Town of Lyons

LYONS
COLORADO

Hazard Identification and Risk Assessment

Public Review Draft / July 2017

amec foster wheeler

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APPENDIX

TOWN OF LYONS HAZARD IDENTIFICATION AND RISK ASSESSMENT

1 BACKGROUND AND PURPOSE

The Town of Lyons prepared this Hazard Identification and Risk Assessment (HIRA) to understand areas of vulnerability to hazards and to identify and refine actions which can be taken to reduce the local risk from potential hazards. The HIRA identifies and provides detailed data regarding hazards; inventory assets; analyze risks (potential impacts and estimated losses of each hazard); and assess the Town's overall vulnerability to hazards. The HIRA is intended to be a resource for planning and resilience capacity building, developed in accordance with the Disaster Mitigation Act of 2000.

This document was developed through a planning process between February and July 2017. The development of the HIRA was guided by a HIRA Advisory Committee (Advisory Committee) consisting of staff representing individual Town departments, with assistance and guidance from a consultant, Amec Foster Wheeler. Amec Foster Wheeler was responsible for facilitating the planning process, conducting the general research, developing the risk assessment, and guiding the mitigation strategy to comply with the state and federal mitigation planning regulations and guidance. The Advisory Committee met three times as a group to develop and advise the HIRA.

The Advisory Committee included the Town staff from the following departments and interested stakeholders:

- Planning
- Engineering
- Building
- Police
- Administration
- Lyons Prepared
- Boulder County Office of Emergency Management
- Lyons Fire Protection District
- Colorado Department of Local Affairs

As part of the HIRA development process a public survey was developed to gather input on hazards and potential mitigation strategies. The results are summarized in Appendix A.

Relationship to Other Planning Mechanisms

Coordination with other community planning efforts that relates to mitigation of hazards helps build resiliency. The following related statewide, regional, and local planning documents were referenced during the HIRA development including: State of Colorado and Boulder County Hazard Mitigation Plans, Lyons Long-Term Recovery Plan, the St. Vrain Watershed Master Plan, Town of Lyons Recovery Plan and the Town of Lyons Sustainability Action Plan. Other referenced documents include the American Planning Association's Community Planning Assistance Team final report on 'Living with the St Vrain,' developed following the 2013 flood. The HIRA was developed in accordance with FEMA's 2013 Local Mitigation Planning Handbook as it pertains to conducting a risk assessment and developing a mitigation strategy.

1.1 Overview

Risk, as defined by the Federal Emergency Management Agency (FEMA), is a combination of hazard, vulnerability, and exposure. Risk is the impact that a hazard would have on people, services, facilities, and structures in a community and refers to the likelihood of a hazard event resulting in an adverse condition that causes injury or damage.

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 natural hazards and provides a framework for developing and prioritizing mitigation actions to reduce risk from future hazard events.

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

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

Data collected through this process has been incorporated into the following sections of this document:

Section 2: Hazard Identification - identifies the natural hazards that threaten the Planning Area and describes why some hazards have been omitted from further consideration.

Section 3: Asset Summary - describes the methodology for determining vulnerability of the planning area to the identified hazards.

Section 4: Hazard Analysis and Risk Assessment - discusses the threat to the Planning Area and describes previous occurrences of hazard events and the likelihood of future occurrences (2013 FEMA Local Mitigation Planning Handbook Risk Assessment Step 1). It also includes an assessment of the Planning Areas' exposure to natural hazards; considering assets at risk, critical facilities, and future development trends (2013 FEMA Local Mitigation Planning Handbook Risk Assessment Steps 2, 3 and 4).

Section 5: Mitigation Action Plan – This section discusses a review and update of the mitigation actions specific to the Town, based on the Lyons Annex to the Boulder County Hazard Mitigation Plan.

2 HAZARD IDENTIFICATION

Using existing natural hazards data and input gained through planning meetings, the Advisory Committee agreed upon a list of natural and man-made hazards that could affect the Town of Lyons. As a starting point the Advisory Committee reviewed the hazards list from the 2014 Boulder County Hazard Mitigation Plan and the 2013 Colorado Natural Hazards Mitigation Plan. Hazards data from a variety of sources were examined to assess the significance of these hazards to the planning area. Significance was measured in general terms and focused on key criteria such as frequency and resulting damage, which includes deaths and injuries and property and economic damage. The natural hazards evaluated as part of this plan include those that have occurred historically or have the potential to cause significant human and/or monetary losses in the future.

The hazards worksheet in Table 2.1 was completed by the Advisory Committee to identify, profile, and rate the significance of identified hazards. The hazards of most concern for Lyons includes flood, windstorms and wildfire. Dam failure, drought, hailstorms and winter storms can also have significant impacts. There are also traffic concerns associated with single access points through existing neighborhoods on inadequately designed roads. With records dating back to 1894, Lyons has had some type of significant flood or wildfire event occur every decade. The historical town and surrounding local area has had damage or destruction to roads, bridges, homes, business, railroads, farmland and streams. Localized nuisance flooding and small wildland fires occur almost every year.

2.1 Planning Area Extent

Located in Boulder County, Lyons (elevation 5,374) is a small town in the foothills of the Rocky Mountains where the North and South St. Vrain Creeks meet. The following map shows the Town boundaries and potential annexation areas which are considered the Lyons Primary Planning Areas or LPPA. The planning area for this HIRA includes the existing municipal boundaries and LPPAs.

Figure 2.1. Town of Lyons Basemap

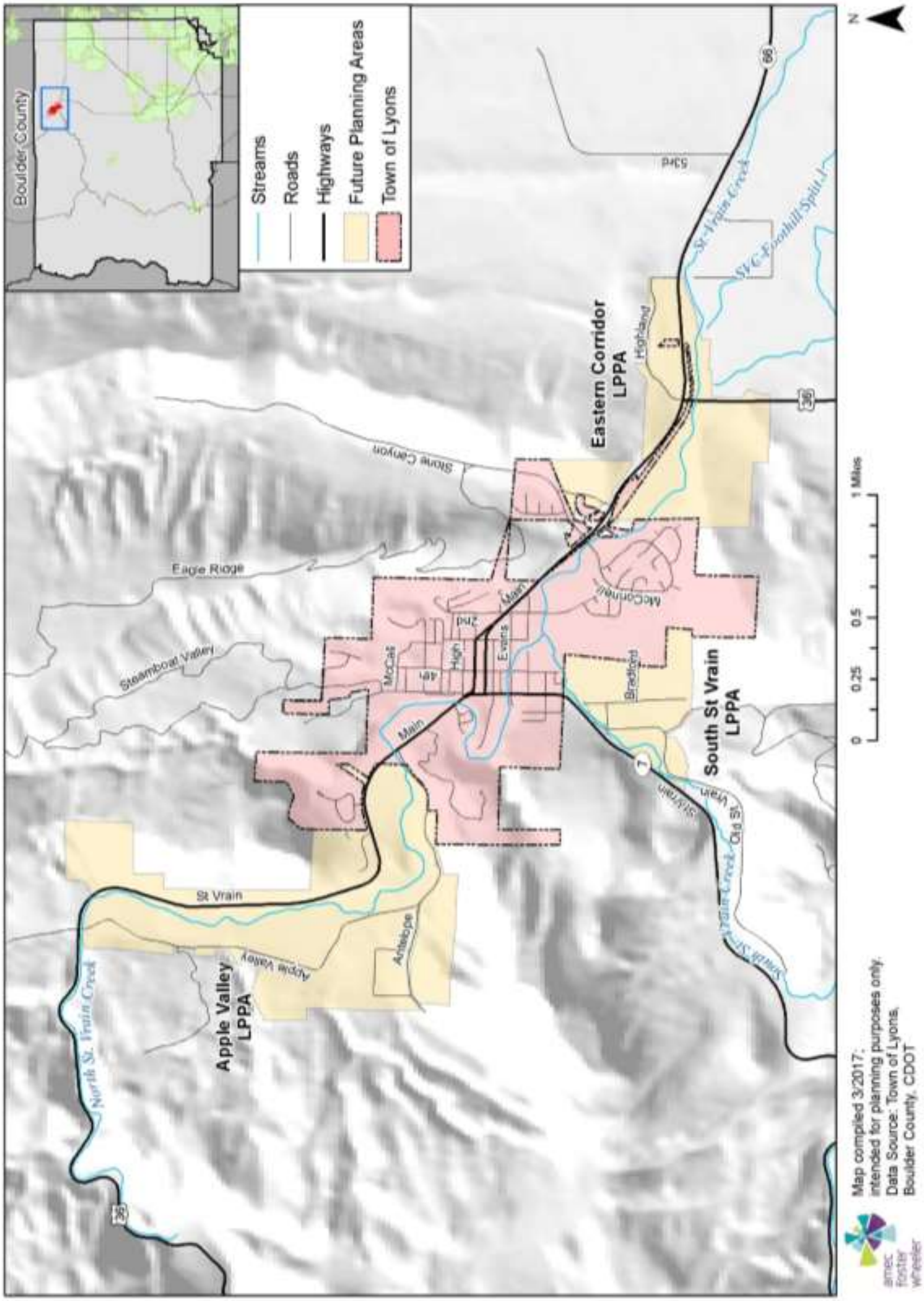


Table 2.1. Town of Lyons Hazard Identification Table

Hazard	Geographic Extent	Probability of Future Occurrences	Magnitude/Severity	Significance
Dam Failure	Significant	Unlikely	Catastrophic	Medium
Drought	Extensive	Likely	Limited	Medium
Earthquake	Extensive	Occasional/Unlikely	Limited	Low
Extreme Temperatures	Extensive	Likely	Limited	Low
Flood	Significant	Likely/Occasional	Critical	High
Hailstorm	Extensive	Likely	Limited	Medium
Landslide/Mud and Debris Flow/Rockfall	Limited	Occasional	Limited	Medium
Lightning	Extensive	Likely	Limited	Medium
Severe Winter Storm	Extensive	Highly Likely	Limited	Medium
Tornado	Significant	Occasional	Limited	Low
Wildfire	Significant	Highly Likely	Critical	High
Windstorm	Extensive	Highly Likely	Critical	High
Hazardous Materials Incident	Extensive	Occasional	Negligible	Low

