74E. PCREA had damage to a couple utility poles and shut down the power which caused issues regarding access to 911 in the impacted area. Damages from this event totaled $28,602.75. (Source: Larimer County HMPC).
- **September 11, 2018 (Seaman Wildfire)** – This fire burned 240 acres 5 miles west of 287 on Highway 14. One firefighter sustained an injury. The fire resulted in trail closures and a voluntary evacuation for Smith Ridge Road. Losses totaled $84,974.81. (Source: Larimer County HMPC).
- **February 10, 2017 (Spring Glade Wildfire)** – A wildfire in the Fossil Creek Wetlands Natural Area burned 150 acres, threatening a water treatment plant and several homes. Several fences and utility poles were damaged, and Timberline and Carpenter Roads were closed for two hours. (Source: Poudre Fire Authority HMPC).
- **September 4, 2016 (Starwood Wildfire)** – This fire burned 304 acres resulting in voluntary evacuations and $16,913.59 in losses. (Source: Larimer County HMPC).
- **June 23, 2012 (Woodland Heights Wildfire)** – This fire was started by a power line rubbing against a pine tree in Estes Park. The fire spread to 27.3 acres, burning 22 houses and two outbuildings on the west side of Estes Park near the boundary of Rocky Mountain National Park. The fire was contained quickly, and residents were allowed to return to the area on June 25, 2012. Estes Valley Fire Protection District's proactive response, along with the extra resources afforded by a cost-sharing agreement with Larimer County, were credited with preventing the fire spreading into a major disaster on the scale of some of the year's other wildfires in the state,
- **June 9, 2012 (High Park Fire)** – This was the largest and most destructive fire in Larimer County's history. The High Park fire was started by a lightning strike and occurred in the mountains west of Fort

Collins. This fire burned over 87,200 acres, destroyed at least 259 homes, and resulted in the death of one person. (Source: High Park Fire Burned Area Emergency Response (BAER) Report).

- **May 14, 2012 (Hewlett Gulch Wildfire)** – This fire burned a total of 7,685 acres just west of Fort Collins and was caused by a camp stove that accidentally burned the grasses nearby. Most of area of high burn severity was within the immediate drainage area of Milton Seaman Reservoir, which is owned and operated by the City of Greeley. This fire area later combined with the High Park Fire area a month later.
- **September 12, 2010** – Dry conditions allowed for another wildfire to spread near Flatiron Reservoir in the foothills west of Loveland as crews were wrapping up the Fourmile Canyon Wildfire near Boulder. The fire started the day after a resident burned some debris on his property. The dry conditions coupled with gusty winds allowed the debris to reignite and the ensuing wildfire to spread. Two homes, 5 other structures, several vehicles and a total of 750 square acres were consumed by the blaze. Property damage estimates totaled $1.5 million (Source: NCEI).
- **September 6, 2010 (Fourmile Canyon Wildfire) –** The Fourmile Canyon Wildfire, northwest of Boulder, originated from an unattended fire pit at a local residence. The wildfire quickly consumed 5 1/2 square miles (3,500 acres) the first day and forced the evacuation of over 3,000 residents. Erratic 45-mph gusts sent the fire in two directions at times. Very dry weather conditions preceded the fire. The combination of strong winds, low relative humidity and dry fuels allowed the wildfire spread rapidly through the steep, heavily forested terrain. The flames were reportedly 20 to 50 feet in length. Towns within the burn area included Salina, Wallstreet and Gold Hill. The dry conditions coupled with gusty winds ranging from 45 to 64 mph persisted for several more days. Fire managers used as many as 700 firefighters and support personnel from 35 agencies and seven air tankers to battle the wildfire. A total of 6,181 square acres or approximately 10 square miles were burned. The Fourmile Canyon Wildfire was the most destructive fire in Colorado history in terms of the damage to personal property. It destroyed 171 homes with an estimated cost of $217 million. (Source: NCEI).
- **June 12, 2000 (Bobcat Gulch Fire and Hi Meadows Wildfire)** – Two large wildfires developed in the Front Range Foothills of Colorado as careless campers and very dry conditions proved to be a dangerous combination. Strong winds gusting in excess of 60 mph on the 13th, fanned the flames, spreading both wildfires out of control. The Hi Meadows wildfire, about 35 miles southwest of Denver, consumed 10,800 acres and 80 structures, mostly high priced homes. The Bobcat wildfire, located about 12 miles southwest of Fort Collins, consumed 10,600 acres and 22 structures. Mother Nature, initially a nemesis to firefighters, also played the key role in dousing the flames. Late on the 16th, a strong cold front moved into northeastern Colorado. Upslope conditions developed in the wake of the front, allowing 2 to 4 inches of snowfall overnight at elevations above 8,500 feet. Firefighters were able to contain both wildfires shortly thereafter.

  Damage from the two wildfires is estimated at over $18.5 million. A Colorado State Forest Service report estimated the cost of just the Bobcat Gulch Fire at $933.94 per acre, or nearly $9.9 million (Source: Mackes, 2015). These estimate makes the Hi Meadows and Bobcat wildfires the costliest to strike the Front Range Foothills. (Source: NCEI)

Location

The area of greatest concern for wildfire risk is the ''wildland-urban interface", or WUI, which is the area where development is close to or within a boundary of natural terrain and fuel, where high potential for wildland fires exist. This area is where the potential for wildfire to directly impact people and property exists. Communities are able to establish the definition and boundary of their local WUI, and the boundaries often help in meeting local management needs. WUI areas can include both public and private land and can help improve local access to funding sources.

Wildfires can occur anywhere that natural vegetation exists as a fuel source. For the purpose of wildfire mitigation strategy development, this plan divides vegetation by four categories of land use types within Larimer County: cultivated agricultural land, forested land, grazing land, and miscellaneous. Cultivated agricultural lands include both irrigated and non-irrigated crop land. Typically, this category of land has very dynamic burning characteristics and seasons. Crops and dormant stands located on Larimer County's cultivated agricultural land can both serve as fuel for wildfires. What makes agricultural land unique is the dynamic nature of the fuel locations and seasons of availability. These factors add to the challenge of wildfire suppression and mitigation.

Figure 4-43 shows WUI areas within Larimer County as determined by the Colorado Wildfire Risk Assessment project (CO-WRAP). CO-WRAP defines the WUI using housing density data to delineate where people and structures meet and intermix with wildland fuels.

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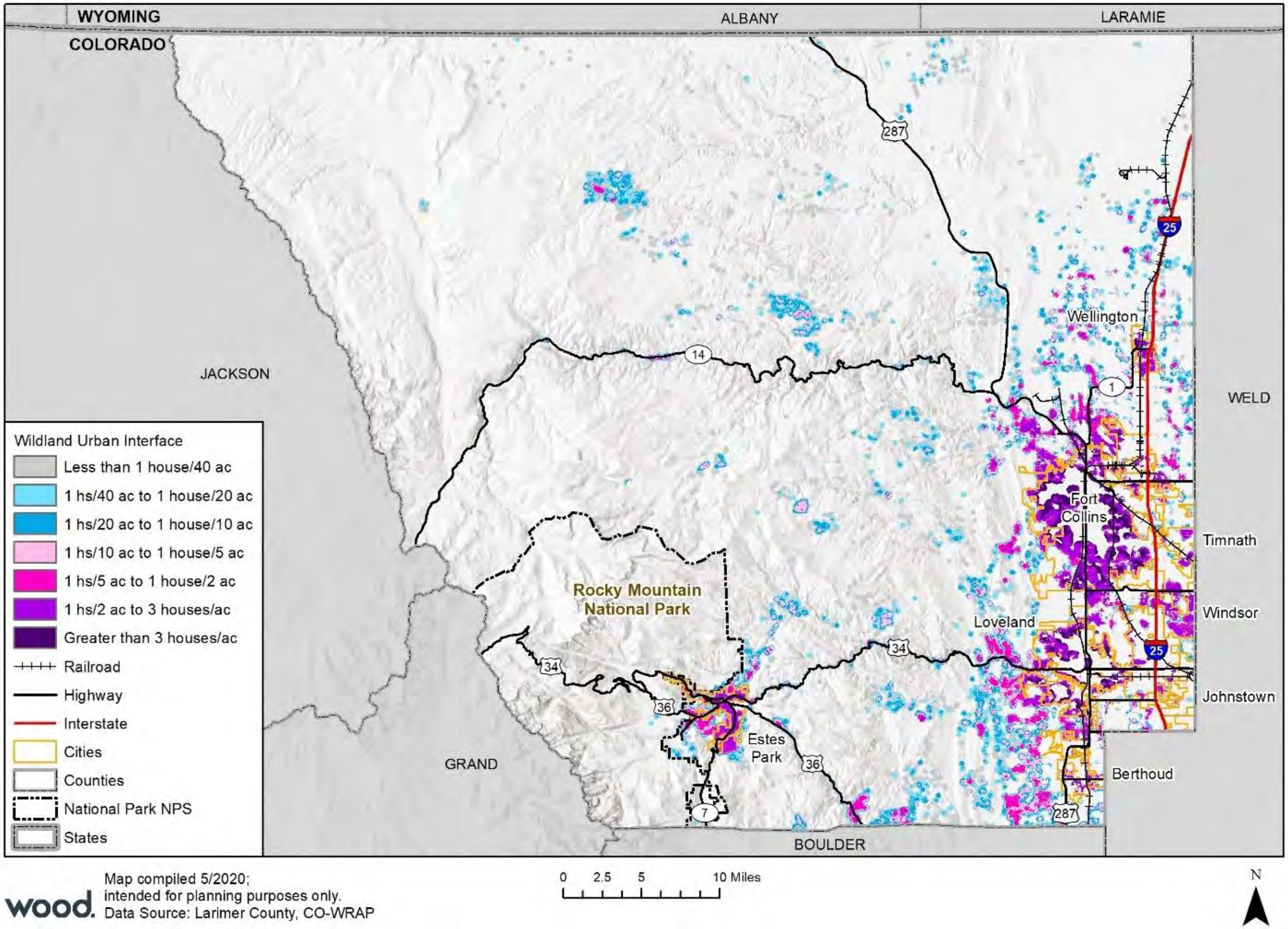
Figure 4-43 Larimer County Wildfire Housing Density within WUI based on CO-WRAP Assessment



In the context of the Larimer County landscape, forested land includes the riparian forest, windbreaks, shelterbelts, living snow fences, and urban forests. The majority of forested land in Larimer County is upland forest. Rocky Mountain National Park makes up a large percentage of the forested land within Larimer County and includes over 350 miles of trails. It is the #1 visited National Park in the United States, leading to a greater threat of human-caused fires within forested areas. Outside of the mountains, much of the forested land in Larimer County occurs along rivers, seasonal water courses, lakes, and ponds. Other forested lands include farmsteads and urban areas. Here, trees are often planted near homes and outbuildings, which contribute to elevated wildfire risk. In addition to the trees, forested lands include a surface cover of dry brush and grasses, which are primary fuel sources for rapidly moving fires.

Grazing lands are primarily made up of sandhill steppe and prairie landscapes. Sandhill steppe is a combination of mixed grasses and sage and is widely used for livestock grazing. Fuel loads on grazing lands are moderate to heavy and large fires have occurred with this fuel type during springtime wind events. In some areas within Larimer County livestock grazing maintains a rather sparse fuel load.

Miscellaneous areas include transportation right of ways, fence lines, disturbed areas, and other locations that contain grasses, tumbleweeds, wild sunflowers, and other vegetation.

Magnitude/Severity

"Wildfire Risk" represents the possibility of loss or harm occurring from a wildfire. For the purpose of this Plan, risk has been derived using the CO-WRAP wildfire risk rating, which combines the probability of a fire occurring with the values at risk, considering all values and assets combined. The inputs for values at risk include the WUI, forest assets, riparian assets, and drinking water importance areas (watersheds). The Wildfire Risk map, shown in As was discussed previously, understanding the location of people living in the wildland-urban interface is essential for defining potential wildfire impacts to people and homes. The WUI Risk analysis provides a rating of the potential impact of a wildfire on people and their homes. The key input, the wildland-urban interface, reflects housing density (houses per acre).

To calculate WUI risk, WUI housing density data was combined with response function data. Response functions are a method of assigning a net change in the value of a resource or asset based on its susceptibility to fire at various intensity levels (such as flame length). The response functions were defined by a team of experts led by Colorado State Forest Service mitigation planning staff. By combining these data sets it is possible to determine where the greatest potential impact to homes and people are likely to occur in Larimer County.

Figure 4-45 shows the various levels of WUI Risk within Larimer County. The range of values is from -1 to -9, with -1 representing the least negative impacts and -9 representing the most negative impact. For example, areas with high housing density and high flame lengths are rated -9, while areas with low housing density and low flame lengths are rated -1. Understandably so, the Map of WUI Risk shows a number of high risk areas concentrated around densely populated parts of the county. Wildland-Urban Interface Risk was also calculated in the 2018 Colorado State Hazard Mitigation Plan using this CO-WRAP data and methodology. This allows for comparison and ordination to be made across the state.

Figure 4-44, identifies areas with the greatest potential impacts from a wildfire, in other words, those areas most at risk. The CO-WRAP data set was produced statewide and ranks areas on a scale from lowest risk to highest risk. All risk rankings are present in Larimer County. The highest wildfire risk areas in the county are located in the central region, in areas where there are lower population densities.

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Figure 4-44 Larimer County Wildfire Risk based on CO-WRAP Assessment

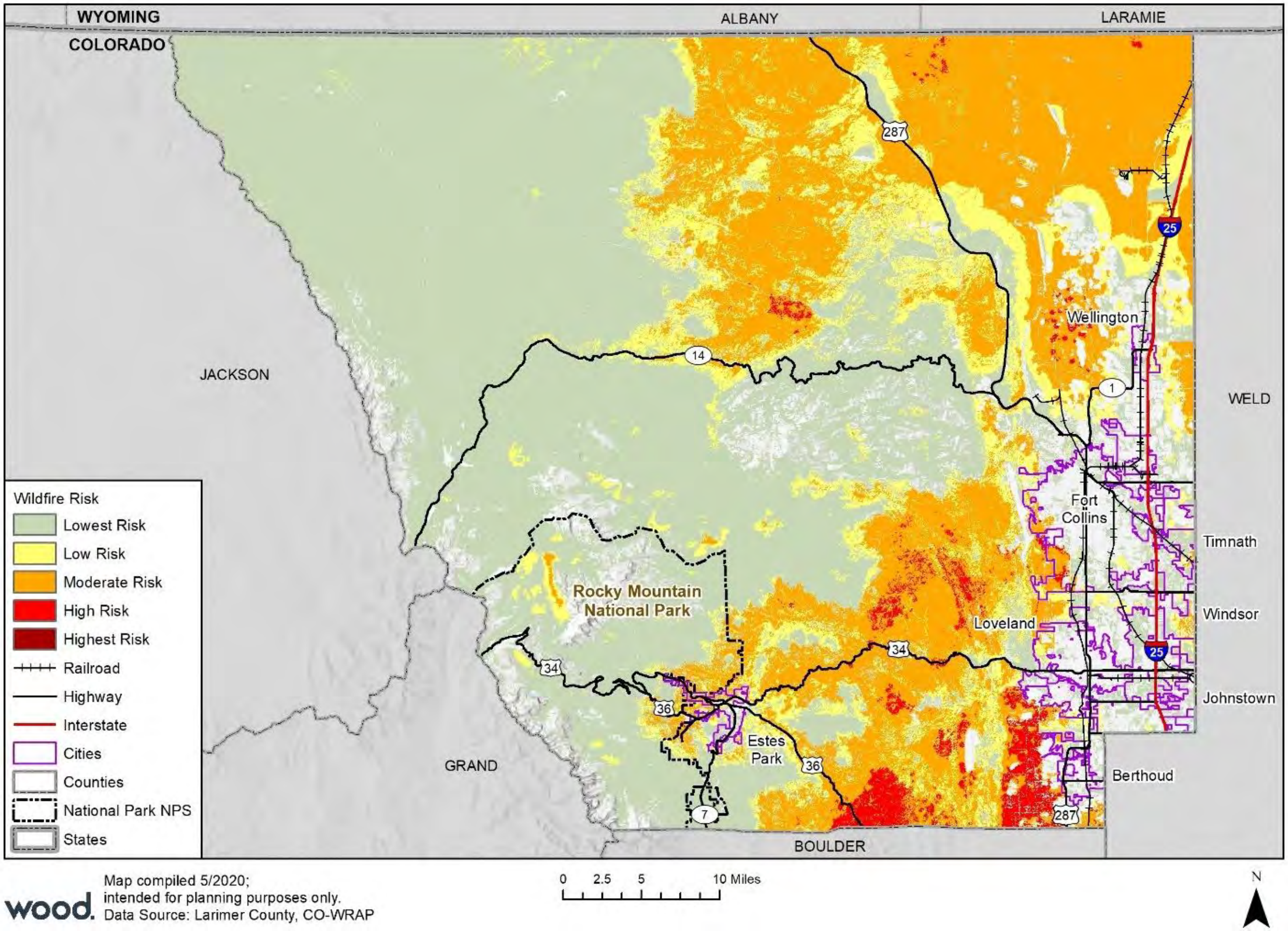
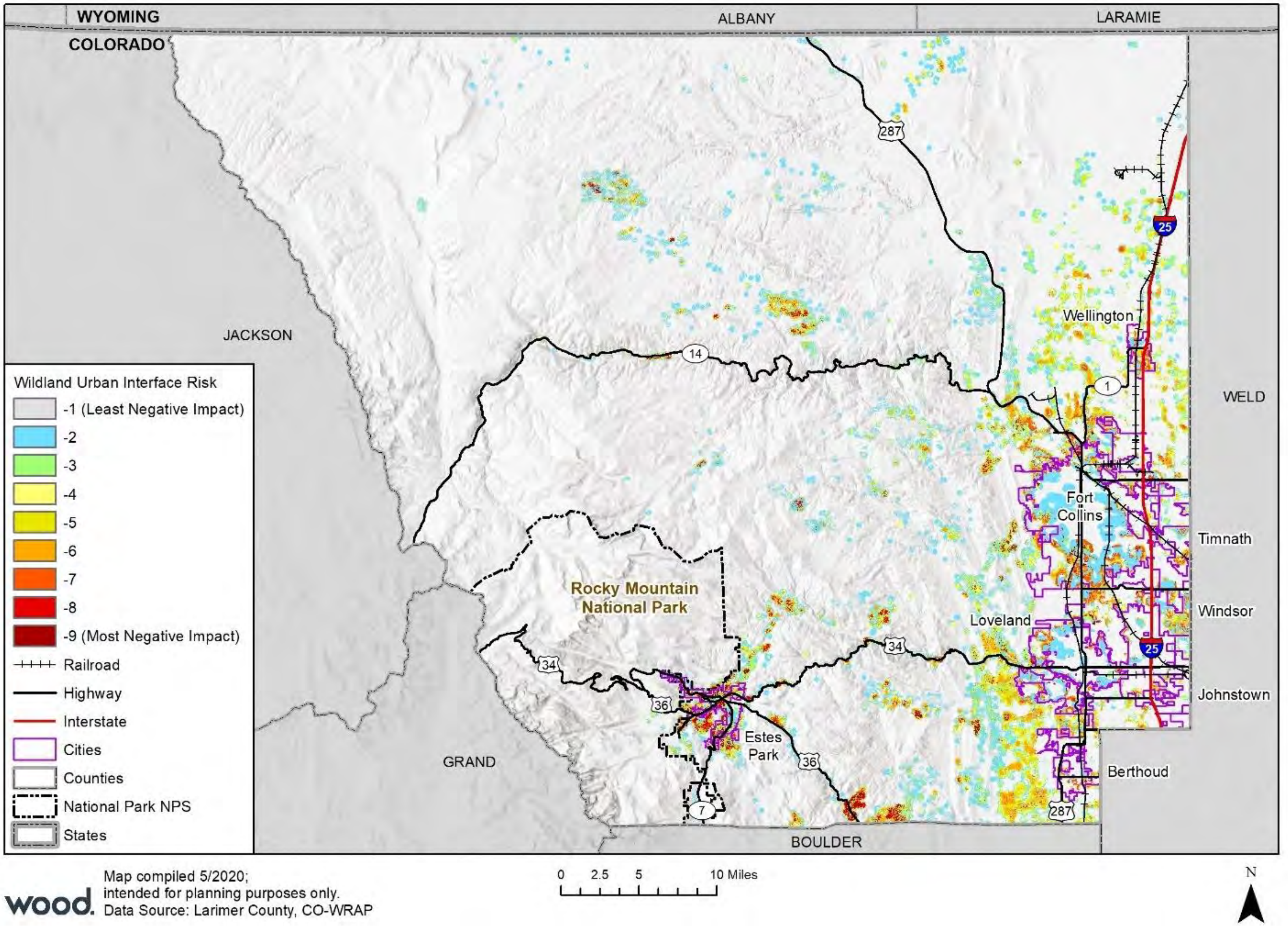


Figure 4-45 Larimer County Wildfire WUI Risk based on CO-WRAP Assessment



As evidenced by the wildfire risk assessment, areas within Larimer County that are characterized by dense development and single-family homes along the wildland-urban interface are most vulnerable to wildfire. The map of Wildland-Urban Interface Risk illustrates the difference in wildfire risk between jurisdictions within the County. The jurisdictions with the highest WUI Risk Index rating include areas of the Town of Estes Park and portions of unincorporated Larimer County located along the foothills.

Speed of Onset

A wildfire can start and spread within hours depending on fuel source, topography, and weather patterns and can burn hundreds or even thousands of acres a day. Several past fires in Larimer County have burned over a hundred acres a day, such as the Mineral Springs Fire in 2015, which burned 462 acres in 3 days, the Bobcat Fire in 2000, which burned 10,599 acres in 37 days (286.5 acres per day), and the High Park Fire in 2015, which burned 87,275 acres in 66 days (1,322.3 acres per day).

Duration

Wildfires can last anywhere from days to months. Per wildfire history data compiled by USGS and CO-WRAP from 1980-2018, the average wildfire in Larimer County lasts five days. The longest lasting wildfire on record in Larimer County during this period, the Fern Lake fire in 2012, lasted 247 days.

Probability of Future Occurrences

As noted above under Past Occurrences, Larimer County has experienced 874 recorded wildfires from 1980 to 2018, 59 of which burned at least 10 acres. Fires of 10 acres or more occurred in 26 of the 39 years on record. Based on this historical record, wildfire is highly likely to occur in any given year.

Recent wildfires and brush fires across Colorado have forced school closures, disrupted telephone services by burning fiber optic cables, damaged railroads and other infrastructure, and adversely affected tourism, outdoor recreation, and hunting. The likelihood of one of those fires attaining significant size and intensity is unpredictable and highly dependent on environmental conditions and firefighting response. Weather conditions, particularly drought events, increase the likelihood of wildfires occurring. That said, it is important to note that 35% of recent past wildfires in Larimer County have been human-caused. Ultimately, the occurrence of future wildfire events will strongly depend on patterns of human activity and events are more likely to occur in wildfire-prone areas experiencing new or additional development.

Wildfires can occur at any time of day and during any month of the year. Moreover, the length of a wildfire season and/or peak months may vary appreciably from year to year. Long-term weather patterns in Larimer County have followed a cyclical pattern of wet years (characterized by average to high precipitation levels for the region), followed by a series of drought years (characterized by below average precipitation levels). During wet years, the typical fire season is from March through November. During drought years, the fire season in Colorado has been as long as a full year.

