Item #5b

MEMORANDUM

TO: Mayor Jones and Members of the Board

FROM: Karen Proctor, Town Administrator

DATE: January 21, 2021

RE: Resolution 2021-03 Adopting the Arapahoe County Hazard Mitigation Plan

BACKGROUND:

The following jurisdictions, in conjunction with Arapahoe County, Colorado, have prepared this 2020 update of the Arapahoe County Hazard Mitigation Plan (HMP).

- Arapahoe County
- Town of Bennett
- Town of Bow Mar
- City of Centennial
- City of Cherry Hills Village
- Town of Deer Trail
- City of Englewood
- Town of Foxfield
- City of Glendale
- City of Greenwood Village
- City of Littleton
- City of Sheridan
- Denver Water

(The City of Aurora, part of which is located in Arapahoe County, has developed and maintains its own hazard mitigation plan.)

The purpose of hazard mitigation is to reduce or eliminate long-term risk to people and property from disasters or hazardous 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. The Federal Emergency Management Agency (FEMA) requires that hazard mitigation plans be updated every five years for the jurisdictions to be eligible for federal mitigation assistance. All sections of the 2015 Arapahoe County Hazard Mitigation Plan were reviewed and updated to address natural and human-caused hazards for the purpose of saving lives and reducing losses from future disasters or hazard events.

This Plan will serve as a blueprint for coordinating and implementing hazard mitigation policies, programs, and projects in Arapahoe County. It provides a list of mitigation goals and related actions that may assist Arapahoe County and its municipalities in reducing risk and preventing loss from future hazard events. The impacts of hazards can often be lessened or even avoided if appropriate actions are taken before events occur. By reducing exposure to known hazard risks, communities will save lives and property and minimize the social, economic, and environmental disruptions that commonly follow hazard events.

This Plan was also developed to maintain Arapahoe County's and participating jurisdictions' 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 (HHPD) grant program.

The Plan is organized into six sections:

Section 1 contains the Plan Introduction and Executive Summary.

Section 2 Community Profile describes the planning area, consisting of Arapahoe County and the participating jurisdictions listed above, with updated information on demographics, social vulnerability, and changes in development. It includes an assessment of programs and policies currently in place across the County to reduce hazard impacts or that could be used to implement hazard mitigation activities, and identifies opportunities to enhance those capabilities.

Section 3 Planning Process describes the process followed to update the Plan. A broad range of public and private stakeholders, including agencies, local businesses, nonprofits, and other interested parties were invited to participate. Public input was sought throughout the planning process including online surveys and public review of the draft Plan.

Section 4 Hazard Identification and Risk Assessment identifies the natural and human-caused hazards of greatest concern to the County, and describes the risk from those hazards. The information generated through the risk assessment helps communities to prioritize and focus their efforts on those hazards of greatest concern and those assets or areas facing the greatest risk(s). The best available information on the impacts of changing weather conditions were taken into account for each hazard. The hazards profiled in the 2020 Plan and their assessed significance by jurisdiction are shown in the following table.

Hazard	Arapahoe County	Bennett	Bow Mar	Centennial	Cherry Hills Village	Columbine Valley	Deer Trail	Englewood	Foxfield	Glendale	Greenwood Village	Littleton	Sheridan	Denver Water	
Active Threat	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Med	Low	Low	
Cyber Threat	Med	Med	Med	Med	Med	Med	Med	Med	Med	Med	Med	High	Med	Med	
Dam Failure	Med	Low	High	Low	Low	High	Low	Med	Low	High	Low	Med	High	Med	
Drought	Med	Med	Med	Med	Med	Med	Med	Med	Med	Med	Med	Med	Med	Med	
Flooding	Med	Med	Med	High	Med	Med	Med	High	Med	Med	Med	Med	Med	Med	
Hazmat Release	Med	Med	Low	Med	Med	Low	Med	High	Low	Low	Med	Med	Med	Med	
Pandemic	High	High	High	High	High	High	High	High	High	High	High	High	High	High	
Severe Summer Weather	High	High	High	High	High	High	High	High	High	High	High	High	High	High	
Severe Wind/ Tornado	Med	High	Med	Med	Med	Med	High	Med	Med	Med	Med	Med	Med	Med	
Severe Winter Weather	High	High	High	High	High	High	High	High	High	High	High	High	High	High	
Wildfire	Med	Med	Med	Med	Med	Med	Med	Low	Med	Med	Med	Med	Low	Med	

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

Section 6 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.

It is important that local decision makers stay involved in mitigation planning to provide new ideas and insight for future updates to the Arapahoe County Hazard Mitigation Plan. It is our long-term goal that the Hazard Mitigation Plan and the mitigation strategies identified within will be fully integrated into daily decisions and routines of local government. This will continue to require dedication and hard work, and to this end, this Plan update continues efforts to further strengthen the resiliency of Arapahoe County.

RECOMMENDED MOTION:
"I move to approve Resolution 2021-03 Adopting the Arapahoe County Hazard Mitigation Plan"

ATTACHMENTS:
Exhibit A: Resolution 2021-03 Adopting the Arapahoe County Hazard Mitigation Plan
Exhibit B: Arapahoe County Hazard Mitigation Plan

Exhibit A

Trustee's Resolution Resolution No 03, Series 2021

A RESOLUTION ADOPTING THE ARAPAHOE COUNTY HAZARD MITIGATION PLAN FOR THE TOWN OF FOXFIELD, COLORADO

WHEREAS, Arapahoe County, with the assistance from the Town of Foxfield, has gathered information and prepared the Arapahoe County Hazard Mitigation Plan;

WHEREAS, the Arapahoe County Hazard Mitigation Plan has been prepared in accordance with FEMA requirements at 44 C.F.R. 201.6;

WHEREAS, Arapahoe County has afforded the citizens an opportunity to comment and provide input in the Plan and the actions in the Plan; and

WHEREAS, The Town of Foxfield has reviewed the Plan and affirms that the Plan will be updated no less than every five years.

BE IT RESOLVED BY THE BOARD OF TRUSTEES OF THE TOWN OF FOXFIELD, COLORADO, adopts the Arapahoe County Hazard Mitigation Plan as this jurisdiction's Multi-Hazard Mitigation Plan, and resolves to execute the actions in the Plan.

DATED, at the Town of Foxfield, Colorado, this _____ day of _____2021.

_____
Lisa Jones, Mayor

ATTEST:

_____
Randi Gallivan, CMC
Town Clerk

_____
COREY Y. HOFFMANN
City Attorney

Exhibit B

ARAPAHOE COUNTY
COLORADO'S FIRST

Arapahoe County Hazard Mitigation Plan

Final Draft for FEMA Review

December 2020

Arapahoe County, Colorado

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1. Introduction and Executive Summary

Arapahoe County has been and will continue to be committed to a long-term strategy for reducing the risks of hazards.

The following jurisdictions, in conjunction with Arapahoe County, Colorado, have prepared this 2020 update of the Arapahoe County Hazard Mitigation Plan (HMP).

- Arapahoe County
- Town of Bennett
- Town of Bow Mar
- City of Centennial
- City of Cherry Hills Village
- Town of Deer Trail
- City of Englewood
- Town of Foxfield
- City of Glendale
- City of Greenwood Village
- City of Littleton
- City of Sheridan
- Denver Water

(The City of Aurora, part of which is located in Arapahoe County, has developed and maintains its own hazard mitigation plan.)

The purpose of hazard mitigation is to reduce or eliminate long-term risk to people and property from disasters or hazardous 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. This updated Plan is the result of the continued effort from stakeholders, partners, and districts to complete a document that updates the 2015 Arapahoe County Hazard Mitigation Plan. The Federal Emergency Management Agency (FEMA) requires that local hazard mitigation plans be updated every five years for the jurisdictions to be eligible for federal mitigation assistance. All sections of the 2015 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 Arapahoe County with the expressed purpose of saving lives and reducing future losses in anticipation of future events.

This plan will serve as a blueprint for coordinating and implementing hazard mitigation policies, programs, and projects in Arapahoe County. It provides a list of mitigation goals and related actions that may assist Arapahoe County and its municipalities in reducing risk and preventing loss from future hazardous events. The impacts of hazards can be lessened and sometimes avoided altogether if appropriate actions are taken before hazardous events occur. By avoiding unnecessary exposure to known hazard risks, communities will save lives and property and minimize the social, economic, and environmental disruptions that commonly follow hazardous events. Arapahoe County and its municipalities agree that hazard mitigation makes sense.

This plan was also developed to maintain Arapahoe County's and participating jurisdictions' 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 (HHPD) grant program.

Arapahoe County is vulnerable to a wide range of natural and human-caused hazards, such as flooding, severe storms, wildfire, earthquakes, hazardous materials incidents, cyber attacks, and other hazards. Working through the cycle of hazard mitigation can help ensure that those vulnerabilities will not increase over time. Encouraging acquisition, relocation, or retrofitting of existing vulnerable structures, along with the protection of valuable natural resources, are steps that can be taken to further decrease those vulnerabilities.

Communities face significant challenges during post-disaster redevelopment in balancing the immediate needs associated with rapid recovery with the implementation of long-term hazard mitigation strategies. The necessity to meet basic needs and resettle displaced populations immediately following a disaster often overshadows the more abstract, longer-term sustainability considerations. Once full-scale reconstruction is initiated, it is difficult to modify projects in progress to meet sustainability objectives. This trend highlights the need for pre-disaster mitigation planning that incorporates principles of sustainable development into the reconstruction context, so that communities can more easily rebuild in a manner that will make them less vulnerable to future hazard events while improving quality of life.

It is imperative that local decision makers become and stay involved in this planning process to provide new ideas and insight for future updates to the Arapahoe County Hazard Mitigation Plan. Arapahoe County will continue to update this plan as mitigation techniques are implemented. It is critical that all local agencies, units of government, non-profit organizations, businesses and industries, and private citizens continue their involvement and dedication to hazard mitigation.

It is our long-term goal that the Hazard Mitigation Plan and the mitigation strategies identified within will be fully integrated into daily decisions and routines of local government. This will continue to require dedication and hard work, and to this end, this Plan update continues efforts to further strengthen the sustainability of Arapahoe County.

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2. Community Profile

Not only is Arapahoe County Colorado's first county, it is also one of the largest counties in the state. The City of Denver was the original county seat until 1902 when the city split off and became a separate county. The City of Littleton became the new Arapahoe County seat and remains the county seat today.

2.1 Geography

Arapahoe County, located in the South Denver Metro area, spans 809 square miles. A land of diverse ecosystems and communities, the western reaches of the county are primarily urban, with residential, retail, office, and industrial development. The eastern area of Arapahoe County consists of primarily agricultural and rural development.

Major state highways cross the county from east to west (I-70, US Highway 36, and US Highway 40). The Union Pacific Railroad also passes through the county at the west edge and runs parallel to I-70 before it exits at the eastern border of the county. Several petroleum lines intersect the county. This includes an interstate high pressure gas line that runs diagonally through the county. Eastern Arapahoe County is home to multiple high pressure gas and gas by-product underground lines. The companies of ownership include:

- Colorado Interstate Gas
- ConocoPhillips Pipeline, Colorado
- NuStar Logistics
- DCP Midstream
- Rocky Mountain Pipeline System, LLC

The Arapahoe County base map shown in Figure 2-1 and Figure 2-2 provides an overview of the geographic area of the county, including prominent features such as municipalities and major highways.

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Figure 2-1 Map of Western Arapahoe County

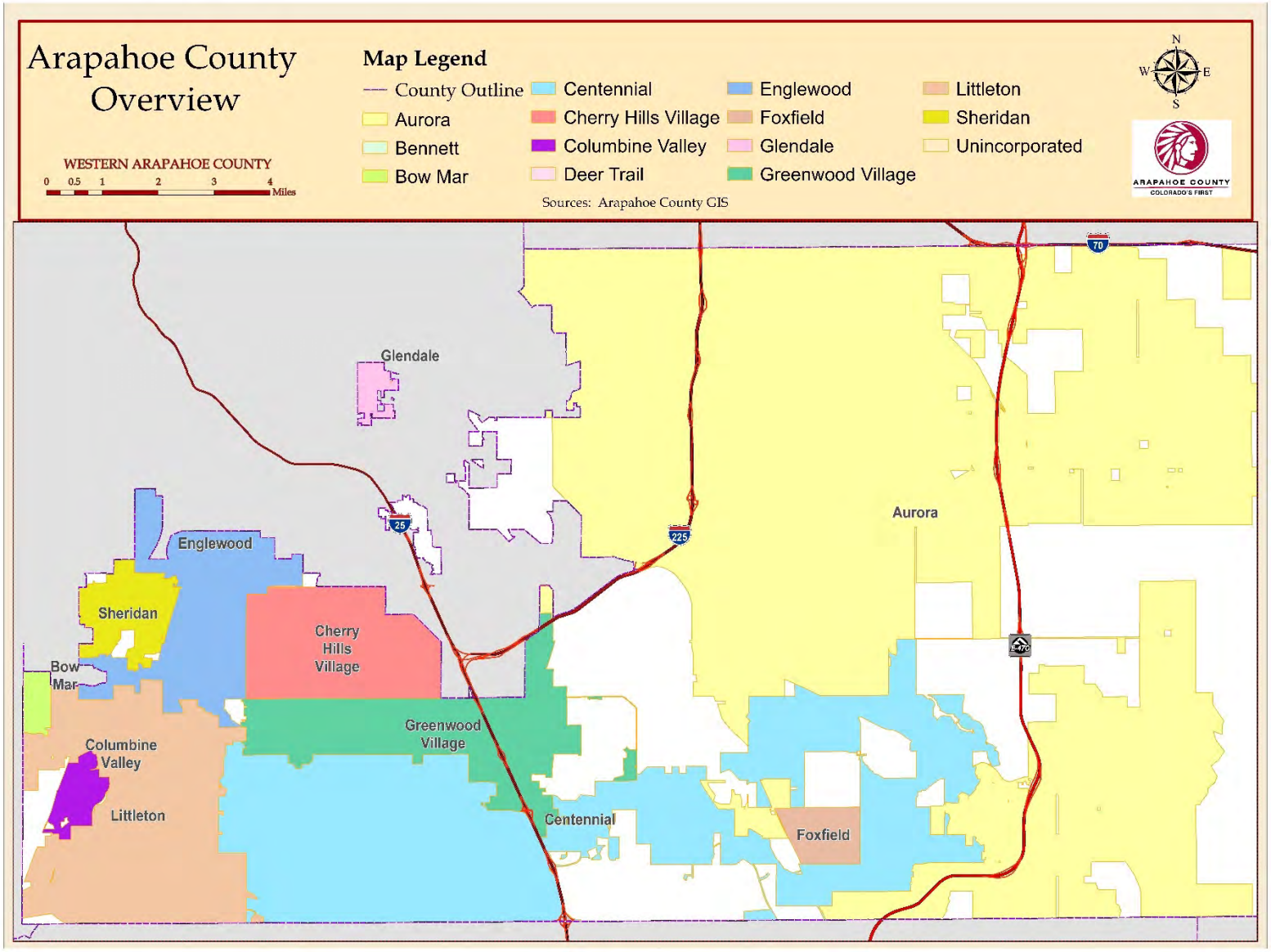
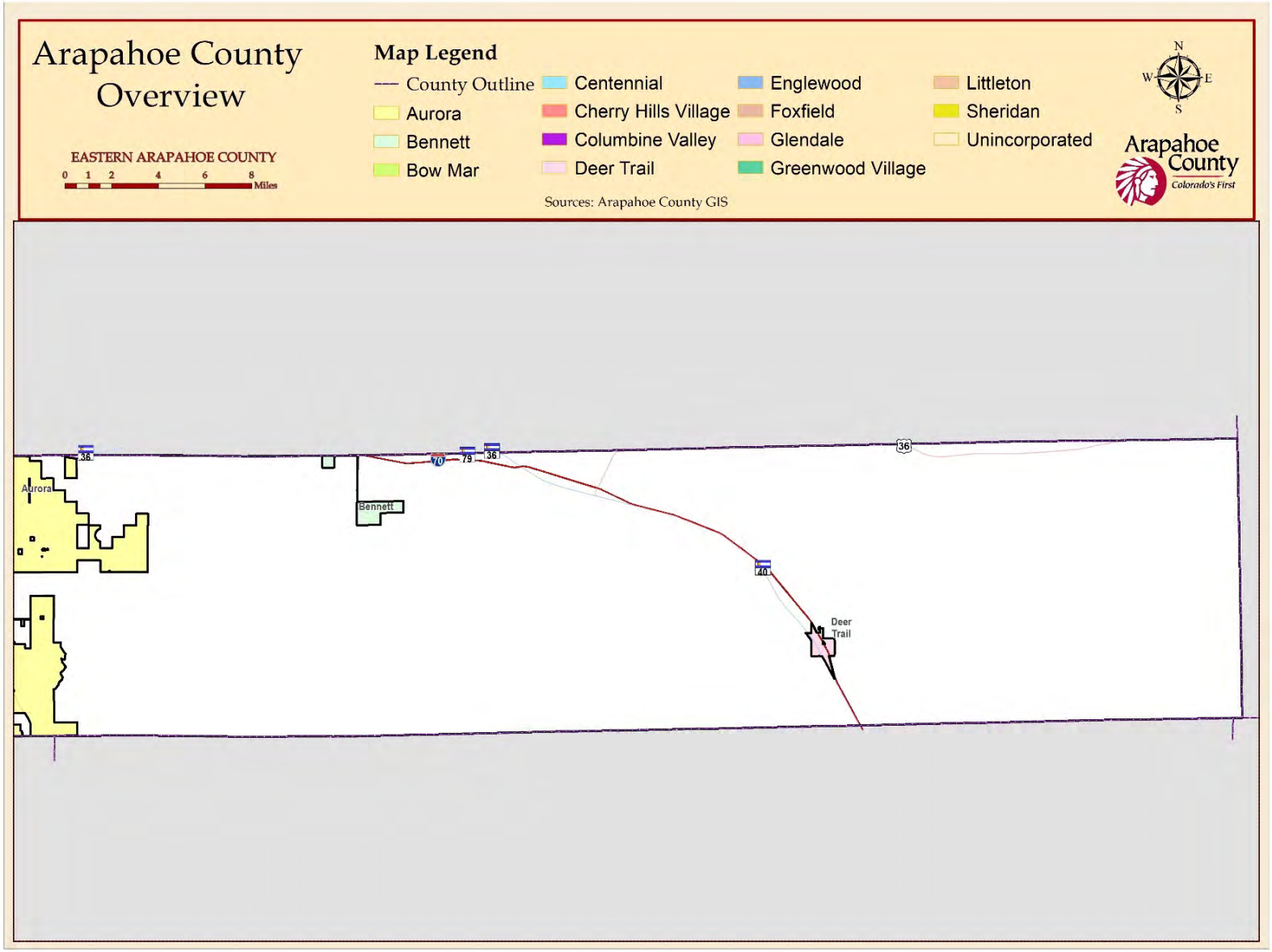


Figure 2-2 Map of Eastern Arapahoe County



2.2 Cities and Communities

Thirteen incorporated cities and towns are wholly or partially located in Arapahoe County:

- City of Aurora (part in Adams and Douglas Counties)
- Town of Bennett (part in Adams County)
- Town of Bow Mar (part in Jefferson County)
- City of Centennial
- City of Cherry Hills Village
- Town of Columbine Valley
- Town of Deer Trail
- City of Englewood
- Town of Foxfield
- City of Glendale
- City of Greenwood Village
- City of Littleton (part in Douglas and Jefferson Counties)
- City of Sheridan

Arapahoe County also includes the following census-designated communities:

- Byers
- Strasburg
- Watkins

The City and County of Denver, acting by and through its Board of Water Commissioners, commonly known as "Denver Water" provides water to governmental entities outside the City and County of Denver by contract. As the primary water provider throughout most of Arapahoe County, Denver Water took part in this Plan update as a participating jurisdiction. However because their service area is countywide, they are not broken out as such in the demographic data presented below.

2.3 Demographics

Arapahoe County is the third most populated county in Colorado (behind Denver and El Paso Counties). According to the Colorado Division of Local Government, State Demography Office and data from the U.S. Census Bureau's 2014-2018 American Community Survey (ACS) 5-Year Estimates, the estimated population of Arapahoe County in 2018 was 636,671. This constitutes a 5% increase in population since 2015 (608,310). Table 2-1 below lists population estimates for each jurisdiction and shows how they have changed in the last five years. For simplicity, the city and town populations include their entire jurisdictions, not just the portion within Arapahoe County. Most jurisdictions experienced a positive change in population growth in the past five years, except for three communities: Bow Mar, Deer Trail, and Foxfield.

Table 2-2 show several key demographic and social characteristics of Arapahoe County and how those characteristics compare to the rest of the state and nation.

Table 2-1 Population in Arapahoe County, 2015 - 2018

	Total Population				% Change
	2015	2016	2017	2018	
Unincorporated County	608,310	617,688	626,612	636,671	5%
Aurora	345,867	351,131	357,323	363,550	5%
Bennett	1,915	2,097	2,291	2,202	15%
Bow Mar	1,045	1,047	950	893	-15%
Centennial	106,604	107,862	108,448	109,505	3%
Cherry Hills Village	6,329	6,414	6,542	6,600	4%
Columbine Valley	1,164	1,190	1,165	1,221	5%
Deer Trail	573	522	479	478	-17%
Englewood	31,877	32,523	33,155	33,820	6%
Foxfield	683	732	710	636	-7%
Glendale	4,744	4,905	5,027	5,170	9%
Greenwood Village	14,920	15,208	15,397	15,677	5%
Littleton	44,553	45,072	45,848	47,035	6%
Sheridan	5,912	5,965	6,018	6,056	2%

Source: Census Bureau, American Community Survey 5-Year Estimates 2010-2015, 2011-2016, 2013-2017, 2014-2018

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

Select Demographic & Social Characteristics	County	Colorado	U.S.
Median Age	36.5	36.6	37.9
Housing Occupancy Rate	95.6%	89.8%	87.8%
% of Housing Units with no Vehicles Available	5%	5.2%	8.7%
Median Home Value	$327,800	$313,600	$204,900
Median Household Income	$73,925	$68,811	$60,293
Per Capita Income	$38,972	$36,415	$32,621
% of Individuals Below Poverty Level	9.0%	10.9%	14.1%
% Without Health Insurance	8.2%	8.1%	9.4%
% of Population Over 25 with High School Diploma	92.4%	91.4%	87.7%
% of Population Over 25 with bachelor's degree or Higher	43.8%	40.1%	31.5%
% with Disability	9%	10.6%	12.6%
% Limited English-Speaking Households	4.5%	2.8%	4.4%

Source: Census Bureau, American Community Survey 5-Year Estimates, 2014-2018

The following tables compare demographic characteristics for each jurisdiction in Arapahoe County. As above, the city and town populations include their entire jurisdictions, not just the portion within Arapahoe County. The County numbers reflect all of Arapahoe County, including those portions of the municipalities that fall within the County.

Table 2-3 Demographic Characteristics in Arapahoe County by Jurisdiction

	County	Aurora	Bennett	Bow Mar	Centennial	Cherry Hills Village	Columbine Valley	Deer Trail	Englewood	Foxfield	Glendale	Greenwood Village	Littleton	Sheridan
Total Population	636,671	363,550	2,202	893	109,505	6,600	1,221	478	33,820	636	5,170	15,677	47,035	6,056
Gender/Age														
Male	49.4%	49%	53%	50.8%	50.9%	48.8%	51%	44.6%	49.8%	49.4%	57.8%	48.9%	48%	53.2%
Female	50.6%	51%	47%	49.2%	49.1%	51.2%	49%	55.4%	50.2%	50.6%	42.2%	51.1%	52%	46.8%
Median Age (value)	36.5	33.6	40.4	46.9	39.4	46.4	55	45.9	36.2	55.8	30.4	43.1	40.9	36.3
Under 5 years	6.4%	7.8%	5.9%	3.1%	6.1%	5.5%	1.7%	4.6%	5.8%	4.6%	2.8%	3.1%	4.8%	8.3%
65 years and over	12.3%	10%	14.4%	17.7%	14.4%	17.5%	26.6%	15.9%	13.4%	29.1%	3.9%	16.4%	17.2%	15%
% of Population with Disability	9%	9.8%	11.9%	4.8%	7.3%	7.3%	8%	26.2%	12.9%	8.1%	5.6%	5.3%	10.5%	13.5%
Race/Ethnicity														
White	60.7%	46.3%	83.9%	89.6%	75%	93.7%	97.6%	87.9%	76.8%	85.2%	62%	80.6%	79.7%	62.1%
American Indian/ Alaska Native	0.4%	0.4%	1.3%	1.1%	0.3%	0.5%	0%	0.4%	0.2%	0%	0.3%	0.1%	0.3%	0.2%
Asian	5.8%	5.2%	1%	1.1%	6%	1.8%	0.2%	0%	1%	5%	5.7%	9.7%	2.3%	1.6%
Black or African American	10.3%	15.3%	0.5%	0%	3.2%	0.5%	0.8%	1.5%	2.4%	4.4%	7.6%	2.4%	2.1%	2.3%
Hawaiian or Pacific Islander	0.2%	0.3%	0%	0%	0.1%	0%	0%	0%	0%	0%	0.9%	0%	0%	0%
Other Race	0.3%	10.7%	3.1%	0%	0.2%	0%	0%	0%	0%	0.2%	0%	0.1%	0%	0.1%
More Than One Race	3.3%	0.1%	4.1%	3.0%	3.4%	0.9%	0.4%	0.8%	2.7%	0%	3.6%	2.1%	2.2%	1.2%

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	County	Aurora	Bennett	Bow Mar	Centennial	Cherry Hills Village	Columbine Valley	Deer Trail	Englewood	Foxfield	Glendale	Greenwood Village	Littleton	Sheridan
Hispanic or Latinx (of any race)	19.1%	28.8%	9.1%	5.2%	11.9%	2.6%	1%	9.4%	16.9%	5.2%	19.9%	95%	13.4%	32.5%
Education														
High school graduate or higher (% of Total >25 years old Population)	92.4%	87.1%	92.3%	97.3%	96.8%	100%	98.9%	95.6%	90.2%	97.8%	89.7%	99%	94.1%	87.9%
% Limited English-Speaking Households	4.5%	7.9%	0%	0%	1.3%	0%	0.4%	0%	2.9%	1.2%	2.6%	0.8%	1.4%	4.4%

Source: Census Bureau, American Community Survey 5-Year Estimates, 2014-2018

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The following tables compare housing characteristics across jurisdictions in Arapahoe County.

Table 2-4 Comparison of Housing Tenure in Arapahoe County

	County	Aurora	Bennett	Bow Mar	Centennial	Cherry Hills Village	Columbine Valley	Deer Trail	Englewood	Foxfield	Glendale	Greenwood Village	Littleton	Sheridan
Total Housing Units	248,618	133,940	830	294	40,690	2,328	489	252	16,280	276	3,271	6,953	20,938	2,850
# Occupied Housing Units	237,559	128,182	814	294	39,701	2,159	473	196	15,258	246	3,014	6,273	20,043	2,733
% Owner-Occupied	63.1%	59%	77.1%	95.9%	84.9%	95.2%	96%	69.9%	49.5%	94.7%	8.6%	66.7%	59.6%	54.2%
% Renter-Occupied	36.9%	41%	22.9%	4.1%	15.1%	4.8%	4%	30.1%	50.5%	5.3%	91.4%	33.3%	40.4%	45.8%
% of Rental Households paying 35% or more of income	42.5%	45.3%	29.1%	37.5%	26.2%	9.6%	0%	21.2%	45.4%	18.2%	43.4%	32%	39.9%	46.6%

Source: Census Bureau, American Community Survey 5-Year Estimates, 2014-2018

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

	County	Aurora	Bennett	Bow Mar	Centennial	Cherry Hills Village	Columbine Valley	Deer Trail	Englewood	Foxfield	Glendale	Greenwood Village	Littleton	Sheridan
Total housing units	248,618	133,940	830	294	41,432	2,328	489	252	16,280	276	3,271	6,953	20,938	2,850
1-unit detached	56.1%	51.4%	82.3%	100%	76.5%	98.4%	93.5%	70.2%	53.9%	100%	2%	54.7%	49.2%	44.7%
1-unit attached	10.1%	11.8%	1.3%	0%	10.1%	0.8%	6.5%	7.5%	5.7%	0%	3.8%	8.2%	9.5%	1.5%
2 units	0.8%	1.0%	0%	0%	0%	0%	0%	0%	1.5%	0%	1.5%	0.7%	0.8%	2.2%
3 or 4 units	2.7%	3.8%	1.7%	0%	1.1%	0%	0%	1.2%	2.4%	0%	1.5%	2.2%	2.0%	2.9%
5 to 9 units	5.8%	6.9%	1.9%	0%	2.8%	0.4%	0%	0%	3.7%	0%	7.9%	4.2%	7.5%	2.4%
10 to 19 units	9.3%	10.4%	0%	0%	3.8%	0%	0%	2.8%	6.5%	0%	15.3%	6.6%	10.8%	10%
20 or more units	14.1%	12.8%	6.1%	0%	5%	0.3%	0%	0%	24.6%	0%	68.1%	23.3%	17.9%	19.1%
Mobile home	1.0%	1.9%	6.6%	0%	0.6%	0%	0%	18.3%	1.5%	0%	0%	0%	2.2%	10.3%
Boat, RV, van, etc.	0.1%	0.1%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	6.8%

Source: Census Bureau, American Community Survey 5-Year Estimates, 2014-2018

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Housing Tenure: Percentage of Owner- vs. Renter- Occupied Housing Units

Homeownership as a community resilience indicator is a measure of a community's economic strength. A high number of homeowners can reflect an individual's connection to a community, place attachment, and ownership of their community. Conversely, low levels of homeownership can be an indication of a fluctuating local economy and may indicate a population with less than long-term commitment to the local community, which according to FEMA could hamper implementation of both individual and community mitigation actions before a disaster as well as during recovery periods.

The county has an average homeownership of 63.1%, which is just below the national average of is 64%. Eight jurisdictions have a higher percentage of homeownership compared to both the county's average and the national average; five of those jurisdictions have over 90% of occupied units being owner occupied. Conversely, five jurisdictions have a lower than average percentage of homeownership. Two jurisdictions, Glendale (91%) and Englewood (51%), have a higher percentage of renter-occupied homes compared to owner-occupied.

Housing Type

As shown in Table 2-5, the dominant housing type in Arapahoe County is 1-unit detached or single family homes. A majority of jurisdictions have more than 50% of the housing units as single family housing, with the exception of Littleton (49%), Sheridan (45%) and Glendale (2%) which have a higher percentage of multi-unit homes compared to the county average. Glendale also has the higher percentage of housing with 20 or more units, which would likely correspond to the high percentage of renter-occupied homes.

Other housing types such as mobile homes are considered to be a vulnerable housing type due to generally lower quality of construction and the lack of basements. Higher number of mobile homes are related to lower levels of resilience in a community due to the home's susceptibility to damage from natural hazards. The county has an average of 1% of mobile homes as total housings; six jurisdictions have a greater percentage of mobile homes compared to the county average. Deer Trail (18%) and Sheridan (10%) have the highest percentage of mobile homes as total housing stock in the county.

Figure 2-3 and Figure 2-4 show population densities across Arapahoe County. Figure 2-5 and Figure 2-6 show population growth in the county from 2010 to 2018.

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Figure 2-3 Map of Population Density in Western Arapahoe County

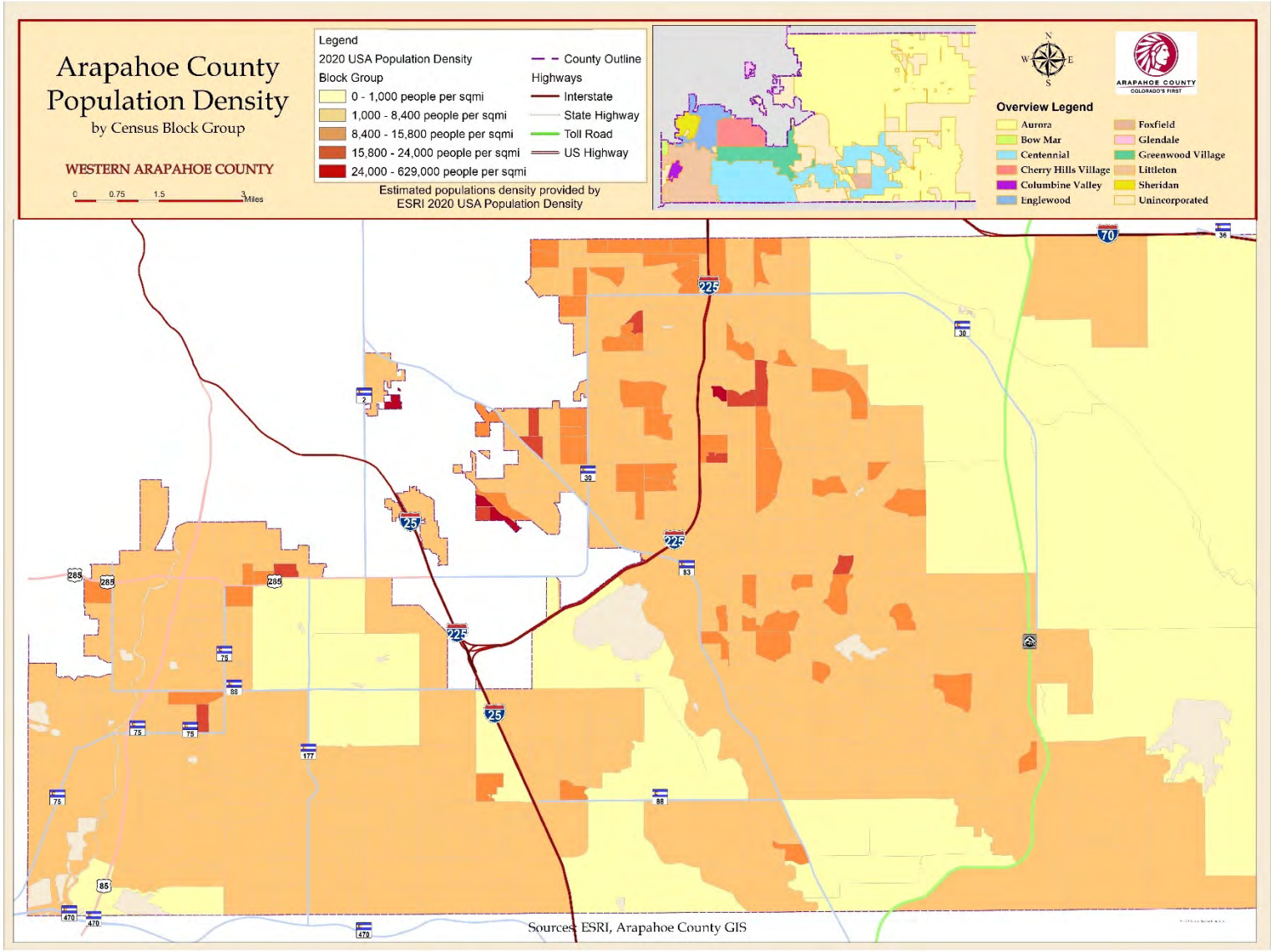


Figure 2-4 Map of Population Density in Eastern Arapahoe

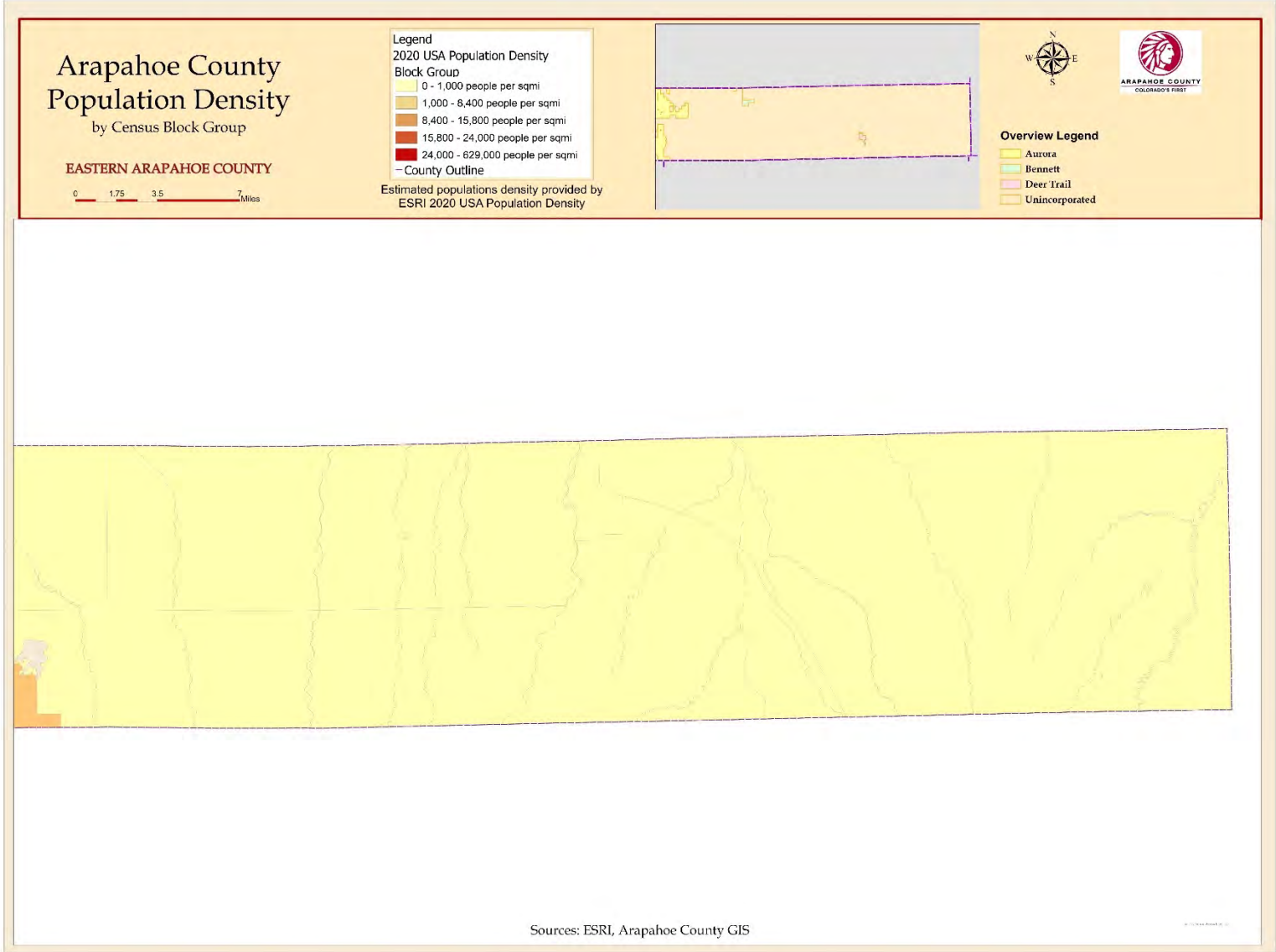


Figure 2-5 Map of Population Growth in Western Arapahoe County, 2010-2018

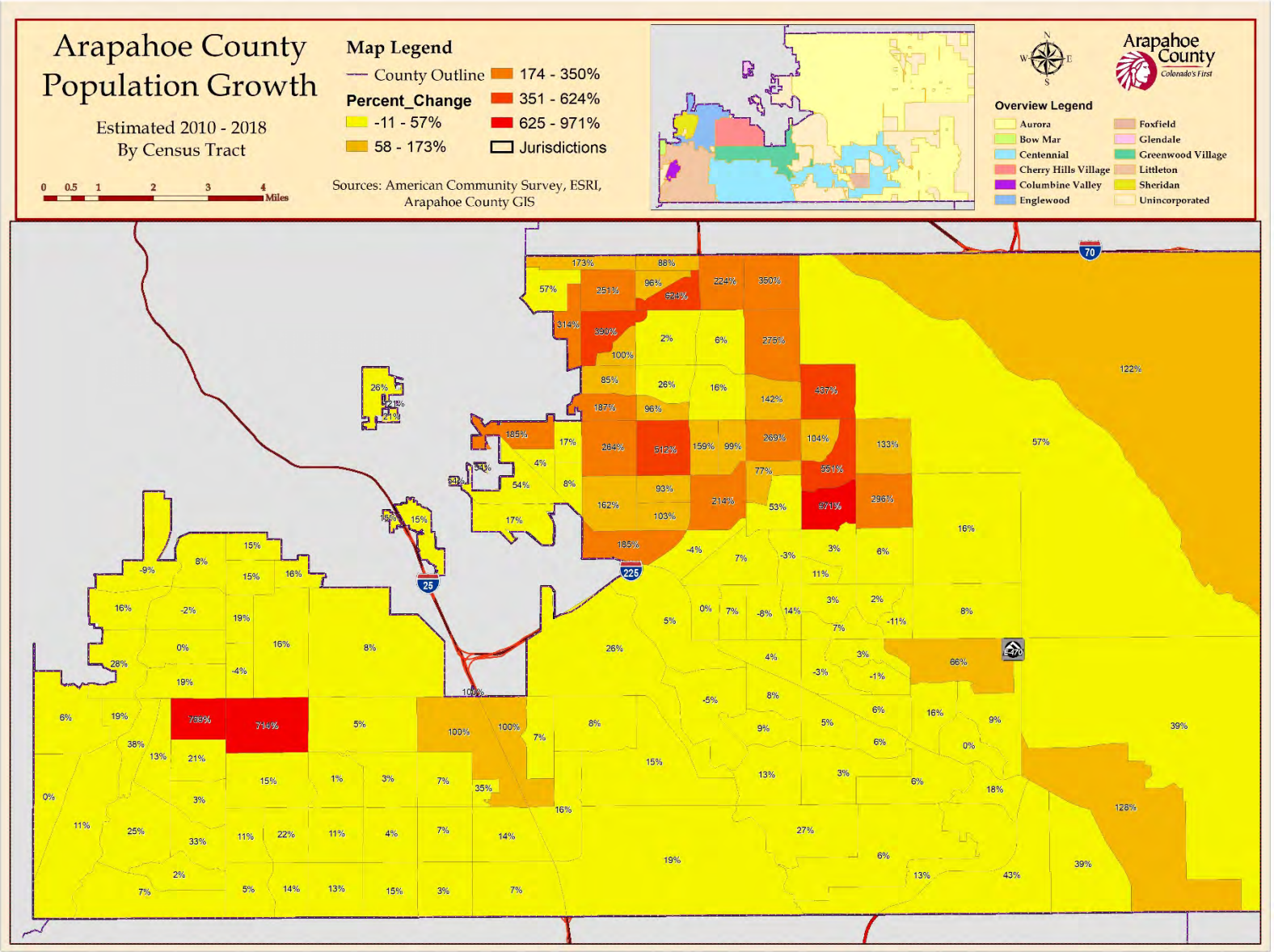
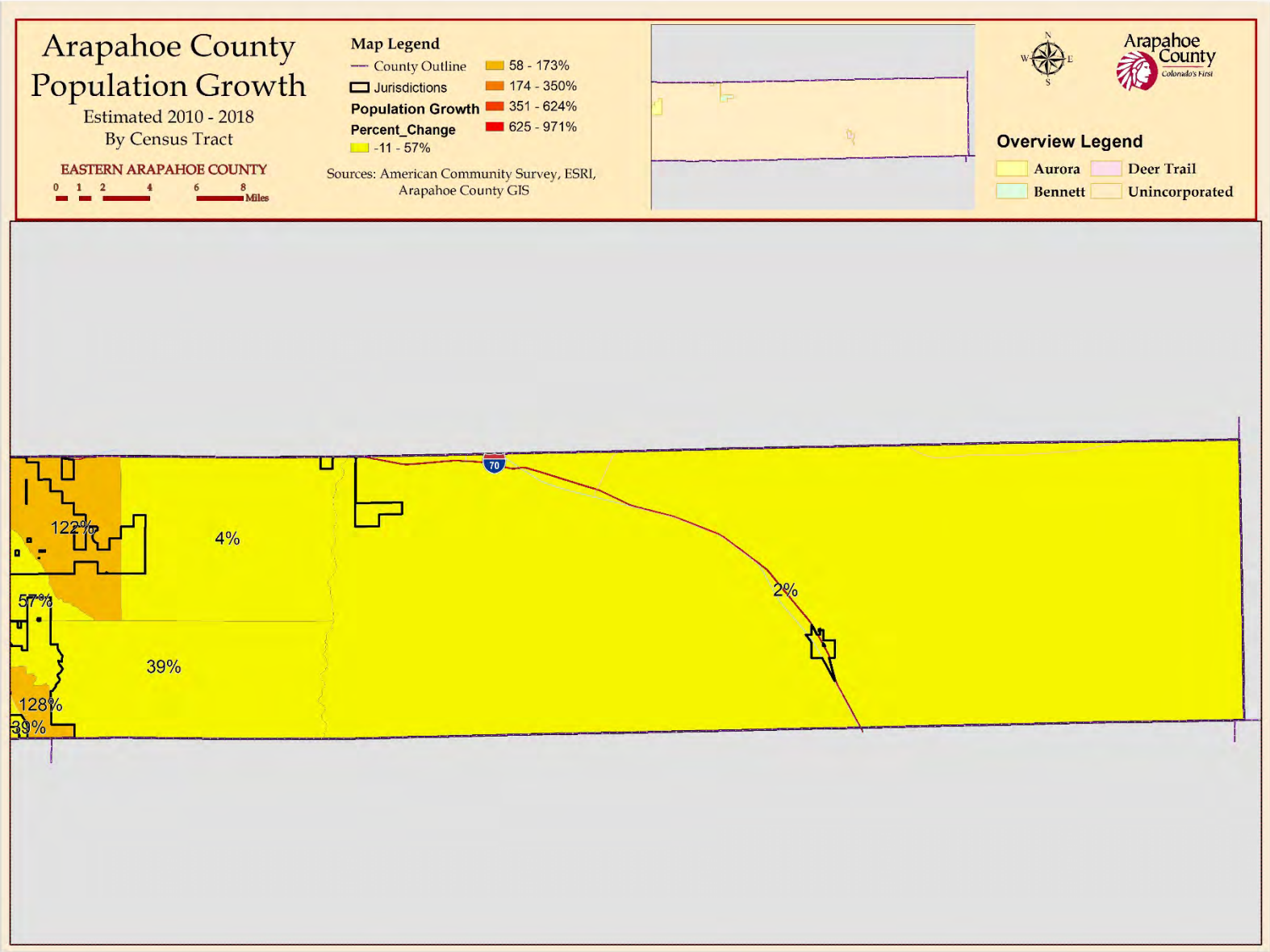


Figure 2-6 Map of Population Growth in Eastern Arapahoe County, 2010-2018



2.4 Social Vulnerability

Local vulnerability to disasters depends on more than the relationship between a place and its exposure to hazards. 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.

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. A number of pre-existing social and economic characteristics contribute to social vulnerability. Very often, the impacts of hazards fall disproportionately on the most disadvantaged or marginalized people in a community – the poor, children, the elderly, the disabled, and minorities. During emergencies, for example, self-evacuation can be nearly impossible for disabled or institutionalized individuals. 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 2015 Plan integrated social vulnerability into the hazard risk analysis 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 2020 Plan. 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 can 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 at 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 Arapahoe County compares to other counties in Colorado and nationally. The rankings show the percentage of counties that Arapahoe County is more vulnerable than, i.e. – high numbers are worse.

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Table 2-6 Social Vulnerability in Arapahoe County

Theme	Variable	Ranking Compared to Colorado Counties	Ranking Compared to US Counties	Vulnerability
Socioeconomic status		29%	10%	Low
	Below poverty	24%	13%	Low
	Unemployment	46%	31%	Below Average
	Income	19%	51%	Above Average
	No high school diploma	43%	17%	Low
Household composition and disability		48%	14%	Low
	Age 65 or older	16%	7%	Low
	Age 17 or younger	78%	74%	Above Average
	Disability	22%	3%	Low
	Single-parent households	79%	59%	Above Average
Minority status and language		84%	89%	High
	Minority	81%	80%	High
	Speaking English “less than well”	81%	89%	High
Housing and transportation		46%	36%	Below Average
	Multiunit structures	90%	99%	High
	Mobile homes	3%	4%	Low
	Crowding	70%	74%	Above Average
	No vehicle	62%	37%	Below Average
	Group quarters	29%	12%	Low
Overall Social Vulnerability		49%	27%	Below Average

The data shows that Arapahoe County’s social vulnerability is below average overall compared to both the state and the nation. However, the county’s vulnerability is high or above average in the following areas:

- Percentage of racial minorities, who historically are hardest hit by disasters.
- Percentage of people who speak English “less than well,” complicating disaster communications.
- Multi-unit housing (defined as more than 10 units per structure), which are more difficult to evacuate during emergencies.
- Lower per capita income, which can make it difficult to both prepare on an individual level before an emergency as well as the ability to recover after an event.
- Percentage of individuals age 17 or younger that are more likely to require financial support, transportation or assistance with daily activities during emergencies.
- Percentage of single-parent households, which tend to have lower socioeconomic status and fewer sources of social support
- Crowding in housing can make it more difficult to evacuate during emergencies.

Figure 2-7 through Figure 2-8 display the SoVI data for Arapahoe 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.

Social vulnerability analysis is particularly useful in the context of hazard mitigation planning because it can reveal disparities within a community that make a difference when it comes to the ability of residents to mitigate, prepare, evacuate, mobilize resources, and recover from disasters. Areas on the map that have medium to high social vulnerability represent areas where age, poverty, race/ethnicity, or special needs factors may make it more difficult for people to prepare, respond, and recover from hazard events. Social vulnerability information can also be used to help communities design effective and appropriate local risk communication and hazard mitigation outreach activities.

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Figure 2-7 Western Arapahoe County Overall Social Vulnerability

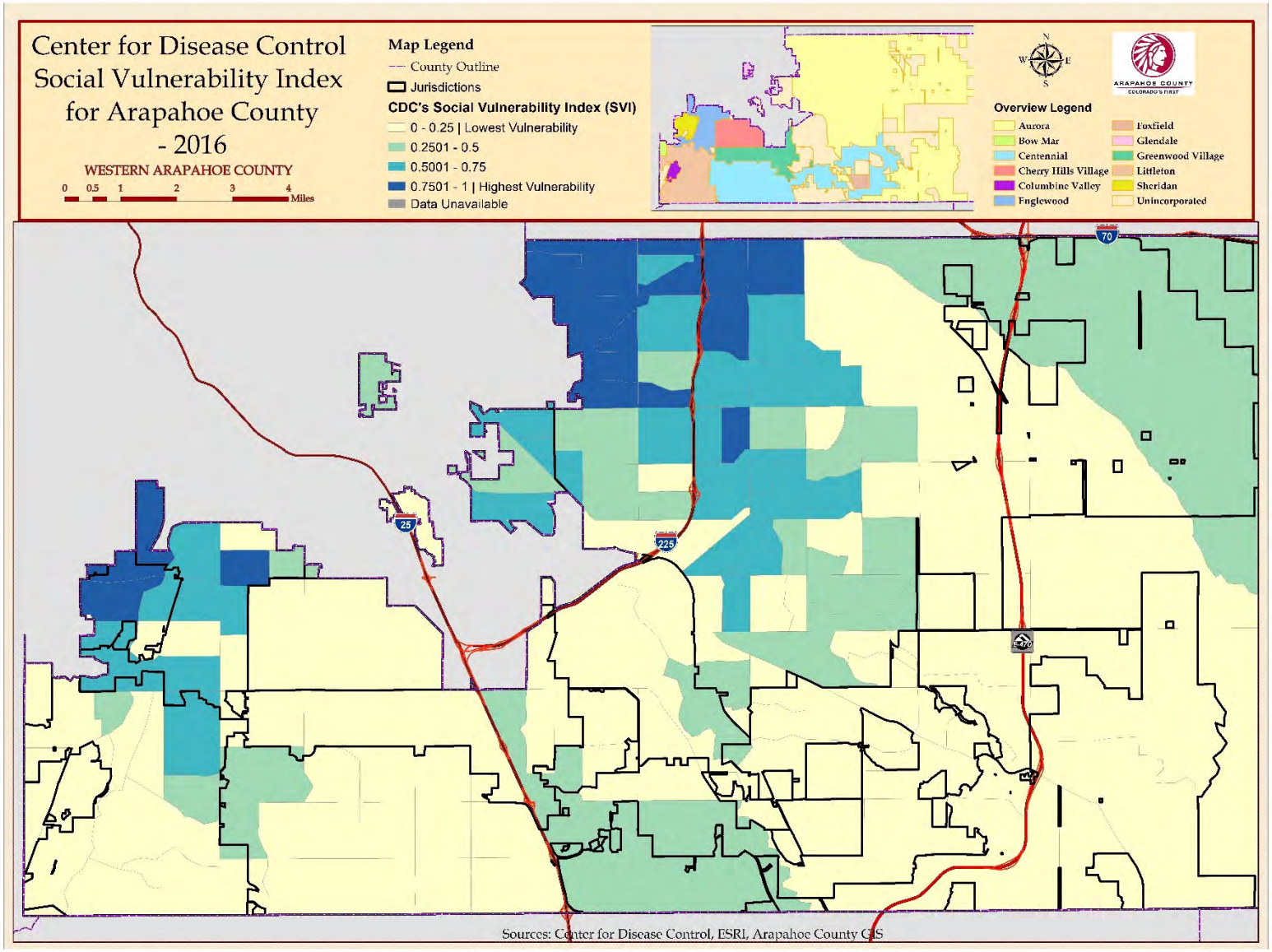
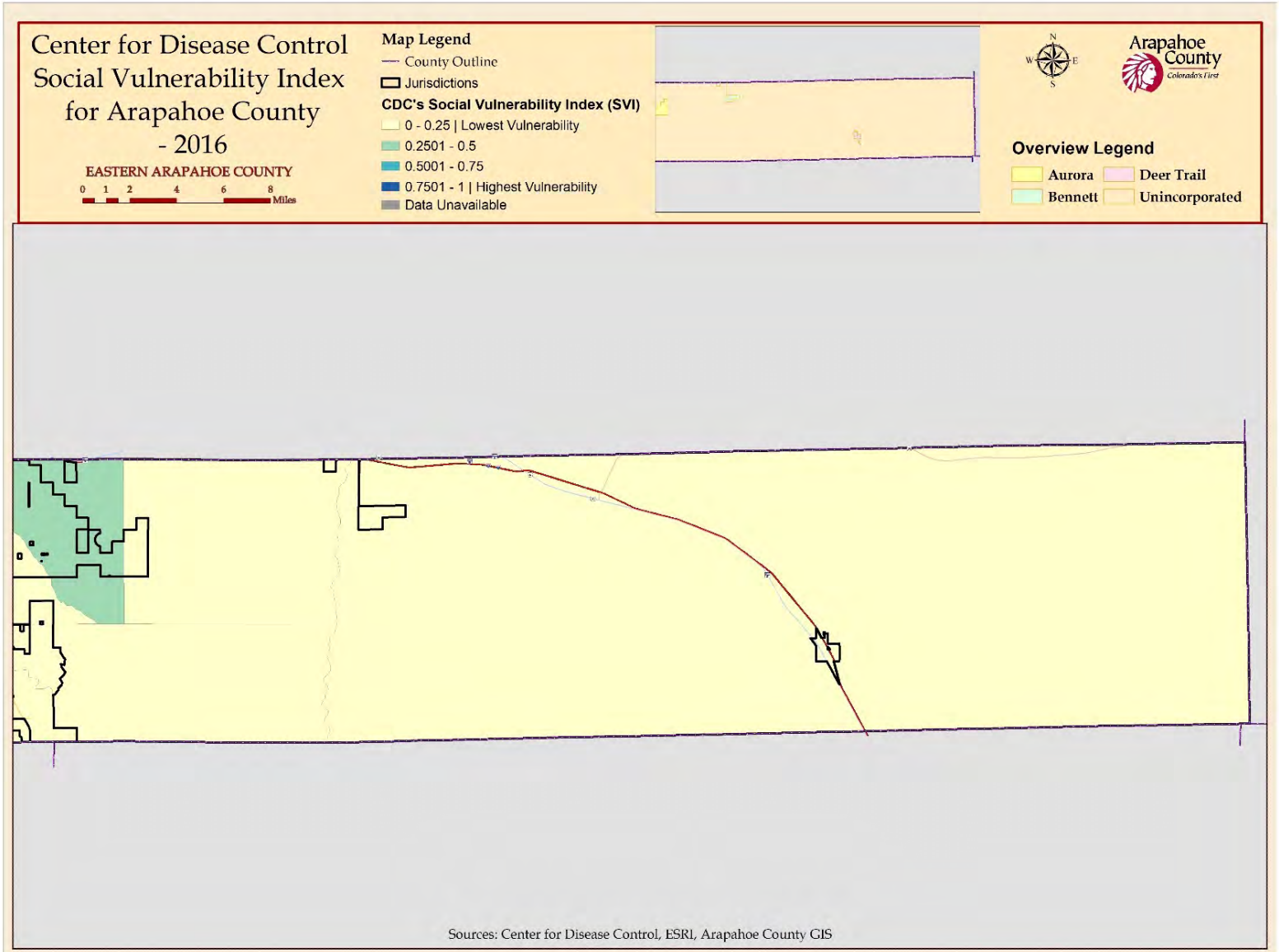


Figure 2-8 Eastern Arapahoe County Overall Social Vulnerability



Age – Percentage of Population Age 65 years and Older

Elderly individuals are often more vulnerable to the impacts of a disaster event due to generally being less mobile and can find it more difficult to prepare for disasters and adapt to extreme circumstances. Individuals over 65 years older often require assistance from other individuals that may not be available during a disaster event. Seniors are more likely to have some form of disability (see below), and many live in some form of group housing such as nursing homes or similar facilities. The national average of individuals age 65 years and older is 15% of the population. Arapahoe County has an average of 12.3% of individuals 65 years and older. There are 8 jurisdictions with a higher percentage of elderly individuals compared to both the county's average and the national average. The Towns of Foxfield and Columbine Valley have the highest number of individuals 65 years and older. Glendale and Aurora are the only jurisdictions with an average lower than the county's or national average of individuals 65 years and older. The following table shows the jurisdictions with a high percentage of individuals age 65 years and older compared to the county.

Disability – Percent of the Population with Disabilities

Individuals with disabilities are also often more vulnerable to physical, social, and economic challenges that comes from a disaster event. Individuals with access and functional needs may need more time and assistance to evacuate an area and may require additional support and resources when recovering from a disaster event. Public information and warning strategies need to include methods to reach people with hearing or vision limitations. U.S. Census Bureau data lists 9% of Arapahoe County residents as having some form of disability, below the national average of 13%. (Note that other sources such as the Centers for Disease Control and Prevention estimate that number to be as high as 25%.) Six of the incorporated jurisdictions have a higher percentage of individuals with disabilities compared to the county's average, and two of those have a higher percentage than the national average. The following table shows the municipalities with a higher percentage of individuals with disabilities than the county's average.

Table 2-7 Jurisdictions with High Percentage of Individuals 65 years and Older

Jurisdiction	Percent
County	12.3
Foxfield	29.1
Columbine Valley	26.6
Bow Mar	17.7
Cherry Hills Village	17.5
Littleton	17.2
Greenwood Village	16.4
Deer Trail	15.9
Sheridan	15
Bennett	14.4
Centennial	14.4

Source: Census Bureau, American Community Survey 5-Year Estimates, 2014-2018

Table 2-8 Jurisdictions with High Percentage of Individuals with Disabilities

Jurisdiction	Percent
County	9
Deer Trail	26.2
Sheridan	13.5
Englewood	12.9
Bennett	11.9
Littleton	10.5
Aurora	11.9

Source: Census Bureau, American Community Survey 5-Year Estimates, 2014-2018

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Limited English Language Proficiency

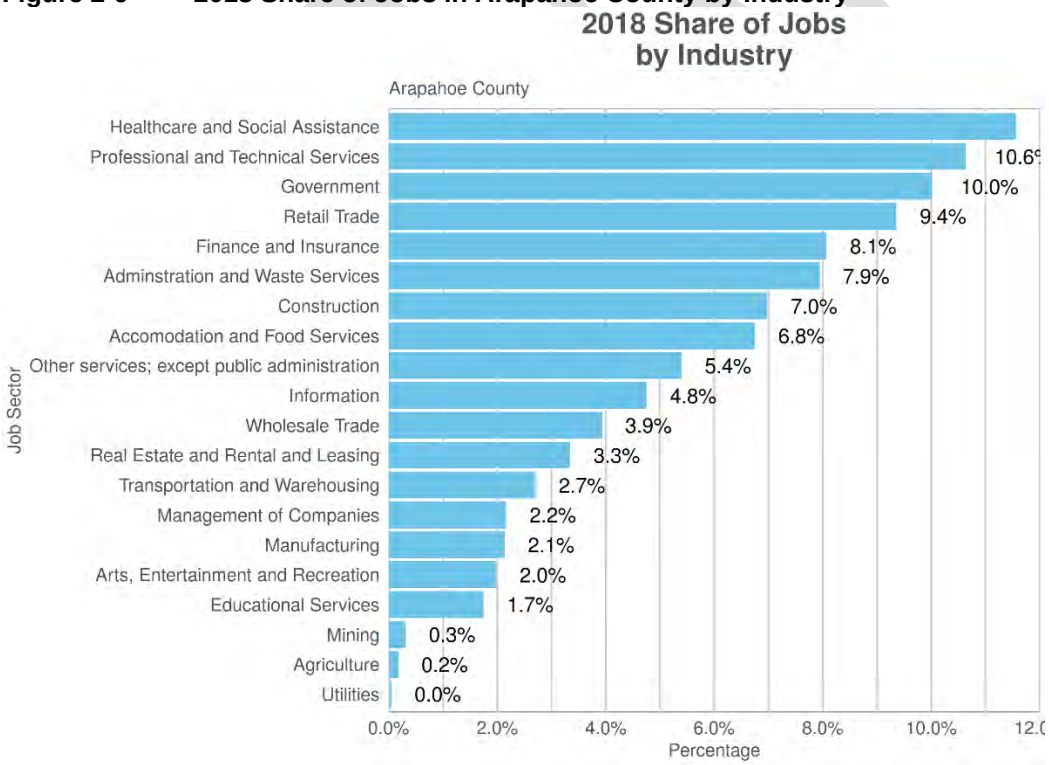
Understanding a community's proficiency in English can improve the ability to communicate to individuals before, during and after an emergency. This also allows individuals to better access community resources and for the community to have translators or information already translated if necessary. Arapahoe County has an average of 4.4% of households with limited English-speaking, compared to the statewide average of 2.8% and the national average of 4.5% of households with limited English-speaking capabilities. The City of Aurora is the only jurisdiction with a higher percentage (7.9%) of limited English-speaking capabilities compared to the county and other incorporated jurisdictions.

2.5 Economy

According to data from the U.S. Bureau of Economic Analysis, Arapahoe County's Gross Domestic Product (GDP) in 2018 was $44,037,874. This constitutes 13% of the State's economy and ranks Arapahoe 2nd among Colorado Counties in terms of GDP. The county's GDP has grown by an average of 3% annually since 2015.

The following figure shows the various industries in Arapahoe County and the share of jobs for each sector type. Health care and social assistance has the greatest share of jobs and has seen the greatest growth since 2005.

Figure 2-9 2018 Share of Jobs in Arapahoe County by Industry



Source: Colorado State Demography Office

The following table shows and compares various economic characteristics for each jurisdiction.

Table 2-9 Select Economic Characteristics in Arapahoe County by Jurisdiction

	County	Aurora	Bennett	Bow Mar	Centennial	Cherry Hills Village	Columbine Valley	Deer Trail	Englewood	Foxfield	Glendale	Greenwood Village	Littleton	Sheridan
% of Families below poverty level	6.3%	8.8%	11%	3.1%	2.2%	4.1%	1.2%	22.5%	11.5%	1.4%	9.9%	3.8%	4.7%	18%
% of Individuals below poverty level	9.0%	12%	11.5%	3.1%	3.7%	3.1%	1.5%	20.6%	15.1%	4.5%	12.8%	5.5%	7.9%	20.4%
Median household income	$73,925	$62,541	$54,701	$184,063	$105,974	$250,001	$168,125	$56,586	$56,586	$120,833	$51,026	$127,134	$73,185	$42,061
Per capita income	$38,972	$28,854	$31,899	$93,992	$47,723	$133,838	$94,755	$35,321	$35,321	$53,733	$35,951	$88,214	$44,581	$25,689
% of Population >16 years old in the Labor Force	71.4%	71.4%	62.5%	55.8%	70.3%	56.1%	54.9%	71.1%	71%	58.3%	84.9%	63.3%	69.4%	63.4%
% of Population Employed	68%	67.4%	58.8%	53.9%	67.8%	55%	53.2%	66.8%	70.9%	55.5%	81.5%	61.1%	66.6%	61%

Source: Census Bureau, American Community Survey 5-Year Estimates, 2014-2018

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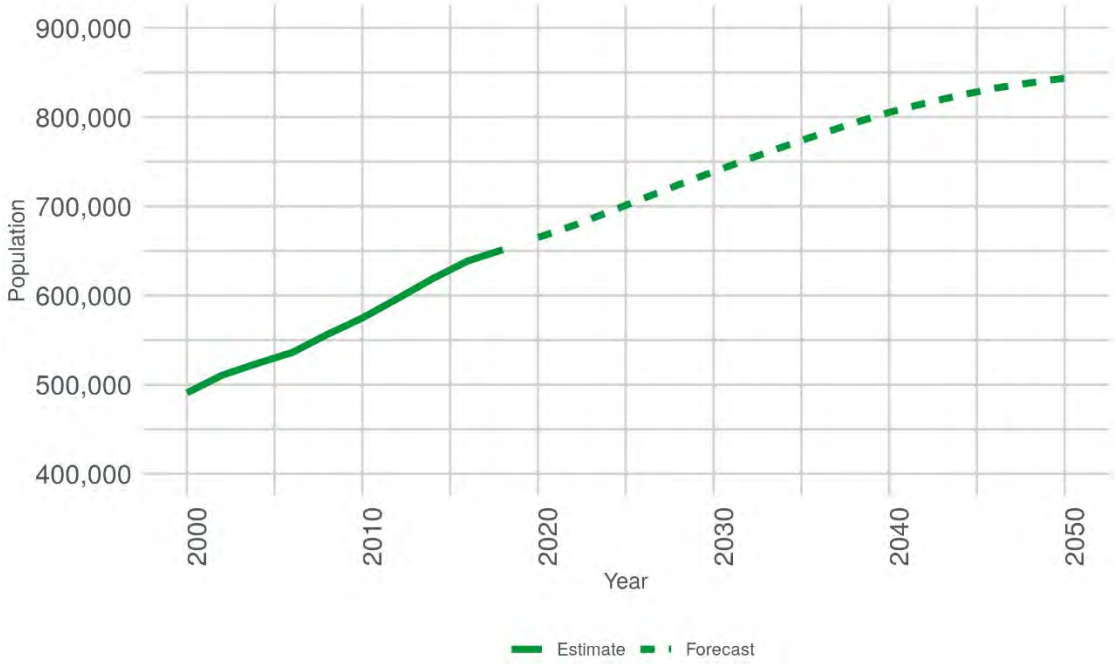
2.6 Future Population Growth and Development Trends

A key strategy for reducing future losses in a community is to avoid development in known hazard areas and to enforce 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.

According to the Colorado State Demography Office, between 2020 and 2030 Arapahoe County's population is projected to grow at an average of 1.1% a year, but the overall growth rate is expected to decrease between 2020 and 2040. The forecasted growth rate between 2030 and 2040 is 0.9%. According to the Demography Office, this is due partly to the aging population and changes in the proportion of the population in childbearing years. The county's population is projected to be 805,302 by 2040. Figure 2-10 shows the population forecast for the next 30 years.

Figure 2-10 Arapahoe County Population Forecast, 2000 to 2050



Source: Colorado State Demography Office

Figure 2-11 Projected Population Growth Western (2019 – 2024)

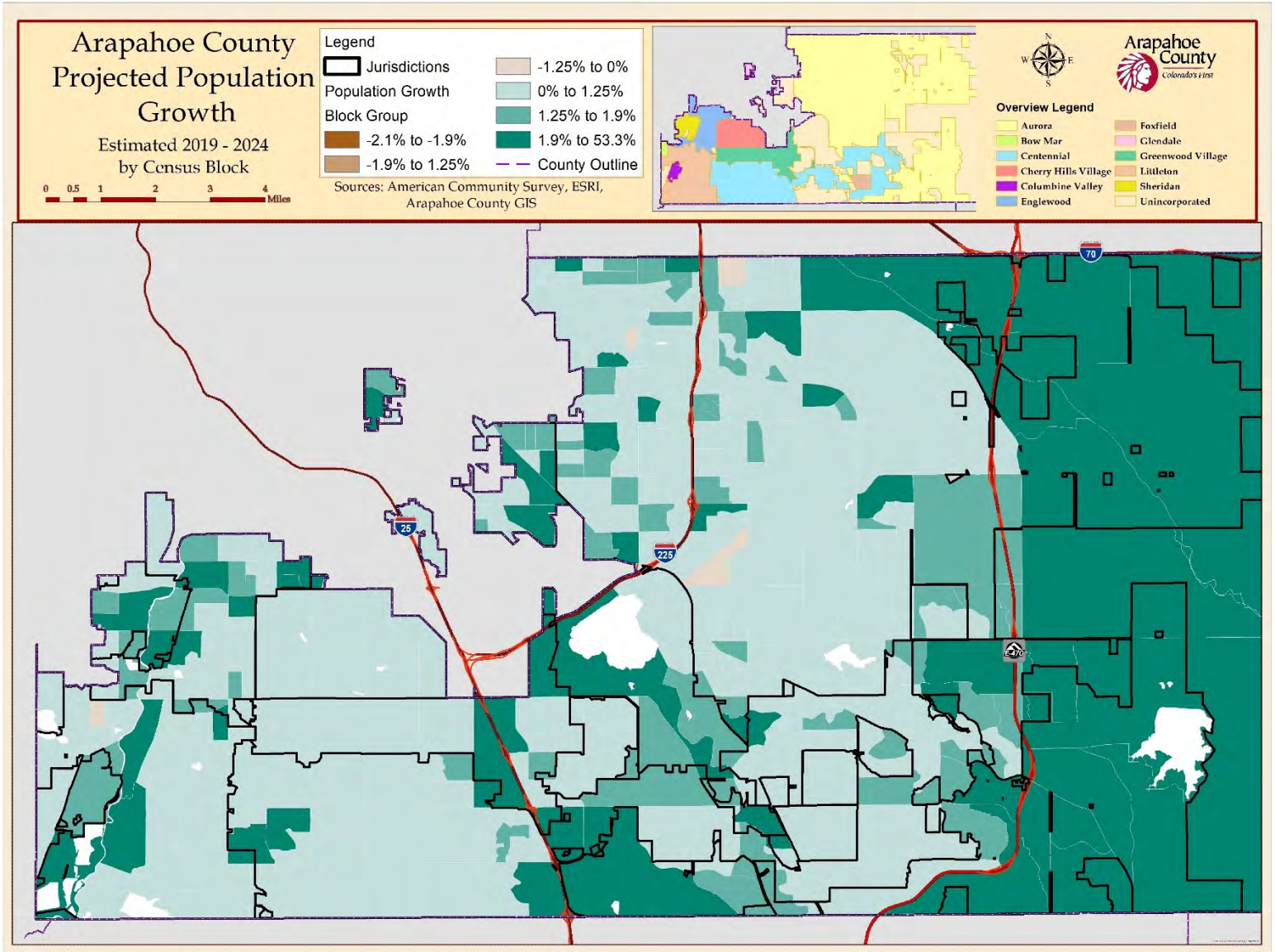
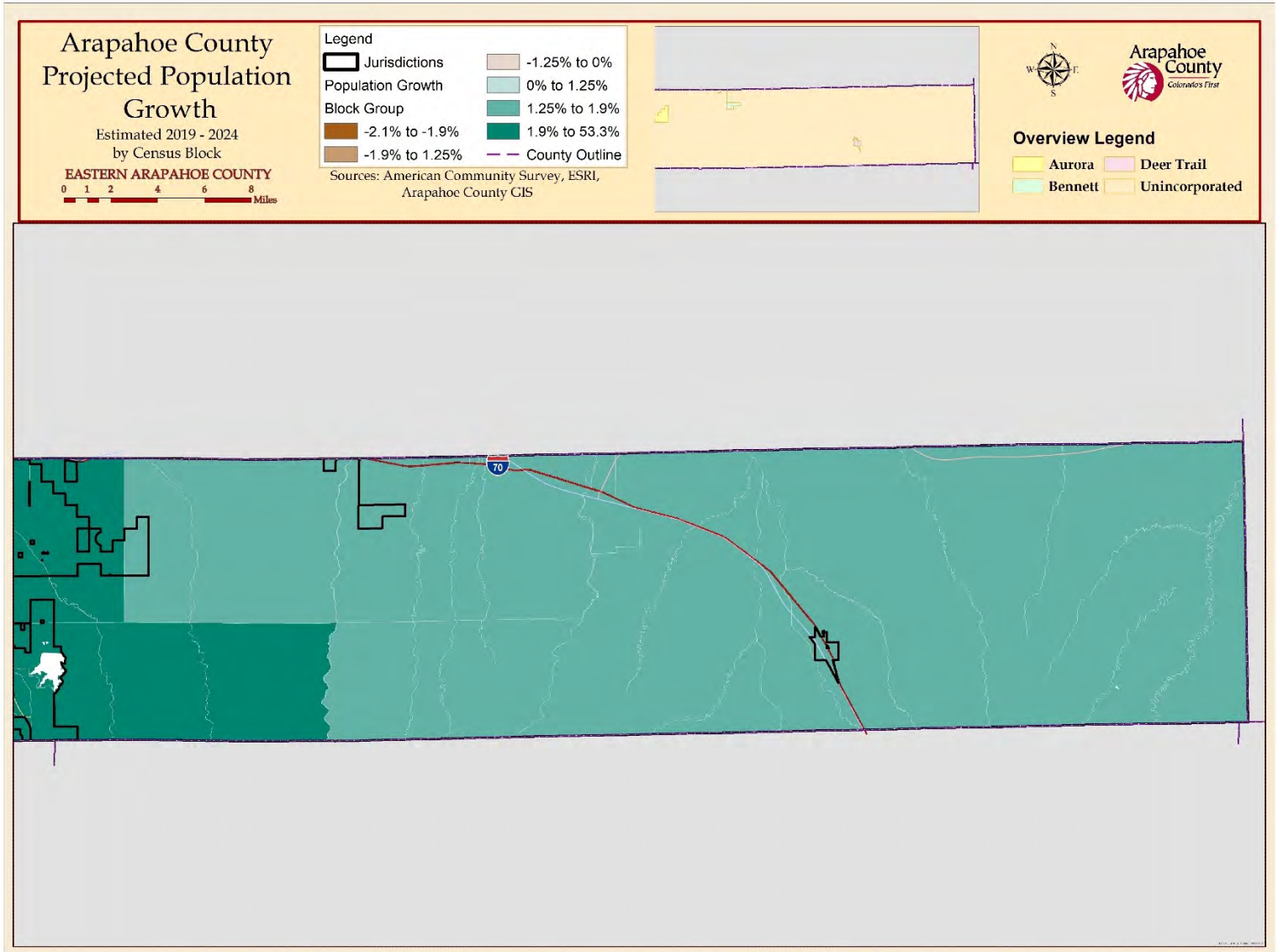


Figure 2-12 Projected Population Growth Eastern (2019 – 2024)



Arapahoe County has grown significantly in the past decade and is one of the fastest growing counties in the Denver Metro Area. The amount of growth that Arapahoe 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 Arapahoe County is expected to remain steady over the next five years. Since the adoption of the 2010 Denver Regional Natural Hazard Mitigation Plan, new residential and commercial development has continued to occur across the county. The following Table depicts the number of new residential building permits issued annually in Arapahoe County between 1990 and 2019.

Table 2-10 Annual New, Privately-Owned Residential Building Permits Issued in Arapahoe County

Year	Permits/Buildings	Units
2019	2386	3497
2018	2230	3561
2017	2370	2757
2016	2067	4667
2015	1715	2830
2014	1293	1896
2013	1267	3079
2012	967	1,715
2011	615	805
2010	830	1,279
2009	574	1,172
2008	801	1,764
2007	1,776	3,881
2006	2,791	3,526
2005	3,212	3,986
2004	3,156	3,847
2003	2,431	3,311
2002	3,409	4,805
2001	3,701	7,655
2000	4,442	8,140
1999	4,298	5,728
1998	3,147	4,456
1997	2,708	4,131
1996	2,473	3,213
1995	2,139	3,351
1994	2,478	4,361
1993	2,269	2,951
1992	1,831	2,274
1991	1,084	1,085
1990	654	654

Source: U.S. Census Bureau

The 2018 Arapahoe County Comprehensive Land Use Plan illustrates the desired concentration of future urban development in distinct zones within the county. These zones are called Planning Reserve Areas. Planning Reserve Areas are areas designated for a greater mix of uses and higher densities than what is currently being developed across the county. Moreover,

the vision of the Planning Reserve Areas is that ample employment opportunities will be available near the places where people live.

The Comprehensive Plan distinguishes Planning Reserve Areas from the parts of the county that will not undergo urban development within the Plan's 20-year time horizon. In places outside of the designated Planning Reserve Areas, land is intended for agricultural purposes, open lands, low density rural development, and sensitive development/conservation areas.

The map in the Figure below shows the location of the Planning Reserve Areas identified in the 2018 Arapahoe County Comprehensive Land Use Plan. Note that there are no Planning Reserve Areas in the western half of the county. The I-70 corridor, located in the eastern portion of the county, is an important area of emerging residential (and commercial) growth. It has been designated as a priority area for future development of mixed-use, high-density residential properties.

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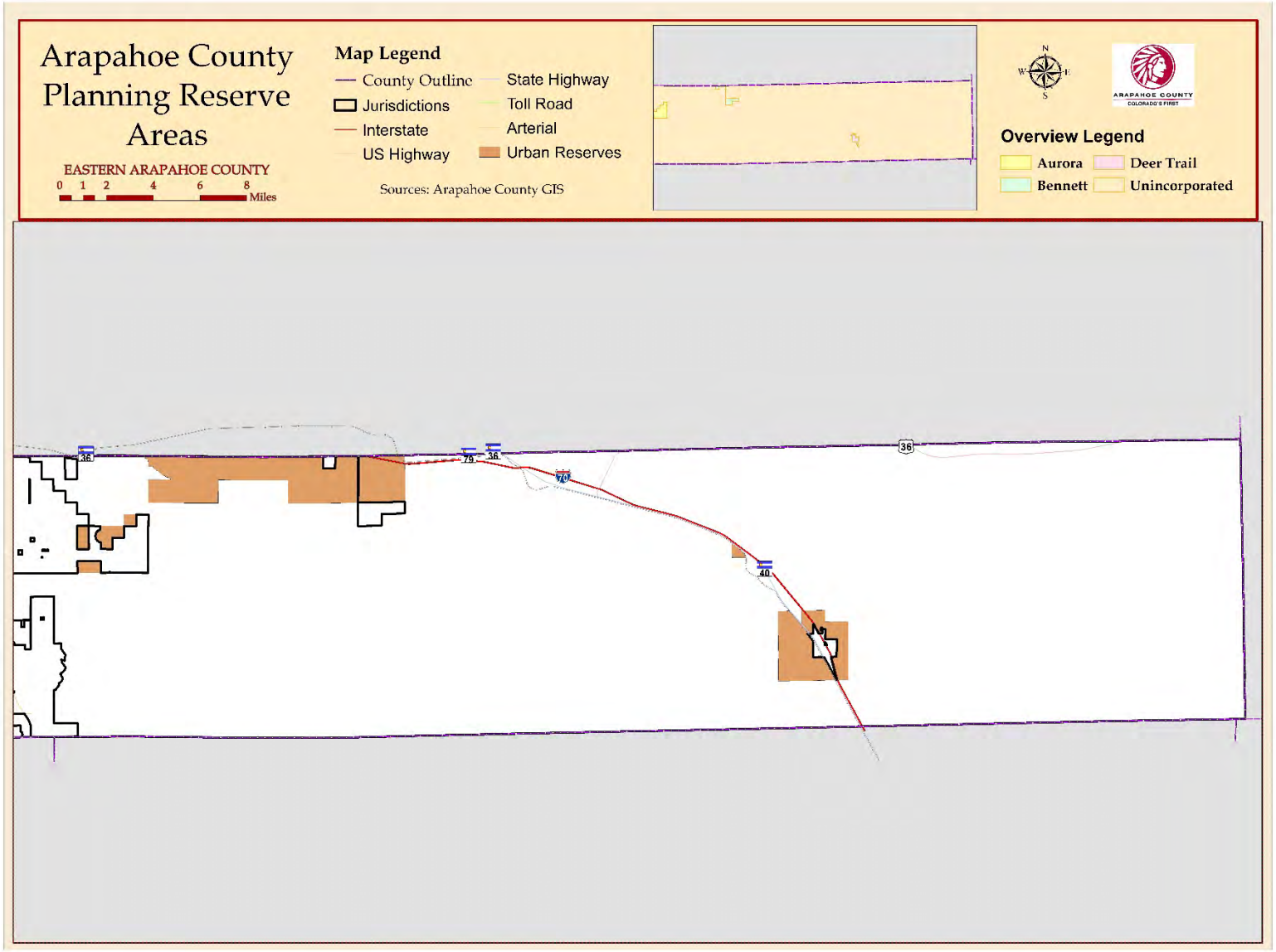
Figure 2-13 Planning Reserve Areas Eastern



2.7 Capability Assessment

The capability and resource assessment examines the ability of Arapahoe County to implement and manage the comprehensive mitigation strategy laid out in this Plan. The strengths, weaknesses, and resources of the county, its partner agencies, and local jurisdictions are identified here as a means for evaluating and maintaining effective and appropriate management of the county's hazard mitigation program.

The information included in the capability assessment was gathered primarily from Planning Team members and other representatives of the participating jurisdictions and agencies. The 2020 update process afforded the participating jurisdictions an 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. Chapter 5 Mitigation Strategy includes mitigation actions aimed at improving community capability to reduce hazard risk and vulnerability.

Together, the capabilities outlined in this plan highlight both strengths and areas of improvement that the county and its local jurisdictions should consider as they work to mitigate hazard impacts, reduce risk to life and property, and build a disaster resilient community.

Planning and Regulatory Capabilities

Table 2-11 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 Arapahoe County. For each of the profiled hazards, several ordinances, regulations, plans, and programs were identified in various communities within County. These are listed here to serve as a reference for related planning efforts.

Table 2-11 Planning and Regulatory Capabilities

Planning and Regulatory Capabilities	Arapahoe County	Bennett	Bow Mar	Centennial	Cherry Hills Village	Deer Trail	Englewood	Foxfield	Glendale	Greenwood Village	Littleton	Sheridan
Building Codes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Building Codes Year	2015	2012	Var.	2017	2018	2012	2018	2015	2018	2012[1]	2012[1]	2015
BCEGS Rating	No	6/6	No	No	No	No	3/3	No	No[2]	No	5/5	4/4
Capital Improvements Program	Yes	Yes	No	Yes	Yes	No	Yes	No	Yes	Yes	Yes	Yes
Community Rating System (CRS)	Yes	No	No	Yes	Yes	No	Yes	No	No	No	Yes	No

Planning and Regulatory Capabilities	Arapahoe County	Bennett	Bow Mar	Centennial	Cherry Hills Village	Deer Trail	Englewood	Foxfield	Glendale	Greenwood Village	Littleton	Sheridan
Community Wildfire Protection Plan (CWPP)	No	Yes	No	No	No	No	No	No	No	No	No	Yes
Comprehensive or General Plan	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Economic Development Plan	No	Yes	No	Yes	No	Yes	Yes	No	Yes	Yes	No	Yes
Elevation Certificates	No	No	No	No	No	No	No	No	No	No	Yes	No
Erosion/Sediment Control Program	Yes	Yes	No	Yes	Yes	No	Yes	No	Yes	Yes	Yes	Yes
Floodplain Management Plan or Ordinance	Yes	Yes	No	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes
Flood Insurance Study	Yes	Yes	No	Yes	Yes	No	Yes	No	Yes	Yes	Yes	Yes
Growth Management Ordinance	No	No	No	No	No	No	No	No	No	No	No	No
Non-Flood Hazard Specific Ordinance or Plan	No	No	No	No	No	No	No	No	No	No	No	Yes
National Flood Insurance Program (NFIP)	Yes	Yes	No	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes
Site Plan Review Requirements	Yes	Yes	No	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes
Stormwater Program, Plan, or Ordinance	Yes	Yes	No	Yes	Yes	No	Yes	No	Yes	Yes	Yes	Yes
Zoning Ordinance	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Other				Yes[3]	Yes[4]							Yes[5]

Notes: 1 - Currently in process of adopting 2018 codes; 2 – Pending; 3 - City property maintenance code; 4 - APWA Accreditation; 5 - International Property Maintenance Code

Denver Water Capabilities

Many of the regulatory capabilities listed above are not applicable to Denver Water. Denver Water does have a number of relevant plans in place, including:

- Emergency Operations Plan
- Drought Response Plan
- Watershed Management Plan
- Crisis Communications Plan
- Climate Adaptation Plan
- Integrated Resource Plan
- FERC Emergency Action Plans (EAPs) on all dams.
- EPA Emergency Response Plans (ERPs)
- Treatment and Distribution Plans.
- Continuity of Operations Plans
- Facility Security Plans

Land Use Planning and Codes

Local land use plans and building codes are tremendous tools for evaluating local policies related to hazard mitigation and risk reduction. Additionally, comprehensive master plans, capital improvement plans, stormwater plans and zoning ordinances all present opportunities for enhanced local capabilities. The Arapahoe County Comprehensive Plan was updated in 2018 and adopted the 2015 Multi-Hazard Mitigation Plan by reference and integrated mitigating hazards into the goals and policies for the countywide plan. Building codes are one tool that communities use to enhance public safety. For example, they can increase structural integrity, mitigate structure fires, and provide benefits in relation to natural hazard avoidance.

The table above shows that most participating jurisdictions have a comprehensive or general plan to guide growth and development, along with zoning ordinances. Most have also adopted recent building codes.

National Flood Insurance Program (NFIP) Participation

The National Flood Insurance Program (NFIP) and Community Rating System (CRS) are highly effective in reducing flood risk for participating communities. Arapahoe County and all participating jurisdictions been mapped for flood hazards and participate fully in the NFIP, except for the Towns of Bow Mar and Foxfield, which have never been mapped. Details of local jurisdiction participation status from the NFIP's Community Information System can be found in Section 4.7 (Flooding). See also Section 5.3 for the participating jurisdictions' commitment to continue participation in the NFIP.

Community Rating System (CRS) Participation

In addition to participating in the NFIP, Arapahoe County and several of its municipalities participate in the Community Rating System (CRS). The CRS is a voluntary program for NFIP participating communities. The goals of the CRS are to reduce flood damages to insurable property, to strengthen and support the insurance aspects of the NFIP, and to encourage 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 which determine the insurance premium discount for policy holders, which range from 5% to a maximum of 45%.

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Six communities including Arapahoe County participate in the CRS program; Table 2-12 lists the participants. Five of the communities are a Class 7 CRS community. These communities have a 15% premium discount for properties in the SFHA and a 5% discount for properties in the non-SFHA. The City of Littleton is Class 5 CRS community. Littleton receives a 25% premium discount for properties in the SFHA and a 10% discount for properties in the non-SFHA.

Table 2-12 CRS Participating Communities in Arapahoe County

Community	CRS Class	SFHA Discount
Unincorporated	7	15%
Aurora	7	15%
Centennial	7	15%
Cherry Hills Village	7	15%
Englewood	7	15%
Littleton	5	25%

Source: FEMA Community Information System.

Administrative and Technical Capabilities

Mitigation is an interdisciplinary effort that requires collaboration across numerous departments and individuals. Existing administrative and technical resources in the participating jurisdictions are summarized in Table 2-13. 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 2-13 Administrative and Technical Capabilities

Administrative and Technical Capabilities	Arapahoe County	Bennett	Bow Mar	Centennial	Cherry Hills Village	Deer Trail	Englewood	Foxfield	Glendale	Greenwood Village	Littleton	Sheridan
Emergency Manager	Yes	No	No	Yes	No	No	Yes	No	Yes	Yes	Yes	Yes
Floodplain Administrator	Yes	Yes	No	Yes	Yes	Yes[2]	Yes	No	Yes	Yes	Yes	Yes
Land Development Planner/Engineer	Yes	Yes	No	Yes	Yes	No	Yes	No	Yes	Yes	Yes	Yes
Natural Hazards Planner, Engineer, or Scientist	No	Yes	No	No	No	No	No	No	No	No	No	No
Construction Engineer/ Professional	Yes	Yes	No	Yes	Yes	No	Yes	No	No	Yes	Yes	Yes
Resiliency Planner	No	Yes	No	No	No	No	No	No	Yes	No	No	No

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Administrative and Technical Capabilities	Arapahoe County	Bennett	Bow Mar	Centennial	Cherry Hills Village	Deer Trail	Englewood	Foxfield	Glendale	Greenwood Village	Littleton	Sheridan
Transportation Planner	Yes	Yes	No	Yes	Yes	No	Yes	No	Yes	Yes	Yes	Yes
Building Official	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
GIS Specialist	Yes	Yes	No	Yes	No	No	Yes	No	Yes	Yes	Yes	Yes
Grant Manager, Writer, or Specialist	No	Yes	No	Yes	No	No	No	No	No	No	Yes	No
General Warning System/Service	No	Yes	No	No	No	Yes	Yes	No	Yes	Yes	No	Yes
Flood Warning System	Yes[1]	No	Yes[1]	Yes[1]	Yes[1]	Yes[1]	Yes[1]	Yes[1]	Yes[1]	Yes[1]	Yes[1]	Yes[1]
Wildfire Warning System	No	No	No	No	No	Yes	No	No	No	No	No	No
Tornado Warning System	No	Yes	No	No	No	Yes	Yes	No	Yes	No	No	Yes
Geological Hazards Warning System	No	No	No	No	No	No	No	No	No	No	No	No

Notes: 1 – Operated by Mile High Flood District. 2 – Not a fulltime position; Town Clerk responsibility.