*Based on occurring anywhere in the United States

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

Probability of Future Occurrences
Highly Likely: Near 100% chance of occurrence in next year, or happens every year.
Likely: Between 10 and 100% chance of occurrence in next year, or has a recurrence interval of 10 years or less.
Occasional: Between 1 and 10% chance of occurrence in the next year, or has a recurrence interval of 11 to 100 years.
Unlikely: Less than 1% chance of occurrence in next 100 years, or has a recurrence interval of greater than every 100 years.

Magnitude/Severity
Catastrophic—More than 50 percent of property severely damaged; shutdown of facilities for more than 30 days; and/or multiple deaths
Critical—25-50 percent of property severely damaged; shutdown of facilities for at least two weeks; and/or injuries and/or illnesses result in permanent disability
Limited—10-25 percent of property severely damaged; shutdown of facilities for more than a week; and/or injuries/illnesses treatable do not result in permanent disability
Negligible—Less than 10 percent of property severely damaged, shutdown of facilities and services for less than 24 hours; and/or injuries/illnesses treatable with first aid

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

2.2 Hazards Not Included

Other hazards were discussed by the Advisory Committee, but ultimately not included in this plan. Hazards in the Boulder County Hazard Mitigation Plan that do not affect Lyons include avalanche, subsidence, and expansive soils. A 2017 geologic hazard study for Boulder County did not indicate the presence of subsidence or expansive soils in the area. Human health hazards including pandemic flu and West Nile Virus are considered in other planning mechanisms and not profiled herein. Thunderstorm is not identified as an individual hazard, but is recognized for its role in the flood, lightning, and windstorm hazards, and is addressed accordingly in those hazard profiles. Erosion/deposition had not been identified previously in the Boulder County Hazard Mitigation Plan for inclusion. However, after the September 2013 rain and flood events it is important to recognize the unique and different impacts these phenomena present. This hazard is considered in the flood section. Fog and volcanoes were considered but removed from the list due to minor occurrences and/or impacts. Coastal erosion, coastal storm, hurricane, and tsunami were excluded because they are not experienced in Boulder County.

2.3 Declaration History

One method the Advisory Committee used to identify hazards was the researching of past events that triggered federal, state, and/or local disaster declarations within the planning area. Federal and state disaster declarations may be granted when the severity and magnitude of an event surpasses the ability of the local government to respond and recover. Boulder County received four presidential major disaster declarations between 1955 and 2016. Boulder County's disaster declaration history is summarized in Table 2.2. The 2013 flood was the most significant event for Lyons in recent years.

Table 2.2. Boulder County Disaster Declaration History, 1969-2017

Year	Declaring Jurisdiction	Disaster Type
1969	Federal/Major Disaster Declaration	Severe Storms and Flooding
1973	Federal/Major Disaster Declaration	Heavy Rains, Snowmelt, and Flooding
1989	Local	Wildfire
1990	Local	Wildfire
1994	Local	Flooding
1995	State	Flooding
1998	Local	Wildfire
2000	U.S. Department of Agriculture	Drought
2001	State	Severe Weather
2002	FEMA/Major Disaster Declaration	Wildfire
2002	U.S. Department of Agriculture	Drought
2003	FEMA/Emergency Declaration	Snow
2006	U.S. Department of Agriculture	Heat, High Winds, and Ongoing Drought (contiguous county)
2006	FEMA Emergency Declaration	Snow
2007	FEMA Emergency Declaration	Snow
2009	FEMA Fire Management Assistance Declaration	Wildfire (Olde Stage)
2010	FEMA Fire Management Assistance Declaration	Wildfire (Four Mile Canyon)
2013	U.S. Department of Agriculture	Drought
2013	FEMA/Major Disaster Declaration	Severe Storms, Flooding, Landslides and Mudslides
2017	U.S. Department of Agriculture	Drought

Source: State of Colorado Natural Hazard Mitigation Plan, 2013; Federal Emergency Management Agency, PERI Presidential Disaster Declaration Site. U.S. Department of Agriculture

3 ASSET INVENTORY

As a starting point for analyzing the Town of Lyons' vulnerability to identified hazards, the Advisory Committee used a variety of data to define a baseline against which all disaster impacts could be compared. If a catastrophic disaster were to occur in the Town, the following information describes significant assets at risk. Data used in this baseline assessment included:

- Total values and assets at risk,
- Critical facility inventory,
- Cultural and natural resource inventory, and
- Development trends.

3.1 Total Values and Assets at Risk

The Town of Lyons provided parcel-level data to support an analysis of total values and assets at risk in the town. It is important to keep in mind in the event of a disaster, it is generally the value of the infrastructure or improvements to the land that is of concern or at risk. Generally, the land itself is not a loss. The Town's total structure exposure is provided in the table below grouped by existing corporate limits and LPPA.

Table 3.1. Town of Lyons Total Exposure by Area and Property Type

Area	Property Type	Parcel Count	Building Count	Improved Value	Est. Content Value	Total Exposure
Town of Lyons	Apartment	1	1	$337,300	$337,300	$674,600
	Commercial	41	51	$9,628,020	$9,628,020	$19,256,040
	Exempt	20	36	$3,867,200	$3,867,200	$7,734,400
	Industrial	2	3	$409,700	$614,550	$1,024,250
	Mixed Use	16	45	$4,374,040	$4,374,040	$8,748,080
	Resident Land	2	2	$38,700	$19,350	$58,050
	Residential	796	929	$212,024,340	$106,012,170	$318,036,510
	State Assessed	2	3	$0	$0	$0
	Total	**880**	**1,070**	**$230,679,300**	**$124,852,630**	**$355,531,930**
Apple Valley LPPA	Ag Mixed	1	2	$196,100	$196,100	$392,200
	Agricultural	2	7	$336,100	$336,100	$672,200
	Exempt	11	17	$766,100	$766,100	$1,532,200
	Mixed Use	1	7	$312,743	$312,743	$625,486
	Resident Land	1	1	$7,300	$3,650	$10,950
	Residential	87	152	$19,236,590	$9,618,295	$28,854,885
	Total	**103**	**186**	**$20,854,933**	**$11,232,988**	**$32,087,921**
Eastern Corridor LPPA	Ag Mixed	1	4	$19,600	$19,600	$39,200
	Commercial	3	8	$468,400	$468,400	$936,800
	Exempt	2	10	$0	$0	$0
	Mixed Use	2	7	$375,800	$375,800	$751,600
	Residential	12	42	$3,615,200	$1,807,600	$5,422,800
	Total	**20**	**71**	**$4,479,000**	**$2,671,400**	**$7,150,400**
South St Vrain LPPA	Agricultural	2	8	$373,900	$373,900	$747,800
	Residential	19	39	$3,379,210	$1,689,605	$5,068,815
	Total	**21**	**47**	**$3,753,110**	**$2,063,505**	**$5,816,615**
	Grand Total	**1,024**	**1,374**	**$259,766,343**	**$140,820,523**	**$400,586,866**

Source: Town of Lyons and Boulder County Assessor

Critical Facility Inventory

The classification and definition of critical facilities definition is consistent with the language specified in Rule 6 of the Department of Natural Resources, Colorado Water Conservation Board's "Rules and Regulations for Regulatory Floodplains in Colorado," dated November 17, 2010, which was adopted by the Town. A "Critical facility" means any structure or related infrastructure, the loss of which may result in severe hazards to public health and safety or may interrupt essential services and operations for the community at any time before, during, and after a flood. Critical facilities are classified as follows: (1) Essential Services Facility, (2) Hazardous Material Facility, (3) At-risk Populations Facility and (4) Vital to Restoring Normal Services. "Essential services facility" means any facility providing essential services that, if flooded, may result in severe hazards to public health and safety or interrupt essential services and operations for the community at any time before, during, or after a flood that include without limitation, public safety, emergency response, emergency medical, designated emergency shelters, communications, public utility plant facilities and equipment, and government operations. "At-risk population facility" means a pre-school, public or private primary or secondary school, before and after school care center with twelve or more students, daycare center with twelve or more children, group home, or assisted living residential or congregate care facility with twelve or more residents. "Hazardous material" means any material used, generated, or stored at a facility of a type and in a quantity that would classify the facility as a hazardous materials facility. "Hazardous material building" means any structure on a hazardous materials facility in which hazardous material is used, generated, or stored. Facilities vital to restoring normal services including government operations consist of essential government operations (public records, building permitting and inspection services, community administration and management, maintenance and equipment centers.