Climate Change Considerations

Climate is a major determinant of wildfire through its control of weather, as well as through its interaction with fuel availability, fuel distribution and flammability at the global, regional and local levels. With hotter temperatures, drier soil and worsening drought conditions in the County, wildfires have the potential to become more extreme. Currently humans are the main cause of fire ignition globally, although lightning has been predominantly responsible for large fires in Larimer County. Colorado and the Western United States have seen significant increases in forest area burned in recent years, and the risk of wildfires in the future are expected to increase due to a lengthening fire season and drier conditions. According to a report from the International Panel on Climate Change:

> *Fire season has already lengthened by 18.7% globally between 1979 and 2013, with statistically significant increases across 25.3% but decreases only across 10.7% of Earth's land surface covered with vegetation; with even sharper changes being observed during the second half of this period. Correspondingly, the global area experiencing long fire weather season has increased by 3.1% per annum or 108.1% during 1979–2013. Fire frequencies under 2050 conditions are projected to increase by approximately 27% globally, relative to the 2000 levels, with changes in future fire meteorology playing the most important role in enhancing global wildfires, followed by land cover changes, lightning activities and land use, while changes in population density exhibit the opposite effects.*

Land use, vegetation, available fuels, and weather conditions (including wind, low humidity, and lack of precipitation) are chief factors in determining the number of fires and acreage burned in Colorado each year. Generally, fires are more likely when vegetation is dry from a winter with little snow and/or a spring and summer with sparse rainfall. For these reasons, climate change in Colorado (specifically, a pattern of extended drought conditions) had contributed to increased concern about wildfire in Larimer County.

The frequency, intensity, and duration of wildfires have increased across the Western United States since the 1980s. The US Department of Agriculture's "Effects of Climate Variability and Change on Forest Ecosystems" General Technical Report, published in December 2012, found that the Colorado region, among others, will face an even greater fire risk over time. The report expects Colorado to experience up to a five-fold increase in acres burned by 2050. The report's findings are consistent with previous studies on the relationship between climate change and fire risk. Colorado landscapes, including those that characterize Larimer County, are expected to become hotter and drier as the planet warms, which will in turn increase regional wildfire risk.

Vulnerability Assessment

Local impacts from wildfire events include the following:

- Loss of life (human, livestock, wildlife)
- Damage to municipal watersheds
- Loss of property
- Evacuations
- Transportation interruption (closing highways)
- Reductions in air quality and human health
- Injuries – burns, smoke inhalation, etc.
- Coal seam or other energy facility ignitions
- Loss of vegetation (erosion, loss of forage and habitat for livestock and wildlife)
- Expense of responding (equipment, personnel, supplies, etc.)
- Loss of revenue from destroyed recreation and tourism areas

Currently, there is no method for estimating wildfire loss. In most cases, the emergency management community equates potential losses to assets exposed to wildfire as a method of quantifying and comparing potential losses across communities. The following exposure data, categorized by risk level from highest to moderate, provides the clearest picture of potential losses to wildfire in Larimer County.

Table 4-75 Improved Properties at Risk to Highest Wildfire Hazard by Parcel Type within Larimer County

Jurisdiction	Parcel Type	Improved Parcels	Building Count	Improved Value	Content Value	Total Value	Population
Unincorporated	Residential	17	17	$5,082,127	$2,541,064	$7,623,191	42
	Total	**17**	**17**	**$5,082,127**	**$2,541,064**	**$7,623,191**	**42**

Source: Larimer County Parcel Data, CO-WRAP

Table 4-76 Improved Properties at Risk to High Wildfire Hazard by Parcel Type within Larimer County

Jurisdiction	Parcel Type	Improved Parcels	Building Count	Improved Value	Content Value	Total Value	Population
Berthoud	Exempt	1	1	$578,476	$578,476	$1,156,952	
	Total	**1**	**1**	**$578,476**	**$578,476**	**$1,156,952**	**0**
Estes Park	Residential	23	27	$12,036,144	$6,018,073	$18,054,217	53
	Total	**23**	**27**	**$12,036,144**	**$6,018,073**	**$18,054,217**	**53**
Fort Collins	Residential	69	69	$33,712,399	$16,856,196	$50,568,595	170
	Total	**69**	**69**	**$33,712,399**	**$16,856,196**	**$50,568,595**	**170**
Loveland	Residential	23	23	$10,411,409	$5,205,704	$15,617,113	55
	Total	**23**	**23**	**$10,411,409**	**$5,205,704**	**$15,617,113**	**55**
Unincorporated	Agricultural	107	115	$54,838,016	$54,838,016	$109,676,032	
	Commercial	6	9	$1,597,878	$1,597,878	$3,195,756	
	Exempt	8	11	$6,768,307	$6,768,307	$13,536,614	
	Mobile Home	18	25	$3,566,866	$1,783,431	$5,350,297	62
	Residential	2,495	2,621	$989,294,646	$494,647,326	$1,483,941,972	6,448
	Total	**2,634**	**2,781**	**$1,056,065,713**	**$559,634,958**	**$1,615,700,671**	**6,509**
Grand Total		**2,750**	**2,901**	**$1,112,804,141**	**$588,293,407**	**$1,701,097,548**	**6,787**

Source: Larimer County Parcel Data, CO-WRAP

Table 4-77 Improved Properties at Risk to Moderate Wildfire Hazard by Parcel Type within Larimer County

Jurisdiction	Parcel Type	Improved Parcels	Building Count	Improved Value	Content Value	Total Value	Population
Berthoud	Commercial	1	1	$284,094	$284,094	$568,188	
	Exempt	1	1	$688,700	$688,700	$1,377,400	
	Mobile Home	1	1	$1,231,700	$615,850	$1,847,550	3
	Multiple Unit	1	13	$14,973,304	$14,973,304	$29,946,608	
	Residential	173	173	$45,991,386	$22,995,694	$68,987,080	433
	Total	**177**	**189**	**$63,169,184**	**$39,557,642**	**$102,726,826**	**435**
Estes Park	Commercial	27	57	$40,497,438	$40,497,438	$80,994,876	
	Exempt	8	51	$24,324,599	$24,324,599	$48,649,198	
	Residential	635	650	$257,822,648	$128,911,309	$386,733,957	1,268
	Total	**670**	**758**	**$322,644,685**	**$193,733,346**	**$516,378,031**	**1,268**
Fort Collins	Agricultural	2	2	$523,047	$523,047	$1,046,094	
	Exempt	3	4	$706,451	$706,451	$1,412,902	
	Residential	224	230	$105,761,544	$52,880,768	$158,642,312	566
	Total	**229**	**236**	**$106,991,042**	**$54,110,266**	**$161,101,308**	**566**
Loveland	Residential	81	81	$24,531,839	$12,265,915	$36,797,754	194
	Total	**81**	**81**	**$24,531,839**	**$12,265,915**	**$36,797,754**	**194**
Timnath	Residential	281	281	$95,057,049	$47,528,526	$142,585,575	933

Jurisdiction	Parcel Type	Improved Parcels	Building Count	Improved Value	Content Value	Total Value	Population
	Total	**281**	**281**	**$95,057,049**	**$47,528,526**	**$142,585,575**	**933**
Windsor	Residential	366	368	$184,147,017	$92,073,508	$276,220,525	1,034
	Total	**366**	**368**	**$184,147,017**	**$92,073,508**	**$276,220,525**	**1,034**
Unincorporated	Agricultural	734	815	$291,199,832	$291,199,832	$582,399,664	
	Commercial	50	93	$40,052,419	$40,052,419	$80,104,838	
	Exempt	75	199	$108,126,581	$108,126,581	$216,253,162	
	Mobile Home	50	83	$12,051,457	$6,025,726	$18,077,183	204
	Multiple Unit	3	6	$849,089	$849,089	$1,698,178	
	Residential	4,825	5,248	$1,718,399,617	$859,199,785	$2,577,599,402	12,910
	Total	**5,737**	**6,444**	**$2,170,678,995**	**$1,305,453,432**	**$3,476,132,427**	**13,114**
Grand Total		**7,541**	**8,357**	**$2,967,219,811**	**$1,744,722,635**	**$4,711,942,446**	**17,543**

Source: Larimer County Parcel Data, CO-WRAP

People

Based on the above assessment of exposure of residential property and the average household size in Larimer County, there are an estimated 24,371 people exposed to the highest to moderate wildfire risk. Areas of highest WUI Risk in the county near Estes Park correspond to areas of above average social vulnerability, including household composition and disability vulnerability as well as housing and transportation vulnerability.

General Property

Overall, 10,308 improved parcels with a total estimated value of $6,420,663,185 are located in the highest to moderate wildfire hazard areas. The majority of exposure to wildfire risk is in unincorporated Larimer County.

Critical Facilities & Infrastructure

Table 4-78 summarizes the exposure data of critical facilities to potential wildfire risk by showing the number of critical facilities located within each wildfire risk category, categorized by FEMA Lifeline. Note that there are no identified critical facilities within the highest wildfire risk area.

Table 4-78 Critical Facilities with Potential Wildfire Risk

Wildfire Risk	Jurisdiction	FEMA Lifeline	Count
High	Loveland	Food, Water, Shelter	1
	Unincorporated	Food, Water, Shelter	2
	Total		**3**
Moderate	Berthoud	Miscellaneous	1
	Estes Park	Miscellaneous	1
	Fort Collins	Safety and Security	1
		Transportation	1
	Unincorporated	Energy	1
		Food, Water, Shelter	24
		Safety and Security	4
	Total		**33**

Wildfire Risk	Jurisdiction	FEMA Lifeline	Count
Low	Estes Park	Safety and Security	1
	Fort Collins	Food, Water, Shelter	1
		Hazardous Material	1
	Unincorporated	Communications	2
		Energy	1
		Food, Water, Shelter	24
		Hazardous Material	3
		Safety and Security	4
	Total		**37**
Lowest	Berthoud	Safety and Security	2
	Estes Park	Food, Water, Shelter	2
	Fort Collins	Energy	4
		Food, Water, Shelter	4
		Miscellaneous	1
		Safety and Security	3
	Johnstown	Energy	1
	Loveland	Energy	5
		Food, Water, Shelter	6
		Safety and Security	1
	Wellington	Safety and Security	1
	Unincorporated	Communications	3
		Energy	1
		Food, Water, Shelter	48
		Hazardous Material	1
		Health and Medical	1
		Miscellaneous	1
		Safety and Security	7
	Total		**92**
Grand Total			**165**

Source: Cascarta, CO-WRAP

There are 36 identified county assets located in areas with high to moderate wildfire risk. The majority of these facilities are within the food, water, and shelter lifeline. Most of the facilities exposed to risk are located in unincorporated Larimer County.

Economy

Fires can extensively impact the economy of an affected area, including agricultural, recreation and tourism industries, and water resources. Businesses in affected areas can be impacted due to evacuation, lack of utility service, or through destruction of property.

Historic, Cultural, and Natural Resources

Wildfire is a consistent threat to natural resources in Larimer County, particularly the county's parks and forests. Wildfires regularly occur in Arapaho and Roosevelt National Forests and Rocky Mountain National

Park. Fire is a natural part of forest growth cycles but can also cause cascading threats to natural resources. After wildfires, the risk of floods and debris flows increases due to the exposure of bare ground and the loss of vegetation. Secondary effects of wildfires also include erosion, landslides, introduction of invasive species, and changes in water quality.

Figure 4-46 Larimer County Fire

Source: Poudre Fire Authority

Land Use and Development Trends

Future development is an important factor to consider in the context of wildfire mitigation because development and population growth can contribute to increased exposure of people and property to wildfire. During the past few decades, population growth in the Larimer County WUI has increased greatly. Subdivisions and other high-density developments have created a situation where wildland fires can involve more buildings than any amount of fire equipment can possibly protect. By identifying areas with significant potential for population growth and/or future development in high-risk areas, communities can identify areas of mitigation interest and reduce hazard risks associated with increased exposure.

As development expands into wildland areas, people and property are increasingly at risk from wildfire. Wildfire mitigation in the wildland-urban interface has primarily been the responsibility of property owners who choose to build and live in vulnerable zones. In practice, successful wildfire mitigation strategies can be quite involved. The most important aspect of successful suppression is disruption of the continuity of fuels, achieved by creating breaks or defensible areas. For interface fires, where homes and other structures fill the space, fuel reduction is best accomplished before the fires begin. Larimer County does have land use codes in place that specifically deal with construction in the WUI. Some of these codes include and/or focus on mandatory mitigation measures.

Figure 4-47 Wildfire Mitigation Activity in Larimer County

Safety zones can be created around structures by reducing or eliminating brush, trees, and vegetation around a home or facility. FEMA recommends using a 30-foot safety zone; including keeping grass below 2 feet tall and clearing all fallen leaves and branches promptly. Additionally, only fire-resistant or non-combustible materials should be used on roofs and exterior surfaces. Firebreaks -- areas of inflammable materials that create a fuel break and reduce the ability for fires to spread and roads and pathways -- can be planned and designed to serve as wildfire mitigation. The Colorado State Forest Service's defensible space guidelines describe three zones:

- Zone 1 is within 30' of the home or other structures. Most flammable vegetation should be removed in this zone, with the possible exception of a few low-growing shrubs or fire-resistant plants.
- Zone 2 extends to 100' and is a is an area of fuels reduction, including thinning and pruning trees and shrubs, designed to diminish the intensity of an approaching fire.
- Zone 3 extends beyond 100' to the property boundary and provides a gradual transition to the forest management objectives of surrounding areas.

Source: Colorado State University

Risk Summary

- Larimer County averages 22 wildfires per year and 3,224.3 acres burned per year. Approximately 6.8 percent of wildfires burn 10 acres or more.
- There are an estimated 24,371 people and 10,308 improved parcels with a total estimated value of $6,420,663,185 located in the highest to moderate wildfire hazard areas in Larimer County. The greatest exposure is in unincorporated Larimer County.

4.3.14 Winter Storm

Hazard	Frequency	Spatial Extent	Severity	Overall Significance
Winter Storm	Highly Likely	Extensive	Critical	High

Description

Winter storms can cause hazardous driving conditions, communications and electrical power failure, community isolation, and can adversely affect business continuity. This type of snow-related weather may include one or more of the following winter factors:

Winter storms can include blizzards, heavy snow, ice storms, and extreme cold.

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

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

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

Extreme Cold in extended periods, although infrequent, could occur throughout the winter months in Larimer County. Heating systems compensate for the cold outside. Most people limit their time outside during extreme cold conditions, but common complaints usually include pipes freezing and cars refusing to start. When cold temperatures and wind combine, dangerous wind chills can develop.

Note that in Larimer County "winter storms" can also occur in fall and spring months.

Past Occurrences

The National Center for Environmental Information (NCEI) archives past "Significant" winter storm, winter weather, and blizzard events in the NCEI Storm Events Database if the event has more than one significant hazard (i.e., heavy snow and blowing snow; snow and ice; snow and sleet; sleet and ice; or snow, sleet, and ice) and meets or exceeds locally/regionally defined twelve or twenty-four hour warning criteria for at least one of the precipitation elements on a widespread or localized basis. According to the best available data there have been 504 winter storms reported in Larimer County between 1996 and 2019. There are no reported injuries or crop damage in Larimer County due to winter storm events between 1996 and 2019. One death was reported in 2004 after a hiker was caught in a snowstorm on the summit of Longs Peak.

The only recorded event causing property damages took place on March 17, 2003. A slow moving storm system moved into Colorado from the Pacific Ocean. In addition to this storm, moist air moved north from the Gulf of Mexico as well as strong winds from the east resulted in an upslope flow across the Front Range. As a result of this storm 3 feet of saturated snow fell in Denver and up to 7 feet of snow fell in the foothills from March 17th through the 20th. In Larimer County approximately 30 inches of heavy snow fell causing damages to homes and businesses, and the closure of local schools including Colorado State University. Property damage as a result of this storm is estimated to be around $31 million dollars. According to data there have been at least six significant winter storm events recorded in Larimer County each year.

The March 13, 2019 “Bomb Cyclone”, a blizzard event that had significant impacts on across the state. The following is a description of the event from the NWS Denver/Boulder Weather Forecast Office:

> *On March 13th, 2019 an extremely powerful low pressure system developed over southern Colorado, setting a record for the lowest pressure ever recorded over Colorado, at Lamar, of 970.4 mb. The system officially met the criteria of a "Bomb Cyclone", in which barometric pressure readings dropped in excess of 24 mb (0.71 in Hg) over a 24-hour period. This storm created widespread blizzard conditions across northeast Colorado, Palmer Divide and over El Paso County. Wind gusts from 60 to 80 mph, with locally up to 100 mph. In addition, 1 to 3 feet of snow fell across the mountains with up to 52" at Wolf Creek Pass.*

Impacts included 1,400 flights cancelled at the Denver International Airport (DIA); all major Highways and Interstates including I-25, which was closed from Wellington to the Wyoming state line; several multi-car accidents took stranding travelers in their cars and at rest stops across northeast Colorado; trees and power poles were damaged causing power outages in some cases for several days; schools, businesses and government facilities were closed for 1 to 2 days in some cases; 1 fatality of a Colorado State Trooper on I-76 northeast of Denver; and livestock economies were impacted due to calving season.

The HMPC also reported a winter storm event that lasted from November 22nd through 23rd 2019 and resulted in 36 inches of snow. U.S. 36 was closed as a result, stranding travelers overnight. HMPC representatives from the Pinewood Springs Fire Protection District noted that the entire District was impacted and that a similar winter storm event has the potential for the Fire Department not being able to reach structures due to impassible roads.

Table 4-79 Historic Winter Storms- Larimer County

Date	Location	Event Type	Injuries	Deaths	Damage to Property	Damage to Crops
1/1/1996	Larimer County between 6,000 & 9,000 feet, and above 9,000 feet	Heavy Snow	0	0	0	0
1/3/1996	Larimer County above 9,000 feet	Heavy Snow	0	0	0	0
1/4/1996	Larimer County between 6,000 & 9,000 feet	Heavy Snow	0	0	0	0
1/18/1996	Larimer County above 9,000 feet	Heavy Snow	0	0	0	0

Date	Location	Event Type	Injuries	Deaths	Damage to Property	Damage to Crops
1/24/1996	Larimer County above 9,000 feet	Heavy Snow	0	0	0	0
1/25/1996	Larimer County below 6,000 feet, Between 6,000 & 9,000 feet	Heavy Snow	0	0	0	0
1/27/1996	Larimer County above 9,000 feet	Heavy Snow	0	0	0	0
1/30/1996	Larimer County above 9,000 feet and between 6,000 & 9,000 feet	Heavy Snow	0	0	0	0
2/17/1996	Larimer County above 9,000 feet	Heavy Snow	0	0	0	0
2/19/1996	Larimer County above 9,000 feet	Heavy Snow	0	0	0	0
2/20/1996	Larimer County above 9,000 feet	Heavy Snow	0	0	0	0
2/22/1996	Larimer County above 9,000 feet	Heavy Snow	0	0	0	0
3/13/1996	Larimer County below 6,000 feet, Between 6,000 & 9,000 feet	Heavy Snow	0	0	0	0
3/16/1996	Larimer County between 6,000 & 9,000 feet, and above 9,000 feet	Heavy Snow	0	0	0	0
3/23/1996	Larimer County below 6,000 feet, between 6,000 & 9,000 feet, and above 9,000 feet	Heavy Snow	0	0	0	0
4/3/1996	Larimer County between 6,000 & 9,000 feet	Heavy Snow	0	0	0	0
4/18/1996	Larimer County above 9,000 feet	Heavy Snow	0	0	0	0
5/25/1996	Larimer County between 6,000 & 9,000 feet, Above 9,000 feet	Heavy Snow	0	0	0	0
9/18/1996	Larimer County between 6,000 & 9,000 feet, Above 9,000 feet	Heavy Snow	0	0	0	0
9/24/1996	Larimer County between 6,000 & 9,000 feet and above 9,000 feet	Heavy Snow	0	0	0	0
10/16/1996	Larimer County above 9,000 feet	Heavy Snow	0	0	0	0
10/19/1996	Larimer County above 9,000 feet	Heavy Snow	0	0	0	0
10/25/1996	Larimer County between 6,000 & 9,000 feet, above 9,000 feet	Heavy Snow	0	0	0	0
11/14/1996	Larimer County above 9,000 feet	Heavy Snow	0	0	0	0
11/15/1996	Larimer County below 6,000 feet, between 6,000 & 9,000 feet, above 9,000 feet	Heavy Snow	0	0	0	0

Date	Location	Event Type	Injuries	Deaths	Damage to Property	Damage to Crops
12/1/1996	Larimer County above 9,000 feet	Heavy Snow	0	0	0	0
12/5/1996	Larimer County above 9,000 feet	Winter Storm	0	0	0	0
12/6/1996	Larimer County between 6,000 & 9,000 feet, above 9,000 feet	Heavy Snow	0	0	0	0
12/16/1996	Larimer County below 6,000 feet, between 6,000 & 9,000 and above 9,000 feet	Winter Storm	0	0	0	0
1/10/1997	Larimer County below 6,000 feet, between 6,000 & 9,000 feet, above 9,000 feet	Heavy Snow	0	0	0	0
1/11/1997	Larimer County between 6,000 & 9,000 feet, above 9,000 feet	Heavy Snow	0	0	0	0
2/6/1997	Larimer County between 6,000 & 9,000 feet	Heavy Snow	0	0	0	0
2/12/1997	Larimer County between 6,000 & 9,000 feet	Heavy Snow	0	0	0	0
2/20/1997	Larimer County between 6,000 & 9,000 feet, above 9,000 feet	Heavy Snow	0	0	0	0
2/23/1997	Larimer County below 6,000 feet, between 6,000 & 9,000 feet	Heavy Snow	0	0	0	0
2/26/1997	Larimer County below 6,000 feet, between 6,000 & 9,000 feet	Heavy Snow	0	0	0	0
2/28/1997	Larimer County between 6,000 & 9,000 feet	Heavy Snow	0	0	0	0
3/3/1997	Larimer County above 9,000 feet	Heavy Snow	0	0	0	0
3/24/1997	Larimer County between 6,000 & 9,000 feet, above 9,000 feet	Heavy Snow	0	0	0	0
4/1/1997	Larimer County between 6,000 & 9,000 feet, above 9,000 feet	Heavy Snow	0	0	0	0
4/4/1997	Larimer County between 6,000 & 9,000 feet	Winter Storm	0	0	0	0
4/9/1997	Larimer County between 6,000 & 9,000 feet	Heavy Snow	0	0	0	0
4/10/1997	Larimer County between 6,000 & 9,000 feet, above 9,000 feet	Heavy Snow	0	0	0	0
4/21/1997	Larimer County above 9,000 feet	Winter Storm	0	0	0	0

Date	Location	Event Type	Injuries	Deaths	Damage to Property	Damage to Crops
4/23/1997	Larimer County below 6,000 feet, between 6,000 & 9,000 feet, above 9,000 feet	Winter Storm	0	0	0	0
4/25/1997	Larimer County between 6,000 & 9,000 feet	Heavy Snow	0	0	0	0
4/29/1997	Larimer County above 9,000 feet	Winter Storm	0	0	0	0
10/24/1997	Northern Front Range Foothills, Upper Larimer and Cache La Poudre River Basins, Rocky Mountain National Park, Medicine Bow Range, Eastern Larimer County	Blizzard	0	0	0	0
11/11/1997	Northern Front Range Foothills, Upper Larimer and Cache La Poudre River Basins, Central Larimer County	Heavy Snow	0	0	0	0
11/28/1997	Northern Front Range Foothills, Upper Larimer and Cache La Poudre River Basins	Winter Storm	0	0	0	0
12/24/1997	Northern Front Range Foothills, Upper Larimer and Cache La Poudre River Basins, Central Larimer County, Eastern Larimer County	Heavy Snow	0	0	0	0
1/5/1998	Rocky Mountain National Park, Medicine Bow Range, Northern Front Range Foothills, Upper Larimer and Cache La Poudre River Basins, Central Larimer County, Western Larimer County	Winter Storm	0	0	0	0
1/17/1998	Rocky Mountain National Park, Medicine Bow Range, Western Larimer County	Blizzard	0	0	0	0
2/24/1998	Rocky Mountain National Park, Medicine Bow Range	Winter Storm	0	0	0	0
3/4/1998	Rocky Mountain National Park, Medicine Bow Range, Western Larimer County	Heavy Snow	0	0	0	0
3/6/1998	Northern Front Range Foothills, Upper Larimer and Cache La Poudre River Basins, Eastern Larimer County	Heavy Snow	0	0	0	0
3/18/1998	Rocky Mountain National Park, Medicine Bow Range, Northern Front Range Foothills, Upper Larimer and Cache La Poudre River Basins, Eastern Larimer County	Winter Storm	0	0	0	0