Denver Water Capabilities

Denver Water administrative and technical staff includes:

- Watershed scientists
- Water resource engineers
- Building/Infrastructure engineers
- Drought planners
- Emergency management staff
- IT/GIS section
- Internal warning/notification systems

Financial Capabilities

Most mitigation projects require funding.

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Table 2-14 details a variety of financial tools that the jurisdictions have used to fund mitigation activities to date.

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Table 2-14 Financial Capabilities That Have Been Used to Fund Mitigation Activities

Financial Capabilities Used to Fund Mitigation Activities	Arapahoe County	Bennett	Bow Mar	Centennial	Cherry Hills Village	Deer Trail	Englewood	Foxfield	Glendale	Greenwood Village	Littleton	Sheridan
Levy for Specific Purposes with Voter Approval	Yes	No	No	No	No	No	Yes	No	Yes	No	No	No
Utilities Fees	No	Yes	No	Yes	No	No	Yes	No	Yes	No	Yes	Yes
System Development Fee	Yes	Yes	No	Yes	No	No	Yes	No	No	No	No	Yes
General Obligation Bonds to Incur Debt	No	Yes	No	No	No	No	Yes	No	Yes	No	No	Yes
Special Tax Bonds to Incur Debt	No	Yes	No	No	No	No	No	No	Yes	No	No	Yes
Withheld Spending in Hazard-Prone Areas	No	No	No	No	No	No	No	No	No	No	No	No
Stormwater Service Fees	No	No	No	Yes	No	No	Yes	No	No	No	Yes	Yes
Capital Improvement Project Funding	Yes	Yes	No	Yes	Yes	Yes	Yes	No	Yes	No	Yes	Yes
Community Development Block Grants	No	Yes	No	No	No	No	Yes	No	No	No	Yes	Yes

Denver Water Capabilities

Denver Water has used fiscal resources to fund mitigation activities, to include:

- Capital Improvements funding
- Water rate increases/fees
- Tapping fees
- General obligation bonds
- Colorado State Forest Service funds
- U.S. Forest Service funds

Other Mitigation Programs and Partnerships

Public Education and 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 Arapahoe County. The participating jurisdictions have several active public education programs to educate the public about hazards and actions they can take to mitigate against those hazards, as shown in Table 2-15.

Table 2-15 Education & Outreach Capabilities

Education & Outreach Capabilities	Arapahoe County	Bennett	Bow Mar	Centennial	Cherry Hills Village	Deer Trail	Englewood	Foxfield	Glendale	Greenwood Village	Littleton	Sheridan
Local Citizen Groups That Communicate Hazard Risks	No	No	No	Yes	No	No	Yes	No	No	No	No	No
Firewise	No	No	No	Yes	No	No	No	No	No	No	No	No
StormReady	Yes	No	No	Yes	No	Yes	Yes	No	No	No	No	No
Other	Yes[1]			Yes[1]	Yes[2]		Yes[3]		Yes[5]		Yes[2]	Yes[4]

Notes: 1 - Members of Colorado Stormwater Council (CSC); 2 - CSC and Splash; 3 - Created communications dept. in 2018 to implement public information and outreach efforts, adopting community engagement plan for the City; 4 - Stormwater Compliance; 5 - Ready Glendale program.

Additionally, South Metro Fire Rescue conducts public education to individuals, HOAs, businesses, organizations, and schools throughout their service area on topics ranging from emergency planning and preparation, to home safety and wildfire mitigation.

Denver Water Capabilities

Denver Water has various outreach and partnerships including public education programs related to water conservation, drought response, water quality, and a very active youth education program focusing on a variety of water-related topics. Denver Water does not currently participate in the Storm Ready or Firewise programs.

Coordination Efforts include:

- Denver Water's External Affairs division consists of Customer Relations, Communications & Marketing, Government & Stakeholder Relations, Conservation, Treated Water Planning, Demand Planning and Water Resources. This group provides a plethora of planning and outreach with local partners. They provide media relations, social media, marketing, publications, internal communication, stakeholder relations, government relations, community outreach, and website communications for both the combined service area of 1.4 million people and for the communities where Denver Water's watersheds and facilities are located.
- Denver Water's Emergency Management, Safety & Security section partners with local OEMs, local law enforcement agencies to work closely on planning, response, recovery and mitigation efforts in order to build a resilient community that can respond to emergencies, to share public safety messages around flood/runoff safety, create a culture of preparedness and foster an understanding of Denver Water's operations and constraints.

Denver Water uses the following communication and coordination methods to conduct public outreach:

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- TAP stories, videos, and infographics across all social media channels, which provide content and opportunities for local partners to adapt for use on their social media channels.
- Partnerships with County Emergency Management and offering content for their annual safety guide
- Presentations to community groups, the annual State of the River event, Emergency Manager's Town Halls, etc.
- Expert interview(s) on local PATV station.
- Proactive media pitches to local publications and websites.

Mile High Flood District (MHFD) and Southeast Metro Stormwater Authority (SEMSWA)

Two key partners in Arapahoe County's flood mitigation efforts are the Mile High Flood District (MHFD) and the Southeast Metro Stormwater Authority (SEMSWA).

The Mile High Flood District (MHFD) – formerly the Urban Drainage and Flood Control District – was established by the Colorado legislature in 1969 to assist local governments in the Denver metropolitan area with multi-jurisdictional drainage and flood control challenges. MHFD covers over 1,600 miles of major streams across an area of 1,608 square miles that includes the western half of Arapahoe County. MHFD programs include watershed services, stream services, operations and development, and flood warning and information services, and conducts public education and outreach related to new and revised flood hazard mapping.

The Southeast Metro Stormwater Authority (SEMSWA) provides stormwater and floodplain management services for drainage and flood control facilities within its service areas in the City of Centennial and unincorporated Arapahoe County. SEMSWA's activities include planning, funding, construction, acquisition, operation, and maintenance. They are responsible for land development review and stormwater and floodplain development permitting, and conducts public education and outreach related to new and revised flood hazard mapping. SEMSWA is also responsible for insuring compliance with National Pollutant Discharge Elimination System (NPDES) and other environmental regulations, and strives to educate the public about stormwater quality. SEMSWA serves as Centennial's Floodplain Administrator and CRS Coordinator.

Opportunities for Enhancement

Based on the capability assessment, Arapahoe 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 and jurisdictions to expand or improve on their capability to further protect the community.

The jurisdictions have several financial tools that could potentially fund mitigation, but many of these tools require further development before they could be used to fund projects. The county may want to consider further investigating the ability to use Community Development Block Grant (CDBG) funds for mitigation projects so that projects can be proposed for any available funds. Additionally, it may be helpful to develop a backlog of projects that could be submitted for CIP funding to anticipate and budget for future mitigation actions.

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In addition to funding, smaller jurisdictions often lack the staffing needed to implement mitigation activities. Table 2-13 above shows that several participating jurisdictions are missing key administrative or technical positions that would be helpful for planning and conducting mitigation activities. The county could consider creating mutual aid agreements to share technical staff among jurisdictions when needed, particularly in the aftermath of a disaster or when funding becomes available.

The county has identified a mitigation action (Table 5-4, Action A-15) to improve the county's CRS rating, which would improve the county's flood resilience while lowing flood insurance rates in the unincorporated areas. This Plan was specifically written to achieve floodplain management planning credit under CRS. This could also potentially result in improvements to the CRS ratings of participating jurisdictions.

Other opportunities include the continuation of incorporating updated risk information into comprehensive plan updates and ensuring risk information is taken into consideration in land use code updates and during the development review process. See Section 6.3 for additional information on ways mitigation can be incorporated into other mechanisms.

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3. The 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 Arapahoe County and participating municipalities in the preparation of this Hazard Mitigation Plan. This chapter consists of the following subsections:

- Background
- What's New in the Plan Update
- Local Government Participation
- The 2020 Planning Process

3.1 Background

Emergency Management is the discipline of identifying, managing, and avoiding 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. Emergency Management is an ever changing process by which all individuals, groups, and communities attempt to manage hazards in an effort to avoid or reduce the impact of disasters.

Figure 3-1 The Emergency Management Cycle

One method to attempt to prevent hazards from developing into disasters is Hazard mitigation planning. Hazard mitigation is defined by FEMA as "any sustained action taken to reduce or eliminate long-term risk to human life and property from a hazard event." A congressionally mandated independent study assessing future savings from mitigation activities determined that mitigation activities are highly cost effective; on average, each dollar spent on mitigation saves society an average of $6 in avoided future losses in addition to saving lives and preventing injuries (Natural Hazard Mitigation Saves: 2019 Report). Hazard mitigation planning is a process to identify policies, capabilities, activities, and tools necessary to implement successful and sustainable mitigation actions.

Why undertake mitigation planning? Mitigation planning offers many benefits, including:

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- 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

Typically, mitigation planning is described as having the 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 will enable 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 other concurrent local planning efforts, and any proposed mitigation strategies must take into account other existing community goals or initiatives that will help complement or hinder their future implementation. Arapahoe County and its jurisdictions have embraced this approach, identifying multiple opportunities to link the Plan with pre-existing programs, policies, plans, and initiatives.

During the last two decades, the approach to 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 waiting for them to occur.

Recognizing the importance of mitigation planning, Arapahoe County first participated in the first Denver Regional Natural Hazard Mitigation Plan, which was approved by FEMA and adopted in 2004. An updated regional plan was adopted in 2010. Development of the 2010 plan was a concerted effort on the part of the Denver Regional Council of Governments (DRCOG) and 19 local jurisdictions, including Arapahoe County. DRCOG planning staff spearheaded the hazard mitigation planning process and prepared the updated mitigation plan document. DRCOG convened a Regional Natural Hazard Plan Steering Committee to help guide the preparation of the plan. The Steering Committee was comprised of representatives from participating city and county governments, the State Office of Emergency Management, and FEMA Region VIII. Additionally, several special district stakeholders participated in flood mitigation planning. These included both the Urban Drainage Flood Control District (now the Mile High Flood District) and the Southeast Metro Stormwater Authority.

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Prior to the expiration of the 2010 DRCOG Plan, Arapahoe County decided to produce its own Hazard Mitigation Plan focused specifically on the county and its jurisdictions. The resulting Arapahoe County Hazard Mitigation Plan was approved by FEMA and adopted in 2015.

The 2015 Hazard Mitigation Plan underwent a comprehensive update in 2020. The planning process followed during the update was similar to that used in the development of the 2015 plan. This planning process utilized input from a multi-jurisdictional Planning Team. The Arapahoe County Office of Emergency Management (OEM) began the update using internal staff in coordination with the multi-jurisdictional planning team. However, the demands of the 2020 COVID-19 pandemic made it impractical to complete the update in-house. Therefore a consultant, Wood Environment and Infrastructure Solutions, Inc. (Wood), was contracted to assist with the update. The plan update process is described further in this section and documented in Appendix B.

This 2020 Plan is the result of continuing work by the citizens of Arapahoe County to update a 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. This updated Plan serves to:

- Protect life and property by reducing the potential for future damages and economic losses that result from natural hazards;
- Qualify for additional grant funding, in both the pre-disaster and post-disaster environment;
- Provide quick recovery and redevelopment following future disasters;
- Integrate other existing and associated local planning documents;
- Demonstrate a firm local commitment to hazard mitigation principles; and
- Comply with state and federal legislative requirements tied to local hazard mitigation planning.

Scope

This 2020 Plan has been prepared to meet requirements set forth by the Federal Emergency Management Agency (FEMA) and the Colorado Division of Homeland Security and Emergency Management (DHSEM) in order for Arapahoe County to be eligible for funding and technical assistance from state and federal hazard mitigation programs. It will continue to be updated and maintained to continually address those natural hazards determined to be of high and moderate risk as defined by the updated results of the local hazard, risk, and vulnerability summary. Other hazards will continue to be evaluated during future updates of the Plan to determine if they warrant additional attention, including the development of specific mitigation measures intended to reduce their impact. This Plan will be updated and FEMA-approved within its five-year expiration date, as described in detail in Chapter 6.

3.2 What's New in the 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 updated HMP complies with 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 2015 plan, and includes an assessment of Arapahoe County's success in evaluating, monitoring, and implementing the mitigation strategy outlined in the initial plan. The process followed to review and revise the chapters of the plan during the 2019-2020 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 Planning Team discussed jurisdictional priorities and concluded there had been no significant changes to priorities that would affect this mitigation plan. 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 Arapahoe County and jurisdictions. Only the information and data still valid from the 2015 plan was carried forward as applicable to this plan update.

Table 3-1 2020 Plan Update Summary of Changes by Section

2015 Plan Section	Update Review and Analysis	2020 Plan Section
Intro & Executive Summary	Moved to Section 1. Updated Exec Sum to reflect updated plan. Moved adoptions to Appendix D.	Section 1 Introduction
1 Planning Process	Moved to Section 3. Added dates & documentation of annual meetings 2016-2020. Described and documented the planning process for the 2020 update, including coordination among agencies and integration with other planning efforts. Described any changes in participation among planning team & stakeholders. Described any changes in jurisdictional priorities. Described 2020 public participation process including surveys. Included updated pics where available. Moved some documentation to Appendix B.	Section 3 Planning Process
2 Community Profile	Updated demographic, social & economic data, including growth since 2015, recent annexations or new development. Expanded on social vulnerability analysis. Updated Assets data. Moved Capability Assessment from Section 5 into Section 2.	Section 2 Community Profile
3 HIRA	Moved to Section 4. Updated existing hazards: • Drought • Flooding • Public Health Hazards • Severe Summer Weather (hail, lightning, extreme heat) • Severe Winter Weather (blizzards, winter storms, extreme cold) • Severe Wind/Tornado • Wildfire Removed hazards:	Section 4 Hazard Identification and Risk Assessment

2015 Plan Section	Update Review and Analysis	2020 Plan Section
	• Earthquake, • Erosion/subsidence, • Extreme temp (moved to Summer & Winter Weather sections) Added new Hazards: • Dam Failure • Hazmat Release • Active Threat • Cyber Threat Included updated maps prepared by County GIS. Reviewed hazards from current Colorado State Hazard Mitigation Plan for consistency. Updated list of disaster declarations to include 2016-2020 data. Updated hazards data to include 2016-2020 data. Updated past occurrences for each hazard to include 2016-2020 data. Incorporated new hazard studies since 2016 and/or CWPPs/wildfire risk mapping. Considered consequences of climate change on hazard frequency and severity. Updated development and land use trends to include Census data, state, county, and local data sources. Used 2020 Assessor's data, 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. Changes in growth and development examined; especially changes in the context of hazard-prone areas and how the changes may affect loss estimates and vulnerability. 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 Add consequence analysis for each hazard per EMAP.	
4 Mitigation Strategy	Moved to Section 5. Reviewed goals and objectives to determine if they are still representative of the county's mitigation strategy. Reviewed mitigation actions from the 2015 plan and developed a status report for each; identified if action has been completed, deleted, or deferred. Identified and detailed new mitigation actions. Identified projects that have been submitted for funding and those that will be likely candidates for this funding.	Section 5 Mitigation Strategy
5 Plan Implementation, Capabilities, and Maintenance	Moved to Section 6. 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. Moved capabilities assessment into Community Profile.	Section 6 Plan Implementation, Capabilities, and Maintenance

2015 Plan Section	Update Review and Analysis	2020 Plan Section
	Review mitigation capabilities and update to reflect current capabilities. Indicated projects that have been implemented that may reduce previously identified vulnerabilities. Described how 2015 plan was integrated into other plans and programs.	
Appendices: Appendix A: Meeting Minutes / Sign-In Sheets / Surveys Appendix B: FEMA's Safe Growth Integration Tool and How-To Guide	Appendix A: Update content for 2020 planning process Appendix B: Describe how this tool was used since last update	Appendix A: Planning Team Appendix B: Planning Process Appendix C: EMAP Crosswalk Appendix D: Adoptions Appendix E: Safe Growth Tool Appendix F: References Appendix G: Glossary

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.

Arapahoe County invited every incorporated city, town, and special district in the county to participate in the 2020 Hazard Mitigation Plan update. The Disaster Mitigation Act requires that jurisdictions participate in the planning process and officially adopt the multi-jurisdictional hazard mitigation plan to be eligible for FEMA Hazard Mitigation Assistance grants. The jurisdictions that chose to participate in the planning process and development of the plan or its update were required to meet strict plan participation requirements defined at the beginning of the process, which included:

- Designate a representative to serve on the Planning Team
- Participate in Planning Team meetings
- Complete and return updates on Mitigation Actions since 2015
- Identify new mitigation actions for the plan
- Review and comment on plan drafts
- Inform the public, local officials, and other interested parties about the planning process and provide opportunity for them to comment on the plan
- Formally adopt the mitigation plan and re-adopt every 5 years

The City of Aurora, which is located in Adams and Douglas Counties in addition to Arapahoe County, maintains its own single-jurisdiction hazard mitigation plan. All the other incorporated municipalities in Arapahoe County participated in the 2020 plan update, with the exception of the Town of Columbine Valley which was unable to participate due to other priorities. Denver Water also joined the 2020 planning process as a water provider. The following jurisdictions met all the participation requirements described above:

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- Arapahoe County
- Town of Bennett
- Town of Bow Mar
- City of Centennial
- City of Cherry Hills Village
- Town of Deer Trail
- City of Englewood
- Town of Foxfield
- City of Glendale
- City of Greenwood Village
- City of Littleton
- City of Sheridan
- Denver Water

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.

3.4 The 2020 Planning Process

The Arapahoe 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	
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

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FEMA's 4-Phase DMA Process	Modified 10-Step CRS Process
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

Phase 1 Organize Resources

Step 1: Organize the Planning Effort

This section describes the planning process used during the 2020 update. The previous planning processes for the 2010 and 2015 planning efforts is well documented and can be referenced in those plans. The Arapahoe 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 Arapahoe County Planning Team that was formed during the 2015 Planning Process has met annually since then to review progress on the implementing the plan and formed the core of the 2020 Planning Team. The Arapahoe 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 2020 update; stakeholders are listed in subsection Step 3: Coordinate with Other Departments and Agencies.

The Disaster Mitigation Act requires that each jurisdiction participate in the planning process and officially adopt the multi-jurisdictional hazard mitigation plan. A 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.

During the plan update process, the Planning Team communicated with a combination of online webinars, phone interviews, and email correspondence. Four planning meetings with the Planning Team were held during the plan's development between January 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. The kickoff meeting was conducted in person, but all subsequent meetings were held virtually due to social distancing requirements associated with

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the ongoing COVID-19 pandemic. The sign-in sheets and agendas for each of the meetings are included in Appendix B.

Table 3-3 Schedule of Planning Team Meetings

Meeting	Topic	Date
Kickoff Meeting	Introduction to DMA and the planning process. Identification of hazards impacting Arapahoe County	January 29, 2020
Re-Engagement Meeting	Planning process was paused due to COVID-19 pandemic. The Re-engagement meeting brought the Planning Team back together and the consulting team was introduced.	June 8, 2020
Risk Assessment Meeting	Review of updated risk assessment	June 23, 2020
Mitigation Strategy Meeting	Review of goals and objectives. Review of status updates of 2014 mitigation actions. Development of new mitigation actions.	July 30, 2020

Kickoff Meeting

Figure 3-2 Kickoff Meeting

The plan update process officially began with a kickoff meeting in Centennial, Colorado, on January 29, 2020. Twenty Planning Team members and stakeholders attended. During the kickoff meeting, the Arapahoe County Emergency Manager and Coordinators 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. A representative from Colorado Department of Homeland Security and Emergency Management (DHSEM) was also present at the kickoff meeting and gave an overview of hazard mitigation planning and financial opportunities to fund mitigation projects. Coordinators also introduced the hazard identification requirements and data. The Planning Team reviewed the hazards list from the 2015 plan, and discussed removing some hazards including earthquake, erosion/subsidence and moving extreme temperatures into the spring summer storms and winter weather. The Planning Team decided to add dam failure/incident cyber threats, hazardous materials incidents, and active threat to the 2020 HIRA. The Planning Team discussed jurisdictional priorities and concluded that there had been no significant changes to priorities that would affect this mitigation plan. The Planning Team discussed past events since the 2015 plan. The Arapahoe County Sheriff's Office PIO provided an update on the public HMP website and upcoming public outreach efforts were discussed. Each jurisdiction provided updates on existing capabilities and ongoing mitigation efforts through a data collection spreadsheet created for incorporation into the plan update.

Re-Engagement Meeting

Due to the COVID-19 pandemic, the planning process was placed on hold in March 2020. A re-engagement webinar was held on June 8, 2020. This type of meeting is ideally conducted in-

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person, however in this instance the meeting was held virtually to comply with social distancing requirements as a result of the ongoing Pandemic. The purpose of this virtual meeting was to re-engage the Planning Team members in the planning process and to introduce Wood Environment & Infrastructure Solutions, Inc. (Wood), the consulting firm hired to facilitate the planning process and complete the plan update. Twenty-two people attended the meeting representing a mix of County departments, participating jurisdictions, and stakeholders.

Risk Assessment Meeting

On June 23, 2020, the Planning Team convened virtually to review and discuss the results of the risk and vulnerability assessment update. Thirty-two 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. A survey was developed by Wood and shared with the Planning Team after the meeting, asking 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 2015 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 5 Mitigation Strategy. Refer to the meeting summary in Appendix B for notes related to each hazard discussed and results from the post meeting survey.

Mitigation Strategy Meeting

The Planning Team convened virtually on July 14, 2020 with forty-five people participating to update the plan's mitigation strategy. The group finalized the plan's goals and objectives, and 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 for their jurisdiction.

City of Englewood Planning Team Meeting

In addition to the four full Planning Team meetings listed above, the City of Englewood Planning Team also held a Hazard Mitigation Plan Workshop on October 6, 2020. Fifteen individuals from the City were present at the workshop. The county Emergency Management Coordinators presented information to the group on the scope, purpose, and requirements of the Hazard Mitigation Plan update, reviewed the updated HIRA results, reviewed the revisions of mitigation goals, and discussed mitigation action and possible alternatives. The workshop ended with the following action items specific to the City of Englewood: ranking hazards, status/implementation updates 2015 mitigation actions, developing new mitigation actions and completing the jurisdictional capabilities survey.

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.

An important component of the success of Arapahoe County's community-based mitigation planning process involves ongoing public, stakeholder, and jurisdiction participation. Individual citizen involvement provides the Planning Team with a greater understanding of local concerns and ensures a higher degree of mitigation success by developing community buy-in from those directly affected by the planning decisions of public officials.

Public input was sought throughout the planning process by advertising an open public survey through local newspapers and bulletins across the county, social media networks (including agency and municipal Twitter and Facebook accounts), and agency websites.

Multiple media platforms were used to reach and engage the maximum number of local and regional stakeholders. Communication pathways included social media outlets including Twitter and Facebook, and County and local jurisdiction websites and email lists, screenshots of the communication can be found in Appendix B.

Figure 3-3 Example of Planning Announcements for Public Engagement and Input

A website was created to provide information to public stakeholders and to obtain feedback on the 2020 Arapahoe County Hazard Mitigation Plan Update. In addition to providing hazard mitigation information, announcements and calendar information, the draft Plan was posted on the website. The screen shot below provides a visual of the project website.

Figure 3-4 Project Website and Public Engagement Platform

Hazard mitigation planning is a process that state, tribal and local governments use to identify risks and vulnerabilities associated with natural and human-caused hazards (tornadoes, floods, cyber-attacks, etc.), and develop long-term strategies for protecting people and property from future events. Developed with community, stakeholder, and public input, state, tribal, and local governments use these plans to help break the cycle of disaster damage, reconstruction and repeated damage.

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 updated plan. The survey gathered public feedback on concerns about hazards and suggestions on mitigation activities. The survey was released on January 30, 2020 and closed on April 30, 2020. The Planning Team distributed links to the public survey through social media, email, and posting the link on websites.

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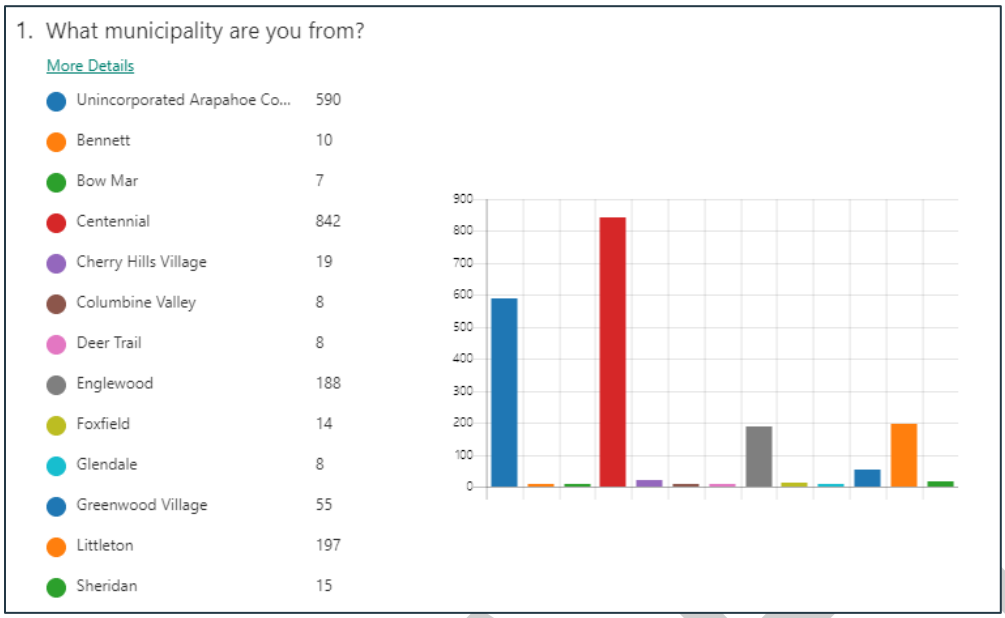
Figure 3-5 Public Survey Responses



One thousand nine hundred and sixty-three (1,963) people filled out the survey online. Results showed that the public perceives the most significant hazards to be severe summer weather; cyber threats; severe winter weather; active threats; and drought. This information was shared with the Planning Team, who were encouraged to refer to the survey results when ranking hazards or thinking of new mitigation actions. A summary of all the survey data and documentation of the public feedback can be found in Appendix B.

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. Arapahoe County provided the plan draft for review and comment on the County website from November 6 to 17, 2020. (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 35 comments from the public. These comments helped to inform the Planning Team on the public's perception of hazard mitigation and hazards in their community and were used when considering potential new mitigation actions.

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 Arapahoe County. Coordination with these organizations and other community planning efforts is vital to the success of this plan update. The Arapahoe 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 Adams, Denver, Elbert, Douglas and Jefferson Counties and the City of Aurora were 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.

Other Government and Stakeholder Representatives

- South Metro Fire*
- Watkins/Bennett Fire Department
- Sable Altura Fire District
- Deer Trail Volunteer Fire Department
- Centennial Airport
- Mile High Flood District*
- Southeast Metro Stormwater Authority (SEMSWA)*
- Colorado State University
- Colorado Division of Homeland Security and Emergency Management (DHSEM)*

Many of these groups found it beneficial to participate on the Planning Team. As part of the Planning Team and public outreach processes, stakeholders were invited to review and comment on the plan prior to submittal to Colorado DHSEM and FEMA.

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. See Appendix A for documentation of stakeholder participation.

Incorporation of Existing Plans and Other Information

Coordination and synchronization with other community planning mechanisms and efforts is 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. Arapahoe 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 Arapahoe 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 3-4 Summary of Review of Key Plans, Studies and Reports

Plan, Study, Report Name	How Plan informed LHMP
Arapahoe County Comprehensive Plan (2018)	Provided background information on the county including some information related to jurisdictions. Informed the Community Profile in Chapter 2 and Chapter 4 Risk Assessment.
Eastern Arapahoe County Community Wildfire Protection Plan (CWPP) (2012)	Informed the wildfire profile in Chapter 4 Risk Assessment.
Arapahoe County 2035 Transportation Plan (2010)	Provided background information on County transportation systems and future development of transportation.
Arapahoe County Flood Insurance Study – Preliminary (2018)	Reviewed for information on past floods and flood problems to inform risk assessment (Chapter 4)
State Demography Office Colorado Demographic Profiles: • Arapahoe County • City of Aurora • City of Centennial • City of Cherry Hills Village • Town of Columbine Valley • City of Deer Trail • City of Englewood • Town of Foxfield • City of Glendale • City of Greenwood Village • City of Littleton • City of Sheridan	Informed the demographic trends in the county and in each incorporated jurisdiction. Chapter 2 Community Profile, Chapter 4 Risk Assessment.
Colorado State Drought Response and Mitigation Plan (2018)	Informed the drought hazard and dam incident profiles and vulnerability assessments in Chapter 4 risk assessment.
Colorado State Hazard Mitigation Plan (2018)	Informed the HIRA (Chapter 4) with risk information specific to Arapahoe County and hazard profile information for each of the hazards. Used as a reference in the development and review of mitigation goals.

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.

- Colorado Emergency Resource Mobilization Plan
- State of Colorado Emergency Operations Plan
- State of Colorado EOP Emergency Support Function Annexes
- State of Colorado EOP Supporting Annexes
- State of Colorado EOP Incident Annexes
- Colorado Division of Water Resources – Dam Safety
- Colorado Wildfire Risk Assessment Portal (CO-WRAP)
- Federal Wildland Fire Occurrence Database
- FEMA Community Information System
- National Drought Mitigation Center – Drought Impact Reporter
- National Oceanic and Atmospheric Administration (NOAA)
- National Register of Historic Places
- National Weather Service (NWS)
- U.S. Army Corps 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. Drought Monitor
- U.S. Environmental Protection Agency (EPA)
- U.S. Geological Survey
- Western Regional Climate Center

Phase 2 Assess Risk

Step 4: Identify the Hazards

Wood and OEM staff led the Planning Team in an effort to review the list of hazards identified in the 2015 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 Arapahoe County. The profile of each of these hazards was then developed and updated in 2020 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 Arapahoe County, the Planning Team 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 to natural and human-caused hazards, both overall and in identified hazard areas. These assets included total number and value of structures; critical facilities and infrastructure; natural, historic, and

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cultural assets; and economic assets. The Planning Team also analyzed development trends in hazard areas. The county's 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. Refer to Section 2.7 for existing capabilities as well as identified opportunities to enhance those capabilities.

A more detailed description of the risk assessment process and the results are included in Chapter 4 Risk Assessment.

Phase 3 Develop the Mitigation Plan

Step 6: Set Goals

Wood facilitated a brainstorming and discussion session with the Planning Team during their fourth meeting to review and update the goals and objectives for the overall hazard mitigation plan update. The Planning Team 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 was provided a survey after the meeting to review the goals and objectives more closely and provide recommendations on revisions. After discussing how jurisdictional priorities had changed since 2015, the Planning Team decided to combine two goals into one goal focused on critical infrastructure and decided not to include objectives in the 2020 plan. The group discussed the ideas and came to consensus on the final goals for the plan update, which are further discussed in Chapter 5.

Step 7: Review Possible Activities

The Planning Team 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 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 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 member. This process is described in more detail in Chapter 5 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 2015 plan.

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Step 8: Draft the Plan

A first draft of the HIRA section was completed in September and distributed to the Planning team for review and comment. The first complete draft of the plan update, including the revised HIRA, was developed and submitted to the Planning Team for review in October 2020. Once the Planning Team's comments were incorporated, a complete draft of the plan was made available online for review and comment by the public and other agencies and interested stakeholders from November 6-17, 2020, as discussed above under Step 2 Involve the Public. 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.

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 D 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 2015 HMP was implemented and maintained since its adoption; this is described in Section 6.2.

The strategy for implementing and maintaining the 2020 plan, including a strategy for continued public involvement, was updated and is described in Chapter 6 Plan Implementation and Maintenance.

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4. Hazard Identification and 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. [The risk assessment shall include a] description of the type of all natural hazards that can affect the jurisdiction.

4.1 Introduction and Summary

This section of the Arapahoe County Hazard Mitigation Plan describes the local Hazard Identification and Risk Assessment summary undertaken by the county and participating jurisdictions. 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 hazardous events.

A key step to mitigate disaster losses in Arapahoe County is developing a comprehensive understanding of the community's hazards, vulnerabilities, and risks. The following terms are used throughout the Plan to facilitate comparisons between communities.

- **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. A hazard may be naturally occurring (flood, tornado, etc.) or it may be human-caused (Active threat, hazmat, etc.).
- **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.
- **Risk:** The potential for damage, loss, or other impacts created by the interaction of hazards with vulnerabilities.

The relationship between hazards, vulnerabilities, and risk is depicted in Figure 4-1. 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. This risk assessment covers the entire geographical area of Arapahoe County. Since this is a multi-jurisdictional plan, the Planning Team also evaluated how the hazards and risks vary from jurisdiction to jurisdiction.

Figure 4-1 Risk Graphic

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The term "threat" is sometimes used to refer to human-caused hazards. Arapahoe County has completed a countywide Threat and Hazard Identification and Risk Assessment (THIRA) in accordance with CPG201. However, despite the similarity in their names, the HIRA and THIRA are two very different documents following very different methodologies. As described in Section 6.3, this updated HIRA can serve to help complete Steps 1-2 of the THIRA process.

Disaster Declaration History

To help focus the list of identified hazards for the Plan, the HMPC examined past events 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 can issue a disaster declaration through FEMA, the U.S. Department of Agriculture (USDA), and/or the Small Business Administration (SBA). FEMA also issues emergency declarations, which are more limited in scope and without the long-term federal recovery programs of major disaster declarations. The quantity and types of damage are the determining factors.

Since 1955, Colorado has received 93 federal declarations, including 22 presidential disaster declarations, 5 emergency declarations, and 66 fire management assistance awards. Arapahoe County has received 11 declarations, consisting of 6 presidential disaster declarations and 5 emergency declarations. These disasters are summarized in Table 4-1.

Table 4-1 Presidential Disaster and Emergency Declarations in Arapahoe County

Declaration #	Date	Event Details
EM-3436 DR-4498	3/13/2020 3/28/2020	COVID-19 Pandemic
EM-3365 DR-4145	9/12/2013 9/14/2013	Severe Storms, Flooding, Landslides, and Mudslides
EM-3270	1/7/2007	Snowstorm
EM-3224	9/5/2005	Colorado Hurricane Katrina Evacuation
EM-3185	4/9/2003	Snowstorm
DR-1421	6/19/2002	Wildfires
DR-385	5/23/1973	Heavy Rain, Snowmelt, Flooding

Declaration #	Date	Event Details
DR-261	5/19/1969	Severe Storms, Flooding
DR-200	6/19/1965	Tornados, Severe Storms, Flooding

Source: FEMA

Changing Future Conditions

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. The term changing future conditions refers to changes over a long period of time. It is generally perceived that changes in future conditions will have a measurable impact on the occurrence and severity of natural hazards around the world. Impacts are likely to include the following:

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

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.

Recent warming in the southwest region is among the most rapid in the nation and is significantly greater than the global average; the period from 1950 to 2018 has been hotter than any comparable long period in at least 600 years. Summer temperatures across the state are expected to increase 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. Figure 4-2 shows the projected changes in average temperatures as compared to the period 1971-1999. The top row shows projections assuming the higher emission scenario, while the maps on the bottom row show projections if emissions were reduced substantially. Under the higher emissions scenario average temperatures in Colorado will warm by 2.5°F to 5.5°F by 2041-2070 and by 5.5°F to 9.5°F by 2070-2099 (NCA4 2018).

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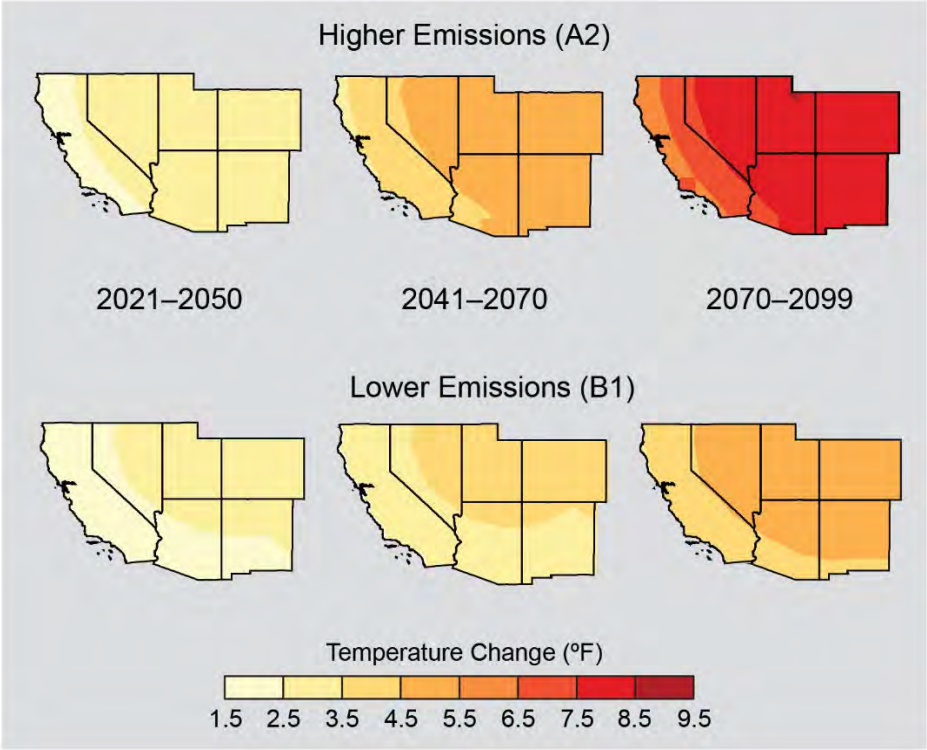
Figure 4-2 Projected Temperature Increases in Southwest Region



Source: NCA4, Adapted from Kunkel et al. 2013

Projected increases in temperatures in the southwest region are also projected to increase the probability 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. They may also affect infrastructure through increased risk of disruptions of electric power generation. Water supplies are 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, representing a major risk for the agricultural industry and food security nationwide.

The impacts of changing future conditions already pose a threat to people and property in the southwest region of the United States, including Arapahoe 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 Arapahoe County has historically dealt with. This is particularly true for drought, flooding, wildfire, and extreme temperature hazards. 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 2020 Arapahoe County Hazard Mitigation Plan update takes changing future conditions into consideration when evaluating the frequency, intensity, and distribution of 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 future conditions projections in the risk rankings and vulnerability assessments of the hazards included in the Plan.

Hazard Identification and Ranking

Historical data, catastrophic potential, relevance to the jurisdiction, and the probability and potential magnitude of future occurrences were all used to identify and prioritize the list of hazards most relevant to Arapahoe County. Hazard data was obtained from various federal, state, and local sources such as FEMA, the Colorado Geological Survey (CGS), the Colorado Dam Safety Division, 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 monetary losses in the future.

Arapahoe 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. Table 4-2 summarizes changes in the hazards profiled in the 2020 update compared to the 2015 HMP. The major changes were the inclusion of four human-caused hazards, and the exclusion of Earthquake and Erosion/Land Subsidence due to their low risk to the county.

Table 4-2 Updates and Changes to Arapahoe County Hazards

Hazard	Status and Update for 2020
Active Threat	New in 2020.
Cyber Threat	New in 2020.
Dam Failure	New in 2020.
Drought	Included in 2015 HMP, updated for 2020.
Earthquake	Included in 2015 HMP, not profiled for 2020 due to low risk.
Erosion/Land Subsidence	Included in 2015 HMP, not profiled for 2020 due to low risk.
Extreme Temperatures	Included in 2015 HMP, combined into Severe Summer Weather and Severe Winter Weather for 2020.
Flooding	Included in 2015 HMP, updated for 2020.
Hazardous Materials Release	New in 2020.
Public Health Hazards	Included in 2015 HMP, updated and retitled to focus on Pandemics.
Severe Storms	Included in 2015 HMP, broken out into Severe Summer Weather and Severe Winter Weather for 2020.
Severe Wind/Tornado	Included in 2015 HMP, updated for 2020.
Wildfire	Included in 2015 HMP, updated for 2020.

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The HMPC also reviewed the following hazards from the 2018 Colorado State Hazard Mitigation Plan, but determined they do not present sufficient risk in Arapahoe County to justify inclusion.

- Animal Disease Outbreak
- Avalanche
- CBRN Attacks
- Critical Infrastructure Disruption
- Dense Fog
- Expansive Soils
- Explosive Attack
- Landslide/Debris Flows/Rock Fall
- Mine Accident
- Pest Infestation
- Power Failure
- Radiological Release
- Radon/CO/Methane/Other Seeps
- Telecommunications Failure
- Wildlife Vehicle Collision

Hazard Ranking Methodology

The 2015 Arapahoe 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 hazardous event occurring in a given year?
- Impact: In terms of injuries, damage, or death, are impacts anticipated to be minor, limited, critical, or catastrophic when a significant hazardous 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 hazardous 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 2020 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 follow, and to make it easier to incorporate the lived experience of HMPC members, stakeholders, and the public. The term 'Extent,' while used by FEMA, was changed to Location to be more clear to a general reader. The term 'Impact' was replaced by Magnitude/Severity. Warning Time and Duration were deleted as separate factors and incorporated into Magnitude/Severity. The criteria used are defined in Table 4-3 below.

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Overall Hazard Significance Summary

Table 4-3 shows overall hazard significance countywide, 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 2020 Plan update, the individual ratings and significance of the hazards was revisited and updated. Public concern was also considered from an online survey and public review of the draft Plan.

Table 4-3 Arapahoe County Hazard Significance

Hazard	Frequency	Spatial Extent	Severity	Overall Significance
Active Threat	Occasional	Limited	Limited	Low
Cyber Threat	Likely	Significant	Critical	Medium
Dam Failure	Unlikely	Significant	Critical	Medium
Drought	Likely	Extensive	Limited	Medium
Flooding	Likely	Significant	Limited	Medium
Hazmat Release	Likely	Significant	Critical	Medium
Pandemic	Occasional	Extensive	Critical	High
Severe Summer Weather	Highly Likely	Significant	Critical	High
Severe Wind/Tornado	Likely	Significant	Limited	Medium
Severe Winter Weather	Highly Likely	Extensive	Limited	High
Wildfire	Highly Likely	Extensive	Limited	Medium

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/Location:
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
Limited: 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 municipalities. Table 4-4 summarizes the overall risk and significance of each hazard by jurisdiction; further details can be found in the Jurisdictional Differences section of the hazard profiles.

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Table 4-4 Hazard Significance by Jurisdiction

Hazard	Arapahoe County	Bennett	Bow Mar	Centennial	Cherry Hills Village	Columbine Valley	Deer Trail	Englewood	Foxfield	Glendale	Greenwood Village	Littleton	Sheridan	Denver Water
Active Threat	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Med	Low	Low
Cyber Threat	Med	Med	Med	Med	Med	Med	Med	Med	Med	Med	Med	High	Med	Med
Dam Failure	Med	Low	High	Low	Low	High	Low	Med	Low	High	Low	Med	High	Med
Drought	Med	Med	Med	Med	Med	Med	Med	Med	Med	Med	Med	Med	Med	Med
Flooding	Med	Med	Med	High	Med	Med	Med	High	Med	Med	Med	Med	Med	Med
Hazmat Release	Med	Med	Low	Med	Med	Low	Med	High	Low	Low	Med	Med	Med	Med
Pandemic	High	High	High	High	High	High	High	High	High	High	High	High	High	High
Severe Summer Weather	High	High	High	High	High	High	High	High	High	High	High	High	High	High
Severe Wind/ Tornado	Med	High	Med	Med	Med	Med	High	Med	Med	Med	Med	Med	Med	Med
Severe Winter Weather	High	High	High	High	High	High	High	High	High	High	High	High	High	High
Wildfire	Med	Med	Med	Med	Med	Med	Med	Low	Med	Med	Med	Med	Low	Med

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4.2 Asset Summary

General Property

General property exposure to hazards is based on Arapahoe County's parcel data containing assessor information such as total number of parcels, improvement values, and residential / non-residential parcel types by jurisdiction. Non-residential property types were not split out by classification in this plan. Only those parcels with improvements, values greater than $0, were used for analysis; non-developed or non-improved parcels were excluded for the purposes of conducting the vulnerability assessment.

Counts and values are based on the latest county assessor's data (as of January 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 using standard FEMA Hazus: 50% of the improvement value for residential structures (including mobile homes) and 100% for non-residential parcels. Finally, Total Values were aggregated by adding the improvement and content values for each jurisdiction. Table 4-5 shows the total number of improved parcels, properties, and their improvement and content values by jurisdiction.

Table 4-6 summarizes parcels for Arapahoe County by parcel type. For this analysis, only parcels and populations falling within Arapahoe County were included; values for municipalities that cross county lines only include those portions within Arapahoe County. The below information indicates that 77% of parcels are residential in nature and 23% are non-residential. The Total Values of parcels available for assessment is over $122 billion including both improvement values and content values. A total of 221,523 parcels were summed up for this exposure summary.

For hazards with a geospatial component and where good data was available, the parcel layer was overlaid with the hazard layer to determine the parcels exposed to the hazards. The hazards that had enough geospatial data to conduct this parcel level hazard analysis were Dam Failure/Incidents, Flood, and Wildfire.

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Table 4-5 Improved Parcel Exposure Values by Jurisdiction

Jurisdiction	Population (Census)	Residential Parcels	Residential Improved Value	Residential Contents	Non-Residential Parcels	Non-Residential Improved Values	Non-Residential Contents	Total Parcels	Total Value
Aurora	324,754	97,542	$27,670,781,515	$13,835,390,758	11,727	$4,134,781,785	$4,134,781,785	109,269	$49,775,735,843
Bennett	400	165	$62,902,430	$31,451,215	94	$990,585	$990,585	259	$96,334,815
Bow Mar	671	226	$132,021,516	$66,010,758	28	$319,725	$319,725	254	$198,671,724
Centennial	110,955	36,067	$12,006,868,610	$6,003,434,305	3,458	$2,839,718,853	$2,839,718,853	39,525	$23,689,740,621
Cherry Hills Village	6,651	2,186	$1,857,622,144	$928,811,072	246	$62,919,789	$62,919,789	2,432	$2,912,272,794
Columbine Valley	1,482	575	$381,740,473	$190,870,237	206	$13,093,229	$13,093,229	781	$598,797,168
Deer Trail	731	326	$52,124,045	$26,062,023	245	$10,956,703	$10,956,703	571	$100,099,474
Englewood	34,963	9,846	$2,681,154,096	$1,340,577,048	1,845	$961,263,517	$961,263,517	11,691	$5,944,258,178
Foxfield	778	278	$168,770,399	$84,385,200	49	$15,083,788	$15,083,788	327	$283,323,175
Glendale	5,026	367	$406,506,027	$203,253,014	179	$313,587,260	$313,587,260	546	$1,236,933,561
Greenwood Village	16,146	4,483	$3,010,228,471	$1,505,114,236	1,036	$2,142,109,897	$2,142,109,897	5,519	$8,799,562,501
Littleton	45,266	12,768	$4,443,881,761	$2,221,940,881	1,859	$1,201,464,244	$1,201,464,244	14,627	$9,068,751,130
Sheridan	6,219	1,232	$374,506,578	$187,253,289	554	$334,615,634	$334,615,634	1,786	$1,230,991,135
Unincorporated	97,668	25,972	$10,089,118,153	$5,044,559,077	7,964	$1,617,869,189	$1,617,869,189	33,936	$18,369,415,608
Total	**651,710**	**192,033**	**$63,338,226,218**	**$31,669,113,109**	**29,490**	**$13,648,774,198**	**$13,648,774,198**	**221,523**	**$122,304,887,723**

Source: Arapahoe County GIS and Assessor's Office, Wood analysis.

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Table 4-6 Improved Parcel Exposure Values by Parcel Type

Parcel Type	Improved Parcels	Improved Values	Content Values	Total Values
Residential	192,033	$63,338,226,218	$31,669,113,109	$95,007,339,327
Non-Residential	29,490	$13,648,774,198	$13,648,774,198	$27,297,548,396
Total	**221,523**	**$76,987,000,416**	**$45,317,887,307**	**$122,304,887,723**

Source: Arapahoe County GIS and County Assessor's Office, Wood analysis.

People

Population estimates were calculated for hazards with a geospatial component and for which data was available for GIS-based parcel analysis. As noted above, population values for municipalities that cross county lines only include those portions within Arapahoe County. These were based on dividing the total 2018 Census population by the total number of residential parcels to get an average number of people per parcel for each jurisdiction. Average population per residential parcel was calculated as Aurora 3.4, Bennett 2.5, Bow Mar 4.0, Centennial 3.0, Cherry Hills Village 3.0, Columbine Valley 2.1, Deer Trail 1.5, Englewood 3.4, Foxfield 2.3, Glendale 14.1, Greenwood Village 3.5, Littleton 3.5, Sheridan 4.9, Unincorporated County 3.2. (Note that Glendale's average is considerably higher, reflecting the high number of apartment buildings and multi-unit structures in that City.) This value was then multiplied by the number of residential parcels that overlap with a hazard layer to get an estimate of the population exposed to that hazard. For more details on economic assets, development trends, and other population and demographic information refer to Chapter 2 Community Profile.

Critical Facilities and Infrastructure

A critical facility is one that is essential in providing utility or direction either during the response to an emergency or during the recovery operation. Table 4-7 summarizes the inventory of critical facilities by jurisdiction and by FEMA Lifeline Type in Arapahoe County based on best available data. The locations of these facilities are displayed in Figure 4-3 and Figure 4-4.

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.

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

Table 4-7 Critical Facilities and Infrastructure in Arapahoe County By Jurisdiction

Jurisdiction	Communications	Energy	Food, Water, Shelter	Hazardous Materials	Health and Medical	Safety and Security	Transportation	Total
Aurora	455	40	196	86	14	175	4	**970**
Bennett							1	**1**
Bow Mar								**0**
Centennial	140	10	92	424	5	13	54	**738**
Cherry Hills Village	16		12	11		8		**47**
Columbine Valley	3			3		2		**8**
Deer Trail	1		6	1		2	1	**11**
Englewood	71	5	43	159	6	12	18	**314**
Foxfield	1	1	2	5		1		**10**
Glendale	43		1	16		2		**62**
Greenwood Village	71	1	29	125	1	4	5	**236**
Littleton	91	6	57	283	4	17	25	**483**
Sheridan	18	2	14	226		4	15	**279**
Unincorporated County	235	20	66	292	1	23	106	**743**
Total	**1,145**	**85**	**518**	**1,631**	**31**	**263**	**229**	**3,902**

Source: Arapahoe County Assessor's Office, Wood analysis.

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

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Figure 4-3 Critical Facilities in Western Arapahoe County

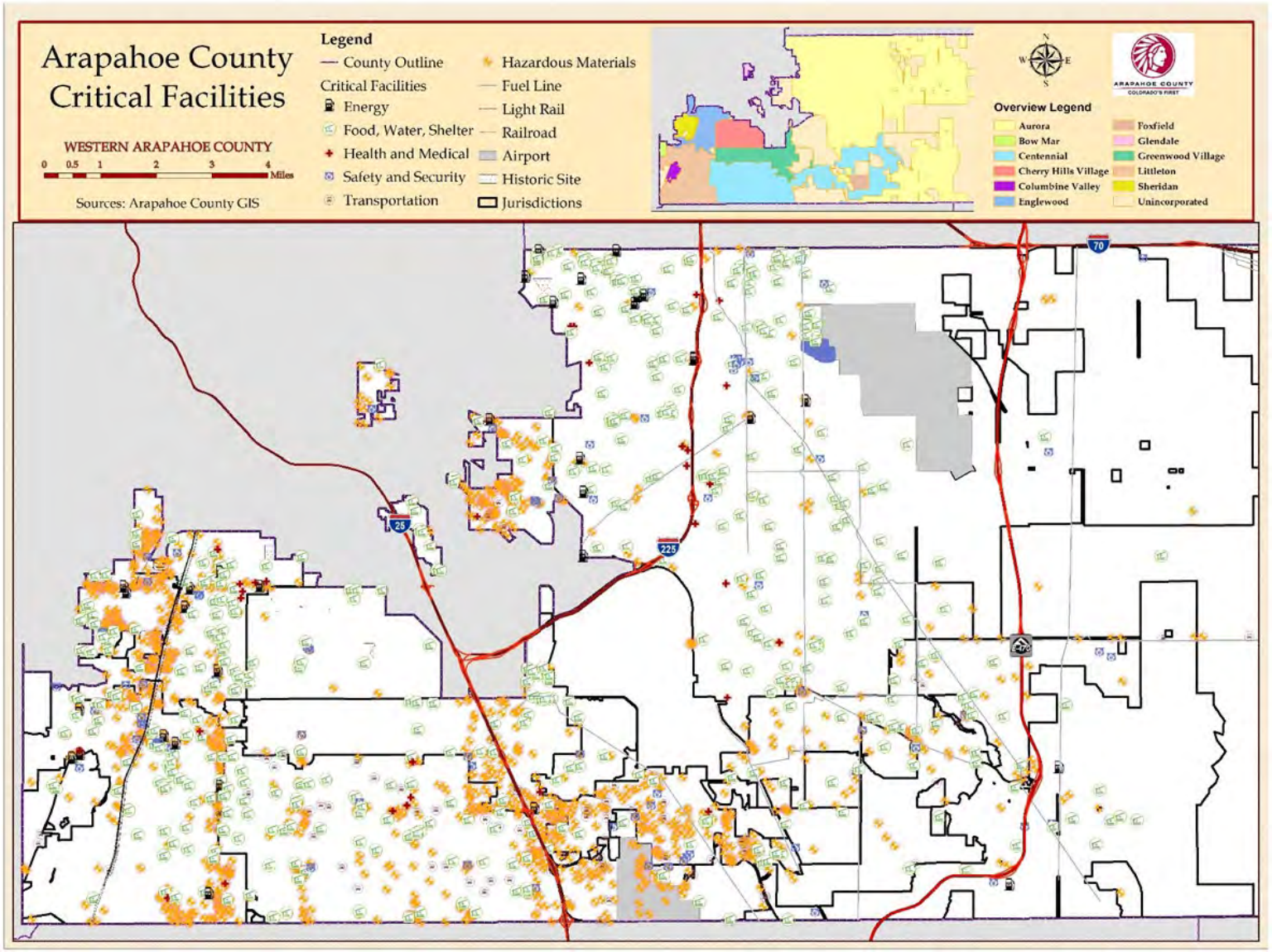
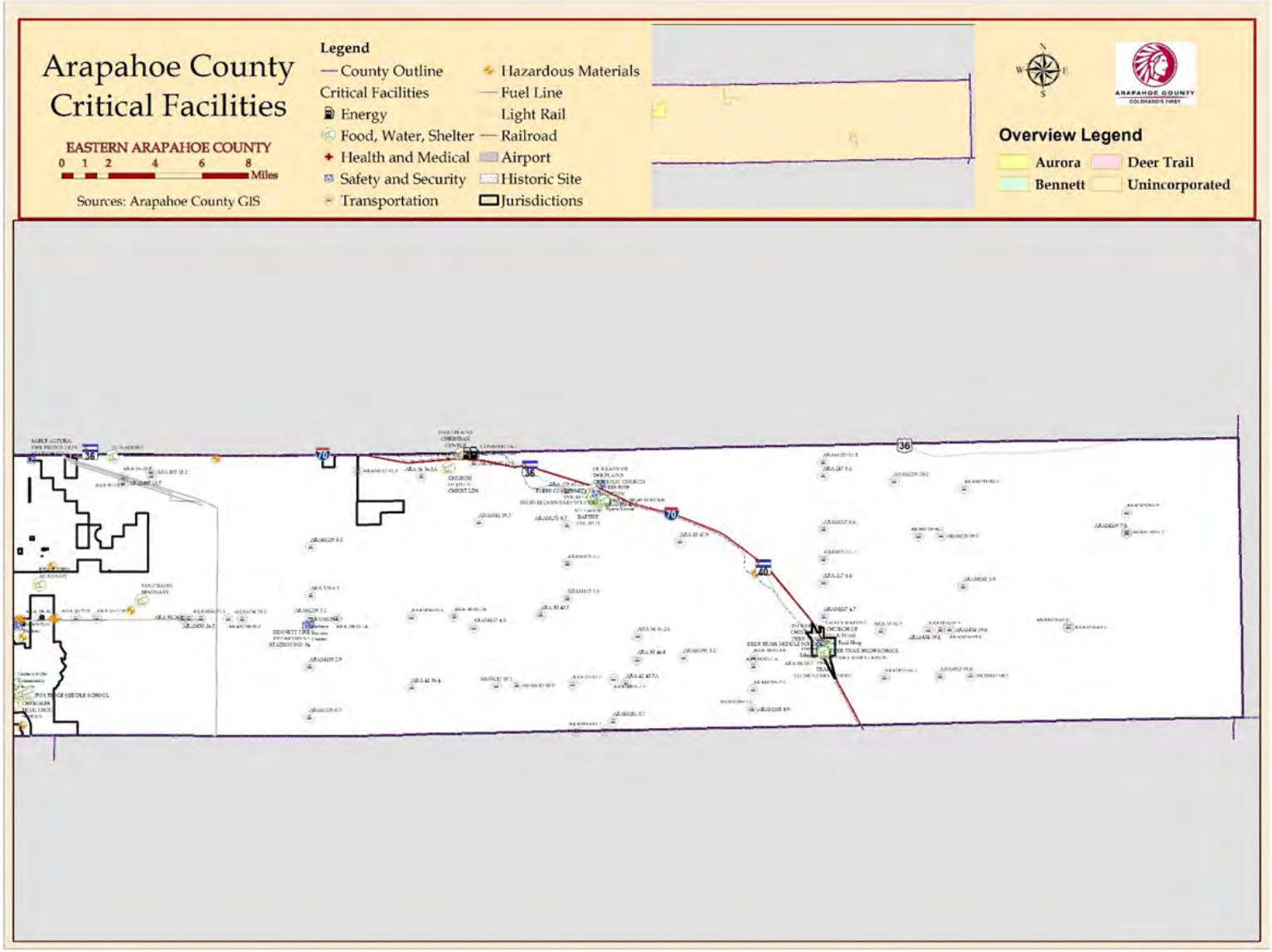


Figure 4-4 Critical Facilities in Eastern Arapahoe County



Historic, Cultural and Natural Resources

Assessing the vulnerability of Arapahoe 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.

Historic 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.

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 Arapahoe County was obtained from the National Register of Historic Places (NRHP). The NRHP database, administered by the National Park Service, is the Nation's official list of cultural resources worthy of preservation, and the NRHP overall 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 NRHP database lists 24 historic resources in Arapahoe County, as summarized in the following table:

Table 4-8 Historic and Cultural Resources Noted by the NRHP

Location	Historic Place Name	Date Entered into Register	Data Source
Aurora	Commandant of Cadets Building, US Air Force Academy	4/24/2007	NRHP
Aurora	DeLaney Barn	2/9/1989	NRHP
Aurora	Gully Homestead	1/9/1986	NRHP
Aurora	Jamaica Primary School	5/1/2017	NRHP

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Location	Historic Place Name	Date Entered into Register	Data Source
Aurora	Melvin School	1/5/1984	NRHP
Aurora	Smith, William, House	9/26/1985	NRHP
Cherry Hills Village	Foster--Buell Estate	4/1/1998	NRHP
Cherry Hills Village	Little Estate	5/29/1998	NRHP
Cherry Hills Village	Maitland Estate	9/3/1998	NRHP
Cherry Hills Village	Owen Estate	9/17/1999	NRHP
Englewood	Arapahoe Acres	11/3/1998	NRHP
Englewood	Brown, David W., House	4/10/1980	NRHP
Englewood	Englewood Post Office	7/20/2011	NRHP
Englewood	Hopkins Farm	4/24/2007	NRHP
Englewood	Key Savings and Loan Association Building	7/18/2016	NRHP
Greenwood Village	Curtis School	6/25/1992	NRHP
Littleton	Arapaho Hills	8/28/2012	NRHP
Littleton	Geneva Home	1/21/1999	NRHP
Littleton	Knight--Wood House	10/6/2004	NRHP
Littleton	Littleton Main Street	4/8/1998	NRHP
Littleton	Littleton Post Office	4/26/2019	NRHP
Littleton	Littleton Town Hall	9/4/1980	NRHP
Parker	Seventeen Mile House	10/6/1983	NRHP
Strasburg	Comanche Crossing of the Kansas Pacific Railroad	8/10/1970	NRHP

Note: NRHP = National Register of Historic Places Source: NPS NRHP

Colorado has a similar historical resource record version, called the Colorado State Register of Historic Properties. This database contains 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 this statewide record set, Arapahoe County contains an additional 6 existing resources deemed historic preservation-worthy.

The National Environmental Policy Act (NEPA) and National Historic Preservation Act (NHPA) define any property over 50 years of age as a historic resource potentially eligible for the National Register. Thus, in the event that the property is to be altered or has been altered as the result of a major federal action, the property must be evaluated under the guidelines set forth by NEPA and the NHPA regarding this key age period. In addition, by law under the NHPA, "members of the public have a voice when federal actions will affect properties that qualify for the National Register of Historic Places, the nation's official list of historic properties" (A Citizen's Guide to Section 106 Review, 2016). Structural mitigation projects are considered alterations for the purpose of these NEPA/NHPA regulations, if regarding historical properties and places.

Table 4-9 Arapahoe County Historic and Cultural Resources in the Colorado Historic Register

Historic Place Name	Location	Date Entered into Register
Cherry Creek Schoolhouse	9300 E. Union Ave., Englewood	12/8/1993
Denver & Rio Grande Railroad Baggage-RPO Car No. 624	Railroad & Monroe St., Strasburg	12/20/2008
Dransfeldt Building	3431-3435 South Broadway, Englewood	9/30/2016
Englewood Depot	3090 S. Galapago St., Englewood	11/9/1994
Francis-Petry House	3200 E. Quincy Ave., Cherry Hills Village	6/25/2015
Willowcroft Manor	3600 W. Bowles Ave., Littleton	3/10/1993

Source: State of Colorado Register Listed Historic Properties; https://www.historycolorado.org/national-state-register-listed-properties

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 can protect sensitive habitat as well as attenuate and store 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 Arapahoe County (as of October 2020). These are listed in Table 4-10.

Table 4-10 Endangered Species in Arapahoe County

Group	Common Name	Scientific Name	Status
Amphibian	Northern leopard frog	Rana pipiens	Resolved Taxon
Birds	Bald Eagle	Haliaeetus leucocephalus	Recovery
Birds	Mountain plover	Charadrius montanus	Resolved Taxon
Birds	Whooping crane	Grus Americana	Experimental Population, Non-Essential
Birds	Swainson's hawk	Buteo swainsoni	Resolved Taxon
Birds	Ferruginous hawk	Buteo regalis	Resolved Taxon
Birds	Mexican Spotted owl	Strix occidentalis lucida	Threatened
Birds	American peregrine falcon	Falco peregrinus anatum	Recovery
Birds	Western burrowing owl	Athene cunicularia ssp. hypugaea	Species of Concern
Birds	White-faced ibis	Plegadis chihi	Species of Concern
Flowering Plants	Western prairie fringed orchid	Platathera praeclara	Threatened
Flowering Plants	Ute ladies' – tresses	Spiranthes diluvialis	Threatened
Mammals	Preble's meadow jumping mouse	Zapus hudsonius preblei	Threatened
Mammals	Little brown bat	Myotis lucifugus	Under Review
Mammals	Long-eared myotis	Myotis evotis	Species of Concern
Mammals	Black-tailed prairie dog	Cynomys ludovicianus	Resolved Taxon
Mammals	Swift Fox	Vulpes velox	Resolved Taxon
Reptiles	Eastern short-horned lizard	Phrynosoma douglassii brevirostra	Species of Concern

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

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4.3 Active Threat

Hazard Description

An active threat can encompass a variety of malicious acts including explosive attacks, conventional firearm attacks, explosives, vehicle rammings, or even chemical/biological/ radiological/nuclear (CBRN) attacks. Typically, an active threat is a very short-lived incident meant to inflict as many casualties as possible, although recovery from an incident can last days or even months.

The Department of Homeland Security defines an active shooter as "an individual actively engaged in killing or attempted to kill people in a confined and populated area; in most cases, active shooters use firearms(s) and there is no pattern or method to their selection of victims…situations are unpredictable and evolve quickly...and are often over within 10 to 15 minutes." However, the presence or suspected presence of secondary devices can lengthen the duration of the event until the attack site is determined to be clear. Although this definition focuses on an active shooter, the elements remain the same for most active threat situations.

While many terrorist attacks can also be described as active shooter incidents, here the term is used to refer to non-politically motivated incidents such as recent tragic incidents at schools, places of worship, and workplaces; these attacks are also sometimes called mass shootings. Active shooters typically use firearms (although for the purposes of this plan, the definition of active shooter is broad and intended to include attacks such as vehicle and knife attacks). The motivations for committing such acts range from retribution for a perceived injustice; to acts of violence against racial minorities, LGBTQ persons, or others; to promoting a specific social or political goal. Typically, active shooters are not interested in taking hostages or attaining material gain, and frequently are not even interested in their own survival. Unlike organized terrorist attacks, most active shooter incidents are carried out by one or two individuals.

For the purposes of this hazard profile, normal law enforcement incidents such as barricaded suspects, hostage negotiations, high-risk warrant searches, bomb threats, and other criminal activities are not included.

Hazard Previous Occurrences

According to the FBI Office of Partner Engagement, there have been 277 active shooter incidents from 2000-2018 resulting in 2,430 casualties. Although there is much uncertainty and debate around exactly what constitutes an active shooter incident, a 2014 FBI study reported that the frequency of attacks has increased sharply in recent years, from an average of 6.4 incidents per year during the period 2000-2007, to 16.4 per year during 2008-2014.

School violence is sometimes considered as a subset of active shooter incidents (although not all school incidents involve the use of firearms). The U.S. Secret Service conducted a study of incidents of "targeted school violence" in the U.S. from 2008 to 2017, which they defined as "any incident in which (i) a current or recently former K-12 school student (ii) purposefully used a weapon (iii) to cause physical injury to, or the death of, at least one other student and/or school employee (iv) in or on the immediate property of the school (v) while targeting in advance one or more specific and/or random student(s) and/or employee(s)." The study excluded spontaneous incidents that resulted from unplanned fights or were tied to other criminal acts such as gang

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violence or drug trafficking. The Secret Service study found 41 incidents that met the criteria from 2008 to 2017, an average of 4 per year. As with active shooter incidents, the number of incidents has increased. From 2008 through 2012, the nation saw an average of 2.6 incidents per year; from 2013 through 2017, that number had risen to 5.4 per year. 61% of attacks used firearms, while 39% used knives. In the 41 attacks, 98 victims were harmed, including 79 injured and 19 killed; this averages out to 1.9 persons injured and 0.5 killed per incident.

Table 4-11 lists active shooter incidents that have occurred in Colorado in the last 20 years. While only two of these incidents (Aurora Theater and Arapahoe High School) occurred within the boundaries of Arapahoe County, several others took place in neighboring jurisdictions.

Table 4-11 Active Shooter Incidents in Colorado, 1999-2019

Incident	Fatalities
Columbine High School – 1999	15
Platte Canyon High School – 2006	2
New Life Church Shooting - 2007	4
Deer Creek Middle School - 2010	0
Aurora Theater Shooting – 2012	12
Arapahoe High School Shooting – 2013	2
Colorado Springs Shooting – 2015	4
STEM School Shooting, Highlands Ranch – 2019	1

Source: news media, HMPC

Turning briefly to the threat of terrorism, the Global Terrorism Database (GTD) catalogues more than 190,000 terrorist attacks dating back to 1970. GTD data shows that despite public perception the number of terrorist attacks on US soil has decreased over recent decades. From an average of 147.5 incidents per year in the 1970s, the frequency of attacks declined to 51.8 per year in the 1980s, then to 37.0 per year in the 1990s, and to 22.8 per year in the 2000s. An increase in attacks from 2015 through 2018 brought that average back up to 39.6 incidents per year for 2011 through 2018 (the most recent year the GTD has analyzed), but this is still well below the frequency seen in the 70s and 80s.

Hazard Location

Active threats can and have happened in Arapahoe County. While the trend in active threats has been to target high population areas, soft target venues, businesses, and schools, incidents across Colorado and the nation shows they can happen anywhere, as shown in Figure 4-5.

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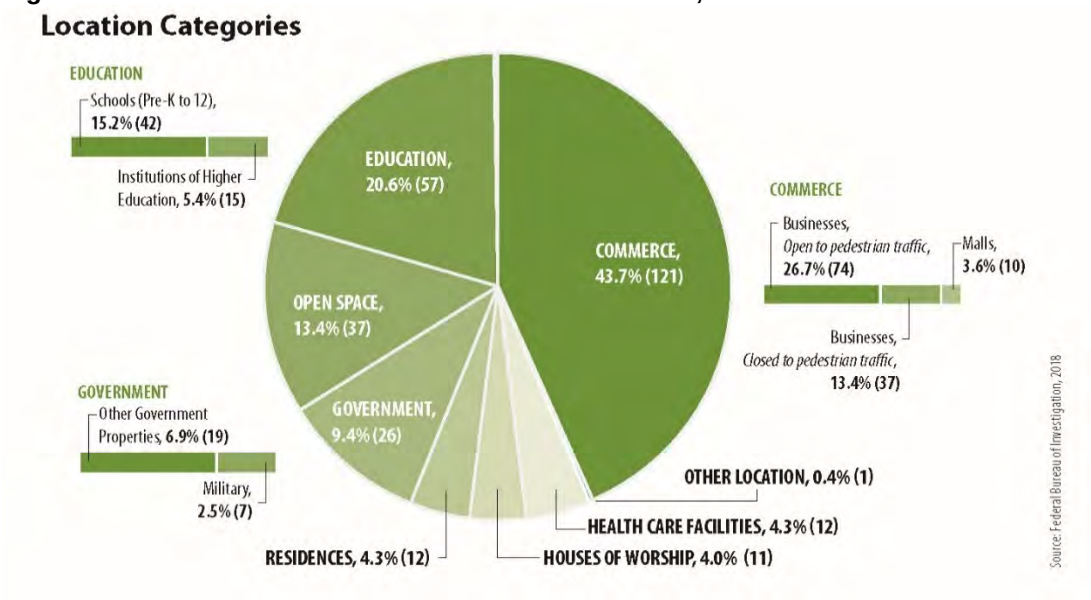
Figure 4-5 277 Active Shooter Incidents in the U.S., 2000-2018



Source: FBI, 2018

Hazard Magnitude/Severity

Active threats can be measured in multiple ways including length of incident, casualties, and number of perpetrators. According to a U.S Department of Justice (DOJ) study of active shooter incidents, the extent of this hazard is:

- Number of incidents: 11.4 annually
- Casualties: Ranges from 1-32 fatalities, and 1-70 casualties (wounded and killed)
- Incident length: Averages 12 minutes

Although an active threat may only directly impact one specific piece of infrastructure (i.e. a school, theater, or concert venue), it indirectly impacts the community in many ways. Ongoing closures for investigation, local and national media logistics, VIP visits, mental health concerns, and aversions to similar infrastructure and subsequent impacts to businesses can manifest after an active threat. The psychological impact of these types of incidents is often even worse than the direct impacts and can continue to affect a community for years.

Hazard Probability of Occurrence

The probability of occurrence for an active threat can be difficult to quantify, largely due to different definitions of what constitutes an active threat. The DOJ study reported an average of 11.4 active shooter incidents per year. The 2014 FBI report estimated 16.4 incidents per year. While either number is tragic, a strictly mathematical analysis might conclude that averaging 16.4 active shooter incidents nationally across 3,142 counties (or county-equivalents), there is roughly a 0.5% chance of an incident occurring in any given county in any given year, all other things being equal. Colorado has experienced seven such incidents in the last 20 years, which over 64 counties also equates to roughly a 0.5% of an incident occurring in any given county in any given year. However it should be noted that attacks in neighboring counties can still have significant impacts on Arapahoe County.

Hazard Consequence Analysis

The consequences from an active threat can range from single fatalities to the destruction of critical infrastructure.

Impact to the Public

Most terrorist attacks are primarily intended to kill and injure as many people as possible. Physical harm from a firearms attack or explosive device is not completely dependent on location, but risk is greater in areas where higher numbers of people gather. If a biological or chemical agent were released indoors, it could result in exposure to a high concentration of pathogens, whereas an outdoors release could affect many more people but probably at a lower dose. Symptoms of illness from a biological or chemical attack could go undetected for days or even weeks. Local healthcare workers may observe a pattern of unusual illness or early warning monitoring systems may detect airborne pathogens. People could also be affected by an attack on food and water supply. In addition to impacts on physical health, any terrorist attack would likely cause significant stress and anxiety.

Similarly, most active shooters primarily target people, attempting to kill or injure large numbers of individuals. The number of injuries and fatalities are highly variable, dependent on many factors surrounding the attack including the location, the number of type of weapons used, the shooter's skill with weapons, the amount of people at the location, and law enforcement response time. Statistics indicate an average of 6.5 casualties per active shooter incident. Psychological effects of the incident on not only victims and responders, but also the general public, may last for years.

Impact to Responders

Responders may be the target of secondary attacks meant to exploit the response system.

Impact to Continuity of Operations (including continued delivery of services)

Unless the active threat is directed at a government facility or critical infrastructure, it is unlikely that continuity of operations will be significantly impacted. Potential impacts may include:

- Call priority – Low priority calls for service may be delayed until the incident is over. Property crimes, minor injuries, and transports via ambulance will see an increased response time.
- Delivery of services at government facilities may be impacted if a shelter in place/lockdown/lockout is implemented.

Impact to Property, Facilities, and Infrastructure

Active shooter incidents rarely result in significant property damage. However, active threats can close down property, facilities, and infrastructure for days or even months for investigation or rehabilitation of the site. As examples, the Aurora Theater was closed for 6 months after that shooting incident, and transformer replacement after the Metcalf Sniper Attack took 5 months.

Impact to the Environment

Most active shooter attacks do not cause widespread damage to the environment. Atypical attacks utilizing CBRN materials could significantly impact the environment. Unless an attacker targets a hazardous materials site (fixed facility or rail), or infrastructure such as wastewater or water purification sites, it is unlikely to result in significant impacts to the environment.

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Impact to the Economic Condition of the County and Jurisdictions

Direct economic impacts from most active shooter attacks are minimal. However, indirect costs can be substantial, including:

- Responder costs, including overtime, equipment, resource expenditure, etc.
- Facility damage
- Loss of revenue
- Legal fees
- Mental health/other healthcare related costs
- VIP visits/security
- Policy/legislative changes to increase security

Some statistics from active threats show the different costs, including rebuilding costs. San Bernardino "had to pay $4 million for the response…Connecticut gave the city of Newtown $50 million just for the costs of rebuilding…the costs from the 1999 shooting at Columbine High School came to roughly $50 million." (Delgadillo, 2018)

Impact to Public Confidence in Government

Public confidence in the government is directly related to the ability to respond to an active threat. The response to the Parkland shooting was widely seen as a failure of both policy and procedure, resulting in multiple lawsuits, a vote of no confidence in the Sheriff, and intense media scrutiny.

Changes in Development

Active threats have happened all across the United States and the world. Changes in development based on lessons learned have resulted in additional security at critical infrastructure, collaboration during construction with security professionals, and better training.

Jurisdictional Differences

There are few significant jurisdictional differences for this hazard. Multiple active shooter incidents take place in areas immediately adjacent to the City of Littleton, so the perceived frequency is perceived as higher for that jurisdiction.

Table 4-12 Active Threat Rankings by Jurisdiction

Active Threat	Frequency	Spatial Extent	Severity	Overall Significance
Arapahoe County	Occasional	Limited	Limited	Low
Bennett	Occasional	Limited	Limited	Low
Bow Mar	Occasional	Limited	Limited	Low
Centennial	Occasional	Limited	Limited	Low
Cherry Hills Village	Occasional	Limited	Limited	Low
Columbine Valley	Occasional	Limited	Limited	Low
Deer Trail	Occasional	Limited	Limited	Low
Englewood	Occasional	Limited	Limited	Low
Foxfield	Occasional	Limited	Limited	Low
Glendale	Occasional	Limited	Limited	Low

Active Threat	Frequency	Spatial Extent	Severity	Overall Significance
Greenwood Village	Occasional	Limited	Limited	Low
Littleton	Likely	Limited	Limited	Medium
Sheridan	Occasional	Limited	Limited	Low
Denver Water	Occasional	Limited	Limited	Low

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4.4 Cyber Threats

Hazard Description

The 2018 Colorado State Hazard Mitigation Plan defines cyber attacks as "deliberate exploitation of computer systems, technology-dependent enterprises, and networks." Cyber-attacks use malicious code to alter computer operations or data. The vulnerability of computer systems to attacks is a growing concern as people and institutions become more dependent upon networked technologies. The Federal Bureau of Investigation (FBI) reports that, "cyber intrusions are becoming more commonplace, more dangerous, and more sophisticated," with implications for private- and public-sector networks. Cyber threats can take many forms, including:

- **Phishing attacks:** Phishing attacks are fraudulent communications that appear to come from legitimate sources. Phishing attacks typically come through email but may come through text messages as well. Phishing may also be considered a type of social engineering meant to exploit employees into paying fake invoices, providing passwords, or sending sensitive information.
- **Malware attacks:** Malware is malicious code that may infect a computer system. Malware typically gains a foothold when a user visits an unsafe site, downloads untrusted software, or may be downloaded in conjunction with a phishing attack. Malware can remain undetected for years and spread across an entire network.
- **Ransomware:** Ransomware typically blocks access to a jurisdiction's/agency's/ business' data by encrypting it. Perpetrators will ask for a ransom to provide the security key and decrypt the data, although many ransomware victims never get their data back even after paying the ransom.
- **Distributed Denial of Service (DDoS) attack:** Perhaps the most common type of cyber attack, a DDoS attack seeks to overwhelm a network and causes it to either be inaccessible or shut down. A DDoS typically uses other infected systems and internet connected devices to "request" information from a specific network or server that is not configured or powerful enough to handle the traffic.
- **Data breach:** Hackers gaining access to large amounts of personal, sensitive, or confidential information has become increasingly common in recent years. In addition to networked systems, data breaches can occur due to the mishandling of external drives.
- **Critical Infrastructure/SCADA System attack:** There have been recent critical infrastructure Supervisory Control and Data Acquisition (SCADA) system attacks aimed at taking down lifelines such as power plants and wastewater facilities. These attacks typically combine a form of phishing, malware, or other social engineering mechanisms to gain access to the system.

The 2018 Colorado State Hazard Mitigation Plan concludes: "This is a newly developing threat, so as more resources are devoted to countering the hazard, the risk of a disruption would hopefully decrease. Mitigation opportunities for this hazard include continued diligence of the state's Office of Information Technology (OIT), as well as for other government and private sector entities to continue to monitor, block, and report cyber-attacks, and continually assess the vulnerability of systems."

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Hazard Previous Occurrences

The cybersecurity firm Symantec reports there were a total of 1,209 data breaches worldwide in 2016. While the number of breaches has remained relatively steady, the average number of identities stolen has increased to almost one million per incident. The report also found that one in every 131 emails contained malware, and the company's software blocked an average of 229,000 web attacks every day.

The Privacy Rights Clearinghouse, a nonprofit organization based in San Diego, maintains a timeline of 9,741 data breaches resulting from computer hacking incidents in the United States from 2005-2019. The database lists 47 data breaches against systems located in Colorado, totaling over 400,000 impacted records; it is difficult to know how many of those affected Arapahoe County residents. Attacks happening outside of the state can also impact local businesses, personal identifiable information, and credit card information. Table 4-13 shows several of the more significant cyber attacks in Colorado in recent years.

Table 4-13 Major Cyber Attacks Impacting Colorado, 2005-2020

Date Reported	Target	Total Records	Description
July 21, 2005	University of Colorado, Boulder	49,000	Data exposure/ personal identifiable information
August 2, 2005	University of Colorado, Denver	36,000	Data exposure/ personal identifiable information
July 17, 2007	Western Union, Greenwood Village	20,000	Credit card breach
April 22, 2014	Centura Health, Englewood	12,286	Health information breach
July 3, 2017	PVHS-ICM Employee Health and Wellness, Fort Collins	10,143	Data exposure/health information
February, 2018	Colorado Department of Transportation (CDOT)	N/A	Data encryption/ ransomware
August, 2019	Regis University	N/A	DDoS
December, 2019	Southeast Metro Storm Water Authority (SEMSWA)	N/A	Ransomware
June, 2020	Colorado Information Analysis Center (CIAC)	Unknown	Data Breach

Source: Privacy Rights Clearinghouse

A 2017 study found ransomware payments over a two-year period totaled more than $16 million. Even if a victim is perfectly prepared with full offline data backups, recovery from a sophisticated ransomware attack typically costs far more than the demanded ransom. However, according to a 2016 study by Kaspersky Lab, roughly one in five ransomware victims who pay their attackers never recover their data.

Recent years have seen an increase in ransomware attacks, particularly against local government systems. The City of Atlanta was hit by a major ransomware attack in 2018, recovery from which wound up costing a reported $2.6 million, significantly more than the $52,000 ransom demand. A similar attack against the City of Baltimore in 2019 affected the city government's email, voicemail, property tax portal, water bill, and parking ticket payment systems, and delayed more than 1,000 pending home sales. In March 2019, Orange County, North Carolina was attacked with a ransomware virus, causing slowdowns and service problems at key public offices such as the Register of Deeds, the Sheriff's Office, and county libraries. The attack impacted a variety of county services, including disrupting the county's

capability to process real estate closings, issue marriage licenses, process fees or permits, process housing vouchers, and verify tax bills.

A large, sophisticated malware attack, known as Olympic Destroyer, was launched against the 2018 Winter Olympics in Pyeongchang, South Korea. The attack initially took down servers, email, Wi-Fi, and ticketing systems, which could have severely disrupted the games. Fortunately, the organizing committee had a robust cybersecurity group that was able to quickly restore most functions.

Hazard Location

Cyber-attacks can and have occurred in every location regardless of geography, demographics, and security posture. Incidents may involve a single location or multiple geographic areas. A disruption can have far-reaching effects beyond the location of the targeted system; disruptions that occur far outside the state can still impact people, businesses, and institutions within the county. All of Arapahoe County is susceptible to cyber-attacks.

Hazard Magnitude/Severity

There is no universally accepted scale to explain the severity of cyber-attacks. The strength of a DDoS attack is often explained in terms of a data transmission rate. One of the largest DDoS disruptions ever, the October 21, 2016 Dyn attack, peaked at 1.2 terabytes per second and impacted some of the internet's most popular sites to include Amazon, Netflix, PayPal, Twitter, and several news organizations.

Data breaches are often described in terms of the number of records or identities exposed. The largest data breach ever reported occurred in August 2013, when hackers gained access to all three billion Yahoo accounts. The hacking incidents associated with Colorado in the Privacy Rights Clearinghouse database are of a smaller scale, ranging from just 32 records to approximately 60,000, along with several cases in which an indeterminate number of records may have been stolen.

Ransomware attacks are typically described in terms of the amount of ransom requested, or by the amount of time and money spent to recover from the attack. One report from cybersecurity firm Emsisoft estimates the average successful ransomware attack costs $81 million and can take 287 days to recover from.

Hazard Probability of Occurrence

Small-scale cyber attacks such as DDoS attacks occur daily, but most have negligible impacts at the local or regional level. Data breaches are also extremely common, but again most have only minor impacts on government services.

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

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The possibility of a larger disruption affecting systems within the county is a constant threat, but it is difficult to quantify the exact probability due to such highly variable factors as the type of attack and intent of the attacker. Major attacks specifically targeting systems or infrastructure in the county cannot be ruled out.

Hazard Consequence Analysis

The impact of a cyber-attack can vary depending on the type of attack and the intent of the malicious actor. Though a cyber disruption can have limited impacts within a system's own operations, it may cause cascading impacts. Ultimately, cyber-attacks can have significant cumulative economic impacts.

Impact to the Public

Injuries or fatalities from cyber attacks would generally only be possible from a major cyber terrorist attack against critical infrastructure. More likely impacts to the public are financial losses and an inability to access systems such as public websites and permitting sites. Indirect impacts could include interruptions to traffic control systems or other infrastructure.

Data breaches and subsequent identify thefts can have huge impacts on the public. The Internet Crime Complaint Center (IC3) estimates that identity theft alone resulted in $2.7 billion in losses to businesses and $149 million in losses to individuals.

Impact to Responders

Cyber-attacks can interfere with emergency response communications, access to mobile data terminals, and access to critical preplans and response documents.

According to the Cyber & Infrastructure Security Agency, cyber risks to 9-1-1 systems can have "severe impacts, including loss of life or property; job disruption for affected network users; and financial costs for the misuse of data and subsequent resolution." CISA also compiled a recent list of attacks on 9-1-1 systems including a DDoS in Arizona, unauthorized access with stolen credentials in Canada, a network outage in New York, and a ransomware attack in Baltimore.

Impact to Continuity of Operations (including continued delivery of services)

The delivery of services can be impacted since governments rely to a great extent upon electronic delivery of services. Most agencies rely on server backups, electronic backups, and remote options for Continuity of Operations/Continuity of Government. Many departments in Arapahoe County have the option to move to a paper method including permitting, DMV services, payments to and from the county, and payroll. However, access to documents on the network, OneDrive access, and other operations that require collaboration across the county will be significantly impacted.

Impact to Property, Facilities, and Infrastructure

The vast majority of cyber attacks affect only data and computer systems. However, sophisticated attacks have occurred against the SCADA systems of critical infrastructure, which could potentially result in system failures on a scale equal with natural disasters. Facilities and infrastructure such as the electrical grid could become unusable. A cyber attack took down the power grid in Ukraine in 2015, leaving over 230,000 people without power. The 2003 Northeast

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Blackout, while not the result of a cyber attack, caused 11 deaths and an estimated $6 billion in economic loss.

Impact to the Environment

The vast majority of cyber incidents have little to no impact on historic, cultural or natural resources. A major cyber terrorism attack could potentially impact the environment by triggering a release of a hazardous materials, or by causing an accident involving hazardous materials by disrupting traffic-control devices.

Impact to the Economic Condition of the County and Jurisdictions

Economic impacts from a cyber attack can be debilitating. The cyber attack in 2018 that took down the City of Atlanta cost at least $2.5 million in contractor costs and an estimated $9.5 million additional funds to bring everything back online. The attack in Atlanta took "more than a third of the 424 software programs offline" and recovery lasted more than 6 months. The 2018 cyber attack on the Colorado Department of Transportation (CDOT) cost an estimated $1.5 million. None of these statistics take into account the economic losses to businesses and ongoing IT configuration to mitigate from a future cyber-attack.

Impact to Public Confidence in Government

Public confidence in the government will likely suffer if systems such as permitting, DMV, voting, or public websites are down for a prolonged amount of time. An attack could raise questions regarding the security of using electronic systems for government services.

Changes in Development

Changes in development have no impact to the threat, vulnerability, and consequences of a cyber attack. Cyber attacks can and have targeted small and large jurisdictions, multi-billion dollar companies, small mom-and-pop shops, and individual citizens.

The decentralized nature of the internet and data centers means that the cyber threat is shared by all, regardless of new construction and changes in development.

Jurisdictional Differences

There are few significant jurisdictional differences for this hazard. The City of Littleton feels its increased reliance on technology due to remote working increased the risk of cyber incidents.

Table 4-14 Cyber Threat Rankings by Jurisdiction

Cyber Threat	Frequency	Spatial Extent	Severity	Overall Significance
Arapahoe County	Likely	Significant	Critical	Medium
Bennett	Likely	Significant	Critical	Medium
Bow Mar	Likely	Significant	Critical	Medium
Centennial	Likely	Significant	Critical	Medium
Cherry Hills Village	Likely	Significant	Critical	Medium
Columbine Valley	Likely	Significant	Critical	Medium
Deer Trail	Likely	Significant	Critical	Medium
Englewood	Likely	Significant	Critical	Medium

Cyber Threat	Frequency	Spatial Extent	Severity	Overall Significance
Foxfield	Likely	Significant	Critical	Medium
Glendale	Likely	Significant	Critical	Medium
Greenwood Village	Likely	Significant	Critical	Medium
Littleton	Likely	Significant	Critical	High
Sheridan	Likely	Significant	Critical	Medium
Denver Water	Likely	Significant	Critical	Medium

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4.5 Dam Failure/Incident

Hazard Description

Dams are water storage, control or diversion structures that impound water upstream in reservoirs. Dam failure can take several forms, including a collapse of, or breach in, the structure. While most dams have storage volumes small enough that failures have few or no repercussions, dams storing large amounts can cause significant flooding downstream.

Dam failures are most likely to happen for one of five reasons:

- Overtopping caused by water spilling over the top of a dam. Overtopping of a dam is often a precursor of dam failure. National statistics show that overtopping due to inadequate spillway design, debris blockage of spillways, or settlement of the dam crest account for approximately 34% of all U.S. dam failures.
- Foundation defects, including settlement and slope instability, cause about 30% of all dam failures.
- Cracking caused by movements like the natural settling of a dam.
- Inadequate maintenance and upkeep.
- Piping is when seepage through a dam is not properly filtered and soil particles continue to progress, and form sink holes in the dam. Seepage often occurs around hydraulic structures, such as pipes and spillways; through animal burrows; around roots of woody vegetation; and through cracks in dams, dam appurtenances, and dam foundations.

The primary drivers of failure can also include various types of human errors, such as slips (actions committed inadvertently), lapses (inadvertent inactions), and mistakes (intended actions with unintended outcomes, due to errors in thinking). In the context of dam safety, mistakes are the most common type of human error which contributes to failures. Violations are also sometimes classified as a category of human errors and involve situations in which there is deliberate non-compliance with rules and procedures, usually because the rules or procedures are viewed as unworkable in practice.

Dam failure can occur with little warning. Intense storms may produce a flood in a few hours or even minutes for upstream locations. Flash floods occur within six hours of the beginning of heavy rainfall and dam failure may occur within hours of the first signs of breaching. Other failures and breaches can take much longer to occur, from days to weeks, as a result of debris jams or the accumulation of melting snow.

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 can help prevent future overtopping or failure. When outlet releases are not enough, spillways are designed to allow excess water to exit the reservoir and prevent overtopping. This can protect the dam but result in flooding downstream.