Facilities layers were obtained from Town of Lyons, the Homeland Security Infrastructure Program Freedom data (2016), and Boulder County. A summary of Lyons' critical facilities are shown in the tables and figures below.

Figure 3.1. Critical Facilities in Lyons

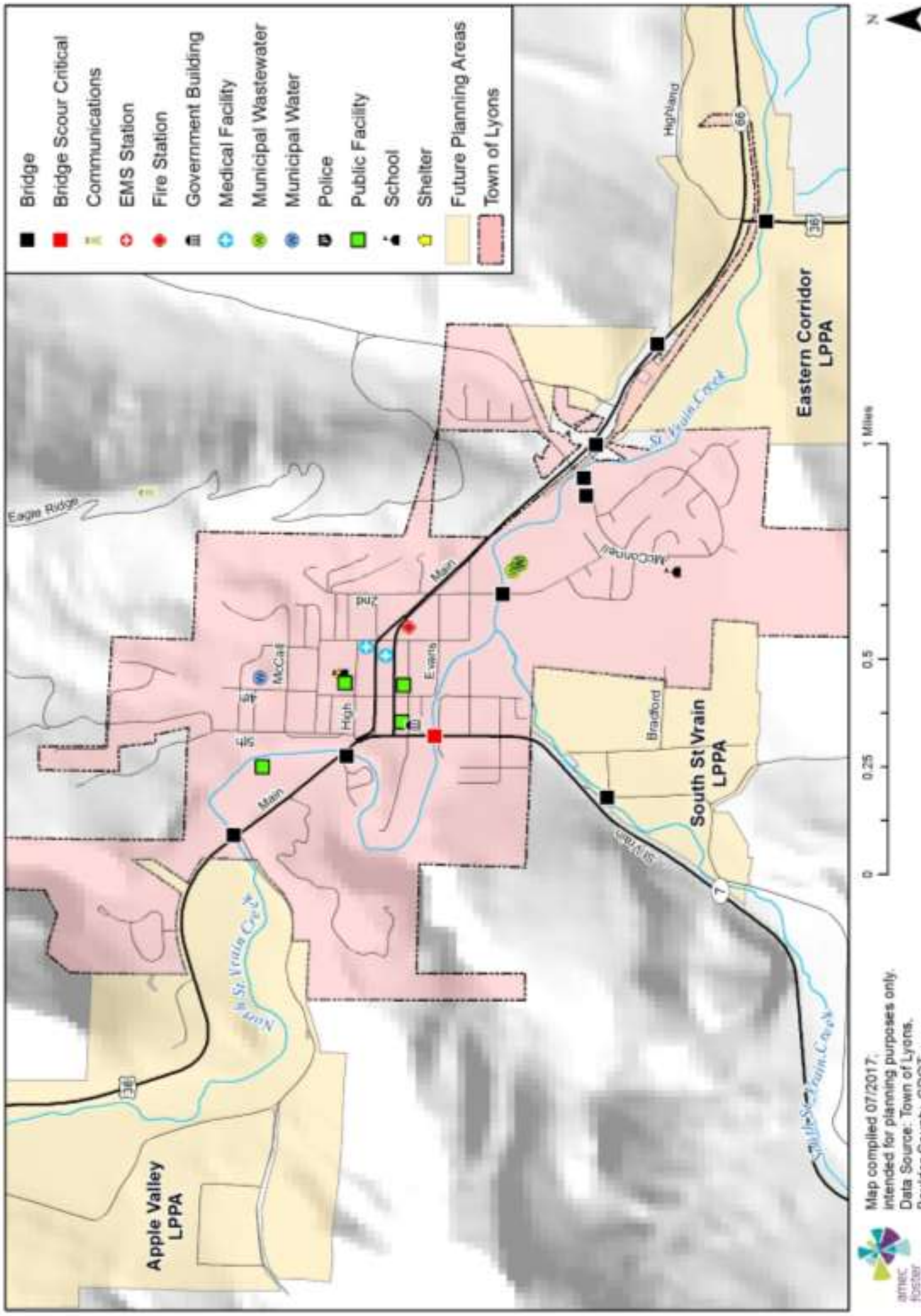


Table 3.2. Town of Lyons Critical Facility Summary

Type	Facility Name	Address
Bridge	Highland Canal & US Hwy 36	1.2 MI SE OF JCT SH 7 LYO
	North St. Vrain Creek & Apple Valley Rd	30 Ft So of US Hwy 36
	North St. Vrain Creek & US Hwy 36	IN LYONS
	North St. Vrain Creek & US Hwy 36	IN LYONS
	South St. Vrain Creek & Old St Vrain Rd	0.1 Mi S of St Hwy 7
	North St. Vrain Creek & US Hwy 36	IN LYONS
	St. Vrain Creek & 2nd Ave	0.1 Mi S of Park Street
	St. Vrain Creek & McConnell Dr	.02 Mi S of US36/SH66
	St. Vrain Creek & McConnell Dr	.08 Mi s of US36/SH66
	Supply Ditch & US Hwy 36	IN LYONS
Bridge Scour Critical	North St. Vrain Creek & Hwy 7	IN LYONS
	St. Vrain Creek & 51st St	0.1 Mi So of St Hwy 66
Communications	Microwave Service Towers	2450 EAGLE RIDGE RD
	Warning Siren	432 5th Ave
EMS Station	Lyons Fire Protection District Station 1	251 BROADWAY STREET
Fire Station	Lyons Station 1	251 Broadway
Government Building	Town Hall	432 5th Ave
Medical Facility	Milestone Medical	303 Main St. Unit C
	Stillwater Healing Arts	304 Main St
Municipal Wastewater	Pump Station (Eagle Canyon)	0 1st Ave.
	Pump Station (Stone Canyon)	0 1st Ave.
	Treatment Plant	0 1st Ave.
Municipal Water	Pump House	12953 N 53rd St
	Water Tower (active)	2157 Apple Valley Rd
	Water Tower (inactive)	0 Reese St
Police	Boulder County Substation	432 5th Ave
Public Facility	Library	405 Main St
	Museum	338 High St
	Planet Bluegrass	500 Main St
	Visitor Center	0 RR Ave
School	Lyons Elementary School	338 High St
	Lyons Middle & High School	100 McConnell Dr.
Shelter	Lyons Elementary School	338 High St

Source: Town of Lyons, Boulder County, HSIP Freedom

Separate summary tables were created to show individual facility risk to mapped hazards including flood and wildfire. These are discussed in the respective hazard's vulnerability summary.

Cultural and Natural Resource Inventory

In evaluating the vulnerability of a given area to disaster, it is important to inventory the cultural and natural resources specific to that area. Cultural and natural resources are important to identify pre-disaster for four reasons:

- The Town may decide that these areas are worthy of a greater degree of protection than currently exists due to their unique and irreplaceable nature.
- Should these resources be impacted by a disaster, knowing about them ahead of time allows for more prudent care in the immediate aftermath, when the potential for additional impacts is high.
- The rules for repair, reconstruction, restoration, rehabilitation, and/or replacement usually differ from the norm.
- Natural resources, such as wetlands and riparian habitat, can have beneficial functions that contribute to the reduction of flood levels and damage.

Cultural and natural resources identified in the Town include:

- Planet Bluegrass
- Town Library
- Redstone Museum (old school building)
- Parks and open space
- Open space in Boulder County adjacent to Town
- North and South St Vrain Creek riparian areas

The following table lists the properties in Lyons that are on the National Register of Historic Places and/or the Colorado State Register of Historic Properties.

Table 3.3. Lyons Historic Properties/Districts in National and State Registers

Property	Address	Date Listed
First Congregational Church of Lyons	High and 4th Streets	12/12/1976
Longmont Power Plant	Old Apple Valley Road	9/10/1987
Lyons Railroad Depot	400 block of Broadway	12/2/1974
Lyons Sandstone Buildings (Lyons Historic District)	U.S. 36 and CO 7 (High St-Main St area)	4/29/1980
Meadow Park Shelter House*	600 Park Drive	3/10/1993
North St. Vrain Creek Bridge	CO 7 at milepost 32.98	10/15/2002

Sources: Directory of Colorado State Register Properties, www.coloradohistory-oahp.org/programareas/register/1503/; National Register Information System, www.nr.nps.gov/
*Only on the Colorado State Register of Historic Properties