Date	Location	Event Type	Injuries	Deaths	Damage to Property	Damage to Crops
4/2/1998	Rocky Mountain National Park, Medicine Bow Range, Northern Front Range Foothills, Upper Larimer and Cache La Poudre River Basins	Winter Storm	0	0	0	0
4/7/1998	Northern Front Range Foothills, Upper Larimer and Cache La Poudre River Basins, Central Larimer County	Heavy Snow	0	0	0	0
4/15/1998	Northern Front Range Foothills, Upper Larimer and Cache La Poudre River Basins, Central Larimer County	Winter Storm	0	0	0	0
4/18/1998	Northern Front Range Foothills, Upper Larimer and Cache La Poudre River Basins, Central Larimer County	Winter Storm	0	0	0	0
4/20/1998	Northern Front Range Foothills, Upper Larimer and Cache La Poudre River Basins	Winter Storm	0	0	0	0
4/26/1998	Northern Front Range Foothills, Upper Larimer and Cache La Poudre River Basins, Central Larimer County	Winter Storm	0	0	0	0
6/4/1998	Northern Front Range Foothills, Upper Larimer and Cache La Poudre River Basins	Heavy Snow	0	0	0	0
10/28/1998	Rocky Mountain National Park, Medicine Bow Range	Winter Storm	0	0	0	0
11/7/1998	Northern Front Range Foothills, Upper Larimer and Cache La Poudre River Basins, Central Larimer County, Eastern Larimer County	Heavy Snow	0	0	0	0
11/8/1998	Northern Front Range Foothills, Upper Larimer and Cache La Poudre River Basins	Heavy Snow	0	0	0	0
12/9/1998	Northern Front Range Foothills, Upper Larimer and Cache La Poudre River Basins, Central Larimer County, Eastern Larimer County	Heavy Snow	0	0	0	0
12/18/1998	Northern Front Range Foothills, Upper Larimer and Cache La Poudre River Basins, Central Larimer County, Eastern Larimer County	Winter Storm	0	0	0	0

Date	Location	Event Type	Injuries	Deaths	Damage to Property	Damage to Crops
12/19/1998	Rocky Mountain National Park, Medicine Bow Range, Northern Front Range Foothills, Upper Larimer and Cache La Poudre River Basins, Central Larimer County, Western Larimer County	Winter Storm	0	0	0	0
12/20/1998	Rocky Mountain National Park, Medicine Bow Range, Western Larimer County	Winter Storm	0	0	0	0
1/4/1999	Rocky Mountain National Park, Medicine Bow Range, Western Larimer County	Winter Storm	0	0	0	0
1/17/1999	Rocky Mountain National Park, Medicine Bow Range	Winter Storm	0	0	0	0
1/21/1999	Rocky Mountain National Park, Medicine Bow Range, Northern Front Range Foothills, Upper Larimer and Cache La Poudre River Basins, Central Larimer County, Western Larimer County	Heavy Snow	0	0	0	0
1/24/1999	Rocky Mountain National Park, Medicine Bow Range, Western Larimer County, Eastern Larimer County	Heavy Snow	0	0	0	0
2/10/1999	Eastern Larimer County	Winter Storm	0	0	0	0
2/17/1999	Rocky Mountain National Park, Medicine Bow Range	Winter Storm	0	0	0	0
2/21/1999	Rocky Mountain National Park, Medicine Bow Range	Winter Storm	0	0	0	0
3/12/1999	Eastern Larimer County	Heavy Snow	0	0	0	0
4/1/1999	Northern Front Range Foothills, Upper Larimer and Cache La Poudre River Basins	Heavy Snow	0	0	0	0
4/14/1999	Northern Front Range Foothills, Upper Larimer and Cache La Poudre River Basins	Heavy Snow	0	0	0	0
4/21/1999	Northern Front Range Foothills, Upper Larimer and Cache La Poudre River Basins	Heavy Snow	0	0	0	0
4/28/1999	Northern Front Range Foothills, Upper Larimer and Cache La Poudre River Basins	Heavy Snow	0	0	0	0
4/29/1999	Northern Front Range Foothills, Upper Larimer and Cache La Poudre River Basins	Heavy Snow	0	0	0	0
5/1/1999	Northern Front Range Foothills, Upper Larimer and Cache La Poudre River Basins, Central Larimer County	Heavy Snow	0	0	0	0

Date	Location	Event Type	Injuries	Deaths	Damage to Property	Damage to Crops
9/28/1999	Northern Front Range Foothills, Upper Larimer and Cache La Poudre River Basins, Central Larimer County, Eastern Larimer County	Heavy Snow	0	0	0	0
10/16/1999	Northern Front Range Foothills, Upper Larimer and Cache La Poudre River Basins, Eastern Larimer County	Heavy Snow	0	0	0	0
10/18/1999	Northern Front Range Foothills, Upper Larimer and Cache La Poudre River Basins, Central Larimer County	Heavy Snow	0	0	0	0
11/21/1999	Northern Front Range Foothills, Upper Larimer and Cache La Poudre River Basins, Central Larimer County, Eastern Larimer County	Winter Storm	0	0	0	0
12/18/1999	Rocky Mountain National Park, Medicine Bow Range, Western Larimer County	Heavy Snow	0	0	0	0
1/9/2000	Rocky Mountain National Park, Medicine Bow Range, Northern Front Range Foothills, Upper Larimer and Cache La Poudre River Basins, Central Larimer County, Western Larimer County	Winter Storm	0	0	0	0
2/10/2000	Northern Front Range Foothills, Upper Larimer and Cache La Poudre River Basins, Eastern Larimer County	Heavy Snow	0	0	0	0
2/15/2000	Northern Front Range Foothills, Upper Larimer and Cache La Poudre River Basins	Heavy Snow	0	0	0	0
2/17/2000	Rocky Mountain National Park, Medicine Bow Range, Northern Front Range Foothills, Upper Larimer and Cache La Poudre River Basins	Heavy Snow	0	0	0	0
3/15/2000	Northern Front Range Foothills, Upper Larimer and Cache La Poudre River Basins, Eastern Larimer County	Heavy Snow	0	0	0	0
3/30/2000	Northern Front Range Foothills, Upper Larimer and Cache La Poudre River Basins	Heavy Snow	0	0	0	0
4/2/2000	Northern Front Range Foothills, Upper Larimer and Cache La Poudre River Basins	Heavy Snow	0	0	0	0

Date	Location	Event Type	Injuries	Deaths	Damage to Property	Damage to Crops
5/17/2000	Northern Front Range Foothills, Upper Larimer and Cache La Poudre River Basins, Central Larimer County, Western Larimer County	Winter Storm	0	0	0	0
9/23/2000	Northern Front Range Foothills, Upper Larimer and Cache La Poudre River Basins, Eastern Larimer County	Heavy Snow	0	0	0	0
11/1/2000	Northern Front Range Foothills, Upper Larimer and Cache La Poudre River Basins, Western Larimer County, Central Larimer County	Heavy Snow	0	0	0	0
11/28/2000	Northern Front Range Foothills, Upper Larimer and Cache La Poudre River Basins, Western Larimer County	Heavy Snow	0	0	0	0
12/30/2000	Rocky Mountain National Park, Medicine Bow Range	Heavy Snow	0	0	0	0
1/15/2001	Northern Front Range Foothills, Upper Larimer and Cache La Poudre River Basins	Heavy Snow	0	0	0	0
1/15/2001	Eastern Larimer County	Heavy Snow	0	0	0	0
2/8/2001	Northern Front Range Foothills, Upper Larimer and Cache La Poudre River Basins, Central Larimer County	Heavy Snow	0	0	0	0
3/10/2001	Northern Front Range Foothills, Upper Larimer and Cache La Poudre River Basins	Heavy Snow	0	0	0	0
3/16/2001	Northern Front Range Foothills, Upper Larimer and Cache La Poudre River Basins, Central Larimer County	Heavy Snow	0	0	0	0
3/25/2001	Eastern Larimer County	Heavy Snow	0	0	0	0
3/25/2001	Northern Front Range Foothills, Upper Larimer and Cache La Poudre River Basins	Heavy Snow	0	0	0	0
4/10/2001	Northern Front Range Foothills, Upper Larimer and Cache La Poudre River Basins, Eastern Larimer County	Winter Storm	0	0	0	0
4/11/2001	Eastern Larimer County	Blizzard	0	0	0	0
4/21/2001	Northern Front Range Foothills, Upper Larimer and Cache La Poudre River Basins, Central Larimer County	Winter Storm	0	0	0	0
4/22/2001	Eastern Larimer County	Winter Storm	0	0	0	0

Date	Location	Event Type	Injuries	Deaths	Damage to Property	Damage to Crops
5/2/2001	Northern Front Range Foothills, Upper Larimer and Cache La Poudre River Basins, Western Larimer County, Central Larimer County	Heavy Snow	0	0	0	0
5/20/2001	Northern Front Range Foothills, Upper Larimer and Cache La Poudre River Basins, Central Larimer County	Heavy Snow	0	0	0	0
1/9/2002	Larimer County between 6,000 & 9,000 feet	Heavy Snow	0	0	0	0
1/23/2002	Larimer County between 6,000 & 9,000 feet	Heavy Snow	0	0	0	0
1/29/2002	Larimer County below 6,000 feet and between 6,000 & 9,000 feet	Heavy Snow	0	0	0	0
3/1/2002	Larimer County below 6,000 feet and between 6,000 & 9,000 feet	Winter Storm	0	0	0	0
3/14/2002	Larimer County between 6,000 & 9,000 feet	Heavy Snow	0	0	0	0
5/23/2002	Larimer County between 6,000 & 9,000 feet	Winter Storm	0	0	0	0
11/1/2002	Larimer County Below 6,000 feet	Winter Storm	0	0	0	0
11/8/2002	Larimer County above 9,000 feet	Winter Storm	0	0	0	0
2/5/2003	Larimer County between 6,000 & 9,000 feet	Heavy Snow	0	0	0	0
3/17/2003	Larimer County between 6,000 & 9,000 feet, and above 9,000 feet	Winter Storm	0	0	15500000	0
3/17/2003	Larimer County Below 6,000 feet	Blizzard	0	0	15500000	0
4/23/2003	Larimer County between 6,000 & 9,000 feet, and above 9,000 feet	Winter Storm	0	0	0	0
5/9/2003	Larimer County between 6,000 & 9,000 feet, and above 9,000 feet	Heavy Snow	0	0	0	0
11/21/2003	Larimer County between 6,000 & 9,000 feet, and above 9,000 feet	Winter Storm	0	0	0	0
11/21/2003	Larimer County Below 6,000 feet, between 6,000 & 9,000 feet, and above 9,000 feet	Winter Storm	0	0	0	0
12/8/2003	Larimer County between 6,000 & 9,000 feet	Winter Storm	0	0	0	0
1/3/2004	Larimer County between 6,000 & 9,000 feet	Winter Storm	0	0	0	0

Date	Location	Event Type	Injuries	Deaths	Damage to Property	Damage to Crops
2/28/2004	Larimer County above 9,000 feet	Winter Storm	0	0	0	0
4/9/2004	Larimer County Below 6,000 feet, between 6,000 & 9,000 feet, and above 9,000 feet	Winter Storm	0	0	0	0
4/21/2004	Larimer County between 6,000 & 9,000 feet	Winter Storm	0	0	0	0
5/12/2004	Larimer County between 6,000 & 9,000 feet	Winter Storm	0	0	0	0
9/4/2004	Larimer County between 6,000 & 9,000 feet	Winter Weather	0	1	0	0
11/28/2004	Larimer County Below 6,000 feet, between 6,000 & 9,000 feet, and above 9,000 feet	Winter Storm	0	0	0	0
1/30/2005	Larimer County between 6,000 & 9,000 feet	Winter Storm	0	0	0	0
2/15/2005	Larimer County Below 6,000 feet, between 6,000 & 9,000 feet, and above 9,000 feet	Winter Storm	0	0	0	0
3/13/2005	Larimer County Below 6,000 feet, between 6,000 & 9,000 feet, and above 9,000 feet	Winter Storm	0	0	0	0
4/10/2005	Larimer County Below 6,000 feet, between 6,000 & 9,000 feet, and above 9,000 feet	Winter Storm	0	0	0	0
4/24/2005	Larimer County between 6,000 & 9,000 feet	Winter Storm	0	0	0	0
4/28/2005	Larimer County Below 6,000 feet, between 6,000 & 9,000 feet, and above 9,000 feet	Winter Storm	0	0	0	0
10/9/2005	Larimer County between 6,000 & 9,000 feet, above 9,000 feet	Winter Storm	0	0	0	0
11/14/2005	Larimer County between 6,000 & 9,000 feet, above 9,000 feet	Winter Storm	0	0	0	0
10/16/2006	Larimer County above 9,000 feet	Heavy Snow	0	0	0	0
10/17/2006	Larimer County between 6,000 & 9,000 feet	Heavy Snow	0	0	0	0
10/20/2006	Larimer County above 9,000 feet	Winter Storm	0	0	0	0
10/25/2006	Larimer County between 6,000 & 9,000 feet, above 9,000 feet	Winter Storm	0	0	0	0
11/13/2006	Larimer County above 9,000 feet	Winter Storm	0	0	0	0
11/28/2006	Larimer County below 6,000 feet, between 6,000 & 9,000 feet, and above 9,000 feet	Winter Storm	0	0	0	0

Date	Location	Event Type	Injuries	Deaths	Damage to Property	Damage to Crops
12/20/2006	Larimer County below 6,000 feet, between 6,000 & 9,000 feet, and above 9,000 feet	Blizzard	0	0	0	0
12/25/2006	Larimer County above 9,000 feet	Winter Weather	0	0	0	0
12/28/2006	Larimer County below 6,000 feet, between 6,000 & 9,000 feet, and above 9,000 feet	Winter Storm	0	0	0	0
1/4/2007	Larimer County above 9,000 feet	Winter Storm	0	0	0	0
1/5/2007	Larimer County below 6,000 feet, between 6,000 & 9,000 feet	Winter Storm	0	0	0	0
1/21/2007	Larimer County between 6,000 & 9,000 feet	Heavy Snow	0	0	0	0
2/16/2007	Larimer County above 9,000 feet	Winter Storm	0	0	0	0
3/24/2007	Larimer County above 9,000 feet	Heavy Snow	0	0	0	0
5/4/2007	Larimer County between 6,000 & 9,000 feet	Winter Weather	0	0	0	0
10/20/2007	Larimer County above 9,000 feet	Winter Storm	0	0	0	0
11/20/2007	Larimer County below 6,000 feet, between 6,000 & 9,000 feet, and above 9,000 feet	Winter Weather	0	0	0	0
12/1/2007	Larimer County above 9,000 feet	Winter Weather	0	0	0	0
12/6/2007	Larimer County above 9,000 feet	Winter Weather	0	0	0	0
12/7/2007	Larimer County above 9,000 feet	Winter Weather	0	0	0	0
12/25/2007	Larimer County between 6,000 & 9,000 feet	Winter Weather	0	0	0	0
12/27/2007	Larimer County below 6,000 feet	Winter Storm	0	0	0	0
1/5/2008	Larimer County above 9,000 feet	Winter Storm	0	0	0	0
1/10/2008	Larimer County above 9,000 feet	Winter Weather	0	0	0	0
2/7/2008	Larimer County above 9,000 feet	Winter Storm	0	0	0	0
2/8/2008	Larimer County above 9,000 feet	Winter Weather	0	0	0	0
2/8/2008	Larimer County above 9,000 feet	Winter Weather	0	0	0	0
4/9/2008	Larimer County above 9,000 feet	Winter Storm	0	0	0	0
4/9/2008	Larimer County above 9,000 feet	Winter Storm	0	0	0	0

Date	Location	Event Type	Injuries	Deaths	Damage to Property	Damage to Crops
5/1/2008	Larimer County above 9,000 feet	Winter Storm	0	0	0	0
11/29/2008	Larimer County above 9,000 feet	Winter Storm	0	0	0	0
12/4/2008	Larimer County between 6,000 & 9,000 feet	Winter Weather	0	0	0	0
12/4/2008	Larimer County below 6,000 feet	Winter Weather	0	0	0	0
1/24/2009	Larimer County above 9,000 feet	Winter Storm	0	0	0	0
3/26/2009	Larimer County below 6,000 feet, between 6,000 & 9,000 feet, and above 9,000 feet	Winter Storm	0	0	0	0
4/3/2009	Larimer County below 6,000 feet, between 6,000 & 9,000 feet, and above 9,000 feet	Winter Storm	0	0	0	0
4/16/2009	Larimer County between 6,000 & 9,000 feet, and above 9,000 feet	Winter Storm	0	0	0	0
10/9/2009	Larimer County below 6,000 feet, between 6,000 & 9,000 feet	Winter Storm	0	0	0	0
10/27/2009	Larimer County below 6,000 feet, between 6,000 & 9,000 feet, and above 9,000 feet	Winter Storm	0	0	0	0
11/14/2009	Larimer County between 6,000 & 9,000 feet	Winter Storm	0	0	0	0
12/5/2009	Larimer County below 6,000 feet, between 6,000 & 9,000 feet	Winter Weather	0	0	0	0
12/13/2009	Larimer County above 9,000 feet	Winter Weather	0	0	0	0
12/22/2009	Larimer County below 6,000 feet, between 6,000 & 9,000 feet	Winter Weather	0	0	0	0
3/18/2010	Larimer County between 6,000 & 9,000 feet, and above 9,000 feet	Winter Storm	0	0	0	0
3/19/2010	Larimer County below 6,000 feet	Winter Weather	0	0	0	0
3/23/2010	Larimer County below 6,000 feet, between 6,000 & 9,000 feet, and above 9,000 feet	Winter Weather	0	0	0	0
4/1/2010	Larimer County above 9,000 feet	Winter Weather	0	0	0	0
4/6/2010	Larimer County above 9,000 feet	Winter Weather	0	0	0	0
4/22/2010	Larimer County above 9,000 feet	Winter Storm	0	0	0	0

Date	Location	Event Type	Injuries	Deaths	Damage to Property	Damage to Crops
4/23/2010	Larimer County between 6,000 & 9,000 feet	Winter Storm	0	0	0	0
5/11/2010	Larimer County below 6,000 feet, between 6,000 & 9,000 feet, and above 9,000 feet	Winter Storm	0	0	0	0
10/22/2010	Larimer County above 9,000 feet	Winter Weather	0	0	0	0
10/25/2010	Larimer County above 9,000 feet	Winter Storm	0	0	0	0
11/9/2010	Larimer County above 9,000 feet	Winter Weather	0	0	0	0
11/15/2010	Larimer County above 9,000 feet	Winter Weather	0	0	0	0
11/16/2010	Larimer County above 9,000 feet	Winter Weather	0	0	0	0
11/21/2010	Larimer County above 9,000 feet	Winter Weather	0	0	0	0
11/24/2010	Larimer County above 9,000 feet	Winter Weather	0	0	0	0
11/28/2010	Larimer County above 9,000 feet	Winter Weather	0	0	0	0
12/10/2010	Larimer County above 9,000 feet	Winter Storm	0	0	0	0
12/14/2010	Larimer County above 9,000 feet	Winter Weather	0	0	0	0
12/18/2010	Larimer County above 9,000 feet	Winter Storm	0	0	0	0
12/30/2010	Larimer County below 6,000 feet, between 6,000 & 9,000 feet	Winter Weather	0	0	0	0
1/9/2011	Larimer County between 6,000 & 9,000 feet	Winter Weather	0	0	0	0
1/16/2011	Larimer County above 9,000 feet	Winter Storm	0	0	0	0
2/1/2011	Larimer County below 6,000 feet	Extreme Cold/ Wind Chill	0	0	0	0
2/5/2011	Larimer County above 9,000 feet	Winter Weather	0	0	0	0
2/7/2011	Larimer County above 9,000 feet	Winter Storm	0	0	0	0
2/24/2011	Larimer County between 6,000 & 9,000 feet, and above 9,000 feet	Winter Weather	0	0	0	0
3/17/2011	Larimer County above 9,000 feet	Winter Storm	0	0	0	0
3/28/2011	Larimer County above 9,000 feet	Winter Weather	0	0	0	0
4/3/2011	Larimer County above 9,000 feet	Winter Weather	0	0	0	0

Date	Location	Event Type	Injuries	Deaths	Damage to Property	Damage to Crops
4/11/2011	Larimer County above 9,000 feet	Winter Weather	0	0	0	0
4/13/2011	Larimer County between 6,000 & 9,000 feet, and above 9,000 feet	Winter Storm	0	0	0	0
4/23/2011	Larimer County above 9,000 feet	Winter Weather	0	0	0	0
4/29/2011	Larimer County above 9,000 feet	Winter Weather	0	0	0	0
5/10/2011	Larimer County between 6,000 & 9,000 feet, and above 9,000 feet	Winter Storm	0	0	0	0
5/18/2011	Larimer County between 6,000 & 9,000 feet, and above 9,000 feet	Winter Weather	0	0	0	0
5/20/2011	Larimer County above 9,000 feet	Winter Weather	0	0	0	0
10/25/2011	Larimer County above 9,000 feet	Winter Storm	0	0	0	0
10/25/2011	Larimer County between 6,000 & 9,000 feet	Winter Storm	0	0	0	0
10/25/2011	Larimer County below 6,000 feet	Winter Storm	0	0	0	0
11/1/2011	Larimer County below 6,000 feet	Winter Storm	0	0	0	0
11/1/2011	Larimer County between 6,000 & 9,000 feet	Winter Storm	0	0	0	0
11/1/2011	Larimer County above 9,000 feet	Winter Weather	0	0	0	0
11/2/2011	Larimer County above 9,000 feet	Winter Storm	0	0	0	0
12/3/2011	Larimer County between 6,000 & 9,000 feet	Winter Storm	0	0	0	0
12/21/2011	Larimer County below 6,000 feet	Winter Weather	0	0	0	0
1/11/2012	Larimer County above 9,000 feet	Winter Weather	0	0	0	0
1/15/2012	Larimer County above 9,000 feet	Winter Weather	0	0	0	0
1/18/2012	Larimer County above 9,000 feet	Blizzard	0	0	0	0
1/20/2012	Larimer County above 9,000 feet	Winter Weather	0	0	0	0
2/2/2012	Larimer County above 9,000 feet	Winter Weather	0	0	0	0
2/2/2012	Larimer County below 6,000 feet	Winter Storm	0	0	0	0
2/2/2012	Larimer County between 6,000 & 9,000 feet	Winter Storm	0	0	0	0