The U.S. Army Corps of Engineers and the Colorado State Engineer classify dams into four categories as determined by analysis of potential consequences from a sunny day failure of the dam, as shown in Table 4-15. The Colorado State Engineer periodically reviews the hazard classification of existing dams by evaluating the consequences of failure. If the State Engineer's review indicates the consequences of failure have changed within the dam failure inundation area, the State Engineer will assign an appropriate new hazard classification. The Colorado

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Division of Water Resources, Dam Safety Division performs regular dam safety inspections at a frequency appropriate to the hazard classification of the dam.

It is important to keep in mind that the hazard classification of a dam is a measure of the consequences if the dam were to fail, not a measure of how likely the dam is to fail.

Table 4-15 Dam Hazard Classification Definitions

Hazard Class	Definition
High	A dam for which life loss is expected to result from failure of the dam.
Significant	A dam for which significant damage, but no life loss is expected to result from failure of the dam. Significant damage is defined as damage to structures where people generally live, work, or recreate, including public and private facilities. Significant damage is determined to be damage sufficient to render structures or facilities uninhabitable or inoperable.
Low	A dam for which neither life loss nor significant damage as defined for a Significant Hazard dam are expected to result from failure of the dam.
No Public Hazard (NPH)	A dam for which neither life loss nor significant damage as defined for a Significant Hazard dam are expected to result from failure of the dam.

Source: Colorado Division of Water Resources, Dam Safety Division, https://dwr.colorado.gov/services/dam-safety

Hazard Previous Occurrences

There has not been a recorded dam failure event for any of the participating jurisdictions involved in this plan. The last major dam failure in Colorado happened in 1982 when the deterioration of the earthen Lawn Lake Dam in the Rocky Mountain National Park breached. The dam released 220 million gallons of water, killing three people and causing $31 million in damage around the town of Estes Park.

Hazard Location

Dams within the Planning Area

For this plan update, the 2018 National Inventory of Dams was consulted. There are 22 dams within the boundaries of Arapahoe County. Of the 22 dams, eight are High Hazard dams, four are Significant Hazard dams, and 10 are Low Hazard dams. Table 4-16 provides the names, locations, and other pertinent information for all high and significant hazard dams in the planning area. Figure 4-6 and Figure 4-7 show the location of dams and inundation areas within Arapahoe County.

Table 4-16 High and Significant Hazard Dams in Arapahoe County

Dam Name	NID #	Hazard Class	EAP	Dam Ht. (ft.)	Storage (acre-ft.)	River	Nearest Downstream City/Distance (miles)
Quincy	CO00104	H	Y	73	4,560	West Toll Gate Creek	Aurora/1
Englewood	CO00300	H	Y	64	3,500	Willow Creek	Littleton/0
Mc Lellan	CO01153	H	Y	125	9,700	Dad Clark Gulch	Littleton/0
Cherry Creek Dam	CO01280	H	Y	189	134,470	Cherry Creek	Denver/1

Dam Name	NID #	Hazard Class	EAP	Dam Ht. (ft.)	Storage (acre-ft.)	River	Nearest Downstream City/Distance (miles)
Holly	CO02214	H	Y	45	455	Little Dry Creek	Littleton/0
Senac	CO02709	H	Y	163	40,400	Senac Creek	Aurora/10
Exposition Park	CO02816	H	Y	19	293	Westerly Creek	Aurora/0
South Platte Reservoir	CO02858	H	Y	83	7,435	South Platte River-OS	Littleton/0
Belisle	CO01789	S	Y	40	398	Big Dry Creek-OS	Englewood/0
Upper Tule Lake	CO01816	S	Y	11	204	S Platte R-TR	Littleton/0
Arapahoe Lake	CO02089	S	Y	23	45	Goldsmith Gulch	Denver/0
Jewell Wetland Detention	CO02832	S	Y	21	96	Westerly Creek-TR	Aurora/0

Source: 2018 National Inventory of Dams; https://nid.sec.usace.army.mil
H = High; S = Significant; EAP = Emergency Action Plan

Dams Upstream of the Planning Area

There are also 41 dams located outside of Arapahoe County's boundaries that could affect Arapahoe County and its population if they were to fail. Of those 41 dams, 27 are High Hazard dams and 14 are Significant Hazard dams. Table 4-17 provides the names, locations, and other pertinent information for all high and significant hazard dams in the planning area. Two of these dams, Polly A. Deane and Willow Springs #1, are currently rated as Unsatisfactory by the Colorado Dam Safety Program.

Table 4-17 High and Significant Hazard Dams Upstream of Arapahoe County

Dam Name	NID #	Hazard Class	EAP	Dam Ht. (ft.)	Storage (acre-ft.)	River	County	Nearest Downstream City/Distance (Miles)
Bear Creek Dam	CO00004	H	Y	0	75,000	Bear Creek	Jefferson	Denver/3
Bear Creek Dam - South Embankment	CO00004	H	Y	0	75,000	Bear Creek	Jefferson	Denver/3
Franktown Parker FPB-1	CO00273	H	Y	24	219	Cherry Creek-Tr	Douglas	Parker/0
Franktown Parker FPP-1	CO00287	H	Y	27	102	Baldwin Gulch	Douglas	Denver/0
Franktown Parker FPS-1	CO00290	H	Y	27	66	Cherry Creek-Tr	Douglas	Parker/0
W. Cherry Creek Det. #7	CO00319	H	Y	38	799	West Cherry Creek	Douglas	Franktown/0
Evergreen	CO00328	H	Y	41	800	Bear Creek	Jefferson	Evergreen/0
Polly A. Deane*	CO00336	H	Y	20	760	Dutch Creek-Os	Jefferson	Littleton/0
Wagon Tongue	CO00343	H	Y	32	210	Wagon Tongue Gulch	Park	Lake George/6
Wellington	CO00345	H	Y	70	5030	S. Fork Buffalo Creek	Jefferson	Buffalo Creek/0
Woodland Park	CO00347	H	Y	60	67	Loy Gulch	El Paso	Woodland Park/2

Dam Name	NID #	Hazard Class	EAP	Dam Ht. (ft.)	Storage (acre-ft.)	River	County	Nearest Downstream City/Distance (Miles)
Antero	CO00351	H	Y	39	92,651	S. Fork S. Platte River	Park	Hartsel/5
Cheeseman	CO00357	H	Y	221	87,227	South Platte River	Douglas	Deckers/5
Eleven Mile Canyon	CO00359	H	Y	128	128,000	South Platte River	Park	Lake George/6
Spring Gulch	CO01279	H	Y	0	1,752	Spring Gulch	Douglas	Denver/8
Chatfield Dam	CO01281	H	Y	0	355,000	South Platte River	Douglas	Denver/8
Willow Springs #1*	CO01791	H	Y	23	140	Turkey Creek-Os	Jefferson	Lakewood/5
Bergen East	CO01821	H	Y	40	1,150	Weaver Gulch	Jefferson	Morrison/0
Harriman	CO01823	H	Y	15	963	Weaver Creek-Os	Jefferson	Lakewood/1
Marston Lake - North Dam	CO02012	H	Y	30	22,500	South Platte River-Os	Denver	Denver/0
Strontia Springs	CO02219	H	Y	292	10,600	South Platte River	Douglas	Kassler/5
Morrison Raw Water	CO02676	H	Y	40	42	Bear Creek-Tr	Jefferson	Morrison/1
Spinney Mountain	CO02677	H	Y	90	83,300	South Platte River	Park	Lake George/22
Marston Lake - South Dam	CO02798	H	Y	33	21,100	South Platte River-Os	Denver	Denver/0
Marston Lake - East Dam	CO02799	H	Y	17	21,100	South Platte River-Os	Denver	Denver/0
Marston Lake - Northwest Dike	CO02800	H	Y	15	21,100	South Platte River-Os	Denver	Denver/0
Genesee No. 2	CO02924	H	Y	98	127		JEFFERSON	NA
Aurora-Rampart	CO00260	S	Y	48	1,596	Willow Creek-Os	Douglas	Kassler/3
J. O. Hill	CO00295	S	Y	29	253	West Creek	Douglas	Deckers/7
Pinery	CO00303	S	Y	68	440	Cherry Creek	Douglas	Parker/5
Wauconda	CO00312	S	Y	42	606	Bear Creek	Douglas	Sedalia/11
Harwood's Storage Reservoir	CO00329	S	Y	32	184	Weaver Gulch	Jefferson	Lakewood/5
Lake George	CO00366	S	Y	18	610	So Platte River-Os	Park	Lake George/1
Manitou Park Lake	CO00371	S	NR	24	290	Trout Creek	Teller	Deckers/14
Bergen West	CO01790	S	Y	25	505	Weaver Gulch	Jefferson	Lakewood/0
Bowles #1	CO01822	S	Y	20	3,115	South Platte River-Os	Jefferson	Bowmar/1
Johnston	CO01827	S	Y	11	1,134	Lilley Gulch	Jefferson	Littleton/0
Fort Logan Dam	CO02425	S	Y	28	98	Bear Creek-Tr	Denver	Sheridan/1
Lockport	CO02426	S	Y	20	60	Troublesome Creek	Jefferson	Kittredge/4
Million Dollar	CO02775	S	Y	10	61	E. Plum Creek-Os	Douglas	Castle Rock/1
Meadowview	CO02854	S	N	20	73	North Turkey Creek-Os	Jefferson	Na

Source: 2018 National Inventory of Dams; https://nid.sec.usace.army.mil
H = High; S = Significant; EAP = Emergency Action Plan; * = Currently rated Unsatisfactory by the Colorado Dam Safety Program.

Figure 4-6 Dam Locations and Inundation Areas in Western Arapahoe County

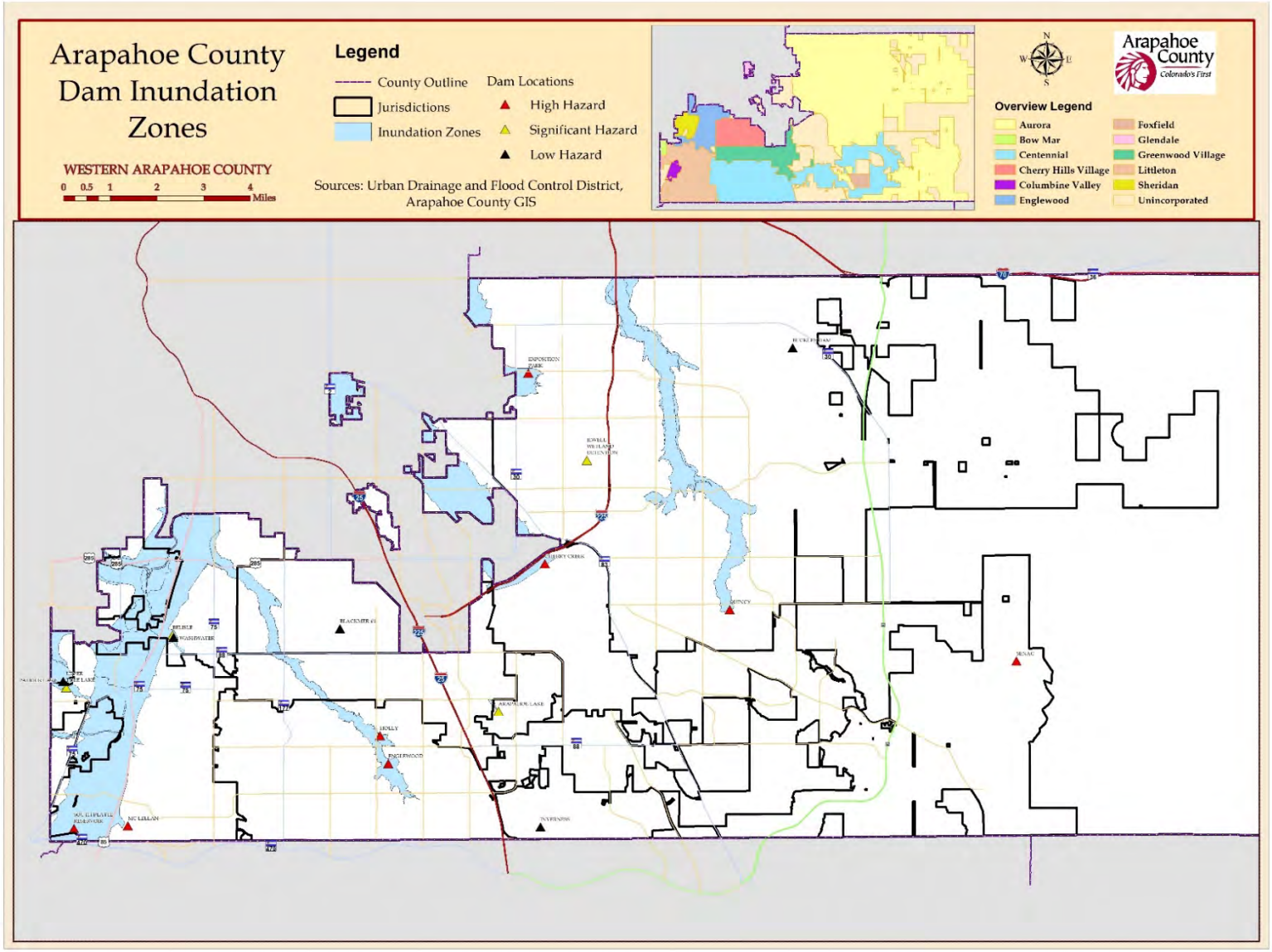
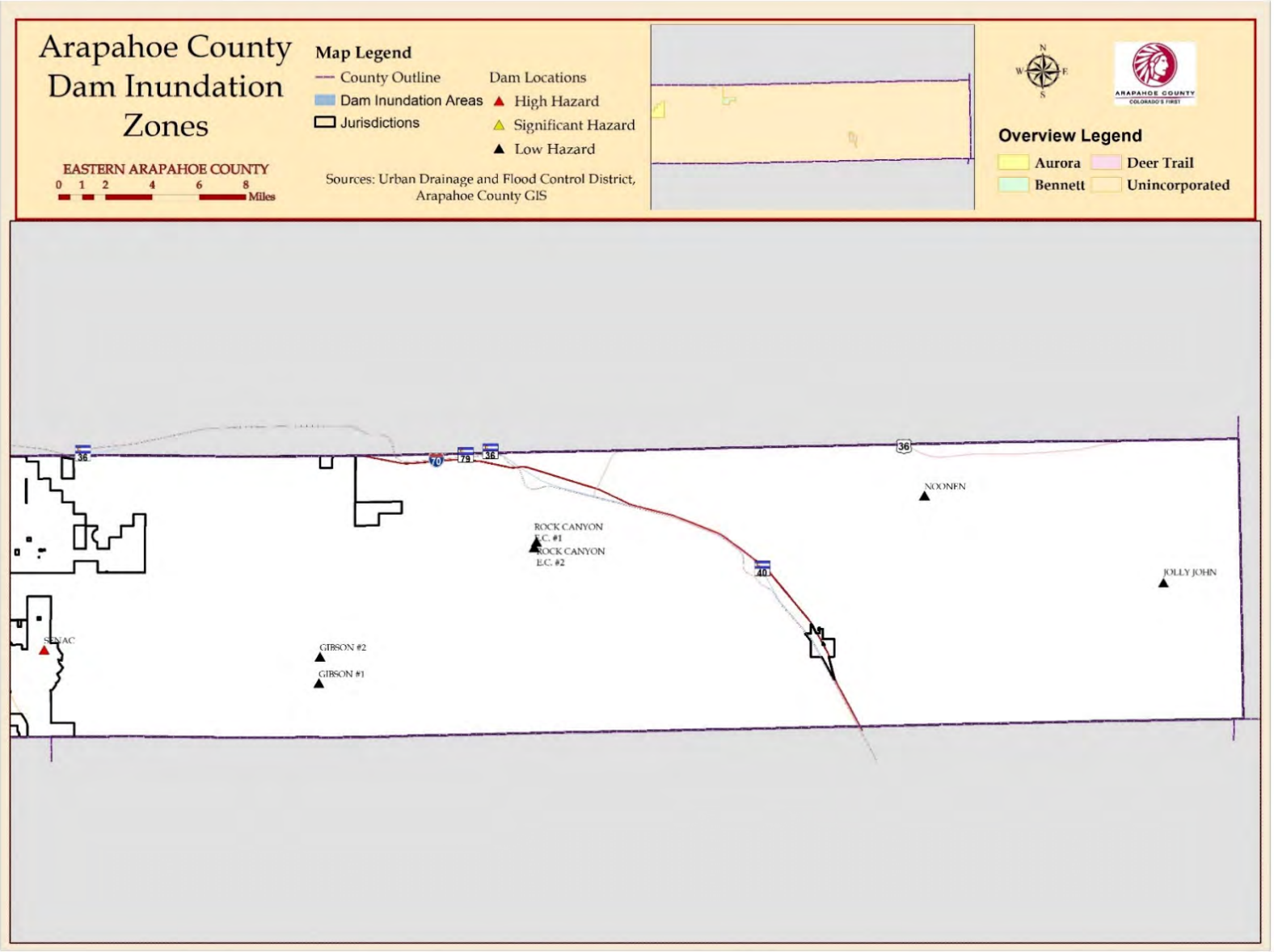


Figure 4-7 Dam Locations and Inundation Areas in Eastern Arapahoe County



Hazard Magnitude/Severity

Potential severity of a dam failure is typically measured by the hazard classification described above. Failure of a high hazard dam could potentially lead to multiple deaths; property destroyed and severely damaged; and/or interruption of essential facilities and services for more than 72 hours.

Water released by a failed dam generates tremendous energy and can cause a flood that is catastrophic to life and property located in the inundation area (downstream). The largest three dams in terms of maximum storage in or upstream of Arapahoe County are: the Chatfield Dam in Douglas County along the South Platte River (with a capacity of 355,000 acre-feet); the Cherry Creek Dam in Arapahoe County along the Cherry Creek River (with a capacity of 134,470 acre-feet); and the Eleven Mile Canyon Dam in Park County (with a capacity of 128,000 acre-feet).

As shown on the maps in the Hazard Location section, large portions of the county are potentially at risk of dam inundation. The property study described in the Consequence Analysis section below identifies 18,355 parcels in inundation areas, 14,634 of which are residential. An estimated 43,000 people and $14B in property are potentially at risk of dam inundation.

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. 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 because of heavy rain can occur within hours of the first signs of failure. A dam failure event caused by a debris jam for example can take from days to weeks (FEMA 2019). 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.

Hazard Probability of Occurrence

Arapahoe County has no recorded events of significant dam failures. The probability of a future event is unlikely, although will always remain possible. High and significant hazard dams are closely monitored, as described above. 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.

Hazard Consequence Analysis

Impact to the Public

Table 4-18 shows the number of residents estimated to live in dam inundation areas, based on the number of residential properties located in inundation zones. Countywide, over 54,000 people (8% of the county population) are potentially at risk of dam inundation.

In practice, dam failure rarely results in fatalities because there is typically enough advance warning to allow people to evacuate the area. However, impacts to residential properties can be severe, to include not only direct flood damage but also contamination due to flooding of hazardous waste results in public health issues, as well as damage to sanitation services. Depending on severity of event, large numbers of people may be displaced or left homeless.

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Table 4-18 Estimated Population at Risk from Dam Inundation

Jurisdiction	Population	%	Jurisdiction	Population	%
Aurora	19,444	6%	Englewood	7,924	23%
Bennett	0	0%	Foxfield	0	0%
Bow Mar	402	60%	Glendale	5,028	100%
Centennial	2,195	2%	Greenwood Village	263	2%
Cherry Hills Village	453	7%	Littleton	8,715	19%
Columbine Valley	1,368	92%	Sheridan	2,905	47%
Deer Trail	0	0%	Unincorporated County	5,742	6%
			Total	**54,437**	**8%**

Source: Arapahoe County GIS, analysis by Wood

Impact to Responders

Responders in flooded areas at the time of incident or assisting in evacuations could be at risk. Impacts to transportation corridors and communications lines could affect first responders' ability to effectively respond.

Impact to Continuity of Operations (including continued delivery of services)

Possible short-term accessibility issues for first responders performing routine duties or personnel reporting to work locations. Damage to facilities/personnel in incident area may require temporary relocation of some operations. Regulatory waivers may be needed locally.

Fulfillment of some contracts may be difficult. Impact may reduce deliveries.

Impact to Property, Facilities, and Infrastructure

Inundation mapping was provided by the Mile High Flood District and the Colorado Water Conservation Board. Combined with the parcel data in a GIS format with assessed values, this allowed comparative analysis of these layers to determine parcels and improvement values by type that fall within the boundaries of the dam inundation areas. Content value is assumed to be 50% the improvement value for residential structures and 100% the improvement value for non-residential structures.

GIS was used to create a centroid or point representing the center of the parcel polygon. The dam inundation areas were then overlaid in the parcel centroids. For the purposes of this analysis, if the dam inundation area intersected a parcel centroid, inundation was assigned for the entire parcel. The model assumes that every parcel with a building or dwelling value greater than zero is improved in some way. Specifically, an improved parcel assumes there is a building on it. It is important to note that there could be more than one structure or building on an improved parcel (i.e. condo complex occupies one parcel but might have several structures). In these cases, the analysis counts this as one structure. Only improved parcels and the value of their improvements were analyzed. The end result is an inventory of the number and types of parcels and buildings subject to dam inundation.

Table 4-19 shows the number of residential and non-residential parcels located in mapped dam inundation areas, broken down by jurisdiction. The table also shows estimated value of the structures and their contents. In all, 8% of the residential parcels and 13% of the nonresidential parcels in the county are at risk of dam inundation, representing almost $14B worth of property.

Table 4-19 Properties Exposed to Dam Inundation

Jurisdiction	Property Type	Improved Parcel Counts	Improved Value	Content Value	Total Exposed Value	% Value Exposed
Aurora	Res	5,892	$2,079,506,525	$1,039,753,263		
	Non-Res	828	$482,482,104	$482,482,104		
	Subtotal	**6,720**	**$2,561,988,629**	**$1,522,235,367**	**$4,084,223,996**	**8%**
Bennett	---	0	$0	$0	$0	**0%**
Bow Mar	Res	134	$77,534,215	$38,767,108		
	Non-Res	8	$319,725	$319,725		
	Subtotal	**142**	**$77,853,940**	**$39,086,833**	**$116,940,773**	**59%**
Centennial	Res	708	$281,284,608	$140,642,304		
	Non-Res	266	$73,287,446	$73,287,446		
	Subtotal	**974**	**$354,572,054**	**$213,929,750**	**$568,501,804**	**2%**
Cherry Hills Village	Res	151	$96,222,550	$48,111,275		
	Non-Res	19	$7,761,360	$7,761,360		
	Subtotal	**170**	**$103,983,910**	**$55,872,635**	**$159,856,545**	**5%**
Columbine Valley	Res	526	$353,474,873	$176,737,437		
	Non-Res	198	$13,093,229	$13,093,229		
	Subtotal	**724**	**$366,568,102**	**$189,830,666**	**$556,398,768**	**93%**
Deer Trail	---	0	$0	$0	$0	**0%**
Englewood	Res	2,201	$673,505,410	$336,752,705		
	Non-Res	1,016	$546,322,595	$546,322,595		
	Subtotal	**3,217**	**$1,219,828,005**	**$883,075,300**	**$2,102,903,305**	**35%**
Foxfield	---	0	$0	$0	$0	**0%**
Glendale	Res	367	$406,506,027	$203,253,014		
	Non-Res	176	$311,804,705	$311,804,705		
	Subtotal	**543**	**$718,310,732**	**$515,057,719**	**$1,233,368,451**	**100%**
Greenwood Village	Res	73	$56,995,986	$28,497,993		
	Non-Res	0	$0	$0		
	Subtotal	**73**	**$56,995,986**	**$28,497,993**	**$85,493,979**	**1%**
Littleton	Res	2,490	$1,116,333,170	$558,166,585		
	Non-Res	631	$352,126,783	$352,126,783		
	Subtotal	**3,121**	**$1,468,459,953**	**$910,293,368**	**$2,378,753,321**	**26%**
Sheridan	Res	581	$261,178,948	$130,589,474		
	Non-Res	256	$221,023,342	$221,023,342		
	Subtotal	**837**	**$482,202,290**	**$351,612,816**	**$833,815,106**	**68%**
Unincorporated Arapahoe County	Res	1,511	$1,053,626,099	$526,813,050		
	Non-Res	323	$97,353,380	$97,353,380		
	Subtotal	**1,834**	**$1,150,979,479**	**$624,166,430**	**$1,775,145,909**	**10%**
Total		**18,355**	**$8,561,743,080**	**$5,333,658,875**	**$13,895,401,955**	**11%**

Source: Arapahoe County GIS, analysis by Wood; Res = Residential Structure; Non-Res = Non-Residential Structure

Critical facilities that could impacted by dam failure are shown in Table 4-20. In all 787 critical facilities have been identified as being at risk of dam inundation. This constitutes 20% of the critical facilities in the county and includes 31% of the identified hazardous materials sites.

Table 4-20 Critical Facilities at Risk of Dam Inundation

Jurisdiction	Communications	Energy	Food, Water, Shelter	Hazardous Materials	Health and Medical	Safety and Security	Transportation	Total	%
Aurora	19	6	15	6	1	4	2	**53**	**5%**
Bennett								**0**	**--**
Bow Mar								**0**	**--**
Centennial	1		2	10	2		5	**20**	**3%**
Cherry Hills Village	1			1				**2**	**4%**
Columbine Valley	3			3		2		**8**	**100%**
Deer Trail								**0**	**--**
Englewood	34	3	13	93	2	8	4	**157**	**50%**
Foxfield								**0**	**--**
Glendale	23			14		2		**39**	**63%**
Greenwood Village								**0**	**--**
Littleton	52	3	13	86	1	10	5	**170**	**35%**
Sheridan	13	2	3	185		1	6	**210**	**75%**
Unincorporated County	14		6	101		2	5	**128**	**17%**
Total	**160**	**14**	**52**	**499**	**6**	**29**	**27**	**787**	**20%**

Source: Arapahoe County GIS, analysis by Wood

Impact to the Environment

Wetland impacts due to dam or levee failure flooding can affect water quality and wildlife habitat. Dam failure flooding may alter stream flow patterns, increase erosion, and lead to release of hazardous materials, sediment, or waste into streams, rivers, drinking water supply, ground water, and air.

Impact to the Economic Condition of the County and Jurisdictions

Local economy and finances could be adversely affected, possibly for an extended period depending on damage. Loss of facilities or infrastructure for the provision of government services is expected to be non-existent or negligible.

Impact to Public Confidence in Government

Ability to respond and recover may be questioned and challenged by the public if planning, response, and recovery are not timely and effective, regardless of the dam owner.

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Changes in Development

Future developments in Arapahoe County will continue to be vulnerable to possible dam failure. The increasing population and expanding areas of development within the county will continue to have risk for communities located downstream of significant or high hazard dams. Additionally, any further development downstream of existing dams will elevate the possible consequences if a dam should fail. Development downstream of dams does not only increase exposure to dams in general through growth, but also the exposure to high hazard dams by increasing the hazard itself.

Jurisdictional Differences

Dam failure has the potential to affect several jurisdictions in Arapahoe County. As can be seen in Figure 4-6 and Figure 4-7, the risk is greatest in the western parts of the county. As shown above in Table 4-18, the percentage of population at risk varies from 0% in Bennett, Deer Trail, and Foxfield to over 90% in Glendale and Columbine Valley. In terms of total value of property, Table 4-19 shows the greatest exposure is in Aurora, Littleton, Englewood, Glendale, and the Unincorporated County. Expressed as a percentage of total parcels exposed, the greatest risk is in Glendale (100%) Columbine Valley (93%), Sheridan (68%), and Bow Mar (59%). Looking at critical facilities exposed to dam failure, Columbine Valley, Sheridan, Glendale, and Englewood each have half or more of their critical facilities at risk.

Table 4-21 Dam Failure/Incident Hazard Rankings by Jurisdiction

Dam Failure/Incident	Frequency	Spatial Extent	Severity	Overall Significance
Arapahoe County	Occasional	Extensive	Critical	High
Bennett	Occasional	Limited	Negligible	Low
Bow Mar	Occasional	Extensive	Critical	High
Centennial	Occasional	Limited	Limited	Low
Cherry Hills Village	Occasional	Limited	Limited	Low
Columbine Valley	Occasional	Extensive	Catastrophic	High
Deer Trail	Occasional	Limited	Negligible	Low
Englewood	Occasional	Significant	Critical	Medium
Foxfield	Occasional	Limited	Negligible	Low
Glendale	Occasional	Extensive	Catastrophic	High
Greenwood Village	Occasional	Limited	Limited	Low
Littleton	Occasional	Significant	Critical	Medium
Sheridan	Occasional	Extensive	Catastrophic	High
Denver Water	Occasional	Extensive	Critical	High

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4.6 Drought

Hazard Description

Drought is a normal part of virtually all climates, including areas with high and low average rainfall. It is a slow-onset hazard caused by a deficiency of precipitation and can be aggravated by other factors such as high temperatures, high winds, and low relative humidity.

According to the National Drought Mitigation Center, there are four primary ways to define droughts and understand drought impacts:

- **Meteorological drought** is defined solely on the degree and duration of dryness. It is expressed as a departure of actual precipitation from an expected average or normal amount based on monthly, seasonal, or annual time scales.
- **Hydrologic drought** is related to the effects of precipitation shortfalls on surface and subsurface water supplies including stream flows and reservoir, lake, and groundwater levels.
- **Agricultural drought** is defined in terms of soil moisture deficiencies and reduced water supply relative to the variable water demands of crops, livestock, and other agricultural operations.
- **Socioeconomic drought** associates the supply and demand of water or other economic goods or services with elements of meteorological, hydrologic, and agricultural drought. Socioeconomic drought occurs when the demand for water exceeds the supply because of a weather related supply shortfall. The incidence of this type of drought can increase because of a change in the amount of rainfall, a change in societal demands for water (or vulnerability to water shortages), or both.

The U.S. Drought Monitor provides a weekly summary of drought conditions across the United States. It provides a single composite drought indicator, often described as a blend of art and science due to its incorporation of multiple quantitative and qualitative measures of drought, including data-based drought indices as well as local expert input. Indicator ratings range from an intensity of D0 Abnormally Dry to D4 Exceptional Drought. Among the indices considered by the U.S. Drought Monitor are the Palmer Drought Severity Index (PDSI) and the Standardized Precipitation Index (SPI). The PDSI uses temperature and precipitation data to calculate water supply and demand, incorporates soil moisture, and is considered most effective for measuring drought on unirrigated cropland. It primarily reflects long-term drought. The SPI is a more simplified probability index that considers only precipitation.

Figure 4-8 shows the U.S. Drought Monitor for Colorado as of June 16, 2020, providing a snapshot illustrating the regional and long-term nature of drought.

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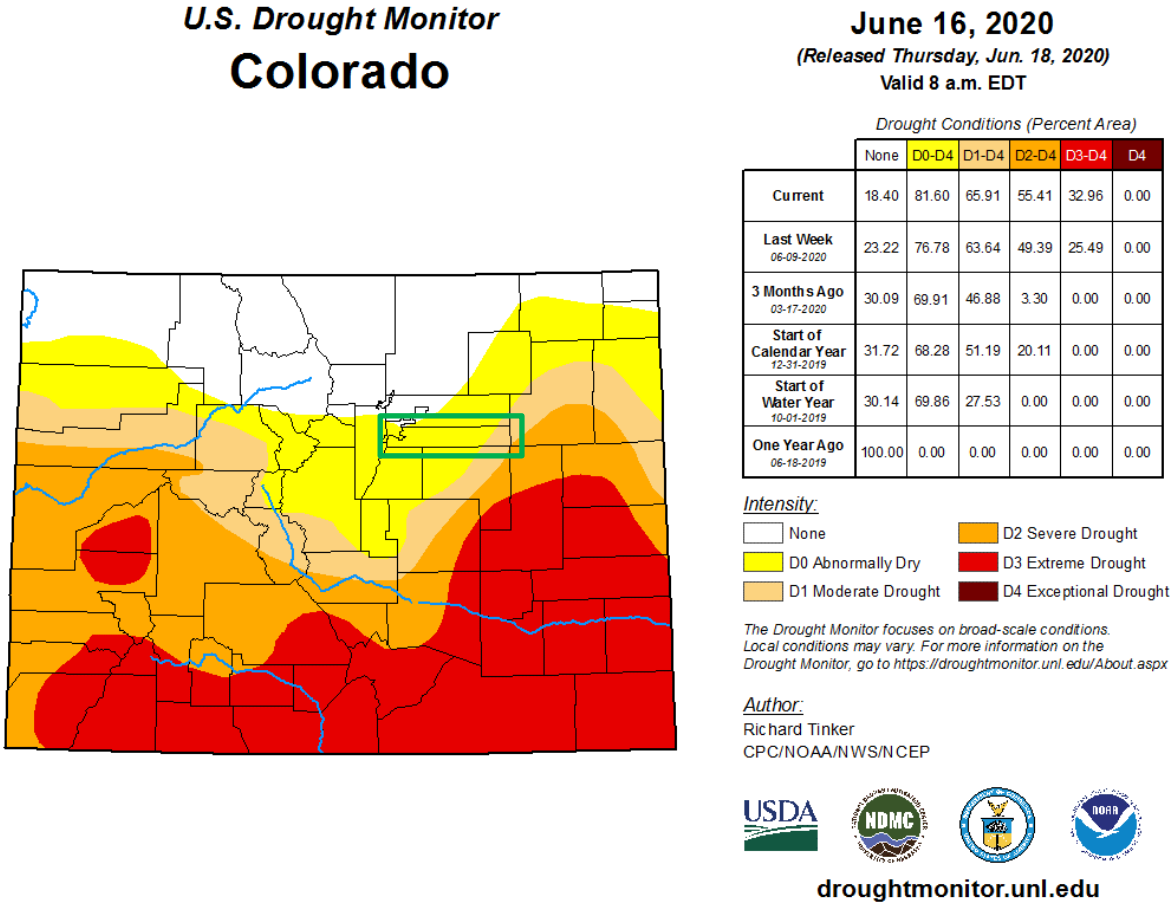
Figure 4-8 U.S. Drought Monitor



	None	D0-D4	D1-D4	D2-D4	D3-D4	D4
Current	18.40	81.60	65.91	55.41	32.96	0.00
Last Week 06-09-2020	23.22	76.78	63.64	49.39	25.49	0.00
3 Months Ago 03-17-2020	30.09	69.91	46.88	3.30	0.00	0.00
Start of Calendar Year 12-31-2019	31.72	68.28	51.19	20.11	0.00	0.00
Start of Water Year 10-01-2019	30.14	69.86	27.53	0.00	0.00	0.00
One Year Ago 06-18-2019	100.00	0.00	0.00	0.00	0.00	0.00

Hazard Previous Occurrences

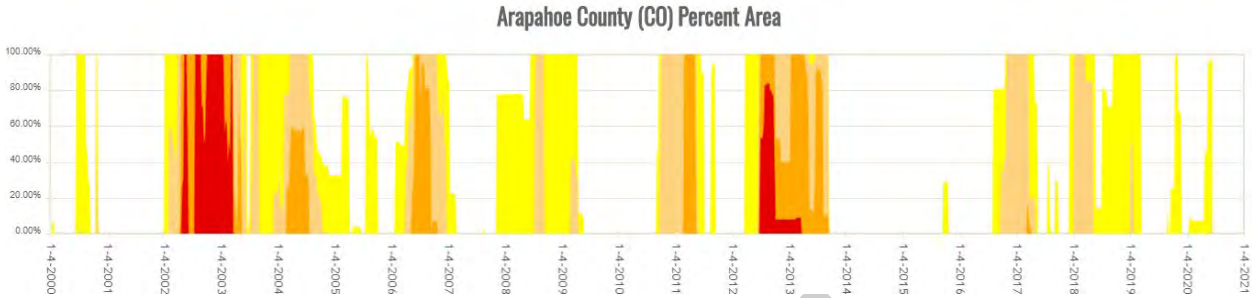
Drought is a regular and widespread occurrence in the State of Colorado. According to the U.S. Drought Monitor records for Arapahoe County, in the 1,044-week period from 2000 through 2019, the county spent 615 weeks (58.9% of the time) in some level of drought, defined as Abnormally Dry (D0) or worse conditions. Approximately 17.3% of the time, or 181 weeks, was spent in Severe Drought (D2) or worse conditions. Weeks in drought are summarized in Table 4-22 and shown in time series in Figure 4-9.

Table 4-22 U.S. Drought Monitor Weeks in Drought by Intensity, 2000-2019

Category	Description	Palmer Drought Severity Index (PDSI)	Standardized Precipitation Index (SPI)	Arapahoe County Weeks in Drought, 2000-2019
D0	Abnormally Dry	-1.0 to -1.9	-0.5 to -0.7	275
D1	Moderate Drought	-2.0 to -2.9	-0.8 to -1.2	159
D2	Severe Drought	-3.0 to -3.9	-1.3 to -1.5	96
D3	Extreme Drought	-4.0 to -4.9	-1.6 to -1.9	85
D4	Exceptional Drought	-5.0 or less	-2.0 or less	0

Source: U.S. Drought Monitor

Figure 4-9 U.S. Drought Monitor Drought Intensity, 2000-2020



Source: U.S. Drought Monitor

Per the 2018 State of Colorado Drought Mitigation and Response Plan, major droughts that have occurred in the state's history include the Dust Bowl of 1930s, the 1950s drought of the Great Plains, the Colorado drought of 2002, and the 2011-2013 drought.

During the 2002 drought, Arapahoe County reached Extreme Drought (D3) conditions for a total of 24 weeks. The entire County remained in at least Moderate Drought (D1) conditions from April 2002 through May 2003. The drought of 2002 was the single most intensive year of drought in Colorado's history. Statewide snowpack was at or near all-time lows, and the year is considered the driest single year recorded in Colorado history. What made the 2002 drought event so unusual was that the entire State was dry at the same time. Regional soil moisture was depleted, and reservoirs dropped to extremely low levels. The dramatic drought conditions prompted widespread water restrictions that were heavily enforced and regulated. These restrictions included limits to watering lawns, washing cars, or the use of water for any other non-essential uses. Some municipalities offered incentives for property owners to remove their lawns and adopt xeriscape landscape designs. Ultimately, it was the wet period of the late 1990s and the increased reservoir storage during that time that helped Colorado to survive the drought of 2002.

More recently, the county experienced Extreme Drought (D3) conditions during the 2011-2013 drought, which also impacted the entire State of Colorado. In February and March of 2012, minimal snow accumulations from below average snowfall and above average temperatures worsened conditions. In April and May of 2012, warm temperatures caused early runoff as the thin snowpack melted rapidly. Stream flows measured only slightly better compared to the extreme drought years of 1934, 1954, 1977, and 2002. Through spring and summer of 2012, agricultural production was heavily impacted by low soil moisture, high temperatures during the spring planting season, and limited water availability for summer irrigation diversions due to less snowpack and runoff. In the eastern plains of Colorado, June temperatures were consistently over 100°F. Crop prices dramatically increased, and many crop and livestock operations suffered. The tourism industry also suffered, with impacts to rafting businesses and ski resorts.

The 2011-2013 drought period contributed to elevated wildfire risk across the state. Two of the State's most destructive wildfires occurred during the 2012 drought period: the High Park Fire and the Waldo Canyon Fire. Dry conditions on the Eastern Plains contributed to an extended grass fire season that threatened homes and property.

The National Drought Mitigation Center (NDMC), located at the University of Nebraska in Lincoln, provides information on drought local drought impacts based on reports from media, observers, impact records, and other sources. According to NDMC's Drought Impact Reporter,

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during the 20-year period from 2000 through 2019, 818 county impacts were reported in Colorado, of which 40 were reported to affect Arapahoe County. These impacts are summarized in Table 4-23.

Table 4-23 NDMC Drought Impact Reporter, 2000-2019

Impact Category	Count of Impacts	Years Reported
Agriculture	6	2015, 2014, 2013, 2012, 2008
Business & Industry	4	2018, 2017, 2012, 2011, 2010, 2003, 2002
Fire	6	2016, 2015, 2013, 2008, 2002
Plants & Wildlife	8	2018, 2017, 2012, 2011, 2010, 2008
Relief, Response & Restrictions	18	2018, 2017, 2015, 2014, 2013, 2012, 2011, 2008, 2007, 2006,
Society & Public Health	3	2013, 2012, 2011, 2010
Tourism & Recreation	4	2018, 2017, 2003, 2002
Water Supply & Quality	11	2018, 2013, 2008, 2006

Source: NDMC Drought Impact Reporter, https://droughtreporter.unl.edu/advancedsearch/impacts.aspx

Over the last two decades, impacts related to relief, response and restrictions made up 45% of drought impacts reported in Arapahoe County, while 27.5% of impacts were related to water supply and quality. Plants and wildlife, agriculture, and fire each made up 15-20% of the total drought impacts reported in the county. Business and industry, tourism and recreation, and society and public health each accounted for 7.5-10% of all impacts. However, many of the business and industry impacts reported were noted to last multiple years.

During drought conditions Secretarial Disaster Declarations are used to make low interest loans and other emergency assistance available to those who have been affected (largely farmers and ranchers). Under the process laid out by the Farm Services Agency (FSA), a USDA Disaster Declaration can be made if any portion of a County has experienced eight consecutive weeks of severe drought according to the U.S. Drought Monitor. Arapahoe County has been included in USDA Disaster Declarations for drought in 2015, 2014, 2013, 2012, and 2011.

Hazard Location

Drought is regional in nature and can occur anywhere in Arapahoe County, affecting all or part of the county at any given time. While the consequences of drought may vary across the county due to the higher vulnerability of agricultural lands, water-dependent recreation, and areas of wildfire risk, all of Arapahoe County may experience drought conditions.

Hazard Magnitude/Severity

Drought impacts can cover large areas and may come in many forms. The impacts associated with drought magnify as the duration of the event increases, as supplemental supplies in reservoirs are depleted and water levels in groundwater aquifers decline.

The U.S. Drought Monitor, which measures drought based on the PDSI, SPI, Keetch-Byram Drought Index, soil moisture indicators, streamflow, and other qualitative inputs, can be used to define drought severity. Figure 4-10 details the criteria for each Drought Monitor category, and Figure 4-11 summarizes the typical impacts associated with each Drought Monitor category in the State of Colorado. These possible impacts indicate that agricultural and rural lands are the

primary affected areas under drought conditions of Category D0 through D2, while Category D3 and worse impacts are felt in urban areas and more severely affect water supplies and recreational industries.

Figure 4-10 U.S. Drought Monitor Categories

			Ranges				
Category	Description	Possible Impacts	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: U.S. Drought Monitor

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Figure 4-11 Colorado Drought Impacts by U.S. Drought Monitor Category

Category	Impact
D0	Hay production decreases; rangeland is dry
	Irrigation begins sooner
D1	Rangeland growth is stunted; very little hay is available
	Dryland crops suffer
	Wildfires increase
	Pheasant population declines; ski season is limited
D2	CRP lands suffer
	Farmers reduce planting; producers sell cattle
	Fire season is extended
	Snowpack is low; surface water levels are low; river flow is reduced
D3	Pasture conditions worsen
	City landscapes are dying
	Large fires develop
	Rafting, fishing, hunting, skiing are reduced; fish kills occur
	Grasshopper and insect infestation are noted
	Reservoirs are extremely low; mandatory water restrictions are implemented; water temperature increases
D4	Dust storms and topsoil removal are widespread
	Agricultural and recreational economic losses are large

Source: U.S. Drought Monitor

Hazard Probability of Occurrence

Identifying various indicators of drought, and tracking these indicators, provides a crucial means of monitoring drought. Additionally, understanding the historical frequency, duration, and spatial extent of drought assists in determining the likelihood and potential severity of future droughts. The characteristics of past droughts provide benchmarks for projecting similar conditions into the future.

The historical drought occurrence data from the U.S. Drought Monitor indicates that over the 1,044-week period from January 2000 through December 2019 Arapahoe County experienced 181 weeks of Severe Drought (D2) or worse conditions. If future occurrences follow this trend, there is a 17.3 percent chance of Arapahoe County experiencing drought in any given week. However, while short term droughts are common, what is of greater concern is consecutive weeks of severe drought that cause significant impacts on the county. Arapahoe County experienced Severe Drought (D2) conditions in 9 of the 20 years from 2000-2019, which equates to a 45% annual chance of Severe Drought.

Considering the NDMC Drought Impact Report records for 2000 through 2019, Arapahoe County experienced drought impacts in 14 of those 20 years, which equates to a 70% annual probability of drought impacts on the county.

Overall, taking these probabilities together, the annual probability of severe drought is likely (defined as between a 10 and 100% probability of occurrence in the next year).

The National Oceanic and Atmospheric Administration Paleoclimatology Program studies drought by analyzing records from tree rings, lake and dune sediments, archaeological remains, historical documents, and other environmental indicators to obtain a broader picture of the frequency of droughts in the United States. According to their research, "paleoclimatic data suggest that droughts as severe as the 1950's drought have occurred in central North America several times a century over the past 300-400 years, and thus we should expect (and plan for) similar droughts in the future. The paleoclimatic record also indicates that droughts of a much greater duration than any in the 20th century have occurred in parts of North America as recently as 500 years ago." Based on this research, the 1950's drought situation could have a 2% annual chance of occurrence. An extreme drought, worse than the 1930's "Dust Bowl," may have an approximately a 0.2% annual chance of occurrence.

Hazard Consequence Analysis

The most significant drought impacts in Colorado are related to water-intensive activities including agriculture, municipal use, wildfire protections, recreation, wildlife preservation, commerce, and tourism. Drought conditions can lead to the compaction of soil, increasing erosion potential and decreasing water quality. The following impacts analysis draws from the 2018 Colorado Drought Mitigation and Response Plan.

Impact to the Public

Although drought events rarely pose immediate risks to public health, they can impact local public health in numerous ways. Drought-induced public health impacts may include: increased respiratory ailments due to increased particulate matter in the air; health problems due to decreased availability of clean water; increased disease caused by wildlife concentrations; and loss of human life from heat stress or suicide. Drought may also impact mental and behavioral health as a result of elevated stress levels, higher costs for water, restrictions on water usage, and unemployment in the agricultural sector, tourism industries, and other businesses related to the natural environment and/or water. Drought may also drive population migration from rural to urban areas.

Impact to Responders

The impact to first responders from drought events is likely to be minimal. One exception would be if drought conditions spark a wildland fire. Responders may receive increased calls during extended periods of drought.

Impact to Continuity of Operations (including continued delivery of services)

Drought may require disaster declarations, aid programs, water restrictions, and/or fire restrictions. These needs may impact funding or administrative resources for other regular operations or may necessitate changes to existing operating procedures.

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Water utilities are likely to face the greatest challenges to continuity of operations and delivery of services, especially during long-term widespread droughts, where opportunities for resource-sharing are limited. Water suppliers may need to change water rates, set usage restrictions, adjust to changes in demand, address water line damage or repairs due to drought stress, account for changes in water quality, and seek alternative water supplies. Should a public water system be severely affected, the cost of shipping in outside water could total into the millions of dollars.

Individuals with private well water may also face impacts, including drinking water turbidity, change in water color or odor, and wells running dry.

Impact to Property, Facilities, and Infrastructure

Drought conditions rarely affect existing buildings, infrastructure, and critical infrastructure; however, critical facilities may lose critical function due to low water supplies. Additionally, severe droughts can damage the water system infrastructure as a result of low flows and water levels. Possible losses to infrastructure include the loss of potable water.

Impact to the Environment

The impacts of drought on local vegetation and wildlife can include death from dehydration and spread of invasive species or disease because of stressed conditions, loss of biodiversity, loss of trees in rural and urban landscapes, loss of wetlands, and degradation of habitat. In general, environmental impacts from drought are more likely at the interface of the human and natural world. The loss of crops or livestock due to drought can have far-reaching economic effects on communities, wind and water erosion can alter the visual landscape, and dust can damage property. Water-based recreational resources are also heavily affected by drought conditions. Indirect impacts from drought arise from increased wildfire risk and greater occurrence of fire. Wildfire may have additional effects on the landscape and sensitive resources such as historic or archeological sites.

Impact to the Economic Condition of the County and Jurisdictions

Drought impacts associated with agriculture, farming, aquaculture, horticulture, forestry or ranching include damage to crop quality; income loss for farmers due to reduced crop yields; reduced productivity of cropland; insect infestation; plant disease; increased irrigation costs; cost of new or supplemental water resource development (wells, dams, pipelines) for agriculture; reduced productivity of rangeland; forced reduction of foundation stock; closure/limitation of public lands to grazing; high cost or unavailability of water for livestock, Christmas tree farms, forestry, raising domesticated horses, bees, fish, shellfish, or horticulture.

Economic damages may also result from impacts to tourism and recreation industries, including water access or navigation problems for recreation; bans on recreational activities; reduced license, permit, or ticket sales (e.g. hunting, fishing, etc.); losses related to curtailed activities (e.g. bird watching, hunting and fishing, boating, etc.); reduced park visitation; and cancellation or postponement of sporting events.

Drought may also indirectly impact non-agriculture and non-tourism businesses, such as lawn care businesses, sales of recreational vehicles or other recreational gear, and plant nurseries. Examples of drought-induced business impacts could include: reduction or loss of employees, change in sales or volume of business, variation in number of calls for service, early closure or late opening for the season, bankruptcy, permanent store closure, economic impacts.

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Drought may also affect power production, electricity rates, energy revenue, and purchase of alternate sources of energy. Examples of potential impacts include hydropower and non-hydropower production when affected by drought, electricity rates, revenue shortfalls and/or windfall profits, and purchase of electricity when hydropower generation is down.

Impact to Public Confidence in Government

Public confidence may be affected because of the drought response process. Water usage restrictions and potential penalties for violations of these restrictions can cause frustration with government. Meetings to discuss drought, efforts to create community drought plans, and public service announcements and education efforts may affect public confidence. Elevated stress levels may result from these processes as well as from demand for higher water rates, cancellation of fundraising events, cancellation/alteration of festivals or holiday traditions, stockpiling water, and/or protests.

Changes in Development

Society's vulnerability to drought is affected largely by population growth, urbanization, demographic characteristics, technology, water use trends, government policy, social behavior, and environmental awareness. These factors are continually changing, and society's vulnerability to drought may rise or fall in response to these changes. For example, increasing and shifting populations puts increasing pressure on water and other natural resources—more people need more water.

Future development greatly impacts drought hazards by stressing both surface and ground water resources. Agricultural and industrial water users consume large amounts of water. Expansion of water-intensive enterprises is limited in a time when water resources are strained. In rapidly growing communities, new water and sewer systems or significant well and septic sites could use up more of the water available, particularly during periods of drought. Public water systems are monitored, but individual wells and septic systems are not as strictly regulated. Therefore, future development could have a profound impact on the vulnerability of Arapahoe County to drought.

Related to both current land use and future development trends, the use of turf grass affects the available water supplies. Maintaining lush, green lawns in the semi-arid climate of the Front Range requires large amounts of water. Urban lawn watering is the single largest water demand on most municipal supplies. Outdoor water use accounts for about 55 percent of the residential water use in the Front Range urban area, most of which is used on turf. Residential and commercial landscaping can greatly impact future drought events and future water use regulations may be able to mitigate this trend.

According to the USDA Census of Agriculture, from 2012 to 2017, farm operations in Arapahoe County increased from 755 to 851 and land enrolled in crop insurance programs increased from 59,139 acres to 74,668 acres. However, total land in farms decreased slightly from 283,226 acres to 282,912 acres, and irrigated agricultural land decreased from 2,460 acres to 1,155 acres. Overall, these trends suggest a slight decrease in agricultural vulnerability to drought in recent years.

As Arapahoe County continues to grow, it will consider practical guidelines for determining the impacts of drought such as measuring the economic value of water in alternative uses and

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objective methods for quantifying non-market impacts of drought on those uses. Additionally, Arapahoe County will continue to follow guidance found within the State of Colorado Hazard Mitigation Plan as well as the Colorado Drought Mitigation and Response Plan.

Jurisdictional Differences

Due to the regional nature of drought, all jurisdictions within Arapahoe County are expected to experience the same magnitude of drought conditions and the same probability of occurrence. However, the impacts of these drought conditions can vary across the county, with greater direct impacts on agricultural areas in the eastern portion of the county. Agricultural communities such as the Town of Bennett, the Town of Deer Trail and unincorporated Arapahoe County are expected to bear the brunt of drought effects in the county due to the potential for crop and livestock losses and the associated economic impacts. The communities in the western portion of the county are more urbanized and less vulnerable to direct impacts from drought. These areas may experience minor impacts to lawns and gardens and restrictions on water usage, but are unlikely to suffer direct property losses.

Table 4-24 Drought Hazard Rankings by Jurisdiction

Drought	Frequency	Spatial Extent	Severity	Overall Significance
Arapahoe County	Likely	Extensive	Limited	Medium
Bennett	Likely	Extensive	Critical	Medium
Bow Mar	Likely	Extensive	Limited	Medium
Centennial	Likely	Extensive	Limited	Medium
Cherry Hills Village	Likely	Extensive	Limited	Medium
Columbine Valley	Likely	Extensive	Limited	Medium
Deer Trail	Likely	Extensive	Critical	Medium
Englewood	Likely	Extensive	Limited	Medium
Foxfield	Likely	Extensive	Limited	Medium
Glendale	Likely	Extensive	Limited	Medium
Greenwood Village	Likely	Extensive	Limited	Medium
Littleton	Likely	Extensive	Limited	Medium
Sheridan	Likely	Extensive	Limited	Medium
Denver Water	Likely	Extensive	Limited	Medium

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4.7 Flooding

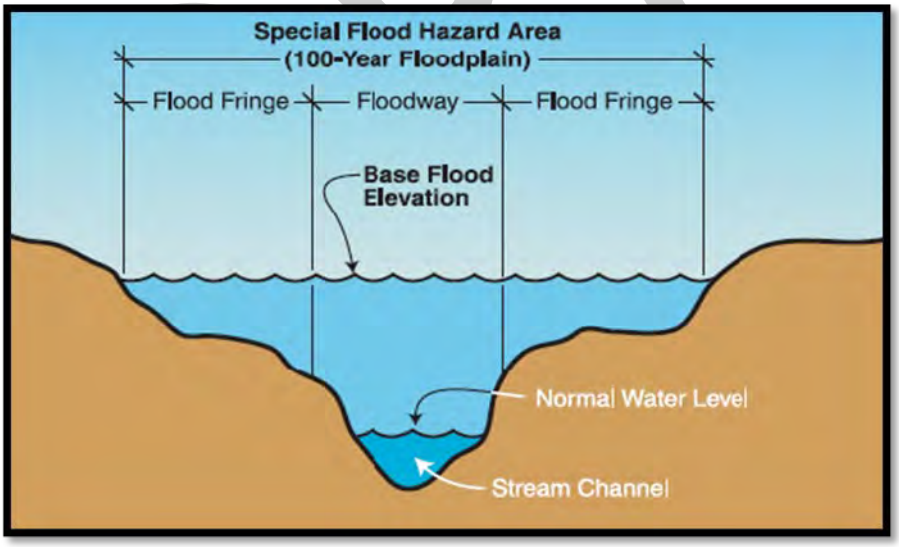
Hazard Description

Floods involve inundation of normally dry land or other areas. Common types of flooding applicable to Arapahoe County include riverine flooding, localized or flash flooding (including storm generated flash floods), stormwater drainage flooding, and dam or levee failure inundation (see Section 4.5 Dam Failure/Incident).

Floods can cause substantial damage to structures, landscapes, and utilities, as well as cause life safety issues. Certain related health hazards are also common to flood events. Standing water and wet materials in structures can become breeding grounds for microorganisms such as bacteria, mold, and viruses. This can cause disease, trigger allergic reactions, and damage materials long after the flood. When flood waters contain sewage or decaying animal carcasses, infectious disease becomes a concern. Direct impacts to populations such as drowning can be limited with adequate warning and public education about what to do during floods. Where flooding occurs in populated areas, warning and evacuation will be of critical importance to reduce life and safety impacts.

Riverine flooding is defined as when a watercourse exceeds its "bank-full" capacity, and is usually the most common type of flood event in Colorado. Riverine flooding generally occurs as a result of prolonged rainfall, or rainfall that is combined with soils already saturated from previous rain events. It also occurs as a result from snowmelt, in which case the extent of flooding depends on the depth of winter snowpack and spring weather patterns. Floodplains are lowlands, adjacent to rivers, streams, and creeks that are subject to recurring floods. Figure 4-12 illustrates common floodplain terminology.

Figure 4-12 Floodplain Terminology



Source: FEMA

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.

A change in environmental conditions or land uses can create localized flooding problems inside and outside of natural floodplains by altering or confining natural drainage channels (e.g. leading to flash flooding). These changes are most often created by human activity in developed areas, but can also be created by other natural events (such as wildland fires) which cause compound effects. For example, wildfires create hydrophobic soils, a hardening or "glazing" of the earth's surface that prevents rainfall from being absorbed into the ground, thereby increasing runoff, erosion, and downstream sedimentation of channels.

Flash flooding events can occur from sudden intense storms, a dam or levee failure, or from a rapid release of water held by an ice jam or snowmelt. Most flash flooding is caused by slow-moving thunderstorms in a local area or by heavy rains associated with hurricanes and tropical storms. Flash flooding in Arapahoe County occurs most often around urbanized areas where much of the ground is covered by impervious surfaces. Flash floodwaters move at very high speeds due to the sudden rush of water, leading to "walls" of water which can reach heights of 10 to 20 feet. Flash floodwaters and the accompanying debris can uproot trees, roll boulders, and damage or destroy buildings, bridges, and roads.

Previous flash flooding events have occurred within Arapahoe County, and an area of Greenwood Village along Belleview and I-25 has been identified as a high-incidence zone. Although data does not currently exist to perform robust assessments of flash flood risk within Arapahoe 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. Stormwater refers to water that collects on the ground surface or is carried in the stormwater system when it rains. In runoff events where the amount of stormwater is too great for the system, or if the channel system is disrupted by vegetation or other debris that blocks inlets or pipes, excess water remains on the surface. This water may pond in low-lying areas, often in street intersections. This is known as stormwater flooding. ***Stormwater flooding*** and ponding can carry debris, dirt, chemicals, and pollutants from impervious surfaces, leading to health issues.

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 discharge 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.

Dam inundation can occur because of structural failure, overtopping, seismic activity, or other reasons that cause a dam or levee to release its contents (often water), leading to flooding. Dam inundation is described in more detail under Section 4.5 Dam Failure/Incident.

According to the latest Arapahoe County Flood Insurance Study (FIS), dated September 28, 2018, most of the county's major floods have historically been on the South Platte River and its tributaries, resulting from snow melt and summer thunderstorms coupled with the tributary basins' structure as they are narrow, hydraulically steep, and composed of highly erodible clay and loam soils. Cherry Creek has also experienced significant floods. Construction of Cherry Creek Dam and Chatfield Dam in the 1950s and 1970s respectively has mitigated the worst flooding problems along those waterways. The FIS notes that intense thunderstorms in the area can generate floods that exceed the existing structural capacities (FEMA 2018).

Hazard Previous Occurrences

There have been several past flooding events throughout the county, ranging widely in terms of location, magnitude, and impacts. The most frequent flooding events are quite localized in nature, resulting from heavy rains in a short period of time over urbanized areas that are not able to appropriately handle stormwater runoff. These events typically do not significantly threaten lives or property and will not result in emergency or disaster declarations; however, some events can lead to injuries and death, as well as thousands or millions of incurred damages. Notable flood events from 1979 to 2019 are summarized in Table 4-25. These events include event-related injuries, deaths, and property or crop damages as applicable.

Table 4-25 Arapahoe County Historical Flood Events (1979-2019)

Date of Event	# Fatalities	# Injuries	Property Damages	Crop Damages	Flood Type	Description
6/7/1979	0	0	$793	$0		
7/18/1985	0	0	$5,555	$5,555		
7/30/1985	0	0	$555	$5,555		
7/20/1990	0	0	$5,000	$0		
5/21/1997	0	0	$0	$0	Flash Flood	Heavy rain and small hail associated with a stationary line of thunderstorms developed over eastern Arapahoe County. Several basements were flooded in the Town of Deer Trail as well as pastures and fields around town. Some streets and intersections in the downtown area were covered by 18 inches of standing water. A storm spotter located 2 miles northeast of Deer Trail recorded nearly 4 inches of rainfall in less than 2 hours.
6/1/1997	0	0	$35,000	$0		
6/13/1997	0	0	$0	$0	Flash Flood	Heavy rain and hail caused Little Comanche Creek to overflow its banks. The areal extent of

Date of Event	# Fatalities	# Injuries	Property Damages	Crop Damages	Flood Type	Description
						the flooding was roughly 50 feet wide and 1 mile long. A flatbed trailer was carried 1/2 mile downstream.
7/27/1997	0	0	$0	$0	Flash Flood	Highwaters from swollen creeks and streams washed out bridges and several sections of road in southeast Aurora. A 200-300 foot section of road was washed away where Picadilly Street dipped across Coal Creek. Three youths had to be rescued when they became stranded by rapidly rising water in another normally small creek.
7/29/1997	0	0	$30,000	$0	Flash Flood	Heavy rain caused flooding and flash flooding problems in central portions of Adams and Arapahoe Counties. Two homes were extensively damaged when water flooded their basements and adjacent pasture area in Strasburg. Highwaters, 4 to 5 feet deep, had pooled in the lower lying areas of town. In addition, Quincy Road had to be blocked off between County Roads 129 and 137 in Arapahoe County. Up to 4 feet of water reportedly covered the roadway.
8/11/1997	0	0	$0	$0	Flash Flood	Intense thunderstorm winds, accompanied by very heavy rain, damaged a barn, and snapped several trees. In addition, flooding and flash flooding was reported along several county roads as 2.5 inches of rain fell in the area.
7/23/1998	0	0	$0	$0	Flash Flood	Heavy rain flooded some local arroyos as they swelled to 5 feet in depth. Some cattle were caught in the high water and carried downstream.
7/24/1998	0	0	$0	$0	Flash Flood	Heavy rain caused flooding and flash flooding problems along small creeks and streams near Deer Trail. Some local roads and bridges were covered by the highwaters. A trained spotter, 3 miles north of Deer Trail, measured 3.5 inches of rainfall.
7/25/1998	0	0	$0	$0		
4/28/1999	0	0	$0	$0	Flood	A steady southeasterly upslope flow brought rainfall. The combination of a persistent upslope and increased runoff allowed for several creeks, rivers, and streams to jump their banks. Rainfall totals over 4 days ranged from 4 to over 6 inches in the hardest hit areas.
8/4/1999	0	0	$0	$0	Flood	Flooding and flash flooding problems developed over portions of the Urban Corridor as slow-moving thunderstorms dumped anywhere from 2 to 3.5 inches of rainfall in approximately 3 hours.
8/19/1999	0	0	$0	$0	Flood	Heavy rain, up to 5 inches in two hours, caused East Tollgate Creek to jump its banks. The bike path adjacent to the creek was underwater at several locations. Several underpasses were also flooded, halting traffic. In addition, an unfinished playground was completely flooded at a local elementary school.
7/16/2000	0	0	$0	$0	Flood	Very moist and unstable conditions, combined with upslope during the late afternoon and evening hours, triggered widespread urban and

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Date of Event	# Fatalities	# Injuries	Property Damages	Crop Damages	Flood Type	Description
						small stream flooding in and around the Denver metropolitan area. Rainfall amounts generally ranged from 1 to 3 inches, with the heaviest rainfall occurring during the evening hours. Since the rain fell in a relatively open area, no flood damage was reported. In Greenwood Village however, near Peoria and Belleview, the road was closed for several hours as 2 feet of standing water covered the roadway.
8/17/2000	0	0	$0	$0	Flash Flood	Thunderstorms producing very heavy rain, up to 3.5 inches in spots, caused flooding and flash flooding problems in and around the Denver Metropolitan area. Extensive flooding was also reported throughout Littleton.
7/8/2001	0	0	$0	$0	Flash Flood	Up to 4.5 inches of rain fell across portions of western Arapahoe County. The underpass of Interstate 25 and Parker Road was inundated with 5 feet of water. Several other streets and underpasses in Aurora were also closed due to the high water. Heavy rain caused extensive damage to several exhibits on display at the Cherry Creek Arts Festival.
7/13/2001	0	0	$0	$0	Flash Flood	Three inches of rain reportedly fell near the Greenwood Village Police Department in the span of 15 minutes. Heavy rainfall caused Toll Gate Creek to jump its banks, flooding low lying areas of Parker Road.
7/18/2003	0	0	$0	$0	Flash Flood	Heavy rain producing thunderstorms caused flash flooding across parts of western Arapahoe County. Automated rain gages indicated 2 to 3 inches of rain had fallen in less than one hour. The heavy rainfall caused many intersections and underpasses to flood, stranding motorists. As a result, sections of Interstates 25 and 225 had to be closed until the floodwaters could recede.
7/23/2004	0	0	$0	$0	Flash Flood	Heavy rain, up to 2 inches in 45 minutes, caused flash flooding problems east of Aurora. Floodwaters, ranging from 2 to 3 feet deep, forced the closure of Powhaten, Gun Club and Picadilly Roads.
8/18/2004	0	0	$0	$0	Flash Flood	Several intersections in Centennial and southern Aurora were impassable due to floodwaters. Two feet of water covered portions of the roadway near Park Meadows Mall. One person had to be rescued near the intersection of Arapahoe Road and Liverpool.
6/3/2005	0	0	$0	$0	Flash Flood	Thunderstorms brought heavy rain to parts of Arapahoe County. Up to 3 feet of standing water was reported over East Orchard Road. Several motorists were stranded in their vehicles and needed to be rescued. Ten vehicles were stranded on Grand Ave; and most had to be towed once the floodwaters receded. Water was also reportedly chest deep at one location on Girard Ave.
7/2/2006	0	0	$0	$0	Flash Flood	Heavy rainfall caused minor flooding along Murphy and Sand Creeks, just east of Buckley Air Force Base. Gun Club Road was closed

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Date of Event	# Fatalities	# Injuries	Property Damages	Crop Damages	Flood Type	Description
						between Alameda and Mississippi Avenues, where three feet of standing water reportedly covered the road.
8/1/2006	0	0	$0	$0	Flash Flood	Heavy rain forced the closure of Arapahoe Road as it was inundated with high water between Holly and Quebec. Flooding was also reported near Park Meadows Mall and Greenwood Village.
8/8/2008	0	0	$10,000	$0	Flash Flood	Extensive flooding was reported; with several motorists stranded in standing water. Heavy rain caused flash flooding over south Denver and its nearby suburbs. Heavy rain, from 2.5 to 4 inches, fell in less than 90 minutes. Firefighters rescued 20 people as water quickly rose along creeks, flooded roadways, and stranded motorists. Three people had to be rescued along Cherry Creek when the bike path flooded.
7/6/2010	0	0	$10,000	$0	Flash Flood	Heavy rain caused flash flooding near Interstate 70 at Byers. Two feet of water was observed moving across the exit ramp. One car was washed into a tree, but no one was injured.
7/14/2011	1	0	$10,000	$0	Flash Flood	Severe thunderstorms in the Denver Metropolitan area produced very heavy rain, large hail, and damaging winds. The strong winds toppled a few trees and the heavy rain caused street flooding and minor flash flooding. Several cars were stranded at the intersection of Santa Fe Drive and Oxford, and near Broadway and U.S. Highway 285. A 16-yr old teenager was seriously injured when he tried to retrieve a ball along the banks of West Toll Gate Creek. He was pulled from the swollen creek and died several days later.
6/6/2012	0	0	$50,000	$50,000	Flash Flood	Severe thunderstorms broke late in the evening, striking areas hardest from Denver southward. Locations impacted by the storms included but were not limited to: Aurora, and Centennial. Heavy rain produced flash flooding in parts of Arapahoe Counties, as thunderstorms brought up to 3.35 inches of rain to some areas within 90 minutes. A water rescue took place on South Gun Club Road in Arapahoe County, where floodwaters were rushing to depth of 3 feet. Flash flooding forced the closure of Quincy Road; South Gun Club Road, between East Exposition Avenue and East Alameda Avenue; South Picadilly Road, between State Highway 30 and East 6th Avenue; and County Road 50, between Delbert Road and County Road 17.
8/3/2013	0	0	$5,000	$0	Flash Flood	Severe thunderstorms brought heavy rain and flash flooding to portions of the Urban Corridor and Northeast Plains. Road closures were set up in both directions on both Picadilly Road and Gun Club Road, just north of Buckley AFB. A man had to be rescued when his car was trapped in flood waters at the intersection of 6th Ave. and Picadilly Road. Flash Flooding was also observed at the junction of E-470 and I-70 with water running over the road.

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Date of Event	# Fatalities	# Injuries	Property Damages	Crop Damages	Flood Type	Description
8/8/2013	0	0	$50,000	$0	Flash Flood	Heavy rain caused localized flash flooding in Aurora. An underground parking garage at an apartment complex was inundated with 3 to 4 feet of water. Flash flooding forced a road closure at East Mississippi Ave. and Alton St. Also, several people had to be rescued when three vehicles stalled in flood waters at Alameda Ave. and Havana St.
9/12/2013	0	0	$3,300,000*	$0	Flood	Continuous heavy rainfall produced flash flooding. East Alameda Parkway between South Chambers Road and South Sable Boulevard was completely underwater. Heavy rain continued to produce widespread flash flooding. Aurora's Prairie Waters, a water recycling and purification system, was shut down due to flooding. Four of the facility's 17 wells where water is siphoned from the South Platte River in Brighton were flooded. Prairie Waters provides up to 20 percent of the city's water. Heavy rain, ranging from 4 to 12 inches through the entire storm event, caused widespread flooding along the entire drainage systems of East Tollgate and Coal Creeks. The areas around Parker Road and Piney Creek were flooded as several holding ponds did overflow their banks. Some of the worst flooded in Centennial occurred along Arapahoe Road near Cottonwood. According to FEMA, 2,138 households were impacted by flooding. Road closures included: East Fitzsimons Pkwy. and North Peoria, East 26th Ave and Fulton St., East 17th Ave and Dayton St., East Colfax and Peoria St., East 12th Ave. between Xanthia St. and Xenia St, East 12th Ave. and Yosemite St., East 11th Ave. and Willow St., East 11th Ave. and Xanthia St., East 11th Ave. and Xenia St., Del Mar Pkwy. and North Havana St., East 1st Ave and Moline St., East Alameda Ave. and South Havana St., South Peoria St. just North of East Ford Ave., South bound 225 and East Alameda Ave., East Alameda Ave. and East Alameda Dr., East Florida Ave. and South Galena St.
9/14/2013	0	0	$0	$0	Flash Flood	The combination of heavy rain, coupled with extremely saturated ground conditions, produced additional flash flooding. Significant flooding was reported at the intersections of Jordan Road and Broncos Parkway, and at Jordon Road and Bluebell. Cars were stalled in several inches of standing water at the intersections of Alameda Ave. and Havana as well as Mississippi Ave. and Kalispell.
5/9/2015	0	0	$15,000	$5,000	Flash Flood	Areal flooding developed along the Cache La Poudre and South Platte River Basins as a combination of heavy rainfall and spring runoff inundated the region. The South Platte rose above flood stage at Kersey from the 9th to the 15thThe hardest hit areas included: Elbert County, along Bijou Creek; eastern portions Adams and Arapahoe Counties. Floodwaters

Date of Event	# Fatalities	# Injuries	Property Damages	Crop Damages	Flood Type	Description
						damaged Arapahoe County Road 42 at the Kings burrow Bridge. Water overtopped the road at several locations. The Byers Fire and Rescue ambulance was attempting to cross an intersection at Morgan County Roads 4 and D to transfer a patient when it was carried into the normally dry creek. Fast water carried the ambulance, with the patient, one passenger and three firefighters, about 100 yards downstream, no injuries due to the accident were reported.
6/11/2015	0	0	$15,000	$0	Flash Flood/ Flood	Thunderstorms producing heavy rainfall caused flooding and flash flooding across parts of the Urban Corridor and adjacent plains. Major flooding occurred in the westbound lane of Arapahoe Road near the Colorado E470 bridge. In Aurora, water was reportedly flowing over the roads at East 6th Ave. and South Picadilly Road. Additional flooding was reported on South Gun Club Road between East Alameda Ave. and East Exposition Avenue, forcing the closure of the road.
8/10/2015	0	0	$50,000	$0	Flash Flood	Heavy rain quickly flooded several intersections. Vehicles stalled in the flooded intersections and two motorists had to be rescued from the flooded roadways at University Blvd and County Line Road and the other, at University Blvd and Dry Creek Rd. At Centennial Airport, a hangar partially collapsed when 2.20 inches of rain fell in one hour. At the Denver Broncos training facility in Dove Valley, the storm left the practice fields and parking lot flooded, and the viewing area near the field house damaged by strong winds. The fields, the team said, received 3.5 inches of rain in an hour during the storm. As a result, the practice facility was closed to the public the following day due to storm damage.
7/24/2018	1	0	$500,000	$0	Flash Flood	Thunderstorms produced very heavy rainfall, 1 to 2 inches in less than 30 minutes. In Englewood, the floodwaters quickly inundated a basement apartment and trapped a woman inside. Near South Acoma, the floodwaters quickly inundated a basement apartment and trapped a 32-year-old woman inside. She was rescued but died several hours later. Several homes in the immediate area suffered severe flood damage. The floodwaters also stalled vehicles and forced the closure of several intersections. Floodwaters stalled several vehicles and forced the closure of several intersections including: East Iliff Ave. and South Chambers Road, Santa Fe Drive and West Oxford Ave., South Buckley Road and East Bates Ave., East 6th Ave. and South Picadilly Road, East Hampden Ave and South Uruvan Way.
Total Events: 38	2	0	$4,091,903	$66,110		

Source: NCEI. * Other sources list the damage from this storm at over $50 million, including $10,000 in crop losses.

Almost all record floods on the South Platte River have been generated near the river's headwaters on the slopes of Monument Divide. The following flood events, principal flood problems, and general terrain and flood related information for Arapahoe County were pulled from the county's 2018 Flood Insurance Study report:

- Major recorded floods (32 total) have occurred on the South Platte River and its tributaries in Arapahoe County from 1844 through 2018. There were 11 devastating floods on the South Platte River, 17 on Cherry Creek, 3 on Bijou, Box Elder, Comanche and Sand Creeks, tributaries of the South Platte and 1 on occurred on Toll Gate Creek.
- The most significant floods of recent times on the South Platte River occurred in 1912, 1921, 1933, 1935, 1942, 1965, and 1973. The discharges for these floods were 13,000 cubic feet per second (cfs), 8,790 cfs, 22,000 cfs, 12,320 cfs, 10,200 cfs, 40,300 cfs, and 33,000 cfs, respectively, at the Denver gage. Cherry Creek experienced similar flood history, with flood discharges of 25,000 cfs, 34,000 cfs, 10,700 cfs, 17,600 cfs, 10,800 cfs and 39,900 cfs in 1912, 1933, 1945, 1963, 1956 and 2013.
- Citizens interviewed in Watkins, Strasburg, Byers, and Deer Trail recalled severe damage and lives lost in 1905, 1933, 1935, and 1965 floods on Box Elder Creek, Comanche Creek, West Bijou Creek, and East Bijou Creek.
- In 1965, a unique combination of orthographic effects and meteorological conditions in the South Platte River Basin caused the worst flooding in the region's recorded history. Severe thunderstorms commenced over the headwaters of Plum Creek and Cherry Creek on June 16 and moved northeasterly down the creeks following and augmenting peak flows. More than 14 inches of rain were recorded at Palmer Lake in 4 hours. Overnight, westerly winds moved the storm front to a position over the Kiowa and Bijou Creek Basins where it met with thunderstorms forming just south of Agate. Here, 5.25 inches fell in 45 minutes. Six people drowned, with two other deaths caused by flood-related activities, and an estimated damages of $500 million in the South Platte River Basin, of which $300 million occurred in the Denver area.

Hazard Location

Arapahoe County falls within the South Platte River Basin, which encompasses 24,151 square miles across 25 Colorado counties. Elevation in the basin ranges from 14,000 feet at the Continental Divide to 3,400 feet at the Colorado-Nebraska state line. Some of the state's and the county's most devastating floods have taken place in the South Platte Basin. The South Platte River is the major stream in the basin, and flows through the western portion of the county in shifting channels and a broad shallow bed with low flat overbanks. The tributaries in the eastern two-thirds of the county flow similarly to the river. The tributary channels to the South Platte River in the western portion of the county are ephemeral and flow in steep narrow channels. The following maps show the mapped FEMA special flood hazard areas.

As shown in Figure 4-13 and Figure 4-14, most of the higher risk areas are located in the western portion of the county and where suburban development pressure is evident in and along the floodplains of the South Platte River, Big Dry Creek, Little Dry Creek, Box Elder Creek, Cottonwood Creek Cherry Creek Sand Creek, Piney Creek, Coal Creek and Comanche Creek (FEMA 2018). According to the county's Flood Insurance Study, the City of Littleton experiences sheetflow flooding on the lower reaches of Little Dry Creek and Slaughterhouse Gulch. While the Flood Insurance Study acknowledges the County Government's efforts to retain open space along the floodplain, historic urbanization has allowed commercial, industrial, and residential developments to encroach into the floodplain.

Figure 4-13 Arapahoe County Special Flood Hazard Areas, Western Portion of County

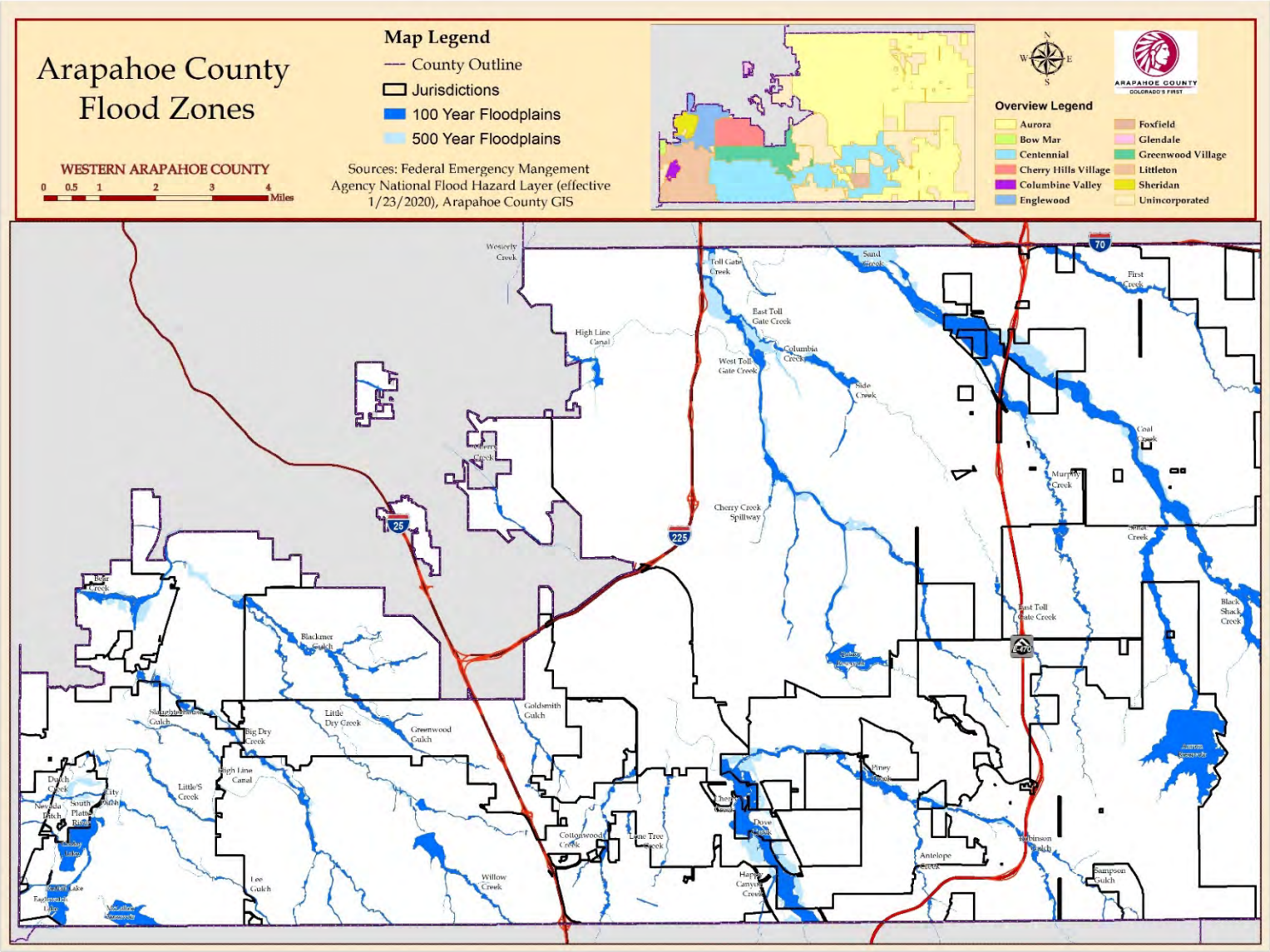
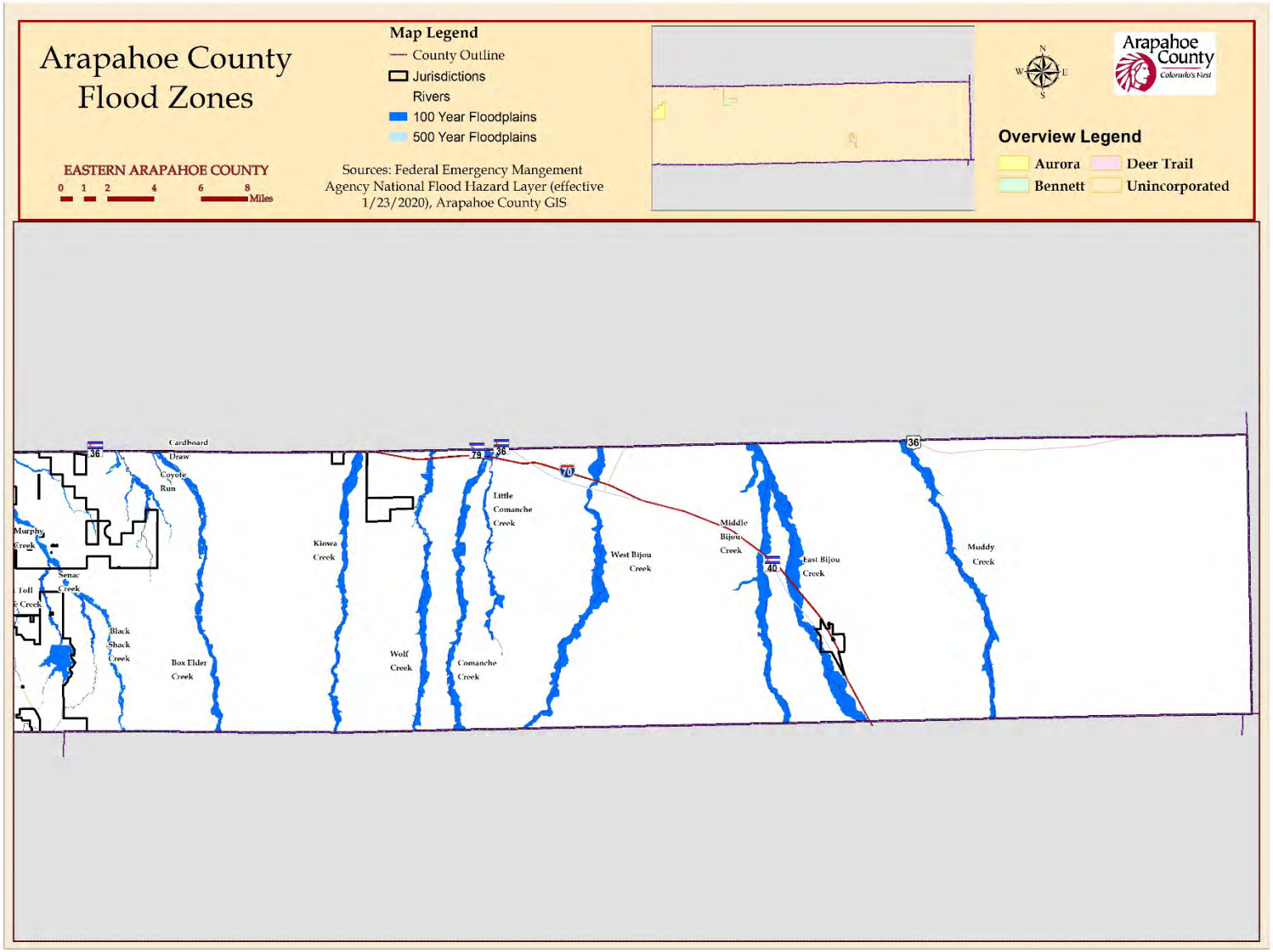


Figure 4-14 Arapahoe County Special Flood Hazard Areas, Eastern Portion of County



Hazard Magnitude/Severity

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 result in death and injuries, induce property damages that threaten structural integrity, 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.

Several 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.

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

Hazard Probability of Occurrence

Periodic flooding of lands adjacent to rivers and streams is a natural occurrence in the county and can be expected to take place based upon established flood recurrence intervals.

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 4-26, and more detailed descriptions of FEMA special flood hazard zones applicable to Arapahoe County are contained in Table 4-27. 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 on Figure 4-13 and Figure 4-14 under the Hazard Location subsection of this chapter.

Table 4-26 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 4-27 FEMA Special Flood Hazard Zones Present in Arapahoe County

Flood Zone	Definitions
FEMA Special Flood Hazard Areas (SFHAs) Subject to Inundation by the 1% or 0.2%-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 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.
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

Based on historical records of 38 flood events since 1979, a damaging flood has occurred in Arapahoe County roughly once every year from 1979 through 2019. Based on this historic frequency, we can assume there is a 95% chance of a flooding event occurring in Arapahoe County each year.

Hazard Consequence Analysis

Flood hazards affect most of the communities in the county, will continue to occur in the future, and can be critical in their magnitude causing injuries or even deaths, and damaging property and infrastructure. The following sub-sections discuss the results of the parcel analysis conducted for Arapahoe County, using parcel centroids and the latest FEMA National Flood Hazard Layer (NFHL) data, updated as of January 23, 2020. Other data sources and vulnerability assessment methods may be used for assets not available in geospatial format, or to supplement existing GIS analysis (e.g. discussion of properties insured by the NFIP).

Impact to the Public

Previous Occurrences of flood events in Arapahoe County have led to 2 recorded fatalities, as detailed in the Hazard Previous Occurrences section for additional event details.

Based on the GIS analysis performed, where the FEMA special flood hazard areas were overlaid with the Arapahoe County parcel layer to obtain the number of vulnerable residential properties (i.e. those intersecting the hazard layer), the total at-risk population to this hazard was estimated. The total population exposed to flooding hazards was calculated by multiplying the average persons per household value for each participating jurisdiction by the total properties of residential nature found to intersect with the flood hazard layers. This assessment estimates that 5,964 people (0.9% of total population) reside within the 1% flood hazard area, while an additional 6,965 people may be found in the 0.2% flood hazard area. For more details, refer to Table 4-15 and Table 4-16.

The impacts of flooding on vulnerable populations can be more severe. Families may have fewer financial resources to prepare for or recover from a flood, and they may be more likely to be uninsured or underinsured. Individuals with disabilities may need more time to evacuate, so evacuation notices will need to be issued as soon as feasible, and communicated by multiple, inclusive methods.

Impact to Responders

Flooding can have various impacts to responders in terms of response time and the personal safety of first responders. Flooded roadways are a common occurrence in Arapahoe County and can block emergency vehicles from crossing certain areas, delaying response times. The Hazard Previous Occurrences events recorded in Table 4-12 show that 24% of flood events resulted in motorists being rescued from stalled vehicles in flooded roadways. These type of rescues can often be dangerous for the first responders due to potentially polluted waters as well as swift waters that can make the response challenging.

Impact to Continuity of Operations (including continued delivery of services)

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.

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Impact to Property, Facilities, and Infrastructure

The type of property damage caused by flood events depends on the depth and velocity of the floodwaters. Faster moving floodwaters can wash buildings off their foundations and sweep cars downstream. 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.

Vulnerability to flooding was determined by summing potential losses to Arapahoe County's parcels in GIS, by using the latest FEMA NFHL data along with the county parcel layer the provided by the Assessor's Office. FEMA's NFHL data depicts the 1% annual chance and the 0.2% annual chance flood events. Flood zones A, AE, and AO are variations of the 1% annual chance event and were included in the analysis due to being present in Arapahoe County. The "Shaded Zone X" along with the subtype 0.2% annual chance hazard zone were used to represent the 500-year flood event.

GIS was used to create a centroid, or point, representing the center of each parcel polygon. Only parcels with improvement values greater than zero were used in the analysis; this assumes that improved parcels have a structure of some type. The FEMA flood zones were overlaid in GIS on the parcel centroid data to identify structures that would likely be inundated during a 1% annual chance or 0.2% annual chance flood event. Property improvement values for the points were based on the assessor's parcel data and summed by parcel type and jurisdiction across the county, along with content values and total values.

Results of the overlay analysis are summarized in Table 4-28 and Table 4-29. Based on these results, there are 3,969 parcels in the 1% annual chance flood zone: 1,804 are residential properties (1% of total in County) and 2,165 are non-residential properties (7% of total in County). The total parcel exposure value vulnerable to the 1% annual chance flood is over $4 billion. The greatest potential losses from 1% annual chance flooding would occur in Aurora, unincorporated Arapahoe County, Centennial, and Littleton. As a percentage of total property values, the communities with the greatest percentage risk are Cherry Hills Village (9%), Littleton (7%), Columbine Valley (7%), and Greenwood Village (6%).

There are 2,908 parcels vulnerable to the 0.2% annual chance flooding: 2,141 are residential properties (1% of total in County) and 767 are non-residential properties (3% of total in County). The City of Aurora has the greatest potential losses from 0.2% annual chance flooding followed by unincorporated Arapahoe County, and the City of Centennial.