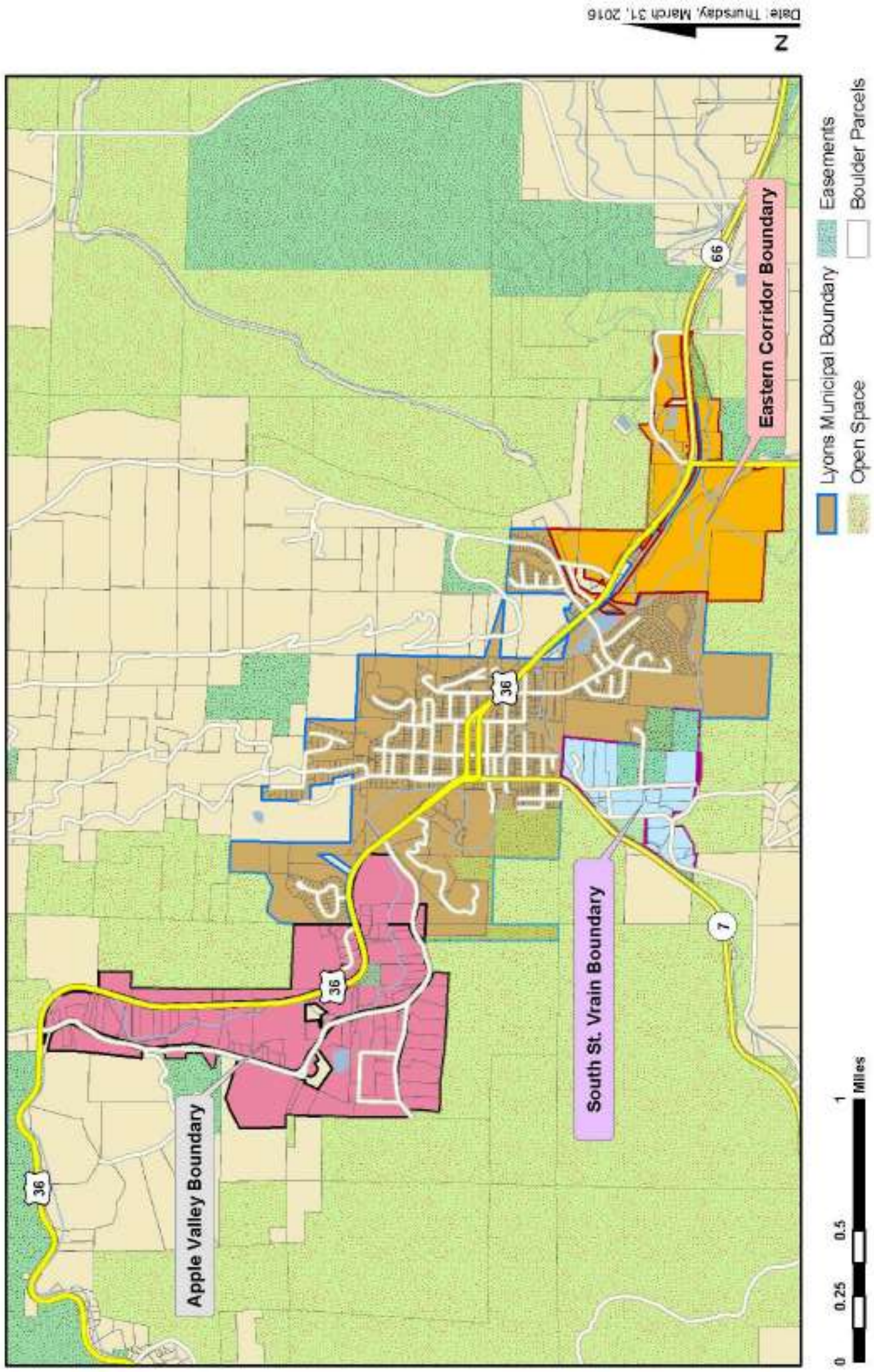
Development Trends

Much of the Town has been developed within and around the floodplains of the St Vrain creek corridors. One of the unique factors constraining the Town's growth is the lack of developable land outside of the floodplain. For several decades, the Boulder County Open Space program has purchased land surrounding the Town of Lyons, including within the Town's planning area. This, combined with a historic growth in housing demand, has left the Town with virtually no developable land to relocate housing or critical public facilities that are located in the floodplain. The few parcels or lots that do exist are constrained by conservation easements, terrain unsuitable for development, or extremely high prices that make it difficult for the Town to purchase them (APA CPAT Report 2014).

The Lyons Comprehensive Plan (March 2010) is the primary long-term planning document for the Town, providing the framework for decisions that affect the Town's physical, social, and economic characteristics. It is intended to provide a foundation for policy direction, land use decisions, and public investments. It is also meant to help the Town prioritize and direct resources toward special initiatives that will help achieve community goals. The Comprehensive Plan recognized and affirmed the necessity to grow and diversify the Town's economy through expansion of its municipal boundaries. The community's Economic Development Commission has also suggested that expansion will be essential, as land for development is becoming increasingly scarce and properties previously targeted for future development have either been purchased by Boulder County for open space or designated as "no development areas." While most parcels within the Town are largely developed, the Town is considering annexations and development within the Lyons Primary Planning Area (LPPA) as described in the 2017 LPPA Master Plan (which serves as an amendment to the 2010 Comprehensive Plan). The Lyons Primary Planning Area consists of three Subareas: The Eastern Corridor, South St. Vrain and Apple Valley. The LPPA Master Plan explains that "to this end, it will be imperative that the Town continually monitor impacts associated with growth. In addition, it will be important to maintain high standards for development within a proactive, yet protective investment climate." The following maps come from the 2017 LPPA Master Plan.

For the purposes of this HIRA the planning area includes the incorporated boundaries of Lyons as well as the LPPA subareas as potential growth areas into adjacent unincorporated Boulder County. The vulnerability of all these areas is analyzed further by hazard, and broken out by sub area where feasible. The Advisory Committee noted that as of May 2017 development was pending in the Eastern LPPA for a Town Public Works building/yard.

Figure 3.2. Lyons Primary Planning Area



Source: LPPA Master Plan

Figure 3.3. South St. Vrain Subarea Unconstrained Area

Source: LPPA Master Plan

Figure 3.4. Apple Valley Subarea Unconstrained Area

4 HAZARD ANALYSIS AND RISK ASSESSMENT

For each hazard, a generic description of the hazard and associated problems is provided along with details specific to the Town of Lyons. Information on past occurrences and the extent or location of the hazard within or near the Town and impacts, where known, are also discussed here. To assess the history of natural hazard events in Lyons, the Advisory Committee evaluated the hazards history for both the Town and the surrounding areas. Much of the existing data and statistics are maintained on a countywide basis; therefore, the Advisory Committee relied heavily on Boulder County data. In general, information provided by planning team members is integrated into this section with information from other data sources, such as National Weather Service databases.

The frequency of past events was used to gauge the likelihood of future occurrences. Based on historical data, the frequency of occurrence is categorized into the following classifications:

- **Highly Likely**—Near 100 percent chance of occurrence in next year or happens every year.
- **Likely**—Between 10 and 100 percent chance of occurrence in next year or has a recurrence interval of 10 years or less.

- **Occasional**—Between 1 and 10 percent chance of occurrence in the next year or has a recurrence interval of 11 to 100 years.
- **Unlikely**—Less than 1 percent chance of occurrence in next 100 years or has a recurrence interval of greater than every 100 years.

Where possible, frequency was calculated based on existing data. It was determined by dividing the number of events observed by the number of years and multiplying by 100. This gives the percent chance of the event happening in any given year (e.g., three droughts over a 30-year period equates to a 10 percent chance of a experiencing a drought in any given year).

An estimate of the vulnerability of the Town to each identified hazard, in addition to the estimate of risk of future occurrence, is provided in each of the hazard-specific sections that follow. Vulnerability is measured in general, qualitative terms and is a summary of the potential impact based on past occurrences, spatial extent, and damage and casualty potential. It is categorized into the following classifications:

- **Extremely Low**—The occurrence and potential cost of damage to life and property is very minimal to nonexistent.
- **Low**—Minimal potential impact. The occurrence and potential cost of damage to life and property is minimal.
- **Medium**—Moderate potential impact. This ranking carries a moderate threat level to the general population and/or built environment. Here the potential damage is more isolated and less costly than a more widespread disaster.
- **High**—Widespread potential impact. This ranking carries a high threat to the general population and/or built environment. The potential for damage is widespread. Hazards in this category may have occurred in the past.
- **Extremely High**—Very widespread and catastrophic impact.

Vulnerability can be quantified in those instances where there is a known, identified hazard area, such as a mapped floodplain. In these instances, the numbers and types of buildings subject to the identified hazard can be counted and their values tabulated. Further, other information can be collected, such as the location of critical historic structures and valued natural resources that are within the specific hazard area. Together, this information portrays the impact, or vulnerability, of that area to that hazard.

The Advisory Committee identified four hazards in the Town of Lyons for which specific geographical hazard areas have been defined: floods, landslides/rockfalls, subsidence/collapsible soils and wildfires. For these hazard areas, the Advisory Committee has inventoried the following for the Town, to the extent feasible, as a means of quantifying the vulnerability and meeting the requirement of how risk varies across the planning area:

- General hazard-related impacts, including impacts to life, safety, and health
- Insurance coverage, claims paid, and repetitive losses

- Values at risk (i.e., types, numbers, and value of land and improvements)
- Identification of critical facilities at risk
- Identification of cultural and natural resources at risk
- Overall community impact
- Development trends within the identified hazard area

Vulnerability and potential impacts from hazards that do not have specific mapped areas, such as drought and severe weather, are discussed in more general terms based on past events.