Date	Location	Event Type	Injuries	Deaths	Damage to Property	Damage to Crops
2/21/2012	Larimer County above 9,000 feet	Winter Weather	0	0	0	0
2/28/2012	Larimer County above 9,000 feet	Winter Weather	0	0	0	0
11/10/2012	Larimer County above 9,000 feet	Winter Weather	0	0	0	0
12/19/2012	Larimer County below 6,000 feet, between 6,000 & 9,000 feet, and above 9,000 feet	Winter Weather	0	0	0	0
12/24/2012	Larimer County above 9,000 feet	Winter Weather	0	0	0	0
1/29/2013	Larimer County above 9,000 feet	Winter Storm	0	0	0	0
2/24/2013	Larimer County above 9,000 feet	Winter Weather	0	0	0	0
2/26/2013	Larimer County between 6,000 & 9,000 feet	Winter Weather	0	0	0	0
3/3/2013	Larimer County above 9,000 feet	Winter Weather	0	0	0	0
3/8/2013	Larimer County between 6,000 & 9,000 feet, above 9,000 feet	Winter Storm	0	0	0	0
4/8/2013	Larimer County between 6,000 & 9,000 feet	Winter Storm	0	0	0	0
4/13/2013	Larimer County above 9,000 feet	Winter Storm	0	0	0	0
4/15/2013	Larimer County below 6,000 feet, between 6,000 & 9,000 feet, and above 9,000 feet	Winter Storm	0	0	0	0
4/22/2013	Larimer County below 6,000 feet, between 6,000 & 9,000 feet, and above 9,000 feet	Winter Storm	0	0	0	0
10/13/2013	Larimer County above 9,000 feet	Winter Weather	0	0	0	0
11/16/2013	Larimer County above 9,000 feet	Winter Weather	0	0	0	0
12/3/2013	Larimer County below 6,000 feet, between 6,000 & 9,000 feet, and above 9,000 feet	Heavy Snow	0	0	0	0
1/3/2014	Larimer County between 6,000 & 9,000 feet, and above 9,000 feet	Winter Weather	0	0	0	0
1/27/2014	Larimer County between 6,000 & 9,000 feet	Winter Weather	0	0	0	0
1/29/2014	Larimer County above 9,000 feet	Winter Storm	0	0	0	0
1/30/2014	Larimer County below 6,000 feet, between 6,000 & 9,000 feet	Winter Storm	0	0	0	0

Date	Location	Event Type	Injuries	Deaths	Damage to Property	Damage to Crops
2/7/2014	Larimer County above 9,000 feet	Winter Storm	0	0	0	0
4/2/2014	Larimer County between 6,000 & 9,000 feet	Winter Storm	0	0	0	0
4/12/2014	Larimer County between 6,000 & 9,000 feet, above 9,000 feet	Heavy Snow	0	0	0	0
5/11/2014	Larimer County below 6,000 feet, between 6,000 & 9,000 feet, and above 9,000 feet	Winter Storm	0	0	0	0
10/13/2014	Larimer County above 9,000 feet	Winter Weather	0	0	0	0
11/11/2014	Larimer County below 6,000 feet, between 6,000 & 9,000 feet, and above 9,000 feet	Winter Weather	0	0	0	0
11/22/2014	Larimer County above 9,000 feet	Winter Storm	0	0	0	0
12/13/2014	Larimer County above 9,000 feet	Winter Weather	0	0	0	0
12/21/2014	Larimer County above 9,000 feet	Winter Storm	0	0	0	0
12/25/2014	Larimer County below 6,000 feet, between 6,000 & 9,000 feet, and above 9,000 feet	Winter Weather	0	0	0	0
2/1/2015	Larimer County between 6,000 & 9,000 feet	Winter Weather	0	0	0	0
2/15/2015	Larimer County between 6,000 & 9,000 feet, above 9,000 feet	Winter Weather	0	0	0	0
2/25/2015	Larimer County between 6,000 & 9,000 feet, above 9,000 feet	Heavy Snow	0	0	0	0
3/2/2015	Larimer County above 9,000 feet	Winter Weather	0	0	0	0
3/3/2015	Larimer County between 6,000 & 9,000 feet	Winter Weather	0	0	0	0
4/2/2015	Larimer County between 6,000 & 9,000 feet	Winter Weather	0	0	0	0
4/16/2015	Larimer County between 6,000 & 9,000 feet, above 9,000 feet	Winter Storm	0	0	0	0
11/16/2015	Larimer County above 9,000 feet	Winter Weather	0	0	0	0
12/14/2015	Larimer County above 9,000 feet	Winter Weather	0	0	0	0
12/15/2015	Larimer County below 6,000 and between 6,000 and 9,000 feet	Winter Storm	0	0	0	0

Date	Location	Event Type	Injuries	Deaths	Damage to Property	Damage to Crops
12/22/2015	Larimer County above 9,000 feet	Winter Storm	0	0	0	0
1/16/2016	Larimer County above 9,000 feet	Winter Storm	0	0	0	0
1/24/2016	Larimer County above 9,000 feet	Winter Weather	0	0	0	0
1/30/2016	Larimer County above 9,000 feet	Winter Weather	0	0	0	0
2/1/2016	Larimer County below 6,000 feet and between 6,000 and 9,000 feet	Winter Storm	0	0	0	0
3/17/2016	Larimer County below 6,000 feet, between 6,000 & 9,000 feet, and above 9,000 feet	Winter Storm and Winter Weather	0	0	0	0
3/22/2016	Larimer County above 9,000 feet	Winter Weather	0	0	0	0
3/23/2016	Larimer County between 6,000 and 9,000 feet	Winter Storm	0	0	0	0
3/23/2016	Larimer County below 6,000 feet	Blizzard	0	0	0	0
3/29/2016	Larimer County above 9,000 feet	Winter Weather	0	0	0	0
4/15/2016	Larimer County between 6,000 and 9,000 feet	Heavy Snow	0	0	0	0
11/17/2016	Larimer County between 6,000 and 9,000 feet and above 9,000 feet	Winter Weather	0	0	0	0
11/27/2016	Larimer County above 9,000 feet	Winter Weather	0	0	0	0
12/10/2016	Larimer County above 9,000 feet	Winter Storm	0	0	0	0
12/27/2016	Larimer County above 9,000 feet	Winter Weather	0	0	0	0
1/2/2017	Larimer County below 6,000 feet, between 6,000 & 9,000 feet, and above 9,000 feet	Winter Weather	0	0	0	0

Date	Location	Event Type	Injuries	Deaths	Damage to Property	Damage to Crops
1/3/2017	Larimer County between 6,000 and 9,000 feet and above 9,000 feet	Winter Storm	0	0	0	0
1/4/2017	Larimer County below 6,000 feet	Winter Storm	0	0	0	0
1/8/2017	Larimer County above 9,000 feet	Winter Storm	0	0	0	0
2/1/2017	Larimer County below 6,000 feet	Winter Weather	0	0	0	0
4/3/2017	Larimer County between 6,000 and 9,000 feet	Winter Weather	0	0	0	0
4/9/2017	Larimer County above 9,000 feet	Winter Weather	0	0	0	0
4/28/2017	Larimer County between 6,000 and 9,000 feet	Winter Storm	0	0	0	0
5/17/2017	Larimer County below 6,000 feet, between 6,000 & 9,000 feet, and above 9,000 feet	Heavy Snow	0	0	0	0
10/1/2017	Larimer County above 9,000 feet	Winter Storm	0	0	0	0
10/1/2017	Larimer County between 6,000 and 9,000 feet	Winter Weather	0	0	0	0
10/8/2017	Larimer County between 6,000 and 9,000 feet and above 9,000 feet	Winter Storm	0	0	0	0
11/4/2017	Larimer County above 9,000 feet	Heavy Snow	0	0	0	0
11/6/2017	Larimer County below 6,000 feet, between 6,000 & 9,000 feet	Winter Weather	0	0	0	0
12/23/2017	Larimer County above 9,000 feet	Winter Storm	0	0	0	0
12/24/2017	Larimer County above 9,000 feet	Winter Storm	0	0	0	0
2/5/2018	Larimer County above 9,000 feet	Winter Weather	0	0	0	0

Date	Location	Event Type	Injuries	Deaths	Damage to Property	Damage to Crops
2/10/2018	Larimer County above 9,000 feet	Winter Weather	0	0	0	0
2/14/2018	Larimer County above 9,000 feet	Winter Storm	0	0	0	0
2/19/2018	Larimer County between 6,000 and 9,000 feet	Winter Weather	0	0	0	0
3/15/2018	Larimer County above 9,000 feet	Winter Weather	0	0	0	0
3/18/2018	Larimer County above 9,000 feet	Winter Weather	0	0	0	0
3/27/2018	Larimer County above 9,000 feet	Winter Weather	0	0	0	0
4/5/2018	Larimer County above 9,000 feet	Winter Storm	0	0	0	0
10/10/2018	Larimer County between 6,000 and 9,000 feet and above 9,000 feet	Winter Weather	0	0	0	0
10/13/2018	Larimer County below 6,000 feet, between 6,000 & 9,000 feet, and above 9,000 feet	Winter Weather	0	0	0	0
10/30/2018	Larimer County between 6,000 and 9,000 feet and above 9,000 feet	Winter Weather	0	0	0	0
11/2/2018	Larimer County above 9,000 feet	Winter Weather	0	0	0	0
11/4/2018	Larimer County above 9,000 feet	Winter Weather	0	0	0	0
11/11/2018	Larimer County below 6,000 feet, between 6,000 & 9,000 feet	Winter Weather	0	0	0	0
11/22/2018	Larimer County above 9,000 feet	Winter Storm	0	0	0	0
11/22/2018	Larimer County between 6,000 and 9,000 feet	Winter Weather	0	0	0	0
12/18/2018	Larimer County above 9,000 feet	Winter Weather	0	0	0	0
1/11/2019	Larimer County between 6,000 and 9,000 feet	Winter Weather	0	0	0	0

Date	Location	Event Type	Injuries	Deaths	Damage to Property	Damage to Crops
1/17/2019	Larimer County above 9,000 feet	Winter Storm	0	0	0	0
2/5/2019	Larimer County above 9,000 feet	Winter Weather	0	0	0	0
2/6/2019	Larimer County between 6,000 and 9,000 feet	Winter Weather	0	0	0	0
2/13/2019	Larimer County above 9,000 feet	Winter Weather	0	0	0	0
3/1/2019	Larimer County between 6,000 and 9,000 feet and above 9,000 feet	Winter Storm	0	0	0	0
3/2/2019	Larimer County below 6,000 feet	Winter Weather	0	0	0	0
3/6/2019	Larimer County above 9,000 feet	Winter Weather	0	0	0	0
4/10/2019	Larimer County between 6,000 and 9,000 feet	Winter Weather	0	0	0	0
4/10/2019	Larimer County below 6,000 feet and above 9,000 feet	Winter Storm	0	0	0	0
4/29/2019	Larimer County above 9,000 feet	Winter Storm	0	0	0	0
4/29/2019	Larimer County between 6,000 and 9,000 feet	Winter Weather	0	0	0	0
5/28/2019	Larimer County above 9,000 feet	Winter Storm	0	0	0	0
10/9/2019	Larimer County below 6,000 feet, between 6,000 & 9,000 feet, and above 9,000 feet	Winter Weather	0	0	0	0
10/19/2019	Larimer County above 9,000 feet	Winter Storm	0	0	0	0
10/23/2019	Larimer County between 6,000 and 9,000 feet	Winter Weather	0	0	0	0
10/27/2019	Larimer County below 6,000 feet and above 9,000 feet	Winter Weather	0	0	0	0

Date	Location	Event Type	Injuries	Deaths	Damage to Property	Damage to Crops
10/29/2019	Larimer County below 6,000 feet, between 6,000 & 9,000 feet	Winter Weather	0	0	0	0
11/25/2019	Larimer County below 6,000 feet, between 6,000 & 9,000 feet, and above 9,000 feet	Winter Storm	0	0	0	0
11/29/2019	Larimer County above 9,000 feet	Winter Weather	0	0	0	0
12/12/2019	Larimer County above 9,000 feet	Winter Storm	0	0	0	0
Total:			**0**	**1**	**$31 million**	**0**

Source: NCEI

Location

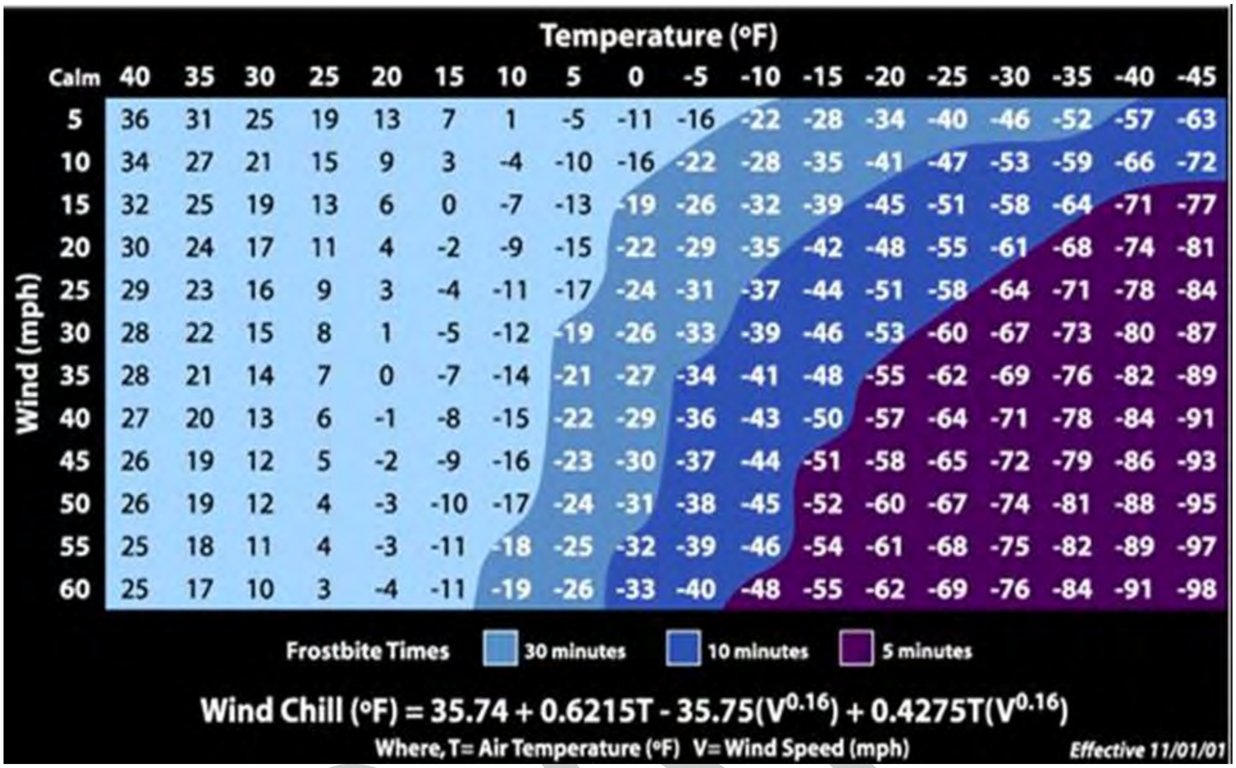
Extensive - Larimer County weather can be severe during the spring and winter months. There can be long periods of sub-degree temperatures in the winter. Blizzards can occur in late spring. Wind and snow blizzards cause whiteouts and drifting snow of 2 to 3 feet and more. Winds can be extremely strong, up to 100 mph in the spring.

Winter storms often occur in multiple locations and elevations at the same time. Of the storms recorded in the NCEI Storm Events Database, approximately 17% occurred in the eastern portion of the county typically below 6,000 feet in elevation. Approximately 38% occurred in the central portion of the county typically between 6,000 feet and 9,000 feet. The majority of winter storms, 45% recorded events, occur in the western portion of the county typically above 9,000 feet. Refer to the Past Occurrences section and Table 4-79 for more information on past winter storm events.

Magnitude/Severity

Critical - Winter storms occur in many forms and can vary significantly in size, strength, intensity, duration, and impact. High winds create snowdrifts, which can block roads and create dangerous wind chill factors. In 2001, the NWS implemented an updated Wind Chill Temperature index, which is reproduced in Figure 4-48. This index was developed to describe the relative discomfort/danger resulting from the combination of wind and temperature. Wind chill is based on the rate of heat loss from exposed skin caused by wind and cold. As the wind increases, it draws heat from the body, driving down skin temperature and eventually the internal body temperature.

Figure 4-48 Wind Chill Temperature Chart



Temperature (°F)

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

Frostbite Times: 30 minutes, 10 minutes, 5 minutes

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

Where, T= Air Temperature (°F) V= Wind Speed (mph) *Effective 11/01/01*

Source: National Weather Service

The NWS has defined winter season watches, warnings, and advisories based on specific criteria. The following is a breakdown on the various warnings that could be issued:

- **Ice Storm Warning** is issued when a period of freezing rain is expected to produce ice accumulations of 1/4" or greater or cause significant disruptions to travel or utilities.
- **Heavy Sleet Warning** is issued when a period of sleet is expected to produce ice accumulations of 1" or greater or cause significant disruptions to travel or utilities.
- **Heavy Snow Warning** is issued when snow is expected to accumulate 4 inches or more in 12 hours, or 6 inches or more in 24 hours.
- **Winter Storm Warning** is issued for a winter weather event in which there is more than one hazard present, and one of the warning criteria listed above is expected to be met.
- **Blizzard Warning** is issued for sustained wind or frequent gusts greater than or equal to 35 mph accompanied by falling and/or blowing snow, frequently reducing visibility to less than 1/4 mile for three hours or more. Watches are issued when conditions may be met 12 to 48 hours in the future.
- **Wind Chill Warning** is issued when wind and temperature combine to produce wind chill values of -35°F.
- **Winter Weather Advisory** is issued when wintry weather is expected, and caution should be exercised. Light amounts of wintery precipitation of patchy blowing snow will cause slick conditions and could affect travel if precautions are not taken

Speed of Onset

Through the identification of various indicators of weather systems, and by tracking these indicators, warning time for snowstorms can be days to as much as a week in advance. Forecasts can change as new data become available.

Duration
The duration and extent of winter hazards varies by storm. Winter storms and the impacts from winter events can last anywhere between a few hours to several days.

Probability of Future Occurrences

Highly Likely - Severe winter storms can be predicted with a reasonable level of certainty. Understanding the historical frequency, duration, and spatial extent of severe winter weather assists in determining the likelihood and potential severity of future occurrences. The characteristics of past severe winter events provide benchmarks for projecting similar conditions into the future. Based on historical records and frequencies there is nearly a 100% chance of this type of event will occur somewhere in Larimer County at least once every year.

Climate Change Considerations

Climate change has the potential to exacerbate the severity and intensity of winter storms, including potential heavy amounts of snow. A warming climate may also result in warmer winters, the benefits of which may include lower winter heating demand, less cold stress on humans and animals, and a longer growing season. However, these benefits are expected to be offset by the negative consequences of warmer summer temperatures which could have statewide economic impacts.

The effects of climate change in Colorado have already been observed. The following climate change observations related to snowfall are noted in the 2018 Colorado State Hazard Mitigation Plan:

- Snowpack, as measured by April 1, 2018 snow-water equivalent (SWE), has been mainly below average since 2000 in all of Colorado's river basins, but long-term (30-year, 50-year) declining trends have been detected.
- The timing of snowmelt and peak runoff has shifted earlier in the spring by 1 to 4 weeks across the state's river basins over the past 30 years, due to the combination of lower SWE since 2000, the warming trend in spring temperatures, and enhanced solar absorption from dust-on-snow.

As Larimer County prepares for regional changes in climate, it will be important to consider scenarios in which larger amounts of snow will fall over shorter periods of time. The impacts have the potential to affect infrastructure, public safety, and the local economy in a diversity of potentially negative ways.

Vulnerability Assessment

All assets located in Larimer County can be considered at risk from winter storms, although based on historic records it's a higher risk for areas that are between 6,000 and 9,000 feet and areas higher in the mountain above 9,000 feet. This includes 338,161 people, or 100% of the County's population, and all buildings and infrastructure within the County. Winter storms affect the entire planning area of Larimer County and its jurisdictions including all above-ground structures and infrastructure. Although losses to structures are typically minimal and covered by insurance, there can be impacts with lost time, maintenance costs, and contents within structures. A timely forecast may not be able to mitigate the property loss but could reduce the casualties and associated injury.

People
The threat to public safety is typically the greatest concern when it comes to impacts of winter storms. The highest risk will be to travelers that attempt to drive during adverse conditions. People can also become isolated from essential services in their homes and vehicles. While virtually all aspects of the population are vulnerable to the potential indirect impacts of a winter storm, others may be more vulnerable, such as individuals with access and functional needs, who may become isolated to essential services. Individuals

over the age of 65 represent 15% of the total population in the County; 10% of the County population are individuals with a disability.

The weight of heavy snowfall and/or ice accumulating on power lines often brings them to the ground, causing service disruptions for thousands of customers. According to data from the U.S. Department of Health and Human Services' emPOWER mapping site, 4,318 of the 57,432 Medicare Beneficiaries in the Larimer County rely on electric-dependent medical equipment such as ventilators to live independent in their homes. In addition, prolonged power outages can also have economic impacts if there is a loss of food in grocery stores and other businesses.

Cold and extreme cold temperatures have been the main cause of winter weather related causalities in the County. Infants, elderly and the homeless population are most vulnerable to the impacts of extreme cold. Exposure to extreme cold can cause frostbite or hypothermia and, in some cases, even death.

The region can experience high winds and drifting snow during winter storms that can occasionally isolate individuals and entire communities and lead to serious damage to infrastructure. Travelers on I-25 in the eastern portions of the planning area, can become isolated and visitors can become stranded, requiring search and rescue assistance and shelter provisions.

General Property

Snow removal costs can impact budgets significantly. High snow loads also cause damage to buildings and roofs. Most property damages with winter storms are related to the heavy snow loads and vehicle accidents. Older buildings are more at risk, as are buildings with large flat rooftops (often found in public buildings such as schools). Vulnerability is influenced both by architecture and type of construction material and should be assessed on a building-by-building basis.

Critical Facilities and Infrastructure

Roads are especially susceptible to the effects of a winter storm, which can temporarily hinder transportation and require resources for snow removal. As noted under the people section, heavy snow accumulation may also lead to downed power lines not only causing disruption to customers but also have potentially negative impacts on critical facilities in the county which may have cascading impacts on the County governments ability to operate.

Economy

Closure of Interstate 25 or U.S. 36 during winter storms could temporarily isolate communities in Larimer County and further isolate remote areas of the County. Depending on the length of the closure it could also hinder the local economy which is dependent on tourism and out of county visitors. Power outages may lead to business closures as was seen in the 2019 Bomb Cyclone event which impacts last for 2 days in some areas.

Historic, Cultural, and Natural Resources

Natural resources may be damaged by the severe winter weather, including broken trees and death of wildlife. Unseasonable storms may damage or kill plants and wildlife, which may impact natural food chains until the next growing seasons. Most of these impacts would be short-term. As noted previously, older, historic buildings could potentially be more vulnerable to roof and structural damage from heavy snow.

Future Land Use and Development

The location of development in County does not increase or reduce the risk necessarily. All future structures built in Larimer County will likely be exposed to severe weather extremes and damage. Larimer County and its jurisdictions must adhere to building codes, and therefore, new development can be built to current standards to account for adverse weather. Additionally, as homes go up in more remote parts of the county, accessing those rural residents may become impossible should sheltering or emergency services be needed in an extreme event.

Risk Summary

- Winter storms often bring heavy snow and sometimes blizzard conditions to the County.
- In the past 23 years the County has experienced 504 winter storm events. There is effectively a 100% probability that a winter storm event will occur in a given year somewhere in the county.
- Winter storms have caused limited injuries and fatalities in the past 23 years.
- Heavy snow can lead to limited structural damage and damages to trees.
- Power outages are possible in severe winter storms. 8% of Medicare Beneficiaries in the County rely on equipment that is electricity dependent to be able to live independently in their homes
- Related Hazards: Severe Wind, Utility Disruption

4 Risk Assessment

Placeholder

5 CAPABILITY ASSESSMENT

This section summarizes Larimer County's existing mitigation capabilities, which are the policies and programs in place that are used to reduce hazard impacts or that can be used to implement hazard mitigation activities. Operational or training capabilities were not assessed. The purpose of conducting a capability assessment is to understand the County's capacity for implementing mitigation activities. With a complete understanding of current capabilities, the County can better develop feasible mitigation activities and can identify opportunities to enhance capability in support of future mitigation. This assessment evaluates planning and regulatory capabilities, administrative and technical capabilities, financial capabilities, and other mitigation partnerships.