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Table 4-28 Parcels Exposed to 1% Annual Chance of Flooding

Jurisdiction	Population	# of Residential Parcels	Residential Improved Value	Residential Content Value	# of Non-Residential Parcels	Non-Residential Improved Value	Non-Residential Content Value	Total # of Parcels	Total Value
Aurora	624	189	$439,164,158	$219,582,079	482	$112,176,304	$112,176,304	671	$883,098,845
Bennett	-	-	-	-	-	-	-	-	-
Bow Mar	-	-	-	-	-	-	-	-	-
Centennial	1,122	362	$238,023,146	$119,011,573	344	$210,787,204	$210,787,204	706	$778,609,127
Cherry Hills Village	492	164	$136,707,521	$68,353,761	52	$34,550,440	$34,550,440	216	$274,162,162
Columbine Valley	48	18	$19,851,326	$9,925,663	30	$7,027,076	$7,027,076	48	$43,831,141
Deer Trail	-								
Englewood	43	12	$57,130,750	$28,565,375	103	$27,076,377	$27,076,377	115	$139,848,879
Foxfield	-	-	-	-	-	-	-	-	-
Glendale	-	-	-	-	8	$15,403,647	$15,403,647	8	$30,807,294
Greenwood Village	634	176	$346,262,853	$173,131,427	72	$0	$0	248	$519,394,280
Littleton	1,218	348	$236,309,535	$118,154,768	244	$133,132,472	$133,132,472	592	$620,729,247
Sheridan	350	70	$15,652,677	$7,826,339	53	$11,486,617	$11,486,617	123	$46,452,250
Unincorporated	1,767	465	$340,983,233	$170,491,617	777	$190,442,510	$190,442,510	1,242	$892,359,870
Total	**6,297**	**1,804**	**$1,830,085,199**	**$915,042,600**	**2,165**	**$742,082,647**	**$742,082,647**	**3,969**	**$4,229,293,093**

Source: FEMA, Arapahoe County GIS, Wood Analysis

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Table 4-29 Parcels Exposed to 0.2% Annual Chance of Flooding

Jurisdiction	Population	# of Residential Parcels	Residential Improved Value	Residential Content Value	# of Non-Residential Parcels	Non-Residential Improved Value	Non-Residential Content Value	Total # of Parcels	Total Value
Aurora	2,561	776	$449,383,754	$224,691,877	301	$151,425,642	$151,425,642	1,077	$976,926,915
Bennett	-	-	-	-	-	-	-	-	-
Bow Mar	-	-	-	-	-	-	-	-	-
Centennial	1,218	393	$257,999,378	$128,999,689	202	$160,520,496	$160,520,496	595	$708,040,059
Cherry Hills Village	60	20	$10,057,600	$5,028,800	0	$0	$0	20	$15,086,400
Columbine Valley	83	32	$22,228,298	$11,114,149	14	$0	$0	46	$33,342,447
Deer Trail	-	-	-	-	-	-	-	-	-
Englewood	245	68	$67,653,551	$33,826,776	65	$49,432,332	$49,432,332	133	$200,344,991
Foxfield	-	-	-	-	-	-	-	-	-
Glendale	-	-	-	-	-	-	-	-	-
Greenwood Village	43	12	$7,079,425	$3,539,713	6	$2,777,952	$2,777,952	18	$16,175,042
Littleton	319	91	$34,892,730	$17,446,365	31	$31,937,286	$31,937,286	122	$116,213,667
Sheridan	95	19	$71,506,425	$35,753,213	25	$5,209,166	$5,209,166	44	$117,677,970
Unincorporated	2,774	730	$240,208,832	$120,104,416	123	$15,825,447	$15,825,447	853	$391,964,142
Total	**7,398**	**2,141**	**$1,161,009,993**	**$580,504,997**	**767**	**$417,128,321**	**$417,128,321**	**2,908**	**$2,575,771,632**

Source: FEMA, Arapahoe County GIS, Wood Analysis

The impacts of floodwater on critical facilities such as police and fire stations, health facilities, and water or wastewater treatment facilities among others can greatly increase the overall effect of a flood event on a community (e.g. if critical potable facilities are impacted). In general, most of these facilities are located in areas with lower risk to flooding due to recent requirements for developers to consider hazard risks in their plans. However, the GIS analysis performed indicates several critical facilities were found to be vulnerable to 1% annual flood hazard area, as listed in Table 4-30. Analysis of critical facilities vulnerable to 0.2% annual flood hazard area was not conducted.

Table 4-30 Critical Facilities in 1% Flood Hazard Area, by Jurisdiction

Jurisdiction	Communications	Energy	Food, Water, Shelter	Hazardous Material	Transportation	Total	%
Aurora	4	6			2	**12**	**1%**
Bennett						**0**	**--**
Bow Mar						**0**	**--**
Centennial	1	2		4	21	**28**	**4%**
Cherry Hills Village	1			1		**2**	**4%**
Columbine Valley						**0**	**--**
Deer Trail					1	**1**	**9%**
Englewood	3				5	**8**	**3%**
Foxfield	1					**1**	**10%**
Glendale						**0**	**--**
Greenwood Village		1			1	**2**	**1%**
Littleton			2	4	5	**11**	**2%**
Sheridan				3	5	**8**	**3%**
Unincorporated	6	6	2	1	22	**37**	**5%**
Total	**16**	**15**	**4**	**13**	**62**	**110**	**3%**

Source: Arapahoe County GIS, Wood Analysis

A total of 110 facilities are located in 1% annual chance flood area, representing 3% of the county's total critical facilities. The majority of those facilities are found in the unincorporated portions of the county, followed by Centennial, Aurora, Littleton, Englewood, Sheridan, Cherry Hills Village, Greenwood Village, Deer Trail and Foxfield. However looked at as a percentage of total critical facilities, Foxfield, Deer Trail, and the unincorporated parts of the county have the greatest risk. According to the analysis there are no critical facilities in the 1% flood area in Bennett, Bow Mar, Columbine Valley or Glendale.

As shown in Table 4-31, the greatest number of facilities in the 1% annual chance flood area across the county are transportation critical facilities such as roadways, bridges, transit, railways, and airports. Review of Hazard Previous Occurrences of flood events in the county show closures of major roadways is common during major flood events.

Table 4-31 Critical Facilities in 1% Flood Hazard Area, by Type

Critical Facilities Type	Count
Transportation	62
Energy	16
Communications	15
Hazardous Material	13
Food, Water, Shelter	4
Total	**110**

Source: Arapahoe County GIS, Wood Analysis

Impact to the Environment

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.

Impact to the Economic Condition of the County and Jurisdictions

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. 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.

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 out buildings. A review of past flood events shows crops damages due to flooding has resulted in $66,110 in crop damages in the past 40 years.

Impact to Public Confidence in Government

Public confidence may be hindered if warnings and alerts prior to the flood event are not communicated effectively. The government's ability to respond and recover may be questioned and challenged by the public if planning, response, and recovery is not timely and effective, particularly in areas that have repeated flooding.

Changes in Development

As population continues to increase in Arapahoe County, future development trajectories can be expected to put more people and property, both private and public, at risk of flooding. It is

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essential that zoning and land use plans take into account not only the dollar amount of damage that buildings near waterways could incur, but also the added risk of floodplain development activity that alters the natural floodplain of the area (for example, narrowing the floodplains by building new structures close to rivers and streams). Historically, suburban residential development has encroached on floodplains throughout the county, specifically along the South Platte River. While development continues, the county is working to retain open space adjacent to floodplains as well as implementing and enforcing the county's Floodplain Regulations which were updated in 2018 in conjunction with updating floodplain mapping.

Jurisdictional Differences

Flooding has the potential to affect several jurisdictions in Arapahoe County depending on the location of the event. Refer to Figure 4-13 and Figure 4-14 under the Hazard Location subsection for the location of the 1% and 0.2% flood hazard areas in the county. Jurisdictions in the western portion of the county are listed most often in the NCEI Storm Events Database compared to jurisdiction in the eastern portion. Due to the highly developed areas, the western portion is likely to experience more damages to homes and businesses compared to the eastern portion. While homes and business can also be impacted in the eastern portion of County, there is also the additional potential economic impact on agricultural properties due to crop damages.

Based on the GIS Analysis described in the Hazard Consequence Analysis section, the jurisdictions with the greatest percentage of residents living in the 1% annual chance flood zone are Cherry Hills Village (8%), Sheridan (6%), and Greenwood Village (4%). Bennet, Bow Mar, Deer Trail, Englewood, Foxfield, and Glendale have effectively 0% living in the 1% zone.

Looking at property and facilities, 1% of the residential parcels and 7% of the nonresidential parcels in the county are located within the 1% annual chance flood zone, worth over $4 billion. The greatest number of parcels within the 1% zone are in the unincorporated County (1,242), Centennial (706), Aurora (671), and Littleton (592). Looked at as a percentage of total property value, 9% of Cherry Hills Village is at risk, followed by Littleton (7%), Columbine Valley (7%), and Greenwood Village (6%). Centennial has the greatest number of critical facilities vulnerable to flooding. The City of Aurora has the greatest number of Repetitive Loss buildings (2) with a total of $50,527.53 payments; Aurora also has the largest number of residential (776) properties and non-residential properties within the 0.2% chance of annual flood.

Additionally, flooding can cause significant localized impacts outside of the 1% annual chance flood zone due to inadequate drainage infrastructure. The City of Englewood has suffered repetitive damaging street flooding, as well as one death when a woman was trapped in a flooded basement in 2018 (see Previous Occurrences in Table 4-25 for more detail). Since this incident, the City of Englewood has updated their flood hazard mapping to reflect their current infrastructure. Additionally, the City has updated their Stormwater System Master Plan that prioritizes stormwater improvement projects for the City. While the City falls outside of the 1% annual chance flood zone due to these drainage constraints the flood risk in Englewood remains elevated for portions of the City.

Each incorporated jurisdiction must implement and enforce their own Floodplain and Development Regulations and take into consideration flood risk across the jurisdictions within the county when considering future development and infrastructure plans.

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National Flood Insurance Program (NFIP) Policies and Repetitive Flood Properties

FEMA insures properties against flooding losses through the NFIP. Table 4-32 provides detailed information on National Flood Insurance Program (NFIP) policies in the plan-participating county jurisdictions, current as of September 28, 2018. NFIP insurance data indicates that as of September 2018, there were 868 flood insurance policies in force in Arapahoe County and its jurisdictions, with $244,943,700 of combined coverage.

Table 4-32 Community Participation in the NFIP and Summary Information

Community	Date Joined	Current Map Date	Study Underway?	Policies in Force	Insurance in Force	# of Paid Losses	Total Losses Paid
Unincorporated	8/15/1977	9/28/2018	Yes	122	$36,038,400	26	$44,612.80
Aurora	6/1/1978	9/28/2018	Yes	271	$69,734,400	83	$286,899
Bennett	9/12/2014	3/5/2007	Yes	1	$8,000	-	-
Centennial	12/1/2002	2/17/2017	Yes	173	$51,852,200	16	$20,859.76
Cherry Hills Village	8/1/1978	12/17/2010	Yes	40	$13,503,000	13	$385,902.64
Columbine Valley	6/15/1978	4/18/2018	Yes	12	$3,955,000	1	$0
Deer Trail	11/5/1985	12/17/2010	Yes	1	$350,000	-	-
Englewood	2/11/1972	4/18/2018	Yes	50	$17,089,800	11	$13,318.58
Glendale	12/5/2005	12/17/2010	Yes	3	$820,000	-	-
Greenwood Village	1/5/1978	2/17/2017	Yes	49	$14,853,000	14	$25,913.44
Littleton	12/1/1978	4/18/2018	Yes	110	$30,204,700	21	$17,353.43
Sheridan	7/13/1976	12/17/2010	Yes	36	$6,535,200	-	-
			Total	**868**	**$244,943,700**	**185**	**$408,957.01**

Source: FEMA Community Information System

As part of the process to reduce or eliminate repetitive flooding to structures across the United States, FEMA has developed an official Repetitive Loss Strategy. The purpose behind the national strategy is to identify, catalog, and propose mitigation measure to reduce flood losses to the relatively few numbers of structures that absorb the majority of the premium dollars from the national flood insurance fund. A repetitive loss property is defined by FEMA as “a property for which two or more NFIP losses of at least $1,000 each have been paid within any 10-year period since 1978”. A repetitive loss property may or may not be currently insured by the NFIP.

As of January 1, 2021, there are five repetitive loss properties in Arapahoe County. Table 4-33 shows these repetitive loss buildings along with information on lasses and payments made.

Table 4-33 Repetitive Loss Properties

Community	Building Type	# of Losses	Total Payments
Aurora	Single Family Residential	2	$ 70,174.86
Aurora	Single Family Residential	2	$ 11,704.87
Cherry Hills Village	Single Family Residential	2	$ 17,172.75
Littleton	Single Family Residential	2	$ 11,578.00
Littleton	Other Residential	2	$ 4,030.57
	TOTAL	**10**	**$114,661.05**

Source: FEMA Community Information System

A Severe Repetitive Loss property (SRL) is defined as a residential property that is covered under an NFIP flood insurance policy and: a) has at least four NFIP claim payments (including building and contents) over $5,000 each, and the cumulative amount of such claims payments exceeds $20,000; or, b) a property for which at least two separate claim payments (building payments only) have been made with the cumulative amount of the building portion of such claims exceeding the market value of the building. For both a) and b) above, at least two of the referenced claims must have occurred within any ten-year period and must be greater than ten days apart. There are no Severe Repetitive Loss properties in Arapahoe County or its jurisdictions as of July 2020.

Refer to the Section 2.7 Capability Assessment for additional details on the CRS program and discussion on opportunities to enhance participating communities Class.

Table 4-34 Flooding Hazard Rankings by Jurisdiction

Flooding	Frequency	Spatial Extent	Severity	Overall Significance
Arapahoe County	Likely	Significant	Limited	Medium
Bennett	Likely	Limited	Limited	Medium
Bow Mar	Likely	Limited	Limited	Medium
Centennial	Likely	Significant	Critical	High
Cherry Hills Village	Likely	Significant	Limited	Medium
Columbine Valley	Likely	Limited	Limited	Medium
Deer Trail	Likely	Limited	Limited	Medium
Englewood	Likely	Limited	Critical	High
Foxfield	Likely	Limited	Limited	Medium
Glendale	Likely	Limited	Limited	Medium
Greenwood Village	Likely	Significant	Limited	Medium
Littleton	Likely	Significant	Limited	Medium
Sheridan	Likely	Significant	Limited	Medium
Denver Water	Likely	Significant	Limited	Medium

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4.8 Hazardous Materials Release

Hazard Description

Hazardous Materials are any material or group of materials of a specific quantity that individually or when combined, cause harm to people, property, or the environment. Arapahoe County recognizes the Environmental Protection Agency's (EPA) list of hazardous materials as required by the Emergency Planning and Community Right to Know Act (EPCRA) as the authoritative list of regulated substances. Hazardous Materials may be stored in fixed locations or transported on road or railways.

The U.S. Department of Transportation (DOT), U.S. Environmental Protection Agency (EPA) and the Occupational Safety and Health Administration (OSHA) all have responsibilities relating to the transportation, storage, and use of hazardous materials and waste. The Right to Know Network maintained by the U.S. Coast Guard's National Response Center (NRC) is a primary source of information on the use and storage of hazardous materials, as well as data regarding spills and releases. In Colorado, the manufacture, use, storage, and transportation of hazardous materials is regulated by the Colorado Department of Public Health and the Environment (CDPHE). Hazardous materials carriers are subject to Colorado Public Utility Commission (PUC) registration and insurance requirements. Colorado statutes require that any person transporting hazardous materials that require placarding to obtain a Hazardous Materials Permit from the Public Utilities Commission. Safety oversight is the jurisdiction of the Colorado State Patrol.

The U.S. Department of Transportation divides Hazardous materials into the following classes:

- Explosives
- Compressed gases: flammable, non-flammable compressed, poisonous
- Flammable & combustible liquids
- Flammable solids: spontaneously combustible, dangerous when wet
- Oxidizers and organic peroxides
- Toxic materials: poisonous material, infectious agents
- Radioactive material
- Corrosive material: destruction of human skin, corrodes steel

Hazard Previous Occurrences

Hazardous materials incidents occur regularly in Arapahoe County. Statistics from the National Response Center (NRC), which 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, indicate that between 1990 and the end of 2019, 360 hazardous materials incidents were reported in Arapahoe County. This number almost certainly excludes a number of very small spills that were not reported to the NRC. As shown in Figure 4-15, the trend has been fairly consistent over the last 30 years, with an average of 10 incidents per year during the 1990s, and 13 per year during the 2000s and 2010s.

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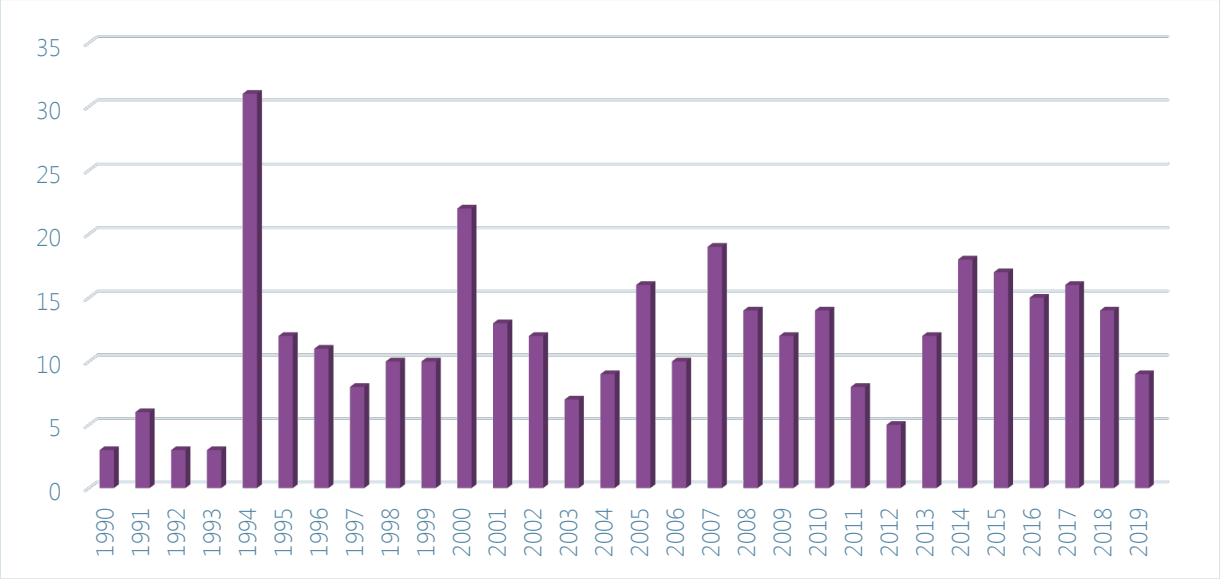
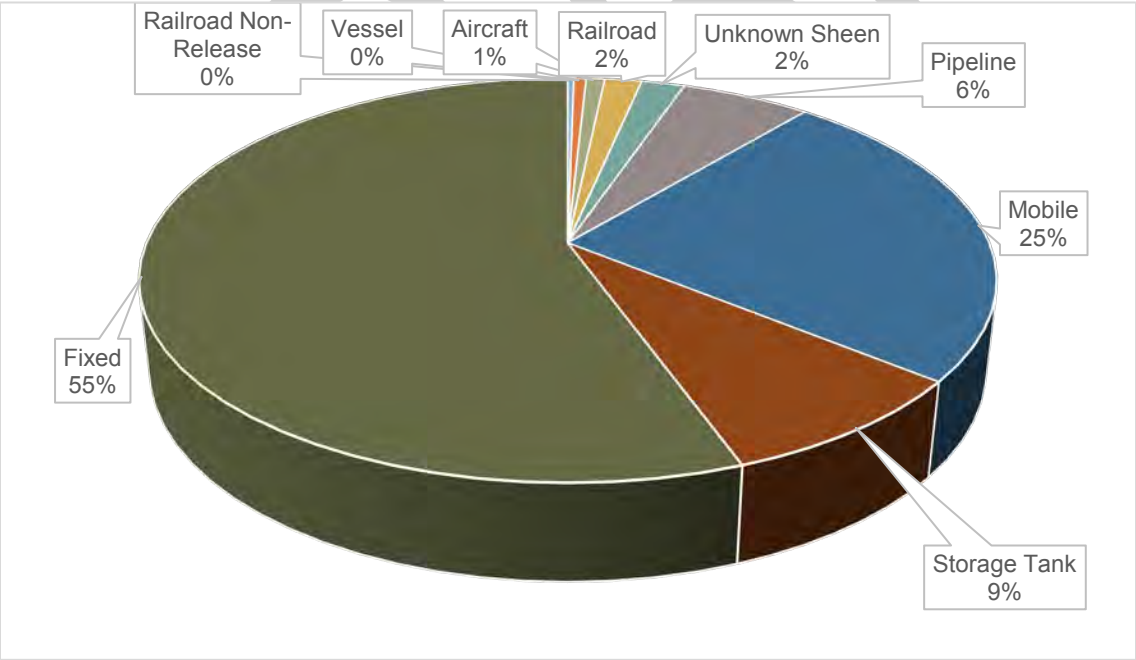
Figure 4-15 Hazardous Materials Incidents Reported in Arapahoe County, 1990-2019



Source: National Response Center

As shown in Figure 4-16, hazardous material incidents in Arapahoe County are most common at fixed sites; only 35% of incidents occur during transportation.

Figure 4-16 Hazardous Materials Incidents in Arapahoe County by Type, 1990-2019



Source: National Response Center

Of these 360 reported incidents listed in the NRC data from 1990 through 2019, only 38 (11%) resulted in any reported injuries, fatalities, evacuations, or property damage. Those 38 incidents are listed as resulting in 5 fatalities, 35 injuries (22 requiring hospitalization), 12 evacuations (a

total of 899 people) and $500,000 in property damages. Averaging these numbers out over 30 years gives annualized rates of 1.3 damaging hazmat incident per year, 1 fatality every 5 years, 1 injury per year, one evacuation every 2.5 years, and $17,000 in property damage per year. 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.

Hazard Location

Hazmat incidents can occur at fixed facilities or during transportation, as discussed below. Overall, the geographic coverage of this hazard in Arapahoe County is limited—less than 10% of the planning area affected based on historical experience – but depending on the type and quantity of spills and the medium affected, the geographic coverage could become large, particularly if a material was released into a stream or waterway.

Generally, with a fixed facility, the hazards are pre-identified. The U.S. Emergency Planning and Community Right-to-Know Act (EPCRA) 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.

Figure 4-3 and Figure 4-4 in the Asset Summary Section show critical facilities in Arapahoe County, including identified hazardous materials sites. As shown in those maps, the majority of these sites are located in the western part of the county, with the largest concentrations in Aurora, Sheridan, Englewood, Foxfield, Centennial, Glendale, Greenwood Village, and the unincorporated Four Square Mile/Sullivan neighborhood west of Aurora.

The EPA also requires facilities containing certain extremely hazardous substances to generate Risk Management Plans (RMPs) and resubmit these plans every five years. As of August 1, 2020, there are 8 RMP facilities located in Arapahoe County. As shown in

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Table 4-35, most are in the western portion of the county, with two located in the eastern part of the county along I-70. There are no significant releases or incidents resulting in deaths or injuries associated with any of these RMP sites. However, plotting these facilities against the other hazards in this plan, two RMP facilities are located in potential dam inundation areas, and two are in Wildland Urban Interface (WUI) zones; none of the RMPs are located in the 100 year floodplain.

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Table 4-35 Risk Management Plan (RMP) Facilities in Arapahoe County

Jurisdiction	RMP Facilities
Aurora	3
Centennial	1
Englewood	2
Unincorporated (Byers)	2
Total	**8**

Source: Right To Know Network https://rtk.rjifuture.org/

The designated hazardous materials routes in Arapahoe County are I-25, I-225, I-70, E-470, and US 36, as shown in Figure 4-17 and Figure 4-18. Additionally, Arapahoe County is transited by Union Pacific and Burlington Northern railroads.

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Figure 4-17 Designated Hazardous Materials Routes in Western Arapahoe County

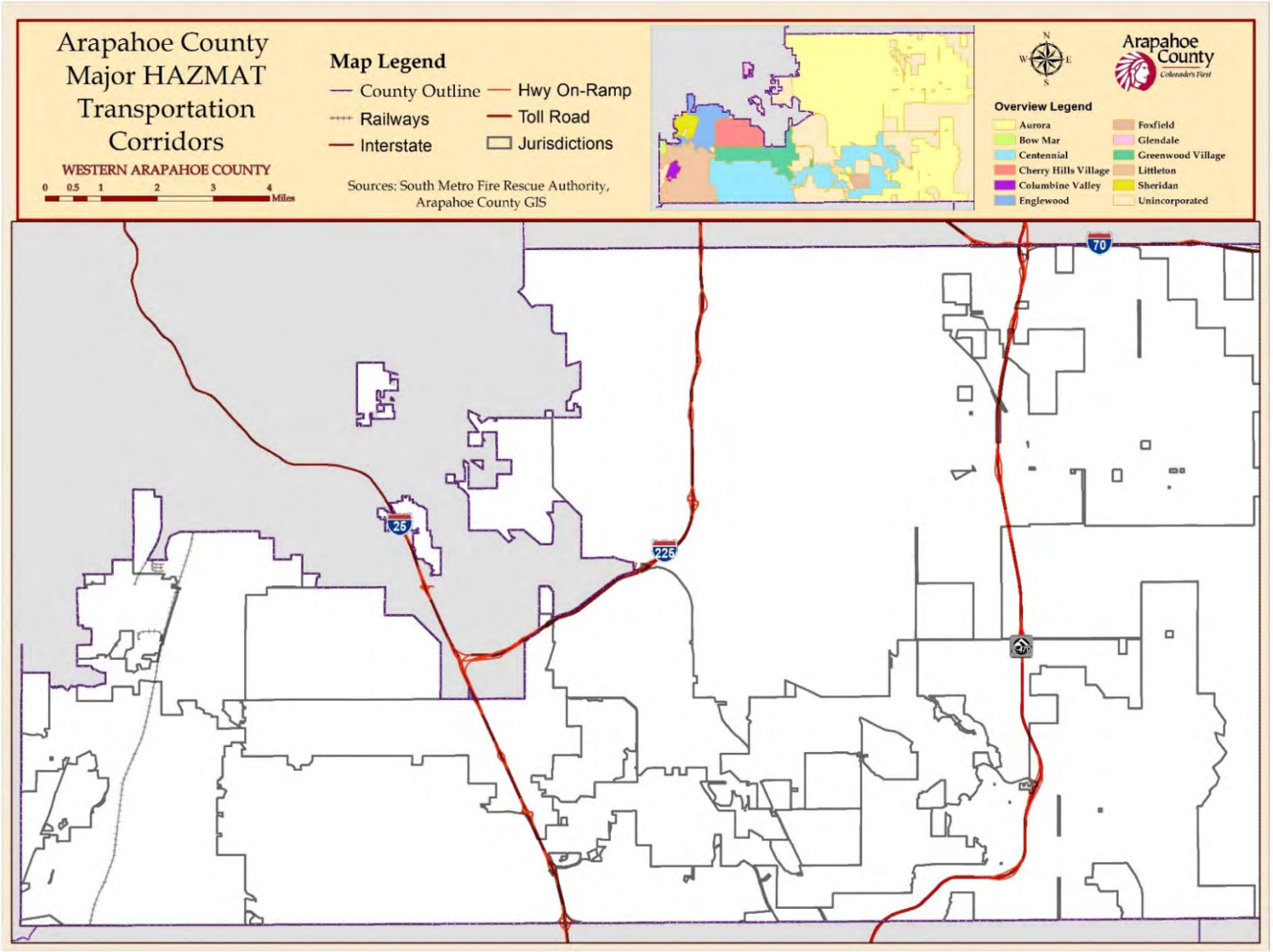
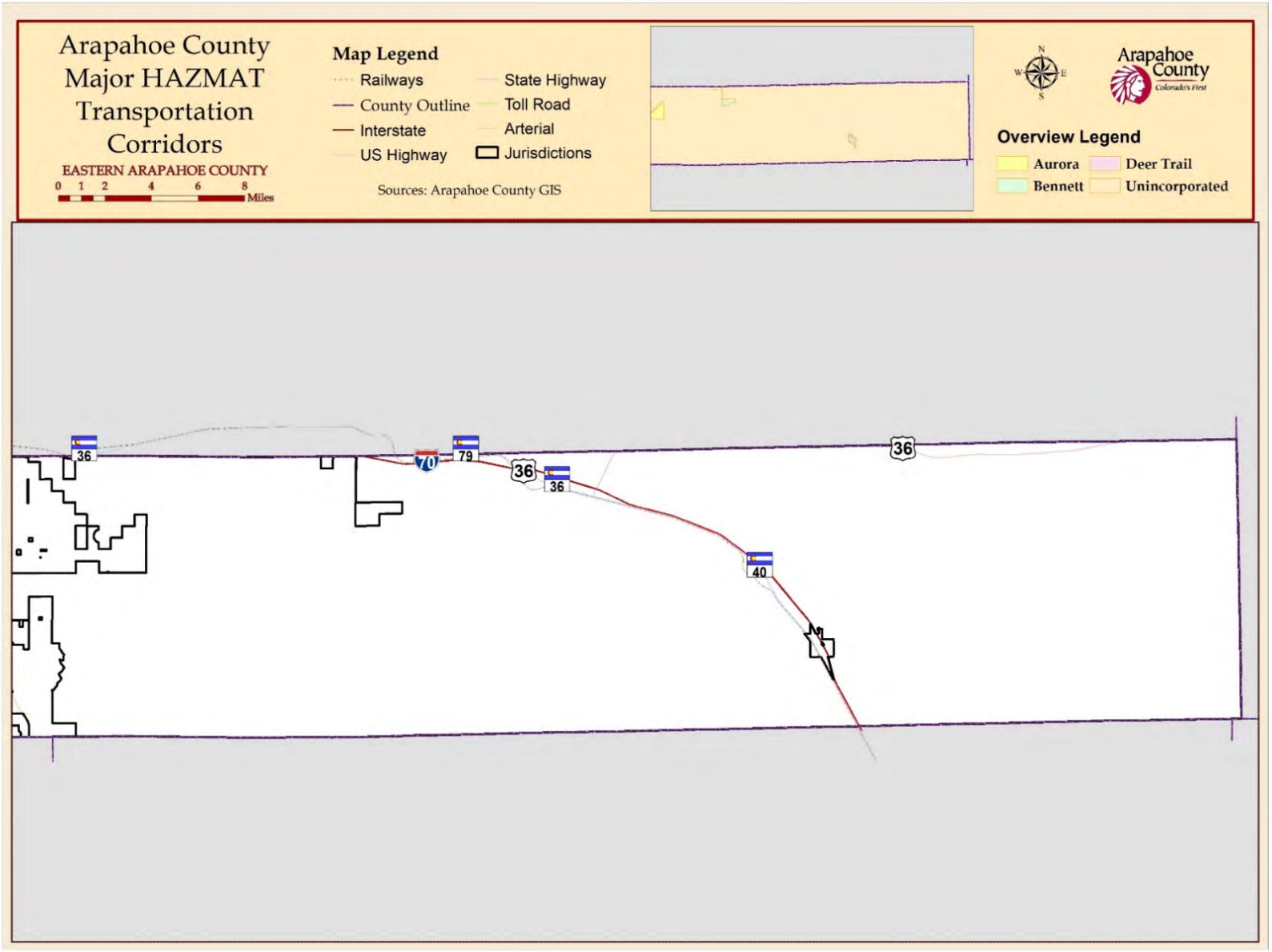


Figure 4-18 Designated Hazardous Materials Routes in Eastern Arapahoe County



Hazard Magnitude/Severity

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.

The release or spill of hazardous materials can also require different emergency responses depending on the amount, type, and location of the spill incident.

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 Arapahoe County have been limited. As noted previously, the county experiences an average of 1 fatality every 5 years, 1 injury per year, one evacuation every 2.5 years, and $17,000 in property damage per year associated with hazardous materials incidents. However the majority of those deaths and injuries result from the accident that caused the release, rather than from exposure to the hazardous material itself. Pipeline accidents and gas explosions account for the majority of deaths and injuries caused directly by hazardous materials.

Hazard Probability of Occurrence

It is almost certain that Arapahoe County will experience a hazardous material incident in any given year. Since 2000, the county has averaged 13 hazardous materials incidents per year, with 1.3 incidents per year resulting in injuries, fatalities, damage, or evacuations.

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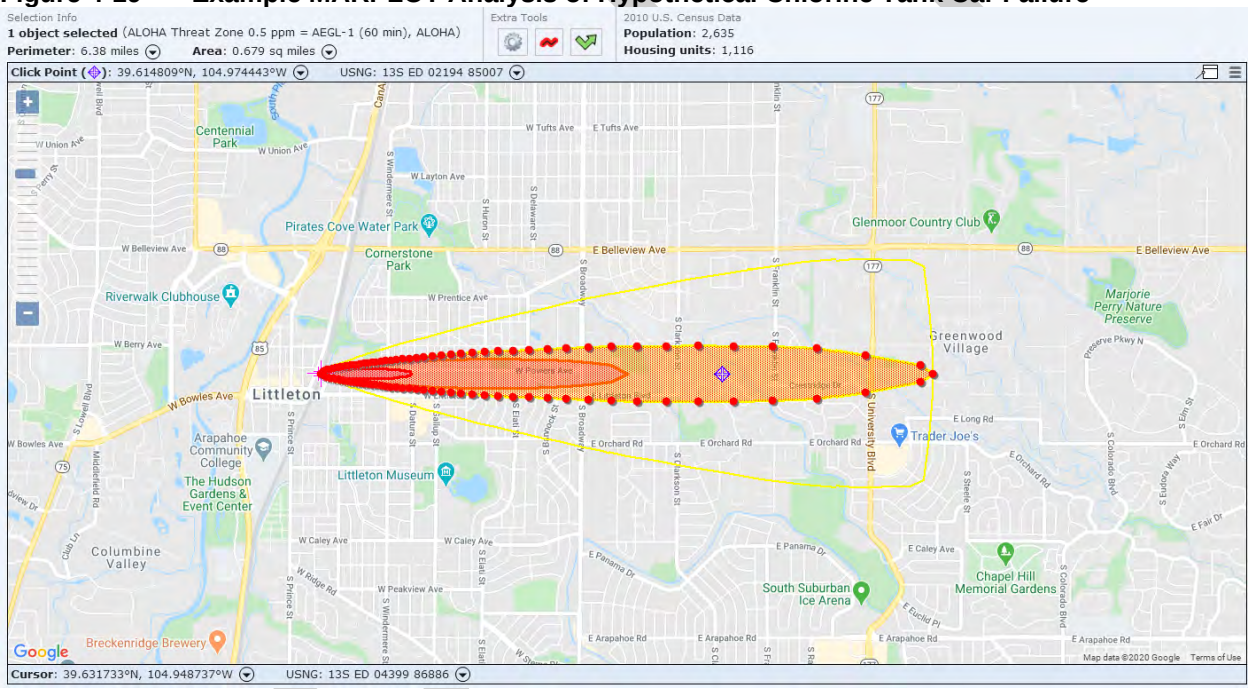
Hazard Consequence Analysis

Impact to the Public

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. The most likely routes are inhalation, absorption, and ingestion. 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.

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. For example, Figure 4-19 and Figure 4-20 model a hypothetical chlorine tank car (IDLH 10ppm) release in the western reaches of the county, which could be devastating with potentially 2,635 people killed and injured. While this is an extreme example, incidents of this magnitude have occurred in other places around the country.

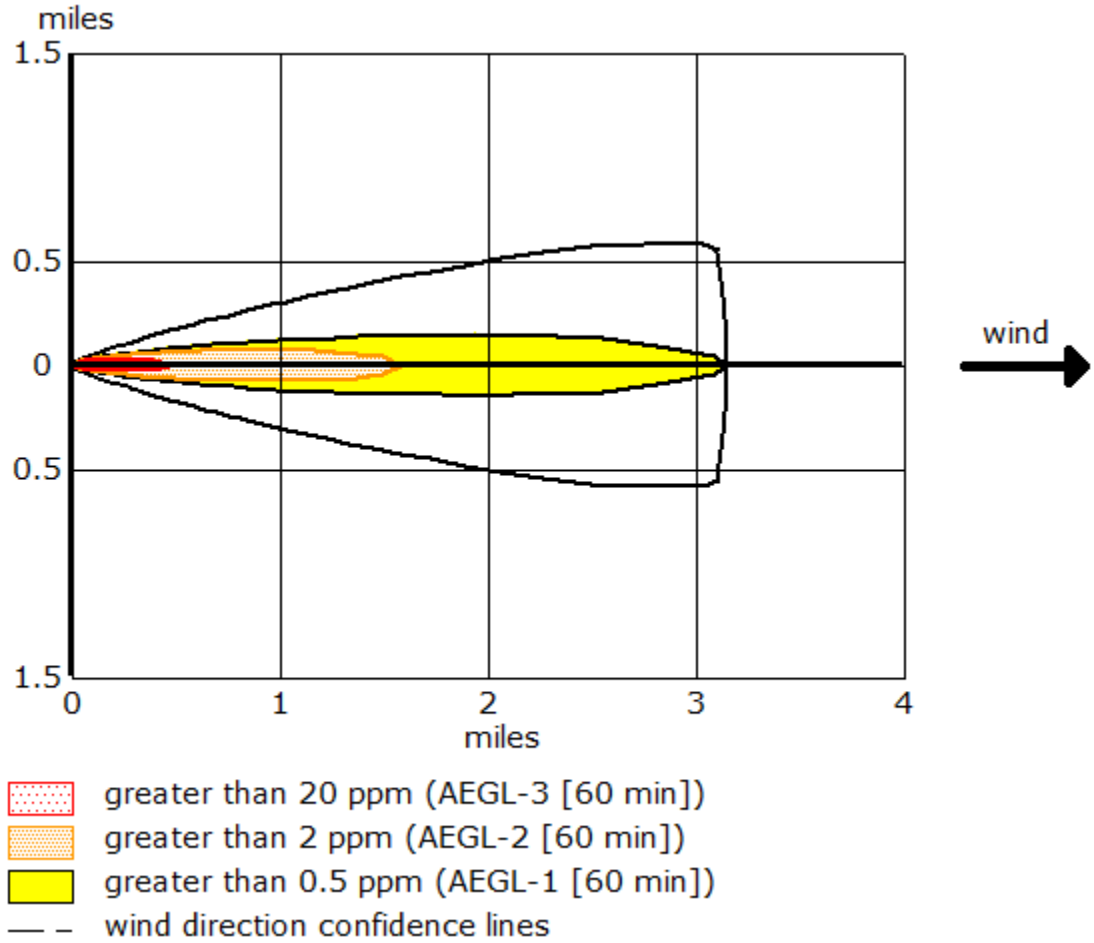
Figure 4-19 Example MARPLOT Analysis of Hypothetical Chlorine Tank Car Failure



Source: MARPLOT

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.

Figure 4-20 Example ALOHA Analysis of Hypothetical Chlorine Tank Car Failure



Source: ALOHA
SITE DATA:
Location: DENVER, COLORADO
Building Air Exchanges Per Hour: 0.85 (unsheltered single storied)
Time: February 12, 2020 1507 hours MST (using computer's clock)
CHEMICAL DATA:
Chemical Name: CHLORINE
CAS Number: 7782-50-5 Molecular Weight: 70.91 g/mol
AEGL-1 (60 min): 0.5 ppm AEGL-2 (60 min): 2 ppm AEGL-3 (60 min): 20 ppm
IDLH: 10 ppm
Ambient Boiling Point: -36.8° F
Vapor Pressure at Ambient Temperature: greater than 1 atm
Ambient Saturation Concentration: 1,000,000 ppm or 100.0%
ATMOSPHERIC DATA: (MANUAL INPUT OF DATA)
Wind: 8 miles/hour from W at 3 meters
Ground Roughness: urban or forest Cloud Cover: 5 tenths
Air Temperature: 28° F Stability Class: D
No Inversion Height Relative Humidity: 50%

Impact to Responders

Hazardous Materials incidents can have a more significant impact to responders, particularly those responders conducting initial size-up operations and those conducting scene entry, mitigation, and clean-up operations. This qualitative assessment is based on the likelihood of

lower levels of personal protective equipment donned by initial responders, the handling and proximity of mitigation responders and clean-up technicians.

Impact to Continuity of Operations (including continued delivery of services)

The vast majority of hazardous materials incidents have minimal impacts on continuity of operations beyond short-term road closures. However a large spill or a particularly hazardous substance could take weeks or even months to clean up.

Impact to Property, Facilities, and Infrastructure

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. Cleanup from major spills can be lengthy and expensive; a petroleum release in 2017 in Greenwood Village resulted in complete removal of asphalt and concrete in multiple lanes of both directions of Interstate 25.

Impacts on critical facilities are similarly 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.

Impact to the Environment

In many instances of hazardous materials releases, the environment is the most significantly affected component of the system consisting of people, property, and the environment. Environmental impact often includes water quality, air quality, and soil contamination. Again, the impact to the environment is scale dependent and ranges from minimal and temporary such as a small chemical spill on a roadway to catastrophic and permanent as seen at the nearby Rocky Mountain Arsenal. Widespread effects can occur when materials 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.

Impact to the Economic Condition of the County and Jurisdictions

The primary economic impact of hazardous material incidents results from lost business, delayed deliveries, property damage, and potential contamination. The economic impacts of major road closures alone can range from $2,000 to $250,000. Large and publicized hazardous material-related events can deter tourists and recreationists and could potentially discourage residents and businesses. Economic effects from major transportation corridor closures can be significant not only for Arapahoe County but also for the entire Denver-metro region.

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. An extreme example is the Lowry Superfund site located near East Quincy Avenue and South Gun Club Road, a billion-dollar cleanup with national economic impacts.

Impact to Public Confidence in Government

Nationally, recent large hazardous materials incidents such as the 2013 fertilizer plant explosion in West, Texas, and several railway fuel oil explosions in 2013-2015 affected confidence in

government's ability to prevent or protect people from those types of disasters. Typically, the impact to public confidence is minimal so long as the government acts appropriately by sharing timely and accurate information, follows mitigation procedures focused on, in this order, life safety, incident stabilization, property protection, and environmental protection. Additionally, the government is responsible for ensuring proper resolution by reviewing remediation reports in the event of spill involving mitigation actions. Issues such as long-term closures of major Interstates may cause frustration from the public. These impacts can be mitigated by following proper messaging and cleanup procedures.

Changes in Development

The development of and drilling of the Niobrara formation for oil and gas production has dramatically increased since the last plan update. From January 2015 to December 2017, there were 119 additional planned or permitted wells in Arapahoe County. The county also saw growth in housing and commercial development during this time. Also of note, while not necessarily development, is a change in hazardous materials transportation routing law that will allow the E-470 Toll Authority to petition the Colorado Department of Transportation requesting status as a designated hazardous materials transportation route, creating more options for hazardous materials routing across the county.

Jurisdictional Differences

Hazardous materials are present throughout the entire County. However, the majority of both fixed sites and major transportation routes are in the western County. That portion of the county also has much greater population density and more critical facilities, which means the impacts from a release would likely be more significant. As discussed above under Hazard Location, the largest concentrations of hazardous materials sites are in Aurora, Sheridan, Englewood, Foxfield, Centennial, Glendale, Greenwood Village, and the unincorporated Sullivan neighborhood west of Aurora. Table 4-36 breaks down the NRC-reported hazardous materials incidents for Arapahoe County by the closest reported city. Aurora, Englewood, and Littleton together account for more than 70% of the county's hazmat incidents.

Table 4-36 Hazardous Materials Incidents in Arapahoe County by Closest City, 1990-2019

Jurisdiction	# of Incidents	Jurisdiction	# of Incidents
Aurora	109	Sheridan	7
Englewood	92	Strasburg	6
Littleton	54	Buckley	5
Rural or Not Specified	24	Bennett	3
Centennial	21	Cherry Hills Village	2
Greenwood Village	14	Watkins	2
Byers	12	Glendale	1
Deer Trail	7		

Source: NRC

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Table 4-37 Hazardous Materials Release Hazard Rankings by Jurisdiction

Hazardous Materials Release	Frequency	Spatial Extent	Severity	Overall Significance
Arapahoe County	Likely	Significant	Critical	Medium
Bennett	Occasional	Significant	Critical	Medium
Bow Mar	Occasional	Limited	Critical	Low
Centennial	Likely	Significant	Critical	Medium
Cherry Hills Village	Occasional	Significant	Critical	Medium
Columbine Valley	Unlikely	Limited	Critical	Low
Deer Trail	Occasional	Significant	Critical	Medium
Englewood	Likely	Significant	Critical	High
Foxfield	Unlikely	Limited	Critical	Low
Glendale	Unlikely	Limited	Critical	Low
Greenwood Village	Likely	Significant	Critical	Medium
Littleton	Likely	Significant	Critical	Medium
Sheridan	Occasional	Significant	Critical	Medium
Denver Water	Likely	Significant	Critical	Medium

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4.9 Pandemic

Hazard Description

A public health emergency is an emergency need for health care [medical] services to respond to a disaster, significant outbreak of an infectious disease, bioterrorist attack or other significant or catastrophic event. Public health emergencies can occur as primary events by themselves, or they may be secondary to another disaster or emergency, such as tornado, flood, or hazardous material incident.

A pandemic can be defined as a public health emergency 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.

There are three conditions that must be met before a 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.

As of March 2020, Arapahoe County, the nation, and the world are dealing with the COVID-19 pandemic, confirming that pandemic is a key public health hazard in the county. This hazard risk assessment includes an analysis of pandemic risk in Arapahoe County and an analysis of the impacts of the hazards profiled in this plan on public health.

Unlike seasonal flu, an influenza pandemic has much greater potential for loss of life and significant social disruption due to higher rates of transmission and more severe health impacts. The COVID-19 virus has a much higher rate of transmission than the seasonal flu, primarily by airborne transmission of droplets/bodily fluid. Common symptoms include fever, cough, fatigue, shortness of breath or breathing difficulties, and loss of smell and taste. While most people have mild symptoms, some people develop acute respiratory distress syndrome with roughly one in five requiring hospitalization and a fatality rate of approximately 1%. A key challenge in containing the spread has been the fact that it can be transmitted by people who are asymptomatic.

Hazard Previous Occurrences

The Colorado Department of Public Health and Environment releases an annual reportable disease summary for each county. The diagnoses with the highest incidences in Arapahoe County for 2016 through 2018 are summarized in Table 4-38.

Table 4-38 Reportable Disease Diagnosis, Arapahoe County 2016-2018

Diagnosis	Incidents in 2016	Incidents in 2017	Incidents in 2018
Influenza - Hospitalized	258	511	487
Hepatitis C, Chronic	386	403	408
Animal Bites	270	189	264
Hepatitis B, Chronic	130	116	114
Carbapenem-Resistant Pseudomonas Aeruginosa (CRPA)	N/A	126	110
Campylobacteriosis	77	100	103
Salmonellosis	73	69	98
Group A Strep Invasive	57	71	77
Pertussis	104	80	74
Giardiasis	54	68	60

Source: https://www.colorado.gov/pacific/cdphe/colorado-reportable-disease-data

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 novel coronavirus pandemic began in December 2019 and was declared a pandemic in March of 2020. As of October 30th, 2020, 45 million cases have been reported around the world with over 1 million deaths, including 9 million cases and 229,000 deaths in the US. Arapahoe County has seen 13,165 cases so far resulting in 1,632 hospitalizations and 400 deaths. The pandemic is expected to last through the remainder of 2020 and into 2021.

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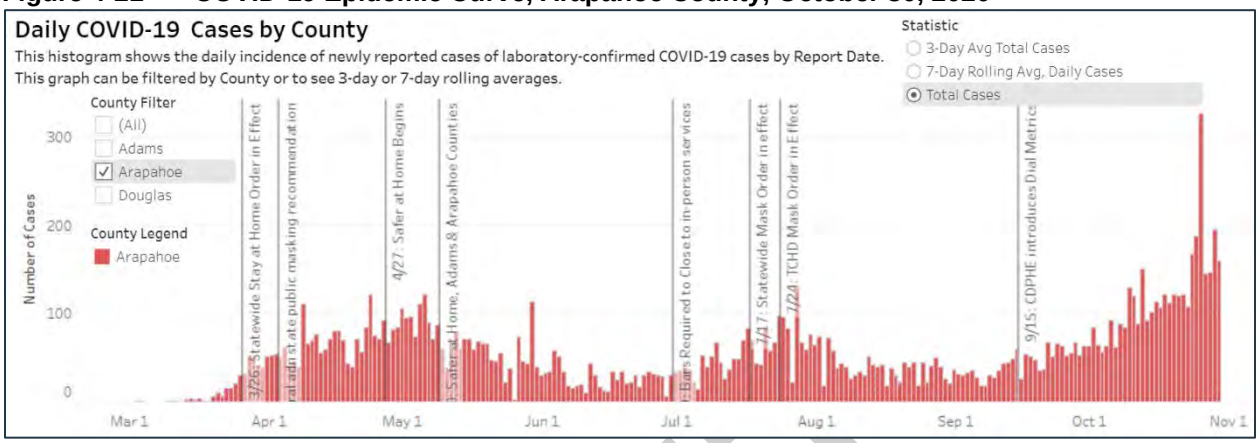
Figure 4-21 COVID-19 Epidemic Curve, Arapahoe County, October 30, 2020



Source: Tri-County Health Department, http://tchd.org/823/Case-Updates

Hazard Location

Pandemics occur not only on a county or state level, but on a national and global scale. It is likely that most communities in Arapahoe County would be affected, either directly or by secondary impacts. More highly-populated areas may be affected sooner and may experience higher infection rates.

The current COVID-19 pandemic has affected all 64 Colorado counties. Arapahoe County has reported 13,165 cases and 400 deaths, as of October 30, 2020, and is currently seeing an increase in cases (See Figure 4-21). All communities in the county are likely to be impacted, either directly or indirectly. Some indirect consequences may be the diversion of resources that may be otherwise available.

Hazard Magnitude/Severity

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

Today, a much larger percentage of the world's population is clustered in cities, making them ideal breeding grounds for epidemics. Additionally, the explosive growth in air travel means 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.

The Pandemic Intervals Framework (PIF) is a six-phased approach to defining the progression of an influenza pandemic. This framework is used to guide influenza pandemic planning and

provides recommendations for risk assessment, decision-making, and action. These intervals provide a common method to describe pandemic activity which can inform public health actions. The duration of each pandemic interval might vary depending on the characteristics of the virus and the public health response.

The six-phase approach was designed for the easy incorporation of recommendations into existing national and local preparedness and response plans. Phases 1 through 3 correlate with preparedness in the **pre-pandemic interval**, including capacity development and response planning activities, while Phases 4 through 6 signal the need for response and mitigation efforts during the **pandemic interval**.

Pre-Pandemic Interval

In nature, influenza viruses circulate continuously among animals (primarily birds). Even though such viruses might develop into pandemic viruses, in Phase 1 no viruses circulating among animals have been reported to cause infections in humans.

- **Phase 1** is the natural state in which influenza viruses circulate continuously among animals but do not affect humans.

In Phase 2 an animal influenza virus circulating among domesticated or wild animals is known to have caused infection in humans, and is thus considered a potential pandemic threat.

- **Phase 2** involves cases of animal influenza that have circulated among domesticated or wild animals and have caused specific cases of infection among humans.

In Phase 3 an animal or human-animal influenza virus has caused sporadic cases or small clusters of disease in people, but has not resulted in human-to-human transmission sufficient to sustain community-level outbreaks. Limited human-to-human transmission may occur under some circumstances, for examples, when there is close contact between an infected person and an unprotected caregiver. Limited transmission under these circumstances does not indicate that the virus has gained the level of transmissibility among humans necessary to cause a pandemic.

- **Phase 3** represents the mutation of the animal influenza virus in humans so that it can be transmitted to other humans under certain circumstances (usually very close contact between individuals). At this point, small clusters of infection have occurred.

Pandemic Interval

Phase 4 is characterized by verified human to human transmission of the virus able to cause “community-level outbreaks.” The ability to cause sustained disease outbreaks in a community marks a significant upward shift in the risk for a pandemic.

- **Phase 4** involves community-wide outbreaks as the virus continues to mutate and become more easily transmitted between people (for example, transmission through the air)

Phase 5 is characterized by verified human to human spread of the virus into at least two countries in one World Health Organization (WHO) region. While most countries will not be affected at this stage, the declaration of Phase 5 is a strong signal that a pandemic is imminent

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and that the time to finalize the organization, communication, and implementation of the planned mitigation measures is short.

- **Phase 5** represents human-to-human transmission of the virus in at least two countries

Phase 6, the pandemic phase, is characterized by community-level outbreaks in at least one other country in a different WHO region in addition to the criteria defined in Phase 5. Designation of this phase will indicate that a global pandemic is underway.

- **Phase 6** is the pandemic phase, characterized by community-level influenza outbreaks.

Hazard Probability of Occurrence

Even before the COVID-19 pandemic began, the Colorado Department of Public Health and Environment (CDPHE) considered a pandemic to be inevitable. However, there is no definite way to predict when the next pandemic might happen. Some indicators will be present, but not every new virus turns into a pandemic. 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.

Based on historical incidents from 2013 through 2018, Arapahoe County experiences an average of 348 reported cases of influenza hospitalizations each year.

Hazard Consequence Analysis

Impact to the Public

Adverse impacts are expected to be severe for unprotected personnel and moderate to light for protected personnel. Medications may be limited to help prevent or treat the disease. It takes years to manufacture a vaccine and would likely become available in small quantities at first. It may become necessary to ration limited amounts of medications, vaccinations, and other health care supplies. 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 pandemics. People without health coverage or access to good medical care are also likely to be more adversely affected. Mental health of the public could also be impacted depending on the length of the event and public health guidance on prevention.

As noted under Previous Occurrences, the COVID-19 pandemic has resulted in 37.5 million cases worldwide as of October 5, 2020, with over 1 million deaths. The U.S. has seen 7.8 million cases with 215,000 deaths. As of October 30, 2020, Arapahoe County specifically has seen 13,165 cases resulting in 1,632 hospitalizations and 400 deaths. In addition to the direct impacts, the pandemic has completely disrupted life for many people. Most large gatherings have had to be cancelled, and many schools have closed. Sheltering in place and social distancing have been highly encouraged and, in some places, mandated, leaving some individuals isolated for months.

Impact to Responders

Medical staff can become overburdened with hundreds of additional cases on top of their normal workload. All other responders will be impacted in similar proportions to the general

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public, thereby reducing available responders. Adverse impacts are expected to be severe for unprotected personnel and uncertain for trained and protected personnel, depending on the nature of the incident.

The COVID-19 pandemic has had severe impacts on healthcare workers and other responders. The difficulty of trying to protect themselves and their families while still doing their jobs was exacerbated initially by shortages of personal protective equipment (PPE). The mental health impacts on responders and healthcare workers have not been fully quantified, but are likely to have impacts for months if not years to come.

Impact to Continuity of Operations (including continued delivery of services)

Unscheduled sick leave from a large portion of the workforce could result in loss of productivity and delivery of services. Even without large numbers of infected workers, social distancing requirements and workplace closures can have a major impact on the government's ability to deliver services, as seen during the COVID-19 pandemic. As residents are quarantined due to the pandemic, as seen during the COVID-19 pandemic the demand for deliveries of essential goods will also increase.

Impact to Property, Facilities, and Infrastructure

Although property would not be directly affected by a pandemic, access to facilities and infrastructure in the area of the incident may be denied until decontamination is complete. Workplace closures due to social distancing and quarantine requirements can make facility operation more difficult.

Impact to the Environment

Incident may cause denial or delays in the use of some areas. Remediation may be needed. Ironically, the decrease in people commuting to work due to the COVID-19 pandemic has led to measurable air quality improvements in many places, including the Denver metro area.

Impact to the Economic Condition of the County and Jurisdictions

Local economy and finances may be adversely affected, possibly for an extended period of time. Unscheduled sick leave from a large portion of the workforce could result in millions, even billions, of dollars lost in productivity. Business restrictions due to social distancing requirements can also be significant. 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 reception or even a depression.

The economic impact of the COVID-19 pandemic and associated closures has been significant, triggering a recession and high unemployment; the unemployment rate jumped for 4.4% in March of 2020 to 14.7% in April and stayed in the double-digits through most of the summer. Some studies estimate that 1 in 5 renters are at risk of eviction. The stock market suffered major losses in the early days of the pandemic. The restaurant, retail, and oil and gas industries have been particularly hard hit, with numerous businesses closing or filing for bankruptcy. And among household with children, food insecurity – defined as when a household does not have sufficient food for its members to maintain healthy and active lives and lacks the resources to obtain more food – has more than doubled from 14% in 2018 to 32% in July 2020.

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Impact to Public Confidence in Government

Ability to respond and recover may be questioned and challenged if planning, response, and recovery are not timely and effective. Help from the federal government and from other states would likely be limited, as all personnel would be deployed throughout the country already. While the federal government would do what they can, communities would have to rely on their own resources for a much longer period of time as compared to other disasters.

It is expected that the government will work towards a solution that will end the pandemic, typically by helping to distribute vaccines and antiviral agents. Continual public messaging and outreach is vital.

Changes in Development

Future development in and around Arapahoe 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.

Population growth and development contribute the greatest to pandemic exposure. As populations increase and the cost of health care climbs, potential losses can be expected to rise. It is possible that infrastructure may not be able to be maintained as necessary during a pandemic because of a significantly decreased workforce.

Jurisdictional Differences

Pandemics have the potential to occur anywhere in Arapahoe County, therefore the location, extent, and probability of occurrence are the same county-wide.

Table 4-39 Pandemic Rankings by Jurisdiction

Pandemic	Frequency	Spatial Extent	Severity	Overall Significance
Arapahoe County	Occasional	Extensive	Critical	High
Bennett	Occasional	Extensive	Critical	High
Bow Mar	Occasional	Extensive	Critical	High
Centennial	Occasional	Extensive	Critical	High
Cherry Hills Village	Occasional	Extensive	Critical	High
Columbine Valley	Occasional	Extensive	Critical	High
Deer Trail	Occasional	Extensive	Critical	High
Englewood	Occasional	Extensive	Critical	High
Foxfield	Occasional	Extensive	Critical	High
Glendale	Occasional	Extensive	Critical	High
Greenwood Village	Occasional	Extensive	Critical	High
Littleton	Occasional	Extensive	Critical	High
Sheridan	Occasional	Extensive	Critical	High
Denver Water	Occasional	Extensive	Critical	High

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4.10 Severe Summer Weather

Hazard Description

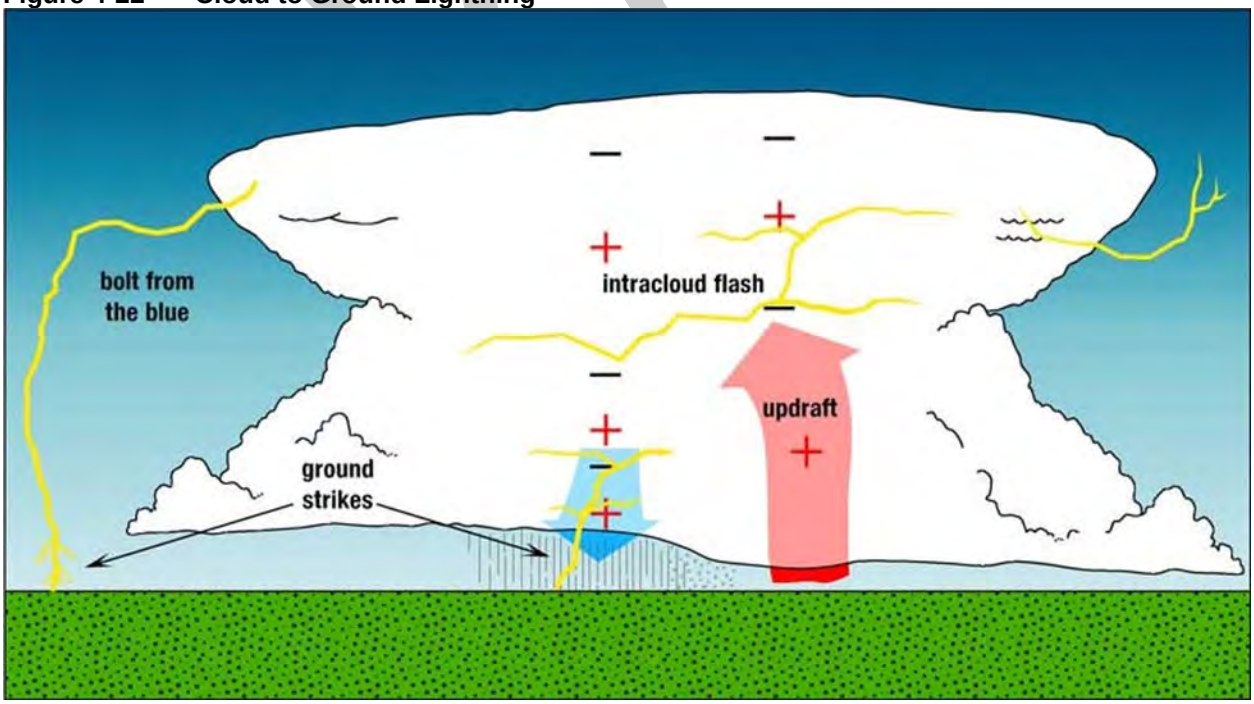
This profile contains hazards associated with severe summer weather, including thunderstorms, lightning, hail, and extreme heat. High winds are profiled under Severe Wind/Tornados.

A typical thunderstorm is 15 miles in diameter and lasts an average of 30 minutes. 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. 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. Approximately 100,000 thunderstorms occur each year in the United States, roughly 10% of which are classified as severe.

Lightning

Lightning develops when ice particles in a cloud collide with other particles, causing 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 4-22 Cloud to Ground Lightning



Source: National Weather Service

Hail

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. Hailstones are usually less than two inches in diameter and can fall at speeds of 120 miles per hour (mph). Severe hailstorms can be quite destructive, causing damage to roofs, buildings, automobiles, vegetation, livestock, and crops.

Extreme Heat

Extreme heat is defined as a period of high heat and humidity with temperatures above 90 degrees. A heat wave is a period of excessive heat, which can lead to illness and other stress to vulnerable people and those who experience prolonged exposure to the heat.

Hazard Previous Occurrences

Lightning

In an average year, about 500,000 lightning flashes hit the ground in Colorado, ranking 19th in the Nation with respect to the number of cloud-to-ground lightning flashes (2009-2018). More seriously, Colorado ranks 4th in the nation for lightning fatalities, with 148 deaths between 1959 and 2017.

Data from NOAA's NCEI Storm Events Database was used to determine previous occurrences of lightning for Arapahoe County. The Storm Events Database only includes lightning events that resulted in a fatality, injury and/or reported property or crop damage. Table 4-40 lists reported lightning strikes for Arapahoe County from 1967 through 2019. Overall, there have been 30 recorded events, with 7 injuries, no fatalities, $944,000 in property damages, and $2,000 in crop damages.

Table 4-40 Lightning Strikes Causing Damage Reported in Arapahoe County, 1967-2019

Date of Event	# Fatalities	# Injuries	Property Damages	Crop Damages	Description
6/24/1996	0	0	$1,000	0	Lightning struck a home in Littleton which sparked a small fire on the roof.
6/13/1997	0	0	0	0	Lightning struck a home in Littleton. The house caught fire, but a damage estimate was not available.
7/30/1997	0	0	$75,000	0	Lightning struck a home in unincorporated Arapahoe County. The fire started in the electrical panel boxes causing extensive damage to the home.
7/22/1998	0	0	0	0	Lightning sparked a fire which caused extensive damage. Most of the second floor was destroyed.
7/25/1998	0	0	0	0	A telephone switchboard was damaged by lightning. Long distance service was knocked out for approximately 18 hours.
7/25/1998	0	1	0	0	A woman was injured when lightning struck a nearby telephone pole. She sustained burns to her head and right shoulder.
7/19/1999	0	0	0	0	Lightning struck two residences in Littleton but caused only minor damage.
7/19/1999	0	0	$30,000	0	Lightning triggered a fire at a residence in Cherry Hills. A small portion of the roof and ceiling were damaged before the fire could be extinguished.

Date of Event	# Fatalities	# Injuries	Property Damages	Crop Damages	Description
8/19/1999	0	0	0	0	Lightning struck a vehicle at East Evans Avenue and Tower Road. The woman inside was not injured.
8/8/2000	0	0	$47,000	0	Lightning struck three homes in Arapahoe County.
8/16/2000	0	0	$250,000	0	Lightning ripped most of the roof off a home in southeast Aurora. The bolt sparked a fire which destroyed the residence.
4/28/2001	0	1	0	0	A 21-yr old man was struck by lightning, along the shoulder of Interstate 225 near Parker Road. His brother's car had broken down and he stopped to help. The bolt stopped the man's heart briefly and caused the right side of his body to go numb.
5/29/2001	0	0	$100,000	0	Lightning sparked a fire at an apartment complex, forcing the evacuation of 24 units. Most of the fire damage was confined to the attic.
6/13/2001	0	0	0	0	Lightning caused a small housefire, damaging the roof.
6/17/2003	0	0	0	0	Lightning struck a feeder line, knocking out electricity to approximately 3000 residents.
2/2/2008	0	0	$1,000	0	Lightning struck a home during an electrically charged snowstorm. A gas meter at the home was hit by lightning and burst into flames.
8/15/2008	0	0	$20,000	0	At least three homes were hit by lightning during the early morning hours in Arapahoe County. Lightning also struck two homes in Castle Rock, damaging the roofs.
8/25/2008	0	0	$75,000	0	Lightning struck a home. The ensuing fire caused extensive roof damage.
7/3/2009	0	0	0	0	Six children received minor injuries when lightning struck a nearby tree. The injuries occurred when they were knocked down by the blast. None of the children suffered burns or appeared to have been directly hit by the lightning.
8/3/2009	0	0	0	$1,000	Lightning sparked a fire which charred approximately 1000 acres of wheat stubble.
9/9/2009	0	1	0	0	A man was critically injured when he was struck by lightning while riding his bicycle. He was nearing a paramedic van when he was hit. His heart stopped but paramedics quickly responded and were able to resuscitate him.
8/8/2010	0	0	$100,000	0	Lightning sparked a fire in a restaurant shortly after midnight. It caused extensive damage.
8/16/2010	0	1	0	0	A 14-year-old teenager was struck by lightning while washing her family's car. The bolt struck the street nearby; it then traveled up a stream of water flowing from the vehicle and hit the teenager. She received minor injuries.
6/20/2011	0	0	$50,000	$0	A severe thunderstorm produced golf ball size hail in Sedgwick County. A lightning strike caused significant damage to a home in Centennial.
6/29/2011	2	0	$0	$0	Isolated severe thunderstorms produced intense microburst winds in portions of Denver, Larimer, and Weld Counties. In Gill, a barn and farmhouse were damaged. A large tree was blown down near Galeton. Two airmen received minor injuries when they were struck by lightning at Buckley Air Force Base in Aurora. A church in Fort Morgan was also struck by lightning.

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Date of Event	# Fatalities	# Injuries	Property Damages	Crop Damages	Description
7/14/2011	0	0	$50,000	$0	Severe thunderstorms in the Denver Metropolitan area produced very heavy rain, large hail, and damaging winds. The strong winds toppled a few trees and the heavy rain caused street flooding and minor flash flooding. Several cars were stranded at the intersection of Santa Fe Drive and Oxford, and near Broadway and U.S. Highway 285. A 16-yr old teenager was seriously injured when he tried to retrieve a ball along the banks of West Toll Gate Creek. He was pulled from the swollen creek and died several days later. Hail up to quarter size was also reported around the area. The thunderstorms also produced frequent lightning. One strike sparked a fire at Aspen Academy, a private school in Greenwood Village. Most of the damage was confined to the roof and attic.
7/21/2011	0	0	$70,000	$0	Lightning struck a home and caused substantial fire damage. Five people were in the home, but no one was injured. There was structural damage to both the interior and exterior of the residence.
6/8/2014	0	0	$25,000	$1,000	Lightning struck a tree in a residential area which caused damage to the two surrounding homes. Parts of the tree went through the roof and basement of one of the homes as well as the driver-side window of the resident's truck.
5/1/2015	1	0	$0	$0	A teenager was critically injured when he struck by lightning. He was standing on a hill in an open field near Town Center Mall.
9/6/2019	0	0	$50,000	$0	Lightning caused extensive damage to a home.
Total: 30	**7**	**0**	**$944,000**	**$2,000**	

Source: NCEI

Hail

Data from NOAA's NCEI Storm Events Database was also used to determine previous occurrences of hail for Arapahoe County, as listed in Table 4-41 and mapped in Figure 4-23 and Figure 4-24. The Storm Events Database only includes hail events with measured diameters of ¾ of an inch or larger, or events that cause significant damages. There have been 499 recorded hail events reported within Arapahoe County between 1960 and 2019. Of those 499 hail events, 10 events were reported as causing property and/or crop damage. These events resulted in no injuries or fatalities, but caused $1.06 billion in property damages, $31,000 in crop damages. It should be noted that the property damage totals are for all areas impacted by the hail event, which may include areas outside Arapahoe County.

Note that the NCEI database only captures uninsured crop losses. Data from the U.S. Department of Agriculture's Risk Management Agency shows more than $5 million in insured crop losses from hail during the same time period.

Table 4-41 Hail Events Causing Damage Reported in Arapahoe County, 1960-2019

Month, Year	Magnitude (Inches)	Deaths	Injuries	Property Damage	Crop Damage	Description
6/19/2018	3	0	0	$276,400,000	$0	Very large hail, up to 3 inches in diameter, pummeled portions of the Front Range Urban Corridor and extended across the northeast plains of Colorado. Reports of collapsed roofs due to hail were reported, with major hail damage across northern portions of the Denver metro area. The Rocky Mountain Insurance Information Association estimated the property damage from the storm totaled $276.4 million, making it the 8th costliest hailstorm to strike the state to date. Frontage roads along Interstate 76 northeast of Denver were also flooded and washed out. In Lincoln County, large hail in the Arriba and Genoa areas damaged vehicles along Interstate 70. A total of four short-lived tornados touched down in the open country of Lincoln and Weld counties. Thunderstorms in Lincoln County also produced damaging wind gusts up to 70 mph. The property estimate value was the total storm damage summary for the event.
9/29/2014	1.75	0	0	$213,300,000	$0	A storm system that moved through the area produced large hail, up to golf ball size, and street flooding in parts of the metro area then spread east into the plains. The hailstorm was the costliest of the summer season with insured losses topping $213.3 million, according to the Rocky Mountain Insurance Information Association. Insurance claims included 29,297 automobile claims worth more than $87.2 million and 14,287 property claims for $126 million, ranking the storm as the eighth most expensive to hit the state. The storm also caused multiple accidents. A semi became detached from a trailer, blocking traffic on westbound Interstate 70 west of Tower Road. Downed power poles blocked a roadway on CO 79 near Bennett, at mile marker 10. In addition to the damaging winds, the storms produced large hail, from nickel to golf ball size. The intense thunderstorm winds also downed trees near Fort Morgan. Flash flooding was reported over parts of northern Washington County. The combination of flash flooding and an accident involving a semi-trailer forced the closure of CO 61 for a several hours.
6/7/2012	2.5	0	0	$161,100,000	$0	Severe thunderstorms brought damaging wind and hail, heavy rain, along several tornados, one of which was rated an EF-2. The storms produced hail from 1.5 to 2.75 inches in diameter. In addition to the large hail, heavy rainfall from 1 to 2 inches also accompanied the storms. The combination of hail and heavy rain caused extensive street flooding across Aurora, Castle Rock, Centennial, Cherry Creek, Englewood, South Denver, Highlands Ranch, Lakewood, and Littleton. The hail was reportedly knee deep in several areas making roads impassable. As a result, snowplows had to be summoned to clear the streets. In Castle Rock, a King Soopers supermarket sustained extensive damage when roof partially collapsed under the weight of the hail. Total property damage estimates along the Front Range for the 6th and 7th combined was 321.1 million dollars. A tornado touched down in Elbert County Thursday evening, June 7th, producing considerable damage to homes and several farm buildings in south central Elbert

Month, Year	Magnitude (Inches)	Deaths	Injuries	Property Damage	Crop Damage	Description
						County. The tornado was rated an EF-2 at its strongest point near Elbert County Road 82 and just west of Elbert County Road 97. The tornado initially touched down approximately at County Road 101 about 1 mile north of County Road 90, and then traveled south-southwest into El Paso County. It was approximately one half mile wide at one point and produced a debris width of 1.5 miles. One minor injury occurred due to broken glass. Two other tornados touched down but did no damage. In Elbert County alone, at least 136 homes were damaged: 32 sustained moderate to severe damage. Severe thunderstorms also produced large hail and damaging winds across parts of Larimer, Weld and Morgan Counties. In Weld County, a flash flood washed out a section of State Highway 392 just east of Lucerne. During the storm, a culvert underneath the road was washed out in addition to a section of the roadway, approximately a 30 foot by 30 foot section.
6/6/2012	1	0	0	$160,000,000	$0	Severe thunderstorms broke late in the evening, striking areas hardest from Denver southward. Locations impacted by the storms included but were not limited to: Aurora, Castle Rock, Centennial, Highlands Ranch, Lone Tree, Parker, Surrey Ridge. The storms produced a barrage of large hail, damaging straight line winds, flash flooding and several short lived tornados. The hail ranged in size from 1 to 2 inches in diameter, and caused extensive damage to homes and automobiles. The hail inundated the roadways with several inches of hail in Douglas County. Consequently, snowplows had to be called out to clear the roadways. One tornado that touched down near Grover in Weld County ripped a tree from the ground and tossed it approximately twenty feet. The combination of torrential hail and heavy rain produced flash flooding in parts of Elbert, Douglas, and Arapahoe Counties, as thunderstorms brought up to 3.35 inches of rain to some areas within 90 minutes. In Aurora, Picadilly Road was closed from flooding north of 6th Avenue. A water rescue took place on South Gun Club Road in Arapahoe County, where floodwaters were rushing to depth of 3 feet. Flash flooding forced the closure of several streets and roads from Parker south to The Pinery, where the floodwaters inundated the roadway with up to 2 feet in several locations. At Centennial Airport in Arapahoe County, a historic B-17 Flying Fortress suffered extensive damage as hailstones as large as ping pong balls hit the aircraft. Although the airframe itself did not require repair, the fabric-covered ailerons and elevators were extensively damaged. The hail came straight down and punched holes in the fabric-covered control surfaces. The plane landed just hours before the storm hit to participate in the weekend tour stop. Lightning struck two homes, one in Lakewood and the other in Parker. Straight line winds downed trees and power lines in Aurora. As a result, scattered electrical outages affect approximately five thousand residents.
8/17/2009	1.5	0	0	$15,000	$0	Severe thunderstorms broke out across Arapahoe, Elbert, Lincoln, and Washington Counties. The hail piled up to a foot deep in spots along State Highway 71, south of Limon. The storms produced hail up to the size of tennis

Month, Year	Magnitude (Inches)	Deaths	Injuries	Property Damage	Crop Damage	Description
						balls and one tornado. Some farm equipment and fiberglass structures were damaged by hail.
8/10/2009	1.25	0	0	$0	$25,000	Another round of severe thunderstorms hammered the Northeast Plains with large hail up to the size of golf balls. Crop damage was reported in the immediate vicinity.
6/7/2009	3	0	0	$161,000,000	$0	Severe thunderstorms in Denver and the surrounding metropolitan area produced five tornados, large hail, and damaging thunderstorm winds. The strongest of the tornados touched down near Southlands Mall, in southeast Aurora. Two men were injured, one seriously. Overall the damage was rated mild to moderate, which translated to an EF1 rating. Four other tornados touched down, two of which caused minor damage. Another EF1 tornado damaged a home, several outbuildings, and injured some horses in unincorporated Elbert County. In addition to the tornados, large hail from 1 to 3 inches in diameter was observed. In parts of Aurora and Centennial, thunderstorm winds blew down power lines and caused electrical outages. Approximately 8,000 homes and businesses were left without power for nearly two hours. Most of the damage consisted of broken windows and roofs. This day was the first in a series of eight to cause damage along the Urban Corridor. Damage to homes and property along the Front Range totaled $161 million during the 8-day span, making it the state's fifth highest insurance loss. Most of the property damage was caused by hail; 21,000 automobile claims and 13,000 homeowner claims were filed.
7/17/2008	1.75	0	0	$5,000	$0	A severe thunderstorm produced large hail, up to the size of golf balls, and damaging thunderstorm winds. The combination of hail and wind broke several windows of a residence. The windshield of their vehicle was also cracked.
7/23/2001	1.5	0	0	$606,000	$6,000	The city of Littleton suffered $612,000 in damage to vehicles, roofs, buildings, landscaping, and computers. Almost every vehicle owned by visitors and employees in the Littleton Center parking lot sustained damage.
10/16/1998	2	0	0	$87,800,000	$0	A potent late season hailstorm struck portions of Denver and the surrounding metro area. The storm began dumping torrential hail, mostly pea sized, over portions of Arvada and Wheat Ridge, northwest of Denver. Hail, heaviest near Interstate 70, reportedly piled up to 6 inches deep. Several accidents were attributed, at least in part, to the hailstorm. Snowplows had to be called out to clear several city streets. As the storm moved southeast, into the Denver and Aurora areas, it intensified. Large hail, up to 2 inches in diameter pounded the area. Damage estimates totaled $87.8 million ($27.3 million in homeowner claims and $60.5 million in automobile claims), making this the 7th costliest hailstorm to strike the Denver Metropolitan Area.
Total: 10			**4**	**$1.06 billion**	**$31,000**	

Source: NCEI

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Figure 4-23 Hail Events in Western Arapahoe County, 1955-2018

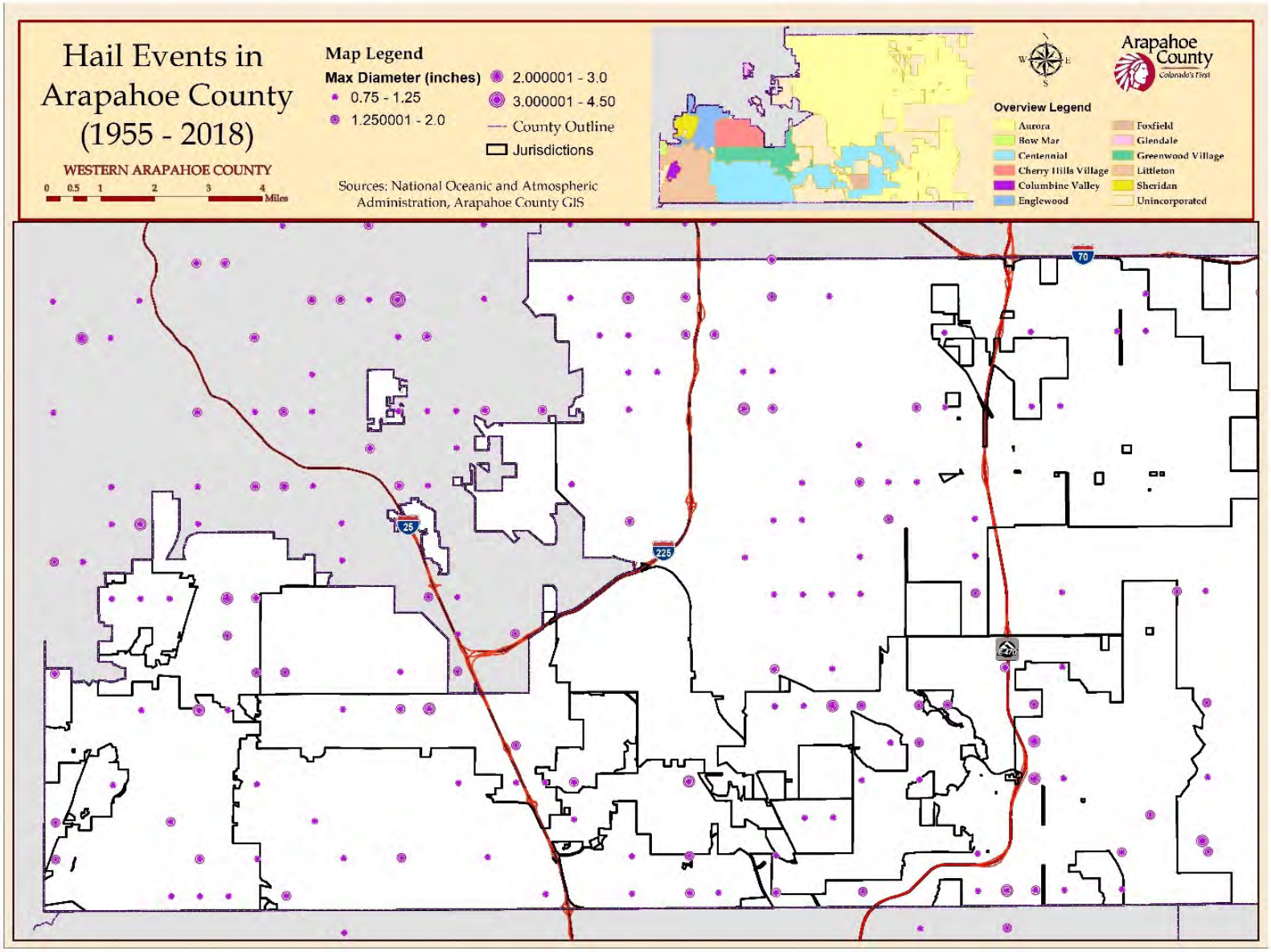
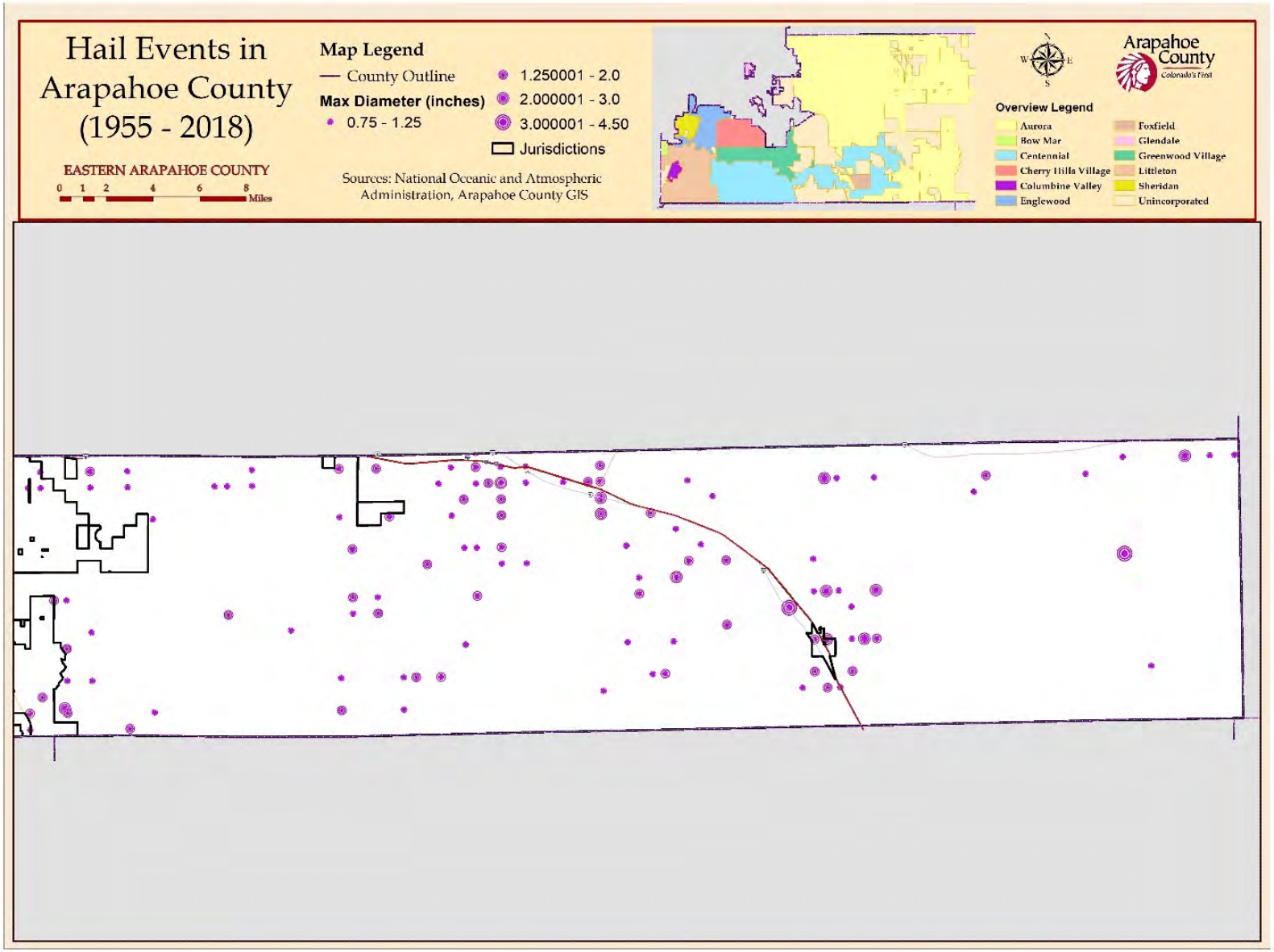


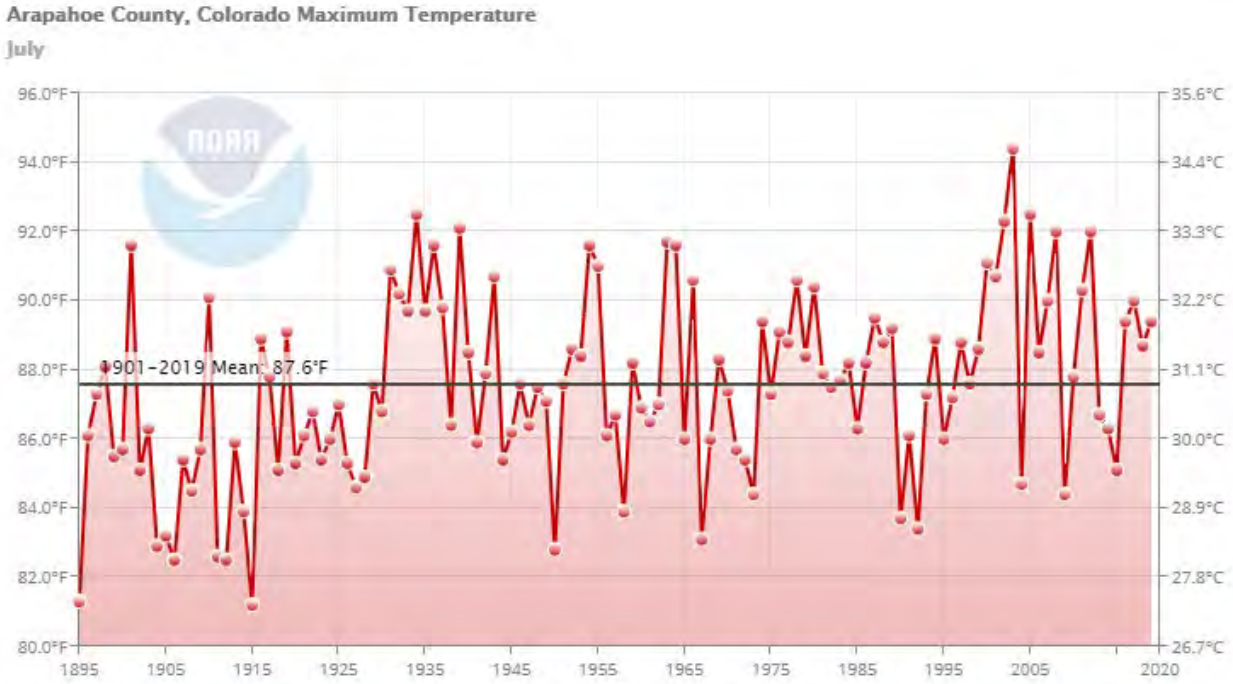
Figure 4-24 Hail Events in Eastern Arapahoe County, 1955-2018



Extreme Heat

Figure 4-25 shows the average daily maximum temperatures in July for Arapahoe County from 1895 to 2020.

Figure 4-25 Average Maximum Temperatures for July in Arapahoe County, 1895-2020



Source: NOAA

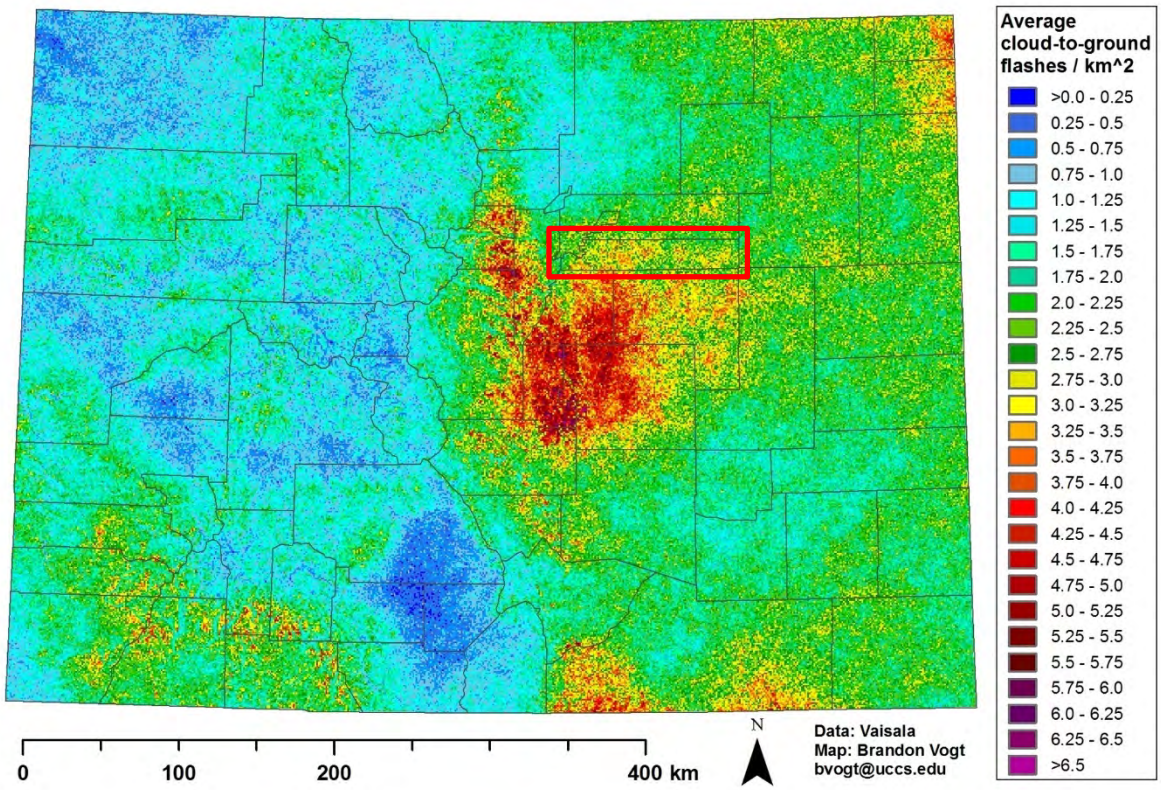
According to the 2018 Colorado State Hazard Mitigation Plan, from 1981 through 2017 Arapahoe County experienced 1,035 days over 90 degrees, 248 days over 95 degrees, 15 days over 100 degrees, and 70 heat waves.