4.1 Dam Failure

Description

Dams are manmade structures built for a variety of uses, including flood protection, power, agriculture, water supply, and recreation. Dams typically are constructed of earth, rock, concrete, or mine tailings. Factors that influence the potential severity of a full or partial dam failure are the amount of water impounded and the density, type, and value of development and infrastructure located downstream.

Dam failures can result from any one or a combination of the following causes:

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

Overtopping is the primary cause of earthen dam failure.

Water released by a failed dam generates tremendous energy and can cause a flood that is catastrophic to life and property. A catastrophic dam failure could challenge local response capabilities and require evacuations to save lives. Impacts to life safety will depend on the warning time and the resources available to notify and evacuate the public. Major loss of life could result as well as potentially catastrophic effects to roads, bridges, and homes. Associated water quality and health concerns could also be an issue.

In general, there are three types of dams: concrete arch or hydraulic fill, earth-rockfill, and concrete gravity. Each type of dam has different failure characteristics. A concrete arch or hydraulic fill dam can fail almost instantaneously: the flood wave builds up rapidly to a peak then gradually declines. An earth-rockfill dam fails gradually due to erosion of the breach: a flood wave will build gradually to a peak and then decline until the reservoir is empty. And, a concrete gravity dam can fail instantaneously or gradually with a corresponding buildup and decline of the flood wave.

The Colorado Division of Water Resources Dam Safety Branch assigns hazard ratings to large dams within the State. Two factors are considered when assigning hazard ratings: existing land use and land use controls (zoning) downstream of the dam. Dams are classified in three categories that identify the potential hazard to life and property:

- High hazard indicates that a failure would most probably result in the loss of life
- Significant hazard indicates a failure could result in appreciable property damage
- Low hazard exists where failure would result in only minimal property damage and loss of life is unlikely.

Privately owned high and significant hazard dams are required by Colorado regulations to have Emergency Action Plans (EAPs) in place. Federally-owned high hazard dams are also required to have EAPs by federal regulations. According to the 2010 State Hazard Mitigation Plan, all high-hazard dams in Colorado have EAPs in place, which provide for the emergency response procedures in the event of a dam emergency event.

Location

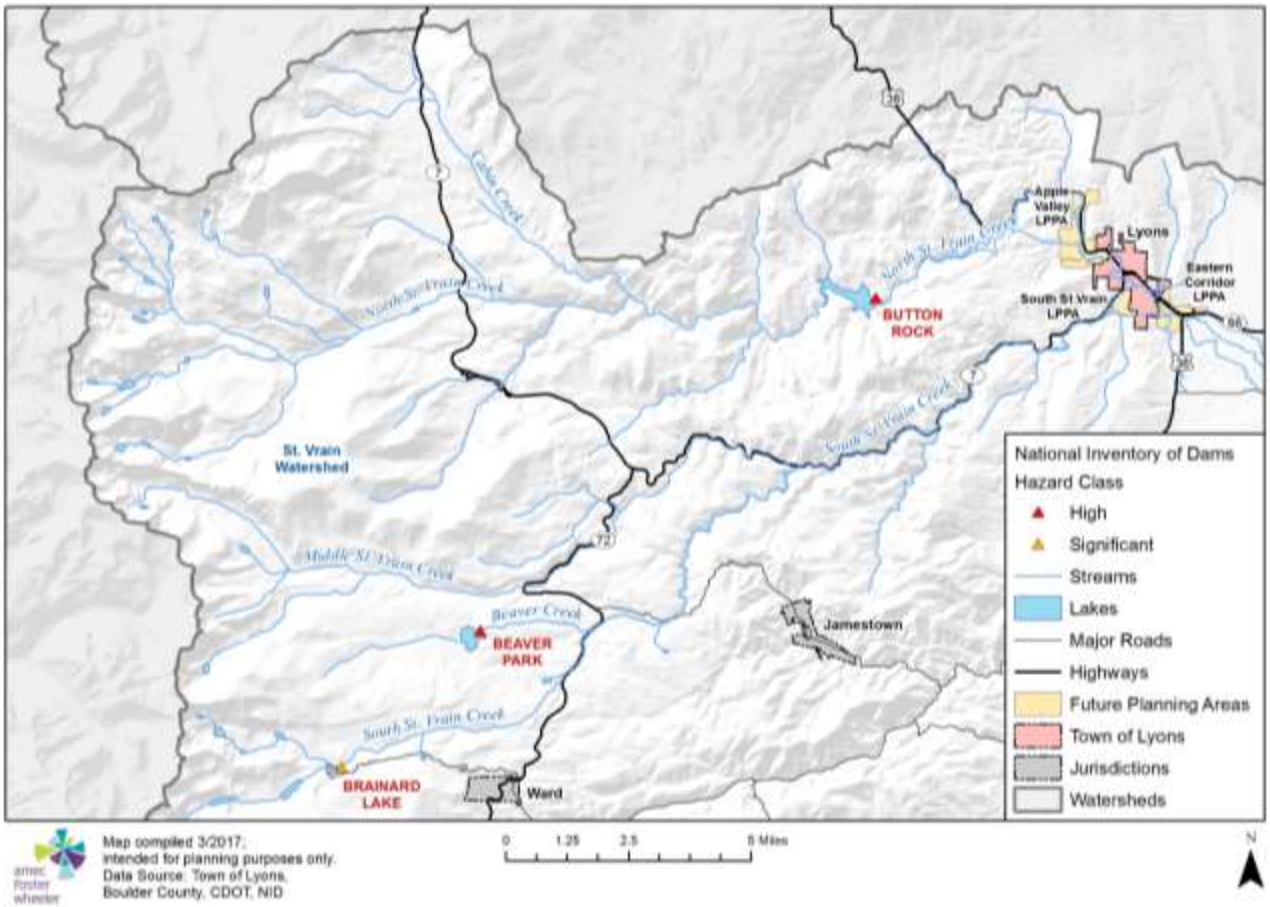
According to the National Performance of Dams Program (NPDP) database, housed in the Department of Civil and Environmental Engineering at Stanford University, there are 2 high hazard and 1 significant hazard dam that could affect the town (see Figure 2.1). The following map displays the location of high and significant hazard dams that could affect the Town.

Table 4.1. Dams Affecting the Town of Lyons

Name	Type of Dam	Year Built	Owner	River	Near City	Distance to City (miles)	Dam Height (ft)	Max Storage (acre-feet*)	Normal Storage (acre-feet*)	Hazard Class	EAP
Beaver Park	Rockfill	1892	St. Vrain Reservoir and Fish Company	Beaver Creek	Lyons	18	33	2,731	2,161	H	Y
Button Rock	Earth	1969	City Of Longmont	North St. Vrain Creek	Lyons	9	210	20,400	16,080	H	Y
Brainard Lake	Earth	1943	USDA Forest Service	South St. Vrain Creek	Lyons	28	11	160	85	S	NR

Source: National Inventory of Dams
* One acre foot of water is equivalent to 325,000 gallons

Figure 4.1. Dams in Watersheds above Lyons



Past Occurrences

According to historical data, there have been no dam failures in Boulder County. Two dams in Boulder County were listed as unsafe in the past but have since been fixed and the unsafe rating removed. However, on July 15, 1982, the nearby Lawn Lake Dam in Rocky Mountain National Park near Estes Park, Colorado, failed causing a flood through downtown Estes Park. Three people were killed in this flood.

During the 2013 flood event there was concern in Lyons about the stability of Button Rock Dam when excess rainfall caused the level of the reservoir to rise and send excess water over the dam's spillway. Despite this torrent of water, the spillway performed as intended to prevent the dam from overtopping.

Likelihood of Future Occurrences

Unlikely: There are no official recurrence intervals calculated for dam failures, so estimating the frequency of occurrence of dam failure is extremely difficult. Based on historical data indicating that there have been no dam failures in the past that adversely impacted the Town, the risk of future occurrences is unlikely. The structural integrity of dams can decrease with age and other factors, thus regular inspections and maintenance should remain a priority.

Climate Change Considerations

Climate change is not likely to have direct impact on the frequency and severity of dam failure.

Magnitude/Severity (Extent)

Button Rock Dam has the potential to have the worst impacts to the Town if a dam failure occurred. As a High Hazard rated dam there would be potential for life loss and significant property damage. The dam failure inundation extent within town limits is considered significant, potentially impacting 10-50% of the planning area.

Vulnerability Assessment and Potential Losses

Dam failure flooding can occur as the result of partial or complete collapse of an impoundment. Dam failures often result from prolonged rainfall and flooding causing overtopping of the structure. The primary danger associated with dam failure is the high velocity flooding of those properties downstream of the dam.

The Division of Water Resources runs the Dam Safety Program in Colorado. According to the State of Colorado Natural Hazards Mitigation Plan, Colorado has emergency action plans (EAP) for nearly all of the state-regulated high- and significant-hazard dams. Inundation maps for some dams have also been developed and exist for Button Rock Dam. These maps are within the EAP and are not presented here due to homeland security concerns. Inundation would be at a minimum similar to a 0.2 % annual chance flood on the North St Vrain as detailed in the Flood section. Impacts would be greater due to greater depths and velocities of flow and entrained debris.

People

According to the analysis of the 0.2% annual chance flood, there is approximately 430 persons in this zone; a large portion of the core town would need to be evacuated in the event of a failure at Button Rock Dam.