The 2021 update process afforded the County and its participating jurisdictions the opportunity to review their capabilities and how those capabilities have changed since the previous plan. Additionally, in summarizing their current capabilities and identifying gaps, plan participants also considered their ability to expand or improve upon existing policies and programs as potential new mitigation strategies. Section 6 Mitigation Strategy includes mitigation actions aimed at improving community capability to reduce hazard risk and vulnerability.

This section focuses primarily on countywide capabilities. Capability assessment information for the participating jurisdictions can be found in their annexes.

5.1 Planning and Regulatory Capabilities

Table 5-1 lists regulatory mitigation capabilities, including planning and land management tools, typically used by local jurisdictions to implement hazard mitigation activities and indicates those that are in place in Larimer County. Excerpts from applicable policies, regulations, and plans and program descriptions follow to provide more detail on existing mitigation capabilities. For each of the profiled hazards, several ordinances, regulations, plans and programs were identified in various communities within the County. These are listed here to serve as a reference for related planning efforts.

Table 5-1 Planning and Regulatory Resources

Regulatory Tool (ordinances, codes, plans)	Yes/ No	Comments
Comprehensive Plan	Yes	County Community Development
Zoning ordinance	Yes	County Land Use Code (Zoning and Subdivision Standards)
Growth management ordinance	Yes	County Community Development
Floodplain ordinance	Yes	County Engineering
Other special purpose ordinance (stormwater, steep slope, wildfire)	Yes	County Engineering, Community Development
Building codes	Yes	2018 I-codes, County Community Development
Fire department ISO rating	Yes	Per each individual fire district
Erosion or sediment control program	Yes	Class 3 Residential/Class 3 Commercial County Community Development
Stormwater management program	Yes	County Engineering
Site plan review requirements	Yes	County Engineering

Regulatory Tool (ordinances, codes, plans)	Yes/ No	Comments
Capital improvements plan	Yes	County Community Development
Economic development plan	Yes	Annually, County Manager, Budget Director
Local emergency operations plan	Yes	County Office of Emergency Management
Other special plans	Yes	Watershed master plans for Big Thompson, Fish Creek and Fall River. Subarea plans for LaPorte Area, Red Feather Lakes.
Flood insurance study or other engineering study for streams	Yes	County Engineering
Elevation certificates (for floodplain development)	Yes	County Engineering
Setback Requirements	Yes	A minimum required setback of 100 feet applies to any stream, creek or river identified on a U.S.G.S. (United States Geological Survey) 7.5' quadrangle map. The setback is measured from the centerline of the water course to the closest point of the building. http://www.larimer.org/planning/planning/Setback/setback_types.htm

Other planning and regulatory mechanisms in place in Larimer County are described below.

Larimer County Comprehensive Plan – The Countywide Comprehensive Plan (2019) serves as the County's long-range framework for decision making and policies related to "future land development, public services, environmental protection, and to support future economic health to sustain the community". The plan is organized according to the Colorado Resiliency Framework and used the County's Community Resiliency Framework and 2016 Hazard Mitigation Plan as foundations in developing the plan. The Comprehensive Plan was used in the updating the 2021 Hazard Mitigation Plan including providing background information and informing the Community Profile section and as a reference in the development of 2021 mitigation goals.

Disaster Recovery Plan – The County Recovery Plan addresses Recovery Support Function 8: Hazard Mitigation. This section includes roles and responsibilities, activation criteria, resources, and procedural checklists for post-disaster mitigation.

Resilience Framework – This Framework was developed to identify the current state of resilience in Larimer County as well as action areas, per community sector, in which resilience could be increased. The update to this framework is on-going with a larger emphasis on interconnectivity of sectors and collaboration opportunities.

CASCARTA – This tool was developed to better identify upstream and downstream impacts of potential hazards and their relationship to critical infrastructure and key resources. All hazards have the potential for cascading effects, and this tool allows us to better assess these so we can act more quickly. This tool allows provides data to better identify Capital Improvement Projects

Supply-Chain Plan – This plan is currently in process and the objective is to better identify gaps in the supply chain to critical and essential services in Larimer County.

Threat and Hazard Identification and Risk Assessment (THIRA) – Larimer County recently facilitated the development of a county-wide THIRA. The purpose of this document is to identify the current state of ESF/RSF capabilities in Larimer County based on catastrophic scenarios, and to conduct a gap analysis with subsequent action items to fill these gaps.

Big Thompson Gauges – These were implemented following the 2013 Floods. Due to the high probability of flash flooding in Larimer County river canyons, these gauges better allow us at the local level to monitor current CFS levels.

Climate Smart Larimer Plan – This plan is currently in process and seeks to identify priority actions to adapt to and mitigate the impacts of Climate Change in Larimer County. This is a cross-sector, collaborative plan seeking to be completed in Spring 2020.

Colorado Resilience and Recovery Collaborative Participation – Larimer County participates in the CRRC, which seeks to share information, collect data and best practices, and identify projects to help increase the resilience of Larimer County communities through collaboration.

Mitigation Projects in General – There are programs for forest thinning on private lands, road and bridge improvements since 2013 Flood, Stream Gauges to monitor flows.

State Regulatory Capabilities:

The State of Colorado mitigates natural hazards through a number of statutes and programs. Funded by the state and federal government, several agencies and programs within the state implement mitigation actions through assistance to local governments. State statues that are applicable to hazard mitigation are listed below:

- County Fire Planning Authority, Colorado Statute, Title 30, Article 11, Part 1:30-11-124
- Colorado Land Use Commission Authority, Colorado Revised Statute, 24-65-101 & 102
- Colorado Land Use Commission Directives & Duties, Colorado Revised Statutes, 25-65-105 & 24- 65-104
- County Building Codes – Master Plan, Colorado Statute, Title 30, Article 28, Part 1:30-28-106
- Local Government Land Use Control Enabling Act, Colorado Revised Statute, 29-20-101, et seq
- Local Land Use Control and Regulation, Colorado Revised Statute, 29-20-104
- Colorado Wildfire Preparedness Plan and Fund, Colorado Revised Statute 24-30-310(2)(3)
- Fire Suppression Program Rules, Colorado Revised Statute, 24-33.5-1205(1) (a)
- State Fire Ban Authority, Colorado Revised Statute, 24-30-308
- Colorado Geological Survey (CGS), Colorado Statute, 34-1-1-1 & 103
- CGS Land Use Review Program (Subdivision Law), Colorado Revised Statute, 30-28-101, et seq
- Soils & Hazard Analyses of Residential Construction Act, Colorado Revised Statute, 6-6.5-101
- Drought Mitigation Planning, Colorado Revised Statute, 37-60-126.5
- Building Codes – Zoning – Planning, Colorado Revised Statute, 22-32-124(1)
- Colorado Floodplain Management Authority, Colorado Revised Statute, 24-65.1-403(1)
- Emergency Dam Repair Cash Fund, Colorado Revised Statute, 37-60-122.5
- Flood Response Fund, Colorado Revised Statute, 37-60-123.2
- Office of Smart Growth, Colorado Revised Statute, 24-32-3201 et seq
- State Engineer – High Hazard Dams Reports, Colorado Revised Statute, 37-87-123
- State Planning and Interest (HB 74-1041), Colorado Revised Statute, 24-65.1-101

Colorado Statute includes a number of measures that dictate the state's ability to influence land use decisions and subsequently impact local vulnerability to hazards. In most cases, these statutes allow county level and local governments to establish their own rules and regulations.

5.2 Administrative and Technical Capabilities

Larimer County OEM is the primary agency responsible for emergency management and hazard mitigation in the County. However, mitigation is an interdisciplinary effort that requires collaboration across numerous departments and individuals. Administrative and technical resources are summarized in Table 5-2. Per this assessment, the County is well-staffed and equipped to assess and mitigate hazards, and to manage exposure through land management and building requirements.

Table 5-2 Administrative and Technical Capabilities

Personnel Resources	Yes/No	Position/Department/Comments
Planner/engineer with knowledge of land development/land management practices	Yes	County Engineer, Development Review team, County Planning
Engineer/professional trained in construction practices related to buildings and/or infrastructure	Yes	County Engineer, Development Review team, Building Official, Building inspection and plan review staff, Road and Bridge engineers
Planner/engineer/scientist with an understanding of natural hazards	Yes	County Engineering, Community Development, Office of Emergency Management
Personnel skilled in GIS	Yes	IT Dept., Community Development staff
Full time building official	Yes	County Building Official, County Community Development
Floodplain manager	Yes	County Floodplain Administrator, County Engineering
Emergency manager	Yes	Office of Emergency Management, Director of Emergency Management
Grant writer	Yes	Office of Emergency Management
GIS Data Resources (Hazard areas, critical facilities, land use, building footprints, etc.)	Yes	GIS staff/IT
Warning Systems/Services (Reverse 9-11, cable override, outdoor warning signals)	Yes	PSAPs, Emergency Notification System and EAS activated through L.C. Sheriff's Office, Larimer Emergency Telephone Authority.
Other key personnel	Yes	IT Dept., Community Development staff, Purchasing Director

5.3 Financial Capabilities

The Finance Department provides all necessary accounting, budget, payroll, and purchasing and sales tax support and information to all County departments and the citizens of Larimer County.

Table 5-3 details a variety of financial tools that can be used for mitigation and their availability to the County. Per this assessment, many of these funding mechanisms are eligible in Larimer County but would require additional development to be accessible to use. For example, new taxes or debt would require voter approval.

Table 5-3 Financial Resources

Financial Resources	Accessible/ Eligible to Use	Has Been Used in the Past	Comments
Community Development Block Grants	Yes	Yes	CDBG-DR grants following the High Park Fire and 2013 Flood
Capital improvements project funding	Yes	Unknown	
Authority to levy taxes for specific purposes	Yes	Yes	Would need citizen vote
Fees for water, sewer, gas, or electric services	No	No	
Impact fees for new development	Yes	No	
Incur debt through general obligation bonds	Yes	No	Would need citizen vote
Incur debt through special tax bonds	Yes	No	Would need citizen vote
Incur debt through private activities	Yes	No	
Withhold spending in hazard prone areas	No	No	

5.4 Other Mitigation Programs and Partnerships

Table 5-4 Education and Outreach Capabilities

Education & Outreach	Yes/No	Comments
Local Citizen Groups That Communicate Hazard Risks	Yes	See below
Firewise	No	6 communities within the county are Firewise communities
StormReady	Yes	Larimer County and Cities of Fort Collins and Loveland
Other		

5.4.1 Public Outreach

Successful sustained mitigation depends upon robust collaboration between the public and private sector, different levels of government, municipal jurisdictions, departments, agencies and community groups within Larimer County. Larimer County has several active public education programs to educate the public about hazards and actions they can take to mitigate against those hazards. Several of these groups serve to communicate hazards risks to the public.

Larimer Connects Program – This program is in place to increase outreach and education to Larimer County community members not only of concepts as emergency preparedness, but resilience overall. The program seeks to increase resilience through promoting and encouraging social connectivity and grassroots action.

Community Events – Larimer OEM strives to have a presence at as many community events as is feasible around the County to provide outreach and education on preparedness and resilience. This includes non-traditional events such as community pancake breakfasts, HOA annual meetings, craft fairs, and holiday events as well

New Employee Orientation – Larimer OEM is responsible for providing the preparedness education for place of business preparedness to all new employees during their orientation day at Larimer County.

Resilient Communities are Connected Communities Seminar – As part of the Larimer Connects Program, this seminar is conducted to educate participants on community resilience, social connectivity, and empowers grassroots action. This seminar is typically conducted bi-annually. At the time of this plan update, this seminar is undergoing revisions for improvement before being held again, as well as modifications for COVID-19 precautions since it is traditionally conducted as an in-person class.

Larimer-Weld County Emergency Preparedness and Family Safety Expo – This has been an ongoing event since 2015 and has been a collaborative effort between Larimer and Weld Counties to bring together all emergency services agencies to provide public education on emergency preparedness and safety.

VOAD Zombie Apocalypse Event – Larimer County participates in this annual event (initiated 2018) that creates a family-friendly atmosphere to teach emergency preparedness. This event is a disaster simulation with zombies as focus. Participants are asked to solve problems that are disaster-related and interact with the different partners that act during a disaster.

Wildland Fire Preparedness Education – Larimer OEM and the LCSO Emergency Services Unit both provide ongoing public education on wildfire preparedness, including community tabletop and functional exercises.

5.4.2 Watershed Coalitions

Larimer County works closely with several nonprofit watershed coalitions that do significant mitigation projects as well as public education and outreach. The following coalitions participated on the planning team for the 2021 HMP Update process.

The Coalition for the Poudre River Watershed (CPRW) was formed after the 2012 High Park and Hewlett Gulch wildfires burned almost 90,000 acres of the Poudre Watershed. CPRW works across the entire Poudre watershed from headwaters to the confluence with the South Platte River on issues relating to rivers, forest resilience and wildfire mitigation. CPRW stakeholder committees include representatives from the US Forest Service, Colorado State University, Larimer County, City of Fort Collins, City of Greeley, Colorado State Forest Service, Town of Windsor, and Weld County among others.

The Big Thompson Watershed Coalition (BTWC) was formed after Colorado's devastating 2013 floods to foster resilience in that watershed by providing multi-purpose and multi-stakeholder benefits to water and forest resources, as well as the wildlife and people who depend on them. Since 2013 BTWC has helped raise over $10 million dollars in federal, state, and local funds for river improvement projects, developed 3 large-scale river management and restoration plans, completed 10 major river enhancement projects, and worked with over 150 private landowners and organizations in the process.

The Estes Valley Watershed Coalition (EVWC) was also formed after the 2013 floods as a grassroots organization to work with the community and partners to protect natural resources, watershed health, forest health, and wildlife in the Estes Valley. EVWC has completed fourteen stream restoration projects totaling five miles on the Big Thompson River, Fall River and Fish Creek. The projects have added, new floodplain areas, more vegetation to absorb high water, fish spawning locations and beaver ponds, and has made the valley more resilient to future events.

5.4.3 Firewise

Firewise USA® is a voluntary program that provides a framework to help neighbors get organized, find direction, and take action to increase the ignition resistance of their homes and community. The program is co-sponsored by the USDA Forest Service, the U.S. Department of the Interior, and the National Association of State Foresters. As of August 2020, the following communities in Larimer County have joined the Firewise program:

- Big Elk Meadows, Lyons
- Cherokee Meadows, Livermore
- Crystal Lakes
- Glacier View Fire Protection District
- Glen Haven
- Mountain River Townhomes, Estes Park
- Windcliff, Estes Park

5.4.4 Storm Ready

As of August 2020, Larimer County, and the Cities of Fort Collins and Loveland are certified as StormReady communities. The National Weather Service's StormReady program helps local governments handle extreme weather and improve the timeliness and effectiveness of hazardous weather related warnings for the public. To be officially StormReady, a community must:

- Establish a 24-hour warning point and emergency operations center
- Have more than one way to receive severe weather warnings and forecasts and to alert the public
- Create a system that monitors weather conditions locally
- Promote the importance of public readiness through community seminars, and
- Develop a formal hazardous weather plan, which includes training severe weather spotters and holding emergency exercises

5.4.5 National Flood Insurance Program (NFIP) and the Community Rating System (CRS)

Larimer County has been mapped for flood hazards and participates in the National Flood Insurance Program (NFIP). Details of local jurisdiction participation status from the NFIP's Community Information System (CIS) are shown in Table 5-5. See also Section 6.3.1 for the participating jurisdictions' commitment to continue participation in the NFIP.

Table 5-5 Communities Participating in the FEMA NFIP

CID	Community	Initial FIRM Identified	Current Effective Map Date	Policies in Force	Total Coverage	# of Claims Paid	Total Losses Paid
080101	Larimer County	04/02/79	02/06/13	521	$147,103,300	332	$10,506,874
080296	Town of Berthoud	12/19/06	02/06/13	7	$2,128,000	1	$139,343
080193	Town of Estes Park	01/17/79	12/19/06	197	$52,158,800	99	$1,983,498
080102	City of Fort Collins	12/04/84	01/06/12	353	$108,494,500	64	$687,909
080103	City of Loveland	09/01/78	02/06/13	124	$41,560,800	28	$1,450,959
080005	Town of Timnath	12/19/06	12/19/06	3	$910,000	1	$4,074
080104	Town of Wellington	02/15/79	12/19/06	30	$10,578,400	10	$52,161
080264	Town of Windsor	09/27/91	09/27/91	64	$20,100,000	11	$6,932
Total				**1,299**	**$383,033,800**	**546**	**$14,831,750**

Source: FEMA, current as of September 1, 2020

In addition to participating in the NFIP, The Cities of Fort Collins and Loveland participate in the Community Rating System (CRS). CRS is a voluntary program for NFIP participating communities focused on reducing flood damages to insurable property and encouraging a comprehensive approach to floodplain management. The CRS provides incentives in the form of insurance premium discounts to communities that go above and beyond the minimum floodplain management requirements and develop extra measures to reduce flood risk. There are 10 CRS classes, and the classification determines the insurance premium discount for policy holders, as shown in Table 5-6.

Table 5-6 CRS Premium Discounts

Class	Discount		Class	Discount	SFHA (Zones A, AE, A1-A30, V, V1-V30, AO, and AH): Discount varies depending on class. SHFA (Zones A99, AR/A, AR/AE. AR/A1-A30, AR/AH, and AR/AO): 10% discount for Classes 1-6; 5% discount for Classes 7-9. Non-SFHA (Zones B, C, X, D): 10% discount for Classes 1-6; 5% discount for Classes 7-9. In determining CRS premium discount, all AR and A99 Zones are treated as non-SFHAs.
1	45%		6	20%	
2	40%		7	15%	
3	35%		8	10%	
4	30%		9	5%	
5	25%		10	--	

Source: FEMA CRS Coordinators Manual

All CRS participating communities start out with a Class 10 rating (which provides no premium discount). Class 1 requires the most credit points and offers the largest premium discount. Within the CRS program, there are 18 activities recognized as measures for eliminating local exposure to flooding. Credit points are assigned to each activity, which have been organized under four main categories:

- Public Information
- Mapping and Regulation
- Flood Damage Reduction
- Flood Preparedness

Within Larimer County, the communities of Fort Collins and Loveland participate in the CRS. Fort Collins is a Class 2 community, one of only nine communities nationwide to qualify for a Class 2 or higher rating. Loveland is rated as a Class 6 community.

5.5 Opportunities for Enhancement

Based on the capability assessment, Larimer County has several existing mechanisms in place that already help to mitigate hazards, including numerous planning tools and many available funding mechanisms. There are also opportunities for the County to expand or improve on its capability to further protect the community.

One such capability enhancement already in progress is that County Engineering is working to implement a grading/stormwater permit system and hire additional staff in coming years.

Other opportunities include the continuation of incorporating updated risk information into updates of the County's Comprehensive Plan and Resiliency Framework. As well as ensuring risk information is taken into consideration in the Land Use Code updates and during the development review process.

An additional opportunity for capability enhancement includes leveraging ongoing recovery efforts to implement a focus on working with impacted community members to further identify ways to create equitable processes and policies for disaster management and decrease barriers to resources for marginalized and underserved communities that are traditionally disproportionately affected by a crisis.

Another opportunity being considered to reduce flood losses is for Larimer County to join the Community Rating System (CRS) and help other communities do the same. As discussed in Section 4.3.6, the City of Fort Collins has been a national leader in the CRS program for years and has achieved a Class 2 rating, making them one of the 10 highest-rated CRS communities in the nation. The City of Loveland has also been very active in the program with a Class 6 rating. The annual savings to their flood insurance policy holders is shown in Table 5-7.

Table 5-7 Current CRS Participation and Summary Information

Community	Current Rating	Policies	Total Premiums	Discount	Current Annual Saving
Fort Collins	2	355	$210,943	40%	$44,040
Loveland	6	129	$101,067	20%	$11,624

Source: FEMA, as of 8/27/20

Table 5-8 shows the potential annual savings to policy holders for each CRS Rating, along with the current ratings and savings for comparison. The direct financial benefits for Berthoud, Johnstown, Timnath, Wellington, and Windsor are fairly low, due to the small number of NFIP policies. However, the County could save tens of thousands of dollars a year even with a relatively low CRS Rating. The Town of Estes Park could also potentially save several thousands of dollars a year. Deciding whether or not to join the CRS program must be based on balancing those benefits against the staff time and jurisdictional commitments required to achieve and maintain certification.

Table 5-8 Potential Benefits of CRS Ratings By Jurisdiction

Community	Class 9 Annual Savings	Class 8 Annual Savings	Class 7 Annual Savings	Class 6 Annual Savings	Class 5 Annual Savings	Class 4 Annual Savings	Class 3 Annual Savings	Class 2 Annual Savings	Class 1 Annual Savings
Larimer County	$28,382	$55,048	$81,715	$110,096	$136,763	$163,429	$190,095	$216,762	$243,428
Berthoud	$0	$0	$0	$0	$0	$0	$0	$0	$0
Estes Park	$3,661	$5,644	$7,626	$11,287	$13,269	$15,251	$17,234	$19,216	$21,198
Fort Collins	$6,627	$11,758	$16,889	$23,515	$28,647	$33,778	$38,909	$44,040*	$49,171
Johnstown	$0	$0	$0	$0	$0	$0	$0	$0	$0
Loveland	$3,119	$5,812	$8,505	$11,624*	$14,317	$17,010	$19,704	$22,397	$25,090
Timnath	$0	$0	$0	$0	$0	$0	$0	$0	$0
Wellington	$385	$770	$1,155	$1,539	$1,924	$2,309	$2,694	$3,079	$3,464
Windsor	$169	$283	$396	$566	$679	$793	$906	$1,202	$1,134

Source: FEMA, as of 8/27/20; * indicates current savings based on 2020 CRS status.

6 MITIGATION STRATEGY

This section of the Plan provides the blueprint for Larimer County and its participating jurisdictions to become less vulnerable to natural hazards. The goals and objectives are based on the consensus of the Larimer County Planning Team and local stakeholder feedback, along with the findings of the Hazard Identification and Risk Assessment. This section consists of the following subsections:

- Overview
- Goals and Objectives
- Progress on Previous Mitigation Plan Actions
- Identification and Prioritization of Mitigation Actions
- 2021 Mitigation Plan Action

6.1 Overview

The intent of the Mitigation Strategy is to provide the County and its participating jurisdictions with the goals that will guide future mitigation policy and project administration. The Mitigation Strategy includes a list of proposed actions deemed necessary to meet those goals and reduce the impact of natural hazards. The development of the strategy included a thorough review of natural hazards and identified policies and projects intended to not only reduce the future impacts of hazards, but also to help Larimer County and participating jurisdictions balance and achieve their economic, environmental, and social goals. The development of the Mitigation Strategy was strategic, in that all policies and projects have been linked to established priorities. Moreover, projects have been assigned to specific departments or individuals responsible for their implementation. Potential funding sources are identified when possible and identified projects were categorized as being realistically achievable over the next five years.

- **Goals** are general guidelines that explain what the county wants to achieve. Goals are usually expressed as broad policy statements representing desired long-term results.
- **Objectives** describe strategies or implementation steps to attain the identified goals. Objectives are more specific statements than goals; the described steps are usually measurable and can have a defined completion date.
- **Actions** provide more detailed descriptions of specific work tasks to help the county and its municipalities achieve prescribed goals and objectives.