Hazard Location

Lightning

Lightning can strike anywhere in Arapahoe County. Figure 4-26 shows the lightning flash density for Colorado from 1996 to 2016. Parts of Arapahoe County experience some of the highest flash densities in the State.

Figure 4-26 Colorado Lightning Density, 1996-2016



Source: NOAA

Hail

Hail forms during thunderstorms and can occur throughout the entire County.

Extreme Heat

Being located on Colorado's Front Range, Arapahoe County experiences some of the higher temperatures in the State. July is typically the hottest month of the year, when the average maximum temperatures is approximately 88 degrees. Extreme heat can occur throughout the entire County, although it may be more severe in the western portions of the County due to the urban heat island effect described above.

Hazard Magnitude/Severity

Hail and lightning are typically associated with thunderstorms. Thunderstorms are prevalent along the Front Range to the eastern plains during the spring and summer. The typical thunderstorm is 15 miles in diameter and lasts an average of 30 minutes.

Lightning

Lightning can occur anywhere there is a thunderstorm and can even strike miles away from the storm. Lightning is measured by the Lightning Activity Level (LAL) scale, shown in Table 4-42, which was 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. Arapahoe County is at risk to experience lightning in any of these categories.

Table 4-42 NWS Lightning Activity Level Scale

Level	Description
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.
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: NWS

Hail

Hail size is often estimated by comparing it to a known object. Most hailstorms are made up of a mix of different sizes. Hail measuring one inch or larger is considered severe. Below are common measurements for hail:

- Pea = 1/4 inch diameter
- Mothball = 1/2 inch diameter
- Penny = 3/4 inch diameter
- Nickel = 7/8 inch
- Quarter = 1 inch — hail quarter size or larger is considered severe
- Ping-Pong Ball = 1 1/2 inch
- Golf Ball = 1 3/4 inches
- Tennis Ball = 2 1/2 inches
- Baseball = 2 3/4 inches
- Teacup = 3 inches
- Softball = 4 inches
- Grapefruit = 4 1/2 inches

Extreme Heat

Although extreme heat events can occur in May or September, they are most common between June and August when above average temperatures are sustained for a prolonged period. During extended periods of very high temperatures, or high temperatures coupled with high humidity, individuals can suffer a variety of health problems, including heatstroke, heat exhaustion, heat syncope, and heat cramps.

The Heat Index, shown in Figure 4-27, measures the severity of hot weather by estimating how hot it feels to humans. By combining air temperature and relative humidity, the Heat Index is directly related to skin temperature. The ambient temperature is quantified by examining the

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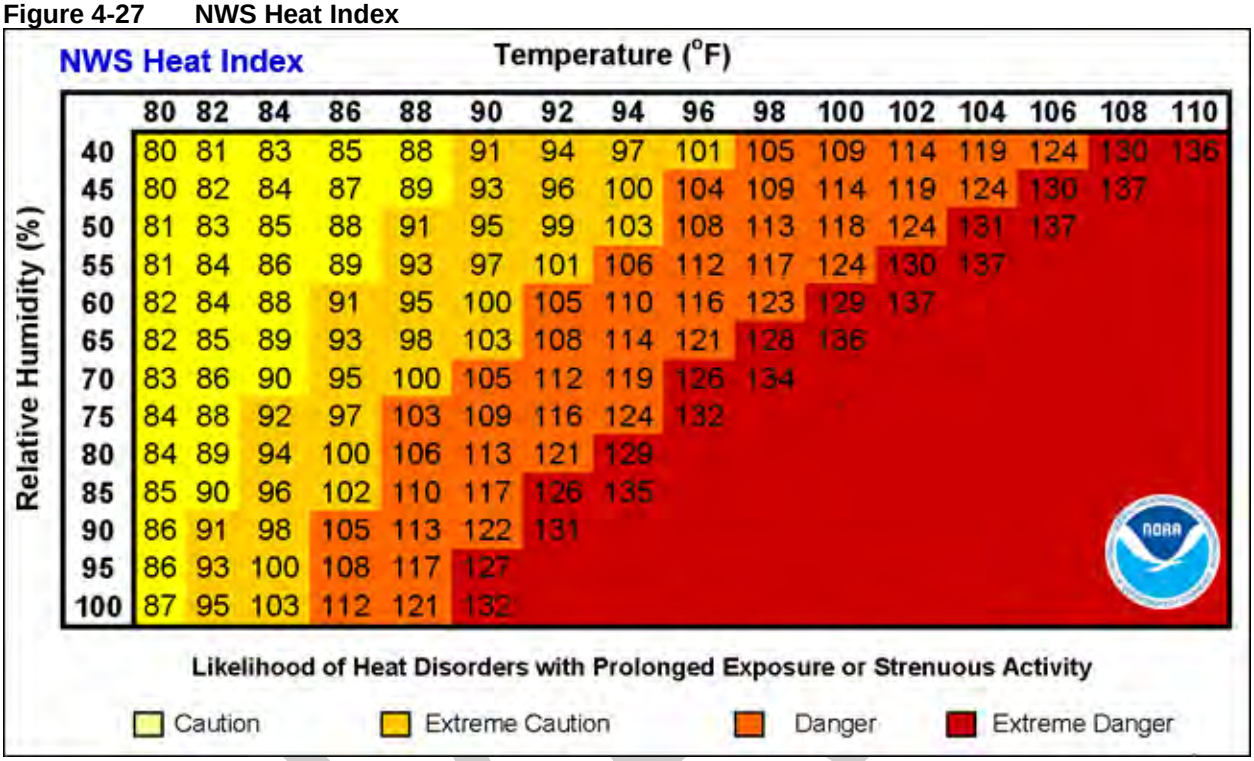
relation between relative humidity versus skin temperature. If the relative humidity is higher (or lower) than the base value, the apparent temperature is higher (or lower) than the ambient temperature. Typically, high humidity is not a large concern in Arapahoe County.

Figure 4-27 NWS Heat Index



Source: NWS

Table 4-43 outlines the heat disorders associated with apparent temperature values during extreme heat events.

Table 4-43 NWS Heat Danger Categories

Danger Category	Heat Disorders	Apparent Temperature (°F)
I Caution	Fatigue possible with prolonged exposure and physical activity	80-90
II Extreme Caution	Sunstroke, heat cramps, and heat exhaustion possible with prolonged exposure and physical activity	90-105
III Danger	Sunstroke, heat cramps, and heat exhaustion likely; heatstroke possible with prolonged exposure and physical activity	105-130
IV Extreme Danger	Heatstroke or sunstroke imminent	>130

Source: NWS

Hazard Probability of Occurrence

Lightning

Although there are a couple records of lightning events prior to 1996, the NCEI did not track lightning events prior to 1996, so it is used as the reference period for the lightning probability of occurrence calculation. Based on historical record of 30 reported lightning strikes from 1996 to 2019 that have either caused reported damages to buildings and infrastructure or resulted in an injury or death, on average the county experiences one damaging lightning strike per year.

Hail

Although Arapahoe County experiences multiple hail events per year, based on historical record of 10 recorded hail events from 1960 to 2019 that have either caused reported damages to buildings and infrastructure or resulted in an injury or death, the county experiences a damaging hail event every six years on average.

Extreme Heat

Based on 1,035 days over 90 degrees in Arapahoe County from 1981 to 2017, the county averages 30 days per year with temperatures over 90 degrees.

Hazard Consequence Analysis

Impact to the Public

Lightning

In recent years, Colorado was tied for 4th in the Nation when it comes to lightning fatalities (years 2008-2017). When looking at a longer period of time, Colorado also ranks 4th in the Nation for fatalities (years 1959-2017).

Cloud to ground lightning can kill or injure people by direct or indirect means. The lightning current can branch off to a person from a tree, fence, pole, or other tall object. In addition, lighting strikes may conduct their current through the ground to a person after the lightning strikes a nearby tree, antenna, or another tall object. The current also may travel through power or telephone lines, or plumbing pipes to a person who is in contact with an electric appliance, telephone, or plumbing fixture. People recreating outdoors are at the highest risk to death or injury from lightning strikes. Lightning strikes have caused 13 injuries in Arapahoe County.

Hail

Hail is unlikely to cause fatalities but may cause injuries to the public. There have been no recorded injuries due to hail in Arapahoe County, but there may have been minor injuries that went unreported. Impacts to personal property, such as cars and homes, are likely. The public may experience financial losses due to damaged property and insurance costs.

Extreme Heat

Impacts on public health are a primary concern during extreme heat events. Heat stroke is the most serious heat-related disorder. It occurs when the body becomes unable to control its temperature. Body temperature rises rapidly, the sweating mechanism fails, and the body cannot cool down. This condition can cause death or permanent disability if emergency treatment is not given. Small children, the elderly, and certain other groups including people with chronic diseases, low-income populations, and outdoor workers have higher risk for heat-related

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illness (Refer to Table 4-57). Previous injuries and deaths due to extreme heat are not well documented in the county or State. This is likely due to milder summer temperatures and low humidity compared to much of the United States. However, the entire County population is vulnerable to the impacts of extreme heat, particularly during times of extended temperatures above 90 degrees.

Impact to Responders

The impact to first responders from lightning and hail events is likely to be minimal. An exception would be if lightning sparks a wildland fire. Responders are as vulnerable to the effects of extreme heat as the general population, and may receive increased calls during extended periods of extreme heat. Additionally, cooling shelters may need to be established during extended extreme heat events.

Impact to Continuity of Operations (including continued delivery of services)

Lightning, hail, and extreme heat will likely have minimal impact on the continuity of operations for Arapahoe County. However, power loss is possible from any severe summer weather event, and may cause disruption if there are no backup generators.

Impact to Property, Facilities, and Infrastructure

Lightning

Lightning strikes can damage property, facilities, and infrastructure. If struck by lightning, structural damage is possible, as well as the potential for a fire. There have been $944,000 in property damages recorded from lightning in the county. Much of these damages were a result of lightning-caused structural fires.

Hail

Hail in Arapahoe County can cause extensive damage to property, facilities, and infrastructure. The damages are likely to be primarily rooftops and vehicles. There has been a total of $1.06 billion in property damage from hailstorms that have occurred in or near Arapahoe County.

Extreme Heat

Extreme heat may cause structural damages to infrastructure such as roadways, railroads, and airport runways. Impacts include buckling roads and distorted railway tracks. Additionally, extreme heat can strain the power grid, particularly with increased air conditioner use, which can lead to power loss or rolling blackouts.

Impact to the Environment

Lightning strikes are a major cause of wildfires. Impacts from hail on the environment are typically minimal. Extreme heat can impact plant and animal species, as well as water levels and soil moisture. This hazard can also contribute to increased drought conditions.

Impact to the Economic Condition of the County and Jurisdictions

Lightning

Power outages from lightning strikes can have economic impacts on businesses; even brief outages can result in significant costs from having to restart production lines. Otherwise, lightning events typically result in little direct impact to the economic condition of the county and jurisdictions. Businesses may be impacted if their structure catches fire due to a lightning strike. Economic losses would be endured during reconstruction of the structure, or the business may

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have to permanently relocate or shut down. It is unlikely large-scale closures would occur to significantly impact the economy.

Hail

Hail events may impact the economy similarly to lightning, in which losses may be accrued if structures endure major damages during a hailstorm. However, hail also has the potential to damage crops in the eastern portion of the county, which may cause losses that impact the economy in for the jurisdictions and populations in eastern Arapahoe County that are more reliant on agriculture. Based on the NCEI previous occurrence data, hail has caused $31,000 in crop damages since 1960. According to the 2017 USDA Census, the market value of agricultural products sold in Arapahoe County was $26,695,000.

Extreme Heat

Extended power outages resulting from extreme heat may cause economic losses to the county and jurisdictions. Extreme heat can also impact crop production and contribute to economic losses in the eastern portion of the county.

A 2014 paper published by economists Tatyana Deryugina of the University of Illinois and Solomon Hsiang of the University of California found that extreme heat can also decrease economic productivity. Their study found that on days with temperatures above 86 F, workers were on average 28% less productive than on a typical day, reducing annual county income by $16.71 per capita.

Impact to Public Confidence in Government

Lightning and hail events are likely to have little impact on the public's confidence in government. However, during an extended extreme heat event, the public would expect alerts and warnings as well as cooling shelters from the government.

Changes in Development

The entire County is subject to severe summer weather events. Therefore, all new development in the county is at risk to damages from these events. New residents are also at risk to the public health impacts of extreme heat events. Over the long term, increased urbanization can lead to increase temperatures due to the urban heat island effect.

Jurisdictional Differences

Severe summer weather has the potential to occur anywhere in the county, therefore the location, extent, and probability of occurrence are the same county-wide.

Lightning

The major differences in impacts coincide with the population density differences between the western and eastern portions of the county. The urban, more densely populated communities of Bow Mar, Centennial, Cherry Hills Village, Columbine Valley, Englewood, Foxfield, Glendale, Greenwood Village, Littleton, and Sheridan are likely to experience the most damages from structural fires as a result from lightning. Additionally, higher populations in these communities puts more people at risk of being struck by lightning.

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The eastern portion of the county, to include the communities of Bennett, Deer Trail, and the majority of unincorporated county are also at risk to structural fires and damages from lightning, but are at a higher risk of crop losses and losses related to lightning-caused wildland fires as well. Additionally, due to lower population fewer people are at risk to being struck by lightning.

Hail

Similar to the lightning hazard, hail is possible in all jurisdictions in the county. Due to the increased density and number of structures, the communities in the western portion of the County are likely to experience high amounts of property losses from a hailstorm. The eastern portion of the county is still at risk to property losses in addition to crop losses.

Extreme Heat

Extreme heat can occur throughout the entire County, although it may be more severe in the western portions of the County due to the urban heat island effect described above. The increased population in the western portion of the county puts more people at risk from extreme heat events, but populations across the county are vulnerable. Additionally, higher social vulnerability scores in the western portion of the county can mean a higher percentage of elderly or disabled individuals who may be more vulnerable to heat, as well as people without air conditioning. Jurisdictions in the eastern portion of the county may experience crop losses from extreme heat.

Table 4-44 Severe Summer Weather Hazard Rankings by Jurisdiction

Severe Summer Weather	Frequency	Spatial Extent	Severity	Overall Significance
Arapahoe County	Highly Likely	Significant	Critical	High
Bennett	Highly Likely	Significant	Critical	High
Bow Mar	Highly Likely	Significant	Critical	High
Centennial	Highly Likely	Significant	Critical	High
Cherry Hills Village	Highly Likely	Significant	Critical	High
Columbine Valley	Highly Likely	Significant	Critical	High
Deer Trail	Highly Likely	Significant	Critical	High
Englewood	Highly Likely	Significant	Critical	High
Foxfield	Highly Likely	Significant	Critical	High
Glendale	Highly Likely	Significant	Critical	High
Greenwood Village	Highly Likely	Significant	Critical	High
Littleton	Highly Likely	Significant	Critical	High
Sheridan	Highly Likely	Significant	Critical	High
Denver Water	Highly Likely	Significant	Critical	High

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4.11 Severe Wind/Tornado

Hazard Description

Tornados 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.

Severe wind can also occur independent of a tornado event. These winds typically develop with strong pressure gradients and gusty frontal passages. The closer and stronger two systems (one high pressure, one low pressure) are, the stronger the pressure gradient, and therefore, the stronger the winds are.

Downburst winds, which can cause more widespread damage than a tornado, occur when air is carried into a storm's updraft, cools rapidly, and comes rushing to the ground. Cold air is denser than warm air, and therefore, wants to fall to the surface. On warm summer days, when the cold air can no longer be supported 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. This type of phenomenon can extend for hundreds of miles and contain wind speeds in excess of 100 mph.

Hazard Previous Occurrences

NOAA's Storm Events Database estimates that 94 tornados have touched down in, or moved through, Arapahoe County between 1964 and 2019. Together, these tornados have caused no fatalities, five injuries, and $9,630,180 in property damage. Nearly all of these have been F0/EF0 or F1/EF1. However, on June 8, 1986 an F2 tornado touched down in the vicinity of Peoria St. and 1st Ave, causing $2.5M in damages. The most damaging tornado in Arapahoe County's history was an F1 that touched down on August 29, 2002 in a subdivision under construction at Gartrell and Arapahoe Road. Four large condominiums under construction were destroyed. A man suffered four broken ribs and several cuts and bruises when the trailer he sought shelter in was flipped three times and torn apart by the tornado.

Table 4-45 Tornado History in the Last Five Years, Arapahoe County, 2015– 2019

Date	Magnitude	Deaths	Injuries	Prop. Damage	Crop Damage
6/5/2017	EF0	0	0	0	0
10/6/2017	EF1	0	0	0	0
7/27/2018	EF1	0	1	$200,000	0
7/27/2018	EF0	0	0	0	0
7/27/2018	EF0	0	0	0	0

Source: NCEI Storm Events Database

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Severe Wind

Data from NOAA's Storm Events Database was used to complete the risk assessment for severe wind events Arapahoe County. Currently, the Storm Events Database includes wind events that are classified as "Thunderstorm Winds", "Strong Winds", and "High Winds".

High Winds: Sustained non-convective winds of 35 knots (40 mph) or greater lasting for 1 hour or longer, or gusts of 50 knots (58 mph) or greater for any duration.

Strong Winds: Non-convective winds gusting less than 50 knots (58 mph), or sustained winds less than 35 knots (40 mph), resulting in a fatality, injury, or damage.

Thunderstorm Winds: Winds, arising from convection (occurring within 30 minutes of lightning being observed or detected), with speeds of at least 50 knots (58 mph), or winds of any speed (non-severe thunderstorm winds below 50 knots) producing a fatality, injury, or damage.

Based on data provided by NOAA's Storm Events Database, 79 Thunderstorm Wind events, 84 High Wind events and 4 Strong Wind events have occurred in Arapahoe County between 1964 and 2019. These 167 events resulted in 9 injuries. No damages are shown, but the data likely is not complete in this regard.

Table 4-46 Severe Wind History in the Last Five Years, Arapahoe County, 2015– 2019

Date	Type	Deaths	Injuries	Prop. Damage	Crop Damage
3/6/2017	High Wind	0	0	0	0
3/6/2017	High Wind	0	0	0	0
3/7/2017	High Wind	0	0	0	0
11/4/2017	High Wind	0	0	0	0
3/5/2018	High Wind	0	0	0	0
3/5/2018	High Wind	0	0	0	0
3/23/2018	High Wind	0	0	0	0
3/23/2018	High Wind	0	0	0	0
4/13/2018	High Wind	0	0	0	0
4/13/2018	High Wind	0	0	0	0
4/17/2018	High Wind	0	0	0	0
4/17/2018	High Wind	0	0	0	0
4/17/2018	High Wind	0	0	0	0
4/17/2018	High Wind	0	0	0	0
11/2/2018	High Wind	0	0	0	0
11/24/2018	High Wind	0	0	0	0
11/24/2018	High Wind	0	0	0	0
4/17/2018	Strong Wind	0	0	0	0
6/24/2015	Thunderstorm Wind	0	0	0	0
7/24/2016	Thunderstorm Wind	0	0	0	0
5/7/2017	Thunderstorm Wind	0	0	0	0
6/5/2017	Thunderstorm Wind	0	0	0	0

Date	Type	Deaths	Injuries	Prop. Damage	Crop Damage
6/5/2017	Thunderstorm Wind	0	0	0	0
9/17/2017	Thunderstorm Wind	0	0	0	0
6/17/2018	Thunderstorm Wind	0	0	0	0
7/23/2018	Thunderstorm Wind	0	0	0	0
7/23/2018	Thunderstorm Wind	0	0	0	0
7/24/2018	Thunderstorm Wind	0	0	0	0
8/4/2018	Thunderstorm Wind	0	0	0	0
7/20/2019	Thunderstorm Wind	0	0	0	0

Source: NCEI

Hazard Location

Tornado

Colorado, lying just west of "tornado alley," is fortunate to experience less frequent and intense tornados than its neighboring states to the east. However, tornados remain a significant hazard in the region.

All portions of Arapahoe County have the potential to be affected by tornados. Historically, tornados have been relatively small on the EF Scale but EF1 tornados can still produce dangerous winds up to 112mph. High winds can cause damage to buildings (tearing shingles from roofs, tearing awnings, collapsing structures, etc.). Figure 4-28 and Figure 4-29 show where tornados have touched down (and traveled) from 1950 through 2018.

Severe Wind

All of Arapahoe County is susceptible to experience severe winds. However, as the air moves down off the Rocky Mountains, it rapidly accelerates as it hurdles down towards the Front Range. The eastern portion of the county can experience stronger winds as there is a lack of trees, hills, and other terrain features to provide friction.

Figure 4-30 and Figure 4-31 show severe wind events causing damage from 1955 through 2018.

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Figure 4-28 Tornado Events in Western Arapahoe County, 1950-2018

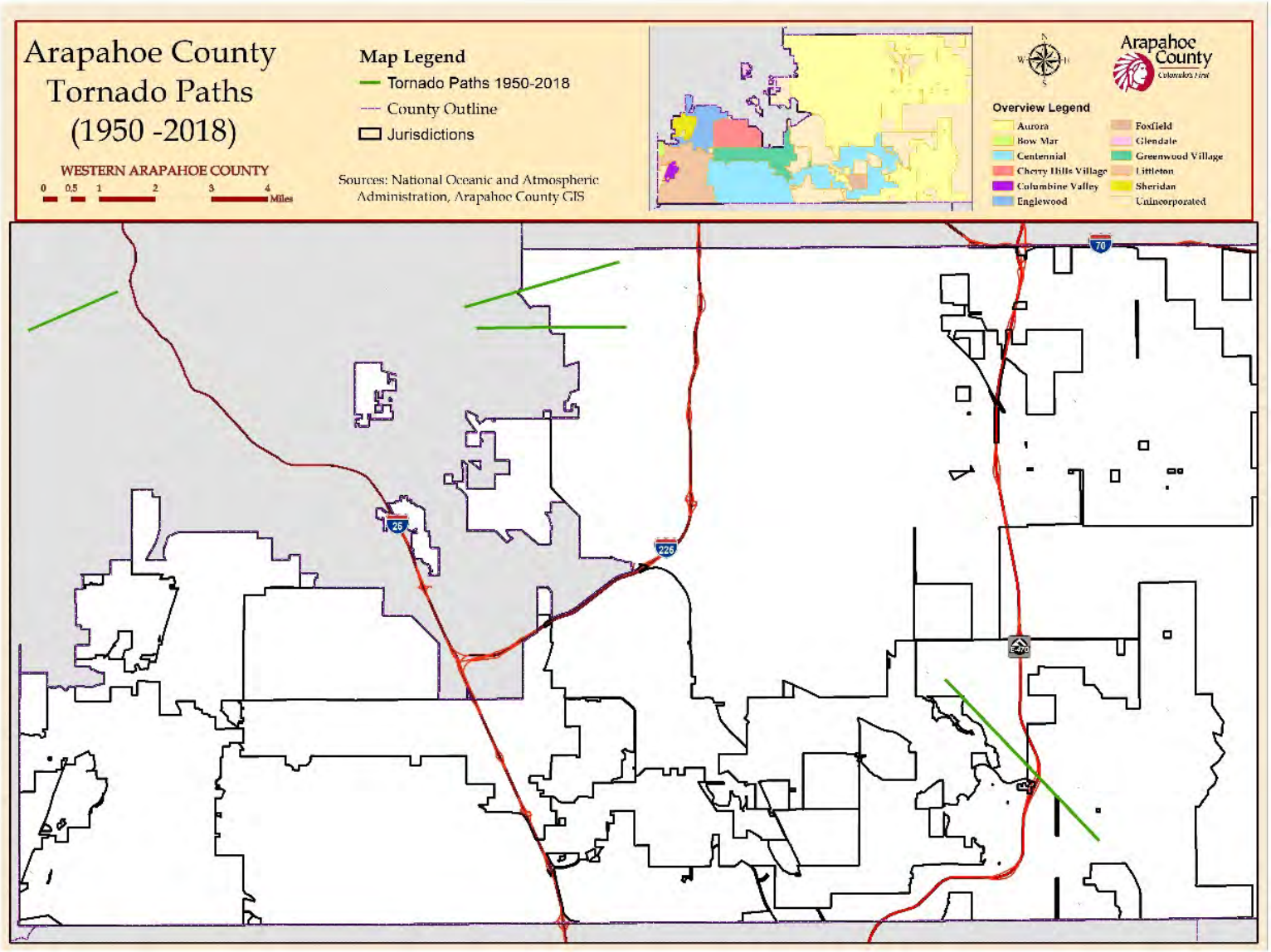


Figure 4-29 Tornado Events in Western Arapahoe County, 1950-2018

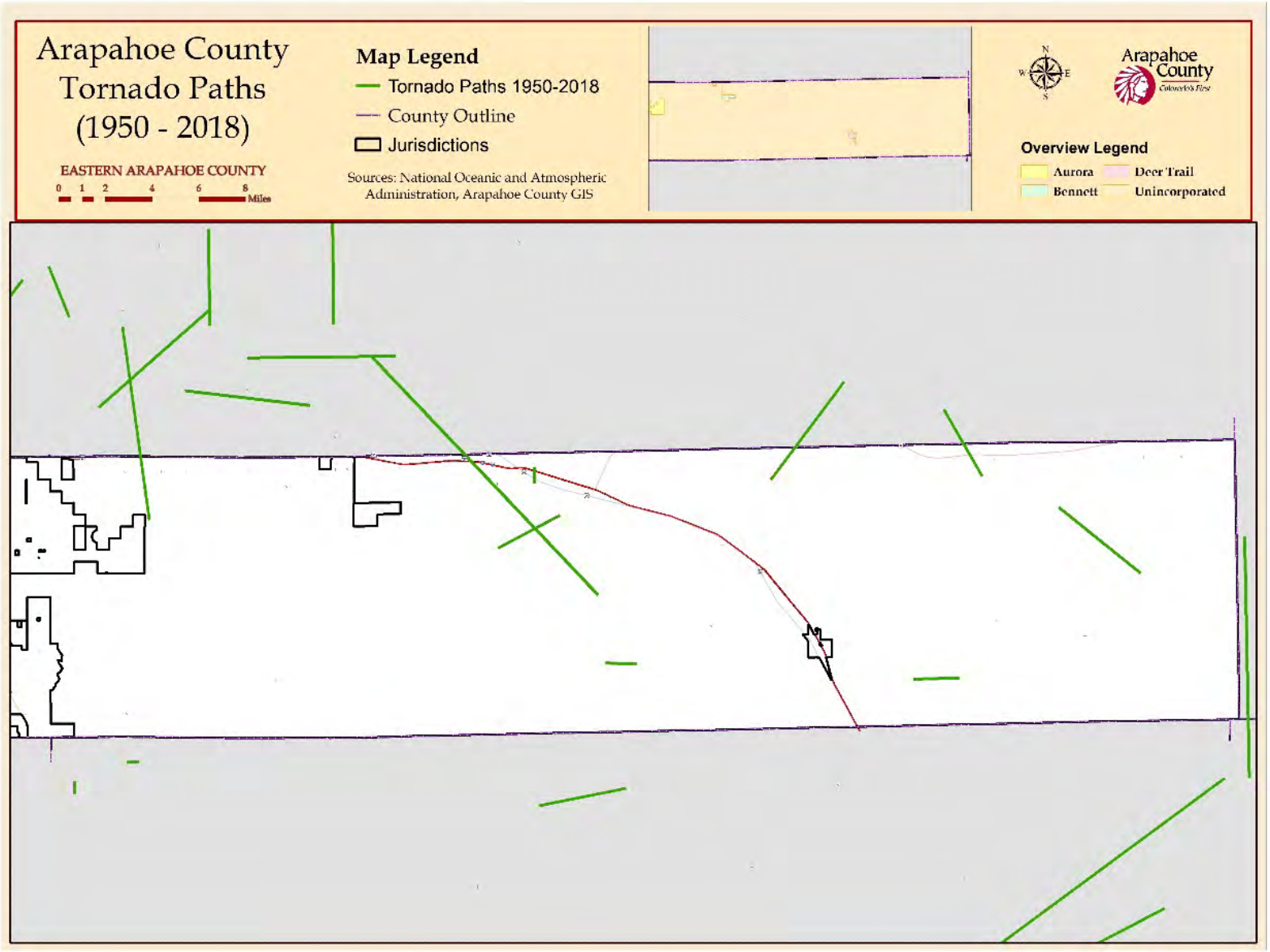


Figure 4-30 Damaging Wind Events in Western Arapahoe County, 1955-2018

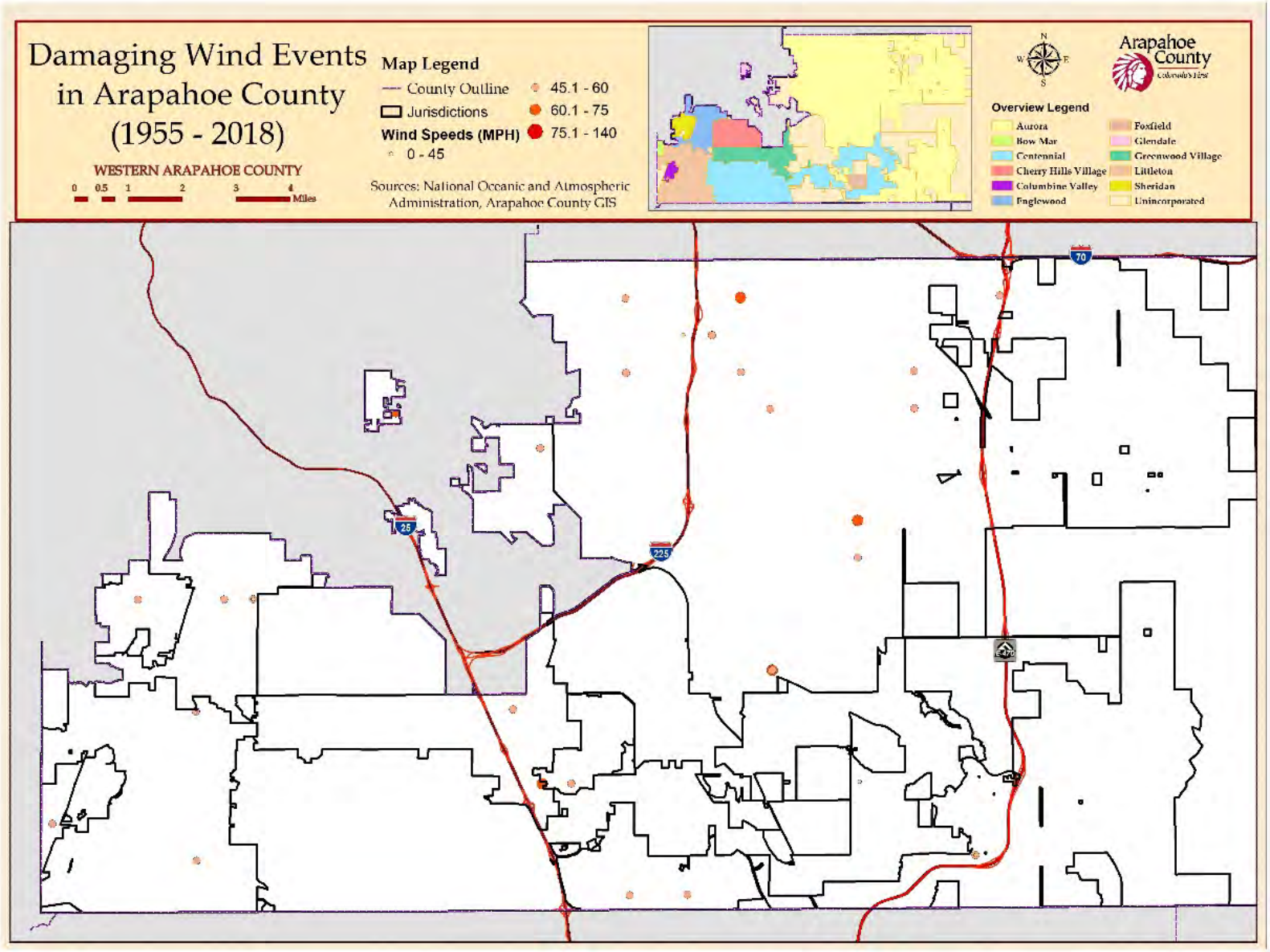
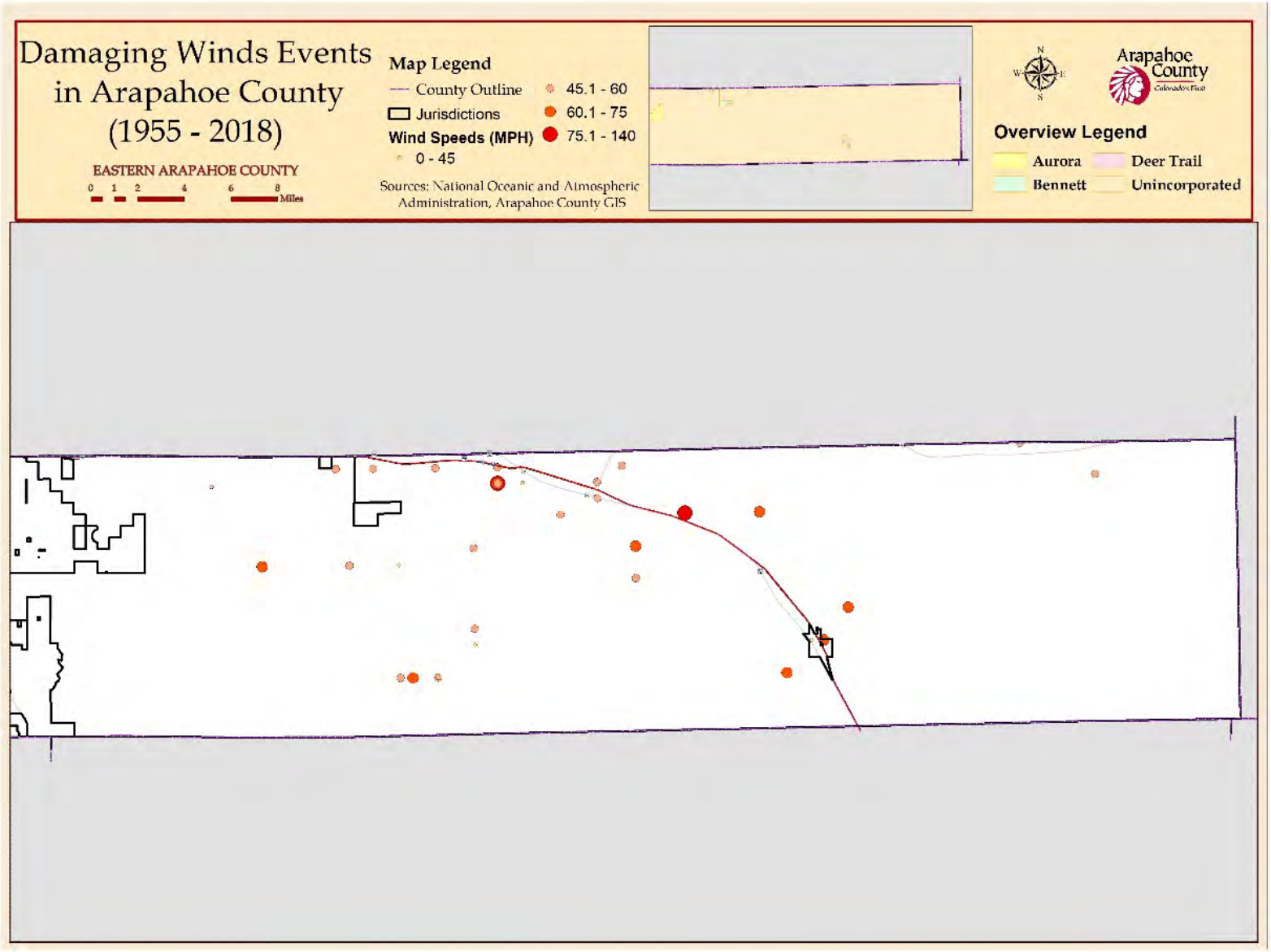


Figure 4-31 Damaging Wind Events in Eastern Arapahoe County, 1955-2018



Hazard Magnitude/Severity

Tornado

Tornados are the most intense storm on earth, 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. Tornados have been recorded with wind speeds exceeding 315 mph.

Before 2007, tornados were classified by their intensity using the Fujita (F) Scale, with F0 being the least intense and F6 being the most intense. The Fujita Scale, shown in Table 4-47, was 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 4-47 Fujita Tornado Damage Scale

Fujita Scale			
F-Scale Number	**Intensity Phrase**	**Wind Speed (mph)**	**Type of Damage**
F0	Gale tornado	40-72	Some damage to chimneys; breaks branches off trees; pushes over shallow-rooted trees; damages signboards.
F1	Moderate tornado	73-112	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	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	Roof and some walls torn off well-constructed houses; trains overturned; most trees in forest uprooted
F4	Devastating tornado	207-260	Well-constructed houses leveled; structures with weak foundations blown off some distance; cars thrown and large missiles generated.
F5	Incredible tornado	261-318	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	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: NWS

On February 1, 2007, the Fujita scale was replaced by the more accurate Enhanced Fujita Scale (aka the EF Scale). The EF-Scale measures tornado strength and associated damages

and classifies tornados into six intensity categories, as shown in Table 4-48. The scale was revised to reflect better examinations of tornado damage surveys 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 tornados.

Table 4-48 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.
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: NWS

As noted above, almost all of the tornados to touch down in Arapahoe County have been F/EF-0, F/EF-1, or F/EF-2, as shown in Table 4-49.

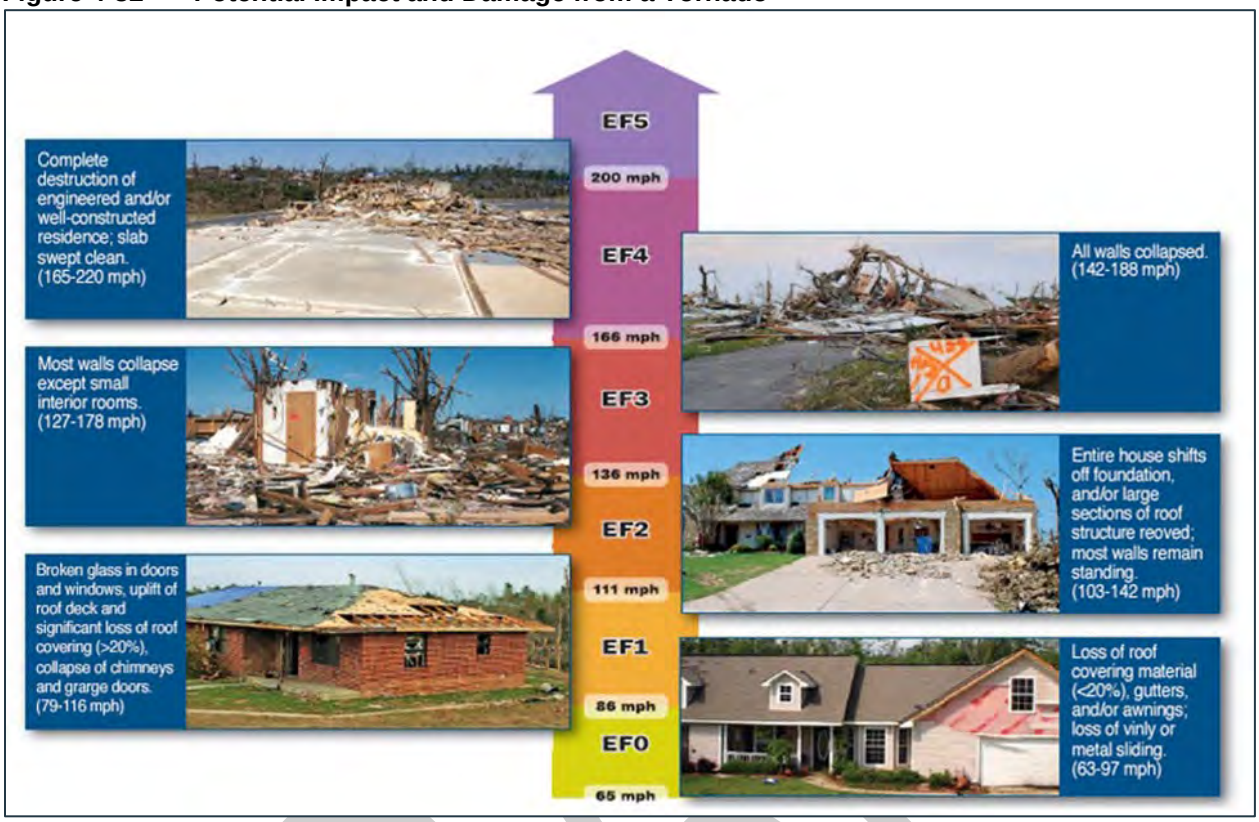
Table 4-49 Tornado History in Arapahoe County by Magnitude, 1964– 2019

Magnitude	Number		Magnitude	Number
F0	46		**EF0**	19
F1	27		**EF1**	4
F2	1		**EF2**	0

Source: NCEI Storm Events Database

Figure 4-32 illustrates the types of damage that can be expected by different magnitude tornados.

Figure 4-32 Potential Impact and Damage from a Tornado



Source: NOAA National Weather Service, Storm Prediction Center

Severe Wind

The Storm Prediction Center has developed damage indicators to be used with the Enhanced Fujita Scale for different types of buildings. These indicators can be also be used to classify any high wind event. Indicators for different building types are shown in the following tables.

Table 4-50 Damage to Institutional Buildings from High Wind

Damage Description	Wind Speed Range (Expected Speed)
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 4-51 Damage to Educational Institutions from High Wind

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

Source: Storm Prediction Center, 2009

Table 4-52 Damage to Metal Building Systems from High Wind

Damage Description	Wind Speed Range (Expected Speed)
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 4-53 Damage to Electric Transmission Lines from High Wind

Damage Description	Wind Speed Range (Expected Speed)
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

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Hazard Probability of Occurrence

As noted above, Arapahoe County has experienced 94 recorded tornados since 1964, an average of 1.7 per year. However, only 21 of those tornados resulted in any damage or injuries, an average of one damaging tornado every 2.6 years.

Severe Wind events are even more common. Arapahoe County has experienced 218 wind events since 1964, an average of four per year. However, only 20 of those wind events resulted in damage or injuries, giving a frequency of one damaging wind event every 2.8 years.

Cold air aloft and wind shear are two of the major variables when it comes to severe weather across all of Colorado. As the summer months approach, the jet stream weakens and travels north impacting the state less often and reducing wind shear. Therefore, tornados and severe wind events 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.

Hazard Consequence Analysis

Impact to the Public

Over the last 70 years there have been no deaths reported in Arapahoe County due to severe wind or tornado events. During the same time period, there have been 10 reported injuries from tornados and 9 reported injuries from severe wind. Monetary losses to property and crops are largely unknown.

The impacts on vulnerable populations can be severe. Poorer families are more likely to live in poorly constructed homes that are more likely to be damaged. Individuals with disabilities may need more assistance after an event, 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.

Impact to Responders

In the event of a tornado or severe wind event there may be localized impacts to response personnel. Impacts to transportation corridors and communications lines affect first responders' ability to respond effectively.

Impact to Continuity of Operations (including continued delivery of services)

Most structures, including the county's critical facilities, should be able to withstand and provide adequate protection from severe wind and tornados. Those facilities with back-up generators should be fully equipped to handle a severe wind and tornado events should the power go out.

Impact to Property, Facilities, and Infrastructure

All infrastructure and facilities located in Arapahoe County can be considered at risk from severe wind and tornados. Older homes, which are often subject to less advanced building codes, suffer increased vulnerability to wind and tornados over time. Mobile homes, which are most often occupied by low-income, socially vulnerable residents, are the most dangerous places during a windstorm or tornado. Studies indicate that 45% of all fatalities during tornados occur in mobile homes, compared to 26% in traditional site-built homes. Overall, mobile homes make up 1% of Arapahoe County's housing stock.

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Infrastructure damage from severe wind or tornados 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

Downed electrical lines following a storm can increase the potential for lethal electrical shock, and can also lead to other hazard events such as wildfires.

Impact to the Environment

Agriculture may be impacted during a tornado or severe wind event. Historic monetary losses to crops are largely unknown.

Impact to the Economic Condition of the County and Jurisdictions

Generally, severe wind events and tornados 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 because of damage to infrastructure, facilities, or interruption of services. Because no specific, countywide loss estimation exists for severe wind and tornado hazards, potential losses are related to historical property damage and injuries/deaths.

Impact to Public Confidence in Government

To maintain public confidence, Arapahoe 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.

Changes in Development

All future structures built in Arapahoe County may be exposed to severe wind and tornado damage. As with other large extent hazards, the increased development trends within Planning Reserve Areas and along the I-70 corridor will increase the vulnerability of these areas. Since the previous plan, the municipalities and unincorporated areas along the I-70 corridor have seen dramatic increase in single family housing units and new commercial development. As this area has been historically more likely to experience tornados, there is an increased population vulnerability. The county's current building code (2018 International Building I Code) requires new structures to be built to withstand a 90-mph wind event (EF1).

Jurisdictional Differences

Due to the nature of tornados and severe wind events, not all jurisdictions within Arapahoe County are expected to be impacted equally. As shown in the maps under Hazard Location, tornados and severe wind events are more common in the eastern half of the county.

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As mentioned above, mobile homes are more vulnerable to tornados and high wind. Mobile homes make up a larger portion of the housing stock in Deer Trail (18%), Sheridan (10%), and Bennett (7%); by contrast Bow Mar, Cherry Hills Village, Columbine Valley, Foxfield, Glendale, and Greenwood Village have very few mobile homes, reducing their vulnerability.

Table 4-54 Severe Wind/Tornado Hazard Rankings by Jurisdiction

Severe Wind/Tornado	Frequency	Spatial Extent	Severity	Overall Significance
Arapahoe County	Likely	Significant	Limited	Medium
Bennett	Likely	Significant	Critical	High
Bow Mar	Occasional	Significant	Limited	Medium
Centennial	Occasional	Significant	Limited	Medium
Cherry Hills Village	Occasional	Significant	Limited	Medium
Columbine Valley	Occasional	Significant	Limited	Medium
Deer Trail	Likely	Significant	Critical	High
Englewood	Occasional	Significant	Limited	Medium
Foxfield	Occasional	Significant	Limited	Medium
Glendale	Occasional	Significant	Limited	Medium
Greenwood Village	Occasional	Significant	Limited	Medium
Littleton	Occasional	Significant	Limited	Medium
Sheridan	Occasional	Significant	Critical	Medium
Denver Water	Likely	Significant	Limited	Medium

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4.12 Severe Winter Weather

Hazard Description

Severe winter weather such as blizzards, heavy snow, ice storms and extreme low temperatures can occur throughout the fall, winter, and spring seasons in Arapahoe County. Snow and ice storms can take down trees and cause damage to property and infrastructure. Cold temperatures are considered hazardous when they drop well below what is considered normal for an area. Combined with increases in wind speed, such temperatures can be life threatening to those who are exposed for extended periods of time.

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 does not necessarily 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 treacherous, even on foot. The strong winds may also cause dangerous wind chills. Ground blizzards can develop when strong winds lift snow off the ground and severely reduce visibilities.

Heavy snow may fall during winter storms in large quantities. Six inches or more in 12 hours, or eight inches or more in 24 hours, creates 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 drop 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 accumulation 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, can occur throughout the winter months in Arapahoe County. When cold temperatures and wind combine, dangerous wind chills can develop. Wind chill is how cold it "feels" and is based on the rate of heat loss on exposed skin from wind and cold. As the wind increases, it draws heat from the body, driving down skin temperature, and eventually lowering internal body temperature. This makes the environment feel much colder than the actual temperature. Most people limit their time outside during extreme cold conditions, but common complaints usually include pipes freezing and cars refusing to start.

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Hazard Previous Occurrences

The analysis of NCEI records reveals that winter weather events are frequent in the Arapahoe County region, with 131 reported events between 1996 and 2019. These 131 events were responsible for 6 deaths (indirectly), 2 injuries (directly), 32 injuries (indirectly), approximately $15.5 million in property damage over a 23-year period. Winter weather events occur frequently and can have a significant impact on Arapahoe County's vulnerable populations.

Significant winter weather events noted by NCEI or listed in the previous Hazard Mitigation Plan include:

- November 1983 – Extreme cold temperatures as low as -21°F were accompanied by a prolonged snowstorm that dumped over 21 inches of snow on the region.
- November 1991 – A large snowstorm dumped over 21 inches of snow.
- October 1997 – An October blizzard dumped over 31 inches of snow in the region, leaving 4,000 travelers stranded at the Denver International Airport. A state of emergency was declared for Colorado.
- December 9, 1998 – Extreme cold temperatures across the region led to power outages, cracked water pipes, and a number of deaths and injuries. Temperatures dipped below 0°F, with a low of -19°F for six consecutive days.
- April 2001 – Severe spring snow, high winds and ice led to snapped power poles and downed power lines. Many residents and businesses were left without power. DIA lost power over two consecutive weekends.
- March 17, 2003 – Largest snowstorm in the Denver Metro region since 1946. The three-day snowfall accumulation measured on March 20th, 2003 remains the most extreme in Arapahoe County to date, coming in at 46.3 inches.
- December 20-29, 2006 – Extreme cold temperatures and multiple snow storms created ice build-up on local streets. Over 20 inches of snow accumulated and led to the closure of the airport, grocery stores, and the US mail service at the height of holiday travel. A state-wide disaster was declared. The snowfall on December 21st, 2016 remains the most extreme one-day snowfall in Arapahoe County to date with an accumulation of 35 inches.
- March 30, 2009 - A band of heavy snow, induced by a strong upper level jetstream. The snow was heaviest on the east side of the Denver metro area where storm totals ranged from 2 to 5 inches. The combination of reduced visibilities and snow packed roadways resulted in multiple accidents during the morning rush hour including an 18-car pileup, a school bus crash and at least three fatalities.
- March 1, 2014 - A band of heavy snow, produced around one inch in less than 30 minutes, contributed to a chain of accidents in the northbound lanes of Interstate 25. The combination of excessive speed and very poor driving conditions led the chain reaction; it involved 104 vehicles and resulted in one death along with 30 injuries. The interstate was closed for approximately 5 hours.
- March 2019 – A rapidly intensifying storm system or bomb cyclone brought hurricane strength winds to the northeast plains of Colorado, along with moderate to heavy snowfall. Peak wind gusts ranged from 60 to 80 mph. Widespread outages, multi-vehicle accidents and road closures prompted the governor to declare a state of emergency which activated the Colorado National Guard to assist state and local authorities in rescuing hundreds of stranded motorists. Arapahoe County, along with many other counties, issued a disaster declaration. Nearly 1,400 flights in and out of Denver International Airport were canceled due to the blizzard. The number of people who lost

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power during the storm totaled 445,000. At least 33 public school districts were closed on the 13 and 14th. Warming centers and shelters opened area wide.

Understanding the historical frequency of winter weather events in Arapahoe County also assists in determining the likelihood of future occurrences. The characteristics of past extreme cold and significant winter weather events provide a benchmark for projecting similar conditions into the future. Table 4-55 lists the significant winter weather, blizzards and winter storms, and cold/wind chill events reported to NCEI for Arapahoe County.

Table 4-55 Severe Weather Events in Arapahoe County, 1996-2019

Year	Blizzard	Extreme Cold/ Wind Chill	Heavy Snow	Winter Storm	Winter Weather	Total
1996	1		6	1		8
1997	1		5	3		9
1998			2	1		3
1999			4	1		5
2000			2			2
2001	2		5	1		8
2002			2	1		3
2003	1		1			2
2004	1			4		5
2005	1			3		4
2006	2		1	2		5
2007	2			2	1	5
2008				1	2	3
2009	1			7	2	10
2010				2	2	4
2011		1		2	4	7
2012				1	3	4
2013	3			2	2	7
2014				2	3	5
2015	1			3	4	8
2016	1		1	3		5
2017	1			2	1	4
2018				1	1	2
2019	2			2	9	13
Total	**20**	**1**	**29**	**47**	**34**	**131**

Source: NCEI

Table 4-56 summarizes the impacts of those storms in terms of deaths, injuries, property damage, and crop damage.

Table 4-56 Severe Weather Events in Arapahoe County, 1996-2019

Year	Deaths (Direct)	Deaths (Indirect)	Injuries (Direct)	Injuries (Indirect)	Property Damage	Crop Damage
1996	0	0	0	0	0	0
1997	0	0	0	0	0	0
1998	0	0	0	0	0	0
1999	0	0	0	0	0	0

Year	Deaths (Direct)	Deaths (Indirect)	Injuries (Direct)	Injuries (Indirect)	Property Damage	Crop Damage
2000	0	0	0	0	0	0
2001	0	0	0	0	0	0
2002	0	0	0	0	0	0
2003	0	0	2	0	$15,500,000	0
2004	0	0	0	0	0	0
2005	0	0	0	0	0	0
2006	0	2	0	0	0	0
2007	0	0	0	0	0	0
2008	0	0	0	0	0	0
2009	0	2	0	2	0	0
2010	0	0	0	0	0	0
2011	0	1	0	0	0	0
2012	0	0	0	0	0	0
2013	0	0	0	0	0	0
2014	0	1	0	30	0	0
2015	0	0	0	0	0	0
2016	0	0	0	0	0	0
2017	0	0	0	0	0	0
2018	0	0	0	0	0	0
2019	0	0	0	0	0	0
Total	**0**	**6**	**2**	**32**	**$15,500,000**	**0**

Source: NCEI

Hazard Location

Each municipality in Arapahoe County has an equal susceptibility to severe winter weather as profiled in this section. The majority of Arapahoe County is located in the flat, grass-covered eastern plains – the high plains of the Great Plains. Winters on the eastern plains are typically dry, cold, and windy. Although snowfall is usually light, winter blizzards can affect all Arapahoe County residents when they occur.

All areas of Arapahoe County are assumed to have the same snowstorm risk. Heavy snow can result in the closing of primary and secondary roads, particularly in rural locations, loss of utility services, and depletion of oil heating supplies.

Hazard Magnitude/Severity

The winter storm season usually runs from November to April. Arapahoe County comes under winter weather advisory and winter storm watches/warnings several times throughout these months. Although snow does fall outside of this time frame, such snowfall is comparatively light and more likely to melt quickly. Figure 4-33 shows the Winter Storm Severity Index (WSSI), which provides NWS partners and the general public with an indication of the level of winter precipitation severity and its potential related societal impacts.

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Figure 4-33 Winter Storm Severity Index (WWSI) Scale

Potential Winter Storm Impacts	
	No Impacts Impacts not expected.
	Limited Impacts Rarely a direct threat to life and property. Typically results in little inconveniences.
	Minor Impacts Rarely a direct threat to life and property. Typically results in an inconvenience to daily life.
	Moderate Impacts Often threatening to life and property, some damage unavoidable. Typically results in disruptions to daily life.
	Major Impacts Extensive property damage likely, life saving actions needed. Will likely result in major disruptions to daily life.
	Extreme Impacts Extensive and widespread severe property damage, life saving actions will be needed. Results in extreme disruptions to daily life

Source: https://www.weather.gov/ict/WSSI_Overview

Figure 4-34 NWS Wind Chill Chart

Wind Chill Chart

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

Frostbite Times: 30 minutes, 10 minutes, 5 minutes

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

Where, T= Air Temperature (°F) V= Wind Speed (mph) Effective 11/01/01

Source: NWS

The state of Colorado experiences extreme cold events fairly frequently, although extended periods of sub-zero temperatures are rare. Average January nighttime low temperatures range from around 10 to 30 °F, with daily highs averaging from the mid-30s to 50°F. Sudden and frequent changes in temperature occur quite often in Colorado. Prolonged periods of extremely

cold weather are unusual; however, temperatures have occurred below 0° F in Arapahoe County. When conditions are appropriate, the National Weather Service issues wind chill warnings. Figure 4-34 above describes the criteria for these warnings.

Severe winter storms can be forecasted with a reasonable level of uncertainty. 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.

Hazard Probability of Occurrence

The exact frequency that Arapahoe County will experience severe winter storms can be difficult to quantify. But based on the NCEI data discussed above, Arapahoe County has experienced 131 such events since 1996. This works out to an average of 5.7 winter weather events recorded in Arapahoe County each year.

As a result of global climate change, the United States is already experiencing more intense rain and snowstorms. The amount of snow falling in the heaviest one percent of storms has risen nearly 74%, averaged nationally, between 1958 and 2011. As Arapahoe 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 ways.

Hazard Consequence Analysis

Severe winter weather can cause hazardous driving conditions, communications and electrical power failure, community isolation, and can adversely affect business continuity. A timely forecast may not be able to mitigate the property loss but could reduce the casualties and associated injury. Although stopping extreme winter temperature and winter storm events is impossible, limiting their effect on people and property in Arapahoe County is feasible.

Impact to the Public

In the context of extreme winter temperature and winter storm events, the most vulnerable members of Arapahoe County are:

- The elderly (people over 65 years of age)
- Infants (under 1 year old)
- Homeless individuals
- Low income families
- Socially isolated individuals
- People with mobility restrictions and/or mental impairments
- The infirm
- Outdoor laborers

Extended power outages during extreme cold events may make many homes and offices unbearably cold. Additionally, during extended winter-time power outages, people often make the mistake of bringing portable generators inside or not venting them properly, leading to carbon monoxide poisoning. With poor road conditions, sheltering residents may present significant logistical challenges with getting people to heated facilities, feeding, and providing

medical care. These situations, accompanied by stranded motorists that need to be rescued, represent significant threats to the population of Arapahoe County.

Casualties caused by extreme cold events can result from a lack of adequate heating, carbon monoxide poisoning from unsafe or unventilated heating systems, and frostbite from exposure to the elements. Again, the most vulnerable populations to extreme cold are the elderly, infirm, homeless, and low-income families. Often, these individuals do not have access to a heat source or are unable to afford to operate one on a regular basis.

Table 4-57 shows Census data related to populations that may be more vulnerable to extreme temperatures. Refer to 4.10 Severe Summer Weather for impacts related to extreme heat.

Table 4-57 Populations Vulnerable to Extreme Temperatures

Jurisdiction	Age: 65 and Over (%)	Persons Below Poverty Level (%)	Renter-occupied housing units (%)
County	12.3	9.0	36.9
Aurora	10	12	41
Bennett	14.4	11.5	22.9
Bow Mar	17.7	3.1	4.1
Centennial	14.4	3.7	15.1
Cherry Hills Village	17.5	3.1	4.8
Columbine Valley	26.6	1.5	4
Deer Trail	15.9	20.6	30.1
Englewood	13.4	15.1	50.5
Foxfield	29.1	4.5	5.3
Glendale	3.9	12.8	91.4
Greenwood Village	16.4	5.5	33.3
Littleton	17.2	7.9	40.4
Sheridan	15	20.4	45.8

Source: Census Bureau, American Community Survey 5-Year Estimates, 2014-2018

Ongoing mitigation activities should focus on protecting lives and preventing injuries during periods of extreme cold and winter storms. This includes, but is not limited to, preseason community outreach campaigns to educate the public about risks and available support; establishing heating centers; reaching out to vulnerable populations and caregivers; and issuing advisories and warnings.

Impact to Responders

The impact to first responders can be extensive during a severe winter storm. Operations can include rescue missions for stranded motorists, medic responses to motor vehicle accidents, and transportation of citizens to warming shelters and medical facilities. First responders are often subjected to the harsh elements of winter storms such as exposure to extreme low temperatures, high winds, and extensive snow for long periods of time.

Impact to Continuity of Operations (including continued delivery of services)

Blizzards, heavy snow, ice storms and extreme low temperatures can have limited impacts to the continuity of operations throughout Arapahoe County. Events such as power loss and poor road conditions can interrupt daily services such as delivery services and staff being able to perform their normal job functions.

Impact to Property, Facilities, 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. All assets located in Arapahoe County can be considered at risk from winter storms and extreme cold temperatures. This includes 602,868 people, or 100% of the county's population and all buildings and infrastructure within the county. Damages primarily occur because of high winds, ice storms, and snow loading. Unlike other natural hazards that affect Arapahoe County, extreme temperatures have limited physical destructive force. However, damages to inventory assets exposed to extreme cold is dependent on the age of the building, type, construction material used, and condition of the structure. Heavy snow loads on roofs, particularly large span roofs, can cause roofs to leak or even collapse depending on their construction. Extremely cold temperatures may cause pipes to freeze and subsequently burst, causing water damage. During the winter months, freezing temperatures and repeated freeze-thaw events can cause potholes, which may damage vehicles. Hazardous travel conditions may result if potholes are not tended to promptly. Frozen pipes, a common occurrence during extreme cold events, can cause service interruptions in water supply, gas supply, and drainage.

Inventory assets exposed to winter storms and extreme cold is dependent on the age of the building, type, construction material used, and condition of the structure. The greatest issue for critical facilities during significant winter storms and extreme cold temperatures is most commonly the inaccessibility of facilities due to poor roadways, utility outages, or dangerous wind chills. During periods of heavy snow, ice, or blizzards, roads can quickly become impassable, stranding motorists and isolating communities. Long term road closures during an extended cold period may diminish and threaten propane and fuel supplies. Possible losses to 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

Debris may also block roadways making transportation and commerce difficult if not impossible. Those facilities with back-up generators are better equipped to handle a prolonged extreme cold temperature or severe winter storm situation should the power go out.

Impact to the Environment

Environmental impacts often include damage to trees and landscaping due to heavy snow loading, ice build-up, and/or high winds which can break limbs or even bring down large trees. Gradual melting of snow and ice provides excellent groundwater recharge; however, high temperatures following a heavy snowfall can cause rapid surface water runoff and severe flash flooding.

Impact to the Economic Condition of the County and Jurisdictions

Local economy and finances may be adversely affected, depending on damage.

Impact to Public Confidence in Government

During extreme winter weather events the public will expect notifications as early as possible and updated frequently as events unfold. The local government agencies will enact winter

weather operations such as extensive plowing operations and the opening of warming shelters. First responders and rescue personnel will perform missions throughout the weather event to ensure safety of the public and continuation of crucial services.

Changes in Development

Since 2015 there has been a steady increase in the population of Arapahoe County. Since all future structures built in Arapahoe County will likely be exposed to severe winter weather extremes and damage, the location of development does not increase or reduce the risk necessarily. However, the increase in population density, and any accompanying increases in social vulnerability, could strain response resources and increase the county's vulnerability overall.

The eastern part of the county especially continues to add new housing developments; its population will continue to increase for the foreseeable future. Arapahoe 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 more challenging should sheltering or emergency services be needed in an extreme event.

Jurisdictional Differences

Severe winter weather has the potential to occur anywhere in Arapahoe County, therefore the location, extent, and probability of occurrence are the same county-wide. Jurisdictions with higher numbers of socially vulnerable residents may experience magnified impacts of extreme temperatures. This includes places with high numbers of elderly residents, low income families and homeless individuals/outdoor laborers.

Table 4-58 Severe Winter Weather Hazard Rankings by Jurisdiction

Severe Winter Weather	Frequency	Spatial Extent	Severity	Overall Significance
Arapahoe County	Highly Likely	Extensive	Limited	High
Bennett	Highly Likely	Extensive	Limited	High
Bow Mar	Highly Likely	Extensive	Limited	High
Centennial	Highly Likely	Extensive	Limited	High
Cherry Hills Village	Highly Likely	Extensive	Limited	High
Columbine Valley	Highly Likely	Extensive	Limited	High
Deer Trail	Highly Likely	Extensive	Limited	High
Englewood	Highly Likely	Extensive	Limited	High
Foxfield	Highly Likely	Extensive	Limited	High
Glendale	Highly Likely	Extensive	Limited	High
Greenwood Village	Highly Likely	Extensive	Limited	High
Littleton	Highly Likely	Extensive	Limited	High
Sheridan	Highly Likely	Extensive	Limited	High
Denver Water	Highly Likely	Extensive	Limited	High

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4.13 Wildfire

Hazard Description

A wildfire is an unplanned fire that burns in a natural area such as a forest, grassland or prairie. They include unauthorized human-caused fires, escaped prescribed burn projects and all other fires where the objective is to put the fire out. Wildfires are frequently associated with lightning and drought conditions, as dry conditions make vegetation more flammable. As new development encroaches into the wildland/urban interface (areas where development occurs within or immediately adjacent to wildland, near fire-prone trees, brush, and/or other vegetation) more and more structures and people are at risk. On occasion, ranchers and farmers intentionally set fire to vegetation to restore soil nutrients or alter the existing vegetation growth. Also, individuals in rural areas frequently burn trash, leaves and other vegetation debris. These fires have the potential to get out of control and turn into wildfires.

Wildfires are fueled by natural ground cover, including native and non-native species of trees, brush, 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 Colorado's wildfires are caused by people through criminal or accidental misuse of fire.

The risk factors considered are:

- High temperature
- High wind speed
- Fuel moisture (greenness of vegetation)
- Low humidity
- Little or no cloud cover
- Topography (not a significant factor in most of Arapahoe County)

Wildfires pose a serious risk to human safety and property in Arapahoe County. They can destroy crops, timber resources, recreation areas, and critical wildlife habitat. The National Weather Service monitors the conditions supportive of wildfires in the State daily so that wildfires can be predicted, and possibly prevented.

Hazard Previous Occurrences

Historical wildfire occurrence data was collected from the Colorado Division of Fire Prevention and Control's Fire Incident Reporting System (CFIRS). The CFIRS data includes wildfire incident types related to natural vegetation fires and cultivated vegetation fires and is currently available for events that occurred from 2009-2019. It is important to note that CFIRS wildfire data is only available when it is voluntarily submitted by participating local fire departments. For this analysis all fires reported in any of Arapahoe County's jurisdictions have been counted; therefore the totals may include some fires outside of the county, such as a fire in the Jefferson County part of Littleton.

Based on the CFIRS data, there have been 2,381 wildfires reported within Arapahoe County between January 1, 2009 and December 31, 2019; these events are summarized in Table 4-59. Losses associated with the 2,381 events include over 84,500 acres of land and over $612,700 dollars. Table 4-60 breaks down these fires by responding jurisdiction. Note that as shown in

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Figure 4-37 and Figure 4-38, several departments have coverage areas larger than their incorporated jurisdiction, which explains why some urban jurisdictions have responded to more wildfires than expected.

Table 4-59 Arapahoe County Reported Wildfires by Year (2009 – 2019)

Year	Count	Total Acres	Total Losses
2009	95	1,023	$7,095
2010	252	1,125	$31,910
2011	268	2,336	$143,335
2012	229	8,417	$31,075
2013	137	13	$18,600
2014	148	1,412	$265,101
2015	155	6,909	$10,200
2016	363	1,004	$37,250
2017	355	1,546	$41,221
2018	214	60,325	$21,710
2019	165	450	$5,300
Total	**2,381**	**84,560**	**$612,797**

Source: CFIRS

Table 4-60 Arapahoe County Reported Wildfires by Jurisdiction (2009 – 2019)

Jurisdiction	Count	Total Acres Burned	Total Losses
Aurora	1,369	61,199	$91,390
Bennett	71	7	$0
Byers	159	5,637	$26,150
Centennial	137	25	$34,106
Cherry Hills Village	11	3	$50,400
Deer Trail	29	1,106	$0
Englewood	184	30	$17,750
Foxfield	1	0	$2,000
Greenwood Village	27	2	$1,270
Littleton	348	16,499	$389,731
Sheridan	1	0	$0
Strasburg	35	47	$0
Watkins	9	4	$0
Total	**2,381**	**84,560**	**$612,797**

Source: CFIRS, Wood analysis

It should be noted that the above numbers are based on self-reporting by individual fire departments, some of whose service areas extend beyond their city limits. As such, these

numbers likely include some fires that were reported by the listed municipality but did not actually occur inside the municipal limits. Some fires were able to be excluded where data made this clear, but a lack of precise location data made it impossible to do this for many fires. The Planning Team noted that the wildfire numbers for Englewood and Littleton in particular seemed high, and may overinflate the wildfire risk in those jurisdictions, as show in the following sections.

Based on the CFIRS data, 2014 was the worst year for wildfires in Arapahoe County in terms of monetary losses ($265,101); 2018 was the worst year for wildfires in the county in terms of total acres burned (60,325); and 2016 was the worst year for wildfires in the county in terms of the total number of events (363).

Based on the CFIRS data, the City of Aurora had the greatest number of wildfires (1,369) and total acres burned (61,199); while the wildfires within the City of Littleton caused the greatest total monetary losses ($389,731).

Figure 4-35 presents the history of wildfire occurrence in and around Arapahoe County as provided by Colorado Wildfire Risk Assessment Portal (COWRAP). This map was derived by modeling historic wildfire ignition locations to create an ignition density map. Historic fire report data was used to create the ignition points for all Colorado fires. This included both federal and non-federal fire ignition locations. The class breaks are determined by analyzing the wildfire occurrence output values for the entire state and determining cumulative percent of acres (i.e. Class 9 has the top 1.5% of acres with the highest occurrence rate). The wildfire occurrence mapping was derived at a 30-meter resolution. This scale of data was chosen to be consistent with the accuracy of the primary surface fuels dataset used in the assessment. While not sufficient for site specific analysis, it is appropriate for regional, county, or local protection mitigation or prevention planning. Based on these two figures, the highest occurrences of wildfires are predominately in western Arapahoe County.

Figure 4-36 also shows the wildfire history in Arapahoe County, but uses data from the Colorado Fire Incident Reporting System (CFIRS). This map shows the locations of all reported wildfires greater than 1 acre; the locations of many fires are approximated. Although the two maps use very different methodology, they both show the same general trend, with the majority of wildfires divided between greenspaces in the western part of the county and the eastern plains.

Figure 4-37 and Figure 4-38 show the coverage areas of the fire departments and districts that serve Arapahoe County. To facilitate continued wildfire mitigation activity and planning at the local jurisdiction levels, the following tables summarize the CFIRS data for each participating local fire department for wildfires located within Arapahoe County. Again, it is important to note, CFIRS wildfire data is only available when it is voluntarily submitted by participating local fire departments. Several departments also serve the surrounding counties and communities outside of Arapahoe County when mutual support is needed; however only fires within Arapahoe County are included in this analysis. Not only do the tables summarize wildfire losses and historical occurrences, they also highlight areas of need for data collection and record keeping for future events.

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Figure 4-35 Wildfire Occurrence in Arapahoe County – COWRAP

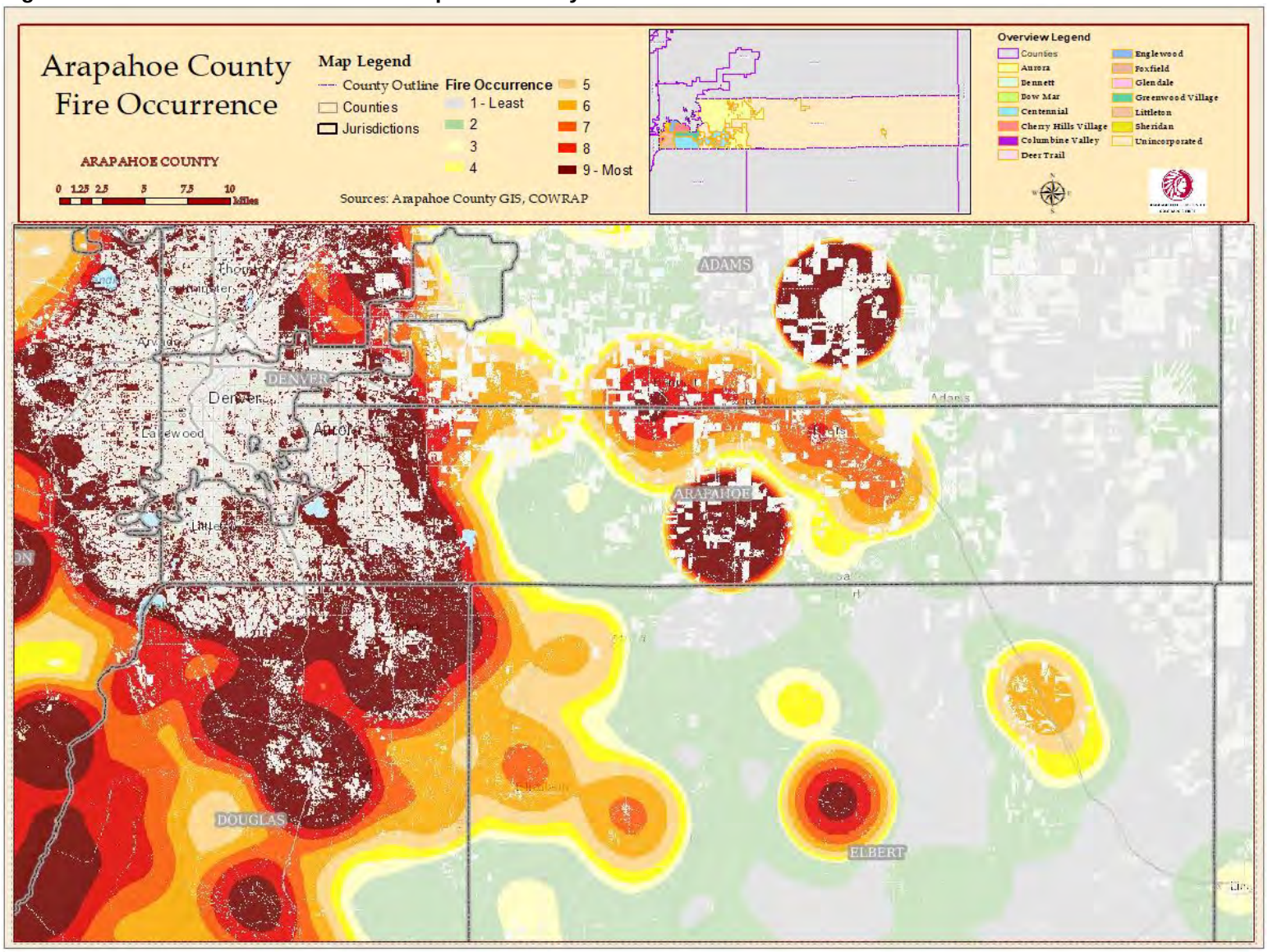

Figure 4-36 Wildfire Occurrence in Arapahoe County – CFIRS

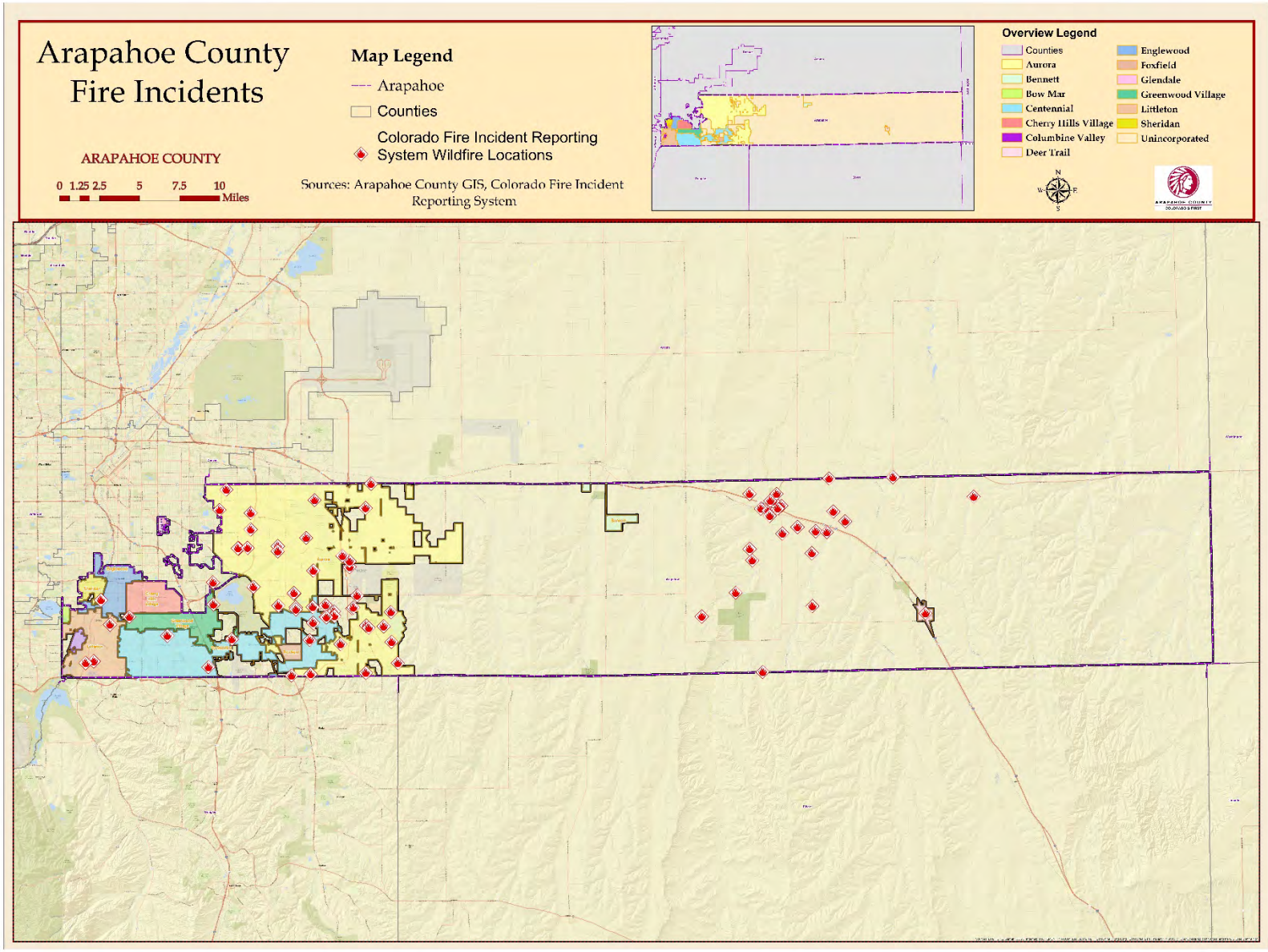

Figure 4-37 Fire Districts in Western Arapahoe County

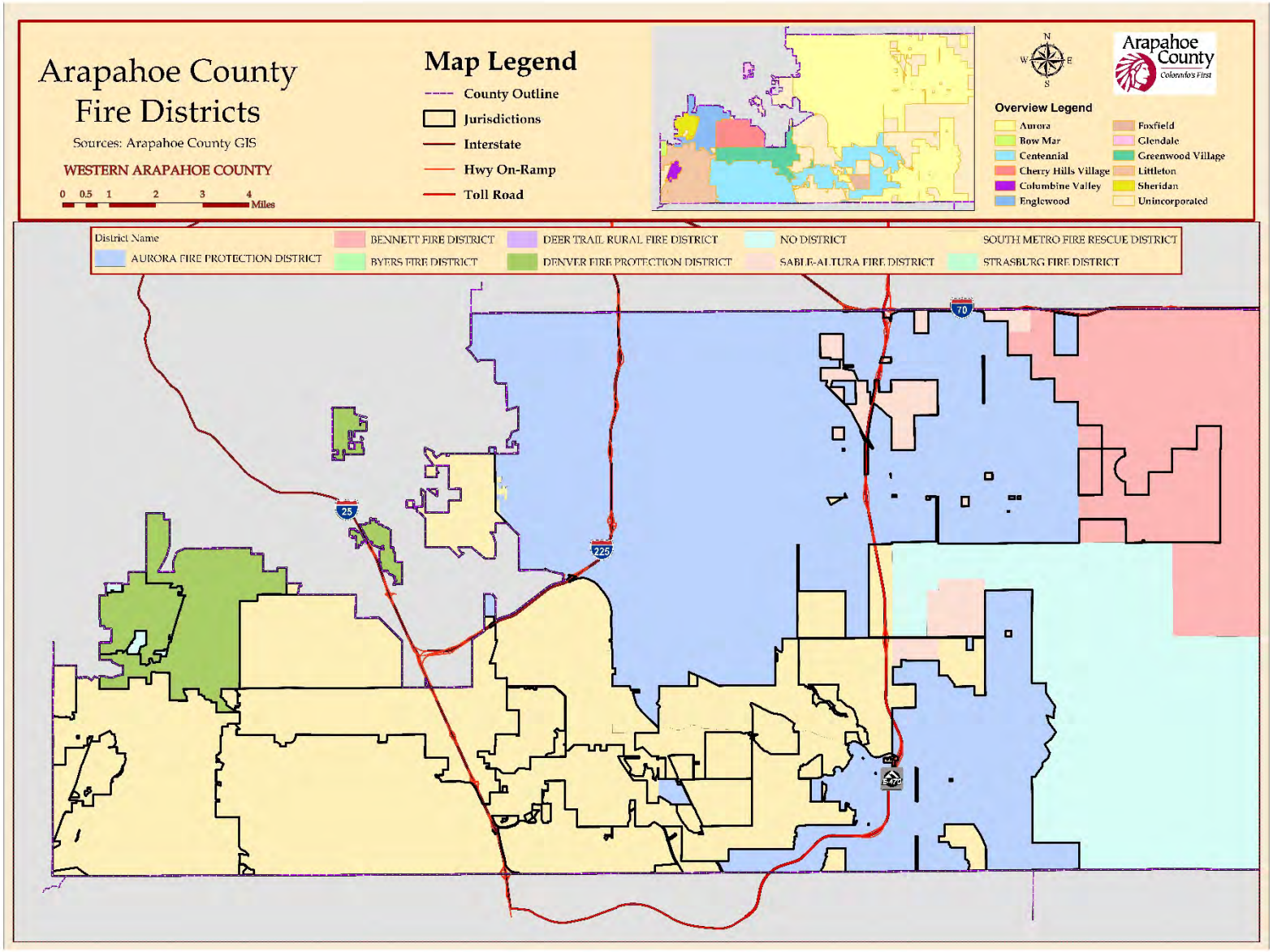

Figure 4-38 Fire Districts in Eastern Arapahoe County

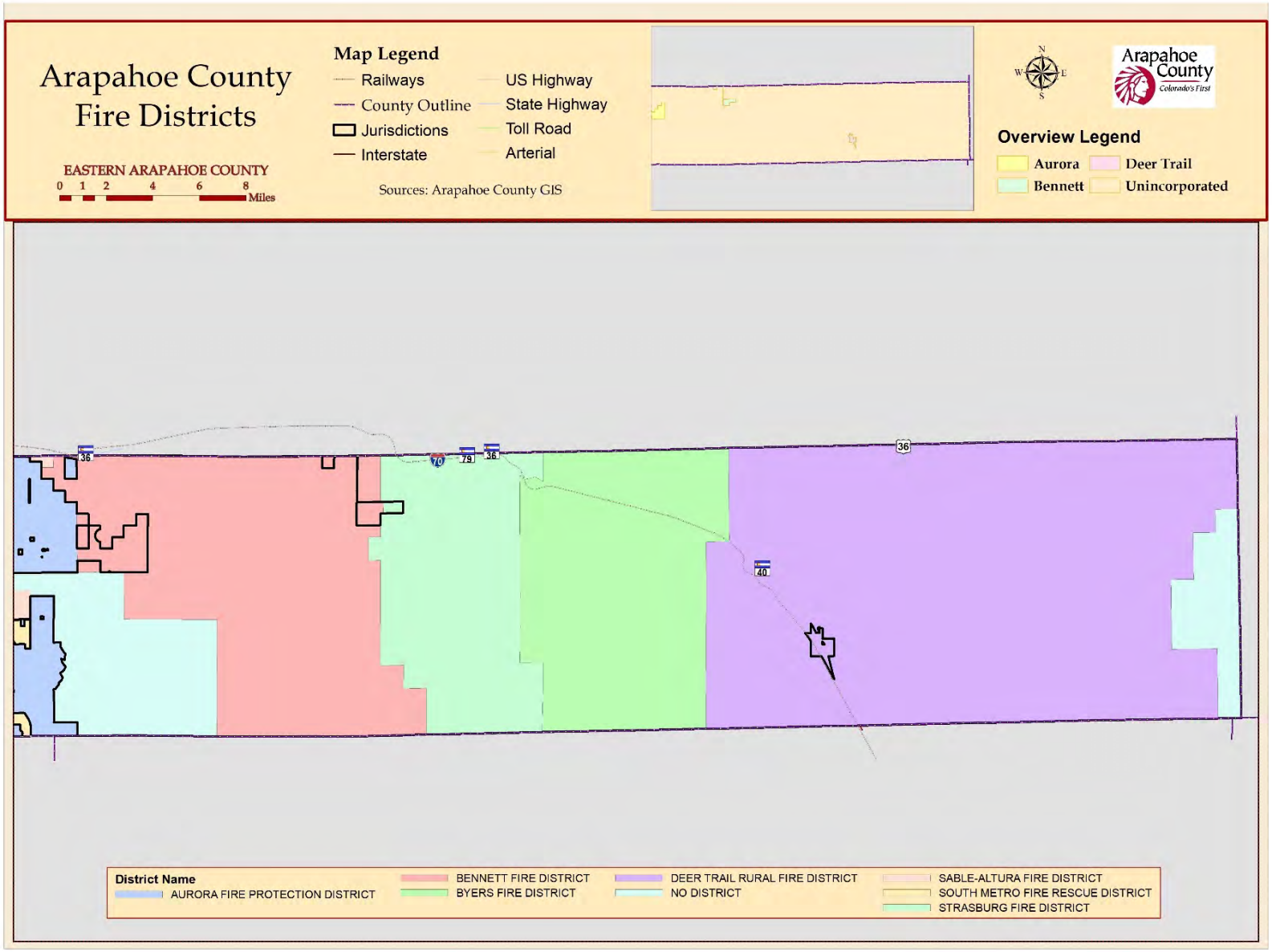

Table 4-61 Arapahoe County Wildfire Events Reported by Fire Department (2009 – 2019)

Fire District	Count	Total Acres Burned	Total Losses
Aurora FD	1,224	61,151	$89,590
Byers FD	305	6,827	$26,150
South Metro FRA	361	318	$115,731
Cunningham FPD	140	15	$2,610
Englewood FD*	62	0	$4,135
Littleton FR	288	16,248	$374,581
Sheridan FD	1	0	$0
Total:	**2,381**	**84,560**	**$612,797**

Source: CFIRS Note: Englewood FD ceased to exist in 2015

Based on the CFIRS data, the Aurora Fire Department addressed the greatest number of wildfires (1,224) and total acres burned (61,151); while the wildfires addressed by the Littleton Fire Department caused the greatest total monetary losses ($374,581)

Table 4-62 Arapahoe County Reported Wildfire Events by Incident Type (2009 – 2019)

Incident Type	Count	Total Acres Burned	Total Losses
Brush, or brush and grass mixture fire	1,551	75,074	$536,541
Cultivated trees or nursery stock fire	12	0	$800
Cultivated vegetation, crop fire, other	15	0	$5,250
Forest, woods, or wildland fire	11	8,211	$20,001
Grass fire	490	1,123	$22,050
Natural vegetation fire, other	302	152	$28,155
Grand Total	**2,381**	**84560**	**$612,797**

Source: CFIRS

Based on the CFIRS data, the most common incident type of wildfire is brush, or brush and grass mixture fire with a total count of 1,551, total acres burned of 75,074, and total monetary loss of $536,541.

Hazard Location

Wildfires are commonly perceived as hazards in the western part of the state; however, wildfires are a growing problem in the wildland-urban interfaces (WUI) of eastern Colorado. Higher risk areas within Arapahoe County include areas of Centennial, Aurora, Greenwood Village, and portions of unincorporated Arapahoe County along the I-70 corridor. The risk of grass or

brushfires remaining significant throughout the eastern half of the county although being less dense in population and development reduces the vulnerability.

Figure 4-39 and Figure 4-40 present the wildfire risk in western and eastern Arapahoe County, as provided by COWRAP. The figures identify areas with the greatest potential impacts from a wildfire – i.e. those areas most at risk when considering the following four components: wildland-urban interfaces (housing density), forest assets, riparian assets and drinking water importance areas. COWRAP designated some areas as non-burnable due to the associated fuel type (i.e. water, roads, urban, agricultural areas, barren areas). The WUI component is a key element of the composite risk since it represents where people live in the wildland and urban fringe areas that are susceptible to wildfires and damages. The risk map was derived at a 30-meter resolution. This scale of data was chosen to be consistent with the accuracy of the primary surface fuels dataset used in the assessment. While not appropriate for site specific analysis, it is appropriate for regional, county, or local planning efforts.