Built Environment

A large portion of the core residential area in the confluence would be impacted in the event of a failure at Button Rock Dam. According to the analysis of the 0.2% annual chance flood, there are approximately 230 structures in this zone (including elevated structures). At total exposure of $57 million in mostly residential property is within this zone; a loss of 25% of that exposure would result in $14 million to structures and contents.

Critical Facilities and Infrastructure

Significant losses would occur to critical facilities and infrastructure. It is likely all the bridges over the North St Vrain would be destroyed, resulting in loss of mobility and compromised access/egress. Critical facilities identified within 1% and 0.2% annual chance flood zones are noted below.

Table 4.2. Critical Facilities at Risk to 1% and 0.2% Annual Chance Flooding

Category	Facility Name
1% Annual Chance	
Bridge	South St. Vrain Creek & Old St Vrain Rd
Bridge	St. Vrain Creek & McConnell Dr
Bridge	St. Vrain Creek & McConnell Dr
Bridge	St. Vrain Creek & 2nd Ave
Bridge	St. Vrain Creek & US Hwy 36
Bridge Scour Critical	North St. Vrain Creek & St Hwy 7
Bridge Scour Critical	St. Vrain Creek & 51st St
0.2% Annual Chance	
Bridge	North St. Vrain Creek & US Hwy 36
Bridge	North St. Vrain Creek & US Hwy 36
Communications	Warning Siren
Government Building	Town Hall
Municipal Wastewater	Pump Station (Eagle Canyon)
Municipal Wastewater	Pump Station (Stone Canyon)
Municipal Wastewater	Treatment Plant
Police	Boulder County Substation
Public Facility	Library
Public Facility	Planet Bluegrass

Economy

Based on the risk assessment, it is evident that a dam failure would have potentially devastating and long term economic impacts to Lyons. Impacts would be at a minimum as devastating as the 2013 flood. This would include significant economic impact (jobs, sales, tax revenue) upon the community and negative impacts on commercial and residential property values.

Natural, Cultural and Historic Resources

Planet Bluegrass is within the Button Rock inundation zone, a significant cultural resource and economic asset to the town. A large number of people attend music festivals in the summer months at this venue.

Future Development

Development along the St. Vrain River is a concern with respect to dam safety issues. While new construction areas are in the 1% annual chance (100-year) flood area are required to be mitigated to that event, development in the 0.2% zone is not and certainly in an area that would be at risk should there be a dam failure.

Potential future annexations into the Apple Valley LPPA would put an additional 43 structures within the Town at risk to both 1% and 0.2% annual chance flooding and dam failure.

Summary

The overall impacts to the Town from a dam failure include those similar to major flood events. The biggest difference is that a catastrophic dam failure has the potential to result in a much greater loss of life and destruction to property and infrastructure due to the potential speed of onset and greater depth, extent, and velocity of flooding in addition to considerable debris. While the severity is considered potentially catastrophic the risk is tempered by the low probability of such an event, and thus the overall the significance is medium.

4.2 Drought

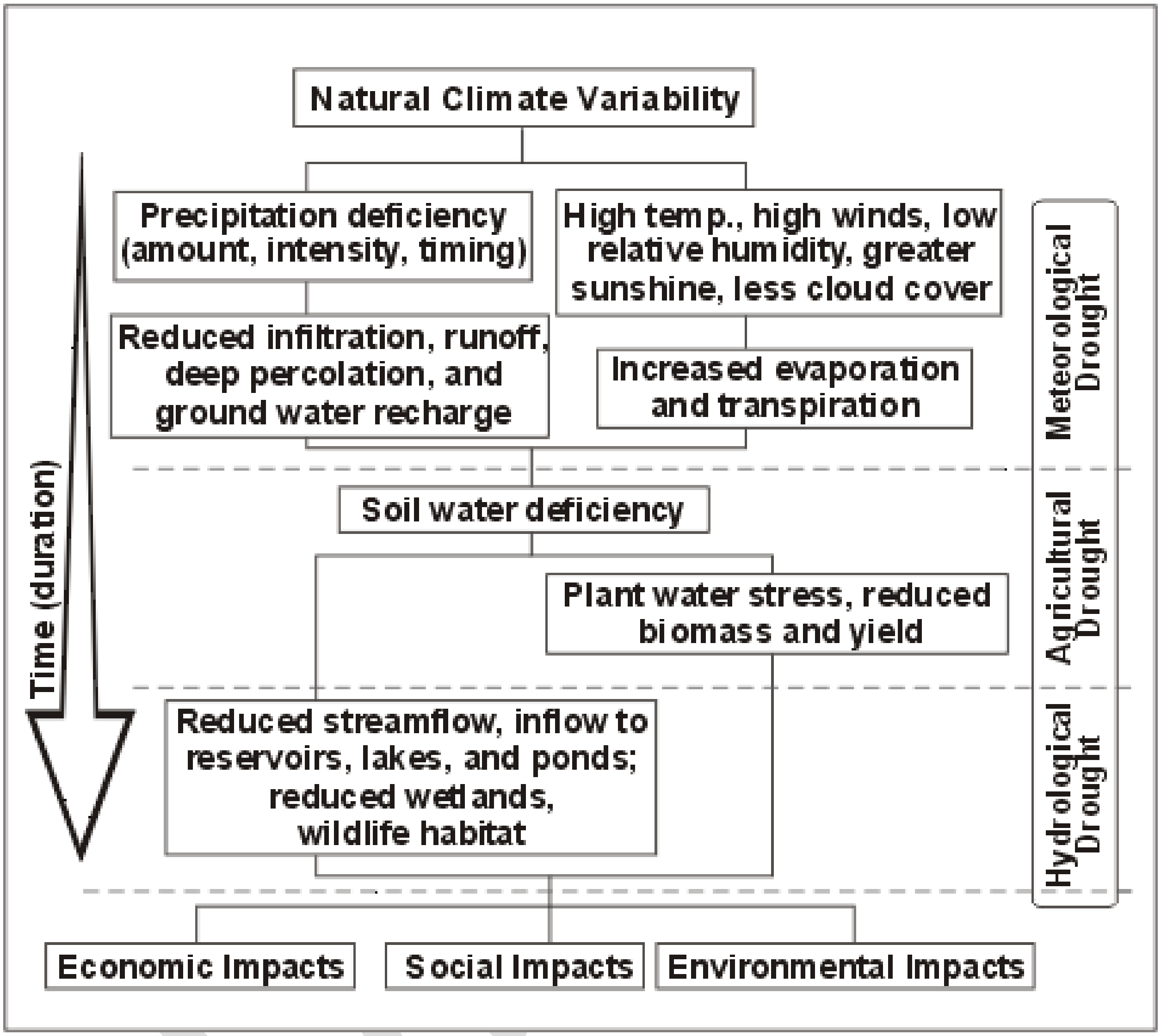
Description

Drought is a gradual phenomenon. Although droughts are sometimes characterized as emergencies, they differ from typical emergency events. Most natural disasters, such as floods or forest fires, occur relatively rapidly and afford little time for preparing for disaster response. Droughts occur slowly, over a multi-year period, and it is often not obvious or easy to quantify when a drought begins and ends.

Drought is a complex issue involving many factors; drought occurs when a normal amount of moisture is not available to satisfy an area's usual water-consuming activities. Drought can often be defined regionally based on its effects:

- **Meteorological** drought is usually an expression of precipitation's departure from normal over some period of time. Meteorological measurements are the first indicators of drought.
- **Agricultural** drought occurs when there is an inadequate water supply to meet the needs of the state's crops and other agricultural operations such as livestock.
- **Hydrological** drought is defined as deficiencies in surface and subsurface water supplies. It is generally measured as streamflow, snowpack, and as lake, reservoir, and groundwater levels.
- **Socioeconomic** drought occurs when a drought impacts health, well-being, and quality of life, or when a drought starts to have an adverse economic impact on a region.