Based on participation from the Larimer County Hazard Mitigation Planning Team, the mitigation strategy from the 2016 Hazard Mitigation Plan has been modified and updated. The goals and objectives were updated, the status of previously identified actions was updated, and new actions have been added to address hazards facing Larimer County and its participating jurisdictions.

Larimer County has also been proactive in integrating hazard mitigation into their post-disaster recovery strategy, as detailed in the County's Disaster Recovery Plan, Recovery Support Function 8: Hazard Mitigation.

6.2 Goals and Objectives

As described above, mitigation goals are overarching targets and describe the ideal long-term outcomes envisioned by the community, while mitigation objectives describe the "how" of the mitigation strategy and are specific and measurable. The 2021 Planning Team approved the following updated mitigation goals and objectives for Larimer County and the participating jurisdictions to provide direction for reducing future hazard-related losses across Larimer County:

2021 Larimer County Hazard Mitigation Goals:

- **Goal 1:** Protect people, property, and natural resources
- **Goal 2:** Increase level of community resilience county-wide and improve capability to reduce disaster losses
- **Goal 3:** Strengthen communication and coordination among public agencies, non-governmental organizations, businesses, and citizens
- **Goal 4:** Increase public awareness of natural and human-caused hazards and mitigation options
- **Goal 5:** Integrate hazard mitigation into other planning mechanisms

2021 Larimer County Hazard Mitigation Objectives:

- **Objective 1:** Continue to develop and expand public awareness and information programs
- **Objective 2:** Enhance training for hazard prevention and mitigation options
- **Objective 3:** Incorporate risk reduction principles into policy documents and initiatives, as well as other institutional plans
- **Objective 4:** Continue to collaborate with area partners through mutual aid agreements and long-term planning efforts
- **Objective 5:** Reduce the vulnerability of local assets and members of the community to the impacts of hazards.

Larimer County's mitigation goals and objectives originated with the goals identified in the 2010 Northern Colorado Regional Hazard Mitigation Plan, which subsequently evolved into the goals and objectives in the 2016 Larimer County HMP. The goals and objectives from those previous plans are listed below to show continuity and give a sense of how the County's strategy have changed over time.

2010 Northern Colorado Regional Hazard Mitigation Plan Goals:

- Goal 1: Protect Life and Property
- Goal 2: Improve Public Awareness
- Goal 3: Strengthen Partnerships and Promote Plan Implementation
- Goal 4: Improve Emergency Services Response Plans

2016 Larimer County Multi-Jurisdictional Hazard Mitigation Plan Goals and Objectives:

- Goal 1: Protect people, property, and natural resources
- Goal 2: Improve capability to reduce disaster losses
- Goal 3: Strengthen communication and coordination among public agencies, nongovernmental organizations, businesses, and citizens
- Goal 4: Increase public awareness of natural hazards and mitigation options
- Goal 5: Integrate hazard mitigation into other planning mechanisms

- Objective 1: Continue to develop and expand public awareness and information programs
- Objective 2: Enhance training for hazard prevention and mitigation options
- Objective 3: Incorporate risk reduction principles into policy documents and initiatives, as well as other institutional plans
- Objective 4: Continue to collaborate with area partners through mutual aid agreements and long-term planning efforts
- Objective 5: Reduce the vulnerability of local assets to the impacts of hazards.

For the 2021 Update, the Planning Team reviewed the goals and objectives from the 2016 Plan, and determined they still reflect the County's desired mitigation strategy. Three edits were made to the 2016 goals and objectives based on suggestions from Planning Team members:

- Goal 2: The words "Increase level of community resilience county-wide" were added to better align the Plan with the County's resiliency strategy.
- Goal 4: Reference to human-caused hazards was added to reflect the plan's evolution beyond just natural hazards, and
- Objective 5: The words "and members of the community" were added to clarify that the mitigation strategy is not just about protecting physical property.

In order to maintain continuity within the local mitigation strategy, each mitigation objective is associated with one or more mitigation goals (as is shown in the following table). This helps communities stay on track during the development of the mitigation strategy and focus their planning efforts around clear priorities. Together, the goals and objectives of the Larimer County mitigation strategy establish the scope and focus of the proposed mitigation actions outlined in this Plan.

Table 6-1 2021 Larimer County Mitigation Strategy – Updated Goals and Objectives

Goal	Objective
GOAL 1: Protect people, property, and natural resources	1. Continue to develop and expand community preparedness education and resilience programs.
	2. Enhance training for hazard prevention and mitigation options.
	3. Incorporate risk reduction principles into policy documents and initiatives, as well as other institutional plans.
	4. Continue to collaborate with area partners through mutual aid agreements and long-term planning efforts.
	5. Reduce the vulnerability of local assets and members of the community to the impacts of hazards.
GOAL 2: Increase level of community resilience county-wide and improve capability to reduce disaster losses	1. Continue to develop and expand community preparedness education and resilience programs.
	2. Enhance training for hazard prevention and mitigation options.
	3. Incorporate risk reduction principles into policy documents and initiatives, as well as other institutional plans.
	4. Continue to collaborate with area partners through mutual aid agreements and long-term planning efforts.
	5. Reduce the vulnerability of local assets and members of the community to the impacts of hazards.
GOAL 3: Strengthen communication and coordination among public agencies, non-governmental organizations, businesses, and citizens	1. Continue to develop and expand community preparedness education and resilience programs.
	2. Enhance training for hazard prevention and mitigation options.
GOAL 4: Increase public awareness of natural and human-caused hazards and mitigation options	1. Continue to develop and expand community preparedness education and resilience programs.
	2. Enhance training for hazard prevention and mitigation options.
	3. Incorporate risk reduction principles into policy documents and initiatives, as well as other institutional plans.
	4. Continue to collaborate with area partners through mutual aid agreements and long-term planning efforts.

Goal	Objective
	5. Reduce the vulnerability of local assets and members of the community to the impacts of hazards.
GOAL 5: Integrate hazard mitigation into other planning mechanisms	3. Incorporate risk reduction principles into policy documents and initiatives, as well as other institutional plans.
	4. Continue to collaborate with area partners through mutual aid agreements and long-term planning efforts.
	5. Reduce the vulnerability of local assets and members of the community to the impacts of hazards.

6.3 Progress on Previous Mitigation Plan Actions

The 2016 Plan identified a number of mitigation actions, which the County and jurisdictions have been successful in implementing to work steadily towards meeting their mitigation goals and objectives. During the 2021 plan update process, the Planning Team reviewed the mitigation actions in the 2016 Plan, and updated their status based on input from the responsible agency for each action, describing which actions had been completed, which were either in progress or not yet started, and if any should be deleted as no longer relevant of achievable.

The 2016 Plan contained a total of 131 mitigation actions. (This does not include 6 actions from jurisdictions that did not participate in the 2021 update, as noted in Section 3.3.) Of those, 57 actions were reported as having been completed. The majority of the actions that had not been completed were reported as being in progress, waiting on funding, or deferred due to competing priorities and limited resources. Overall, the high number of actions that have been completed is a sign of the effectiveness of Larimer County's hazard mitigation program and that the County and its jurisdictions are steadily working towards the goals of this plan.

The statuses of the 2016 mitigation actions are summarized by jurisdiction in Table 6-2 below along with the number of new actions added in 2021. Larimer County's completed actions are listed in Table 6-3; actions completed by other participating jurisdictions are listed in that jurisdiction's annex.

Table 6-2 Mitigation Actions Summary by Jurisdiction

Jurisdiction	# of Actions in 2016 HMP	# of Actions Completed	# of Actions Deleted	# of New Actions	Total # of 2021 Actions
Larimer County	22	12	1	19	28
Town of Berthoud	6	5	0	2	3
Berthoud Fire Protection District	6	4	0	2	4
Crystal Lakes Fire Protection District	5	1	0	2	6
Town of Estes Park	7	4	1	5	7
Estes Park Health	2	1	0	1	2
Estes Valley Fire Protection District	1	1	0	2	2
Estes Valley Recreation & Park District	1	1	0	2	2
City of Fort Collins	32	10	0	13	35
Glacier View Fire Protection District	3	0	0	2	5
Town of Johnstown	2	0	0	2	4
Livermore Fire Protection District	5	4	0	3	4
City of Loveland	7	4	0	5	7

Jurisdiction	# of Actions in 2016 HMP	# of Actions Completed	# of Actions Deleted	# of New Actions	Total # of 2021 Actions
Northern Water	1	0	0	11	12
Pinewood Springs Fire Protection District	5	3	0	2	4
Poudre Canyon Fire Protection District	1	0	0	1	2
Poudre Fire Authority	3	0	0	2	5
Thompson Valley EMS	3	0	0	1	4
Town of Timnath	3	0	0	2	5
Upper Thompson Sanitation District	3	2	0	2	3
Town of Wellington	2	1	0	3	4
Wellington Fire Protection District	2	1	0	3	4
Town of Windsor	6	1	0	2	7
Windsor Severance Fire Rescue	3	2	0	2	3
Grand Totals	**131**	**57**	**2**	**91**	**162**

Table 6-3 Completed and Deleted County Mitigation Actions From the 2016 HMP

2016 Action ID	Hazard(s)	Mitigation Action	Comments
Larimer – 3	Extreme Temperatures and Fire	Wildfire Education and Outreach. Development of a coordinated wildfire education and outreach program with multiple wildfire and natural lands partners.	This effort has been successful through the Larimer Connects Program and due to the fact that OEM partners with many departments including Public Health, Emergency Services, and more to promote information at community events such as FireWise community events, assisting with development of local CWPPs, during the Preparedness and Family Safety Expo, and more.
Larimer – 5	Land Subsidence, Flood, Severe Storm and Fire	Flood Risk Velocity and Depth Criteria Project. Develop velocity and depth criteria for all floodplains in Larimer County and incorporate criteria into floodplain regulations	The Engineering Department completed a feasibility project to determine if flood risk should be measured via velocity and depth criteria. This information was presented to the BCC who opted not to change our current evaluation criteria.
Larimer – 8	Flooding	High Water Mark Initiative Project. Purchase and install 2013 Flood High Water Mark placards	This project was completed and implemented in 2018 and was done in partnership with FEMA, City of Loveland, and City of Fort Collins in a series of 3 public events. This project includes signage that demonstrates the high water marks from the 1997 Spring Creek Flood and the 2013 Larimer County Flood and further provides flood education and preparedness information to the public.
Larimer – 9	Fire and Flood	Post Fire Restoration. Identifying which areas of the burn area are still at risk of degrading water quality and threatening life and property and then designing on the ground restoration treatments	Coalition for the Poudre River Watershed and stakeholders completed an analysis of remaining post-fire priorities. Based on that analysis, additional stakeholder input, and available funding, CPRW and partners completed 3 post-fire restoration projects (Skin Gulch, UT3,

2016 Action ID	Hazard(s)	Mitigation Action	Comments
		that help reduce erosion and stabilize channels and reduce runoff volumes.	Seaman Reservoir). Monitoring in the watershed indicates that there are few to no remaining post-fire impacts to streams and rivers. Thus, implementation actions are considered complete. However, planning for responding to the next post-wildfire is an ongoing, annual action.
Larimer – 11	Earthquake, Flood, Severe Storm, and Fire	Bridge Improvement Project. In accordance with the Larimer Strategic Plan, replace all structurally deficient bridges in Larimer County by 2020	The Engineering Department had a goal in 2013 Strategic Plan to update all structurally deficient bridges, this was completed.
Larimer – 12	Flood	Hydrology Analysis and Infrastructure Upgrades. Analyze need for bridge and crossing improvements and pursue funding for replacement structures.	The Engineering Department had a goal in the 2013 Strategic Plan to complete infrastructure updates. This was completed.
Larimer – 13	Drought, Earthquake, Land Subsidence, Extreme Temperatures, Flood, Severe Storm, Wind & Tornado, Fire, Public Health, Hazmat	Long-Range Community Planning. The purpose of this mitigation action is to develop a long-range plan for the area affected by the 2012 High Park Wildfire and 2013 Flood, plus other areas susceptible to natural hazards.	Larimer County successfully completed a full update to the Larimer County Comprehensive Plan, adopted in 2018. This was a 2-part plan including the Mountain Resilience Plan and the Eastern Plains Plan that take into account the unique needs of both regions. This plan provides a framework for identifying best solutions for community planning and development county-wide.
Larimer – 14	Drought, Earthquake, Land Subsidence, Extreme Temperatures, Flood, Severe Storm, Wind & Tornado, Fire, Public Health, Hazmat	Mitigation Code Changes. Update Larimer County Land Use, Wildfire and Building Codes with recommendations approved by the Board of Commissioners, Planning Commission and Flood Review Board to decrease future risk and disaster losses.	Implemented and completed
Larimer – 17	Earthquake, Land Subsidence, Flood, Severe Storm, Fire	Transportation Master Plan Update. Review and update the Transportation Master Plan.	This effort was completed and implemented in 2018
Larimer – 18	Civil Disturbance and Hazmat	Risk Assessment Program. Develop a risk assessment program for large businesses, hazardous materials fixed facilities,	Finalized in 2017, Larimer County participated in the RRAP in partnership with Idaho National Labs and the City of Fort Collins to Identify impacts to critical infrastructure. This was expanded in 2018 and 2019 to the RIIP (Resilient Infrastructure

2016 Action ID	Hazard(s)	Mitigation Action	Comments
		schools, and industry to develop awareness, decrease risk and improve response protocols.	Improvement Project), which then informed the development of the tool CASCARTA. This tool looks at upstream and downstream dependencies to better identify how to allocate resources for critical infrastructure and key resources county-wide. In 2019, Larimer County also completed a THIRA (Threat and Hazard Identification and Risk Assessment) which is an assessment of current capabilities associated with ESFs and RSFs county-wide. Collaborated with Federal, State and Local partners on Infrastructure Protection Gateway Tool
Larimer – 19	Flood	River Restoration Projects. Resilient restoration techniques which focus on holistic watershed health, including stabilizing river channel and banks, considering how infrastructure is located in the floodplain; creating and improving aquatic and riparian habitat.	All project milestones have been implemented on this project, and like CPRW, the Big Thompson Watershed Coalition is expanding efforts into longer-term sustainability and forest restoration projects.
Larimer – 20	Flood	River Restoration and Mitigation Projects. Resilient restoration techniques which focus on holistic watershed health, including stabilizing river channel and banks, considering how infrastructure is located in the floodplain; creating and improving aquatic and riparian habitat.	All project milestones have been implemented on this project, and like CPRW, the Big Thompson Watershed Coalition is expanding efforts into longer-term sustainability and forest restoration projects. However, the Little Thompson Watershed Coalition disbanded in 2019.
Larimer-21	Flood	Cotton Willows Subdivision Engineering Study. Conduct 1) a Groundwater and Drainage Study and 2) a Floodplain Mitigation Study	Deleted. Unable to implement mitigation measures for this area due to private land issues.

6.3.1 Continued Compliance with NFIP

Recognizing the importance of the National Flood Insurance Program (NFIP) in mitigating flood losses, an emphasis will be placed on continued compliance with the NFIP by Larimer County and its participating communities including the Cities of Fort Collins and Loveland, and the Towns of Berthoud, Estes Park, Johnstown, Timnath, Wellington, and Windsor. As NFIP participants, these communities have and will continue to make every effort to remain in good standing with NFIP. This includes continuing to comply with the NFIP's standards for updating and adopting floodplain maps and maintaining and updating the floodplain zoning ordinance. Other details related to NFIP participation are discussed in the flood vulnerability discussion in Section 4.3.6, in Section 5.5.4 of the Capability Assessment, and the individual jurisdictional annexes.

Larimer County and participating jurisdictions have been proactive in implementing mitigation activities focused on reducing the impacts to critical facilities from flooding and other hazards. The 12 facilities protected by levee in Table 4-32 are an example of removing facilities from the 1% and 0.2% floodplain. Actions completed since the last plan update that specifically addressed reducing the vulnerability of critical facilities to flooding include the following actions, as listed in Section 6.3 and the jurisdictional annexes:

- Larimer-11
- Larmier-12
- Larimer-20
- Estes Park-3
- EPMC-1
- EVRP-1
- Fort Collins-1
- Fort Collins-6
- Fort Collins-7
- Fort Collins-14
- Loveland-4
- Loveland-5
- Pinewood Springs FPD-3

Several new and continuing mitigation actions listed in Section 6.5 and the jurisdictional annexes target reducing the vulnerability of critical facilities to flooding.

- LC-4
- LC-6
- LC-10
- LC-12
- LC-13
- LC-16
- LC-25
- LC-26
- A-2
- D-2
- E-1
- H-1
- H-2
- H-5
- H-6
- H-9
- H-10
- H-12
- H-13
- H-14
- H-16
- H-20
- H-21
- H-22
- H-26
- H-27
- H-28
- H-29
- H-30
- H-33
- H-34
- J-2
- J-3
- J-4
- L-1
- L-25
- L-91
- L-130
- M-1
- T-3
- V-4
- V-5
- V-6
- V-7
- R-2
- R-3
- R-5

As mentioned in Section 4.3.6, the Larimer County Recovery Plan outlines policies and procedures to recover from floods and other disasters. The plan includes roles and responsibilities, the concept of operations, direction and coordination, and financial management, along with 17 Recovery Support Functions (RSFs). Post-flood recovery should focus on activities to protect public health and safety, such as providing safe drinking water, monitoring for disease and contaminants, and cleaning up debris.

Other plans, policies, regulations, or programs in place to reduce the vulnerability of critical facilities to flooding, such as floodplain ordinances, stormwater management programs, and Drainage Basin Master Plan, are discussed in Section 5.1 of the Base Plan and in the Capability Assessment sections of the Jurisdictional Annexes.

6.4 Identification and Prioritization of Mitigation Actions

The natural and human-caused hazards identified in Section 4 Risk Assessment were evaluated to identify and prioritize mitigation actions to support the mitigation goals and objectives described above.

6.4.1 Identification of New Mitigation Actions

The Planning Team considered the following categories of mitigation actions, as defined in FEMA's 2013 *Local Mitigation Planning Handbook*:

- **Plans and regulations:** These actions include government authorities, policies, or codes that influence the way land and buildings are developed and built.
- **Structure and infrastructure projects:** 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 manmade structures to reduce the impact of hazards.
- **Natural systems protection:** These are actions that minimize damage and losses and also preserve or restore the functions of natural systems.

- **Education and awareness:** These are actions to inform and educate citizens, elected officials, and property owners about hazards and potential ways to mitigate them. These actions may also include participation in national programs, such as StormReady or Firewise Communities. Although this type of mitigation reduces risk less directly than structural projects or regulation, it is an important foundation. A greater understanding and awareness of hazards and risk among local officials, stakeholders, and the public is more likely to lead to direct actions.

The Planning Team also considered the following categories as defined in the Community Rating System:

- **Prevention:** Administrative or regulatory actions or processes that influence the way land and buildings are developed and built.
- **Property protection:** Actions that involve the modification of existing buildings or structures to protect them from a hazard or remove them from the hazard area.
- **Structural:** Actions that involve the construction of structures to reduce the impact of a hazard.
- **Natural resource protection:** Actions that, in addition to minimizing hazard losses, also preserve or restore the functions of natural systems.
- **Emergency services:** Actions that protect people and property during and immediately after a disaster or hazard event.
- **Public information/education and awareness:** Actions to inform and educate citizens, elected officials, and property owners about the hazards and potential ways to mitigate them.

At planning meeting #3, the Planning Team was provided with handouts describing the categories and listing examples of potential mitigation actions for each category, as well as for the identified hazards. FEMA's 2013 document *Mitigation Ideas: A Resource for Reducing Risk to Natural Hazards* was also referenced and made available for reference. Attendees were then asked to submit mitigation action ideas via an online poll. Action submissions included details describing how the actions will be implemented and administered, to include cost estimates, potential funding sources, and estimated timeline for completion. Each action was required to be tied to one or more of the goals and objectives.

It was not always feasible or realistic for every jurisdiction to develop mitigation actions against every identified hazard. However actions were compared against identified hazards to ensure that the plan contains a comprehensive range of mitigation actions and projects for each of the most high risk hazards. An emphasis on new and existing buildings and infrastructure was stressed. While the Planning Team focused primarily on those hazards identified as posing the highest risk to the jurisdiction, mitigation actions were also suggested for some low priority hazards. Similarly, while the primary focus was on developing mitigation actions in the categories described above, some jurisdictions identified actions that do not fall into one of the above categories and which may be better defined as planning or preparedness actions. Some of these actions were nonetheless included in the plan, as the jurisdiction felt they were important actions to reduce losses from future disasters even if they do not meet the strict definition of mitigation.

A total of 92 new actions were submitted, as summarized in Table 6-2 and detailed in Table 6-4.

6.4.2 Prioritization Process

After the planning team had developed new mitigation actions as described above, those new actions were consolidated into lists by jurisdiction for prioritization. Continuing actions from the 2016 Plan were also included in the list so they could be re-prioritized relative to the new actions. Due to the COVID-19 pandemic that was ongoing at the time, it was not possible to conduct a facilitated prioritization exercise in person. Instead, the list of new and continuing actions was developed into an online poll, with planning team members prioritizing the actions for their jurisdiction.

The Planning Team was provided with several decision-making tools, including FEMA's recommended prioritization criteria, STAPLEE, to assist in deciding why one recommended action might be more important, more effective, or more likely to be implemented than another. STAPLEE stands for the following:

- **Social:** Does the measure treat people fairly? (e.g., different groups, different generations) Does it consider social equity, disadvantaged communities, or vulnerable communities?
- **Technical:** Will it work? (Is the action technically feasible? Does it solve the problem?)
- **Administrative:** Is there capacity to implement and manage the project? (adequate staffing, funding, and other capabilities to implement the project?)
- **Political:** Who are the stakeholders? Did they get to participate? Will there be adequate political and public support for the project?
- **Legal:** Does the jurisdiction have the legal authority to implement the action? Is it legal? Are there liability implications?
- **Economic:** Is the action cost-beneficial? Is there funding available? Will the action contribute to the local economy?
- **Environmental:** Does the action comply with environmental regulations? Will there be negative environmental consequences from the action?

In accordance with the Disaster Mitigation Act requirements, an emphasis was placed on the importance of a benefit-cost analysis in determining action priority. Other criteria used to assist in evaluating the benefit-cost of a mitigation action included:

- Does the action address hazards or areas with the highest risk?
- Does the action protect lives?
- Does the action protect infrastructure, community assets or critical facilities?
- Does the action meet multiple objectives (Multiple Objective Management)?
- What will the action cost?
- What is the timing of available funding?

The above criteria were used to prioritize actions in an iterative process over the course of the plan update process. At the start of the process, participating jurisdictions were asked to validate or update the priorities of their continuing actions from the 2016 Plan. When submitting new mitigation actions, planning team members were asked to prioritize those as well. Finally, once all new and continuing actions had been collated into a draft mitigation strategy, jurisdictions were asked to verify or update the priorities of each action compared to their other actions.

6.5 2021 Mitigation Action Plan

The 2021 Larimer County mitigation action plan lists the actions developed and prioritized as described above, to include continuing actions from the 2016 Plan. The action plan details how the participating jurisdictions will reduce the vulnerability of people, property, infrastructure, and natural and cultural resources to future disaster losses. The action plan summarizes who is responsible for implementing each of the prioritized actions as well as when and how the actions will be implemented. All actions are tied to specific goals and objectives to ensure alignment with the Plan's overall mitigation strategy. Over time the implementation of these projects will be tracked as a measure of demonstrated progress on meeting the plan's goals.