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Figure 4-39 Wildfire Risk in Western Arapahoe County

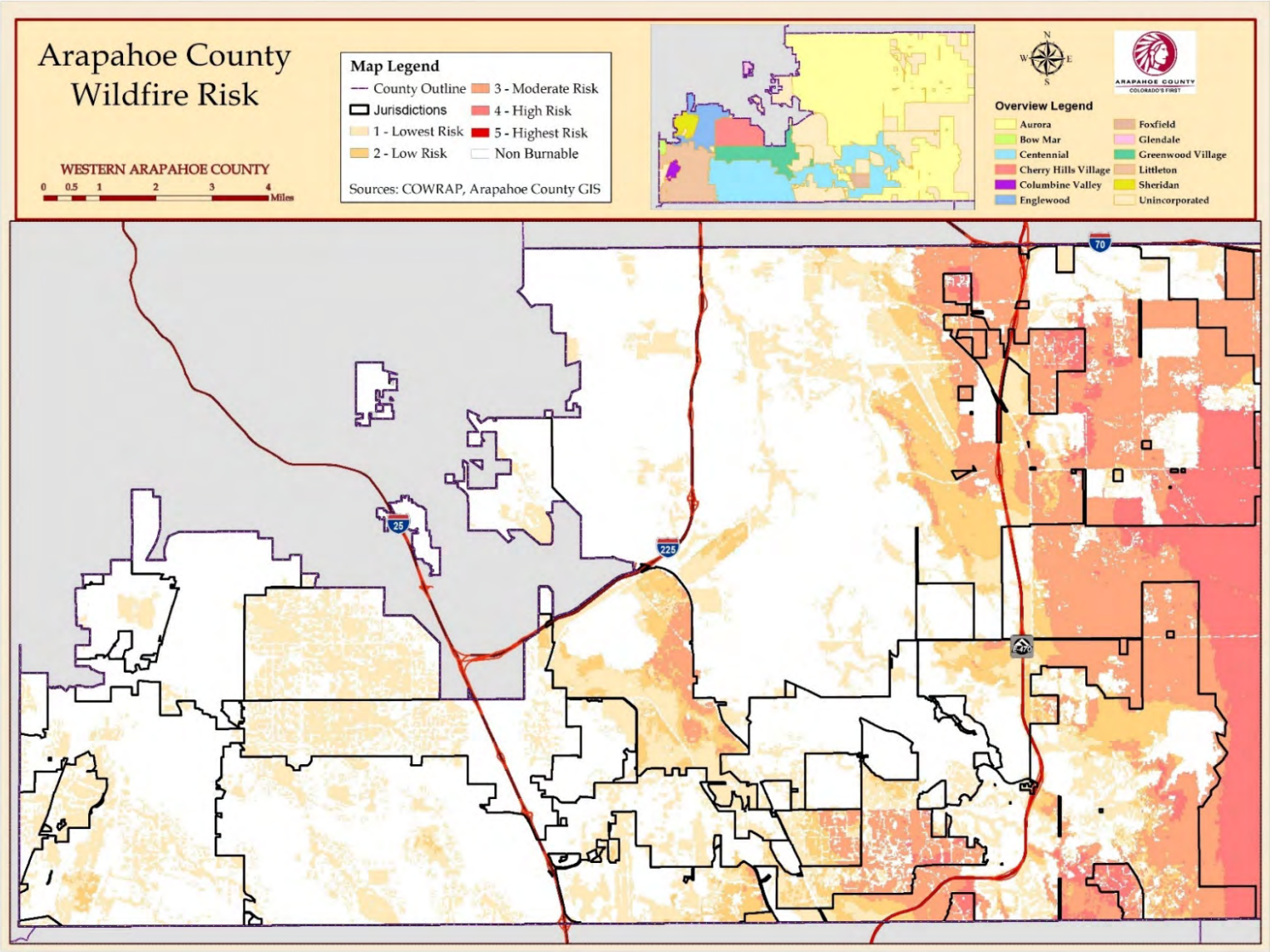
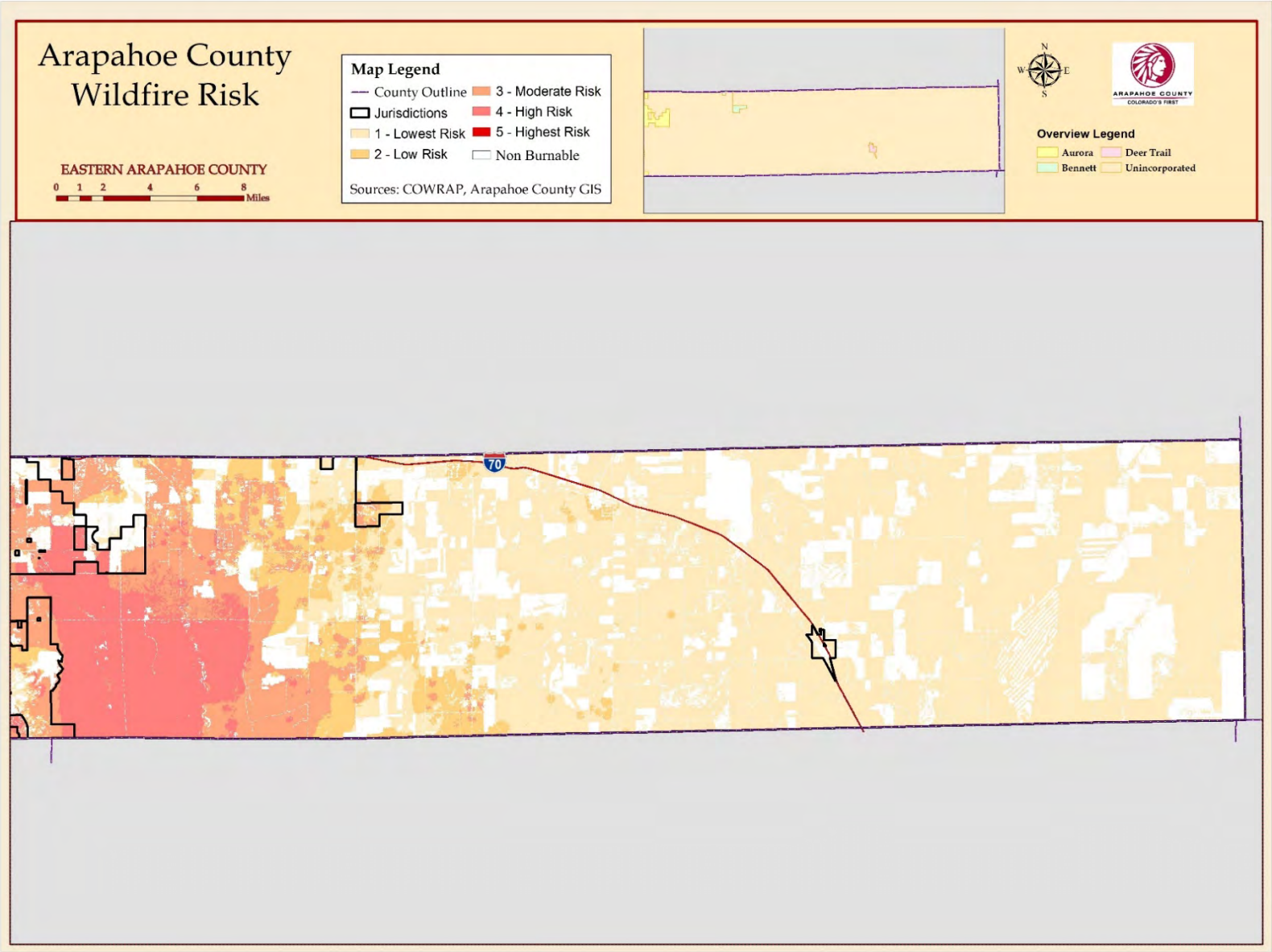


Figure 4-40 Wildfire Risk in Eastern Arapahoe County



Hazard Magnitude/Severity

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 several 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 insulation, 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.

Arson and accidents, including sparks from equipment and vehicles, can also cause wildfires. Human-caused wildfires are typically worse than those caused by natural agents. 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.

Hazard Probability of Occurrence

The probability that Arapahoe County will experience a wildfire event can be difficult to quantify, but based on data provided by CFIRS, with 2,381 events since 2009, there are an average of 216 wildfire events in Arapahoe County each year.

Additionally, burn probability (BP), as provided by COWRAP, has been calculated for the county as the annual probability of any location burning due to a wildfire. The annual BP was calculated as the number of times that a cell was burned, and the number of iterations used to run the wildfire simulation models. Figure 4-41 and Figure 4-42 present the burn probability for western and eastern Arapahoe County. From these figures we can see the area with the highest burn probability is located within unincorporated Arapahoe County just east of the City of Aurora.

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Figure 4-41 Burn Probability in Western Arapahoe County

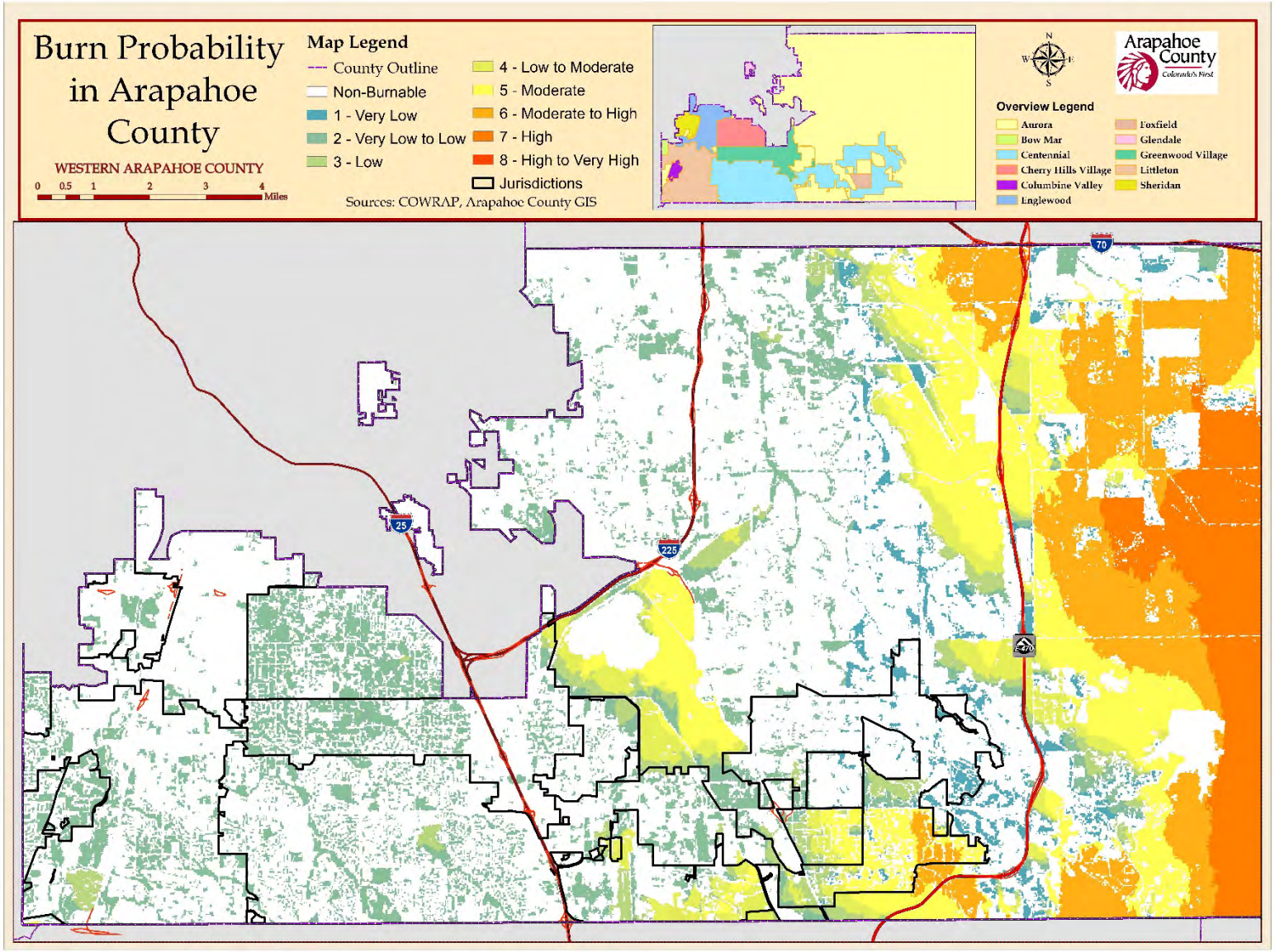
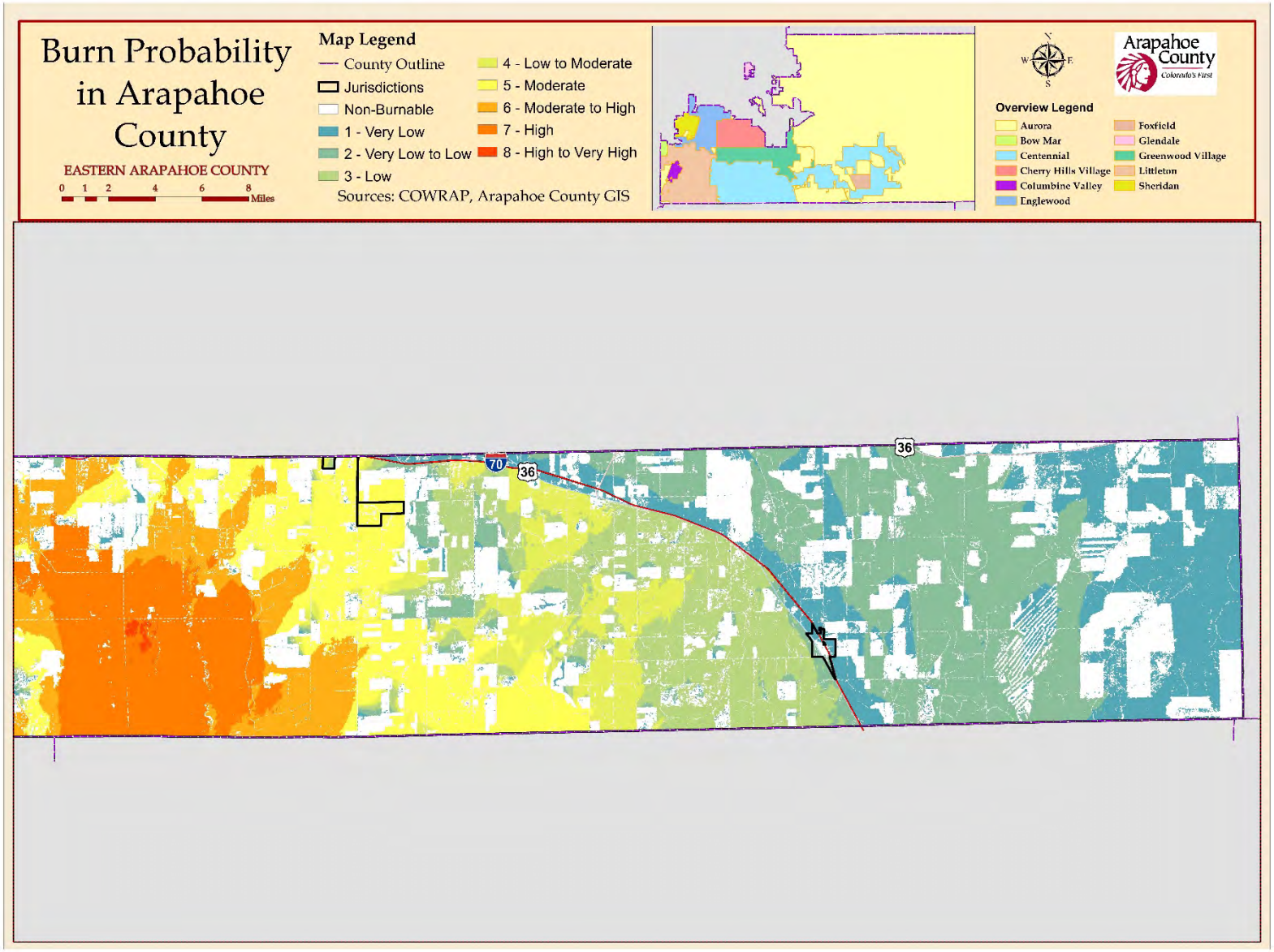


Figure 4-42 Burn Probability in Eastern Arapahoe County



Hazard Consequence Analysis

Impact to the Public

Local impacts to the public, including recreationists, campers, and property owners in remote areas or within the wildland urban interface areas, include the following:

- Loss of life (human, livestock, wildlife);
- Loss of property, including structures and crops;
- Evacuations;
- Reductions in air quality and human health. Pollutants emitted from fires can be harmful to human health and welfare; and
- Injuries – burns, smoke inhalation, etc.

Table 4-63 shows the estimated population living in Wildland Urban Interface zones. A total of 296,811, or roughly 46% of the total population, are estimated to be living in WUI areas at risk of wildfire, this includes 3% in the high risk zone, 8% in the medium risk zone, and 34% in the low risk zone. Figure 4-43 and Figure 4-44 present the WUI Risk for western and eastern Arapahoe County.

Table 4-63 Population at Risk to WUI Hazard within Arapahoe County

Jurisdiction	Population at Low WUI Risk	Population at Medium WUI Risk	Population at High WUI Risk	Total
Aurora	100,871	31,301	12,210	**144,382**
Bennett	-	331	22	**353**
Bow Mar	243	-	-	**243**
Centennial	42,095	6,597	3,100	**51,792**
Cherry Hills Village	5,490	306	111	**5,907**
Columbine Valley	1,394	75	52	**1,521**
Deer Trail	440	260	29	**728**
Englewood	3,200	-	-	**3,200**
Foxfield	-	524	246	**770**
Glendale	-	-	-	**-**
Greenwood Village	11,707	878	119	**12,704**
Littleton	23,062	2,496	434	**25,991**
Sheridan	1,335	35	-	**1,370**
Unincorporated	31,259	10,290	6,300	**47,850**
Total	**221,096**	**53,092**	**22,623**	**296,811**

Source: COWRAP, Arapahoe County GIS

Impact to Responders

Fire event-related duties may cause significant danger to response personnel including evacuation, suppression, law enforcement, and damage assessment. Local impacts to responders from wildfire events can include the following:

- Loss of life
- Injuries – burns, smoke inhalation, etc.

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- Expense of responding (equipment, personnel, supplies, etc.)

Impact to Continuity of Operations (including continued delivery of services)

Local impacts to Continuity of Operations from wildfire events include the following:

- Availability of resources over an extended response
- Power interruption is likely if not adequately equipped with backup generation.
- Loss or degradation of radio towers
- Loss of County or municipal facilities

Impact to Property, Facilities, and Infrastructure

Buildings, equipment, vehicles, and communications and utility infrastructure are exposed and lost to wildfires every year in Arapahoe County. Local impacts to property, facilities and infrastructure from wildfire events include the following:

- Damage to the highways and bridges.
- Visibility issues along highways due to wildfire smoke.
- Damage or destruction of transmission and distribution lines, substations, and other vulnerable facilities and infrastructure.
- Coal seam or other energy facility ignitions (solar; radio towers; pipelines; rail lines)
- Loss of businesses, crops, and livestock
- Interruption of utilities

Figure 4-43 and Figure 4-44 map the Wildland Urban Interface (WUI) Risk, to illustrate the potential impact of a wildfire on people and their homes. To calculate the WUI Risk, housing density data was combined with flame length data and response functions were defined to represent potential impacts. The response functions were defined by a team of experts led by Colorado State Forest Service mitigation planning staff. By combining flame length with the housing density data, it is possible to determine where the greatest potential impact to homes and people is likely to occur. Customized urban encroachment algorithms were used to ensure those fringe urban areas were included in the WUI Risk outputs. Encroachment distances into urban areas were based on the underlying fuel models and their fuel types and propensity for spotting and spreading.

Table 4-64 through Table 4-66 present the potential losses to improved structures and population within Arapahoe County for low risk (1 to 3 rating of least negative impact), medium risk (4 to 6 rating) and high risk (7 to 9 rating of most negative impact). The total value of properties located in WUI zones (including high, medium, and low risk) is more than $62 billion, which represents 51% of the total property values in the county. The high risk WUI zone alone includes over $42 billion worth of property and contents, which is 35% of the county's total.

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Figure 4-43 WUI Risk in Western Arapahoe County

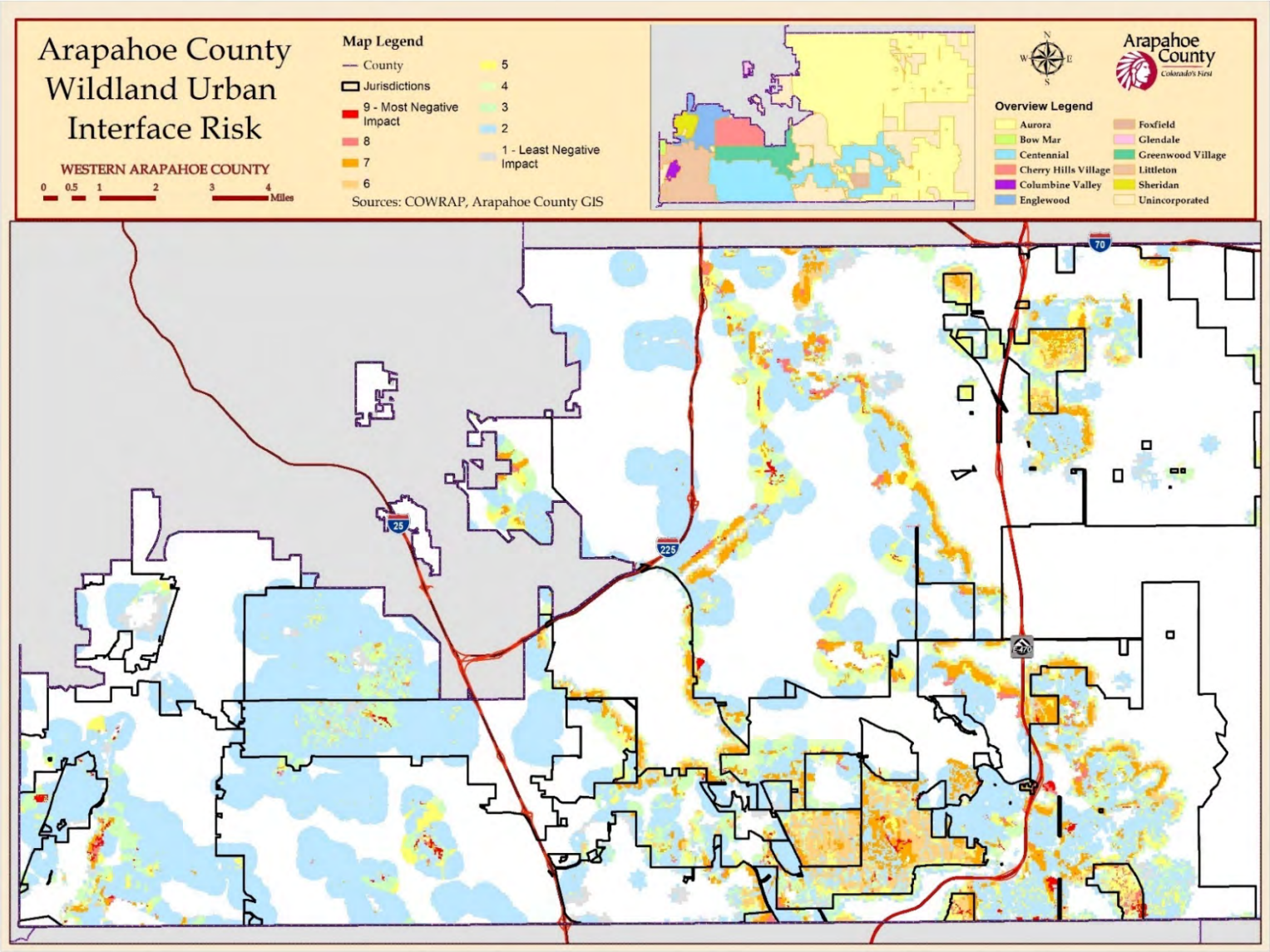

Figure 4-44 WUI Risk in Eastern Arapahoe County

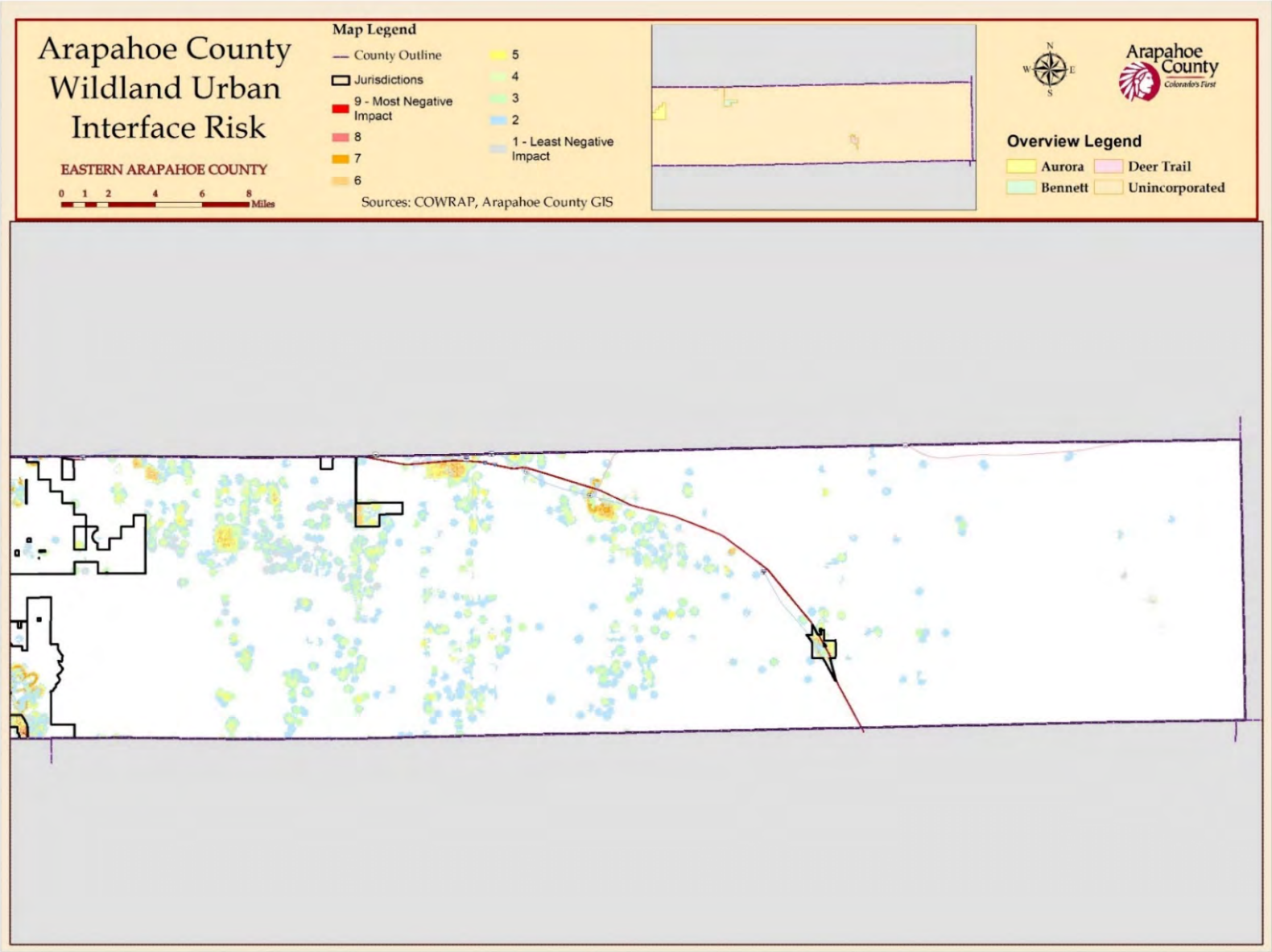

Table 4-64 Improved Properties in Low WUI Hazard Areas in Arapahoe County

Jurisdiction	Residential Parcels	Residential Improved Value	Residential Contents	Non-Residential Parcels	Non-Residential Improved Values	Non-Residential Contents	Total Parcels	Total Value
Aurora	30,567	$8,662,136,574	$4,331,068,287	3,058	$961,187,044	$961,187,044	33,625	**$14,915,578,949**
Bennett	-	-	-	9	-	-	9	**-**
Bow Mar	81	$52,102,940	$26,051,470	3	$40,437	$40,437	84	**$78,235,284**
Centennial	13,579	$4,561,237,389	$2,280,618,695	1,532	$888,502,615	$888,502,615	15,111	**$8,618,861,314**
Cherry Hills Village	1,830	$1,500,277,680	$750,138,840	171	$28,371,024	$28,371,024	2,001	**$2,307,158,568**
Columbine Valley	536	$344,686,573	$172,343,287	175	$7,674,507	$7,674,507	711	**$532,378,874**
Deer Trail	200	$25,123,299	$12,561,650	87	$9,714,814	$9,714,814	287	**$57,114,577**
Englewood	889	$603,328,532	$301,664,266	65	$57,298,107	$57,298,107	954	**$1,019,589,012**
Foxfield	-	-	-	15	$9,825,964	$9,825,964	15	**$19,651,928**
Glendale	-	-	-	-	-	-	-	**-**
Greenwood Village	3,252	$1,973,797,210	$986,898,605	478	$452,524,143	$452,524,143	3,730	**$3,865,744,101**
Littleton	6,589	$2,371,633,629	$1,185,816,815	884	$486,126,075	$486,126,075	7,473	**$4,529,702,594**
Sheridan	267	$96,836,845	$48,418,423	212	$158,959,652	$158,959,652	479	**$463,174,572**
Unincorporated	8,226	$3,300,833,448	$1,650,416,724	1,799	$593,870,489	$593,870,489	10,025	**$6,138,991,150**
Total	**18,334**	**$7,743,101,132**	**$3,871,550,566**	**3,373**	**$1,691,480,359**	**$1,691,480,359**	**74,504**	**$42,546,180,921**

Source: COWRAP, Arapahoe County GIS

Table 4-65 Improved Properties in Medium WUI Hazard Areas in Arapahoe County

Jurisdiction	Residential Parcels	Residential Improved Value	Residential Contents	Non-Residential Parcels	Non-Residential Improved Values	Non-Residential Contents	Total Parcels	Total Value
Aurora	9,485	$3,050,582,281	$1,525,291,141	1,590	$621,688,896	$621,688,896	11,075	**$5,819,251,214**
Bennett	138	$53,381,306	$26,690,653	43	$1,100,902	$1,100,902	181	**$82,273,763**
Bow Mar	-	-	-	-	-	-	-	**-**
Centennial	2,128	$979,124,993	$489,562,497	315	$456,626,236	$456,626,236	2,443	**$2,381,939,962**
Cherry Hills Village	102	$173,905,723	$86,952,862	28	$9,992,207	$9,992,207	130	**$280,842,999**
Columbine Valley	29	$26,074,426	$13,037,213	9	$155,310	$155,310	38	**$39,422,259**

Jurisdiction	Residential Parcels	Residential Improved Value	Residential Contents	Non-Residential Parcels	Non-Residential Improved Values	Non-Residential Contents	Total Parcels	Total Value
Deer Trail	118	$21,622,285	$10,811,143	69	$272,770	$272,770	187	**$32,978,968**
Englewood	-	-	-	3	-	-	3	**-**
Foxfield	187	$107,307,479	$53,653,740	10	-	-	197	**$160,961,219**
Glendale	-	-	-	-	-	-	-	**-**
Greenwood Village	244	$233,658,552	$116,829,276	59	$235,928	$235,928	303	**$350,959,684**
Littleton	713	$377,006,509	$188,503,255	98	$78,591,790	$78,591,790	811	**$722,693,344**
Sheridan	7	$68,537,400	$34,268,700	22	$3,383,442	$3,383,442	29	**$109,572,984**
Unincorporated	2,708	$1,367,243,537	$683,621,769	870	$110,978,639	$110,978,639	3,578	**$2,272,822,584**
Total	**15,859**	**$6,458,444,491**	**$3,229,222,246**	**3,116**	**$1,283,026,120**	**$1,283,026,120**	**18,975**	**$12,253,718,977**

Source: COWRAP, Arapahoe County GIS

Table 4-66 Improved Properties in High WUI Hazard Areas in Arapahoe County

Jurisdiction	Residential Parcels	Residential Improved Value	Residential Contents	Non-Residential Parcels	Non-Residential Improved Values	Non-Residential Contents	Total Parcels	Total Value
Aurora	3,700	$2,289,249,878	$1,144,624,939	1,154	$590,202,588	$590,202,588	4,854	**$4,614,279,993**
Bennett	9	$3,621,700	$1,810,850	4	-	-	13	**$5,432,550**
Bow Mar	-	-	-	-	-	-	-	**-**
Centennial	1,000	$580,757,522	$290,378,761	254	$183,913,880	$183,913,880	1,254	**$1,238,964,043**
Cherry Hills Village	37	$36,110,089	$18,055,045	10	$20,125,758	$20,125,758	47	**$94,416,650**
Columbine Valley	20	$21,636,850	$10,818,425	13	$1,075	$1,075	33	**$32,457,425**
Deer Trail	13	$1,302,450	$651,225	7	$15,354	$15,354	20	**$1,984,383**
Englewood	-	-	-	-	-	-	-	**-**
Foxfield	88	$53,196,370	$26,598,185	22	$6,581,040	$6,581,040	110	**$92,956,635**
Glendale	-	-	-	-	-	-	-	**-**
Greenwood Village	33	$23,433,406	$11,716,703	18	-	-	51	**$35,150,109**

Jurisdiction	Residential Parcels	Residential Improved Value	Residential Contents	Non-Residential Parcels	Non-Residential Improved Values	Non-Residential Contents	Total Parcels	Total Value
Littleton	124	$96,839,984	$48,419,992	70	$58,309,536	$58,309,536	194	**$261,879,048**
Sheridan	-	-	-	-	-	-	-	**-**
Unincorporated	1,658	$875,529,025	$437,764,513	601	$105,949,792	$105,949,792	2,259	**$1,525,193,122**
Total	**6,682**	**$3,981,677,274**	**$1,990,838,637**	**2,153**	**$965,099,023**	**$965,099,023**	**8,835**	**$7,902,713,957**

Source: COWRAP, Arapahoe County GIS

Table 4-67 lists critical facilities located in High Risk WUI areas of the county; 67 facilities representing 4% of the county's total critical facilities, are at high risk of WUI fires.

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Table 4-67 Critical Facilities in High WUI Hazard Areas in Arapahoe County

Jurisdictions	Communications	Energy	Food, Water, Shelter	Hazardous Material	Health and Medical	Safety and Security	Transportation	Total	%
Aurora	42	4	5	2		73	1	**127**	**13%**
Bennett								**0**	**0%**
Bow Mar								**0**	**-**
Centennial	4	2	3	5			1	**15**	**2%**
Cherry Hills Village						1		**1**	**2%**
Columbine Valley								**0**	**0%**
Deer Trail							1	**1**	**9%**
Englewood								**0**	**0%**
Foxfield	1	1	1			1		**4**	**40%**
Glendale								**0**	**0%**
Greenwood Village								**0**	**0%**
Littleton				1			1	**2**	**0%**
Sheridan								**0**	**0%**
Unincorporated	4	5	2	3		1	2	**17**	**2%**
Total	**51**	**12**	**11**	**11**	**0**	**76**	**6**	**167**	**4%**

Impact to the Environment

Local impacts to the environment from wildfire events include the following:

- Damage to municipal watersheds
- Reductions in air quality
- Loss of vegetation (erosion, loss of forage and habitat for livestock and wildlife)
- Loss of revenue from destroyed recreation and tourism areas

Impact to the Economic Condition of the County and Jurisdictions

Local impacts to the economic condition of the county and jurisdictions from wildfire events include the following:

- Expense of responding (equipment, personnel, supplies, etc.)
- Loss of revenue from destroyed businesses, recreation, and tourism areas

Impact to Public Confidence in Government

Public holds high expectations of government capabilities for warning, public information, and response and recovery activities related to wildfires. Local impacts to public confidence in government from wildfire events include the following:

- Expense of responding (equipment, personnel, supplies, etc.)
- Communication of real-time property-level damage assessments

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Changes in Development

Future development in the wildland-urban interface/intermix areas would increase vulnerability to this hazard.

Jurisdictional Differences

Wildfires can occur throughout Arapahoe County; however, the threat is not evenly distributed. Wildfire risk and burn probability are highest in the central portion of the county, as shown in Figure 4-39 through Figure 4-42. The risk of brushfires remains significant throughout the eastern half of the county, although the sparse development reduces its vulnerability. 46% of the county's population overall lives in WUI areas exposed to wildfire risk, but that percentage varies greatly as shown in Table 4-64 through Table 4-66; over 90% of the population of Cherry Hills Village, Columbine Valley, Deer Trail, and Foxfield are estimated to live in WUI areas.

Looking at property values expose to wildfire risk, the greatest dollar value at risk is in Aurora ($25 billion), Centennial ($12 billion), and the unincorporated County ($10 billion). The greatest percentage of property values at risk are in Columbine Valley (100%), Foxfield (97%), Cherry Hills Village (92%), Deer Trail (92%), Bennett (91%). Foxfield also has a high portion of its critical facilities located in High Risk WUI zones.

Table 4-68 Wildfire Hazard Rankings by Jurisdiction

Wildfire	Frequency	Spatial Extent	Severity	Overall Significance
Arapahoe County	Highly Likely	Extensive	Limited	Medium
Bennett	Highly Likely	Extensive	Limited	Medium
Bow Mar	Highly Likely	Significant	Limited	Medium
Centennial	Highly Likely	Significant	Limited	Medium
Cherry Hills Village	Likely	Extensive	Critical	Medium
Columbine Valley	Highly Likely	Extensive	Critical	Medium
Deer Trail	Likely	Extensive	Critical	Medium
Englewood	Occasional	Limited	Limited	Low
Foxfield	Likely	Extensive	Critical	Medium
Glendale	Highly Likely	Limited	Limited	Medium
Greenwood Village	Likely	Extensive	Limited	Medium
Littleton	Likely	Significant	Limited	Medium
Sheridan	Likely	Significant	Limited	Low
Denver Water	Highly Likely	Extensive	Limited	Medium

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5. Hazard Mitigation Goals, Objectives, and Actions

DMA Requirement §201.6(c)(3):
[The plan shall include] a mitigation strategy that provides the jurisdiction's blueprint for reducing the potential losses identified in the risk assessment, based on existing authorities, policies, programs and resources, and its ability to expand on and improve these existing tools. This section shall include: *(i) A description of mitigation goals to reduce or avoid long-term vulnerabilities to the identified hazards.* *(ii) A section that identifies and analyzes a comprehensive range of specific mitigation actions and projects being considered to reduce the effects of each hazard, with particular emphasis on new and existing buildings and infrastructure.* *(iii) An action plan describing how the actions identified in section (c)(3)(ii) will be prioritized, implemented, and administered by the local jurisdiction. Prioritization shall include a special emphasis on the extent to which benefits are maximized according to a cost benefit review of the proposed projects and their associated costs.*

This section of the Plan provides the blueprint for Arapahoe County and participating municipalities to become less vulnerable to natural hazards. It is based on the consensus of the Arapahoe 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:

- Goals and Objectives
- Community Values, Historic and Special Considerations
- Progress on Previous Mitigation Plan Actions
- Identification and Prioritization of Mitigation Actions
- 2020 Arapahoe County Hazard Mitigation Action Plan

The intent of the Mitigation Strategy is to provide Arapahoe County and participating municipalities with the goals that will serve as the guiding principles for future mitigation policy and project administration, along with a list of proposed actions deemed necessary to meet those goals and reduce the impact of natural hazards. It is designed to be comprehensive and strategic in nature. 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 Arapahoe County and participating municipalities achieve compatible economic, environmental, and social goals. The development of this section is also intended to be strategic, in that all policies and projects are linked to establish priorities assigned to specific departments or individuals responsible for their implementation. Potential funding sources are identified when possible and identified projects were assumed to be realistically achievable over the coming five years.

- **Mitigation 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.
- **Mitigation 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. The inclusion of mitigation objectives is optional.
- **Mitigation 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 Arapahoe County Planning Team, the mitigation strategy from the 2015 Arapahoe County Hazard Mitigation Plan was modified and updated. Completed

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actions were noted and deleted. New actions have been added to address particular hazards facing Arapahoe County and the consensus achieved in how to address those actions.

5.1 Mitigation Goals

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 2020 Planning Team approved the following updated mitigation goals for Arapahoe County and the participating jurisdictions to provide direction for reducing future hazard-related losses across Arapahoe County.

2020 Arapahoe County Hazard Mitigation Goals:

1. Prevent the loss of lives and injuries from hazards.
2. Prevent and/or reduce damages to public and private property from hazards.
3. Reduce the adverse economic and natural resource impacts of hazards.
4. Reduce the vulnerability of critical infrastructure and key facilities to the impacts of hazards.

After discussion, the Planning Team decided not to include mitigation objectives in the 2020 Plan. The prioritization criteria listed in Section 5.3 below can be regarded as objectives for implementing the mitigation goals.

Arapahoe County's mitigation goals originated with the goals identified in the 2010 Denver Regional Hazard Mitigation Plan, which subsequently evolved into the goals and objectives in the 2015 Arapahoe 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 has changed over time.

2010 Denver Regional Hazard Mitigation Plan Goals:

1. Protect people, property, and natural resources.
2. To increase public awareness of natural hazards and their mitigation.
3. Strengthen communication and coordination among public agencies, non-governmental organizations (NGOs), businesses, and private citizens.
4. Coordinate and integrate natural hazard mitigation activities with local land development planning activities and emergency operations planning.

2015 Arapahoe County Hazard Mitigation Goals:

1. To prevent the loss of lives and injuries from hazards
2. To prevent or reduce damages to public and private property from hazards

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3. To strengthen communication and coordination among public agencies, non-governmental organizations (NGOs), businesses, and private citizens

4. To reduce the adverse economic and natural resource impacts of hazards

5. To improve local resiliency to hazard events

2015 Arapahoe County Hazard Mitigation Objectives:

1. Reduce public exposure to hazards

2. Increase knowledge of hazard mitigation options

3. Increase awareness of hazards and their impacts

4. Adopt a coordinated alert system for jurisdictions within the county

5. Build redundancy into communication systems

During the 2020 Planning process, the Planning Team decided to eliminate Goals 4 and 5 from the 2015 Plan and replace them with a single goal focused on critical infrastructure and facilities. The Planning Team reviewed the objectives from the 2015 Plan, but felt they merely restated the goals and did not add anything to the mitigation strategy. The Planning Team discussed the possibility of having participating jurisdictions adopt their own objectives within the countywide goals, but the group felt their mitigation strategies were similar enough to not make developing separate objectives a useful exercise. Therefore objectives were not included in the 2020 Plan update.

5.2 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, Arapahoe County has 24 properties listed on the National Register of Historic Places and four Historic Districts, as listed in Section 4.2.

Depending on the number of historic resources within a community, it can be unrealistic to assume that all 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. Arapahoe County realizes that the preservation and maintenance of historic sites and structures contributes to the cultural heritage of Colorado's first county and is in the long-term best interest of the community.

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5.3 Progress on Previous Mitigation Plan Actions

The 2015 Plan identified several mitigation actions, which the county and jurisdictions have been successful in implementing to work steadily towards meeting their mitigation goals and objectives. During the 2020 plan update process, the Planning Team reviewed the mitigation actions in the 2015 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 2015 Plan contained a total of 95 mitigation actions. Of those, 21 actions were reported as having been completed. These actions are listed in Table 5-1 below. Overall, the high number of actions that have been completed is a sign of the effectiveness of Arapahoe County's hazard mitigation program and that the county and its jurisdictions are steadily working towards the goals of this plan.

Table 5-1 Completed Mitigation Actions from the 2015 HMP

2015 ID	Jurisdiction	Mitigation Action	Comments
2010-03	Arapahoe County	Update EOC Backup Power Systems	New EOC added to generator.
2010-08	Arapahoe County	Provide the DRCOG HMP to other departments for possible integration into various planning efforts	N/A
2015-01	Arapahoe County	Improvements and updates to the county emergency notification system	The Denver Regional Emergency Managers Weather Information Network (EMWIN-DR) operates in cooperation with the National Weather Service and emergency managers from 22 Colorado counties served by the NWS Forecast Office in Boulder. The MHFD provided list server and technical support for EMWIN-DR. Arapahoe County is part of this networks. One feature is the ability to issue Civil Emergency Messages through an EAS (Emergency Alert System) web interface. The request from local governments is vetted by NWSBOU before they issue the broadcast. There is no direct cost to Arapahoe County for this service. The downside is that WEA (Wireless Emergency Alert) notifications are not activated automatically. IPAWS does activate WEA. OEM alerts in IPAWS via Code Red
2015-02	Arapahoe County	Improvements to Computer Aided Dispatch systems to ensure interoperability	Shared CAD for Arapahoe is complete using Tritech.
2015-07	Arapahoe County	Continue coordination efforts pertaining to the upcoming Integrated Emergency Management Conference	N/A
2015-08	Town of Bennett	Town of Bennett to join the NFIP	Completed in September 2014.
2015-23	Town of Bow Mar	Participation and adoption of the MHFD Flood Hazard Area Delineation (FHAD) Studies affecting the county	Bow Mar does not have anything in this area.
2015-30	Town of Bow Mar	Develop Engineering guidelines for drainage from new development	
2015-17	City of Centennial	Implement continuity of data system for emergency management-related GIS databases and software	

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2015 ID	Jurisdiction	Mitigation Action	Comments
2015-20	City of Centennial	Updating data sets relating to hazardous material locations, various community assets, and hydrology	
2010-05	Cherry Hills Village	Continued National Flood Insurance Program (NFIP) Participation	City Council approved Ordinance No. 5 - Series 2020 on August 4, 2020, to adopt the Federal Emergency Management Agency's revised Flood Insurance Study and Flood Insurance Rate Map for Arapahoe County and its incorporated areas.
2015-24	Cherry Hills Village	Continue participation in the NFIP Community Rating System (CRS) Program	The City renewed their CRS in April of 2020.
2015-33	Cherry Hills Village	Adopt and Enforce 2012 International Building Codes	2018 Building Code adopted on February 18, 2020.
2015-41	Town of Foxfield	Publicize sheriff's department Twitter account. Monitor snow removal practices and procedures to ensure adequacy. Serve as a clearinghouse for emergency announcements; making sure these are communicated to residents.	Do not plan to have Facebook or Twitter for Town communication. Too much upkeep with limited staff and time. Continue to use Nextdoor and newsletters for communication to residents.
2015-11	City of Greenwood Village	Participation and adoption of the MHFD master plans affecting the county	
2015-23	City of Greenwood Village	Participation and adoption of the MHFD Flood Hazard Area Delineation (FHAD) Studies affecting the county	
2015-45	City of Greenwood Village	Increase Severe Weather Risk Awareness - A multi- pronged approach to increase citizen awareness through a combination of the city newsletter, web site, social media, and community/ HOA/School presentations.	
2015-46	City of Greenwood Village	Improve Citizen Knowledge and Understanding of Severe Weather Warning Systems in Place - Utilizing the city newsletter, web site, social media, community/HOA/school presentations, and park signs, educate public on severe weather warning systems in place at city parks.	
2015-50	City of Sheridan	River Run Park/ Rehab riverbanks and chutes	Completed in 2019.
2015-51	City of Sheridan	Storm Water Evaluation/ Proposed new storm sewers and drainage in nine key areas	Completed during Driving Change Bond Program.
2015-52	City of Sheridan	Tri County Health Department Health Impact Assessment	Completed in 2017.

The Planning Team also determined that some of the 2015 actions should not be included in the 2020 mitigation action plan. A total of 14 actions were deleted. Eleven of which were due to changes in priorities or lack of resources. Three actions from the Town of Columbine Valley were deleted due to the Town not participating in the 2020 planning process. These actions are shown in Table 5-2 below.

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Table 5-2 Deleted Mitigation Actions from 2015 HMP

2015 ID	Jurisdiction	Mitigation Action	Comments
2015-26	Arapahoe County	Participate in the UDFCD Program for Public Information (PPI) Committee	MHFD is longer proposing PPI
2015-04	Arapahoe County	Increase awareness and use of First Watch within Arapahoe County and support implementation in neighboring counties.	Not in use. SMFR is using a different program now
2015-18	City of Centennial	Enhancements to citywide addressing based on the City's two fire department dispatches.	No longer applicable
2015-19	City of Centennial	Update contacts for Special Districts	No longer applicable
2015-40	Town of Foxfield	Provide information to residents, perhaps by using Facebook and Twitter	Do not plan to have Facebook or Twitter for Town communication. Too much to keep up, with limited staff and time.
2015-16	City of Englewood	Conduct a risk assessment focused on the distribution of county resources	Changes to Departments since plan was written. Englewood Fire is now Denver Fire, servicing City of Englewood
2015-37	City of Englewood	Public Information/awareness programs	Combined with action #2015-37 (now H-3)
2015-44	City of Glendale	Increase participation in "Ready Colorado"	No longer applicable
2015-21	City of Littleton	Monitor Hazardous Materials commodity flow by rail through the BNSF and UP rail lines	Littleton no longer has a fire department, and it was fire department that coordinated this.
2015-47	City of Littleton	Locate and identify tornado shelter areas in City of Littleton public buildings	Littleton has decided to not pursue this.
2015-48	City of Littleton	Work with railroads (BNSF and UP) to identify and then monitor hazardous commodity flows and hazards.	Littleton no longer has a fire department, and it was fire department that coordinated this.

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 Arapahoe County and all participating communities have been mapped for flood hazards: Arapahoe County, Aurora, Bennett, Centennial, Cherry Hills Village, Columbine Valley, Deer Trail, Englewood, Glendale, Greenwood Village, Littleton, and Sheridan. 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. See Table 5-4 mitigation actions A-1, B-3, D-1, E-5, G-1, H-1, K-1, L-1, M-1, and N-1. Arapahoe County, Aurora, Centennial, Cherry Hills Village, Englewood, and Littleton will also continue to participate in the Community Rating System (CRS) to go above and beyond the requirements of the NFIP. Other details related to NFIP participation are discussed in Section 2.7 and in the flood vulnerability discussion in Section 4.7.

5.4 Identification and Prioritization of Mitigation Actions

The natural and human-caused hazards identified in Chapter 4 Risk Assessment were evaluated to identify and prioritize mitigation actions to support the mitigation goals and objectives described above.

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 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.

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- **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 shared with the Planning Team. Attendees were then asked to submit mitigation action ideas via an online survey. 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.

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 29 new actions were submitted. These new actions, along with the continuing actions carried over from the 2015 Plan, form the 2020 mitigation action plan as summarized in Table 5-3 and detailed in Table 5-4.

Table 5-3 Mitigation Actions Summary by Jurisdiction

Jurisdiction	# of Actions in 2015 HMP	# of Actions Completed	# of Actions Deleted	# of Actions Continued	# of New Actions	Total 2020 Actions
Arapahoe County	21	5	2	14	5	**19**
Town of Bennett	6	1	0	5	4	**9**
Town of Bow Mar	4	2	0	2	1	**3**
City of Centennial	8	2	2	4	5	**9**
City of Cherry Hills Village	6	3	0	3	4	**7**
Town of Deer Trail	3	0	0	3	3	**6**
City of Englewood	10	0	2	8	5	**13**
Town of Foxfield	5	1	1	3	1	**4**
City of Glendale	6	0	1	5	4	**9**
City of Greenwood Village	5	4	0	1	5	**6**
City of Littleton	9	0	3	6	4	**10**
City of Sheridan	6	3	0	3	4	**7**
Denver Water	0	0	0	0	3	**3**

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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 2015 Plan were also included in the list so they could be re-prioritized relative to the new actions.

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 populations?
- **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 goals
- 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 status and priority of their continuing actions from the 2015 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 action plan, jurisdictions were asked to verify or update the priorities of each action compared to their other actions based on the above criteria.

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5.5 2020 Arapahoe County Hazard Mitigation Action Plan

The 2020 Arapahoe County mitigation action plan lists the actions developed and prioritized as described above, to include continuing actions from the 2015 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 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.

Arapahoe County's mitigation actions are listed in Table 5-4 below. Actions carried over from the 2010 and 2015 plans have been given new item numbers for simplicity, but their previous item numbers are also included for reference. As discussed in Section 5.4, the priorities of each action were reviewed to updated to reflect changes since 2015.

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Table 5-4 2020 Hazard Mitigation Actions

ID	Jurisdiction	Description/Background/ Benefits	Hazards Mitigated	Goals	Lead Agency & Partners	Cost Estimate	Potential Funding	Priority	Timeline	Status and Implementation Notes
Arapahoe County Mitigation Actions										
A-1 *2010 -05*	Arapahoe County	Continued National Flood Insurance Program (NFIP) Participation. This includes continuing to comply with the NFIP's standards for updating and adopting floodplain maps and maintaining and updating the floodplain zoning ordinance.	Flooding	1,2,3, 4	**County Public Works: Engineering Services Division** OEM	Staff Time	Dept. Budget	High	ongoing	Annual Implementation. Majority of jurisdictions continue to participate in the NFIP, additional jurisdictional participation added as new Plan Action in 2015. Floodplain Management and Flood Damage Prevention Regulations in Section 12-1900 of the Land Development Code have been updated to remain current with State and federal requirements: 2007, 2010, 2013, 2017, 2018. County Storm Ready recert completed in July 2020.
A-2 *2010 -07*	Arapahoe County	Monitor proceedings of the Colorado Water Availability Task Force. This will help maintain awareness of conditions that affect Colorado's water supply, including snowpack, precipitation, reservoir storage, streamflow and weather forecasts. The task forces also provide a forum for interpreting potential flood hazard and water availability information. Meetings of the two task forces are held regularly and occasionally are held together.	Drought	2,3,4	**OEM** MHFD	Staff Time	Dept. Budget	Medium	ongoing	Annual Implementation. The MHFD monitors. The State's Flood Task Force dovetails nicely with this group. When necessary, support water providers in the implementation of conservation measures.
A-3	Arapahoe County	Continue public education about wildfire mitigation	Wildfire	1,2,3, 4	**OEM**, Fire Departments	$0 - $10,000	EMPG	High	ongoing	Annual Implementation. Education about fire ban on

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ID	Jurisdiction	Description/Background/ Benefits	Hazards Mitigated	Goals	Lead Agency & Partners	Cost Estimate	Potential Funding	Priority	Timeline	Status and Implementation Notes
2015 -03		using the Ready, Set, Go Program								the website. CWPP reviewed and current Plan is still current. Outreach events limited due to COVID. No updates required.
A-4 *2015 -05*	Arapahoe County	Centralize the storage and dissemination of FOUO GIS data sets to help ensure the availability and improve the accuracy of data used across the County for numerous efforts. This will include better identification of critical facilities located in areas at increased risk of hazards.	Active Threat, Cyber Threat, Dam Failure, Drought, Flooding, Hazmat Release, Pandemic, Severe Summer Weather, Severe Wind/ Tornado, Severe Winter Weather, Wildfire	1,2,3, 4	**Arapahoe County GIS** OEM	$0 - $10,000	Dept budget	Low	2023	In Progress. Ongoing project with regional situational awareness viewer. Arapahoe GIS workgroup started meeting to get various GIS administrators to talk about sharing data and collaborating on layers. Plans to expand group beyond current members to increase information sharing. Received GIS data from Denver Water through signing an NDA. Portal project for NCR.
A-5 *2015 -06*	Arapahoe County	Develop, maintain, centralize, and store CIKR GIS data sets. Help ensure the availability and improve the accuracy of data used across the County for numerous efforts. This will include better identification of critical facilities located in areas at increased risk of hazards.	Active Threat, Cyber Threat, Dam Failure, Drought, Flooding, Hazmat Release, Pandemic, Severe Summer Weather, Severe Wind/ Tornado, Severe Winter Weather, Wildfire	1,2,3, 4	**Arapahoe County GIS** OEM	$0 - $10,000	Dept Budget	Low	2025	In Progress. Arapahoe GIS workgroup meetings with special districts. Coordination with GIS administrators to get information from various special districts - SEMSWA, MHFD, National Guard to get various data sets. Data gathering delayed by COVID.
A-6	Arapahoe County	Continued utilization of the MHFD alert system. Real-	Flooding, Dam Failure	1,2,3, 4	**OEM** MHFD	Staff Time	Dept Budget	Medium	ongoing	Annual Implementation.

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ID	Jurisdiction	Description/Background/ Benefits	Hazards Mitigated	Goals	Lead Agency & Partners	Cost Estimate	Potential Funding	Priority	Timeline	Status and Implementation Notes
2015 -09		time alert system provides precipitation and flooding related notifications.								
A-7 *2015 -10*	Arapahoe County	Involvement in the MHFD Emergency Action Plans for the Holly & Englewood Dams. Participate in the roll-out of these newly produced EAPs, and integrate into County EOP.	Dam Failure	1,2,3, 4	**OEM** MHFD	Staff Time	Dept Budget	Medium	ongoing	Annual Implementation. Participation by Arapahoe OEM, but info sent to partner agencies as well. OEM personnel in attendance and participated in training.
A-8 *2015 -11*	Arapahoe County	Participation and adoption of the MHFD master plans affecting the County. Part of the master planning efforts involves identification of capital improvement projects and are based on future conditions hydrology (watershed level).	Flooding, Dam Failure	2,3,4	**Arapahoe County,** Bennett, Bow Mar, Centennial, Cherry Hills Village, Columbine Valley, Foxfield, Sheridan, Glendale, Greenwood Village, Littleton, Englewood, MHFD, SEMSWA	Staff Time	MHFD, SEMSWA	Medium	2020-2025	Annual Implementation. CHV continues to work with MHFD identifying capital projects and participating in studies. County PWD continue to participate in MHFD Master Planning. Other jurisdictions to verify with Planning Departments. County Public Works and Development along with SEMSWA continue to participate in MHFD Master Planning studies
A-9 *2015 -12*	Arapahoe County	Continued development of the Cherry Creek School District's collaboration meetings with first responders. Meetings are quarterly and currently involve nine agencies across the District.	Active Threat, Severe Summer Storm, Severe Wind/ Tornado, Severe Winter Weather	1,2,3, 4	**Cherry Creek School District** OEM	Staff Time	Dept Budget	Medium	ongoing	Annual Implementation. OEM coordinated with SROs to train in GIS and response events. Working with Cherry Creek to attend tabletop exercises and participate in school emergency trainings. Discussion with security staff to obtain camera access that would benefit first responders. Received new copy of Readiness and

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ID	Jurisdiction	Description/Background/ Benefits	Hazards Mitigated	Goals	Lead Agency & Partners	Cost Estimate	Potential Funding	Priority	Timeline	Status and Implementation Notes
										Emergency Management for Schools. Completed training.
A-10 *2015 -21*	Arapahoe County	Monitor Hazardous Materials commodity flow by rail through the BNSF and UP rail lines. Obtain and monitor commodity flow from the Burlington Northern Santa Fe and Union Pacific Railroads. Share that information with the Arapahoe County LEPC as appropriate	Hazmat	1,2,3, 4	**County LEPC** Littleton	Staff Time	Dept Budget	Medium	ongoing	Annual Implementation. Have received commodity flows from BNSF and UP. Need to obtain 2020 flows, delayed by COVID.
A-11 *2015 -22*	Arapahoe County	Involvement in the Denver Water Emergency Action Plans for the Marston & Harriman Dams. Participate in the update and orientation of the Dam EAPs, and integrate into County EOP.	Dam Failure	1,2,3, 4	**Littleton,** OEM	Staff Time	Dept Budget	Medium	ongoing	Annual Implementation. OEM personnel in attendance. Both Arapahoe and Littleton attend EAP meetings and update plans as applicable.
A-12 *2015 -23*	Arapahoe County	Participation and adoption of the MHFD Flood Hazard Area Delineation (FHAD) Studies affecting the County. New or updated flood risk areas are identified, providing communities with best available flood risk data for permitting and land development decisions.	Flooding	1,2,3, 4	**Arapahoe County Public Works**, MHFD	Staff Time	MHFD	Medium	2025	In Progress. County Public Works and Development along with SEMSWA continue to participate in MHFD FHAD studies
A-13 *2015 -24*	Arapahoe County	Continue participation in the NFIP Community Rating System (CRS) Program. Flood Insurance premiums are reduced to reflect the reduced flood risk based on the community's floodplain management programs and activities	Flooding	1,2,3, 4	**Arapahoe County Public Works**, SEMSWA	Staff Time	Dept Budget	High	ongoing	Annual Implementation. County Public Works and Development has been re-certified as an CRS 7 community effective 2019
A-14	Arapahoe County	Improve County's Community Rating System	Flooding	1,2,4	**Arapahoe County Public**	$0 - $10,000	Dept Budget	High	2021-2023	In Progress.

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ID	Jurisdiction	Description/Background/ Benefits	Hazards Mitigated	Goals	Lead Agency & Partners	Cost Estimate	Potential Funding	Priority	Timeline	Status and Implementation Notes
2015 -27		(CRS) rating from 7 to 5 or 6. Each step increase would save NFIP policy holders $1000-$145000 each year. This could also potentially result in improvements to the CRS ratings of participating jurisdictions. May require involvement of BOCC			**Works** SEMSWA, MHFD					Will explore improving rating in 2023.
A-15	Arapahoe County	Subdivision Design/Setback requirements in Wildland Urban Interface. Require larger setbacks or non-flammable walls or stone setbacks around new subdivisions that are developed in the high-risk Wildland Urban Interface. Avoid property damage	Wildfire	1,2,3	**Arapahoe County Planning Department**	TBD	TBD	Medium	TBD	New for 2020
A-16	Arapahoe County	Alternate EOC. Relocate and implement a warm alternate EOC. Perform studies of County infrastructure to determine best location - generator use, IT infrastructure, access, multi-use space. Provides additional critical infrastructure in a space geographically separated from the primary, outfitted with the required technology to perform mission critical support functions.	Active Threat, Cyber Threat, Dam Failure, Drought, Flooding, Hazmat Release, Pandemic, Severe Summer Weather, Severe Wind/ Tornado, Severe Winter Weather, Wildfire	4	**Arapahoe County Sheriff/OEM**	TBD	EMPG	Medium	1-2 years	New for 2020
A-17	Arapahoe County	Complete a Master Drainage Plan for the Kiowa Creek watershed, to be implemented as	Dam Failure, Flooding, Severe Summer	2,3	**Arapahoe County Public Works**	$100,000	CIP	High	2023-2025	New for 2020

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ID	Jurisdiction	Description/Background/ Benefits	Hazards Mitigated	Goals	Lead Agency & Partners	Cost Estimate	Potential Funding	Priority	Timeline	Status and Implementation Notes
		development occurs in the area. The watershed is primarily undeveloped and the MDP will be used to provide guidance for future construction as development occurs. The project team will delineate the 100-year floodplain and investigate flood-prone areas, drainage problems, stream stabilization and roadway crossing structure adequacy. The team will assess degradation along the Creek and look for areas that may require bank stabilization. The team will also perform an environmental assessment to locate wetlands, riparian areas, and nesting sites.	Weather, Severe Winter Weather, Wildfire								
A-18	Arapahoe County	Wolf Creek Master Drainage Plan. The plan will consider existing and proposed land use, existing and proposed roadways, existing and proposed drainage systems, known drainage or flooding problems, known or anticipated erosion problems, stormwater quality enhancement, right-of-way needs, existing wetlands and riparian zones, open space and wildlife habitat benefits, legal requirements, and cost and benefits. This process will include but is not limited to a detailed field review of roadway crossings along Wolf Creek and its	Flooding	1,2,3	**Arapahoe County Public Works**	$242,000	CIP	High	2020	New for 2020. Project nearing completion

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ID	Jurisdiction	Description/Background/ Benefits	Hazards Mitigated	Goals	Lead Agency & Partners	Cost Estimate	Potential Funding	Priority	Timeline	Status and Implementation Notes
		tributaries, existing structures in the floodplain, and their conditions pertinent to the master planning process. The master planning process will also include preparing a base map of existing conditions to illustrate recommendations for existing roadway crossings. In addition, the selected consultant shall develop an implementation plan and cost projections that reflect the County's existing and anticipated capital improvement programs.								
A-19	Arapahoe County	Comanche Creek Master Drainage Plan. The plan will consider existing and proposed land use, existing and proposed roadways, existing and proposed drainage systems, known drainage or flooding problems, known or anticipated erosion problems, stormwater quality enhancement, right-of-way needs, existing wetlands and riparian zones, open space and wildlife habitat benefits, legal requirements, and cost and benefits. This process will include but is not limited to a detailed field review of roadway crossings along Comanche Creek and its tributaries, existing structures in the floodplain, and their conditions	Flooding	1,2,3	**Arapahoe County Public Works**	$193,000	CIP	High	Fall 2021	New for 2020. Contracting in process

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ID	Jurisdiction	Description/Background/ Benefits	Hazards Mitigated	Goals	Lead Agency & Partners	Cost Estimate	Potential Funding	Priority	Timeline	Status and Implementation Notes
		pertinent to the master planning process. The master planning process will also include preparing a base map of existing conditions to illustrate recommendations for existing roadway crossings. In addition, the selected consultant shall develop an implementation plan and cost projections that reflect the County's existing and anticipated capital improvement programs.								
Town of Bennett Mitigation Actions										
B-1 *2015 -11*	Town of Bennett	Participation and adoption of the MHFD master plans affecting the County. Part of the master planning efforts involves identification of capital improvement projects and are based on future conditions hydrology (watershed level).	Flooding	1,2,3, 4	**Town of Bennett Safety Officer,** Community Development	$10,000	Dept. Budget	High	2022	In Progress. Town uses District's criteria and have adopted the standards. Master plan is not adoption ready.
B-2 *2015 -23*	Town of Bennett	Participation and adoption of the MHFD Flood Hazard Area Delineation (FHAD) Studies affecting the County. New or updated flood risk areas are identified, providing communities with best available flood risk data for permitting and land development decisions.	Flooding	1,2,3, 4	**Town of Bennett Safety Officer,** Community Development	$10,000	Dept. Budget	Medium	2022	In Progress. Town uses District's criteria and have adopted the standards. FHAD is not adoption ready.
B-3 *2015 -24*	Town of Bennett	Continue participation in the NFIP and the Community Rating System (CRS) Program. This includes continuing to comply with the NFIP's standards for	Flooding	1,2,3, 4	**Town of Bennett Safety Officer,** Community Development	$10,000	Dept. Budget	Medium	2021	In Progress.

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ID	Jurisdiction	Description/Background/ Benefits	Hazards Mitigated	Goals	Lead Agency & Partners	Cost Estimate	Potential Funding	Priority	Timeline	Status and Implementation Notes
		updating and adopting floodplain maps and maintaining and updating the floodplain zoning ordinance. Flood Insurance premiums are reduced to reflect the reduced flood risk based on the community's floodplain management programs and CRS activities								
B-4 *2015 -28*	Town of Bennett	Wildfire Mitigation Planning. Mitigation Plans will be incorporated into Code by adoption of specific ordinance by the Town of Bennett.	Wildfire	1,2,3, 4	**Town of Bennett Safety Officer,** Fire District	$10,000	Dept. Budget	High	2021	In Progress. Working with Bennett Fire District.
B-5 *2015 -29*	Town of Bennett	Stormwater Drainage Master Plan.	Flooding	1,2,3, 4	**Town of Bennett Safety Officer,** Community Development	$150,000	Town match from CIP. Budget	High	2021	In Progress. Submitted grant application but were not awarded. Will reapply in the future
B-6	Town of Bennett	Develop hazard mitigation brochure to be made available to the public in hard copy and placed on the Town's website that will provide public information on how to prepare for hazard events as well as mitigate vulnerabilities on their property.	Active Threat, Cyber Threat, Dam Failure, Drought, Flooding, Hazmat Release, Pandemic, Severe Summer Weather, Severe Wind/ Tornado, Severe Winter Weather, Wildfire	1,2,3	**Town of Bennett Safety Officer and Community Development**	Little to no cost	Staff Time/ Dept. Budget	Medium	2021	New in 2020.
B-7	Town of Bennett	Stoplight and intersection infrastructure at Marketplace Drive and Hwy 79. This is a	Hazmat	1,2,3, 4	**Town of Bennett Public Works**	$1.2M	CIP Budget	Medium	2021	New in 2020.

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ID	Jurisdiction	Description/Background/ Benefits	Hazards Mitigated	Goals	Lead Agency & Partners	Cost Estimate	Potential Funding	Priority	Timeline	Status and Implementation Notes
		high traffic intersection right off I-70 with multiple businesses including King Soopers, Love's Travel w/truck stop, McDonalds, and a Tractor Supply. Redesign and installation of a stoplight area will assist with traffic safety for commercial vehicles as well as residential vehicles.								
B-8	Town of Bennett	Replacement of culverts of on Kiowa-Bennett Road and Hwy 36. When Bennett experiences heavy rains and/or snowfall in this area, the Kiowa-Bennett road has experienced flooding and erosion issues. Replacement of culverts is expected to reduce and/or eliminate the flooding and erosion.	Flooding, Severe Winter Weather	2,3,4	**Town of Bennett Public Works**	$500,000	CIP Budget	High	2021	New in 2020.
B-9	Town of Bennett	Design of expansion for wastewater treatment facility. With the growth that the Town of Bennett is experiencing, it is necessary to begin the process for design of expansion of this facility to accommodate the growth. The site also experienced stormwater flooding in 2019.	Flooding	2,3,4	**Town of Bennett Public Works**	$350,000	CIP Budget	High	2021	New in 2020.
Town of Bow Mar Mitigation Actions										
C-1 *2015 -11*	Town of Bow Mar	Participation and adoption of the MHFD master plans affecting the County. Part of the master planning efforts involves identification of capital improvement projects	Flooding	2,3,4	**Public Works Commissioner** OEM	Unknown	TBD	Low	Ongoing	In Progress. Will continue to participate as requested.

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ID	Jurisdiction	Description/Background/ Benefits	Hazards Mitigated	Goals	Lead Agency & Partners	Cost Estimate	Potential Funding	Priority	Timeline	Status and Implementation Notes
		and are based on future conditions hydrology (watershed level).								
C-2 *2015 -31*	Town of Bow Mar	Complete a drainage study for the Town of Bow Mar	Flooding	1,2,3, 4	**Mayor, Public Works Commissioner**	$5,000	General operating budget	High	2020	In Progress.
C-3	Town of Bow Mar	Emerald Ash Borer Mitigation. Develop a strategy for removing or treating Ash trees on town property and a strategy to support citizens as they address treating or removing trees on private property. Do this in advance of significant tree damage, which could lead to property damage.	Severe Summer Weather, Severe Wind, Tornado, Severe Winter Weather, Wildfire	1,2,3	**Parks and Recreation Commissioner, Public Works Commissioner**	$100,000	TBD	Medium	2030	New for 2020
City of Centennial Mitigation Actions										
D-1 *2010 -05*	City of Centennial	Continued National Flood Insurance Program (NFIP) Participation. This includes continuing to comply with the NFIP's standards for updating and adopting floodplain maps and maintaining and updating the floodplain zoning ordinance.	Flooding	1,2,3, 4	**City Community Development**, SEMSWA	Staff Time	City General Fund, SEMSWA	High	2020-2025	In Progress. SEMSWA administers the floodplain management regulations and program on behalf of Centennial to ensure NFIP compliance. Floodplain Management Regulations updated to adopt new FIS & FIRMs effective September 4, 2020. PMRs on-going.
D-2 *2015 -11*	City of Centennial	Participation in MHFD master plans affecting the County. Part of the master planning efforts involves identification of capital improvement projects and are based on future conditions hydrology (watershed level).	Flooding	2,3,4	**City Community Development**, MHFD, SEMSWA	Staff Time	MHFD, SEMSWA	Medium	2020-2025	In Progress. 5-year plan requests submitted to MHFD annually.
D-3	City of Centennial	Participation and adoption of the MHFD Flood Hazard Area Delineation (FHAD)	Flooding	1,2,3, 4	**City Community**	Staff Time	MHFD	Medium	2020-2025	In Progress. 5-year plan requests submitted to MHFD annually. SEMSWA's goal is

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ID	Jurisdiction	Description/Background/ Benefits	Hazards Mitigated	Goals	Lead Agency & Partners	Cost Estimate	Potential Funding	Priority	Timeline	Status and Implementation Notes
2015 -23		Studies affecting the County. New or updated flood risk areas are identified, providing communities with best available flood risk data for permitting and land development decisions.			**Development**, MHFD					to increase outreach to impacted property owners identified at risk in FHAD Studies.
D-4 *2015 -24*	City of Centennial	Continue participation in the NFIP Community Rating System (CRS) Program. Flood Insurance premiums are reduced to reflect the reduced flood risk based on the community's floodplain management programs and activities	Flooding	1,2,3, 4	**City Community Development**, SEMSWA	Varies by year for consultant support	SEMSWA	Medium	Annual recertifications in May. Next 5-year Cycle Verification will be in 2024.	In Progress. Centennial maintained Class 7 with 5-year Cycle Verification in 2019. Potential opportunities for improvement include BCEGS evaluation and submitting HMP for review through CRS Modification or Verification.
D-5	City of Centennial	Replace span-wire traffic signals. Remove span wire poles and install mast-arm poles at existing signalized intersections. This prevents wires hanging over traffic and is a known crash reduction factor listed by FHWA. Varies by intersection. Can be analyzed with known software, purchase of which would be part of the mitigation plan. Depending on traffic volumes and conditions, B/C of 2-5 are expected.	Severe Summer Weather, Severe Wind/ Tornado, Severe Winter Weather	1,2,3, 4	**Centennial Public Works - Traffic Engineering,** CDOT, FHWA, adjoining jurisdictions	$10 Million	HSIP, DRCOG, collaboration with adjoining jurisdictions	Medium	5 years	New for 2020
D-6	City of Centennial	Electrical Undergrounding. Summer and winter storms often impact above ground power lines and cause downed power lines. Prevent loss of critical resources that utilize	Severe Summer Weather, Severe Wind/ Tornado, Severe Winter	1,2,4	**City of Centennial Public Works,** Xcel Energy, IREA	$500,000	City of Centennial, IREA, Xcel Energy, FEMA grants	High	5 years for select portions	New for 2020

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ID	Jurisdiction	Description/Background/ Benefits	Hazards Mitigated	Goals	Lead Agency & Partners	Cost Estimate	Potential Funding	Priority	Timeline	Status and Implementation Notes
		electricity (e.g. heat, medical equipment, refrigeration, etc.) Avoid fire hazard by not having above ground lines near open space and undeveloped areas. Prevent injury or death from human interacting with downed power lines	Weather, Wildfire							
D-7	City of Centennial	Public Works Mutual Aid Agreements. During severe winter storms, Public Works may have insufficient resources or not have access to specialized resources needed to respond. By having agreements with multiple jurisdictions in the metro area. Services delays/failures during storms due to insufficient resources or lack of specialized equipment	Severe Winter Weather	3,4	**City of Centennial Public Works** Arapahoe County	$0	NA	Low	2021	New for 2020
D-8	City of Centennial	Bridge Replacement. Arapahoe Road over Big Dry Creek (Cent 42-5.1). Centennial is designing a project to replace this 75 year old bridge, due to flooding with the existing bridge being in the flood plain. The new structure will clear the 100-year storm and will provide improved pathways for users on Arapahoe Road, as well as for those on the trail below. Prevent vehicle damage/loss and risk to life, requiring emergency rescue. Provide reliable transportation route	Flooding	1,2,3, 4	**City of Centennial Public Works** Southeast Metro Stormwater Authority (SEMSWA) and South Suburban Parks and Recreation District (SSPRD)	$6,500,000	Centennial SEMSWA, others as they may become available	High	Begin in 2021, complete early 2022.	New for 2020

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ID	Jurisdiction	Description/Background/ Benefits	Hazards Mitigated	Goals	Lead Agency & Partners	Cost Estimate	Potential Funding	Priority	Timeline	Status and Implementation Notes
		for all modes, including for emergency and commercial vehicles. New bridge will help to sustain economic vitality.								
D-9	City of Centennial	Centennial is working with WaterNow Alliance and Western Resource Advocates to evaluate ways to update the City's Land Development Code to increase community resilience related to water supply and stormwater management.	Drought, Flooding	1,2,3, 4	**City Community Development**, SEMSWA	Staff Time	N/A	Medium	2021	New in 2020
Cherry Hills Village Mitigation Actions										
E-1 *2015 -11*	Cherry Hills Village	Participation and adoption of the MHFD master plans affecting the County. Part of the master planning efforts involves identification of capital improvement projects and are based on future conditions hydrology (watershed level).	Flooding	2,3,4	Cherry Hills Village Community Development and Public Works Departments, MHFD	Staff Time	N/A	Medium	Ongoing	In Progress. CHV continues to work with MHFD identifying capital projects and participating in studies.
E-2 *2015 -23*	Cherry Hills Village	Participation and adoption of the MHFD Flood Hazard Area Delineation (FHAD) Studies affecting the County	Flooding	1,2,3, 4	Cherry Hills Village Community Development and Public Works Departments, MHFD	Staff Time	N/A	Medium	Ongoing	In Progress. The City continues to participate in efforts with the Mile High Flood Control District to identify Flood Hazard Area Delineation areas.
E-3 *2015 -32*	Cherry Hills Village	Enforcement of Floodplain Regulations to limit development in floodplain areas. New or updated flood risk areas are identified, providing communities with best available flood risk data	Flooding	1,2,4	Cherry Hills Village Community Development and Public Works Departments	Staff Time	N/A	High	Ongoing	In Progress. Cherry Hills Village; Codes already adopted, will continue to enforce its Floodplain Development Regulations

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ID	Jurisdiction	Description/Background/ Benefits	Hazards Mitigated	Goals	Lead Agency & Partners	Cost Estimate	Potential Funding	Priority	Timeline	Status and Implementation Notes
		for permitting and land development decisions.								
E-4	City of Cherry Hills Village	Hazard and Stormwater Mapping. The City has limited information on a large portion of its older stormwater infrastructure including private dams and structures within the City. Data collection and mapping are needed to better understand and maintain the system. Will help reduce loss of lives, damage to public/private property and reduction of adverse economic impacts.	Flooding	1,2,3, 4	**City of Cherry Hills Village Public Works**, MHFD	$100,000	Mile High Flood District	Medium	Two to five years	New for 2020
E-5	City of Cherry Hills Village	Continued National Flood Insurance Program (NFIP) Participation. This includes continuing to comply with the NFIP's standards for updating and adopting floodplain maps and maintaining and updating the floodplain zoning ordinance.	Flooding	1,2,3, 4	**Public Works**, SEMSWA	Staff Time	City General Fund, SEMSWA	High	2020-2025	New for 2020
E-6	City of Cherry Hills Village	Utility Line Undergrounding. In 2014, City Council appointed a Utility Line Undergrounding Study Committee to evaluate strategies and options to bury existing overhead utility lines. The Committee studied the likely cost, the possibility for cost sharing, the priority for the sequence of work and possible changes to the Municipal Code. The City of Cherry	Severe Summer Weather, Severe Wind/ Tornado, Severe Winter Weather	3,4	**Public Works**, Xcel Energy	$1M	Capital Fund, Xcel Energy Fund	Medium	2024	New for 2020

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ID	Jurisdiction	Description/Background/ Benefits	Hazards Mitigated	Goals	Lead Agency & Partners	Cost Estimate	Potential Funding	Priority	Timeline	Status and Implementation Notes
		Hills Village is in the preliminary stages of undergrounding utility lines along Quincy Avenue from Happy Canyon Road to Holly Street. Quincy Avenue has been identified as a priority because of the view corridors and the damage to the mature tree canopy when Xcel Energy trims tree branches along the lines.								
E-7	City of Cherry Hills Village	Belleview/Clarkson Drainage Improvements. The existing storm sewer does not have adequate capacity which contributes to ponding issues. Upsizing the storm sewer piper will resolve the ponding issue by increasing drainage capacity. This project is a partnership with Greenwood Village.	Flooding	2,3,4	**Public Works**, Greenwood Village Public Works	$180,000	CIP budget and Greenwood Village CIP budget (50-50 cost sharing)	Medium	2021	New for 2020
Town of Deer Trail Mitigation Actions										
G-1 *2010 -05*	Town of Deer Trail	Continued National Flood Insurance Program (NFIP) Participation. This includes continuing to comply with the NFIP's standards for updating and adopting floodplain maps and maintaining and updating the floodplain zoning ordinance.	Flooding	1,2,3, 4	**Mayor**, OEM	Staff Time	Dept Budget	High	Ongoing	Annual Implementation
G-2 *2015 -23*	Town of Deer Trail	Participation and adoption of the MHFD Flood Hazard Area Delineation (FHAD) Studies affecting the County. New or updated flood risk areas are identified, providing communities with	Flooding	1,2,3, 4	**Mayor,** OEM	Staff Time	Dept Budget	Medium	Ongoing	In progress

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ID	Jurisdiction	Description/Background/ Benefits	Hazards Mitigated	Goals	Lead Agency & Partners	Cost Estimate	Potential Funding	Priority	Timeline	Status and Implementation Notes
		best available flood risk data for permitting and land development decisions.								
G-3 *2015 -25*	Town of Deer Trail	Continued mowing/ maintenance of the WPA ditch and roadway for wildfire mitigation. Preventative maintenance will assist with wildfire mitigation efforts.	Wildfire	1,2,3	**Mayor,** County Public Works,	Staff Time	Dept Budget	Medium	Ongoing	Annual Implementation
G-4	Town of Deer Trail	Clean out debris from culverts. Culverts in town have vegetation and debris build up which clogs the culverts and causes them to not function properly leading to flooding in roads. This will reduce infrastructure damages and transportation impacts from flooding on roadways	Flooding	1,2,3, 4	**Town Clerk,** Arapahoe County Road and Bridge	$50,000-$75,000	HMA grants; general funds, town maintenance budget	Medium	2023	New in 2020
G-5	Town of Deer Trail	Public education and outreach program. Deer Trail Fire conducts fire safety education and outreach through the local schools, but it is currently focused on prevention of house fires. We would like to expend this program to address wildfire mitigation, and eventually include all hazards.	Active Threat, Cyber Threat, Dam Failure, Drought, Flooding, Hazmat Release, Pandemic, Severe Summer Weather, Severe Wind/ Tornado, Severe Winter Weather, Wildfire	1,2,3, 4	**Deer Trail Fire**	Unknown	FEMA HMA grants	Medium	2021-2025	New in 2020
G-6	Town of Deer Trail	Forest thinning. This project would focus on tree thinning and clearing out slash in	Flooding, Wildfire	1,2,3, 4	**Deer Trail Fire**, State Forest Service	Unknown	FEMA HMA grants	Medium	2021-2025	New in 2020

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ID	Jurisdiction	Description/Background/ Benefits	Hazards Mitigated	Goals	Lead Agency & Partners	Cost Estimate	Potential Funding	Priority	Timeline	Status and Implementation Notes
		wildland areas, particularly creek bottoms, reducing wildfire risk. This will also reduce the impact of flooding, since downed trees frequently cause backups at bridges and culverts, resulting in flooding.								
City of Englewood Mitigation Actions										
H-1 *2010-05*	City of Englewood	Continued National Flood Insurance Program (NFIP) Participation. This includes continuing to comply with the NFIP's standards for updating and adopting floodplain maps and maintaining and updating the floodplain zoning ordinance.	Flooding	1,2,3, 4	**Englewood Public Works**	$10,000	$0	High	Yearly	Annual Implementation
H-2 *2015-11*	City of Englewood	Participation and adoption of the MHFD master plans affecting the County. Part of the master planning efforts involves identification of capital improvement projects and are based on future conditions hydrology (watershed level).	Flooding	2,3,4	**Englewood Public Works**	$10,000	$0	Medium	2021-2022	In Progress. Work with MHFD annually in maintenance eligibility programs and capital project identification process. Will look into adopting master plan.
H-3 *2015-13*	City of Englewood	Increase public awareness by utilizing the County's various social media and public events and trainings. Utilize the city's various social media and listservs to educate citizens on hazards and the recommended protective actions; host preparedness trainings and safety fairs for citizens. Possible funding: NCR	Active Threat, Cyber Threat, Dam Failure, Drought, Flooding, Hazmat Release, Pandemic, Severe Summer Weather, Severe Wind/ Tornado,	2,3,4	**Englewood Communications Department**	Staff Time	Dept. Budget	Medium	Ongoing	Annual Implementation. Added full time staff member assigned to social media to implement public messaging. Have boosted messaging during emergencies significantly.

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ID	Jurisdiction	Description/Background/ Benefits	Hazards Mitigated	Goals	Lead Agency & Partners	Cost Estimate	Potential Funding	Priority	Timeline	Status and Implementation Notes
		Citizen Corps Grants, department budgets.	Severe Winter Weather, Wildfire							
H-4 *2015 -14*	City of Englewood	Implement Water Conservation Plan. Ensure Water Conservation Plan is implemented, and citizens are educated on conservation measures.	Drought	4	**Englewood Utilities**	$0 - $10,000	Dept. Budget	Low	2021	In Progress
H-5 *2015 -15*	City of Englewood	Create and consolidate a GIS vulnerability dataset. Consolidate various hazard maps to create one overall city-wide hazard vulnerability map. Possible funding: HMEP and department budgets.	Active Threat, Cyber Threat, Dam Failure, Drought, Flooding, Hazmat Release, Pandemic, Severe Summer Weather, Severe Wind/ Tornado, Severe Winter Weather, Wildfire	3,4	**Englewood IT**	$0 - $10,000	Dept. Budget	Medium	2025	In Progress. Strategic Plan in the works
H-6 *2015 -23*	City of Englewood	Participation and adoption of the MHFD Flood Hazard Area Delineation (FHAD) Studies affecting the County. New or updated flood risk areas are identified, providing communities with best available flood risk data for permitting and land development decisions.	Flooding	1,2,3, 4	**Englewood Public Works**	$100,000	$100,000 Match from MHFD	Medium	2021	Not Started
H-7 *2015 -24*	City of Englewood	Continue participation in the NFIP Community Rating System (CRS) Program. Flood Insurance premiums	Flooding	1,2,3, 4	**Englewood Public Works**	$20,000	Dept. Budget	High	Ongoing	Annual Implementation

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ID	Jurisdiction	Description/Background/ Benefits	Hazards Mitigated	Goals	Lead Agency & Partners	Cost Estimate	Potential Funding	Priority	Timeline	Status and Implementation Notes
		are reduced to reflect the reduced flood risk based on the community's floodplain management programs and activities								
H-8 *2015 -38*	City of Englewood	Evacuation and shelter plan	Active Threat, Dam Failure, Flooding, Hazmat Release, Severe Summer Weather, Severe Wind/ Tornado, Severe Winter Weather, Wildfire	1,2,3, 4	**Englewood PD/OEM**	$0 - $10,000	Dept. Budget	Medium	2025	Not Started
H-9	City of Englewood	Stormwater Plan Implementation. Implement stormwater mitigation projects identified in Stormwater Master Plan to reduce private property flooding in the City. Reduce damages to private property, preventing loss of life/injury	Flooding	1,2,3, 4	**Englewood Public Works,** CDPHE, MHFD	$31 million	Stormwater Utility Fees	High	2021-2024	New in 2020
H-10	City of Englewood	Converting wastewater plant disinfection process to UV eliminating need for chemical treatment. Reduces the risk of a release into the Platte River; reduces the amount of hazmat stored and transported on site. Will help loss of life, costs associated with hazmat release, impact to water quality/environment.	Hazmat Release	1,2,3, 4	**South Platte Renew**	$8 million	Rates and fees	High	2023	New in 2020

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ID	Jurisdiction	Description/Background/ Benefits	Hazards Mitigated	Goals	Lead Agency & Partners	Cost Estimate	Potential Funding	Priority	Timeline	Status and Implementation Notes
H-11	City of Englewood	Emerald Ash Borer Mitigation. Develop a strategy for removing or treating Ash trees on town property and a strategy to support citizens as they address treating or removing trees on private property. Do this in advance of significant tree damage, which could lead to property damage.	Severe Summer Weather, Severe Wind, Tornado, Severe Winter Weather, Wildfire	1,2,3	**Englewood Public Works**	$250,000	Capital Improvements Fund	High	2025	New for 2020
H-12	City of Englewood	Security Camera expansion/ replacement program. The City's network of cameras needs to be updated for continued usability. The City depends on security cameras as an investigative tool. Without the ability to upgrade existing cameras to ensure better quality video or add additional cameras where needed may place our employees and assets in a vulnerable situation.	Active Threat	1,4	**Information Technology**, Police	$180,000	Capital Improvements Fund	Medium	2025	New for 2020
H-13	City of Englewood	Develop and implement an IT Disaster Recovery Site that the IT Department can temporarily relocate to following a security breach or natural disaster. A disaster recovery site ensures that Englewood can continue operations until it becomes safe to resume work at its usual location.	Active Threat, Cyber Threat, Dam Failure, Flooding, Severe Summer Weather, Severe Wind/ Tornado, Severe Winter Weather	2,3,4	**Information Technology**	$55,000	Capital Improvements Fund	High	2021	New for 2020
Town of Foxfield Mitigation Actions										
J-1	Town of Foxfield	Participation and adoption of the MHFD master plans affecting the County. Part of	Flooding	2,3,4	**Town Clerk**	Staff Time	Dept Budget	Medium	Ongoing	In Progress.