Figure 4.2. Causes and Impacts of Drought

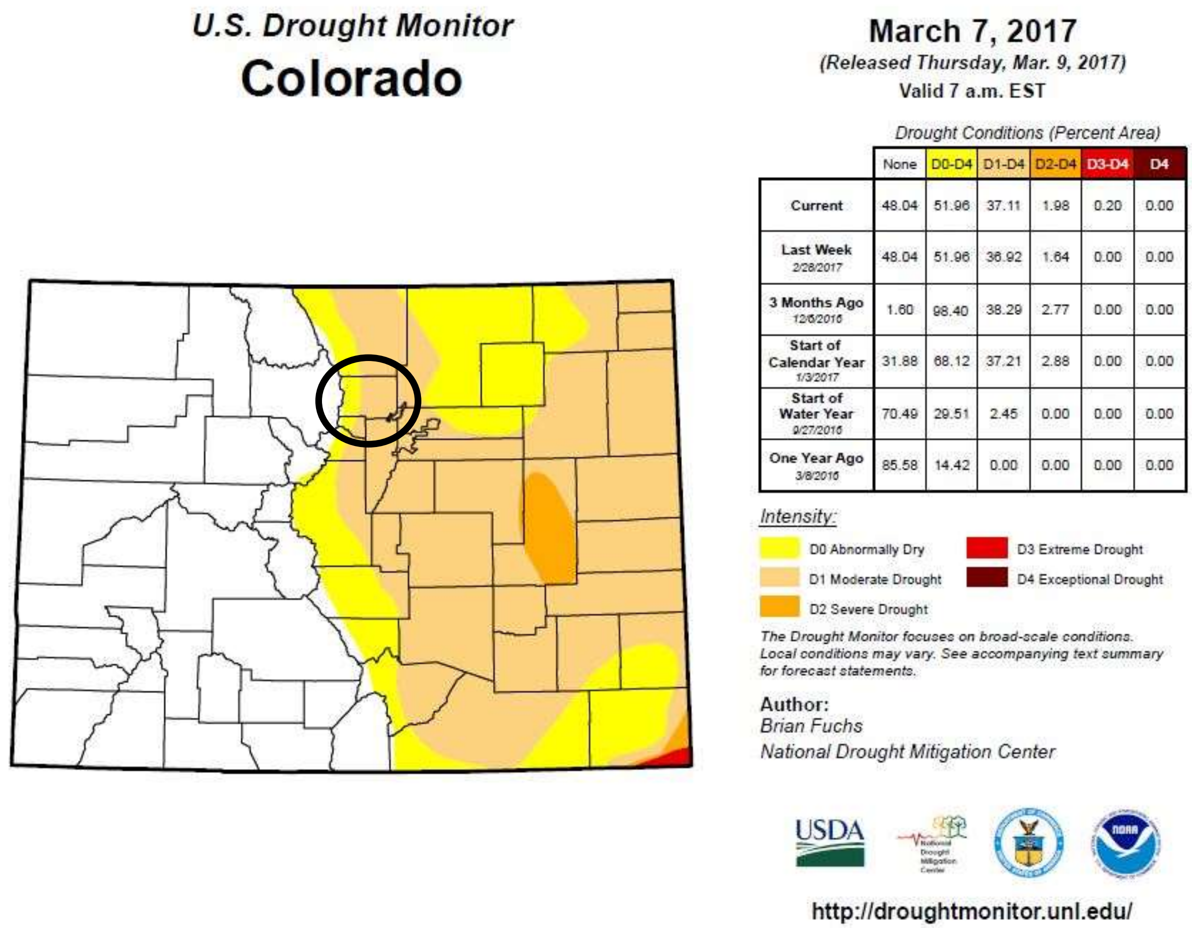


Source: National Drought Mitigation Center

Location

Drought in the United States is monitored by the National Integrated Drought Information System (NIDIS). A major component of this portal is the U.S. Drought Monitor. The Drought Monitor concept was developed jointly by the NOAA's Climate Prediction Center, the National Drought Mitigation Center (NDMC), and the USDA's Joint Agricultural Weather Facility in the late 1990s as a process that synthesizes multiple indices, outlooks and local impacts, into an assessment that best represents current drought conditions. The final outcome of each Drought Monitor is a consensus of federal, state, and academic scientists who are intimately familiar with the conditions in their respective regions. A snapshot of the drought conditions in Colorado and the planning area can be found in Figure 4.3. The map indicates that the majority of the State is in moderate to severe drought, with abnormally dry conditions in the Boulder County.

Figure 4.3. March 2017 Drought Status in Colorado and Boulder County



Source: US Drought Monitor; White oval indicates approximate location of Lyons

With its semiarid conditions, drought is a natural but unpredictable occurrence in Colorado. Due to natural variations in climate and precipitation sources, it is rare for all of Colorado to be deficient in moisture at the same time. However, single season droughts over some portion of the state are quite common. Defining when a drought begins is a function of drought impacts to water users. Hydrologic conditions constituting a drought for water users in one location may not constitute a drought for water users elsewhere, or for water users that have a different water supply. Individual water suppliers may use criteria, such as rainfall/runoff, amount of water in storage, or expected supply from a water wholesaler, to define their water supply conditions. The drought issue is further compounded by water rights specific to a state or region. Water is a commodity possessed under a variety of legal doctrines.

Drought impacts are wide-reaching and may be economic, environmental, and/or societal. The most significant impacts associated with drought in Colorado are those related to water intensive activities such as agriculture, wildfire protection, municipal usage, commerce, tourism, recreation, and wildlife preservation. A reduction of electric power generation and water quality deterioration are also potential problems. Drought conditions can also cause soil to compact and not absorb water well, potentially making an area more susceptible to flooding. An ongoing drought may also leave an area more prone to beetle kill and associated wildfires. Drought impacts increase with the length of a drought, as carry-over supplies in reservoirs are depleted and water levels in groundwater basins decline. The drought hazard extent within Town limits is considered extensive, potentially impacting 50-100% of the planning area.

Past Occurrences

The planning area has experienced 7 multi-year droughts since 1893, with the most pronounced being in the 1930s and 1950s. Table 4.3 is from the *Colorado Drought Mitigation & Response Plan (2013).*

Table 4.3. Historical Dry and Wet Periods in Colorado

Date	Dry	Wet	Duration (years)
1893-1905	X		12
1905-1931		X	26
1931-1941	X		10
1941-1951		X	10
1951-1957	X		6
1957-1959		X	2
1963-1965	X		2
1965-1975		X	10
1975-1978	X		3
1979-1999		X	20
2000-2006	X		6
2007-2010		X	3
2010-2012	X		2

Source: 2013 Colorado Drought Mitigation and Response Plan

The *Colorado Drought Mitigation and Response Plan* was last updated in August 2013. The update provided the following additional information to the table above, drawn from the 2004 *Drought & Water Supply Assessment* (DWSA):

"The period 2000 through 2003 was a 'significant multi-year statewide drought, with many areas experiencing [the] most severe conditions in Colorado instrumented history.'"[1] The 2007 *DWSA Update* notes that the "effects of Colorado's recent drought (1999-2003) still linger among municipal providers."

The Advisory Committee identified the following as drought events of significance to the Town of Lyons and Boulder County.

- **1930-1937**—The drought of the 1930s had the greatest impact on the agricultural industry. Poor farming techniques, low market prices, and a depressed economy compounded the problem.
- **1951-1957**—Similar to the drought of the 1930s, the drought of the 1950s once again impacted the agricultural industry. Improvements in irrigation and farming techniques mitigated the effects.
- **1976-1977**—This drought was characterized as a winter event, limited in duration. It was the driest winter in recorded history for much of Colorado's high country and western slope, severely impacting the ski industry.
- **1980-1981**—This drought, beginning in the fall of 1980 and lasting until the summer of 1981, also had costly impacts to the ski industry.
- **1994**—This growing season drought that impacted northeast Colorado was considered to be one of the driest years on record. Significant impacts included increased wildfires statewide, winter wheat crop losses, difficulties with livestock feeding, and declines in the state's fisheries.
- **2000**—Strong La Niña conditions created below average precipitation and above average temperatures for most months in 2000. Statewide, snowpack started out well below average but recovered to near average in March. However, an early snowmelt resulted in low stream flows, and by June, drought conditions began to affect most of the state. Conditions were most severe in the northeastern plains and the Rio Grande and San Juan/Dolores basins in the southwest. Wildfire conditions were extreme and several fires were reported statewide. Agriculture also suffered. Dryland farming and ranching was affected the most. As of October 2000, 17 Colorado counties and 29 contiguous counties were eligible for assistance as a result of a USDA secretarial disaster designation. Boulder County was eligible for aid as a contiguous county. By fall, weather patterns returned to near normal with average precipitation and below average temperatures.
- **May 2002**—The Colorado governor, for the first time in state history, asked the federal government to declare all of Colorado a drought disaster area. With an average temperature of 52.4 degrees, 2001 was the warmest year since 1986. The drought started in late 1999 and was compounded by scarce snowfall in 2001. 2002 was the driest year on record for the Denver region and much of the state. Total precipitation for 2002 was 7.48 inches.

[1] Colorado Water Conservation Board, *Updated Information Provided in Support of the 2002 Colorado Drought Mitigation and Response Plan*, June 2007. Available online at http://cwcb.state.co.us/NR/rdonlyres/1F537E1C-A4FC-4B8D-A553-7C5D381BA250/0/FinalReportJune2007.pdf last accessed July 13, 2009.

- **2011-2012 –** Based on the U.S. Drought Monitor, approximately 50% of Colorado was already under drought conditions at the beginning of 2012. Drought conditions and a period of extremely hot temperatures in June 2012 contributed to very dry forests, contributing to the conditions that led to the High Park fire in northern Colorado and the Waldo Canyon fire near Colorado Springs, two of Colorado's most destructive wildfires. Drought conditions also exacerbated the Lower North Fork fire in Jefferson County in March of 2012. Reservoir levels in many portions of the State helped abate some of the drought impacts seen in 2011-2013. Had the reservoir levels not been at levels sufficient for carryover storage into 2012 (due to record breaking high snowpack in 2011) in many river basins, many of the impacts discussed above may have been worse.