Many of these mitigation actions are intended to reduce impacts to existing development. Those that protect future development from hazards, as required per the DMA 2000 regulations, are indicated by an asterisk '*' in the action identification number. These actions include those that promote wise development and hazard avoidance, such as building code, mapping, and zoning improvements, and continued enforcement of floodplain development regulations.

Larimer County's mitigation actions are listed in Table 6-4 below. Mitigation actions for the other participating jurisdictions are summarized in Table 6-2 above and detailed in each jurisdiction's Annex.

Additional details on each action can be found in the project worksheets in Appendix D.

Table 6-4 2021 Larimer County Mitigation Action Plan

ID	Related Goal(s)	Hazard(s) Mitigated	Description	Lead Agency and Partners	Cost Estimate	Potential Funding	Priority	Timeline	Status and Implementation Notes
LC-1	Goals 1,2,4 Objectives 1,2,5	Drought, Earthquake, Land Subsidence, Extreme Temperatures, Flood, Severe Storm, Wind & Tornado, Fire, Public Health, Hazmat	**Larimer Connects Project.** Location: Countywide. Issue: Community Outreach regarding mitigation measures is currently lacking. Recommendation: The purpose of this project is to build community connections – within communities, between communities and the connections that reach past communities into formal structures (municipalities, special districts, counties, region, and state). Action: Larimer Connects Community Outreach includes the development of community connections through coursework, education and outreach throughout all of Larimer County to increase overall community knowledge, education, and readiness leading to a culture of community resilience at the lost local level. The project components involve three phases: 1) community assessment and identification of resources, 2) synthesis of available data, and 3) implementation of the program.	**Larimer OEM,** All municipal and other emergency management partners in the county	~$100,000	The Board of Commissioners has approved $100,000 for the initial study.	High	Ongoing	Annual Implementation. The Larimer Connects Project was successfully implemented in 2017 and continues to the present. This project was put in place to increase emergency preparedness through outreach and education and to foster and encourage social connectivity and grassroots resilience throughout Larimer County. The project has made a presence in numerous community events including expos, pancake breakfasts, annual meetings, holiday events, and more to increase awareness. The Resilient Communities are Connected Communities workshop has trained over 80 people since its inception with biannual events being offered. The project also helped to jumpstart hub networks at the local level, led by community champions. This led to the creation of the North 40 Mountain Alliance in the northern mountain communities that have a robust system of volunteers that have been instrumental in helping their neighbors and solving problems during disaster (i.e. information sharing during wildfires, and most recently, delivering 16,000+ pounds to elderly or vulnerable neighbors in partnership with the Food Bank during the COVID-19 pandemic).
LC-2	Goals 1,2,4 Objectives 1,2,5	Public Health	**Emergency Preparedness Public Education/ Outreach.** Location: Countywide. Issue: During the recent wildfire and flood events, many residents, especially in mountain areas, were not prepared to evacuate or to shelter-in-place. Many ran out of water, medicines,	**Health and Environment,** OEM, CDPHE, CDC	Cost will depend upon each specific recovery project	Emergency Preparedness and Response grant	High	Ongoing	Annual Implementation. This effort has been successful through the Larimer Connects Program and due to the fact that OEM partners with many departments including Public Health, Emergency Services, and more to

ID	Related Goal(s)	Hazard(s) Mitigated	Description	Lead Agency and Partners	Cost Estimate	Potential Funding	Priority	Timeline	Status and Implementation Notes
			diapers, etc., in two or three days and expected government to provide resources for them. Some refused to leave their homes because they had no plans for dealing with pets or livestock. Recommendation: Continue public education/outreach, especially in mountainous areas, encouraging residents to develop Family Disaster Plans and assemble an Emergency Kit. Action: Continue to post information on Health Department website. Attend safety and health fairs. Develop displays/educational materials and create opportunities to present information to mountain locations.						promote information at community events, during the Preparedness and Family Safety Expo, and more.
LC-3	Goals 1,2,3 Objectives 4,5	Wildfire	**Forest Resilience and Wildfire Fuels Reduction.** Work with the Watershed Coalitions, the Northern Colorado (NoCo) Fireshed Network, LCSO, Youth Corps, and other organizations and individual volunteers to identify and conduct collaborative forest resilience/fuels reductions projects to reduce the negative impacts of wildfires. This will include a focus on areas where county lands are adjacent to private lands for effective fuels and forest health treatment. Will work together to identify opportunities to partner on outreach efforts and united communications to the public and/or landowners.	**CPRW,** Watershed coalitions, Nature Conservancy, Wildlands Restoration Volunteers, CSFS, NRCS, Larimer County Conservation Corps, and Boy Scout Ranch, LCSO, NoCo Fireshed Network, USFS, Colorado State Forest Service	~$100,000 annually	City of Fort Collins, CSFS, Patagonia, New Belgium Brewing, and Dept Natural Resources.	High	Ongoing	Annual Implementation. CPRW has a robust forest management program established and frequently partners with many entities including CFRI, CSFS, USFS, Larimer Emergency Services, Nature Conservancy, and more to conduct prescribed burning management and helps foster relationships for this effort between public and private landowners. Additionally, CPRW partnered with Larimer County to fund a forest restoration project benefitting both the Poudre and Big Thompson Watersheds in 2019. CPRW also facilitates the Northern Colorado Fireshed Network, a collaborative that seeks to bring increased prescribed burning and mitigation efforts to northern Colorado.
LC-4	Goals 1,2 Objectives 3,4,5	Flood, Severe Storm, and Wildfire	**Flood and Fire Recovery Mitigation Activities.** Location: Areas impacted by 2013 Floods, High Park Fire and Cameron Peak Fire. Issue: Larimer County continues to move through the recovery from the 2012 High Park	**Engineering Department and Community Development**	Cost will depend upon each specific	FEMA Public Assistance funding, HMGP funding,	High	Ongoing	In progress. The 2012 High Park Wildfire was closed out in 2017. Larimer OEM continues to monitor the ground for impacts during high rain events, otherwise recovery is

ID	Related Goal(s)	Hazard(s) Mitigated	Description	Lead Agency and Partners	Cost Estimate	Potential Funding	Priority	Timeline	Status and Implementation Notes
			Wildfire, the 2013 Flood, and the 2020 Cameron Peak Wildfire. Many projects remain unfinished, allowing the county to look at mitigation opportunities for the future. Recommendation: Assess all unfinished recovery projects for possible mitigation opportunities and implement alternatives when appropriate. Action: Include mitigation alternatives in flood and fire recovery efforts whenever possible.	**,** Public Works and OEM	recovery project	county resources			complete. The 2013 Flood is still in recovery and we remain working with FEMA to close out final projects.
LC-5	Goals 1,2,3 Objectives 5	Land Subsidence, Flood, Severe Storm, Wildfire	**Rainfall and Stream Gauge Monitoring System.** Location: Larimer County Watersheds. Issue: Rainfall and stream gauges exist on a small section of the county's watersheds and many of these gauges were damaged or destroyed during the 2013 Flood. Recommendation: Install rainfall and stream gauges throughout Larimer County's major watersheds, including the Big Thompson River, Little Thompson River and the Cache la Poudre River and connect all with a monitoring system that can provide real-time data and early warning to citizens and emergency responders. Action: Install rainfall and stream gauge monitoring hardware and software in major watersheds throughout Larimer County.	**Engineering Department,** Community Development and OEM	$300,000	2015 HMGP funding for partial implementati on county funding	High	2021	In progress. Completed and implemented those for the Big Thompson River. The Cache La Poudre and Little Thompson Rivers will be completed in 2020.
LC-6*	Goals 1,2,3 Objectives 1,3,5	Flood	**Full Adoption of Updated FEMA Floodplains.** Location: Countywide. Issue: Floodplain mapping is out of date and the 2013 Flood caused extensive changes to current floodplains. Recommendation: Work with FEMA on updating current floodplain mapping throughout Larimer County. Action: By 2020, all Larimer County watersheds will be mapped and adopted	**Engineering Department,** Community Development and OEM	$300,000	Colorado State Flood Hazard Mapping Project	Medium	2021-2022	In progress. Both CHAMP and RiskMAP are all in various states of adoption, but not complete. The new mapping for the Little Thompson will be approved by FEMA in July and then we have 6 months to approve it. This adoption will be official by the end of the year. The other mapping projects will be complete in the next few years.
LC-7	Goals 1,2,3,4 Objectives 1,4,5	Public Health	**Maintain adequate public health monitoring, surveillance, response capabilities.** Location: Countywide. Issue: Larimer County is vulnerable to a wide variety of public health threats, including disease	**Health and Environment,** OEM, CDPHE, CDC, local hospitals and	TBD	Emergency Preparednes s and Response grant, other	High	Ongoing	Annual Implementation. Larimer County has established a robust EPR program and Incident Command System that is closely connected to and remains in contact with OEM. This

ID	Related Goal(s)	Hazard(s) Mitigated	Description	Lead Agency and Partners	Cost Estimate	Potential Funding	Priority	Timeline	Status and Implementation Notes
			epidemics and exposure to chemical, biological or radiological agents. Recommendation: Continue to ensure that adequate resources are in place to monitor public health threats and take the necessary steps to prevent or limit the scope and magnitude of threats that could escalate into public health emergencies. Action: Continue to monitor disease outbreaks and remain prepared to provide safe and rapid prophylaxis of residents during large-scale events through the SNS program. Maintain capability to identify and respond to chemical, biological or radiological incidents. Maintain systems for education, notification, and communication with partners.	other healthcare providers, Larimer County Emergency Healthcare Coalition.		grant and general fund monies.			partnership and subsequent efforts of this program have been vital in addressing the current COVID-19 Pandemic. In order to accomplish the project milestones, are in collaboration with hospital partners and serve as a facilitator/chair in the local Healthcare coalitions.
LC-8	Goals 1,2 Objectives 3,5	Land Subsidence, Flood and Severe Storm	**Box Elder Stormwater and Drainage Master Plan Implementation.** Location: Countywide. Issue: The Box Elder Stormwater and Drainage Master Plan has been established and needs to be implemented. The Box Elder Basin Regional Stormwater Authority has begun the regional portions of the project. The Larimer County portion of the master plan will follow. Recommendation: Implement the Larimer County portions of the master plan. Action: Larimer County will need to upgrade infrastructure to fully implement the master plan, including increasing flow capacity at county crossings.	**Engineering Department,** Community Development	$5.3 million in county resources and another $14 million from the authority	Larimer County and authority resources. BRIC grant	Medium	Dec 2021	In progress. The Boxelder Basin regional stormwater improvements are mostly completed. The regional flood control facilities are fully completed, and the downstream floodplains now reflect their existence. The Boxelder Authority is dealing with the need to mitigate for groundwater that was exposed in the bottom of the flood control reservoir that either requires a subdrain or a water augmentation plan. The City of Fort Collins also improved downstream bridge crossings on Boxelder Creek along Prospect Road. However, it should be noted that this is only a portion (about one-third) of the total improvements identified in the original stormwater master plan. For example, upgrades to most County road crossings upstream of CR 52 are still needed.
LC-9	Goals 1,2 Objectives 5	Severe Storm, Wildfire	**Vehicle for Severe Storm and Fire Events.** Issue: In severe weather, particularly snowstorms, there are many miles of public	**Red Feather Lakes Volunteer**	$110,000	Red Feather Lakes VFD,	Medium	1 year	Not started. Currently seeking funding.

ID	Related Goal(s)	Hazard(s) Mitigated	Description	Lead Agency and Partners	Cost Estimate	Potential Funding	Priority	Timeline	Status and Implementation Notes
			and private roads which will not be cleared. Any emergency response (Law, Fire, EMS) may be delayed for hours or days until roads can be cleared. Many residential roads are not maintained and can be impassable until a contractor can remove snow. Some of these roads are miles long. Recommendation: Obtain a vehicle which is capable of transporting responders and supplies/equipment into a scene, and be capable of removing citizens trapped or in distress when over the road vehicles are not able to make access. Action: Determine vehicle configurations are adaptable to fire and EMS situations that can travel off-road or over snow-closed road. Obtain trailer for such vehicle, if needed, obtain storage location which will be accessible to Red Feather Lakes Fire Protection Members when roads are impassable. Train members on the use operation, use, and driving. Red Feather Lakes Fire would maintain and repair this vehicle. They would also make other agencies aware of this capability and of its availability for situations in their district. We would also make this available for organizations providing essential services for our area. (REA, Verizon, etc.)	**Fire Department,** Crystal Lakes Fire Protection District, Sheriff Office		fund raising, grants.			
LC-10*	Goals 1,2,4,5 Objectives 1,3,5	Flooding	**Larimer County Floodplain Code Update.** The County floodplain regulations under Section 4.2.2 are being updated to better enforce building regulations under the NFIP within regulatory floodplains.	**Engineering Department,** Community Development Department	Staff time	General fund	High	2020-2021	New in 2021.
LC-11*	Goals 1,2 Objectives 3,5	Flooding, erosion, environmental (pollutant discharge)	**Development of Land Disturbance Permit.** Land Disturbance Permit will be developed to provide controls over grading, stockpiling, and other land disturbance activities, particularly within the MS4 permit area and in proximity to waterways.	**Engineering Department,** Natural Resources, Community Development	$27,000 for consultant + staff time	General fund	Medium	Dec. 2021	New in 2021.

ID	Related Goal(s)	Hazard(s) Mitigated	Description	Lead Agency and Partners	Cost Estimate	Potential Funding	Priority	Timeline	Status and Implementation Notes
LC-12*	Goals 1,2 Objectives 3,5	Flooding and drainage	**Larimer County Stormwater Design Standards Update.** The County's stormwater design standards last revised in 2006 will be updated to meet current standards per the Mile High Flood District's Urban Storm Drainage Criteria Manual.	**Engineering Department,** Community Development	$85,000	General fund	Medium	Dec. 2021	New in 2021.
LC-13	Goals 1,2 Objectives 5	Flooding	**Larimer County Strategic Plan Improvements.** A selected plan of floodplain and drainage projects will be identified to improve adverse flooding & drainage impacts. These projects may include projects such as upsizing culverts or other crossings, floodplain stabilization, construction of overflow paths, and others.	**Engineering Department,** County Fire Departments, OEM	TBD, project specific	FEMA HMP Grants	Medium	Dec. 2020	New in 2021.
LC-14	Goals 1,2 Objectives 5	Wildfire	**Wildfire Initial Attack module that is All Hazards capable.** Hire six full time wildland firefighters (2 squad Bosses and 4 firefighters) at the Larimer County Sheriff's Office. Supplemented with an additional 4 seasonal firefighters in the summer months funded by grant monies if available. Currently the Initial Attack (IA) Module is solely grant funded and supplemented with on-call firefighters. The IA module has a turnover about every two years as people gain experience and then move to jobs in fire that are not as tenuous, creating a gap in skills and knowledge in the fire program. The on-call firefighter program fluctuates with availability, especially for initial attack. The IA Module's primary work is with County Parks and some Watershed coalitions working on hazardous wildfire fuels reduction and forest health projects. If there is no grant funding available, the IA module would be dissolved and needed mitigation work would not get done. Grant monies are getting harder to obtain. Vision would be to expand to 10 during the summer months funded with grants, allowing for 7-day coverage. Hazardous wildfire fuels reduced to sustain forest health, neighborhoods assessed for	**Larimer County Sheriff's Office,** Emergency Services County Fire Departments, OEM	$275,000	General fund, supplemented by grants if available	High	2021 initiate, ongoing into the future	New in 2021.

ID	Related Goal(s)	Hazard(s) Mitigated	Description	Lead Agency and Partners	Cost Estimate	Potential Funding	Priority	Timeline	Status and Implementation Notes
			needed work to increase survivability as well as evacuation route updates						
LC-15	Goals 1,2 Objectives 5	Wildfire, Utility Disruption	**Wildfire Communications Infrastructure Mitigation.** Create an assessment/inventory of communications infrastructure assets in wildfire prone areas of Larimer County and identify mitigation solutions based on risk	**Larimer OEM,** LCSO Emergency Services LETA 911, ARES	$100,000	TBD	Medium	2023	New in 2021.
LC-16	Goals 1,2,3,4 Objectives 1,2,4,5	Flooding: Flash flooding, (debris flow) post-fire flooding, riverine flooding	**River Restoration Projects.** As a result of flooding and wildfires in Larimer County since 2013, efforts still continue to conduct river restoration and subsequently forest restoration work for our watersheds. This effort seeks to identify projects in collaboration with local watershed coalitions including the Coalition for the Poudre River Watershed, the Big Thompson Watershed Coalition, and the Estes Valley Watershed Coalition where river restoration could occur that also minimize flood risk and impacts. This also includes outreach and education efforts to involve landowners and the public in understanding risk and being engaged in mitigation efforts	**Larimer OEM** BTWC, EVWC, CPRW, NoCo Fireshed Network	TBD, project specific	USFS, CSFS, CWCB, DOLA	High	2025	New in 2021.
LC-17	Goals 1,2,3,4 Objectives 1,4,5	Wildfire Risk (evacuation)	**Ingress & Egress Mapping and Solution Implementation.** There are many communities in Larimer County that have a single point of ingress and egress for the community, and many of these are in wildfire-prone communities. This project would be conducted in partnership with the LCSO to map these communities and subsequently identify and implement potential solutions to increase egress for residents.	**LCSO**, Larimer OEM LETA	TBD, project specific	TBD	High	2023	New in 2021.
LC-18	Goals 1,2,3 Objectives 4,5	Biological contagion	**Point of Distribution (POD) Planning.** The 2020 COVID-19 crisis has emphasized the need for more robust POD planning, especially when the entirety of the community may be in need of vaccination to minimize spread of disease. This type of effort requires a lot of collaboration between multiple	**Health and Environment** Larimer OEM, CDPHE, Hospital systems, CSU, Health District	TBD	CDPHE, CDC	High	2021	New in 2021.

ID	Related Goal(s)	Hazard(s) Mitigated	Description	Lead Agency and Partners	Cost Estimate	Potential Funding	Priority	Timeline	Status and Implementation Notes
			different agencies. This project would be to develop a comprehensive County-wide POD plan.						
LC-19	Goals 1,2,3 Objectives 4,5	Biological contagion	**Pandemic Plan.** The 2020 COVID-19 pandemic has illuminated the fact that much of the information and procedures outlined in the current Larimer County pandemic plan are outdated or are no longer feasible. This project would be to conduct a complete overhaul and re-development of the Larimer County Pandemic plan.	**LCDHE** Larimer OEM, LCSO, Hospital systems, Health District, CSU, CDPHE	TBD	CDPHE, CDC	High	2021	New in 2021.
LC-20	Goals 1,2,3 Objectives 4,5	Communication failure (Wildfire, Flood scenarios)	**HAM Radio Capacity Expansion.** In many of our rural unincorporated communities, communications infrastructure is very limited due to geography. Additionally, in many of our disasters, communications have broken down as a result of other systems failing (i.e. internet, cell, landline) but radio always tends to be an effective backup. We would like to work with local partners like the Amateur Radio Emergency Services and our LCSO office to implement HAM radio infrastructure at local fire districts in rural areas, to improve HAM radio infrastructure as needed to ensure connectivity and functionality, and to help train local citizens to be HAM radio operators so we have capacity within the mountain communities themselves to help assist with communications efforts.	**Larimer County OEM,** ARES, LCSO	$50,000, project specific	EMPG	High	2025	New in 2021.
LC-21	Goals 1,2,3 Objectives 4,5	Wildfire	**Big Thompson Watershed Forestry and Fuels Management.** Reducing high fuel loads in critical forested catchments in the Big Thompson Watershed, downstream of Olympus Dam. Collaborative planning and implementation of forest resilience/fuels reductions projects to reduce the negative impacts of wildfires. BTWC will work with partners, private landowners, funders, private contractors and volunteers to thin forests and manage fuels for up to 50 acres of high priority forests per year over the next 5 years.	**Big Thompson Watershed Coalition,** CPRW, EVWC, USFS, Larimer Co OEM, Larimer Co Sheriff, LFRA, CSFS, Northern Water, City of	$150,000 per year	CSFS, Northern Water, City of Fort Collins, CWCB, Peaks to People, other grants/municipal and water utilities investment	High	Goal of 50 acres set for every year over the next 5 years	New in 2021. Related to Action LC-3.

ID	Related Goal(s)	Hazard(s) Mitigated	Description	Lead Agency and Partners	Cost Estimate	Potential Funding	Priority	Timeline	Status and Implementation Notes
			Prioritizing the communities of Cedar Park/Storm Mountain and Glen Haven. Life, property, and water resource threatening wildfire.	Fort Collins, other partners					
LC-22	Goals 1,2,3,4 Objectives 1,2,4,5	Wildfire	**Big Thompson Forest Resilience and Wildfire Preparedness Outreach.** No Co Fireshed Network and other local collaborative networks are aiming to increase the consistency and accuracy of information sharing around forest health, resilience, management, and community preparedness for wildfire while expanding partnerships and capacity-leveraging across public-private sectors to increase the scale and pace of forest management and wildfire fuel reduction. Watershed Coalitions provide facilitation and communication between resource management partners and local communities within the watershed through one-on-one engagement opportunities, relationship building, and other resources that encourage on-the-ground participation. BTWC is developing its forestry program, emphasizing community outreach on forest health and wildfire fuel reduction through annual in-person and remote engagement opportunities, project partnership opportunities, and hard-copy resource distribution.	**Big Thompson Watershed Coalition (and other Coalitions)** USFS, CSFS, LFRA, CPRW, EVWC, and other partners as described in other forestry project submission	$20,000 per year	CWCB, USFS	High	Ongoing over the next 5 years	New in 2021.
LC-23	Goals 1,2,3,4 Objectives 1,2,4,5	Wildfire, Post Fire Flooding/ Erosion/ Damage	**NoCo Fireshed Collaborative - Stakeholder Planning, Engagement, & Implementation**. To mitigate against future high-intensity wildfires that impact communities and watershed resources, stakeholders (federal, state, local agencies, local nonprofits, and community organizations have been coordinating and planning landscape scale, cross-boundary forest management projects. These efforts are primarily geared to increasing the pace and scale of wildfire mitigation using prescribed fire. Additionally,	**CSU-CFRI,** CPRW, USFS-ARP, USFS-Rocky Mtn Research Station, The Nature Conservancy, Forest Stewards Guild, other watershed	$200,000+	USFS, other grants	High	10 years	New in 2021.