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ID	Jurisdiction	Description/Background/ Benefits	Hazards Mitigated	Goals	Lead Agency & Partners	Cost Estimate	Potential Funding	Priority	Timeline	Status and Implementation Notes
2015 -11		the master planning efforts involves identification of capital improvement projects and are based on future conditions hydrology (watershed level).								
J-2 *2015 -23*	Town of Foxfield	Participation and adoption of the MHFD Flood Hazard Area Delineation (FHAD) Studies affecting the County. New or updated flood risk areas are identified, providing communities with best available flood risk data for permitting and land development decisions.	Flooding	1,2,3, 4	**Town Clerk**	Staff Time	Dept Budget	Medium	Ongoing	In Progress.
J-3 *2015 -39*	Town of Foxfield	Working with our local fire district, publicizing fire bans and warnings, especially related to fireworks	Wildfire	1,2,3, 4	**Town Clerk** South Metro Fire	$0 - $10,000	Dept Budget	Low	2022	In Progress. Continue to use Nextdoor and newsletter for communication to residents. Use Next Door and newsletters to inform residents. Newsletter sent via email and has approx. 90% of the residents' emails.
J-4	Town of Foxfield	Wildfire Mitigation Planning and Maintenance. Create a wildfire mitigation plan, in addition to preventative maintenance in our ditches and open spaces. Avoiding the loss of property, homes, and lives.	Wildfire	1,2,3, 4	**Town Clerk,** South Metro Fire	$1,000	General Fund	High	1 year, by summer of 2021	New for 2020
City of Glendale Mitigation Actions										
K-1 *2010 -05*	City of Glendale	Continued National Flood Insurance Program (NFIP) Participation. This includes continuing to comply with the NFIP's standards for updating and adopting floodplain maps and maintaining and updating	Flooding	1,2,3, 4	**City Public Works**, FEMA, State	Staff Time	Dept Budget	Medium	Ongoing	In Progress. City of Glendale has automatically adopted all revisions to the Flood Insurance Study for Arapahoe County (FIS) with its accompanying Flood Insurance Rate Maps (FIRM) applicable to the

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ID	Jurisdiction	Description/Background/ Benefits	Hazards Mitigated	Goals	Lead Agency & Partners	Cost Estimate	Potential Funding	Priority	Timeline	Status and Implementation Notes
		the floodplain zoning ordinance.								areas located in the City of Glendale by the September 4th, 2020 as required by FEMA in order to continue participation in the NFIP.
K-2 *2015 -11*	City of Glendale	Participation and adoption of the MHFD master plans affecting the County. Part of the master planning efforts involves identification of capital improvement projects and are based on future conditions hydrology (watershed level).	Flooding	2,3,4	**Glendale Public Works**, MHFD, City of Denver	Staff Time	Dept Budget	Low	Ongoing	In Progress. The City of Glendale continues to partner with Mile High Flood District (MHFD) and participated in planning activities.
K-3 *2015 -23*	City of Glendale	Participation and adoption of the MHFD Flood Hazard Area Delineation (FHAD) Studies affecting the County. New or updated flood risk areas are identified, providing communities with best available flood risk data for permitting and land development decisions.	Flooding	1,2,3, 4	**Glendale Public Works**, MHFD, City of Denver	Staff Time	Dept Budget	Low	2025	In Progress. The City of Glendale continues to partner with Mile High Flood District (MHFD) and participated in planning activities. Additionally, the City has adopted the FIS for Arapahoe County and its accompanying FIRM. Currently applicable Letters of Map Revisions (LOMR) which includes Physical Map Revisions (PMR) are also recognized by the City of Glendale as enforceable under Glendale Municipal Code.
K-4 *2015 -42*	City of Glendale	Continue/expand community-wide "Run- Hide- Fight-Treat" training.	Active Threat	1,2,3, 4	**Glendale Police Dept.**	$0 - $10,000	Dept Budget	Medium	Ongoing	In Progress. This continues to be an area of focus and will be moving forward.
K-5 *2015 -43*	City of Glendale	Increase participation in Reverse 911 opt-in	Active Threat, Cyber Threat, Dam Failure, Flooding, Hazmat Release,	1,2,3, 4	**Glendale Police Dept.**	$0 - $10,000	Dept Budget	Medium	ongoing	In Progress. This continues to be an area of focus and will be moving forward.

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ID	Jurisdiction	Description/Background/ Benefits	Hazards Mitigated	Goals	Lead Agency & Partners	Cost Estimate	Potential Funding	Priority	Timeline	Status and Implementation Notes
			Pandemic, Severe Summer Weather, Severe Wind/ Tornado, Severe Winter Weather, Wildfire							
K-6	City of Glendale	Re-Locate the City Gas Pumps. The City Gas Pumps are in an area that is prone to flooding and provides easy access to non-city employees. This is a key vulnerability. Loss of the ability to fuel critical vehicles during flooding. Potential explosion causing damage and loss of ability to fuel critical vehicles following a criminal act.	Active Threat, Flooding	1,2,4	**Glendale OEM and Public Works Department,** Glendale Police Department	$100,000	General Fund	Medium	2022	New for 2020
K-7	City of Glendale	Adopt 2018 IFC (International Fire Code). Revise City ordinances to reflect 2018 IFC, amend IFC to meet City needs, adopt IFC by council. In addition to other benefits, 2018 IFC code mandates redundancy for fire suppression (additional water source for sprinklers), tightens regulations on portable heat sources, and reduces the ability for tampering with fire suppression fixtures. Reducing the potential for a structure fire and increasing the functionality of suppression for new	Wildfire	1,2,4	**City of Glendale Public Works**, City of Glendale Building Department, Denver Fire	$20,000	City of Glendale Annual Budget (Public Works, Building Dept)	High	1 year	New for 2020

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ID	Jurisdiction	Description/Background/ Benefits	Hazards Mitigated	Goals	Lead Agency & Partners	Cost Estimate	Potential Funding	Priority	Timeline	Status and Implementation Notes
		construction will mitigate the potential for fires to spread in an urban setting. Adopting the 2018 IFC will allow for these items to be enforceable through ordinance.								
K-8	City of Glendale	Relocate 911 center. Glendale 911 is located within the Cherry Creek Dam inundation area, and is currently in the basement. Moving this center out of the basement will increase resiliency and city operations during and after a dam failure event	Dam Failure	4	OEM, IT Department	$250,000	Capital Improvement Budget	High	2024	New in 2020
K-9	City of Glendale	Relocate server room. The City server room is located within the Cherry Creek Dam inundation area, and is currently in the basement. Moving the server room out of the basement will increase resiliency and city operations during and after a dam failure event	Dam Failure	4	OEM, IT Department	$250,000	Capital Improvement Budget	High	2025	New in 2020
City of Greenwood Village Mitigation Actions										
L-1 *2010-05*	City of Greenwood Village	Continued National Flood Insurance Program (NFIP) Participation. This includes continuing to comply with the NFIP's standards for updating and adopting floodplain maps and maintaining and updating the floodplain zoning ordinance.	Flooding	1,2,3, 4	**Greenwood Village Public Works, Community Development**	Staff Time	NA	High	Ongoing	Annual Implementation. This is an ongoing action.
L-2	City of Greenwood Village	Active Threat assessment and mitigation plan for Cherry Creek High School	Active Threat	1,2,3, 4	**Greenwood Village Police Department**,	TBD	Regular budgetary expenditure	High	1-2 years	New for 2020

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ID	Jurisdiction	Description/Background/ Benefits	Hazards Mitigated	Goals	Lead Agency & Partners	Cost Estimate	Potential Funding	Priority	Timeline	Status and Implementation Notes
		campus. It is critical we identify all points of ingress and egress of Cherry Creek High School as well as collaborating with all key stakeholders on the campus. At any given point, the campus is comprised of 6500(+) people during normal operation. With situations occurring in the United States daily, it is important we have thorough mapping system at the tips of our fingers as well as being on the same page with school safety and security with our deployment/response.			Cherry Creek School District Safety and Security Teams		s regarding time spend to complete project			
L-3	City of Greenwood Village	Goldsmith Gulch drainage project: under crossing storm water pipe installs under Orchard Rd at Silo Park, and Storm water under-crossing pipe and box at the intersection of Belleview and Clarkson. Both of these will improve drainage runoff and mitigate flooding issues.	Flooding	1,2,3, 4	**Greenwood Village Public Works**	$2 million	CIP budget and MHFD funding	High	2022	New for 2020
L-4	City of Greenwood Village	Belleview/Clarkson Drainage Improvements. The existing storm sewer does not have adequate capacity which contributes to ponding issues. Upsizing the storm sewer piper will resolve the ponding issue by increasing drainage capacity. This project is a partnership with Cherry Hills Village.	Flooding	2,3,4	**Greenwood Village Public Works**, Cherry Hills Public Works	$180,000	CIP budget and Chery Hills Village CIP budget (50-50 cost sharing)	Medium	2021	New for 2020

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ID	Jurisdiction	Description/Background/ Benefits	Hazards Mitigated	Goals	Lead Agency & Partners	Cost Estimate	Potential Funding	Priority	Timeline	Status and Implementation Notes
L-5	City of Greenwood Village	Goldsmith Gulch – Orchard - Silo Park Drainage improvements. Replace existing culvert with a larger structure to reduce the potential for overtopping of Orchard Road in a 100-year flood. The schedule is based on anticipated funding from the Mile High Flood District.	Flooding	2,3,4	**Greenwood Village Public Works**, MHFD	$1,535,000	CIP budget and MHFD	Medium	2022	New for 2020
L-6	City of Greenwood Village	Village greens Park Lightning Prediction Update. Existing lightning prediction system at Village Greens needs to be updated to include installation of a remote horn and an internet connection for remote monitoring to help determine timing of delay of play. Additionally, a lightning shelter would be built on the mountain bike course for protection of patrons.	Severe Summer Weather	2,3,4	**Greenwood Village Public Works**	$100,000	CIP budget	High	2020	New for 2020
City of Littleton Mitigation Actions										
M-1 *2010-05*	City of Littleton	Continued National Flood Insurance Program (NFIP) Participation. This includes continuing to comply with the NFIP's standards for updating and adopting floodplain maps and maintaining and updating the floodplain zoning ordinance.	Flooding	1,2,3,4	**Public Works**	Staff Time	Storm water enterprise fund	High	Ongoing	In Progress
M-2 *2015-11*	City of Littleton	Participation and adoption of the MHFD master plans affecting the County. Part of the master planning efforts involves identification of capital improvement projects	Flooding	2,3,4	**Public Works**	Staff Time	Storm water enterprise and cost sharing with MHFD	Medium	Ongoing	In Progress. Littleton continues to participate with MHFD and surrounding jurisdictions on Master Planning Studies.

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ID	Jurisdiction	Description/Background/ Benefits	Hazards Mitigated	Goals	Lead Agency & Partners	Cost Estimate	Potential Funding	Priority	Timeline	Status and Implementation Notes
		and are based on future conditions hydrology (watershed level).								
M-3 *2015 -22*	City of Littleton	Involvement in the Denver Water Emergency Action Plans for the Marston & Harriman Dams. Participate in the update and orientation of the Dam EAPs, and integrate into City EOP.	Dam Failure	1,2,3, 4	**Emergency Management, Public Works**	Staff Time	NA	Medium	Ongoing	In Progress. Littleton attends these meetings as they are announced and we are invited.
M-4 *2015 -23*	City of Littleton	Participation and adoption of the MHFD Flood Hazard Area Delineation (FHAD) Studies affecting the County. New or updated flood risk areas are identified, providing communities with best available flood risk data for permitting and land development decisions.	Flooding	1,2,3, 4	**Public Works**	Staff Time	Storm water enterprise and cost sharing with MHFD	Medium	Ongoing	In Progress. Littleton continues to participate with MHFD and surrounding jurisdictions on FHADs
M-5 *2015 -24*	City of Littleton	Continue participation in the NFIP Community Rating System (CRS) Program. Flood Insurance premiums are reduced to reflect the reduced flood risk based on the community's floodplain management programs and activities	Flooding	1,2,3, 4	**Public Works**	Staff Time	Storm water enterprise fund	High	Ongoing	In Progress. Littleton achieved a Class 5 rating in 2017.
M-6 *2015 -49*	City of Littleton	Identify evacuation shelters and evacuation routes. Create and refine emergency vehicular evacuation routes and procedures specific to hazard types. Will help reduce loss of life and injuries.	Active Threat, Dam Failure, Flooding, Hazmat Release, Pandemic, Severe Summer Weather, Severe Wind/ Tornado, Severe	1,4	**Public Works**	$0 - $10,000	FEMA HMA grant	medium	5 years	In Progress. Rough evacuation routes established but may need more detail. No progress on shelters. Plans to coordinate with ARC for shelter surveying

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ID	Jurisdiction	Description/Background/ Benefits	Hazards Mitigated	Goals	Lead Agency & Partners	Cost Estimate	Potential Funding	Priority	Timeline	Status and Implementation Notes
			Winter Weather, Wildfire							
M-7	City of Littleton	Emergency Management Organization. Designate emergency manager and/or team for the city and update Emergency Operations Center program including planning and training of city staff. Will help reduce loss of life, property, damages, economic impacts	Active Threat, Cyber Threat, Dam Failure, Drought, Flooding, Hazmat Release, Pandemic, Severe Summer Weather, Severe Wind/ Tornado, Severe Winter Weather, Wildfire	1,2,3, 4	**Littleton Police Department, Public Works**	$100,000	City general fund	High	5 years	New for 2020
M-8	City of Littleton	Storm and Flood Master Planning. Develop and implement a storm drainage master plan to identify and mitigate flood risk from inadequate infrastructure or maintenance needs. Will help reduce loss of life and property, property damages. Severe summer storms are typically high intensity and lead to street flooding in the city of Littleton due to lack of storm sewer in many older neighborhoods. Hail can clog storm drains, exacerbating flooding. The storm drainage master plan will identify areas in need of storm sewer upgrades or system expansion.	Flooding, Severe Summer Weather	1,2,3, 4	**City of Littleton Public Works,** Mile High Flood District	$150,000	Storm Drainage enterprise fund	Medium	2 years	New for 2020

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ID	Jurisdiction	Description/Background/ Benefits	Hazards Mitigated	Goals	Lead Agency & Partners	Cost Estimate	Potential Funding	Priority	Timeline	Status and Implementation Notes
M-9	City of Littleton	City data network center. Evaluate and improve the city's network data backup center. This will help protect city data from cyber attacks, reduce recovery time, and help ensure continuity of critical government services following an attack.	Cyber Threat	4	**City of Littleton Information Technology,** South Metro Fire	$200,000 - $250,000	City general fund, grants	High	5 years	New for 2020
M-10	City of Littleton	Power line undergrounding master plan and power line burial. Phase 1 would create an Undergrounding Master Plan to access funds in the Xcel Energy 1% undergrounding set aside. This plan would prioritize locations for burying overhead power lines throughout the city and identify costs for each project. Phase 2 would then implement line burials.	Severe Summer Weather, Severe Wind/ Tornado, Severe Winter Weather, Wildfire	2,3,4	**City of Littleton Public Works,** Xcel Energy	$75,000 for Phase 1 master plan; Phase 2 costs TBD	Capital Improvements Budget, Xcel Energy Funds	Medium	2022-2025	New for 2020. Phase 1 was proposed for City 2021 budget but not funded.
City of Sheridan Mitigation Actions										
N-1 *2010-05*	City of Sheridan	Continued National Flood Insurance Program (NFIP) Participation. This includes continuing to comply with the NFIP's standards for updating and adopting floodplain maps and maintaining and updating the floodplain zoning ordinance.	Flooding	1,2,3, 4	**Sheridan Community Development**	Staff Time	Staff Time	Dept budget	High	Annual Implementation. This is an ongoing program.
N-2 *2015-11*	City of Sheridan	Participation and adoption of the MHFD master plans affecting the County. Part of the master planning efforts involves identification of capital improvement projects and are based on future	Flooding	2,3,4	**Sheridan Community Development**	Staff Time	Staff Time	Dept budget	Medium	Annual Implementation

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ID	Jurisdiction	Description/Background/ Benefits	Hazards Mitigated	Goals	Lead Agency & Partners	Cost Estimate	Potential Funding	Priority	Timeline	Status and Implementation Notes
		conditions hydrology (watershed level).								
N-3 *2015 -23*	City of Sheridan	Participation and adoption of the MHFD Flood Hazard Area Delineation (FHAD) Studies affecting the County. New or updated flood risk areas are identified, providing communities with best available flood risk data for permitting and land development decisions.	Flooding	1,2,3, 4	**Sheridan Community Development**	Staff Time	Staff Time	Dept budget	Medium	Annual Implementation
N-4	City of Sheridan	Monitor Flood Plan and Hazard Zone for Overgrowth and Homeless Population. Monitor flood hazard and flood way for overgrowth of brush and trees, particularly along Bear Creek and Parts of the South Platte. Dense growth in these areas led to a lot of issues with trees falling obstructing water flow and causing dam issues during low flows. The dense growth also allows undetected homeless camps and contamination within waterways. By thinning trees and brush we can better identify homelessness within flood hazard zones, and reduce contamination of waterway from e coli and human waste, as well as prevent loss of life when the area floods.	Flooding, Pandemic	1,2,3, 4	**Sheridan Public Works**/ Mile High Flood District, All agencies with flood zone	$20,000 per year	Mile High Flood District / Grants / General Fund	Medium	Ongoing	New for 2020
N-5	City of Sheridan	Develop an early warning system to alert the public about extreme heat and extreme cold events.	Severe Summer Weather, Severe	1,2	**Sheridan Public Works**	TBD	CIP budget, grants	Medium	2023	New for 2020

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ID	Jurisdiction	Description/Background/ Benefits	Hazards Mitigated	Goals	Lead Agency & Partners	Cost Estimate	Potential Funding	Priority	Timeline	Status and Implementation Notes
			Winter Weather							
N-6	City of Sheridan	Emergency shelters. Identify sites to be used as emergency shelters during severe weather events. Develop an action plan, identify and implement structural changes needed to shelter sites such as backup power capability.	Severe Summer Weather, Severe Wind/ Tornado, Severe Winter Weather	1	**Sheridan Public Works**	TBD	CIP budget, grants	Medium	2025	New for 2020
N-7	City of Sheridan	Debris cleanup contractor. Identify and implement on-call contracts for private contractors to assist with debris following a severe weather incident. This will make Sheridan more resilient and reduce recovery time.	Severe Summer Weather, Severe Wind/ Tornado, Severe Winter Weather	2,3	**Sheridan Public Works**	Staff Time	NA	medium	2024	New for 2020
Denver Water Mitigation Actions										
O-1	Denver Water	Castlewood Pump Station. Add connectivity for temp emergency generator. Water loss	Dam Failure, Flooding	1,2,3, 4	Denver Water	$4 million	DW Capital Improvement Plan	Medium	2021	New for 2020
O-2	Denver Water	Cherry Hills Pump Station. Cathodic protection improvement project. Critical infrastructure	Dam Failure, Flooding	4	Denver Water	$310,000	DW Capital Improvement Plan	Medium	2021	New for 2020
O-3	Denver Water	Clarkson Pump Station. Major rebuild of facility. Critical infrastructure	Dam Failure, Flooding	4	Denver Water	$4.1 million	DW Capital Improvement Plan	Medium	2022	New for 2020

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6. Plan Implementation, Capabilities, and Maintenance

DMA Requirement §201.6(c)(4)(ii):
[The plan shall include] a plan maintenance process that includes: *(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.*

This Chapter discusses how the Arapahoe County Mitigation Strategy will be implemented by participating jurisdictions and how the overall Hazard Mitigation Plan will be evaluated and enhanced over time. Implementation and maintenance of the plan is the final step of the 10-step planning process and is critical to the overall success of hazard mitigation planning. This chapter provides an overview of the strategy for plan implementation and maintenance, and outlines the method and schedule for monitoring, evaluating, and updating the plan. The chapter also discusses incorporating the plan into existing planning mechanisms and how the participating jurisdictions will ensure continued public involvement in mitigation planning. Chapter 6 consists of the following subsections:

- Implementation
- Plan Maintenance
- Integration into Other Planning Mechanisms
- Continued Public Involvement

6.1 Implementation

Once adopted, the plan faces the truest test of its worth: implementation. While this plan contains many worthwhile actions, the participating jurisdictions will need to decide which action(s) to undertake first. Two factors will help with making that decision: the priority assigned the actions in the planning process and funding availability. Low or no-cost actions most easily demonstrate progress toward successful plan implementation.

Implementation will be accomplished by adhering to the schedules identified for each mitigation action in Table 5-4 in Chapter 5 Mitigation Strategy, and through pervasive efforts to network and highlight the multi-objective, win-win benefits of each project to the Arapahoe County community and its stakeholders. These efforts include the routine actions of monitoring agendas, attending meetings, and promoting a safe, sustainable community.

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.

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

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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.

Implementation and Maintenance of the 2015 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 2015 Plan included a process for implementation and maintenance of the plan, which was generally followed. The 2015 Plan stated that the Planning Team would meet annually to review progress on mitigation actions, assess how effective those actions have been in mitigating losses, and how well the Plan's goals and objectives are being met. The Planning Team would also monitor how elements of this Plan were being incorporated in into other planning mechanisms. Over the past five years, the Planning Team has met five times.

The status of mitigation actions and success stories are captured in Chapter 5. Other ways in which the 2015 Plan was integrated into other planning mechanisms and processes include:

- The Arapahoe County Sheriff's Office used the risk assessment data from this plan to update the county EOP in 2019.
- The Arapahoe County Sheriff's Office worked with the Planning Department to include hazard information in the 2018 update of the county Comprehensive Plan.
- The City of Glendale integrated hazard information into its Ready Glendale" public education program.

Role of the Planning Team in Implementation and Maintenance

With adoption of this plan Arapahoe County and its participating jurisdictions will be tasked with plan implementation and maintenance. This will be accomplished by keeping the Planning Team 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, providing technical assistance in implementing mitigation codes and ordinances, 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

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media. Unincorporated communities and special districts not participating in this plan will be integrated into mitigation implementation wherever possible.

6.2 Plan Maintenance

The Arapahoe 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. All participating jurisdictions will follow the process and schedule described below.

Monitoring

Monitoring refers to tracking the implementation of the plan over time. Arapahoe 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 members at least annually to identify and track any significant changes in their agencies' mitigation efforts.

Arapahoe 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.

As part of this coordination, OEM and the Planning Team will also monitor repetitive losses; evaluate changes in hazards, vulnerabilities, or the distribution of risk across the county; and seek to identify new and ongoing mitigation opportunities.

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).

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The Planning Team will meet annually to evaluate the implementation of the plan and consider any changes in priorities that may be warranted. The annual evaluation will not only include an investigation of whether mitigation actions were completed, but also an assessment of how effective those actions were in mitigating losses. A review of the qualitative and quantitative benefits (or avoided losses) of mitigation activities will support this assessment. Results of the evaluation will then be compared to the goals established in the plan and decisions will be made regarding whether actions should be discontinued or modified in any way in light of new developments in the community. Progress will be documented by the Planning Team for use in the next plan update. Finally, the Planning team will monitor and incorporate elements of this Plan into other planning mechanisms, as detailed in Section 6.3.

Arapahoe 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.

Updates

The Arapahoe 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 and jurisdictions changed?
- Are there new hazards that have the potential to impact the county and jurisdictions?
- Have growth and development changed the county's and jurisdictions' 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.

Any interested party wishing for an update of this Plan sooner than the regular 5-year update will submit such a request to Arapahoe County OEM for consideration. OEM will evaluate all such requests and bring them to the full Planning Team for consideration.

6.3 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

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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 6.1 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 Chapter 5, 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 provides some guidance on how Arapahoe County may use the updated HMP to inform and improve other plans, procedures, and programs.

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 Arapahoe County Comprehensive Plan was last updated in 2018, and included hazards information from the 2015 HMP, which is cited as a supporting document to the Comprehensive Plan. Arapahoe County OEM will work with the Planning Department to ensure that hazards data and mitigation goals and objectives inform the next Comprehensive Plan update.

Threat and Hazard Identification and Risk Assessment (THIRA)

Arapahoe 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 (Chapter 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 flooding, detailed GIS analysis has 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.

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Response Plans

The Arapahoe County Emergency Operations Plan (EOP) was last updated in 2019. 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.
- **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 Chapter 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.

Recovery Plan

The Arapahoe County Recovery Plan was last updated in 2019. The risk and vulnerability data in the HMP should help inform the post-disaster recovery planning process, especially by ensuring that the recovery elements of those plans fully take into account 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

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- 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."

Continuity of Operations Plans (COOP)

All departments and agencies of Arapahoe 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.

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 (Chapter 5) and Mitigation Strategy (Chapter 5) should also be included in the county's training and exercise planning.

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.

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.

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Capital Improvements Plan

Many of the mitigation actions listed in the Mitigation Strategy (Section 5.4) 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 5-4, 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.

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.

6.4 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, 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

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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.

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APPENDIX A: PLANNING TEAM

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APPENDIX A: PLANNING TEAM MEMBERS

Dept./Agency	Title	Name	Mtg 1/29/20	Mtg 6/8/20	Mtg 6/23/20	Mtg 7/30/20	Other[1]
Arapahoe County							
Emergency Management[2]	Manager	Nathan Fogg	X		X		
Emergency Management[2]	Deputy Manager	Ashley Cappel	X	X	X		
Emergency Management[2]	Deputy Manager	Jason Fredrickson	X	X		X	
Emergency Management[2]	Emergency Management Coordinator	Elizabeth Clay	X	X	X	X	
Emergency Management[2]	Emergency Management Coordinator	Dan Johnson	X		X	X	
Emergency Management[2]	Emergency Management Coordinator	Steven Peck			X		
Emergency Management[2]	Emergency Management Coordinator	Kevin Kay	X				
Public Works – Engineering[2,3]	Division Manager	Chuck Haskins				X	
Public Works – Planning [2,3]	Division Manager	Jan Yeckes	X		X	X	
Public Works – Planning[2,3]	Planner – Oil and Gas Specialist	Diane Kocis			X	X	
Public Works – Road & Bridge[2,3]	Division Manager	Allen Peterson				X	
GIS	Director	Dominick Cisson	X	X	X		
IT	GIS Analyst	Michael Hubbard	X		X	X	
Open Space and Recreation [2,3]	Director	Glen Poole	X	X			
Town of Bennett							
Public Works[2,3]	Town Safety Officer	Gerilynn Scheidt	X	X	X	X	
Town of Bow Mar							
Town of Bow Mar[2,3]	Town Clerk (contractor)	Angie Kelly					X
City of Centennial							
Emergency Management [2]	Emergency Manager	Jonah Schneider	X	X	X	X	
Public Works – Engineering[2,3]	Engineering Manager	Arthur Negretti	X	X	X	X	
City of Cherry Hills Village							
Public Works[2,3]	Deputy City Manager and Director of Public Works	Jay Goldie			X	X	
Community Development[2,3]	City Manager	Chris Crammer	X		X		
Town of Deer Trail							
Fire Department[2]	Chief	Rich Loveless					X

[1] Those that are not listed as attending a meeting participated in the planning process in other ways such as emails, phone calls and face-to-face meetings with the County Project Manager and consultants.
[2] Local or Regional Agency involved in hazard mitigation activities.
[3] Agency with authority to regulate development.

APPENDIX A: PLANNING TEAM MEMBERS

Dept./Agency	Title	Name	Mtg 1/29/20	Mtg 6/8/20	Mtg 6/23/20	Mtg 7/30/20	Other[1]
City of Englewood							
Public Works[2 3]	Director	Maria D'Andrea					COE Mtg 10/6
Utilities [2 3]	Director	Steve Simon			X		COE Mtg 10/6
Parks, Recreation & Library	Director	Christina Underhill					COE Mtg 10/6
Communications[2]	Manager	Chris Harguth					COE Mtg 10/6
Police Department[2]	Deputy Chief	Sam Watson					COE Mtg 10/6
Building Division[2 3]	Chief Building Official	Karen Montanez					COE Mtg 10/6
South Platte Renew & City of Englewood Utilities[2 3]	Director	Pieter Van Ry					COE Mtg 10/6
Public Works[2 3]	Operations & Maintenance Manager	Steve Ortega					COE Mtg 10/6
Fire Marshal's Office[2]	Fire Marshal	Mike Smith					COE Mtg 10/6
City Attorney	City Attorney	Alison McKenney Brown					COE Mtg 10/6
Community Development[2 3]	Director	Brad Power					COE Mtg 10/6
IT	Director	Margaret Brocklander					COE Mtg 10/6
City Manager's Office[2]	City Manager	Shawn Lewis					COE Mtg 10/6
Finance[2]	Director	Maria Sobota					COE Mtg 10/6
City Clerk	City Clerk	Stephanie Carlile					COE Mtg 10/6
Town of Foxfield							
Town Clerk/ Treasurer	Town Clerk/Treasurer	Randi Gallivan		X	X	X	
City of Glendale							
Police Department	Chief	William Haskins					
Police Department	Operation Commander	Mike Gross		X		X	
Police Department	Crime Analyst	Tyler Shepler				X	
Public Works [2 3]	GIS	Kevin Brown			X		
City of Greenwood Village							
Police Department	Division Commander	Joe Gutgsell					X
City of Littleton							
Public Works – Engineering Division [2 3]	Water Resource Manager	Carolyn Roan	X	X	X		
Police Department	Chief	Doug Stephens					
Police Department	Division Chief	Gene Enley	X	X	X		
City of Sheridan							

APPENDIX A: PLANNING TEAM MEMBERS

Dept./Agency	Title	Name	Mtg 1/29/20	Mtg 6/8/20	Mtg 6/23/20	Mtg 7/30/20	Other[1]
Public Safety[2]	Director	Mark Campbell					
Public Works[2 3]	Floodplain Manager	Randy Mourning	X		X	X	
Denver Water							
Emergency Management[2]	Emergency Manager	Becky Franco			X		
Emergency Management [2]	Emergency Specialist	Lisa Ciazza				X	
Stakeholders							
South Metro Fire[2]	Staffing Chief	Tom Chavez					
South Metro Fire	Emergency Manager	Jackie Erwin		X	X	X	
South Metro Fire	Chief	Jerry Rhodes		X		X	
South Metro Fire	Community Risk Reduction Specialist	Kim Sphuler					
City of Byers/Fire Department[2]	Chief	Mike Disher					
City of Strasburg/ Fire Department[2]	Chief	Frank Fields					
Watkins/Bennett Fire Rescue[2]	Assistant Chief	Tim Mccawley					
Sable Altura Fire Department	Chief	Rich Soloman					
Centennial Airport	Assistant Airport Director	Lorie Hinton					
Centennial Airport	Director of Operations	Brian Lewis					
SEMSWA[2]	Floodplain Manager	Stacey Thompson	X	X	X	X	
Mile High Flood District[2]	Program Manager	Kevin Stewart		X		X	
East Cherry Creek Valley Water and Sanitation District[2]	Engineer	Justin Blair	X				
Arapahoe County Water and Wastewater Authority [2]	Engineering Manager	Martin Stegmiller	X				
City of Aurora – Emergency Management[2]	Manager	Matt Chapman					
Elbert County – Emergency Management[2]	Manager	Alex Jakubowski					
Douglas County – Emergency Management[2]	Manager	Tim Johnson					
City and County of Denver – Emergency Management[2]	Manager	Matthew Mueller					
Jefferson County – Emergency Management[2]	Emergency Management Specialist	Erika Roberts					

APPENDIX A: PLANNING TEAM MEMBERS

Dept./Agency	Title	Name	Mtg 1/29/20	Mtg 6/8/20	Mtg 6/23/20	Mtg 7/30/20	Other[1]
Adams County – Emergency Management[2]	Manager	Ron Sigman					
Colorado State – DHSEM	Planning Manager	Patricia Gavelda		X			
Colorado State – DHSEM	Mitigation Planning Specialist	Mark Thompson	X	X		X	
Colorado State - DHSEM	Regional Field Manager	Cory Stark					
CD Smith (working for Englewood)	Engineer	Paniz Miesen				X	

APPENDIX B: PLANNING PROCESS DOCUMENTATION

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SERVING WITH INTEGRITY
ARAPAHOE SHERIFF
SINCE 1858

January 14, 2020

Dear Mr. Sturgeon,

Arapahoe County is in the process of updating its Hazard Mitigation Plan. This project involves identifying local mitigation actions that used over the long term reduce risk and future losses from disasters. The detailed plan assesses a variety of potential natural and human caused hazards that could affect some or all of the county's residents and businesses. Throughout the planning process, the county looks forward to engaging our partner jurisdictions and obtaining your input. Arapahoe County is committed to reducing the vulnerability of its citizens to the effects of hazards and this Hazard Mitigation Plan is an important tool in helping to do so.

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
- Demonstrating a firm commitment to improving community health and safety

Participating will not obligate a jurisdiction to anything; however, not adopting the Plan will jeopardize eligibility of federal disaster assistance, specifically, the Federal Emergency Management Agency's (FEMA) Hazard Mitigation Assistance grant programs (HMA).

We already have a designated representative for your jurisdiction and appreciate the continued support during this planning process.

Sincerely,

Ashley Cappel

Deputy Emergency Manager

Arapahoe County

720-874-4046

SERVING WITH INTEGRITY

ARAPAHOE SHERIFF

SINCE 1858

January 14, 2020

Dear Mr. Thorsen,

Arapahoe County is in the process of updating its Hazard Mitigation Plan. This project involves identifying local mitigation actions that used over the long term reduce risk and future losses from disasters. The detailed plan assesses a variety of potential natural and human caused hazards that could affect some or all of the county's residents and businesses. Throughout the planning process, the county looks forward to engaging our partner jurisdictions and obtaining your input. Arapahoe County is committed to reducing the vulnerability of its citizens to the effects of hazards and this Hazard Mitigation Plan is an important tool in helping to do so.

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We already have a designated representative for your jurisdiction and appreciate the continued support during this planning process.

Sincerely,

Ashley Cappel

Deputy Emergency Manager

Arapahoe County

720-874-4046

SERVING WITH INTEGRITY
ARAPAHOE SHERIFF
SINCE 1858

January 14, 2020

Dear Mr. Lewis,

Arapahoe County is in the process of updating its Hazard Mitigation Plan. This project involves identifying local mitigation actions that used over the long term reduce risk and future losses from disasters. The detailed plan assesses a variety of potential natural and human caused hazards that could affect some or all of the county's residents and businesses. Throughout the planning process, the county looks forward to engaging our partner jurisdictions and obtaining your input. Arapahoe County is committed to reducing the vulnerability of its citizens to the effects of hazards and this Hazard Mitigation Plan is an important tool in helping to do so.

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We already have a designated representative for your jurisdiction and appreciate the continued support during this planning process.

Sincerely,

Ashley Cappel

Deputy Emergency Manager

Arapahoe County

720-874-4046

SERVING WITH INTEGRITY

ARAPAHOE SHERIFF

SINCE 1858

January 14, 2020

Dear Ms. Cassaday,

Arapahoe County is in the process of updating its Hazard Mitigation Plan. This project involves identifying local mitigation actions that used over the long term reduce risk and future losses from disasters. The detailed plan assesses a variety of potential natural and human caused hazards that could affect some or all of the county's residents and businesses. Throughout the planning process, the county looks forward to engaging our partner jurisdictions and obtaining your input. Arapahoe County is committed to reducing the vulnerability of its citizens to the effects of hazards and this Hazard Mitigation Plan is an important tool in helping to do so.

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
- Demonstrating a firm commitment to improving community health and safety

Participating will not obligate a jurisdiction to anything; however, not adopting the Plan will jeopardize eligibility of federal disaster assistance, specifically, the Federal Emergency Management Agency's (FEMA) Hazard Mitigation Assistance grant programs (HMA).

We already have a designated representative for your jurisdiction and appreciate the continued support during this planning process.

Sincerely,

Ashley Cappel

Deputy Emergency Manager

Arapahoe County

720-874-4046

SERVING WITH INTEGRITY

ARAPAHOE SHERIFF

SINCE 1858

January 14, 2020

Dear Mr. Jackson,

Arapahoe County is in the process of updating its Hazard Mitigation Plan. This project involves identifying local mitigation actions that used over the long term reduce risk and future losses from disasters. The detailed plan assesses a variety of potential natural and human caused hazards that could affect some or all of the county's residents and businesses. Throughout the planning process, the county looks forward to engaging our partner jurisdictions and obtaining your input. Arapahoe County is committed to reducing the vulnerability of its citizens to the effects of hazards and this Hazard Mitigation Plan is an important tool in helping to do so.

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Sincerely,

Ashley Cappel

Deputy Emergency Manager

Arapahoe County

720-874-4046

SERVING WITH INTEGRITY

ARAPAHOE SHERIFF

SINCE 1858

January 14, 2020

Dear Mr. Relph,

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We already have a designated representative for your jurisdiction and appreciate the continued support during this planning process.

Sincerely,

Ashley Cappel

Deputy Emergency Manager

Arapahoe County

720-874-4046

SERVING WITH INTEGRITY
ARAPAHOE SHERIFF
SINCE 1858

January 14, 2020

Dear Mr. Granbery,

Arapahoe County is in the process of updating its Hazard Mitigation Plan. This project involves identifying local mitigation actions that used over the long term reduce risk and future losses from disasters. The detailed plan assesses a variety of potential natural and human caused hazards that could affect some or all of the county's residents and businesses. Throughout the planning process, the county looks forward to engaging our partner jurisdictions and obtaining your input. Arapahoe County is committed to reducing the vulnerability of its citizens to the effects of hazards and this Hazard Mitigation Plan is an important tool in helping to do so.

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In order to work together through this update process, we ask that you provide us with the name and contact information of whom you are designating from your jurisdiction to be the point of contact during the Hazard Mitigation Planning process.

Sincerely,

Ashley Cappel

Deputy Emergency Manager

Arapahoe County

720-874-4046

SERVING WITH INTEGRITY

ARAPAHOE SHERIFF

SINCE 1858

January 14, 2020

Dear Ms. Stiles,

Arapahoe County is in the process of updating its Hazard Mitigation Plan. This project involves identifying local mitigation actions that used over the long term reduce risk and future losses from disasters. The detailed plan assesses a variety of potential natural and human caused hazards that could affect some or all of the county's residents and businesses. Throughout the planning process, the county looks forward to engaging our partner jurisdictions and obtaining your input. Arapahoe County is committed to reducing the vulnerability of its citizens to the effects of hazards and this Hazard Mitigation Plan is an important tool in helping to do so.

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Sincerely,

Ashley Cappel

Deputy Emergency Manager

Arapahoe County

720-874-4046

SERVING WITH INTEGRITY

ARAPAHOE SHERIFF

SINCE 1858

January 14, 2020

Dear Mayor Feldkamp,

Arapahoe County is in the process of updating its Hazard Mitigation Plan. This project involves identifying local mitigation actions that used over the long term reduce risk and future losses from disasters. The detailed plan assesses a variety of potential natural and human caused hazards that could affect some or all of the county's residents and businesses. Throughout the planning process, the county looks forward to engaging our partner jurisdictions and obtaining your input. Arapahoe County is committed to reducing the vulnerability of its citizens to the effects of hazards and this Hazard Mitigation Plan is an important tool in helping to do so.

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Sincerely,

Ashley Cappel

Deputy Emergency Manager

Arapahoe County

720-874-4046

SERVING WITH INTEGRITY
ARAPAHOE SHERIFF
SINCE 1858

January 14, 2020

Dear Mr. McCrumb,

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Sincerely,

Ashley Cappel

Deputy Emergency Manager

Arapahoe County

720-874-4046

SERVING WITH INTEGRITY
ARAPAHOE SHERIFF
SINCE 1858

January 15, 2020

Dear Mayor Johnson,

Arapahoe County is in the process of updating its Hazard Mitigation Plan. This project involves identifying local mitigation actions that used over the long term reduce risk and future losses from disasters. The detailed plan assesses a variety of potential natural and human caused hazards that could affect some or all of the county's residents and businesses. Throughout the planning process, the county looks forward to engaging our partner jurisdictions and obtaining your input. Arapahoe County is committed to reducing the vulnerability of its citizens to the effects of hazards and this Hazard Mitigation Plan is an important tool in helping to do so.

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Sincerely,

Ashley Cappel
Deputy Emergency Manager
Arapahoe County
720-874-4046

SERVING WITH INTEGRITY

ARAPAHOE SHERIFF

SINCE 1858

January 15, 2020

Dear Mayor Jones,

Arapahoe County is in the process of updating its Hazard Mitigation Plan. This project involves identifying local mitigation actions that used over the long term reduce risk and future losses from disasters. The detailed plan assesses a variety of potential natural and human caused hazards that could affect some or all of the county's residents and businesses. Throughout the planning process, the county looks forward to engaging our partner jurisdictions and obtaining your input. Arapahoe County is committed to reducing the vulnerability of its citizens to the effects of hazards and this Hazard Mitigation Plan is an important tool in helping to do so.

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We already have a designated representative for your jurisdiction and appreciate the continued support during this planning process.

Sincerely,

Ashley Cappel

Deputy Emergency Manager

Arapahoe County

720-874-4046

Hazard Mitigation Plan Review

May 17th, 2016 @ 1300 – 1430

Arapahoe County Sheriff's Office: 13101 E Broncos Pkwy, Centennial

Training Room #1

1. Introductions: Name, Jurisdiction, Role you had during planning process and/or role you have now during 5 year maintenance process.

2. Grant Updates
    a. Jurisdictions sharing projects they have submitted
    b. Any suggestions for future grant projects that may require multiple jurisdictions to collaborate
    c. Lessons learned/Improvements for future grants from those that have submitted?

3. Review current goals for each jurisdiction – any updates?

4. Status update of entire Mitigation Strategy Spreadsheet
    a. Has the nature or magnitude of hazards affecting the County changed?
    b. Are there new hazards that have the potential to impact the County?
    c. Do the identified goals and actions address current and expected conditions?
    d. Have mitigation actions been implemented or completed?
    e. Has the implementation of identified mitigation actions resulted in expected outcomes?
    f. Are current resources adequate to implement the plan?
    g. Should additional local resources be committed to address identified hazards?

5. Any additional comments/updates

Next meeting will be Spring of 2017.

Please provide any applicable personnel changes to this workgroup to: acappel@arapahoegov.com

Hazard Mitigation Plan Review

June 22nd, 2017 0900 - 1030

Arapahoe County Sheriff's Office: 13101 E Broncos Pkwy, Centennial

Community Room

1. Introductions: Name, Jurisdiction, Role you had during planning process and/or role you have now during 5 year maintenance process.

2. Grant Updates:
    a. Jurisdictions sharing projects submitted
    b. Any suggestions for future grant projects that may require multiple jurisdictions to collaborate.

3. SEMSWA mitigation project presentation

4. Status update of entire Mitigation Strategy Spreadsheet
    a. Has the nature or magnitude of hazards affecting the County changed?
    b. Are there new hazards that have the potential to impact the County?
    c. Do the identified goals and actions address current and expected conditions?
    d. Have mitigation actions been implemented or completed?
    e. Has the implementation of identified mitigation actions resulted in expected outcomes?
    f. Are current resources adequate to implement the plan?
    g. Should additional local resources be committed to address identified hazards?

5. Any additional comments/updates

Next meeting will be Spring of 2018.

Please provide any applicable personnel changes to this workgroup to: acappel@arapahoegov.com

Hazard Mitigation Plan Review

Arapahoe County Sheriff's Office, Community Room

13101 E. Broncos Pkwy., Centennial

May 24, 2018

10:00 – 11:30 AM

1. Introductions — Fredrickson
    a. Name
    b. Jurisdiction
    c. Role in the planning/maintenance process

2. Grant Updates — Fogg
    a. Jurisdictions with submitted projects
    b. Jurisdiction with suggestions for future projects

3. NAPSG Project Debrief — Fredrickson

4. Comprehensive Plan HMP update — Fogg

5. Status update of Mitigation Strategy Spreadsheet — Fredrickson
    a. Has the nature or magnitude of hazards affecting the County changed?
    b. Are there new hazards that have the potential to impact the County?
    c. Do the identified goals and actions address current and expected conditions?
    d. Have mitigation actions been implemented or completed?
    e. Has the implementation of identified mitigation actions resulted in expected outcomes?
    f. Are current resources adequate to implement the plan?
    g. Should additional local resources be committed to address identified hazards?

6. Future Planning Timeline — Thompson

7. Other topics/open discussion — Fredrickson

Next meeting will be early Spring of 2019.

Please provide any applicable personnel changes to this workgroup to: jfredrickson@arapahoegov.com

Hazard Mitigation Plan Review

Arapahoe County Sheriff's Office, Training room #1

13101 E. Broncos Pkwy., Centennial

August 29, 2019

10:00 – 11:30 AM

1. Introductions — Fredrickson
    a. Name
    b. Jurisdiction
    c. Role in the planning/maintenance process

2. Grant Updates — All Partners
    a. Jurisdictions with submitted projects
    b. Jurisdictions with suggestions for future projects

3. PowerPoint/PDM and FMA grants — Thompson

4. Timeline for 2020-2015 update — Cappel

5. Status update of Mitigation Strategy Spreadsheet — Fredrickson
    a. Has the nature or magnitude of hazards affecting the County changed?
    b. Are there new hazards that have the potential to impact the County?
    c. Do the identified goals and actions address current and expected conditions?
    d. Have mitigation actions been implemented or completed?
    e. Has the implementation of identified mitigation actions resulted in expected outcomes?
    f. Are current resources adequate to implement the plan?
    g. Should additional local resources be committed to address identified hazards?

6. Other topics/open discussion — Fredrickson

Next meeting will be January of 2020.

Please provide any applicable personnel changes to this workgroup to: jfredrickson@arapahoegov.com

2019-2020 Hazard Mitigation Plan Revision Timeline

Date	Brief Description	Action Items
August 2019	Annual Meeting	• Determine Planning Committee Membership • Public Outreach Begins
January 2020	Planning Committee Meeting (Kickoff)	• Planning Committee Review Progress, Goals and Future Strategic Actions
Spring 2020	Check In	• Complete Risk Assessment • Report Progress
May 2020	Planning Committee Meeting (Review)	• Planning Committee Members Finalize Future Goals and Actions
June 2020	Public Meetings	• Arapahoe OEM and Planning Committee Members Coordinate Public Meetings
Summer 2020	Approval Submissions	• Planning Committee Submits their Respective Sections to their Respective Jurisdictions for Adoption • Arapahoe OEM Submits to State and FEMA for Preliminary Approval
Fall 2020	Board Adoption	• All Participating Jurisdictions Submit Proof of Adoption • Arapahoe OEM Submits to County Board for Adoption
December 2020	Adopt 2020-2025 HMP	• Full HMP Plan Adopted
2020-2025 Continuous Annual Meetings		

Hazard Mitigation 2020-2025 Update Kick-off Meeting

Arapahoe County Sheriff's Office, Training room #1

13101 E. Broncos Pkwy., Centennial

January 29, 2020

10:00 – 11:30 AM

1. Introductions — Fredrickson
    a. Name
    b. Jurisdiction
    c. Role in the planning/maintenance process

2. 'Kickoff' PowerPoint — Thompson

3. Expectations of adopting jurisdictions and the planning team — Cappel/Fredrickson

4. Hazard Identification and Risk Assessment Chart — Clay

5. Capabilities/Survey/Homework — Clay

6. Public Outreach/Survey's — Fredrickson/Sherman

7. Other topics/open discussion — Fredrickson

Next meeting will be late March or early April of 2020.

Please provide any applicable personnel changes to this workgroup to: jfredrickson@arapahoegov.com

2019-2020 Hazard Mitigation Plan Revision Timeline

Date	Brief Description	Action Items
August 2019	Annual Meeting	• Determine Planning Committee Membership • Public Outreach Begins
January 2020	Planning Committee Meeting (Kickoff)	• Planning Committee Review Progress, Goals and Future Strategic Actions
March/April 2020	Check In Meetings	• Complete Risk Assessment • Report Progress
May 2020	Planning Committee Meeting (Review)	• Planning Committee Members Finalize Future Goals and Actions
June 2020	Submit to State	• Arapahoe County OEM Submits to State
Summer 2020	Approval Submissions	• Planning Committee Submits their Respective Sections to their Respective Jurisdictions for Adoption • Arapahoe OEM Submits to FEMA for Approval
Fall 2020	Board Adoption	• All Participating Jurisdictions Submit Proof of Adoption • Arapahoe OEM Submits to County Board for Adoption
December 2020	Adopt 2020-2025 HMP	• Full HMP Plan Adopted
2020-2025 Continuous Annual Meetings		

SERVING WITH INTEGRITY

ARAPAHOE SHERIFF

SINCE 1858

2020-2025 HAZARD MITIGATION UPDATE KICKOFF MEETING

01/29/2020, 10AM-11:30AM

Name	Email	Agency/Jurisdiction	Initials
Bedell, Glen	gbedell@eecv.org		
Blair, Justin	jblair@eccv.org	ECCV	JBR
Campbell, Mark	mcampbell@sheridangov.org		
Cappel, Ashley	ACappel@arapahoegov.com	Arap. CEM	AC
Carmann, T	tcarmann@iconeng.com		
Chapman, Matt	mchapman@auroragov.org		
Chavez, Tom	tchavez@cfpd.org		
Cisson, Dominick	DCisson@ArapahoeGov.com	Arapahoe Co-O	DC
Clay, Elizabeth	EClay@arapahoegov.com	ACSO	EC
Cottrell, Bret	bcottrell@columbinevalley.org		
Cramer, Chris	ccramer@cherryhillsvillage.com	Cherry Hills Vil.	CC
D'Andrea, Maria	mdandrea@englewoodco.gov		
Disher, Mike	mdisher@byersfire.org		
Englert, Tim	tenglert@englewoodgov.org		
Erwin, Jackie	jackie.erwin@southmetro.org		
Fields, Frank	ffields@svfd8.org		
Fogg, Nathan	NFogg@arapahoegov.com	ACOEM/ENG	NDF
Fredrickson, Jason	jfredrickson@arapahoegov.com	ACSO	JF
Gavelda, Patricia	patricia.gavelda@state.co.us		
Giroux, Daniel	dangiroux@terramax.us		
Gross, Mike	mgross@glendale.co.us		

SERVING WITH INTEGRITY

ARAPAHOE SHERIFF

SINCE 1858

2020-2025 HAZARD MITIGATION UPDATE KICKOFF MEETING

01/29/2020, 10AM-11:30AM

Name	Email	Agency/Jurisdiction	Initials
Haskins, Chuck	CHaskins@arapahoegov.com		
Haskins, William	whaskins@glendale.co.us		
Hinton, Lorie	lhinton@centennialairport.com		
Hubbard, Michael	MHubbard@ArapahoeGov.com	ACSO IT	MH
Johnson, Dan	DJohnson7@arapahoegov.com	ACSO OEM	DJ
Kay, Kevin	KKay@arapahoegov.com	ACSO OEM	KK
Kocis, Diane	DKocis@arapahoegov.com		
Lewis, Brian	blewis@centennialairport.com		
Loveless, Rich	rloveless.dtfire@gmail.com		
Mccawley, Tim	timothymccawley@bennettfirerescue.org		
McCrumb, JD	jdmccrumb@columbinevalley.org		
Morianti, Michael	mmorianti@acwwa.com		
Mourning, Randy	rmourning@sheridangov.org		
Mueller, Matthew	Matthew.Mueller@denvergov.org		
Peck, Steven	SPeck@arapahoegov.com		
Peterson, Allen	apeterson@arapahoegov.com		
Poole, Glen	gpoole@arapahoegov.com	GR Poole	GRP
Reester, Keith	kreester@littletongov.org		
Rhodes, Jerry	jrhodes@cfpd.org		
Roan, Carolyn	croan@littletongov.org	Littleton	CRR
Scheidt, Gerilynn	gscheidt@bennett.co.us	Town of Bennett	GMS

SERVING WITH INTEGRITY

ARAPAHOE SHERIFF

SINCE 1858

2020-2025 HAZARD MITIGATION UPDATE KICKOFF MEETING

01/29/2020, 10AM-11:30AM

Name	Email	Agency/Jurisdiction	Initials
Schneider, Jonah	jschneider@centennialco.gov	Centennial	
Sherman, Deborah	DSherman@arapahoegov.com		
Soloman, Rich	solomon.rich@sablealturafire.org		
Spuhler, Kim	kim.spuhler@southmetro.org		
Stark, Cory	cory.stark@state.co.us		
Stegmiller, Martin	mstegmiller@acwwa.com	ACWWA	
Stephens, Doug	dougstephens@littletongov.org		
Stewart, Kevin	kstewart@udfcd.org		
Thompson, Brent	bthompson@littletongov.org		
Thompson, Mark	markw.thompson@state.co.us	DHSEM	
Thompson, Stacey	sthompson@semswa.org	SEMSWA	
Town of Bow Mar	bowmartown@gmail.com		
Town of Foxfield Engineer	sjardine@sehinc.com		
Town of Foxfield Planner	brea@mccooldevelopment.com		
Yeckes, Jan	JYeckes@arapahoegov.com	Public Works/Planning	
Enley, Gene	GENLEY@littletongov.org		
Arthur Negretti	anegretti@centennialco.gov	Cent.	

- **Jason called the start of the meeting at 1005.**
- Jason walked through the agenda.
- Nate gave a brief introduction and background on the HMP. Nate talked about a bill that would establish a match fund for mitigation projects (HB20-1142) at CDPS. This could be used for the match portion of Federal grant projects.
- Jason walked over the proposed timeline.
- Mark Thompson walked through his PowerPoint. Purpose of HMP is to address potential consequences such as loss of life, property damage, displacement, etc. We have enough information to know where (most) hazards will occur. Mitigation is to reduce long term risk in this process. Financial opportunities as a result of this process include:
  1. Pre-Disaster Mitigation Grant (PDMG) – Annual Grant (last year), all natural hazards.
  2. Building Resilient Infrastructure and Communities (BRIC) – Rolling out 2020, all natural hazards, focused on community level infrastructure. Percentage of previous year's spending on response and recovery will be used to fund mitigation (6%).
  3. Flood mitigation assistant program – Funded from NFIP premiums.
  4. Hazard mitigation grant program – After a disaster.
  5. All 75% federal, 25% state/local match.
  6. **See PowerPoint for more information.**
- Mark walked through mitigation examples, mitigation financial benefits, and an overview of mitigation projects in Colorado.
- HMP does not require you to spend money. Adopting the plan doesn't require you to execute the projects.
- Mark fielded some questions relating to the HMP process:
  1. Question about jurisdictions not adopting – They can adopt later if they participate in the process.
  2. Question about tech hazard such as a fire being caused by Xcel - Can work with private entities if you want to include in match. Examples given include Mile High Flood District, Tri-State Energy, etc.
  3. Question about projects already started – FEMA won't fund a project already started.
  4. Question about outreach, public education eligibility – Possible after a disaster.
  5. Question about tie-in with cybersecurity – Not addressed by FEMA right now.
- Ashley went over expectations of the planning team. Each jurisdiction has a profile in the plan and it is tailored to that area. We need the right people and information to make sure it is a valuable process and plan.
- Lisa talked about hazard profiles and changes from 2015 plan to the new plan. Removing some hazards and adding human-caused and technological hazards (dams, hazmat, cyber threat, active threat).
- Question about removing soil erosion. It can be added in as a sub category say under flooding.

No other questions on the hazards moving forward. The hazards presented will be used for the planning process.

- Lisa showed an example of the risk rankings process.

- Lisa asked the group to send any events that have happened since the last HMP process i.e. Tom Bay, 2018 tornado west of deer trail, etc. Also asked for any data or studies related to hazard mitigation.
- Jason and Lisa showed examples of the mapping products used in the plan.
- Common form for all communities to fill out their capabilities.
- Deb Sherman, Arapahoe County Sheriff's Office PIO, made a webpage for the HMP. Deb walked through the purpose of the site and how it will help spread the word to folks in Arapahoe County. Deb also showed the survey and video.

Arapahoe County
Hazard Mitigation Plan 2020 Update

Re-Engagement Webinar Summary
9:30am – 10am
June 8, 2020

Introductions and Opening Remarks

This document summarizes the re-engagement webinar for the Arapahoe County Hazard Mitigation Plan update for 2020. The County had an initial kickoff webinar on January 29, 2020. While much work was completed, in April the project was placed on hold due to the Covid-19 pandemic. The purpose of this webinar was to re-engage the HMPC members in the planning process and to introduce Wood Environment & Infrastructure Solutions, Inc. (Wood), the consulting firm hired to facilitate the planning process and complete the plan update. This type of meeting is ideally conducted in-person, however in this instance the meeting was done in a webinar format in order to comply with social distancing requirements as a result of the COVID-19 Pandemic. Scott Field, Project Manager at Wood, began the meeting with introductions. Twenty-two people attended the webinar representing a mix of County departments, participating jurisdictions, and stakeholders. The key discussion is summarized below; additional details can be found in the meeting PowerPoint presentation and webinar recording.

Hazard Mitigation Overview

Scott outlined what hazard mitigation is and why it is important. The overall purpose of a local hazard mitigation plan is to prevent knowable hazards from having an impact on the community. Hazard mitigation should be an ongoing effort integrated into both day-to-day operations and long-term planning. FEMA is only concerned with natural hazards being profiled within these plans but explained this does not preclude communities from including human-caused hazards in order to have a one-stop plan for all types of hazards that pose a risk to the community. A hazard mitigation plan is not a regulatory document and is not a set-in-stone commitment of resources.

There are two main types of benefits a community gains from having a FEMA approved hazard mitigation plan (HMP); (1) bringing people together in the community; (2) eligibility for FEMA mitigation grants (Pre-Disaster Mitigation, Flood Mitigation Assistance, Hazard Mitigation Grant Program-Post-Disaster). Requests for FEMA mitigation funding need to be based on the hazards and mitigation strategy in the HMP. Information from the hazard mitigation plan, specifically the vulnerability assessment and mitigation strategy, can be used in other hazard related plans such as community wildfire protection plans.

FEMA will only fund mitigation projects that will reduce future demand for and the costs of disaster response and recovery, such as retrofitting a critical facility, enforcing building codes, land use planning, or removing a structure from a hazard area. Mitigation funding cannot be used for response actions such as purchasing vehicles for fire or police departments. Scott continued by briefly reviewing the benefit cost relationship of mitigation projects. A 2017 National Institute of Building Science Report showed that mitigation grants

funded through select federal government agencies, on average, can save the nation $6 in future disaster costs for every $1 spent on hazard mitigation.

Hazard Mitigation Planning Process and Requirements

The meeting continued with a review of the specific planning requirements the County will have to meet in order to have a FEMA approved plan. Scott reviewed the Disaster Mitigation Act (DMA) of 2000 Requirements and explained that the Larimer County Multi-Jurisdictional Hazard Mitigation Plan (HMP) will be updated in accordance with these requirements. The planning process involves a 4 Phase approach:

- Phase 1: Organize Resources
- Phase 2: Risk Assessment
- Phase 3: Develop a Mitigation Strategy
- Phase 4: Update Plan, Review & Adoption

Role of the Hazard Mitigation Planning Committee (HMPC)

The first step in getting organized is to determine the hazard mitigation planning committee members, which has already started with those in attendance at the kickoff webinar. Scott gave those present additional recommendations of who could also be invited to be on the committee, starting with those who were on the committee for the 2015 planning process. Special districts could also be considered jurisdictions and be eligible for FEMA funding on their own or have the option to participate as a stakeholder. As a stakeholder they would not need to adopt the plan but could not apply directly to FEMA for grant funding.

Local input, and participation from the county, municipalities, and special districts is required for full approval from FEMA. Participation includes the following:

- Attend meetings and participate in the planning process
- Provide requested information to update or develop jurisdictional information
- Review drafts and provide comments
- Identify mitigation projects specific to jurisdiction, provide status
- Assist with and participate in the public input process
- Coordinate formal adoption

Stakeholders include other local, state and federal agencies with a stake in hazard mitigation in the County or may include academic institutions and local business and industry. State and federal stakeholders may include the Colorado Department of Transportation (CDOT), Colorado Department of Public Health (CDPHE), Colorado Water Conservation Board (CWCB) and Colorado Geological Survey (CGS). Neighboring counties will also be notified about the update and given an opportunity to provide input into the process.

Stakeholders have various options and levels of participation including:

- Attend HMPC meetings or stay in loop via email list
- Provide data/information
- Partner on mitigation efforts
- Review draft plan

Plan Update Requirements, Key Elements and Schedule

Aspects of the planning process include:

- Engage the participants to take part in planning process and efforts
- Raise awareness and engage the public
- Update hazards and baseline development data to reflect current conditions
- Update the mitigation strategy
- Document progress and note changes in priorities

An important requirement of the hazard mitigation planning process is to involve the public in the process. FEMA requires two opportunities for public involvement: once during the drafting stage and once more prior to plan approval. FEMA does not prescribe how to involve the public at either of these steps. There are several advantages to involving the public including developing solutions that fit local needs better, strengthening local support for the plan and ensuring a fair process in the development of the plan. It was acknowledged that it can be challenging to get the public to attend meetings. Wood recommended to "piggyback" public meetings and outreach with other related meetings or webinars. The County released a public survey in January and received 1,962 responses from the public.

Another requirement of the plan update process is performing a community capability assessment. This is an assessment of the communities existing plans, regulations, fiscal abilities, administrative and technical abilities. Identifying fiscal abilities early on is important because FEMA requires a 25% match of local funds for most mitigation grants. Early identification will help to understand potential funding sources now that could be used to possibly match the federal funds. Capability Assessment surveys were sent earlier in the process to all participating jurisdictions and will continue to open until all jurisdictions have responded.

Conducting a risk assessment is a key aspect of a hazard mitigation plan and involves two components: hazard identification (what can happen here) and the vulnerability assessment (what will be affected). The HMP update will be based on existing documents and studies, with the Arapahoe County Hazard Mitigation Plan (2015) providing the baseline for identified hazards and the groundwork for goals, policies and actions for hazard mitigation.

Overview of 2016 Larimer County Hazard Mitigation Plan

Based on hazards from the previous plan, the list of potential hazards was reviewed. The significance level of some hazards may vary across the County, and some hazards may not be applicable to all jurisdictions.

- Drought
- Flooding
- Public Health Hazards
- Severe Summer Weather
- Severe Winter Weather
- Severe Wind/Tornado
- Wildfire
- Dam failure
- Hazmat Release

- Active Threat
- Cyber Threat

Initial Information Needs and Next steps

The HMP will be updated over the next six months, with at least two more meetings with the Hazard Mitigation Planning Committee. Wood will finish updating the Hazard Identification and Risk Assessment (HIRA) in the next couple of months, with input from the HMPC. Three drafts of the HMP will be created: the first for review by HMPC committee, a second for public review, and a third for state and FEMA review. The tentative project schedule is shown below, although these dates may need to be adjusted based on the ongoing pandemic situation.

Project Milestone	Anticipated Timeline
• HMPC Meeting #2 – HIRA Review	June 2020
• Updated HIRA	July 2020
• HMPC Meeting #3 – Mitigation Strategy	Late July – early August
• HMPC Review Draft	August 2020
• Public Review Draft	September 2020
• CO DHSEM Review	October 2020
• FEMA Review (estimated)	October – December 2020
• Final Approved HMP for local adoption	December 2020

Wood will continue work in the Hazard Identification and Risk Assessment. The next HMPC webinar is tentatively planned for later in June following the update of the Hazard Identification and Risk Assessment section of the plan. However, the project schedule may need to be adjusted due to the current pandemic situation. Meeting dates and other deadlines will be shared when available.

Adjourn

The meeting adjourned at 2:37 pm

ATTENDANCE RECORD
Arapahoe County
Hazard Mitigation Plan Update
HMPC Re-Engagement Meeting
Monday, June 8, 2020 at 9:30 am-10:00 am MDT

Name	Jurisdiction/Organization	Title	E-mail
Black, Emily			
Cappel, Ashley	Arapahoe County OEM	Deputy Manager	ACappel@arapahoegov.com
Cisson, Dominick	Arapahoe County/ GIS	GIS Director	DCisson@ArapahoeGov.com
Clay, Elizabeth	Arapahoe County OEM	Emergency Management Coordinator	EClay@arapahoegov.com
Enley, Gene	City of Littleton/Police Department	Division Chief	genley@littletongov.org
Erwin, Jackie	South Metro Fire	OEM	jackie.erwin@southmetro.org
Fredrickson, Jason	Arapahoe County OEM	Deputy Manager	jfredrickson@arapahoegov.cor
Gavelda, Patricia	Colorado State/ DHSEM	Planning Manager	patricia.gavelda@state.co.us
Gross, Mike	Glendale PD	Operation Commander	mgross@glendale.co.us
Johnson, Dan	Arapahoe County OEM	Emergency Management Coordinator	DJohnson7@arapahoegov.com
Kocis, Diane	Arapahoe County Public Works - Planning	Oil and Gas Specialist	DKocis@arapahoegov.com
Negretti, Arthur	City of Centennial Public Works	Engineering Manager	anegretti@centennialco.gov
Poole, Glen	Arapahoe County/Open Space	Director	gpoole@arapahoegov.com
Rhodes, Jerry	South Metro Fire	Chief	jerry.rhodes@southmetro.org
Roan, Carolyn	City of Littleton Public Works – Engineering Division	Water Resource Manager	croan@littletongov.org
Scheidt, Gerilynn	Town of Bennett	Town Safety Officer	gscheidt@bennett.co.us
Schneider, Jonah	City of Centennial	Emergency Manager	jschneider@centennialco.gov
Stephens, Doug	Arapahoe County/Open Space		dougstephens@littletongov.org
Stewart, Kevin	Mile High Flood District	Program Manager	kstewart@udfcd.org
Thompson, Mark	CO DHSEM	Mitigation Planning Specialist	markw.thompson@state.co.us
Thompson, Stacey	SEMSWA	Floodplain Manager	sthompson@semswa.org
Wiersma, Dakota			

Arapahoe County Hazard Mitigation Plan Update

Hazard Identification and Risk Assessment Meeting

Tuesday, June 23, 2020 9:30-11:30 AM
Meeting held online via Microsoft Teams
Phone: 866-670-1764, Conference ID: 3157542#

Subject/Purpose: The purpose of the meeting is to review the highlights of the updated Hazard Identification and Risk Assessment.

1. **Introductions**

2. **Review of the Planning Process**

3. **Review of Identified Hazards and Vulnerability Assessment Overview**

4. **Update on Public Involvement**

5. **Mitigation Goals and Objectives**

6. **Next Steps**

7. **Questions and Answers/Adjourn**

wood.

ATTENDANCE RECORD
Arapahoe County
Hazard Mitigation Plan Update
HMPC Meeting #2 –Hazard Identification and Risk Assessment
Tuesday, June 23, 2020 at 9:30 am-11:30 pm MDT

Name	Jurisdiction/Organization	Title	E-mail
Bertrand, Josh			
Brown, Kevin	Glendale GIS		
Cappel, Ashley	Arapahoe County OEM	Deputy Manager	ACappel@arapahoegov.com
Cisson, Dominick	Arapahoe County/ GIS	GIS Director	DCisson@ArapahoeGov.com
Clay, Elizabeth	Arapahoe County OEM	Emergency Management Coordinator	EClay@arapahoegov.com
Cramer, Chris	Town of Cherry Hills Village	Community Development Director	ccramer@cherryhillsvillage.com
Enley, Gene	City of Littleton/Police Department	Division Chief	genley@littletongov.org
Erwin, Jackie	South Metro Fire	OEM	jackie.erwin@southmetro.org
Fogg, Nathan	Arapahoe County OEM	Manager	NFogg@arapahoegov.com
Franco, Becky	Denver Water/Emergency Management	Manager	
Goldie, Jay	Cherry Hills Village/Public Works		
Hubbard, Michael	Arapahoe County	GIS Specialist	MHubbard@ArapahoeGov.com
Johnson, Dan	Arapahoe County OEM	Emergency Management Coordinator	DJohnson7@arapahoegov.com
Kocis, Diane	Arapahoe County Public Works - Planning	Oil and Gas Specialist	DKocis@arapahoegov.com
Mourning, Randy	City of Sheridan/Floodplain		rmourning@sheridangov.org
Negretti, Arthur	City of Centennial Public Works	Engineering Manager	anegretti@centennialco.gov
Peck, Steven	Arapahoe County OEM	Emergency Management Coordinator	SPeck@arapahoegov.com
Roan, Carolyn	City of Littleton Public Works – Engineering Division	Water Resource Manager	croan@littletongov.org
Scheidt, Gerilynn	Town of Bennett	Town Safety Officer	gscheidt@bennett.co.us
Schneider, Jonah	City of Centennial	Emergency Manager	jschneider@centennialco.gov
Thompson, Stacey	SEMSWA		sthompson@semswa.org

Yeckes, Jan	Arapahoe County Planning	Planning Division Manager	JYeckes@arapahoegov.com
303-408-5936			
303-754-3358			
303-789-2541			

Summary of the Arapahoe County
Multi-Hazard Mitigation Plan Update
Hazard Mitigation Planning Committee Meeting #2

June 23, 2020
9:30am – 11:30am
Risk Assessment Webinar

Introductions and Opening Remarks

Scott Field of Wood Environment and Infrastructure Solutions, the consulting firm hired to complete the plan development process, began the meeting with welcoming remarks. Thirty-two people attended the webinar representing various county departments, participating jurisdictions and stakeholders.

Review of Mitigation, Disaster Mitigation Act (DMA) Requirements, and the Planning Process

Following introductions, Scott Field reviewed the planning process being followed and discussed the project status.

Risk Assessment Presentation and Discussion

The general risk assessment requirements were outlined before turning to a detailed discussion of each hazard. Highlights were presented on each hazard included in the updated risk assessment chapter of the plan. Refer to the Arapahoe County HMP Risk Assessment PowerPoint presentation for specific details on each hazard and a handout summarizing hazard significance. Highlights of the discussion are noted by hazard in the table below.

Hazard or Topic	Meeting Discussion and Problem Statements
Drought	• No comments
Extreme Heat	• Previously profiled as part of drought. Hazard will be moved under summer weather.
Flooding	• Add note of NFIP participation that City of Aurora is not participating in the County's HMP update
Severe Summer Storms	• Change "storms" to "weather" • Vulnerability assessment should include injuries and fatalities as well as the ability (or inability) to respond to a call or a call for service.
Severe Wind/Tornado	• No comments
Severe Winter Storms	• Change "storms" to "weather"
Wildfire	• No comments
Dam Failure	• HMPC noted that Littleton is in the path of the Polly Deane overflows. • Wood will review that dams that are not ranked and determine if they should be included in the analysis.
Public Health Hazards	• Note vulnerability for people with underlying health issues. • Increase significance to "high" • HMPC noted that in past experiences with pandemics the county was confident with response. Current covid-19 event has shown gaps in the assumptions.
HazMat Release	• Note economic vulnerability from close I25 and I70 as well as well as the inconvenience on local neighborhood when cutting through due to closures.

Hazard or Topic	Meeting Discussion and Problem Statements
	• HMPC recommends increasing risk rankings, spatial extent, severity and overall significance. • Consider impacts to waterways.
Active Threat	• No comments
Cyber Threat	• SEMSWA was impacted by ransomware earlier in 2020 • Significance should be increased, due to increased dependence on technology and its potential impacts

Plan Goals Update

The HMPC reviewed the goals and objectives from the previous plan to see if they were still relevant or needed updating, based on a handout that included the state mitigation plan goals and other related plan goals from the County's 2015 Comprehensive Plan. In general, the group thought was they were still valid, but one member noted that protecting critical facilities was missing. A post meeting survey was shared that allows the HMPC to review the goals again and provide specific comments or revisions on each goal.
https://bit.ly/Arapahoe_HMP_Post_HIRA_Mtg_Survey

Plan Timeline/Next steps

The next HMPC planning meeting will be at the end of July. The purpose of that meeting will be to review the mitigation actions from 2015 plan and discuss developing new mitigation actions for the 2020 plan update.

The meeting materials from this meeting will be shared electronically, including the presentation and handouts.

The meeting adjourned at 11:30 am.

ARAPAHOE COUNTY HAZARD MITIGATION PLAN
2020 UPDATE
Updating the Mitigation Strategy

Mitigation Planning Goals, Objectives, and Actions - Definitions

Goals, objectives, and mitigation actions should be based on the information revealed in the Risk Assessment. Definitions are provided below:

Goals are general guidelines that explain what you want to achieve. Goals are defined before considering how to accomplish them so that the goals are not dependent on the means of achievement. They are usually broad policy-type statements, long term, and represent global visions, such as:

- Reduce exposure to hazard related losses
- Minimize the risk from natural disasters to existing facilities and proposed development.
- Reduce the impact of natural hazards to the citizens of the county.
- Provide protection for natural resources from hazard impacts
- Maintain and enhance existing mitigation measures.
- Increase public awareness of vulnerability to hazards and support and demand for hazard mitigation

Objectives define strategies or implementation steps to attain the identified goals. Unlike goals, objectives are specific and measurable, such as:

- Maintain the flood mitigation programs to provide 100-year flood protection
- Protect critical facilities to the 500 year flood
- Educate citizens about wildfire defensible space actions.
- Prepare plans and identify resources to facilitate reestablishing operations after a disaster.

Mitigation Actions are specific actions that help you achieve your goals and objectives. Some examples include:

- Elevate three historic structures located in the downtown district
- Sponsor a community fair to promote wildfire defensible space
- Retrofit the police department to withstand flood damage

The goals and objectives from the Montezuma County Hazard Mitigation Plan 2016 are shown on the next page. The 2020 plan update presents an opportunity to review the goals and modify if desired. Use this handout to verify that they are still appropriate or suggest modifications to the planning committee and Wood (amy.carr@woodplc.com).

Arapahoe County 2015 Hazard Mitigation Plan
Goals and Objectives

Goal 1: Prevent the loss of lives and injuries from hazards.

Goal 2: Prevent and/or reduce damages to public and private property from hazards.

Goal 3: Strengthen communication and coordination among public agencies, non-governmental organizations (NGOs), businesses, and private citizens.

Goal 4: Reduce the adverse economic and natural resource impacts of hazards.

Goal 5: Improve local resiliency to hazard events.

Objective 1: Reduce public exposure to hazards

Objective 2: Increase knowledge of hazard mitigation options

Objective 3: Increase awareness of hazards and their impacts

Objective 4: Adopt a coordinated alert system for jurisdictions within the County

Objective 5: Build redundancy into communication systems

Other Related Plan Goals

It is also important to integrate the mitigation strategy with other existing goals to ensure consistency, efficiency, and effectiveness, which is also useful in identifying funding opportunities. The following are provided for reference purposes.

Arapahoe County 2018 Comprehensive Plan – selected goals polices & strategies:

- **Goal GM 3** – Reduce the Loss of Life, Health and Property Due to Risks Posed by Natural and Man-made Hazards
  - **Policy GM 3.1** – Direct Future Development to Areas with Low Risks from Natural and Man-made Hazards
    - Strategy GM 3.1(a) - Identify Potential Hazardous Areas
    - Strategy GM 3.1(b) – Restrict Future Development in Known Hazard Areas
  - **Policy GM 3.2** – Determine Appropriate Uses and Land Use Intensities for Natural Hazard Areas
    - Strategy GM 3.2(a) – Adopt Hazard Area Zoning Regulations
    - Strategy GM 3.2(b) – Implement Geologic Hazard Regulations
  - **Policy GM 3.3** – Integrate Hazard Mitigation into Land Use and Capital Improvement Planning

    - Strategy GM 3.3(a) – Require Hazard Identification, Risk Assessment and Mitigation Plans for Development Applications
    - Strategy GM 3.3(b) – Coordinate with Fire Districts on Fire Hazard Mitigation
    - Strategy GM 3.3(c) – Provide Assistance in Reducing Wildfire Hazards
    - Strategy GM 3.3(d) – Fund Capital Improvements that Mitigate Natural Hazards
    - Strategy GM 3.3(e) – Plan and Fund Major Infrastructure Improvements that Avoid Areas Containing Natural Hazards
    - Strategy GM 3.3(f) – Consider Acquisition of Hazard Areas
    - Strategy GM 3.3(g) – Continue Restricting Development in Floodplains
    - Strategy GM 3.3(h) – Locate Critical Facilities to Avoid Floodplains
    - Strategy GM 3.3(i) - Adopt Standards to Limit or Mitigate Development in Other Hazard Areas
    - Strategy GM 3.3(j) – Consider Amendments to Building Codes to Protect Structures from Extreme Temperatures, Severe Storms and Severe Wind/Tornados
- **Policy GM 3.4** – Prepare for Recovery from Disasters
    - Strategy GM 3.4(a) – Adopt Post-Disaster Procedures
- **Policy GM 3.5** – Protect Existing and New Development from Man-made Hazards
    - Strategy GM 3.5(a) – Continue Enforcing Airport Influence Area Overlay Zone
    - Strategy GM 3.5(b) – Establish Oil and Gas Operation Setbacks
- **Policy GM 3.6** – Inform Citizens of Natural and Man-made Hazards
    - Strategy GM 3.6(a) - Increase Public Awareness about Potential Environmental Hazards
    - Strategy GM 3.6(b) – Consider Requiring Disclosure Statements

Arapahoe County 2020 Capital Improvement Program goals:

- Ensure infrastructure improvements provide the public with an acceptable and enhanced transportation network accounting for access, mobility and economic viability for citizens of Arapahoe County.
- Coordination with adjacent jurisdictions, districts and private entities on optimization of services and joint funding for projects.
- Investigation of innovative ways to maintain, improve and fund infrastructure needs.
- Maximization and effective management of federal and state grant monies for Capital Improvement Projects.
- Verify proposed improvements are compatible with existing infrastructure and in general compliance with County standards.

- Provides input and recommendations for standards development to the Metropolitan Government Pavement Engineer's Council.

Arapahoe County 2035 Transportation Plan goals:

- Promote an Efficient and Balanced Transportation System
- Promote Alternative Transportation Solutions
- Coordinate Land Use and Transportation
- Develop A Strategic Management and Tracking Approach to The County's Transportation System

Arapahoe County 2010 Open Space Master Plan:

- **Mission:** "protect Arapahoe County's treasured parks, trails and open space for residents to enjoy today and forever."
- Open Space Themes:
    - Diversity
    - Connectivity
    - Partnerships
    - Leadership
    - Environment
    - Public Responsibility
    - Sustainability
    - Environmental Awareness and Stewardship
    - Legacy

STATE OF COLORADO 2018 HAZARD MITIGATION PLAN GOALS

I: Minimize the loss of life and personal injuries from all-hazard events
Objectives: A, D, F, G, H
II: Reduce losses and damages to state, tribal, and local governments, as well as special districts and private assets, and support similar local efforts
Objectives: J, O
III: Reduce federal, state, tribal, local, and private costs of disaster response and recovery
Objectives: D, E, J, P, Q
IV: Support mitigation initiatives and policies that promote disaster resiliency, nature-based solutions, cultural resources and historic preservation, and climate adaptation strategies
Objectives: A, B, E, M, N
V: Minimize interruption of essential services and activities
Objectives: D, E, J, L, P, Q
VI: Incorporate equity considerations into all mitigation strategies
Objectives: A, E
VII: Support improved coordination of risk mitigation between and among the public, private, and non-profit sectors
Objectives: A, C, D, E, G, I, K, L, M, N, O, R
VIII: Create awareness and demand for mitigation as a standard of practice
Objectives: A, B, C, E, G, K, L, M, N, O

State of Colorado 2018 Mitigation Objectives:

A. Support and empower local and regional mitigation strategies through statewide guiding principles, programs, and resources

B. Promote activities that are climate neutral and supportive of appropriate renewable and alternative energy

C. Strengthen hazard risk communication tools and procedures

D. Strengthen continuity of operations at the federal, state, regional, tribal, and local levels of government to ensure the delivery of essential services

E. Strengthen cross-sector connections across the state government

F. Identify specific areas at risk to natural hazards and zones of vulnerability

G. Expand public awareness, education, and information programs relating to hazards and mitigation methods and techniques

H. Develop mitigation projects focused on preventing loss of life, injuries, and negative impacts to natural resources and reliant community sectors from natural, technological, and human-caused hazards

I. Assist local government officials with construction, non-construction, and regulatory hazard mitigation activities

J. Protect state critical, essential, and necessary assets located in natural hazard risk areas

K. Improve state, tribal, and local government mitigation project monitoring and decision-making tools

L. Strengthen connections between hazard mitigation activities and preparedness, response, and recovery activities

M. Improve coordination of state government mitigation resources with federal, tribal, and local government and private nonprofit resources

N. Increase state, tribal, and local government and private nonprofit participation in existing hazard mitigation programs

O. Partner with local and tribal governments to develop projects, initiatives, and public resources that protect private property from hazards

P. Reduce services interruptions and revenue losses, resulting from hazard events, to the state

Q. Reduce downtime and revenue losses, resulting from hazard events, for local and tribal governments and private nonprofit organizations

R. Through training, grants, and technical assistance, increase local government use of land use strategies that reduce risks to hazards

New Grant Requirement: Rehabilitation of High Hazard Potential Dams (HHPD) Grant Program

- HHPD3. Did Element S8 (mitigation goals) include mitigation goals to reduce longterm vulnerabilities from HHPDs that pose an unacceptable risk to the public?

Respondent

1 | Anonymous

10:04
Time to complete

1. Please rate the overall significance of each hazard for Arapahoe County as a whole based:

	Low	Medium	High
Drought	○	●	○
Flooding	○	●	○
Severe Summer Storms	○	○	●
Severe Wind/Tornado	○	●	○
Severe Winter Storms	○	○	●
Wildfire	○	●	○
Dam Failure/Incident	○	●	○
Public Health Hazard	○	○	●
Hazmat Release	○	●	○
Active Threat	●	○	○
Cyber Threat	○	●	○

2. Any comments or additional information on any of the above hazards?

All estimates can change based on the location, population, CIKR, date/time, and type of incident that is occurring and where it is occurring.

3. Below are the Goals from the 2015 Arapahoe County Hazard Mitigation Plan. Please comment if you think any changes should be made for the 2020 update, or if they should be readopted as is:

   1. Prevent the loss of lives and injuries from hazards.
   2. Prevent and/or reduce damages to public and private property from hazards.
   3. Strengthen communication and coordination among public agencies, non-governmental organizations (NGOs), businesses, and private citizens.
   4. Reduce the adverse economic and natural resource impacts of hazards.
   5. Improve local resiliency to hazard events.

4. Below are the Objectives from the 2015 Arapahoe County Hazard Mitigation Plan. Please comment if you think any changes should be made for the 2020 update, or if they should be readopted as is:

   1. Reduce public exposure to hazards
   2. Increase knowledge of hazard mitigation options
   3. Increase awareness of hazards and their impacts
   4. Adopt a coordinated alert system for jurisdictions within the County
   5. Build redundancy into communication systems

Respondent

2 | Anonymous

79:34
Time to complete

1. Please rate the overall significance of each hazard for Arapahoe County as a whole based:

	Low	Medium	High
Drought	○	●	○
Flooding	○	●	○
Severe Summer Storms	○	○	●
Severe Wind/Tornado	○	●	○
Severe Winter Storms	○	○	●
Wildfire	○	●	○
Dam Failure/Incident	○	●	○
Public Health Hazard	○	○	●
Hazmat Release	●	○	○
Active Threat	○	●	○
Cyber Threat	○	●	○

2. Any comments or additional information on any of the above hazards?

3. Below are the Goals from the 2015 Arapahoe County Hazard Mitigation Plan. Please comment if you think any changes should be made for the 2020 update, or if they should be readopted as is:

   1. Prevent the loss of lives and injuries from hazards.
   2. Prevent and/or reduce damages to public and private property from hazards.
   3. Strengthen communication and coordination among public agencies, non-governmental organizations (NGOs), businesses, and private citizens.
   4. Reduce the adverse economic and natural resource impacts of hazards.
   5. Improve local resiliency to hazard events.

4. Below are the Objectives from the 2015 Arapahoe County Hazard Mitigation Plan. Please comment if you think any changes should be made for the 2020 update, or if they should be readopted as is:

   1. Reduce public exposure to hazards
   2. Increase knowledge of hazard mitigation options
   3. Increase awareness of hazards and their impacts
   4. Adopt a coordinated alert system for jurisdictions within the County
   5. Build redundancy into communication systems

Respondent

3 | Anonymous

86:02
Time to complete

1. Please rate the overall significance of each hazard for Arapahoe County as a whole based:

	Low	Medium	High
Drought	○	●	○
Flooding	○	●	○
Severe Summer Storms	○	○	●
Severe Wind/Tornado	○	○	●
Severe Winter Storms	○	●	○
Wildfire	○	●	○
Dam Failure/Incident	○	●	○
Public Health Hazard	○	○	●
Hazmat Release	○	●	○
Active Threat	●	○	○
Cyber Threat	○	●	○

2. Any comments or additional information on any of the above hazards?

I was surprised by the higher significance by some of these. I would have ranked them lower.

3. Below are the Goals from the 2015 Arapahoe County Hazard Mitigation Plan. Please comment if you think any changes should be made for the 2020 update, or if they should be readopted as is:

   1. Prevent the loss of lives and injuries from hazards.
   2. Prevent and/or reduce damages to public and private property from hazards.
   3. Strengthen communication and coordination among public agencies, non-governmental organizations (NGOs), businesses, and private citizens.
   4. Reduce the adverse economic and natural resource impacts of hazards.
   5. Improve local resiliency to hazard events.

   Readopt as is.

4. Below are the Objectives from the 2015 Arapahoe County Hazard Mitigation Plan. Please comment if you think any changes should be made for the 2020 update, or if they should be readopted as is:

   1. Reduce public exposure to hazards
   2. Increase knowledge of hazard mitigation options
   3. Increase awareness of hazards and their impacts
   4. Adopt a coordinated alert system for jurisdictions within the County
   5. Build redundancy into communication systems

   Readopt as is.

Respondent

4 | Anonymous

87:01
Time to complete

1. Please rate the overall significance of each hazard for Arapahoe County as a whole based:

	Low	Medium	High
Drought	●	○	○
Flooding	○	●	○
Severe Summer Storms	○	○	●
Severe Wind/Tornado	○	●	○
Severe Winter Storms	○	○	●
Wildfire	○	●	○
Dam Failure/Incident	●	○	○
Public Health Hazard	○	●	○
Hazmat Release	○	●	○
Active Threat	○	●	○
Cyber Threat	○	●	○

2. Any comments or additional information on any of the above hazards?

3. Below are the Goals from the 2015 Arapahoe County Hazard Mitigation Plan. Please comment if you think any changes should be made for the 2020 update, or if they should be readopted as is:

   1. Prevent the loss of lives and injuries from hazards.
   2. Prevent and/or reduce damages to public and private property from hazards.
   3. Strengthen communication and coordination among public agencies, non-governmental organizations (NGOs), businesses, and private citizens.
   4. Reduce the adverse economic and natural resource impacts of hazards.
   5. Improve local resiliency to hazard events.

4. Below are the Objectives from the 2015 Arapahoe County Hazard Mitigation Plan. Please comment if you think any changes should be made for the 2020 update, or if they should be readopted as is:

   1. Reduce public exposure to hazards
   2. Increase knowledge of hazard mitigation options
   3. Increase awareness of hazards and their impacts
   4. Adopt a coordinated alert system for jurisdictions within the County
   5. Build redundancy into communication systems

   Thinking out loud, not sure what this would look like in a statement. But several of these have cascading impacts that don't stand alone on their individual hazard's mitigation tactics. The strategies need to be flexible to changing conditions. For example - if there is a cyber attack on a hazardous materials facility. Are we planning for mitigation methods that don't just mitigate one or other in a silo. Much like how we may mitigate wildfire differently year to year based on drought or heavy precipitation.

Respondent

5 | Anonymous

01:53
Time to complete

1. Please rate the overall significance of each hazard for Arapahoe County as a whole based:

	Low	Medium	High
Drought	○	○	●
Flooding	○	○	●
Severe Summer Storms	○	○	●
Severe Wind/Tornado	○	○	●
Severe Winter Storms	○	○	●
Wildfire	○	●	○
Dam Failure/Incident	○	●	○
Public Health Hazard	○	●	○
Hazmat Release	○	●	○
Active Threat	○	●	○
Cyber Threat	○	○	●

2. Any comments or additional information on any of the above hazards?

3. Below are the Goals from the 2015 Arapahoe County Hazard Mitigation Plan. Please comment if you think any changes should be made for the 2020 update, or if they should be readopted as is:

   1. Prevent the loss of lives and injuries from hazards.
   2. Prevent and/or reduce damages to public and private property from hazards.
   3. Strengthen communication and coordination among public agencies, non-governmental organizations (NGOs), businesses, and private citizens.
   4. Reduce the adverse economic and natural resource impacts of hazards.
   5. Improve local resiliency to hazard events.

   add infrastructure and critical facility protection, otherwise re adopt

4. Below are the Objectives from the 2015 Arapahoe County Hazard Mitigation Plan. Please comment if you think any changes should be made for the 2020 update, or if they should be readopted as is:

   1. Reduce public exposure to hazards
   2. Increase knowledge of hazard mitigation options
   3. Increase awareness of hazards and their impacts
   4. Adopt a coordinated alert system for jurisdictions within the County
   5. Build redundancy into communication systems

   identify critical infrastructure and faclities.

Respondent

6 | Anonymous

95:48
Time to complete

1. Please rate the overall significance of each hazard for Arapahoe County as a whole based:

	Low	Medium	High
Drought	○	●	○
Flooding	○	●	○
Severe Summer Storms	○	○	●
Severe Wind/Tornado	○	●	○
Severe Winter Storms	○	○	●
Wildfire	○	●	○
Dam Failure/Incident	○	●	○
Public Health Hazard	○	○	●
Hazmat Release	○	●	○
Active Threat	●	○	○
Cyber Threat	○	●	○

2. Any comments or additional information on any of the above hazards?

Consider changing Summer and Winter "Storms" to Summer and Winter "Weather."

3. Below are the Goals from the 2015 Arapahoe County Hazard Mitigation Plan. Please comment if you think any changes should be made for the 2020 update, or if they should be readopted as is:

   1. Prevent the loss of lives and injuries from hazards.
   2. Prevent and/or reduce damages to public and private property from hazards.
   3. Strengthen communication and coordination among public agencies, non-governmental organizations (NGOs), businesses, and private citizens.
   4. Reduce the adverse economic and natural resource impacts of hazards.
   5. Improve local resiliency to hazard events.

   Specific attention to CIKR

4. Below are the Objectives from the 2015 Arapahoe County Hazard Mitigation Plan. Please comment if you think any changes should be made for the 2020 update, or if they should be readopted as is:

   1. Reduce public exposure to hazards
   2. Increase knowledge of hazard mitigation options
   3. Increase awareness of hazards and their impacts
   4. Adopt a coordinated alert system for jurisdictions within the County
   5. Build redundancy into communication systems

   1) NOAA/NWS "Storm Ready" status was added since 2015 HMP and is currently being re-certified. 2) I think we have accomplished #4 from 2015 with the use of IPAWS via Code Red.

Respondent

7 | Anonymous

05:17
Time to complete

1. Please rate the overall significance of each hazard for Arapahoe County as a whole based:

	Low	Medium	High
Drought	●	○	○
Flooding	○	●	○
Severe Summer Storms	○	○	●
Severe Wind/Tornado	○	●	○
Severe Winter Storms	○	○	●
Wildfire	○	●	○
Dam Failure/Incident	●	○	○
Public Health Hazard	○	●	○
Hazmat Release	○	●	○
Active Threat	●	○	○
Cyber Threat	○	●	○

2. Any comments or additional information on any of the above hazards?

3. Below are the Goals from the 2015 Arapahoe County Hazard Mitigation Plan. Please comment if you think any changes should be made for the 2020 update, or if they should be readopted as is:

   1. Prevent the loss of lives and injuries from hazards.
   2. Prevent and/or reduce damages to public and private property from hazards.
   3. Strengthen communication and coordination among public agencies, non-governmental organizations (NGOs), businesses, and private citizens.
   4. Reduce the adverse economic and natural resource impacts of hazards.
   5. Improve local resiliency to hazard events.

   Protect and maintain critical infrastructure and services.

4. Below are the Objectives from the 2015 Arapahoe County Hazard Mitigation Plan. Please comment if you think any changes should be made for the 2020 update, or if they should be readopted as is:

   1. Reduce public exposure to hazards
   2. Increase knowledge of hazard mitigation options
   3. Increase awareness of hazards and their impacts
   4. Adopt a coordinated alert system for jurisdictions within the County
   5. Build redundancy into communication systems

Respondent

8 | Anonymous

94:38
Time to complete

1. Please rate the overall significance of each hazard for Arapahoe County as a whole based:

	Low	Medium	High
Drought			
Flooding			
Severe Summer Storms			
Severe Wind/Tornado			
Severe Winter Storms			
Wildfire			
Dam Failure/Incident			
Public Health Hazard			
Hazmat Release			
Active Threat			
Cyber Threat			

2. Any comments or additional information on any of the above hazards?

With flooding I also think you need to look at infrastructure in a community and if a community is able to move the flood water to the river or is this going to sustain the flood hazard. Active and Cyber threats are becoming more and more prominent throughout Colorado and the US. The effect of both arre very costely, both in life and injury as well as monitary lose.

3. Below are the Goals from the 2015 Arapahoe County Hazard Mitigation Plan. Please comment if you think any changes should be made for the 2020 update, or if they should be readopted as is:

   1. Prevent the loss of lives and injuries from hazards.
   2. Prevent and/or reduce damages to public and private property from hazards.
   3. Strengthen communication and coordination among public agencies, non-governmental organizations (NGOs), businesses, and private citizens.
   4. Reduce the adverse economic and natural resource impacts of hazards.
   5. Improve local resiliency to hazard events.

   These goals are okay. I would agree to add protection of critical facilities and infrastructure.

4. Below are the Objectives from the 2015 Arapahoe County Hazard Mitigation Plan. Please comment if you think any changes should be made for the 2020 update, or if they should be readopted as is:

   1. Reduce public exposure to hazards
   2. Increase knowledge of hazard mitigation options
   3. Increase awareness of hazards and their impacts
   4. Adopt a coordinated alert system for jurisdictions within the County
   5. Build redundancy into communication systems

   I would agree with these objectives.

Respondent

9 | Anonymous

99:04
Time to complete

1. Please rate the overall significance of each hazard for Arapahoe County as a whole based:

	Low	Medium	High
Drought	○	●	○
Flooding	○	●	○
Severe Summer Storms	○	○	●
Severe Wind/Tornado	○	●	○
Severe Winter Storms	○	○	●
Wildfire	○	○	●
Dam Failure/Incident	○	●	○
Public Health Hazard	○	○	●
Hazmat Release	●	○	○
Active Threat	●	○	○
Cyber Threat	○	●	○

2. Any comments or additional information on any of the above hazards?

It seems like the consideration of our existing systems to mitigate a hazard should be weighed in. In my mind, the less structures we have in place increases our mitigation efforts to define/create them

3. Below are the Goals from the 2015 Arapahoe County Hazard Mitigation Plan. Please comment if you think any changes should be made for the 2020 update, or if they should be readopted as is:

   1. Prevent the loss of lives and injuries from hazards.
   2. Prevent and/or reduce damages to public and private property from hazards.
   3. Strengthen communication and coordination among public agencies, non-governmental organizations (NGOs), businesses, and private citizens.
   4. Reduce the adverse economic and natural resource impacts of hazards.
   5. Improve local resiliency to hazard events.

   Good general goals

4. Below are the Objectives from the 2015 Arapahoe County Hazard Mitigation Plan. Please comment if you think any changes should be made for the 2020 update, or if they should be readopted as is:

   1. Reduce public exposure to hazards
   2. Increase knowledge of hazard mitigation options
   3. Increase awareness of hazards and their impacts
   4. Adopt a coordinated alert system for jurisdictions within the County
   5. Build redundancy into communication systems

   Good general objectives

Respondent

10 | Anonymous

235:31
Time to complete

1. Please rate the overall significance of each hazard for Arapahoe County as a whole based:

	Low	Medium	High
Drought	○	●	○
Flooding	○	●	○
Severe Summer Storms	○	○	●
Severe Wind/Tornado	○	●	○
Severe Winter Storms	○	○	●
Wildfire	○	●	○
Dam Failure/Incident	○	●	○
Public Health Hazard	○	○	●
Hazmat Release	○	●	○
Active Threat	●	○	○
Cyber Threat	○	●	○

2. Any comments or additional information on any of the above hazards?

One thing that wasn't discussed during the slides in related to drought is the impact on water resources. The County has seen a lot of development moving east, and that is expected to continue in the future. Water is already a limiting resource out east and could be worsened during a drought. Also, in regards to Nate's comment about the bomb cyclone categorization, I think in general in the "winter weather" profile the blizzard category should definitely be highlighted a bit. I think the bomb cyclone would probably fall most closely into the blizzard category, but in general, blizzard conditions (high wind, blowing snow) are major issues during winter storms particularly out east. It causes major impacts to the roads and I70 will close frequently. All of my other thoughts I believe were captured during the meeting!

3. Below are the Goals from the 2015 Arapahoe County Hazard Mitigation Plan. Please comment if you think any changes should be made for the 2020 update, or if they should be readopted as is:

   1. Prevent the loss of lives and injuries from hazards.
   2. Prevent and/or reduce damages to public and private property from hazards.
   3. Strengthen communication and coordination among public agencies, non-governmental organizations (NGOs), businesses, and private citizens.
   4. Reduce the adverse economic and natural resource impacts of hazards.
   5. Improve local resiliency to hazard events.

   I think #3 should be removed and replaced with a goal specifically addressing critical infrastructure. The way it is currently written, #3 is more like a way to achieve nearly all the goals than a goal in itself.

4. Below are the Objectives from the 2015 Arapahoe County Hazard Mitigation Plan. Please comment if you think any changes should be made for the 2020 update, or if they should be readopted as is:

   1. Reduce public exposure to hazards
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   3. Increase awareness of hazards and their impacts
   4. Adopt a coordinated alert system for jurisdictions within the County
   5. Build redundancy into communication systems

Respondent

11 | Anonymous

221:48
Time to complete

1. Please rate the overall significance of each hazard for Arapahoe County as a whole based:

	Low	Medium	High
Drought	○	●	○
Flooding	○	●	○
Severe Summer Storms	○	●	○
Severe Wind/Tornado	○	●	○
Severe Winter Storms	○	○	●
Wildfire	●	○	○
Dam Failure/Incident	○	●	○
Public Health Hazard	○	●	○
Hazmat Release	○	●	○
Active Threat	●	○	○
Cyber Threat	○	●	○

2. Any comments or additional information on any of the above hazards?

none

3. Below are the Goals from the 2015 Arapahoe County Hazard Mitigation Plan. Please comment if you think any changes should be made for the 2020 update, or if they should be readopted as is:

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   3. Strengthen communication and coordination among public agencies, non-governmental organizations (NGOs), businesses, and private citizens.
   4. Reduce the adverse economic and natural resource impacts of hazards.
   5. Improve local resiliency to hazard events.

   No changes

4. Below are the Objectives from the 2015 Arapahoe County Hazard Mitigation Plan. Please comment if you think any changes should be made for the 2020 update, or if they should be readopted as is:

   1. Reduce public exposure to hazards
   2. Increase knowledge of hazard mitigation options
   3. Increase awareness of hazards and their impacts
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   5. Build redundancy into communication systems

   No changes

Respondent

12 | Anonymous

1862:15
Time to complete

1. Please rate the overall significance of each hazard for Arapahoe County as a whole based:

	Low	Medium	High
Drought	○	●	○
Flooding	○	●	○
Severe Summer Storms	○	○	●
Severe Wind/Tornado	○	○	●
Severe Winter Storms	○	○	●
Wildfire	○	○	○
Dam Failure/Incident	●	○	○
Public Health Hazard	○	○	●
Hazmat Release	●	○	○
Active Threat	●	○	○
Cyber Threat	●	○	○

2. Any comments or additional information on any of the above hazards?

3. Below are the Goals from the 2015 Arapahoe County Hazard Mitigation Plan. Please comment if you think any changes should be made for the 2020 update, or if they should be readopted as is:

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   3. Strengthen communication and coordination among public agencies, non-governmental organizations (NGOs), businesses, and private citizens.
   4. Reduce the adverse economic and natural resource impacts of hazards.
   5. Improve local resiliency to hazard events.

   readopt

4. Below are the Objectives from the 2015 Arapahoe County Hazard Mitigation Plan. Please comment if you think any changes should be made for the 2020 update, or if they should be readopted as is:

   1. Reduce public exposure to hazards
   2. Increase knowledge of hazard mitigation options
   3. Increase awareness of hazards and their impacts
   4. Adopt a coordinated alert system for jurisdictions within the County
   5. Build redundancy into communication systems

   readopt

Respondent

13 | Anonymous

18:30
Time to complete

1. Please rate the overall significance of each hazard for Arapahoe County as a whole based:

	Low	Medium	High
Drought	○	●	○
Flooding	○	●	○
Severe Summer Storms	○	○	●
Severe Wind/Tornado	○	●	○
Severe Winter Storms	○	○	●
Wildfire	○	●	○
Dam Failure/Incident	○	●	○
Public Health Hazard	○	○	●
Hazmat Release	○	●	○
Active Threat	●	○	○
Cyber Threat	○	●	○

2. Any comments or additional information on any of the above hazards?

Support OEM on increased risk for Hazmat release and cyber threat. Cyber threat is a real concern.

3. Below are the Goals from the 2015 Arapahoe County Hazard Mitigation Plan. Please comment if you think any changes should be made for the 2020 update, or if they should be readopted as is:

   1. Prevent the loss of lives and injuries from hazards.
   2. Prevent and/or reduce damages to public and private property from hazards.
   3. Strengthen communication and coordination among public agencies, non-governmental organizations (NGOs), businesses, and private citizens.
   4. Reduce the adverse economic and natural resource impacts of hazards.
   5. Improve local resiliency to hazard events.

   no change

4. Below are the Objectives from the 2015 Arapahoe County Hazard Mitigation Plan. Please comment if you think any changes should be made for the 2020 update, or if they should be readopted as is:

   1. Reduce public exposure to hazards
   2. Increase knowledge of hazard mitigation options
   3. Increase awareness of hazards and their impacts
   4. Adopt a coordinated alert system for jurisdictions within the County
   5. Build redundancy into communication systems

   No change

Hazard Mitigation 2020-2025 Update

Englewood Civic Center
1000 Englewood Parkway
Englewood, CO 80110

October 6, 2020

1:00 – 4:30 PM

1. Introductions — Fredrickson
    a. Name
    b. Position
    c. Role in the planning/maintenance process

2. HMP PowerPoint — Clay

3. Expectations of adopting jurisdictions and items needed — Fredrickson/Clay
    - Action Tracker on Past Projects
    - New Mitigation Action Form
    - Municipality Survey
    - Participation in planning process

4. HMP future — Fredrickson

5. Other topics/open discussion — Fredrickson/Clay

Please provide any applicable personnel changes to this workgroup to:
jfredrickson@arapahoegov.com

SERVING WITH INTEGRITY

ARAPAHOE SHERIFF

SINCE 1858

2020 HAZARD MITIGATION PLAN UPDATE ENGLEWOOD MEETING

10/06/2020, 1:00PM-4:30PM

Name	Email	Agency	Initials
Jason Fredrickson	jfredrickson@arapahoegov.com	OEM/ACSO	JF
Christina Underhill	cunderhill@englewoodco.gov	COE	cu
CHRIS HARGUTH	charguth@englewoodco.gov	COE	CH
Sam Watson	swatson@englewoodco.gov	EPD	[illegible]
Karen Montanez	kmontanez@englewoodco.gov	CD/Bldg	KM
Preston Vanry	pvanry@englewoodco.gov	SPR/COE VT	PVR
Maria D'Andrea	mdandrea@englewoodco.gov	COE	MAD
Steve Ortega	sortega@englewoodco.gov	COE	[illegible]
Mike Smith	MJSmith@EnglewoodCo.gov	EPD	[illegible]
AM Brown	ambrown@englewoodco.gov	CAO	[illegible]
BRAD POWER	BPower@ENGLEWOODCO.GOV	COMM DEV	[illegible]
Margaret Brocklander	mbrocklander@englewoodco.gov	COE	[illegible]
Shawn Lewis	slewis@englewoodco.gov	COE	[illegible]
Maria Sibota	msibota@englewoodco.gov	COE	[illegible]
Stephanie Carlile	scarlile@englewoodco.gov	COE	[illegible]

attachments unless you recognize the sender and know the content is safe.

Jason,

I have reviewed and have nothing to add to the current update.

Thank you, Richard

On Thu, Oct 29, 2020 at 08:01 Jason Fredrickson <JFredrickson@arapahoegov.com> wrote:

> Good Morning Chief,
>
> Could you send me an email that states that you listened to the meetings in the link below and looked over the criteria for the HMP update? We can then use that email as proof for FEMA that Deer Trail participated in the process and Deer Trail can adopt the plan. Thank you sir!
>
> HMP Meetings
>
> **Jason Fredrickson**
> Deputy Emergency Manager
> Office of Emergency Management
> 13101 E. Broncos Parkway
> Centennial, Colorado 80112
> Office phone 720-874-4186
>
> SERVING WITH INTEGRITY ARAPAHOE SHERIFF SINCE 1858
>
> www.ArapahoeSheriff.org

--

Fire Chief Richard Loveless
Deer Trail Fire/Rescue
P.O. Box 257
Deer Trail, CO. 80105
(303)619-7898
rloveless.dtfire@gmail.com

I was able to get through the information below and listening to the meetings. No questions from me. Thank you

Angie Kelly, District Manager
Community Resource Services of Colorado, LLC
7995 East Prentice Avenue, Suite 103E
Greenwood Village, CO 80111
(303) 381-4980 - Direct
(303) 381-4960 – Office
(303) 381-4961 – Facsimile
akelly@crsofcolorado.com

From: Jason Fredrickson <JFredrickson@arapahoegov.com>
Sent: Wednesday, October 28, 2020 4:40 PM
To: Angela Kelly <akelly@crsofcolorado.com>
Cc: Lisa Clay <EClay@arapahoegov.com>
Subject: RE: Arapahoe County Hazard Mitigation Plan

Hi Angie,

Sorry about this, but I just spoke to our contractor for the HMP and I have one more ask of you before we can sign-off on Bow Mar. Can you please send me an email that states that you have listened to the HMP meetings and reviewed the criteria. That will then suffice for Bow Mar's participation in the process.

Please click below for meetings and information. If you have any questions please let me know.

HMP Meetings

Thanks!

Jason Fredrickson
Deputy Emergency Manager
Office of Emergency Management
13101 E. Broncos Parkway
Centennial, Colorado 80112
Office phone 720-874-4186

www.ArapahoeSheriff.org

From: Angela Kelly <akelly@crsofcolorado.com>
Sent: Thursday, October 8, 2020 2:58 PM
To: Jason Fredrickson <JFredrickson@arapahoegov.com>
Cc: Lisa Clay <EClay@arapahoegov.com>
Subject: RE: Arapahoe County Hazard Mitigation Plan

CAUTION: This email originated from outside of the organization. Do not click links or open attachments unless you recognize the sender and know the content is safe.

Good afternoon,

Please find the updated sheet for bow mar.

Angie Kelly, District Manager
Community Resource Services of Colorado, LLC
7995 East Prentice Avenue, Suite 103E
Greenwood Village, CO 80111
(303) 381-4980 - Direct
(303) 381-4960 – Office
(303) 381-4961 – Facsimile
akelly@crsofcolorado.com

From: Jason Fredrickson <JFredrickson@arapahoegov.com>
Sent: Thursday, October 1, 2020 1:58 PM
To: Angela Kelly <akelly@crsofcolorado.com>
Cc: Lisa Clay <EClay@arapahoegov.com>
Subject: Arapahoe County Hazard Mitigation Plan

Hi Angie,

Hope all is well. I just wanted to check-in with you in regards to Bow Mar and the HMP update. I believe the only thing we still need from Bow Mar is the previous action item status's. I've attached the spreadsheet and I believe the Bow Mar tab at the bottom has 4 previous items to address. If you scroll all the way over to the right you will notice the last two sections in blue is all that needs attention. The first section is just a drop down with a few options to select on the status of those items. There is no right or wrong answer on this, just the best status update you have at this time. The 2nd column is any additional comments you may have about those action items, if known come to mind a simple N/A works just fine. Once completed, if you could just let Lisa or myself know and shoot us back the spreadsheet that would be great. Please let me know if you have any questions or if there is anything we can help you with.

Thanks!

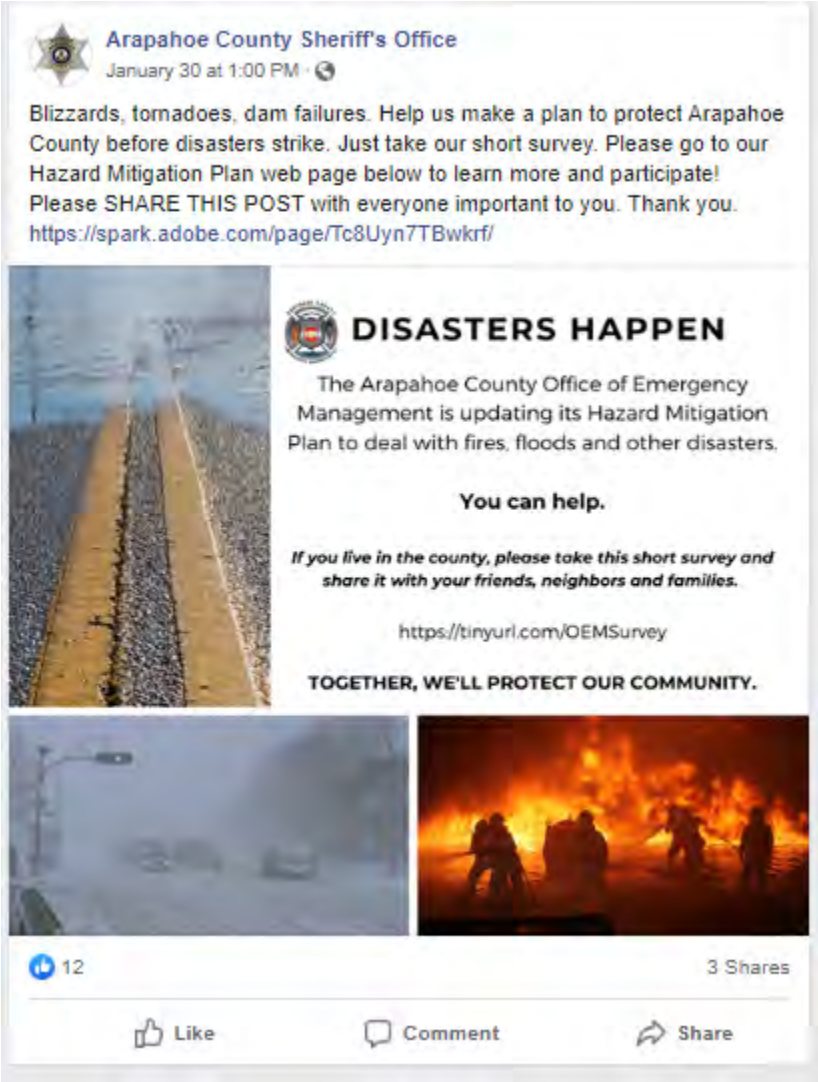
Jason Fredrickson

Deputy Emergency Manager
Office of Emergency Management
13101 E. Broncos Parkway
Centennial, Colorado 80112
Office phone 720-874-4186

www.ArapahoeSheriff.org

HMP Public Outreach

1. Project website and survey:
    a. Website: https://spark.adobe.com/page/Tc8Uyn7TBwkrf/
    b. Survey: https://forms.office.com/Pages/ResponsePage.aspx?id=JrbXVx3X9keEwcQ72hm6FpJmgjd5v_1Ctb8JqjuV0j9UQlZNSUJZRFVKU00xOUZCM1VZUjZWWlFUMS4u
    c. Launched 1/30/2020 via facebook and accessible on the County website. Screenshots below:



Home › News Flash

Arapahoe County News

Posted on: January 30, 2020

We're updating our disaster plan

Blizzards, tornadoes, dam failures.

Help our Office of Emergency Management make a plan to protect Arapahoe County before disasters strike. Just take our short survey. Visit the Hazard Mitigation Plan web page to learn more about the plan and the process.

Take the Survey

⇐ Previous
A Conversation with Commissioner Jeff Baker

Next ⇒
New check-in program lets Arapahoe County seniors know someone cares

d. 1/30/2020: Displayed/discussed during EOC grand opening (photos: G:\Sheriff\Special Ops\Plans\HMP (Hazard Mitigation Plan)\2020-2025 Hazard Mitigation Plan\Pictures - EOC Grand Opening and on Sheriff's Office facebook page)
e. 1/31/2020: website and survey included in the February "Detail" newsletter distributed to Sheriff's Office Staff and the public via facebook and public distro list. See screenshots below.

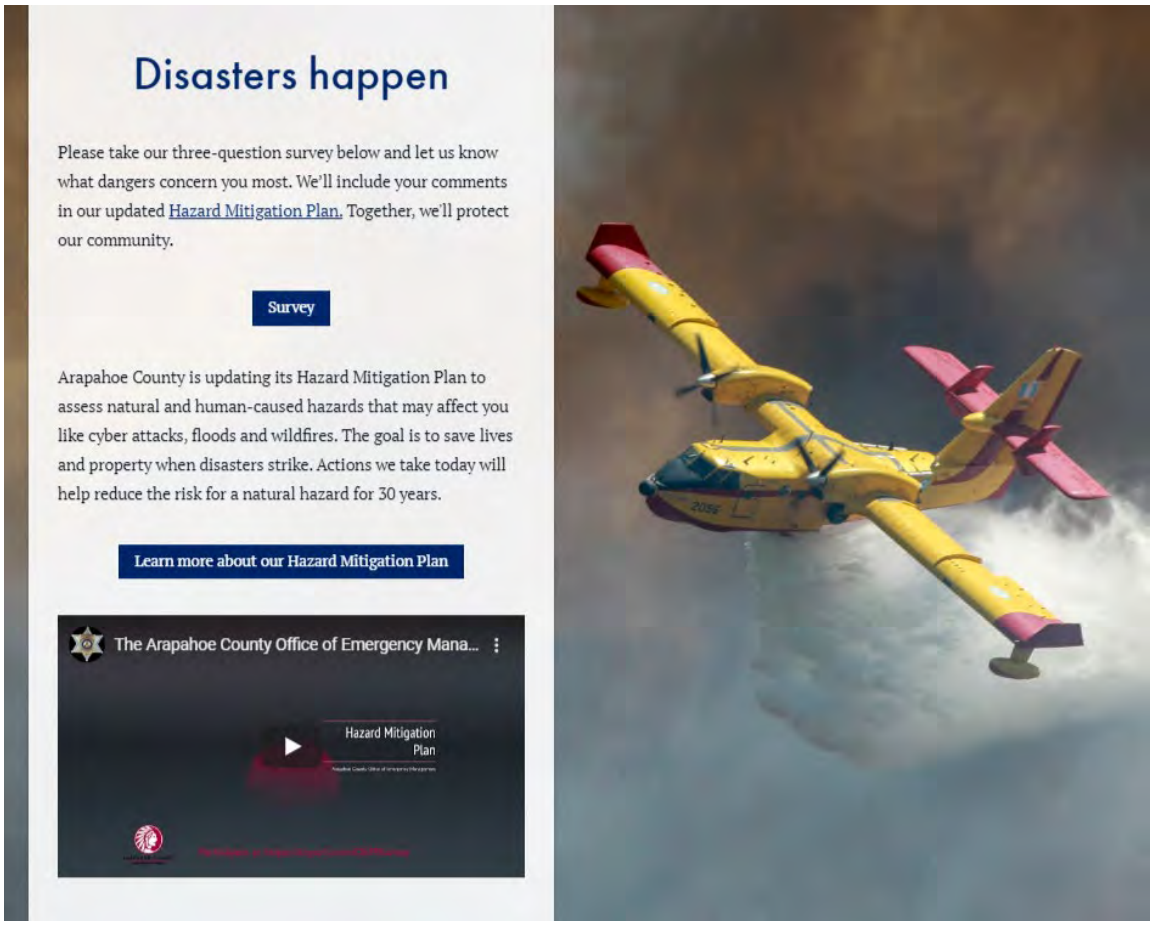
Arapahoe County Sheriff's Office
January 31 at 11:39 AM

A new Emergency Operations Center opens, a program to check in on seniors is underway and the county jail has a new book club. Those stories and more in this month's Detail. Sign up here:
http://www.arapahoegov.com/1564/Newsletter-The-Detail

SPARK.ADOBE.COM
The Detail - February 2020 Edition
See the story

26 1 Comment 2 Shares

Like Comment Share



f. 1/31/2020: City of Centennial shared website/survey on twitter. Screenshot below.

City of Centennial @CentennialGov · 19h

The Arapahoe County Sheriff's Office is seeking your input on updating their Hazard Mitigation Plan, a plan outlining measures that protect our community from a variety of natural and human made hazards. Learn more and take their one-minute survey today!

Hazard Mitigation Plan
See the story
spark.adobe.com

Hazard Mitigation Plan

Arapahoe County Office of Emergency Management

Hazard mitigation planning is a process that state, tribal and local governments use to identify risks and vulnerabilities associated with natural and human-caused hazards (tornadoes, floods, cyber-attacks, etc.), and develop long-term strategies for protecting people and property from future events. Developed with community, stakeholder, and public input, state, tribal, and local governments use these plans to help break the cycle of disaster damage, reconstruction and repeated damage.

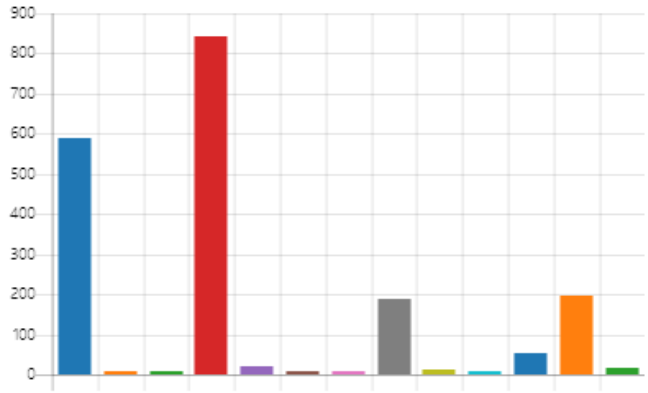
What's happening now

Arapahoe County is updating its Hazard Mitigation Plan to assess a variety of natural and human-caused hazards that may affect residents and businesses. This project involves identifying local mitigation actions that, used over time, reduce risk and future losses from disasters. Throughout the planning process, the county looks forward to engaging our partner

1. What municipality are you from?

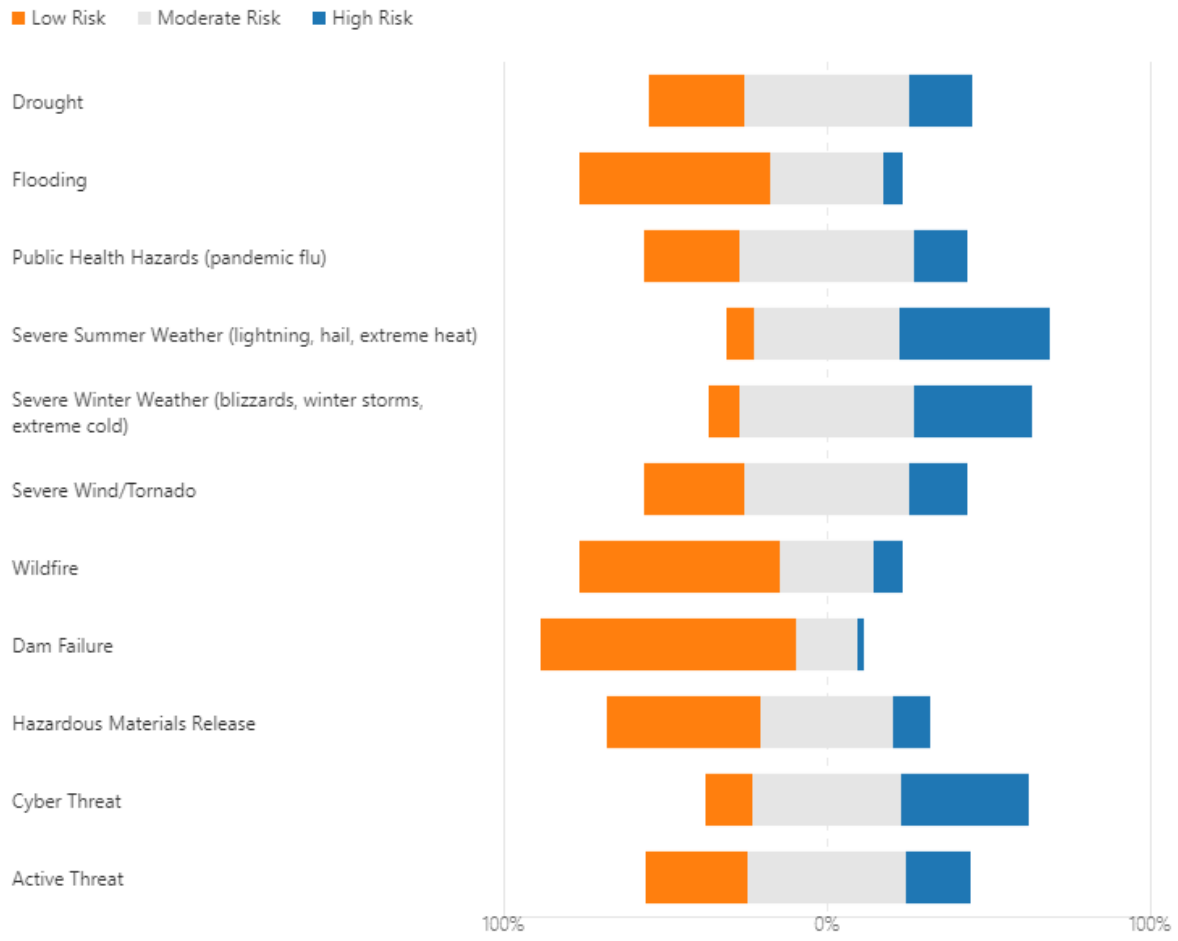
More Details

Unincorporated Arapahoe Co...	590
Bennett	10
Bow Mar	7
Centennial	842
Cherry Hills Village	19
Columbine Valley	8
Deer Trail	8
Englewood	188
Foxfield	14
Glendale	8
Greenwood Village	55
Littleton	197
Sheridan	15



2. Below are the natural and human-caused hazards that impact Arapahoe County. Please rank how you perceive your risk to each hazard based on your local community.

More Details



3. Have you participated in an emergency preparedness education event in your community?

More Details

ID	Start time	Select affiliation (select one):	Please provide comments regarding the Draft Update of the Arapahoe County Hazard Mitigation Plan here:
1	11/9/20 10:17:30	Member of the Public	I think it is fine
2	11/9/20 10:19:10	Member of the Public	I am unaware of what it is.
3	11/9/20 10:22:02	Member of the Public	Very comprehensive. I am thinking there needs to be a better description of how downed power lines, especially main running lines, affect our communities, and how we are working with other neighboring counties and cities to mitigate especially if a weather c terror event happens, but certainly may have missed it. I am concerned on how the wildfire mitigation if not implemented by the plan can affect urban and suburban parts of the county in the Western part of the county, if not contained in the eastern part more
4	11/9/20 10:35:26	Member of the Public	I appreciate that people with disabilities are included but there's no concrete plan of how to address or particularly inform those who have hearing issues. Getting information when electronics may not work (think blackout of 2003) became problematic.
5	11/9/20 10:42:06	Member of the Public	
6	11/9/20 10:48:07	Member of the Public	
7	11/9/20 11:12:14	Member of the Public	
8	11/9/20 11:13:16	Member of the Public	
9	11/9/20 11:36:30	Member of the Public	You should help establish and actively support Community Emergency Response in city and town. They can be a useful adjunct to governmental agencies and employees
10	11/9/20 11:46:02	Member of the Public	We need fireworks bans and enforcement of said bans. As the climate becomes more unstable we will see an increase of wildfires and the conditions that foster them. It's careless to ignore the risk that embers from fireworks represent.
11	11/9/20 13:44:14	Member of the Public	Make sure you detail plans for elderly in different care settings. For example, the home up to long term care. The fluctuating needs of our most at risk population is often underestimated. I have worked in many different senior living settings and I'd be happy to joi you for this part of your discussion plan. Good luck and thank you for doing this for our community.
12	11/9/20 14:23:16	Member of the Public	I'm assuming there is some kind of draft already in place that is to be up dated. I saw no draft to make comments on attached to this survey
13	11/9/20 14:21:05	Member of the Public	More police patrol at Sterne Pkwy & Broadway and also Clement Park in Columbine. Thank you Littleton Police and Fire Depts. You are doing a wonderful job. I'm proud to live in Littletor
14	11/9/20 15:20:34	Member of the Public	The documents and 133 pages. The executive summary does not outline the highlights of the plan. It would be helpful to see a brief highlight to best be able to answer this question
15	11/9/20 16:53:25	Member of the Public	In reading the info regarding the pandemic what I did not see is action. Until there is a viable vaccine I would surly like to see you put some teeth in your suggestions for masks and social distancing. Since a large group are ignoring these suggestions perhaps som consequences would be in order. Kind of like what they did to prevent the spread of aides making it a crime, assault, to spit on someone just is case you had aides. Also, if there is a serious fine involved in ignoring the mandates then collecting those fines might replace part of the income the city and county has lost in sales tax revenue.
16	11/9/20 17:34:04	Member of the Public	
17	11/9/20 17:34:56	Member of the Public	I am trying to find the draft update. Where is it? Looters and lawlessness seem to be our biggest worry now. Who defends our private property? I have no gun or strength to protect myself.
18	11/9/20 17:59:18	Member of the Public	Impressive. Extremely thorough. Beyond my knowledge and abilities to add anything
19	11/9/20 18:44:12	Member of the Public	No comment.
20	11/9/20 18:50:13	Member of the Public	
21	11/9/20 18:55:06	Member of the Public	
22	11/9/20 21:27:49	Member of the Public	My big concerns and priorities would include Fire safety by cleaning the dead trees and wood and grass in our Forests Covid 19 hand washing, high anti bacterial use and stop protest groups from gathering in mass and spreading the virus.
23	11/9/20 22:42:11	Member of the Public	First of all we need a MANDATE, with punishments and fines, that all MUST WEAR MASKS, thru end of 2020. And it MUST be enforced
24	11/9/20 23:44:40	Member of the Public	Safety issues such as break-ins, robberies, riots, etc. defunding sheriff and police is incredibly stupid.
25	11/10/20 0:36:07	Member of the Public	Very concerned about Covid
26	11/10/20 3:08:42	Member of the Public	I would like to see the outdoor shooting range at Cherry Creek State Park addressed. This past summer a hot Bullet caused a fire. Future fires from bullets need to be better prevented. Also, there are many walking and biking trails (and roads) close to the shootir range and seemingly inadequate barriers in place to prevent a less experienced shooter from accidentally striking a passerby. Surely the county and/or state could work together to install tall raised soil berms or walls that would increase safety and lessen the hazard. I would like to see the county strengthen its laws, rules and controls for reducing the spread of Coronavirus and other potential future virus pandemics. The fact that we had face mask mandates and yet so many people not following rules at indoor public places was horrible. We need better enforcement and fines for violators and better enforcement and harsher punishments for people who harass business employees for attempting to enforce mask requirements. Covid-19 is wrecking our economy and forcing local businesses to go bankrupt, and much of the spread can be prevented with tighter public health controls and enforcement.
27	11/10/20 9:58:22	Member of the Public	I would like to know more about it.
28	11/10/20 15:20:39	Member of the Public	Thank you for thinking about the safety of our community. We all appreciate all that you do.
29	11/10/20 16:26:42	Member of the Public	1)PAGES 4-3 to 4-5, "Changing Future Conditions" Climate change should be addressed objectively from a broader perspective, and not entirely focused on warming. There is increasing evidence that climate change is a tremendously dynamic issue, not necessarily related to terrestrial or human induced "emission as referenced in the discussion. The discussion should reflect uncertainty, address possibilities for both warming and cooling, and focus more on our primary climate driver – solar variability. 2)PAGE 4-5, "Hazard Identification and Ranking" The sun is now (year 2020) entering a period of increased activity relative to its 11 year cycle. The earth and its inhabitants are always at some risk for a damaging CME / geomagnetic event, but this likelihood is enhanced as the clock ticks toward solar maximum. This issue is addressed in the Presidential Policy Directive for Critical Infrastructure Security and Resilience (PPD-21, 2/12/2013). The Arapahoe County Hazard Mitigation Plan should address the key risks and potentially extreme consequences related to such an event
30	11/11/20 0:22:55	Member of the Public	
31	11/13/20 9:27:06	Member of the Public	I've lived in Arapahoe county for 30 years. The only condition I've ever worried about is tornadoes, and y'all seem to have nailed that long ago. My suggestion regarding future "scamdemics"? BACK OFF. Your job is to make us AWARE, not bubble wrap the populace STOP MAKING STUPID ORDERS. ***AND WHERE ARE THE CORRESPONDING DEATH COUNTS???*****
32	11/14/20 7:14:17	Member of the Public	
33	11/14/20 20:21:54	Member of the Public	Need to stop losing power in Deer Trail during blizzards and high wind days.
34	11/14/20 23:45:03	Member of the Public	My biggest concern/Public Hazard is CRIME! Home break-ins, Auto break-ins, auto theft and beyond are rampant in the metro area. Marxist, communist groups being allowed to push an anti police agenda are also another major threat. If you care about "health' push healthy living, healthy lifestyles and diet.
35	11/17/20 8:42:42	Member of the Public	Open up. At least let kids go to school!

From:	Lisa Clay
To:	Alex Jakubowski; Allen Peterson; Carr, Amy; Arthur Negretti; Ashley Cappel; Brent Thompson; Brett Cottrell; Brian Lewis; Carolyn Roan; Chris Cramer; Chuck Haskins; cory.stark; Dan Johnson; Daniel Giroux; Deborah Sherman; Diane Kocis; Dominick Cisson; Doug Stephens; Erika Roberts ; Frank Fields; Gene Enley; Gerilynn Scheldt; Glen Bedell; Glen Poole; Jackie Erwin; Jan Yeckes; Jason Fredrickson; jdmccrumb; Brislawn, Jeff P; Jerry Rhodes; Jonah Schneider; Justin Blair; Keith Reester; Kevin Kay; Kevin Stewart; Kim Spuhler; Lisa Ciazza ; Lisa Clay; Lorie Hinton; mdandrea; Mark Campbell; Mark Thompson; Martin Stegmiller; Matt Chapman; Matthew Mueller; Michael Hubbard; Michael Morianti; Mike Disher; Mike Gross; Nathan Fogg; Patricia Gavelda; rmourning; Rebecca Franco; Rich Loveless; Rich Solomon; Ronald Sigman; Field, Scott; Stacey Thompson; Steven Peck; T. Carmann; Tim Johnson; Tom Chavez; Karen Reutzel; Town of Foxfield Engineer; Town of Foxfield Planner; William Haskins
Subject:	Hazard Mitigation Plan Meeting Materials
Date:	Monday, June 22, 2020 4:20:03 PM
Attachments:	image001.png Arapahoe County HIRA Meeting Agenda 6-23-2020.docx Arapahoe County HIRA Meeting Slides 6-23-2020.pdf Arapahoe HMP_Mitigation Goals Reference.docx

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CAUTION: External email. Please do not click on links/attachments unless you know the content is genuine and safe.

Hi All,

Attached is the agenda, presentation, and a handout for our Hazard Mitigation Plan - Hazard Identification and Risk Assessment (HIRA) Teams meeting tomorrow. We will be going over the presentation and the associated handout during the meeting. Looking forward to seeing everyone (virtually) tomorrow!

Thanks,
Lisa

Lisa Clay
Emergency Management Coordinator
Office of Emergency Management
13101 E. Broncos Parkway
Centennial, Colorado 80112
720-874-3004

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ARAPAHOE SHERIFF
SINCE 1858

From: Jason Fredrickson
To: Alex Jakubowski; Allen Peterson; Carr, Amy; Arthur Negretti; Ashley Cappel; Brent Thompson; Brett Cottrell; Brian Lewis; Carolyn Roan; Chris Cramer; Chuck Haskins; cory.stark; Dan Johnson; Daniel Giroux; Diane Kocis; Dominick Cisson; Doug Stephens; Erika Roberts ; Frank Fields; Gene Enley; Gerry Scheidt; Glen Poole; Jackie Erwin; Jan Yeckes; Jason Fredrickson; jdmccrumb; Brislawn, Jeff P; Jerry Rhodes; Jonah Schneider; Justin Blair; Keith Reester; Kevin Stewart; Kim Spuhler; Lisa Ciazza ; Lisa Clay; Lorie Hinton; mdandrea; Mark Campbell; Martin Stegmiller; Matt Chapman; Matthew Mueller; Michael Hubbard; Mike Disher; Mike Gross; Nathan Fogg; Patricia Gavelda; rmourning; Rebecca Franco; Rich Loveless; Rich Solomon; Ronald Sigman; Field, Scott; Stacey Thompson; Steven Peck; T. Carmann; Thompson - CDPS, Mark; Tim Johnson; Tom Chavez; Karen Reutzel; Town of Foxfield Engineer; Town of Foxfield Planner; William Haskins
Subject: HMP Meeting #3 Agenda and Docs
Date: Thursday, July 30, 2020 7:18:20 AM
Attachments: image001.png
image002.png
image003.png
image004.png
image006.png
image007.png

CAUTION: External email. Please do not click on links/attachments unless you know the content is genuine and safe.

Good Morning Everyone,

Below is a link which will bring you to the material we will cover in today's HMP meeting.

Hope to see you all at the meeting!

https://drive.google.com/drive/folders/1wmKQta9ParHT0L7htTJ4AlpLyRKv8v-l?usp=sharing

Thanks,

Jason Fredrickson
Emergency Management Coordinator
Office of Emergency Management
13101 E. Broncos Parkway
Centennial, Colorado 80112
Office phone 720-874-4186

From: Jason Fredrickson
To: Alex Jakubowski; Allen Peterson; Carr, Amy; Arthur Negretti; Ashley Cappel; Brent Thompson; Brett Cottrell; Brian Lewis; Carolyn Roan; Chris Cramer; Chuck Haskins; cory.stark; Dan Johnson; Daniel Giroux; Diane Kocis; Dominick Cisson; Doug Stephens; Erika Roberts ; Frank Fields; Gene Enley; Gerry Scheidt; Glen Poole; Jackie Erwin; Jan Yeckes; Jason Fredrickson; jdmccrumb; Brislawn, Jeff P; Jerry Rhodes; Jonah Schneider; Justin Blair; Keith Reester; Kevin Stewart; Kim Spuhler; Lisa Ciazza ; Lisa Clay; Lorie Hinton; mdandrea; Mark Campbell; Martin Stegmiller; Matt Chapman; Matthew Mueller; Michael Hubbard; Mike Disher; Mike Gross; Nathan Fogg; Paniz Miesen ; Patricia Gavelda; rmourning; Rebecca Franco; Rich Loveless; Rich Solomon; Ronald Sigman; Field, Scott; Stacey Thompson; Steve Simon ; Steven Peck; T. Carmann; Thompson - CDPS, Mark; Tim Johnson; Tom Chavez; Karen Reutzel; Town of Foxfield Engineer; Town of Foxfield Planner; William Haskins
Subject: HMP Update New Mitigation Action Form
Date: Friday, July 31, 2020 9:08:19 AM
Attachments: image001.png
image013.png
image014.png
image015.png
image017.png
image018.png

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Good Morning Everyone,

I would like to thank all of those again who could attend the meeting yesterday. If you weren't able to attend the meeting please remember that we record all of our meetings through Microsoft TEAMS, and I encourage you to please listen to them. Below is the link to the New Mitigation Action Worksheet. Please take the time to discuss this with your organization and complete the form. Just a friendly reminder, if you're an adopting jurisdiction we need at least one new mitigation action item from you!

Arapahoe County HMP Update 2020 New Mitigation Action Worksheet - https://bit.ly/NewMitActions

We will also be re-sending out shortly the Action Spread Sheet in case you have any new updates since our meeting.

Thank you all for being a part of this HMP update and please remember to reach out with any questions.

Have a wonderful weekend!

Jason Fredrickson
Emergency Management Coordinator
Office of Emergency Management
13101 E. Broncos Parkway
Centennial, Colorado 80112
Office phone 720-874-4186

From:	Jason Fredrickson
To:	Alex Jakubowski; Allen Peterson; Carr, Amy; Arthur Negretti; Brent Thompson; Brett Cottrell; Brian Lewis; Carolyn Roan; Chris Cramer; Chuck Haskins; cory.stark; Daniel Giroux; Diane Kocis; Dominick Cisson; Doug Stephens; Erika Roberts ; Frank Fields; Gene Enley; Gerry Scheidt; Glen Poole; Jackie Erwin; Jan Yeckes; Jason Fredrickson; jdmccrumb; Brislawn, Jeff P; Jerry Rhodes; Jonah Schneider; Justin Blair; Keith Reester; Kevin Stewart; Kim Spuhler; Lisa Ciazza ; Lisa Clay; Lorie Hinton; mdandrea; Mark Campbell; Martin Stegmiller; Matt Chapman; Matthew Mueller; Michael Hubbard; Mike Disher; Mike Gross; Nathan Fogg; Paniz Miesen ; Patricia Gavelda; rmourning; Rebecca Franco; Rich Loveless; Rich Solomon; Ronald Sigman; Field, Scott; Stacey Thompson; Steve Simon ; Thompson - CDPS, Mark; Tim Johnson; Tom Chavez; Karen Reutzel; Town of Foxfield Engineer; Town of Foxfield Planner; Troy Carmann; William Haskins; Susan Jesse
Subject:	HMP HIRA Review
Date:	Wednesday, September 2, 2020 7:53:40 AM
Attachments:	image001.png image002.png image003.png image004.png image006.png image007.png

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CAUTION: External email. Please do not click on links/attachments unless you know the content is genuine and safe.

Good Morning Everyone,

Below is the link which will take you to the new updated HIRA first draft.

The draft is available in Word, pdf, or Goggle Docs format; we'll take comments in whatever method is easiest for members. Note however that Google Docs tends to severely mangle the formatting, so if anyone is reviewing in that format they should focus on content rather than layout and the like. Anything in yellow highlighting is something we specifically need planning team input on. This includes getting feedback from the municipalities on how the hazard rankings differ for their jurisdictions.

To keep the project on schedule for FEMA approval, we would like to get comments back by **Monday September 14th**. All are welcome to email their comments to us directly, or upload them to the Google Docs folder.

Lots of thanks to Scott Field and his team for the hard work that went into this!

https://drive.google.com/drive/folders/1T0XRGsKyD1_sJjlM0ggC2ePzwPJOgqkK

Thanks,

Jason Fredrickson
Deputy Emergency Manager
Office of Emergency Management
13101 E. Broncos Parkway
Centennial, Colorado 80112
Office phone 720-874-4186

From:	Lisa Clay
To:	Alex Jakubowski; Allen Peterson; Carr, Amy; Angie Kelly; Arthur Negretti; Ashley Cappel; Brent Thompson; Brett Cottrell; Brian Lewis; Carolyn Roan; Chuck Haskins; cory.stark; Dan Johnson; Daniel Giroux; Diane Kocis; Dominick Cisson; Doug Stephens; Erika Roberts ; Randi Gallivan; Frank Fields; Gene Enley; Gerilynn Scheldt; Glen Poole; Jackie Erwin; Jan Yeckes; Jason Fredrickson; jdmccrumb; Brislawn, Jeff P; Jerry Rhodes; Joe Gutgsell; Jonah Schneider; Justin Blair; Keith Reester; Kevin Stewart; Kim Spuhler; Lisa Ciazza ; Lisa Clay; Lorie Hinton; mdandrea; Mark Campbell; Mark Thompson; Martin Stegmiller; Matt Chapman; Matthew Mueller; Michael Hubbard; Mike Disher; Mike Gross; Mike Smith ; Nathan Fogg; Paniz Miesen ; Patricia Gavelda; Paul Workman ; rmourning; Rebecca Franco; Rich Loveless; Rich Solomon; Ronald Sigman; Field, Scott; slewis; Stacey Thompson; Steve Simon (SSimon@englewoodco.gov); Steven Peck; T. Carmann; Tim Johnson; Tom Chavez; Karen Reutzel; William Haskins
Cc:	John Collins (jcollins@Englewoodco.gov)
Subject:	Draft Hazard Mitigation Plan for Review
Date:	Tuesday, October 20, 2020 10:20:28 AM
Attachments:	image001.png

CAUTION: External email. Please do not click on links/attachments unless you know the content is genuine and safe.

Hi Hazard Mitigation Planning Team,

The full draft of the 2020 Arapahoe County Hazard Mitigation Plan is ready for your review. It has been uploaded here:
https://drive.google.com/drive/folders/1T0XRGsKyD1_sJjlM0ggC2ePzwPJOgqkK?usp=sharing

As with the HIRA draft, anything in yellow highlighting is something we specifically need input on, so please give particular attention to anything in yellow. Anything in green highlighting is a placeholder for our contractor, Wood. Please submit your comments in track changes in the Word version, comments in the pdf, or whatever other method works best for you.

In order to keep this project on schedule and have an approved plan by our deadlines, we need everyone to get their comments back to us by **October 31st**.

Thank you for all your hard work and input on this, and please feel free to reach out to Jason or I with any questions!

Lisa Clay
Emergency Management Coordinator
Office of Emergency Management
13101 E. Broncos Parkway
Centennial, Colorado 80112
720-874-3004

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From:	Lisa Clay
To:	Alex Jakubowski; Allen Peterson; Carr, Amy; Angie Kelly; Arthur Negretti; Ashley Cappel; Brent Thompson; Brett Cottrell; Brian Lewis; Carolyn Roan; Chuck Haskins; cory.stark; Dan Johnson; Daniel Giroux; Diane Kocis; Dominick Cisson; Doug Stephens; Erika Roberts ; Randi Gallivan; Frank Fields; Gene Enley; Gerilynn Scheldt; Glen Poole; Jackie Erwin; Jan Yeckes; Jason Fredrickson; jdmccrumb; Brislawn, Jeff P; Jerry Rhodes; Joe Gutgsell; Jonah Schneider; Justin Blair; Keith Reester; Kevin Stewart; Kim Spuhler; Lisa Ciazza ; Lorie Hinton; mdandrea; Mark Campbell; Mark Thompson; Martin Stegmiller; Matt Chapman; Matthew Mueller; Michael Hubbard; Mike Disher; Mike Gross; Mike Smith ; Nathan Fogg; Paniz Miesen ; Patricia Gavelda; Paul Workman ; rmourning; Rebecca Franco; Rich Loveless; Rich Solomon; Ronald Sigman; Field, Scott; slewis; Stacey Thompson; Steve Simon (SSimon@englewoodco.gov); Steven Peck; T. Carmann; Tim Johnson; Tom Chavez; Karen Reutzel; William Haskins
Cc:	John Collins (jcollins@Englewoodco.gov)
Subject:	RE: Draft Hazard Mitigation Plan for Review
Date:	Wednesday, October 28, 2020 3:58:39 PM
Attachments:	image001.png

CAUTION: External email. Please do not click on links/attachments unless you know the content is genuine and safe.

Hi all,

I am reaching out with a reminder that all comments for the draft Hazard Mitigation Plan are due by Saturday, October 31st.

The full draft of the Plan has been uploaded here:
https://drive.google.com/drive/folders/1T0XRGsKyD1_sJjlM0ggC2ePzwPJOgqkK?usp=sharing

Please let me know if you have any questions!

Thank you,
Lisa

Lisa Clay
Emergency Management Coordinator
Arapahoe County Office of Emergency Management
720-874-3004

From: Lisa Clay <EClay@arapahoegov.com>
Sent: Tuesday, October 20, 2020 10:20 AM
To: Alex Jakubowski <alex.jakubowski@elbertcounty-co.gov>; Allen Peterson <APeterson@arapahoegov.com>; Amy carr <amy.carr@woodplc.com>; Angie Kelly <akelly@crsofcolorado.com>; Arthur Negretti <anegretti@centennialco.gov>; Ashley Cappel <ACappel@arapahoegov.com>; Brent Thompson <bthompson@littletongov.org>; Brett Cottrell <Bcottrell@columbinevalley.org>; Brian Lewis <blewis@centennialairport.com>; Carolyn Roan <croan@littletongov.org>; Chuck Haskins <CHaskins@arapahoegov.com>; cory.stark <cory.stark@state.co.us>; Dan Johnson <DJohnson7@arapahoegov.com>; Daniel Giroux <dangiroux@terramax.us>; Diane Kocis <DKocis@arapahoegov.com>; Dominick Cisson <DCisson@ArapahoeGov.com>; Doug Stephens <dougstephens@littletongov.org>; Erika Roberts <elroberts@co.jefferson.co.us>; Randi Gallivan <CLERK@TOWNOFFOXFIELD.COM>; Frank Fields <ffields@svfd8.org>; Gene Enley <genley@littletongov.org>; Gerilynn Scheldt

<gscheidt@bennett.co.us>; Glen Poole <GPoole@arapahoegov.com>; Jackie Erwin <jackie.erwin@southmetro.org>; Jan Yeckes <JYeckes@arapahoegov.com>; Jason Fredrickson <JFredrickson@arapahoegov.com>; jdmccrumb <jdmccrumb@columbinevalley.org>; Jeff Brislawn <jeff.brislawn@woodplc.com>; Jerry Rhodes <jerry.rhodes@southmetro.org>; Joe Gutgsell <jgutsell@greenwoodvillage.com>; Jonah Schneider <jschneider@centennialco.gov>; Justin Blair <jblair@eccv.org>; Keith Reester <pwkr@littletongov.org>; Kevin Stewart <kstewart@udfcd.org>; Kim Spuhler <kim.spuhler@southmetro.org>; Lisa Ciazza <Lisa.Ciazza@denverwater.org>; Lisa Clay <EClay@arapahoegov.com>; Lorie Hinton <lhinton@centennialairport.com>; mdandrea <mdandrea@Englewoodco.gov>; Mark Campbell <mcampbell@sheridangov.org>; Mark Thompson <markw.thompson@state.co.us>; Martin Stegmiller <mstegmiller@acwwa.com>; Matt Chapman <mchapman@auroragov.org>; Matthew Mueller <matthew.mueller@denvergov.org>; Michael Hubbard <MHubbard@ArapahoeGov.com>; Mike Disher <mike.disher@byersfirerescue.org>; Mike Gross <mgross@glendale.co.us>; Mike Smith <mjsmith@englewoodco.gov>; Nathan Fogg <NFogg@arapahoegov.com>; Paniz Miesen <miesenpb@cdmsmith.com>; Patricia Gavelda <patricia.gavelda@state.co.us>; Paul Workman <pworkman@cherryhillsvillage.com>; rmourning <rmourning@sheridangov.org>; Rebecca Franco <Rebecca.Franco@denverwater.org>; Rich Loveless <rloveless.dtfire@gmail.com>; Rich Solomon <solomon.rich@sablealturafire.org>; Ronald Sigman <RSigman@adcogov.org>; Scott Field <scott.field@woodplc.com>; slewis <slewis@englewoodco.gov>; Stacey Thompson <sthompson@semswa.org>; Steve Simon (SSimon@englewoodco.gov) <SSimon@englewoodco.gov>; Steven Peck <SPeck@arapahoegov.com>; T. Carmann <tcarmann@iconeng.com>; Tim Johnson <tmjohnso@dcsheriff.net>; Tom Chavez <tchavez@cfpd.org>; Karen Reutzel <bowmartown@gmail.com>; William Haskins <whaskins@glendale.co.us>
Cc: John Collins (jcollins@Englewoodco.gov) <jcollins@Englewoodco.gov>
Subject: Draft Hazard Mitigation Plan for Review

Hi Hazard Mitigation Planning Team,

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https://drive.google.com/drive/folders/1T0XRGsKyD1_sJjlM0ggC2ePzwPJOgqkK?usp=sharing

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In order to keep this project on schedule and have an approved plan by our deadlines, we need everyone to get their comments back to us by **October 31st**.

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Lisa Clay
Emergency Management Coordinator

Office of Emergency Management
13101 E. Broncos Parkway
Centennial, Colorado 80112
720-874-3004

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APPENDIX C: EMAP CROSS-WALK

DRAFT

APPENDIX C: EMAP CROSSWALK

The Emergency Management Accreditation Program (EMAP) is a voluntary standards, assessment, and accreditation process for disaster preparedness programs throughout the country. It provides emergency management programs the opportunity to be recognized for compliance with industry standards, to demonstrate accountability, and to focus attention on areas and issues where resources are needed. The EMAP program consists of 66 standards, last updated in 2019, that evaluate all aspects of a jurisdiction's comprehensive emergency management program.

Two of the EMAP Standards specifically address hazard assessment and mitigation planning:

- Standard: 4.1 Hazard Identification, Risk Assessment and Consequence Analysis
- Standard: 4.2 Hazard Mitigation

This Appendix demonstrates compliance with these two EMAP standards and their associated subsections, and references where the information can be found in the plan.

Standard: 4.1 Hazard Identification, Risk Assessment and Consequence Analysis		
An Accredited Emergency Management Program has a Hazard Identification, Risk Assessment (HIRA), and Consequence Analysis.		
Subsection 4.1.1	**Location**	**Notes**
The Emergency Management Program identifies the natural and human-caused hazards that potentially impact the jurisdiction using multiple sources. The Emergency Management Program assesses the risk and vulnerability of people, property, the environment, and its own operations from these hazards.	Section 4 (page 4-1 to 4-156)	See Section 4.1 for identification of hazards, summarized in table 4-3. Sections 4.3 through 4.13 assess the risk and vulnerability from each identified hazard.
Subsection 4.1.2	**Location**	**Notes**
4.1.2 The Emergency Management Program conducts a consequence analysis for the hazards identified in Standard 4.1.1 to consider the impact on the following: (1) public; (2) responders; (3) continuity of operations including continued delivery of services; (4) property, facilities, and infrastructure; (5) environment; (6) economic condition of the jurisdiction and (7) public confidence in the jurisdiction's governance.	Section 4.3 through 4.13 (page 4-19 to 4-156)	See the Hazard Consequence Analysis section of each hazard profile.
Subsection 4.1.3	**Location**	**Notes**
The Emergency Management Program has a maintenance process for its HIRA identified in Standard 4.1.1 and the Consequence Analysis identified in Standard 4.1.2, which includes a method and schedule for evaluation and revision.	Section 6.2 (page 6-3 to 6-4)	See Evaluation and Updates subsections for method and schedule.

Standard: 4.2 Hazard Mitigation		
An Accredited Emergency Management Program has a mitigation program that regularly and systematically utilizes resources to mitigate the effects of emergencies/disasters associated with the risks identified in the HIRA.		
Subsection 4.2.1	**Location**	**Notes**
The Emergency Management Program has a plan to implement mitigation projects and sets priorities based upon loss reduction.	Section 5 (page 5-1 to 5-33)	See section 5.3 for progress on implementing the mitigation program to

	and Section 6 (page 6-1 to 6-9)	date. See Sections 6.1 and 6.3 for how the plan will be implemented.
(1) The plan is based on the natural and human-caused hazards identified in Standard 4.1.1 and the risk and consequences of those hazards.	Section 5.5 (page 5-9 to 5-33)	See Table 5-3 "Hazards Mitigate" column for hazards. See section 5.3 for how risk and consequences are considered when developing and prioritizing actions.
(2) The plan is developed through formal planning processes involving Emergency Management Program stakeholders.	Section 3-3 and 3-4 (page 3-6 to 3-18)	Summarized in Table 3-2. See Also Appendix A and B.
(3) The plan establishes short and long-term strategies, actions, goals, and objectives.	Section 5-1 (page 5-2 to 5-3) and Section 5.5 (page 5-9 to 5-33)	See Table 5-3 "Timeline" column for short and long-term strategies.
Subsection 4.2.2	**Location**	**Notes**
The Emergency Management Program documents project ranking based upon the greatest opportunity for loss reduction and documents how specific mitigation actions contribute to overall risk reduction.	Section 5.4 (page 5- 6 to 5-9) and Section 6.2 (page 6-3 to 6-4)	See Prioritization subsection (p5-8) for how projects were ranked based on loss reduction, and Monitoring and Evaluation subsections (p6-3 to 6-4) for how the contribution of specific actions will be tracked and documented.
Subsection 4.2.3	**Location**	**Notes**
The Emergency Management Program has a process to monitor overall progress of the mitigation activities and documents completed initiatives and their resulting reduction or limitation of hazard impact on the jurisdiction.	Section 6.2 (page 6-3 to 6-4)	See Monitoring and Evaluation subsections (p6-3 to 6-4) for how progress will be tracked and documented.
Subsection 4.2.4	**Location**	**Notes**
The Emergency Management Program, consistent with the scope of the mitigation program, does the following:	---	---
(1) identifies ongoing mitigation opportunities and tracks repetitive loss;	Section 6.2 (page 6-4 to 6-4)	See Monitoring subsection (p6-4)
(2) provides technical assistance in implementing mitigation codes and ordinances;	Section 6.1 (page 6-1 to 6-2)	See Role of the Planning Team in Implementation and Maintenance subsection (p6-2)
(3) participates in jurisdictional and multijurisdictional mitigation efforts.	Section 2.7 (page 2-34 to 2-36), Section 5.3 (5-9 to 5-33), Section 6 (page 6-1 to 6-9)	See Other Mitigation Programs and Partnerships subsection (p2-34 to 2-36) and Opportunities for Enhancement subsection (p2-36) for jurisdictional and multijurisdictional mitigation efforts. See also Table 5-3 "Lead Agency and Partners" column.
Subsection 4.2.5	**Location**	**Notes**
The Emergency Management Program has a maintenance process for the plan identified in Standard 4.2.1, which includes a method and schedule for evaluation and revision.	Section 6.2 (page 6-3 to 6-4)	See Evaluation and Updates subsections for method and schedule.

APPENDIX D: ADOPTION RESOLUTIONS AND FOLLOW-UP PARTICIPATION LETTERS

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APPENDIX D: ADOPTION RESOLUTIONS

Note: The records of adoption will be incorporated as an electronic appendix. When the plan is adopted in 2021, the jurisdictions and adoption date will be noted here, but scanned versions of all adoption resolutions will be kept on file with Arapahoe County Emergency Management. A sample adoption resolution is provided here.

Hazard Mitigation Plan Adoption Sample Resolution

Resolution # _____

Adopting the Arapahoe County
Hazard Mitigation Plan 2020

Whereas, *(name of county or community) recognizes the threat that natural hazards pose to people and property within our community; and*

Whereas, *undertaking hazard mitigation actions will reduce the potential for harm to people and property from future hazard occurrences; and*

Whereas, *an adopted Multi-Jurisdictional Hazard Mitigation Plan is required as a condition of future funding for mitigation projects under multiple FEMA pre- and post-disaster mitigation grant programs; and*

Whereas, *(name of county or community) resides within the Planning Area, and fully participated in the mitigation planning process to prepare this Hazard Mitigation Plan; and*

Whereas, *the Colorado Department of Homeland Security and Emergency Management and Federal Emergency Management Agency, Region VIII officials have reviewed the Arapahoe County Hazard Mitigation Plan and approved it contingent upon this official adoption of the participating governing body; and*

Now, therefore, be it resolved, *that the (name of board or council), hereby adopts the Arapahoe County Hazard Mitigation Plan, as an official plan; and*

Be it further resolved, *Arapahoe County Emergency Management will submit this Adoption Resolution to the Colorado Department of Homeland Security and Emergency Management and Federal Emergency Management Agency, Region VIII officials to enable the Plan's final approval.*

Passed: ___(date)___

_____

Certifying Official

APPENDIX E: SAFE GROWTH ADUIT TOOL

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FEMA's SAFE GROWTH INTEGRATION TOOL AND HOW-TO GUIDE

(Source: Integrating Hazard Mitigation into Local Planning: Case Studies and Tools for Community Officials. FEMA, March 201

Safe Growth Integration Tool Worksheet (Page 1)

✓ = Area of Existing Overlap
★ = Gap Between Mitigation Plan and Planning Framework

				PLANNING FRAMEWORK							
				Comprehensive/ General Plan Elements			Zoning Ordinances and Development Regulations			Capital Improvement and Infrastructure Programs	
HAZARD MITIGATION	Risk Assessment										
	Mitigation Goals and Objectives										
	Mitigation Actions	Local Plans and Regulations									
		Education and Awareness Programs									
		Natural Systems Protection									
		Structure and Infrastructure Projects									

Safe Growth Integration Tool Worksheet (Page 2)

✓ = Area of Existing Overlap
★ = Gap Between Mitigation Plan and Planning Framework

				PLANNING FRAMEWORK									
				Area Plans			Functional Plans			Special Programs		Public and Stakeholder Engagement	
HAZARD MITIGATION	Risk Assessment												
	Mitigation Goals and Objectives												
	Mitigation Actions	Local Plans and Regulations											
		Education and Awareness Programs											
		Natural Systems Protection											
		Structure and Infrastructure Projects											

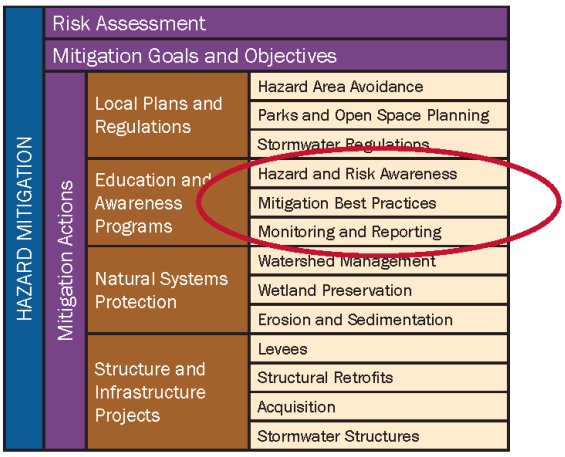
Appendix A: How to Use the Safe Growth Integration Tool

The Safe Growth Integration Tool can be used to inventory your community's hazard mitigation approach and components of your planning framework and help identify integration opportunities. The blank tool included in this appendix can be used as-is, or can be modified to reflect the unique circumstances of your community. The Safe Growth Integration Tool is intended to be concise and flexible and can be an effective way to structure your integration conversation.

To use the tool, complete these five simple steps:

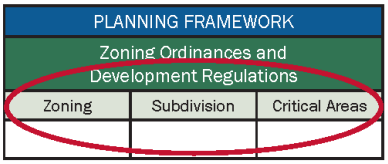
1. Review your community's hazard mitigation plan and list specific mitigation actions along the Z (vertical) axis of the matrix.

The matrix is organized by the basic categories of a hazard mitigation plan, including risk assessment, mitigation goals and objectives, and mitigation actions. The mitigation actions are further organized into the typical categories of local plans and regulations, education and awareness programs, natural systems protection, and structure and infrastructure projects. Within each of these categories, identify and list specific actions called for in your plan.



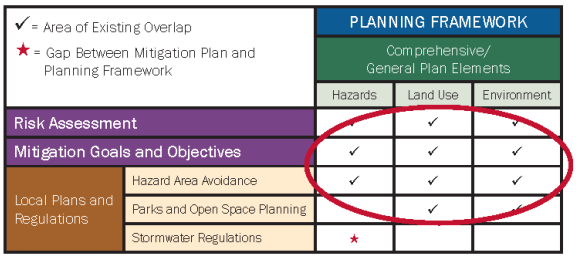
2. List the components of your community's planning framework along the X (horizontal) axis.

The x axis has been organized into categories that include comprehensive/general plan elements, zoning ordinances and development regulations, capital improvement and infrastructure programs, area plans, functional plans, special programs, and public and stakeholder engagement. Within these categories, identify the specific plans, policies, regulations, and programs that exist in your community. Try to identify everything that affects land use and development in some way, including those that you may not typically associate with planning such as an economic development plan or capital improvement program.



3. Identify areas of existing overlap between your hazard mitigation plan and planning framework.

For example, your community may have a floodplain development ordinance that is called out as an action in your hazard mitigation plan and also exists within your land development ordinance. The simplest method for identifying overlap is to put a checkmark in the boxes where overlap exists. If you need more detail you could include specific code or plan citations.



4. Identify gaps between your hazard mitigation plan and planning framework.
For example, if your hazard mitigation plan calls for open space preservation of a hazard area to provide a buffer from developed areas, but there is no existing program to acquire open space, then identify where in your planning framework this action would best be integrated. You can use a different mark, or symbol, to distinguish gaps from existing overlaps.

✓ = Area of Existing Overlap ★ = Gap Between Mitigation Plan and Planning Framework		PLANNING FRAMEWORK		
		Comprehensive/ General Plan Elements		
		Hazards	Land Use	Environment
Risk Assessment		✓	✓	✓
Mitigation Goals and Objectives		✓	✓	✓
Local Plans and Regulations	Hazard Area Avoidance	✓	✓	✓
	Parks and Open Space Planning		✓	✓
	Stormwater Regulations	★		

5. Identify further opportunities for integration.
For example, your hazard mitigation plan may call for wetland preservation to provide additional flood storage, and you may have an ordinance that requires wetland preservation. However, there may be other opportunities to integrate this action, such as tying wetland preservation into an existing Transfer of Development Rights (TDR) program, or by acquiring and preserving wetlands as part of your open space acquisition program.

✓ = Area of Existing Overlap ★ = Gap Between Mitigation Plan and Planning Framework		PLANNING FRAMEWORK		
		Comprehensive/ General Plan Elements		
		Hazards	Land Use	Environment
Risk Assessment		✓	✓	✓
Mitigation Goals and Objectives		✓	✓	✓
Local Plans and Regulations	Hazard Area Avoidance	✓	✓	✓
	Parks and Open Space Planning		✓	✓
	Stormwater Regulations	★		
Education and Awareness Programs	Hazard and Risk Awareness	✓		
	Mitigation Best Practices	✓		
	Monitoring and Reporting	✓		
Natural Systems Protection	Watershed Management			✓
	Wetland Preservation			✓
	Erosion and Sedimentation			

Once you have filled in the matrix, you can quickly see where overlaps exist, where they are needed, and what future integration opportunities are available. The completed matrix can also help to identify priorities for your integration strategy. (Refer to Chapter 3, Figure 3-2 for a completed example.)

APPENDIX F: REFERENCES

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APPENDIX G: GLOSSARY

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APPENDIX G: GLOSSARY

ACRONYMS

ACS	American Community Survey
BRIC	Building Resilient Infrastructure and Communities grant program
CBRN	Chemical/Biological/Radiological/Nuclear
CDC	Center of Disease Control and Prevention
CDOT	Colorado Department of Transportation
CDPHE	Colorado Department of Public Health and Environment
CFIRS	Colorado Division of Fire Prevention and Control's Fire Incident Reporting System
CFR	Code of Federal Regulations
CISA	Cyber & Infrastructure Security Agency
CO-WRAP	Colorado Wildfire Risk Assessment Program
COVID-19	Coronavirus Disease 2019
CRS	Community Rating System
CWCB	Colorado Water Conservation Board
CWPP	Community Wildfire Protection Plan
DDoS	Distributed Denial-of-Service
DEM	Digital Elevation Model
DFIRM	Digital Flood Insurance Rate Maps
DHSEM	Department of Homeland Security and Emergency Management
DMA	Disaster Mitigation Act
DOJ	Department of Justice
DOT	Department of Transportation
DRCOG	Denver Regional Council of Governments
EAP	Emergency Action Plan
ECOS	Environmental Conservation Online System
EF	Enhanced Fujita
EMAP	Emergency Management Accreditation Program
EOP	Emergency Operations Plan
EPA	U.S. Environmental Protection Agency
EPR	Health Department Emergency Preparedness and Response
ESA	Endangered Species Act
ESF	Emergency Support Functions
FEMA	Federal Emergency Management Agency
FERC	Federal Energy Regulatory Commission
FIRM	Flood Insurance Rate Map
FMA	Flood Management Assistance grant program

FIS	Flood Insurance Study
FSA	Farm Services Agency
GDP	Gross Domestic Product
GIS	Geographic Information System
GTD	Global Terrorism Database
Hazus-MH	Hazards, United States-Multi Hazard
HMA	Hazard Mitigation Assistance grant program
HMGP	Hazard Mitigation Grant Program
HMPC	Hazard Mitigation Planning Committee
IC3	Internet Crime Compliant Center
LAL	Lightning Activity Scale
LEPC	Local Emergency Planning Committee
MHFD	Mile High Flood District
Mph	Miles per Hour
NASA	National Aeronautics and Space Administration
NCA4	Fourth National Climate Assessment
NCEI	National Center for Environmental Information
NDMC	National Drought Mitigation Center
NEHRP	National Earthquake Hazards Reduction Program
NEPA	National Environmental Protection Act
NFHL	National Flood Hazard Layer
NFIP	National Flood Insurance Program
NHPA	National Historic Preservation Act
NID	National Inventory of Dams
NOAA	National Oceanic and Atmospheric Administration
NPDES	National Pollutant Discharge Elimination System
NRC	National Response Center
NRHP	National Register of Historic Places
NWS	National Weather Service
OEM	Office of Emergency Management
OIT	Office of Information Technology
OSHA	Occupational Safety and Health Administration
PDM	Pre-Disaster Mitigation
PDI	Palmer Drought Index
PDSI	Palmer Drought Severity Index
PHDI	Palmer Hydrological Drought Index

PPE	Personal Protective Equipment
PUC	Colorado Public Utility Commission
RMP	Risk Management Plan
SBA	Small Business Administration
SCADA	Supervisory Control and Data Acquisition
SEMSWA	Southeast Metro Stormwater Authority
SFHA	Special Flood Hazard Area
SPI	Standardized Precipitation Index
SRL	Severe Repetitive Loss
THIRA	Threat Hazard Identification Risk Assessment
USACE	U.S. Army Corps of Engineers
USDA	U.S. Department of Agriculture
USFS	U.S. Forest Service
USFW	U.S. Fish and Wildfire Service
USGS	U.S. Geological Survey
WHO	World Health Organization
WUI	Wildland Urban Interface

DEFINITIONS

100-Year Flood: The term "100-year flood" can be misleading. The 100-year flood does not necessarily occur once every 100 years. Rather, it is the flood that has a 1% chance of being equaled or exceeded in any given year. Thus, the 100-year flood could occur more than once in a relatively short period of time. The Federal Emergency Management Agency (FEMA) defines it as the 1% annual chance flood, which is now the standard definition used by most federal and state agencies and by the National Flood Insurance Program (NFIP).

Acre-Foot: An acre-foot is the amount of water it takes to cover 1 acre to a depth of 1 foot. This measure is used to describe the quantity of storage in a water reservoir. An acre-foot is a unit of volume. One acre foot equals 7,758 barrels; 325,829 gallons; or 43,560 cubic feet. An average household of four will use approximately 1 acre-foot of water per year.

Asset: An asset is any man-made or natural feature that has value, including, but not limited to, people; buildings; infrastructure, such as bridges, roads, sewers, and water systems; lifelines, such as electricity and communication resources; and environmental, cultural, or recreational features such as parks, wetlands, and landmarks.

Base Flood: The flood having a 1% chance of being equaled or exceeded in any given year, also known as the "100-year" or "1% chance" flood. The base flood is a statistical concept used to ensure that all properties subject to the NFIP are protected to the same degree against flooding.

Benefit: A benefit is a net project outcome and is usually defined in monetary terms. Benefits may include direct and indirect effects. For the purposes of benefit/cost analysis of proposed mitigation measures, benefits are limited to specific, measurable risk reduction factors, including reduction in expected property losses (buildings, contents, and functions) and protection of human life.

Benefit/Cost Analysis: A benefit/cost analysis is a systematic, quantitative method of comparing projected benefits to projected costs of a project or policy. It is used as a measure of cost effectiveness.

Building: A building is defined as a structure that is walled and roofed, principally aboveground, and permanently fixed to a site. The term includes manufactured homes on permanent foundations on which the wheels and axles carry no weight.

Capability Assessment: A capability assessment provides a description and analysis of a community's current capacity to address threats associated with hazards. The assessment includes two components: an inventory of an agency's mission, programs, and policies, and an analysis of its capacity to carry them out. A capability assessment is an integral part of the planning process in which a community's actions to reduce losses are identified, reviewed, and analyzed, and the framework for implementation is identified. The following capabilities were reviewed under this assessment:

- Legal and regulatory capability
- Administrative and technical capability
- Fiscal capability

Community Rating System (CRS): The CRS is a voluntary program under the NFIP that rewards participating communities (provides incentives) for exceeding the minimum requirements of the NFIP and completing activities that reduce flood hazard risk by providing flood insurance premium discounts.

Critical Area: An area defined by state or local regulations as deserving special protection because of unique natural features or its value as habitat for a wide range of species of flora and fauna. A sensitive/critical area is usually subject to more restrictive development regulations.

Critical Facility: Facilities and infrastructure that are critical to the health and welfare of the population. These become especially important after any hazard event occurs. For the purposes of this plan, critical facilities include:

- Structures or facilities that produce, use, or store highly volatile, flammable, explosive, toxic or water reactive materials.
- Hospitals, nursing homes, and housing likely to contain occupants who may not be sufficiently mobile to avoid death or injury during a hazard event.
- Police stations, fire stations, vehicle and equipment storage facilities, and emergency operations centers that are needed for disaster response before, during, and after hazard events.
- Public and private utilities, facilities and infrastructure that are vital to maintaining or restoring normal services to areas damaged by hazard events.
- Government facilities.

Dam: Any artificial barrier or controlling mechanism that can or does impound 10 acre-feet or more of water.

Dam Failure: Dam failure refers to a partial or complete breach in a dam (or levee) that impacts its integrity. Dam failures occur for a number of reasons, such as flash flooding, inadequate spillway size, mechanical failure of valves or other equipment, freezing and thawing cycles, earthquakes, and intentional destruction.

Disaster Mitigation Act of 2000 (DMA): The DMA is Public Law 106-390 and is the latest federal legislation enacted to encourage and promote proactive, pre-disaster planning as a condition of receiving financial assistance under the Robert T. Stafford Act. The DMA emphasizes planning for disasters before they occur. Under the DMA, a pre-disaster hazard mitigation program and new requirements for the national post-disaster Hazard Mitigation Grant Program (HMGP) were established.

Drought: Drought is a period of time without substantial rainfall or snowfall from one year to the next. Drought can also be defined as the cumulative impacts of several dry years or a deficiency of precipitation over an extended period of time, which in turn results in water shortages for some activity, group, or environmental function. A hydrological drought is caused by deficiencies in surface and subsurface water supplies. A socioeconomic drought impacts the health, well-being, and quality of life or starts to have an adverse impact on a region. Drought is a normal, recurrent feature of climate and occurs almost everywhere.

Exposure: Exposure is defined as the number and dollar value of assets considered to be at risk during the occurrence of a specific hazard.

Extent: The extent is the size of an area affected by a hazard.

Fire Behavior: Fire behavior refers to the physical characteristics of a fire and is a function of the interaction between the fuel characteristics (such as type of vegetation and structures that could burn), topography, and weather. Variables that affect fire behavior include the rate of spread, intensity, fuel consumption, and fire type (such as underbrush versus crown fire).

Fire Frequency: Fire frequency is the broad measure of the rate of fire occurrence in a particular area. An estimate of the areas most likely to burn is based on past fire history or fire rotation in the area, fuel conditions, weather, ignition sources (such as human or lightning), fire suppression response, and other factors.

Flash Flood: A flash flood occurs with little or no warning when water levels rise at an extremely fast rate

Flood Insurance Rate Map (FIRM): FIRMs are the official maps on which the Federal Emergency Management Agency (FEMA) has delineated the Special Flood Hazard Area (SFHA).

Flood Insurance Study: A report published by the Federal Insurance and Mitigation Administration for a community in conjunction with the community's FIRM. The study contains such background data as the base flood discharges and water surface elevations that were used to prepare the FIRM. In most cases, a community FIRM with detailed mapping will have a corresponding flood insurance study.

Floodplain: Any land area susceptible to being inundated by flood waters from any source. A FIRM identifies most, but not necessarily all, of a community's floodplain as the SFHA.

Floodway: Floodways are areas within a floodplain that are reserved for the purpose of conveying flood discharge without increasing the base flood elevation more than 1 foot. Generally speaking, no development is allowed in floodways, as any structures located there would block the flow of floodwaters.

Floodway Fringe: Floodway fringe areas are located in the floodplain but outside of the floodway. Some development is generally allowed in these areas, with a variety of restrictions. On maps that have identified and delineated a floodway, this would be the area beyond the floodway boundary that can be subject to different regulations.

Freeboard: Freeboard is the margin of safety added to the base flood elevation.

Frequency: For the purposes of this plan, frequency refers to how often a hazard of specific magnitude, duration, or extent is expected to occur on average. Statistically, a hazard with a 100-year frequency is expected to occur about once every 100 years on average and has a 1% chance of occurring any given year. Frequency reliability varies depending on the type of hazard considered.

Fujita Scale of Tornado Intensity: Tornado wind speeds are sometimes estimated on the basis of wind speed and damage sustained using the Fujita Scale. The scale rates the intensity or severity of tornado events using numeric values from F0 to F5 based on tornado wind speed and damage. An F0 tornado (wind speed less than 73 miles per hour [mph]) indicates minimal damage (such as broken tree limbs), and an F5 tornado (wind speeds of 261 to 318 mph) indicates severe damage.

Goal: A goal is a general guideline that explains what is to be achieved. Goals are usually broad-based, long-term, policy-type statements and represent global visions. Goals help define the benefits that a plan is trying to achieve. The success of a hazard mitigation plan is measured by the degree to which its goals have been met (that is, by the actual benefits in terms of actual hazard mitigation).

Geographic Information System (GIS): GIS is a computer software application that relates data regarding physical and other features on the earth to a database for mapping and analysis.

Hazard: A hazard is a source of potential danger or adverse condition that could harm people or cause property damage.

Hazardous Material: A substance or combination of substances which, because of quantity, concentration, or physical, chemical, or infectious characteristics, may either cause or significantly contribute to, an increase in mortality or an increase in serious, irreversible, or incapacitating reversible, illness.

Hazard Mitigation Grant Program (HMGP): Authorized under Section 202 of the Robert T. Stafford Disaster Relief and Emergency Assistance Act, the HMGP is administered by FEMA and provides grants to states, tribes, and local governments to implement hazard mitigation actions after a major disaster declaration. The purpose of the program is to reduce the loss of life and property due to disasters and to enable mitigation activities to be implemented as a community recovers from a disaster

Hazards U.S. Multi-Hazard (Hazus-MH) Loss Estimation Program: Hazus-MH is a GIS-based program used to support the development of risk assessments as required under the DMA. The Hazus-MH software program assesses risk in a quantitative manner to estimate damages and losses associated with natural hazards. Hazus-MH is FEMA's nationally applicable, standardized methodology and software program and contains modules for estimating potential losses from earthquakes, floods, and wind hazards. Hazus-MH has also been used to assess vulnerability (exposure) for other hazards.

Hydraulics: Hydraulics is the branch of science or engineering that addresses fluids (especially water) in motion in rivers or canals, works and machinery for conducting or raising water, the use of water as a prime mover, and other fluid-related areas.

Hydrology: Hydrology is the analysis of waters of the earth. For example, a flood discharge estimate is developed by conducting a hydrologic study.

Intensity: For the purposes of this plan, intensity refers to the measure of the effects of a hazard.

Inventory: The assets identified in a study region comprise an inventory. Inventories include assets that could be lost when a disaster occurs and community resources are at risk. Assets include people, buildings, transportation, and other valued community resources.

Lightning: Lightning is an electrical discharge resulting from the buildup of positive and negative charges within a thunderstorm. When the buildup becomes strong enough, lightning appears as a "bolt," usually within or between clouds and the ground. A bolt of lightning instantaneously reaches temperatures approaching 50,000ºF. The rapid heating and cooling of air near lightning causes thunder. Lightning is a major threat during thunderstorms. In the United States, 75 to 100 Americans are struck and killed by lightning each year (see http://www.fema.gov/hazard/thunderstorms/thunder.shtm).

Local Government: Any county, municipality, city, town, township, public authority, school district, special district, intrastate district, council of governments (regardless of whether the council of governments is incorporated as a nonprofit corporation under State law), regional or interstate government entity, or agency or instrumentality of a local government; any Indian tribe or authorized tribal organization, or Alaska Native village or organization; and any rural community, unincorporated town or village, or other public entity.

Mitigation: A preventive action that can be taken in advance of an event that will reduce or eliminate the risk to life or property.

Mitigation Actions: Mitigation initiatives are specific actions to achieve goals and objectives that minimize the effects from a disaster and reduce the loss of life and property.

Objective: For the purposes of this plan, an objective is defined as a short-term aim that, when combined with other objectives, forms a strategy or course of action to meet a goal.

Preparedness: Preparedness refers to actions that strengthen the capability of government, citizens, and communities to respond to disasters.

Presidential Disaster Declaration: These declarations are typically made for events that cause more damage than state and local governments and resources can handle without federal government assistance. Generally, no specific dollar loss threshold has been established for such declarations. A Presidential Disaster Declaration puts into motion long-term federal recovery programs, some of which are matched by state programs, designed to help disaster victims, businesses, and public entities.

Probability of Occurrence: The probability of occurrence is a statistical measure or estimate of the likelihood that a hazard will occur. This probability is generally based on past hazard events in the area and a forecast of events that could occur in the future. A probability factor based on yearly values of occurrence is used to estimate probability of occurrence.

Repetitive Loss Property: Any NFIP-insured property that, since 1978 and regardless of any changes of ownership during that period, has experienced:

- Four or more paid flood losses in excess of $1000.00; or
- Two paid flood losses in excess of $1000.00 within any 10-year period since 1978 or
- Three or more paid losses that equal or exceed the current value of the insured property.

Return Period (or Mean Return Period): This term refers to the average period of time in years between occurrences of a particular hazard (equal to the inverse of the annual frequency of occurrence).

Riverine: Of or produced by a river. Riverine floodplains have readily identifiable channels. Floodway maps can only be prepared for riverine floodplains.

Risk: Risk is the estimated impact that a hazard would have on people, services, facilities, and structures in a community. Risk measures the likelihood of a hazard occurring and resulting in an adverse condition that causes injury or damage. Risk is often expressed in relative terms such as a high, moderate, or low likelihood of sustaining damage above a particular threshold due to occurrence of a specific type of hazard. Risk also can be expressed in terms of potential monetary losses associated with the intensity of the hazard.

Risk Assessment: Risk assessment is the process of measuring potential loss of life, personal injury, economic injury, and property damage resulting from hazards. This process assesses the vulnerability of people, buildings, and infrastructure to hazards and focuses on (1) hazard identification; (2) impacts of hazards on physical, social, and economic assets; (3) vulnerability identification; and (4) estimates of the cost of damage or costs that could be avoided through mitigation.

Risk Ranking: This ranking serves two purposes, first to describe the probability that a hazard will occur, and second to describe the impact a hazard will have on people, property, and the economy. Risk estimates for the City are based on the methodology that the City used to prepare the risk assessment for this plan.

Robert T. Stafford Act: The Robert T. Stafford Disaster Relief and Emergency Assistance Act, Public Law 100-107, was signed into law on November 23, 1988. This law amended the Disaster Relief Act of 1974, Public Law 93-288. The Stafford Act is the statutory authority for most federal disaster response activities, especially as they pertain to FEMA and its programs.

Special Flood Hazard Area: The base floodplain delineated on a FIRM. The SFHA is mapped as a Zone A in riverine situations. The SFHA may or may not encompass all of a community's flood problems

Stakeholder: Business leaders, civic groups, academia, non-profit organizations, major employers, managers of critical facilities, farmers, developers, special purpose districts, and others whose actions could impact hazard mitigation.

Thunderstorm: A thunderstorm is a storm with lightning and thunder produced by cumulonimbus clouds. Thunderstorms usually produce gusty winds, heavy rains, and sometimes hail. Thunderstorms are usually short in duration (seldom more than 2 hours). Heavy rains associated with thunderstorms can lead to flash flooding during the wet or dry seasons.

Tornado: A tornado is a violently rotating column of air extending between and in contact with a cloud and the surface of the earth. Tornadoes are often (but not always) visible as funnel clouds. On a local scale, tornadoes are the most intense of all atmospheric circulations, and winds can reach destructive speeds of more than 300 mph. A tornado's vortex is typically a few hundred meters in diameter, and damage paths can be up to 1 mile wide and 50 miles long.

Vulnerability: Vulnerability describes how exposed or susceptible an asset is to damage. Vulnerability depends on an asset's construction, contents, and the economic value of its functions. Like indirect damages, the vulnerability of one element of the community is often related to the vulnerability of another. For example, many businesses depend on uninterrupted electrical power. Flooding of an electric substation would affect not only the substation itself but businesses as well. Often, indirect effects can be much more widespread and damaging than direct effects.

Wildfire: Wildfire refers to any uncontrolled fire occurring on undeveloped land that requires fire suppression. The potential for wildfire is influenced by three factors: the presence of fuel, topography, and

air mass. Fuel can include living and dead vegetation on the ground, along the surface as brush and small trees, and in the air such as tree canopies. Topography includes both slope and elevation. Air mass includes temperature, relative humidity, wind speed and direction, cloud cover, precipitation amount, duration, and the stability of the atmosphere at the time of the fire. Wildfires can be ignited by lightning and, most frequently, by human activity including smoking, campfires, equipment use, and arson.

Windstorm: Windstorms are generally short-duration events involving straight-line winds or gusts exceeding 50 mph. These gusts can produce winds of sufficient strength to cause property damage. Windstorms are especially dangerous in areas with significant tree stands, exposed property, poorly constructed buildings, mobile homes (manufactured housing units), major infrastructure, and aboveground utility lines. A windstorm can topple trees and power lines; cause damage to residential, commercial, critical facilities; and leave tons of debris in its wake.

Zoning Ordinance: The zoning ordinance designates allowable land use and intensities for a local jurisdiction. Zoning ordinances consist of two components: a zoning text and a zoning map.