ID	Related Goal(s)	Hazard(s) Mitigated	Description	Lead Agency and Partners	Cost Estimate	Potential Funding	Priority	Timeline	Status and Implementation Notes
			this effort incorporates significant community outreach and engagement around these issues. In Larimer County, there are several implementation projects in various stages of planning/implementation, including Magic Feath Collaborative Burn, North Rim Rd, & South Fork/Jack's Gulch.	coalitions, other community groups					
LC-24	Goals 1,2,3,4,5 Objectives 1,3,4,5	Wildfire	**Long Term Wildfire Mitigation Strategy.** Documented in the Glen Haven VFD Community Wildfire Preparation Plan/Firewise Risk Assessment. This strategy is integrated with mitigation plans on public land by the USFS. It includes creation of fuel reduction zones, mitigation of escape routes, and property defensible space. Larimer County Sheriff's Office Emergency Services is assisting us with execution of this plan by sending a crew to perform mitigation work in Sept. and may continue to do so in the future. The remaining work will be conducted using volunteer labor.	**Glen Haven Area VFD,** Larimer County Sheriff's Office	TBD, project specific	Fireshed collaborative partners, CSFS, USFS, NRCS	High	2025	New in 2021.
LC-25	Goals 1,2,3,4,5 Objectives 3,4,5	Flood, Landslide/ Rockslide	**Wildfire Recovery and Restoration.** Larimer County has experienced multiple large wildfires in the last decade. The largest wildfire in County history occurred in August 2020 burning over 200,000 acres of USFS lands, Rocky Mountain National Park and county/private lands. This mitigation action is to assist in mitigating against future flooding, debris flows, and sediment flows from the burn scar. Values at risk include private residences, businesses, county and state critical infrastructure, roads and bridges.	**Larimer OEM**, USFS-ARP, CSU, CPRW, State of CO	$1,000,000	General Fund, BRIC, FEMA, CO Water Conservation Board, Division of Water Resources, other grants	High	2023	New in 2021
LC-26	Goals 1,2,3,4,5 Objectives 3,5	Drought, Extreme Temperatures, Flood, Severe Storm, Wind & Tornado, Public Health	**Implementation of Climate Smart Larimer Framework.** Climate change will continue to have impacts on our community and environment into the future and will exacerbate hazards and the risks associated with them (including such things as catastrophic wildfire potential, drought, infectious disease, severe storms, etc). Larimer	**Larimer County**, Fort Collins, CSU	TBD	TBD	Medium	2022	New in 2021

ID	Related Goal(s)	Hazard(s) Mitigated	Description	Lead Agency and Partners	Cost Estimate	Potential Funding	Priority	Timeline	Status and Implementation Notes
			County, along with several partners have drafted a framework to address climate change and have outlined different recommendations for strategies Larimer County can take for climate change mitigation and adaptation. Reduction of or adaptation to long-term climate change impacts including catastrophic wildfire potential, extreme heat conditions for the public, increased flood potential, etc. and the associated social, environmental, and economic impacts						
LC-27	Goals 2,3,5 Objectives 3,4,5	Wildfire, Flood	**Cameron Peak Wildfire Recovery.** Coordinate with LCSO, USFS, and other partners to identify and implement post-fire recovery and post-fire flooding mitigation projects as a result of the Cameron Peak Wildfire.	**Larimer OEM**	Unknown	HMGP, BRIC	High	2020-2021	New in 2021. This project is related to LC-25 above, but is specific to the more recent Cameron Peak fire and is more extensive due to the size of that fire.
LC-28	1, 3, 4	Dam Inundation	**Dam Non-failure Inundation Mapping to further identify flood risk and inform mitigation and response activities.** In 2020 the Colorado Division of Water Resources Dam Safety Branch was working to map non-failure inundation below 40 high hazard dams in Larimer County. The mapping represents where the potential areas of flooding where outlet capacity exceeds the downstream channel capacity. The mapping can be used to understand downstream flood risk by local emergency managers and planners.	**CO DWR Dam Safety Branch, Larimer County OEM,** City of Fort Collins, City of Loveland	$90,000	CO CWCB, Risk MAP	High	2020-2021	New in 2021. Project funded and in progress with anticipated completion in fall 2021.

7 PLAN IMPLEMENTATION AND MAINTENANCE

DMA Requirement §201.6(c)(4)(ii):
[The plan shall include] (i) A section describing the method and schedule of monitoring, evaluating, and updating the mitigation plan within a five-year cycle. *(ii) A process by which local governments incorporate the requirements of the mitigation plan into other planning 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.* *(iii) Discussion on how the community will continue public participation in the plan maintenance process.*

Having a solid plan for monitoring, evaluating, and updating the County's mitigation strategy is critical to maintaining its value and success. Ensuring effective implementation of mitigation activities paves the way for continued momentum in the planning process and gives direction for the future. This chapter provides an overview of the strategy for plan implementation and maintenance; outlines the method and schedule for monitoring, evaluating, and updating the plan; and explains who will be responsible for maintenance activities and what those responsibilities entail. The chapter also discusses incorporating the plan into other planning mechanisms and how to ensure continued public involvement in mitigation planning.

7.1 Implementation

Mitigation is most successful when it is incorporated into the day-to-day functions and priorities of government and development. Implementation will be accomplished through the routine actions of monitoring agendas, as well as attending meetings, and promoting a safe, sustainable community. Additional mitigation strategies could include consistent and ongoing enforcement of existing policies and vigilant review of programs for coordination and multi-objective opportunities.

Implementation will also be accomplished by adhering to the schedules identified for each mitigation action in Table 6-4 in Section 6 Mitigation Strategy, and through pervasive efforts to network and highlight the multi-objective, win-win benefits of each project to Larimer County and its jurisdictions and stakeholders. These efforts include the routine actions of monitoring agendas, attending meetings, and promoting a safe, sustainable community.

Simultaneously to these efforts, it is important to maintain a constant monitoring of funding opportunities that can be leveraged to implement some of the costlier recommended actions. This will include creating and maintaining a bank of ideas on how to meet local match or participation requirements, should grants be pursued; this will help ensure participating jurisdictions are in a position to capitalize on the opportunity when funding becomes available. Funding opportunities to be monitored include special pre- and post-disaster funds, special district budgeted funds, state and federal earmarked funds, and other grant programs, including those that can serve or support multi-objective applications.

7.1.1 Implementation and Maintenance of the 2016 Plan

In general, the County has made considerable progress on the implementation of the plan, and on decreasing the County's vulnerability to hazards. The 2016 Plan included a process for implementation and maintenance of the plan, which was generally followed. The 2016 Plan stated that the Planning Team would conduct a bi-annual review with participating jurisdictions of all mitigation actions included in the 2016 Mitigation Strategy. Over the past five years, the Planning Team has met five times during the County's annual All-Risk Summit with all agencies.

The status of mitigation actions and success stories are captured in Chapter 6. The 2016 Plan also discussed a number of strategies that Larimer County and its jurisdictions would use to integrate the plan into other planning mechanisms and processes. Larimer County's implementation strategy included:

- The Larimer County Office of Emergency Management will be the lead agency for the plan and the follow up. Meetings will occur at least once every six months to check in on mitigation actions and determine next steps.
  - The Planning Team determined that meeting annually was sufficient.
- The Larimer County Office of Emergency Management has standing public meetings with the Board of Commissioners on key projects and will ensure the HMP is reviewed and updated during these meetings.
  - This was accomplished. OEM meets with the BCC quarterly and regularly reviewed status updates on mitigation plan.
- We will update our hazard mitigation codes in the Land Use, Wildfire and Building Code documents.
  - This was accomplished through the formal code review process and approved by the BCC and Land Use Committee.

Additional ways in which the County incorporated information from the 2016 HMP into other plans and processes include:

- The 2016 HMP is referenced in the 2019 Larimer County Comprehensive Plan: "High risk hazard areas (wildfire, flood, geologic, and soils) affect current and future land uses. As part of the comprehensive planning process, questions relating to regulating development in known high hazards areas were vetted to help reduce or minimize impacts on the built environment and reduce the liability to taxpayers who subsidize those who chose to build in hazard-prone areas. The Comprehensive Plan also helps fulfill two land-use related mitigation projects identified in the HMP: 1) A long-range community planning effort to bring together all watershed coalition, governmental and non-governmental plans into one unified planning effort, and 2) an update to the Larimer County Land Use, Wildfire and Building Codes with recommendations to decrease future risk and disaster losses."
- The Larimer Community Resiliency Framework, completed in 2016, references the 2016 HMP as a source of hazards information and recommended mitigation actions.
- The Larimer County Emergency Operations Plan (EOP) was last updated in 2018; hazards and vulnerability information from the HMP was used to inform the EOP update by ensuring processes and procedures were consistent across multiple hazards.
- Local Emergency Managers meet monthly to coordinate and report out on status. All ES agencies meet once a year in an All-Risk Summit. City of FC may have additional info for the CRS requirements.

The jurisdictional annexes include additional information on how they incorporated the 2016 HMP into other planning mechanisms and processes, as well as their plans to continue this integration with the 2021 Plan.

7.1.2 Role of the Planning Team and Floodplain Management Steering Committee in Implementation and Maintenance

With adoption of this plan Larimer County and its participating jurisdictions will be tasked with plan implementation and maintenance. This will be accomplished by keeping the Planning Team and FMSC active throughout the lifecycle of the plan. The participating jurisdictions agree to:

- Act as a forum for hazard mitigation issues,

- Disseminate hazard mitigation ideas and activities to all participants,
- Pursue the implementation of high-priority, low/no-cost recommended actions,
- Keep the concept of mitigation in the forefront of community decision making by identifying plan recommendations when other community goals, plans, and activities overlap, influence, or directly affect increased community vulnerability to disasters,
- Maintain a monitoring of multi-objective cost-share opportunities to help the community implement the plan's recommended actions for which no current funding exists,
- Monitor and assist in implementation and update of this plan,
- Report on plan progress and recommended changes to the County Commissioners, City/Town Councils, governing boards, and other partners, and
- Inform and solicit input from the public.

Other duties include reviewing and promoting mitigation proposals, considering stakeholder concerns about hazard mitigation, passing concerns on to appropriate entities, and posting relevant information on the County and jurisdiction websites, in the local newspaper, and on social media. Other Larimer County communities not participating in this plan may nevertheless be integrated into mitigation implementation where possible.

7.2 Plan Maintenance

The Larimer County Hazard Mitigation Plan is a living document that may be adjusted or updated as conditions change, actions progress, or new information becomes available. This section describes the method and schedule the participating jurisdictions will follow for monitoring, evaluating, and updating the Plan over the next five years. Each participating jurisdiction will follow the process and schedule described below, unless they have made modifications to the process and schedule as detailed in that jurisdiction's Annex.

7.2.1 Monitoring

Monitoring refers to tracking the implementation of the plan over time. Larimer County OEM will be responsible for reaching out to lead and supporting agencies identified in the Mitigation Actions table for status on those mitigation actions. OEM will also coordinate with Planning Team and FMSC members at least annually to identify and track any significant changes in their agencies' mitigation efforts.

Larimer County OEM will use the following process to track progress, note changes in vulnerabilities, and consider changes in priorities as a result of project implementation:

- A representative from the responsible entity identified in each mitigation action will be responsible for tracking and reporting to the Planning Team when project status changes. The representative will provide input on whether the project as implemented meets the defined goals and objectives, and is likely to be successful in reducing vulnerabilities.
- If the project does not meet identified goals and objectives, the Planning Team may select alternative projects for implementation.
- Projects that were not ranked high priority but were identified as potential mitigation strategies will be reviewed periodically to determine feasibility of future implementation.
- New mitigation projects identified will require an individual assigned to be responsible for defining the project scope, implementing the project, monitoring success of the project.
- Mitigation activities not identified as actions in this plan will also be tracked to ensure a comprehensive hazard mitigation program, and to assist with future updates.

7.2.2 Evaluation

Evaluating refers to assessing the effectiveness of the plan at achieving its stated purpose and goals. Evaluation of progress can be achieved by monitoring changes in vulnerabilities identified in the plan, such as:

- Decreased vulnerability because of implementing recommended actions,
- Increased vulnerability because of failed or ineffective mitigation actions, and/or
- Increased vulnerability because of new development (and/or annexation).

The Planning Team will meet quarterly to evaluate the implementation of the plan and consider any changes in priorities that may be warranted. Larimer County OEM will coordinate with all participating jurisdictions to facilitate an effective maintenance and implementation process. Completed projects will be evaluated to determine how they have reduced vulnerability. Changes will be made to the plan to accommodate for projects that have failed or are not considered feasible after a review for their consistency with established criteria, the time frame, priorities, and/or funding resources.

7.2.3 Updates

The Larimer County Hazard Mitigation Plan will be reviewed and revised at least once every five years in accordance with the DMA 2000 requirements and latest FEMA and DHSEM hazard mitigation planning guidance. Updates to this plan will consider:

- Has the nature or magnitude of hazards affecting the County changed?
- Are there new hazards that have the potential to impact the County?
- Have growth and development changed the County's vulnerabilities?
- Do the identified goals and actions still address current and expected conditions?
- Have mitigation actions been implemented or completed?
- Has the implementation of identified mitigation actions resulted in expected outcomes?
- Are current resources adequate to implement the plan?
- Should additional local resources be committed to address identified hazards?
- The updated plan will document success stories where mitigation efforts have proven effective, as well as areas where mitigation actions were not effective, and will include re-adoption by all participating entities following DHSEM/FEMA approval.

7.3 Integration Into Other Planning Mechanisms

Another important implementation mechanism that is highly effective and low-cost is the incorporation of the hazard mitigation plan recommendations and their underlying principles into other jurisdictional plans and mechanisms. Mitigation is most successful when it is incorporated into the day-to-day functions and priorities of government and development. The mitigation plan can be considered as the hub of a wheel with spokes radiating out to other related planning mechanisms that will build from the information and recommendations contained herein. Properly implemented, the HMP should serve as one of the foundational documents of the jurisdictions' emergency management programs, since everything emergency management does should relate back in one way or another to the hazards the jurisdiction faces.

As stated in Section 7.1 above, implementation through existing plans and/or programs is recommended wherever possible. Based on this Plan's capability assessment and progress made on mitigation actions noted in Chapters 5 and 6, the participating jurisdictions continue to implement policies and programs to reduce losses to life and property from natural and human-caused hazards. The Planning Team will be responsible for integrating the data, goals and objectives, and other elements of this Plan into other plans, as appropriate.

The following sections provide some guidance on how Larimer County may use the updated HMP to inform and improve other plans, procedures, and programs. The jurisdictional annexes include additional information on how they will incorporate the updated HMP into their planning mechanisms and processes.

7.3.1 Comprehensive Plans

Integrating hazard mitigation into the jurisdiction's comprehensive or general plan is considered a best practice by both FEMA and the American Planning Association. The Larimer County Comprehensive Plan was last updated in 2019, and included hazards information from the 2016 HMP, as described in 7.1.1 above. Larimer County OEM will work with the County Planning Department to ensure that hazards data and mitigation goals and objectives inform the next Comprehensive Plan update.

7.3.2 Threat and Hazard Identification and Risk Assessment (THIRA)

Larimer County has completed a County-level Threat and Hazard Identification and Risk Assessment (THIRA). CPG201 "Threat and Hazard Identification and Risk Assessment (THIRA) establishes Step 1 as "Identify the Threats and Hazards of Concern" and lists HIRAs and HMPs as possible sources of threat/hazard information.

The criteria for selecting which Threats/Hazards are "of concern" are defined as:

- Factor #1: Likelihood of a Threat or Hazard Affecting a Community
- Factor #2: The Impacts of a Threat or Hazard

Each natural and human-caused hazard profiled in the HIRA (Section 4) contains a section analyzing the probability of future events, which provides a data-driven answer to Factor #1. Similarly, the vulnerability assessment section of the hazard profiles address what impacts can realistically be expected from both routine and extreme events of each hazard, which specifically addresses Factor #2.

Step 2 of CPG 201 is to "Give the Threats and Hazards Context" by creating a scenario for each hazard of concern, with specifics like time of day, area, and magnitude of the event, which are then used to establish capability targets for each of the 32 core capabilities. All the hazards profiled in the HIRA contain detailed information to ensure the hazard scenarios are plausible. For some hazards, such as flood or earthquake, detailed Hazus modeling runs have been done that can easily be incorporated as THIRA scenarios. Other hazards include details on the most extreme historical events on record that can quickly be updated to modern scenarios.

7.3.3 Response Plans

The Larimer County Emergency Operations Plan (EOP) was last updated in 2018. While the EOP is an all hazards document, it also contains hazard-specific information and concerns. Hazard information from this HMP update will be incorporated into the next EOP update. At a minimum, all high significance hazards identified in this Plan should be addressed in future EOP updates.

Several other operational or functional response plans are also influenced by information contained in the HMP. These plans include but are not limited to:

- Damage Assessment Plan: A review of the vulnerability and estimated losses detailed in the hazard profiles can help identify what areas to initially prioritize following a hazard event. Similarly, a review of Section 4.2 Asset Summary can help identify what critical facilities need to be assessed following a hazard event.

- Debris Management Plan: HAZUS runs conducted for earthquake and flood scenarios include an estimate of how many tons of debris would likely be generated by those scenarios. These estimates can be used as bounding limits for how much and what type of debris generation is likely to be required, as well as what areas are most likely to see heavy debris generations.
- Evacuation & Sheltering Plan: A review of the vulnerability and estimated losses detailed in the hazard profiles can help identify what areas are more likely to need evacuation in different hazard scenarios. The Community Profile in Section 2 can help identify not only how many people would potentially be impacted by disasters, but how many are likely to need assistance with transportation, special medical or sheltering needs, etc. This review can also help evaluate the impacts of multiple or cascading hazards, so that evacuees are not relocated into an area that puts them at risk from other hazards.

7.3.4 Recovery Plan

The Larimer County Recovery Plan was last updated in 2018. The risk and vulnerability data in the HMP should help inform the pre- and post-disaster recovery planning process, especially by ensuring that the recovery elements of those plans fully consider the dangers posed by other hazards, rather than focusing exclusively on the most recent hazard event. The HMP in turn will be revisited during recovery to help identify opportunities to incorporate mitigation in the recovery and rebuilding process, including maximizing FEMA PA and HMGP funding where applicable.

The FEMA publication "Pre-Disaster Recovery Planning Guide for State Governments" notes:

> *"…much of the research involved in the development of mitigation plans can be used to inform the pre-disaster recovery planning effort.*
>
> *"The pre-disaster recovery planning process will benefit from and build upon hazard mitigation as:*
>
> - *The mitigation planning process identifies local hazards, risks, exposures, and vulnerabilities;*
> - *Implementation of mitigation policies and strategies will reduce the likelihood or degree of disaster-related damage, decreasing demand on resources post-disaster;*
> - *The process will identify potential solutions to future anticipated community problems; and*
> - *Mitigation activities will increase public awareness of the need for disaster preparedness.*
>
> *"Pre-disaster recovery planning efforts also increase resilience by:*
>
> - *Establishing partnerships, organizational structures, communication resources, and access to resources that promote a more rapid and inclusive recovery process;*
> - *Describing how hazard mitigation will underlie all considerations for reinvestment;*
> - *Laying out a process for implementation of activities that will increase resilience; and*
> - *Increasing awareness of resilience as an important consideration in all community activities."*

At the time of this plan update, Larimer County is creating a post-disaster recovery plan for the COVID-19 pandemic and is considering creating one for the Cameron Peak Fire. The information in this HMP will be consulted to help inform those plans.

7.3.5 Resiliency Framework

The terms mitigation and resiliency are often used interchangeably, but while both relate to reducing the impacts of disasters and other stresses, they approach the subject from two different directions. The Larimer Community Resiliency Framework, adopted in 2016, describes this distinction:

> "This Framework is not a hazard mitigation plan. It is not intended to provide an exhaustive review of all the shocks and stresses that might impact the community, but instead is intended to broaden understanding of shocks and stresses and how they have impacts across many aspects of the community."

> "[R]esiliency addresses vulnerability arising from both acute shocks and latent stresses. A resilient community is one that thrives in good times and bad. Hence, resiliency planning necessarily addresses a broader array of issues than traditional hazard mitigation planning. For example, hazard mitigation may help reduce the flood exposure of a neighborhood while resiliency planning recognizes that disparate conditions in that neighborhood, whether due to poverty, illness, language barriers, or other underlying factors, create and exacerbate negative outcomes before, during, and after a hazard event occurs."

The Larimer Community Resiliency Framework is currently being updated in a parallel planning process to this HMP update. Information from the 2021 HMP, including hazards data, social vulnerability information, and proposed mitigation activities, are being used to inform that update, and vice-versa.

7.3.6 Continuity of Operations Plans (COOP)

All departments and agencies of Larimer County government are required to maintain a Continuity Of Operations Plan (COOP) that details that agency's critical functions and how they will protect those functions in order to continue to provide essential services during a disaster or interruption. By defining and describing the hazards facing the County, including frequency and severity, the HIRA informs agency COOP plans by giving context to what types of disasters of interruptions are most likely to occur. Critical facilities and assets located in hazard areas in Section 4.2 should be prioritized for COOP planning.

7.3.7 Training and Exercise Plan

Training on hazard mitigation principles and procedures should be included in the County's training and exercise planning. Any training and exercise needs identified in the Capabilities Assessment (Section 5) and Mitigation Strategy (Section 5) should also be included in the County's training and exercise planning.

7.3.8 Public Awareness and Education Programs

The County's ongoing public education and outreach efforts should reflect the hazards and vulnerabilities described in this Plan. In addition to preparing for disasters, public education should include ways in which the public can reduce their vulnerability to natural and human caused hazards. Furthermore, mitigation activities and success stories should be communicated to the public to show the benefits of effective mitigation planning.

7.3.9 Critical Infrastructure Protection Plan

Critical facilities and assets identified in Section 4.2 should be included in Critical Infrastructure Protection Planning (CIPP), with prioritization given to assets located in hazard-prone areas. Hazardous materials facilities in particular should be viewed both as critical assets in need of protection, and as potential hazards in their own right.

7.3.10 Capital Improvements Plan

Many of the mitigation actions listed in the Mitigation Strategy (Section 6.4.2) came from the County's Capital Improvements Plan, and thus have already been identified for funding. Other high-dollar actions listed or identified in the future can also be added to the Capital Improvements Plan to ensure that hazard mitigation projects continue to receive funding. The prioritization of actions listed in Table 6-4, while not binding on capital improvement planning, can be used to inform the prioritization of those actions. Even projects for which the County intends to seek grant funding may also need to be addressed in the Capital Improvements Plan, given that most mitigation grants require significant local matching funds.

7.3.11 Sustainability Plans

Sustainability is a separate area of concern from hazard mitigation, but there are areas where the two fields overlap and influence one another positively or negatively.

Sustainability plans should be reviewed to identify where there may be synergy between sustainability and mitigation/resiliency. For example, sustainability efforts aimed at increasing County's adaptability to climate change can also make the County more resilient to drought and severe weather. Increasing the percentage of food obtained locally could make the County more resilient to supply-chain interruptions or the impacts of disasters in other states. Adding more trees and grass to urban areas to reduce the heat island effect could help mitigate the impact of extreme weather events, as well as reducing flood risk by increasing the amount of permeable surfaces. This may help raise the priority of some sustainability efforts, as well as suggest complimentary mitigation efforts.

It is equally important to identify areas where sustainability efforts may work to reduce the County's resilience to hazards. For example, a sustainability goal of promoting use of public transit and reducing private car ownership could potentially make it harder to evacuate the public during a disaster if public transit is damaged and offline (as was observed during Hurricane Sandy). Similarly, reduced production of solid waste could lead to a reduction in the number of public resources such as dump trucks, which means that in a disaster those resources would not be available for debris removal and similar tasks. The intent of this review is not to say that sustainability goals should not be pursued, but rather to identify areas of concern that should be considered during implementation of these goals. For example, evacuation plans may need to be revised to reflect a larger percentage of families without cars; or contracts may need to be put in place to obtain additional dump trucks in a disaster.

At the time of this plan update, Larimer County has completed the initial draft of the Climate Smart Larimer Framework, which outlines recommendations and strategies for climate change adaptation and mitigation. The current Hazard Mitigation Plan has been drafted in parallel with this framework to ensure that the two plans complement one another, and that strategies and actions align.

7.4 Continued Public Involvement

Continued public involvement is also imperative to the overall success of the Plan's implementation. This updated HMP will be posted on the County's website for reference and can be used to help inform the County's ongoing public education and outreach program, such as the completion of mitigation actions that reduce the community's vulnerability, can be shared with the public through forums like the Local Emergency Planning Committee (LEPC), public meetings, public preparedness and resilience trainings, and through social media. This helps keep the concept of hazard mitigation alive and helps show the public that their government officials are working to keep them safe.

The update process provides an opportunity to publicize success stories from the Plan implementation and seek additional public comment. When the Planning Team reconvenes for the five-year plan update, they will coordinate with all stakeholders participating in the planning process—including those that joined the committee since the planning process began—to update and revise the plan. The plan maintenance and update process will include continued public and stakeholder involvement and input through participation in designated committee meetings, surveys, web postings, and press releases to local media.