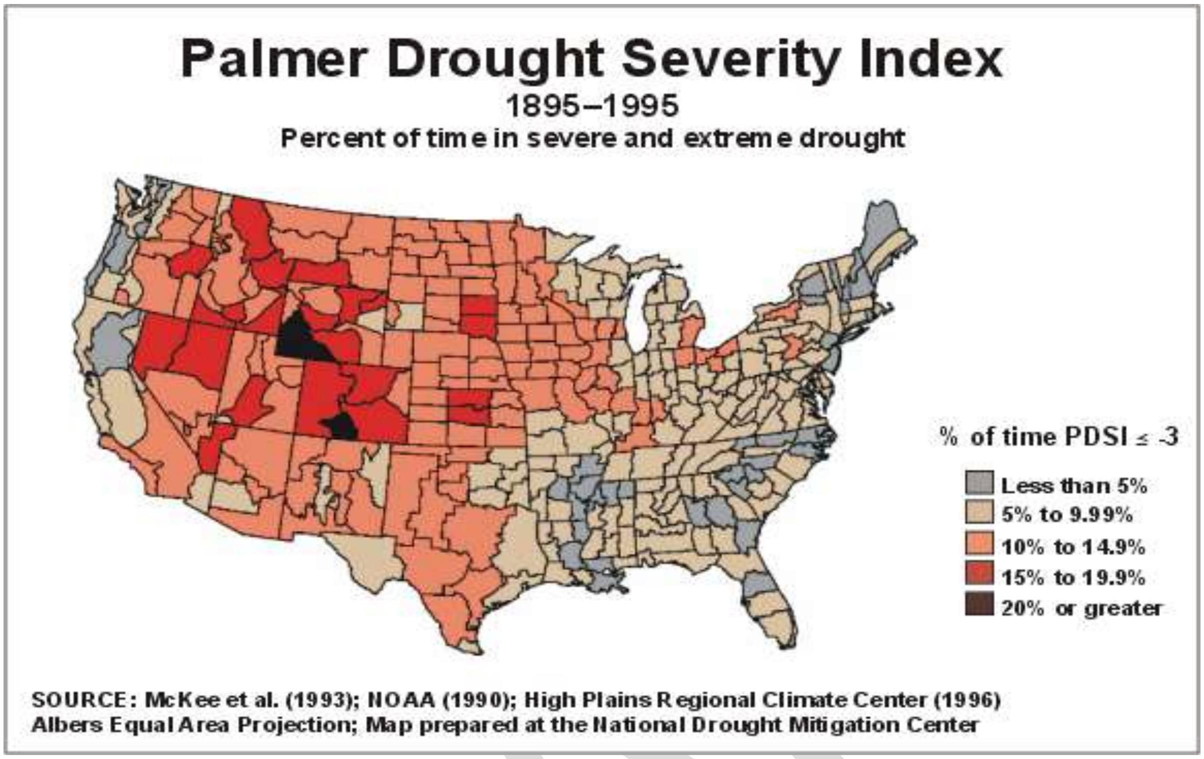
Likelihood of Future Occurrences

Likely: The 2010 Colorado Drought Hazard Mitigation Plan found that short duration drought as defined by the three-month Standardized Precipitation Index (SPI) occur somewhere in Colorado in nearly nine out of every ten years. However, severe, widespread multiyear droughts are much less common.

According to local historical data, Lyons has experienced seven periods of drought since 1930, assuming the 2000 and 2002 events are considered as one. With drought conditions worsening in 2012, the town will have experienced eight period of drought since the 1930's. Based on the 8 historical droughts, this is an average of one drought every 10.2 years or a 9.8 percent chance of drought in any given year. Given the geographic location of the planning area, its semiarid conditions, and historical drought cycles, drought is likely to affect the Town of Lyons in the future.

The figure below indicates that drought occurs approximately every five to 10 years in the region where Lyons is located. The figure indicates the planning area spent approximately 10-15% of the 100 year span from 1895 to 1995 in severe or extreme drought. This is consistent with the data in the Past Occurrences subsection which suggests that severe multi-year droughts have occurred roughly every ten years since the mid-20th century. An occurrence interval of roughly once every ten years corresponds to a **likely** frequency of occurrence.

Figure 4.4. United States: Percent of Time in Drought, 1895–1995



Climate Change Considerations

According to the Boulder County Climate Change Preparedness Plan, the nature and frequency of drought could be altered from climate change. A future of reduced overall precipitation, warmer summers, and greater demand downstream of the county will cause much more stress to water supplies. The Town of Lyons relies primarily on snowpack in the watersheds for its water supply. Higher temperatures can lead to declining snowpack and earlier snowmelt and runoff. If Boulder County's future climate warms as expected, snowpack could become a less reliable mechanism for water storage, even without any changes in total precipitation. Future extended droughts that impact snowpack in the high mountains – especially if such droughts reduce the frequency or size of spring upslope storms – could push the Town into more severe drought restrictions.

Warmer temperatures can lead to more severe drought impacts, even if the precipitation deficit is the same. In addition, the projected seasonal shift in precipitation and earlier runoff could see additional stress on natural and human systems in the summers of drought years. What is less certain, but probable, is the possibility for more frequent, longer-term or more severe droughts.

Magnitude/Severity (Extent)

In order to determine a magnitude and severity rating for comparison with other hazards, and to assist in assessing the overall impact of the hazard on the planning area, information from the event of record is used. In some cases, the event of record represents an anticipated worst-case scenario, and in others, it is a reflection of common occurrence. The event of record for the Town of Lyons occurred between 2000 and 2003. The drought seriously impacted water supply levels and water quality, and several severe wildfires, augmented by drought conditions, occurred in the planning area during this time.

The U.S. Drought Monitor classifies droughts into different categories, from D0 (Abnormally Dry) to D4 (Exceptional Drought). Periods of dryness are classified in one of these categories as the drought's life cycle is tracked. The following table explains each of these categories.

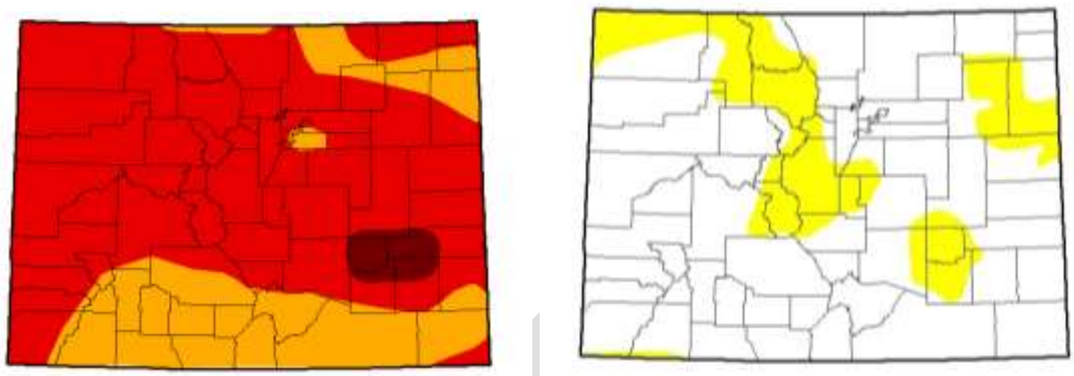
Table 4.4. U.S. Drought Monitor Drought Severity Classifications

Category	Description	Possible Impacts	Palmer Drought Severity Index (PDSI)	Standardized Precipitation Index (SPI)
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	-0.5 to -0.7
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	-0.8 to -1.2
D2	Severe Drought	- Crop or pasture losses likely - Water shortages common - Water restrictions imposed	-3.0 to -3.9	-1.3 to -1.5
D3	Extreme Drought	- Major crop/pasture losses - Widespread water shortages or restrictions	-4.0 to -4.9	-1.6 to -1.9
D4	Exceptional Drought	- Exceptional and widespread crop/pasture losses - Shortages of water in reservoirs, streams and wells creating water emergencies	-5.0 or less	-2.0 or less
				Source: United States Drought Monitor

Drought extent maps are available from the archive of the U.S. Drought Monitor. They consistently change as conditions lessen or worsen, and show both the severity and magnitude of the drought conditions across the State. The following figure shows drought conditions from two different time periods – the height of Colorado's last large-scale drought in 2012, and from November 2015. Note the extent of the drought conditions in the Town of Lyons and across the State in 2012 when the majority of the state and the Town were in D3 Extreme Drought conditions. In November 2015, the majority of the state was experiencing normal precipitation conditions.

Figure 4.5. Colorado: Drought Conditions, 2012 and 2015

July 24, 2012	November 10, 2015



Source: United States Drought Monitor

The 2013 State of Colorado Drought Mitigation and Response Plan assessed the risks to drought to each of Colorado's counties. According to the plan, impacts of future drought will vary by region. The Town will see an increase in dry fuels, beetle kill, associated wildfires, and may see loss of tourism revenue. Water supply issues for municipal, industrial, and domestic needs will be a concern for the entire county; vulnerability increases with consecutive winters of below-average snow pack.

Based on these factors, the magnitude severity ratings for droughts are considered **critical**.

Vulnerability Assessment and Potential Losses

Drought impacts are wide-reaching and may be economic, environmental, and/or societal. The most significant impacts associated with drought in the Planning Area are those related to water intensive activities such as wildfire protection, municipal usage, commerce, tourism and recreation. During a drought, water allocations go down, which results in reduced water availability. The Town has a senior, diversified water rights portfolio that includes a partnership with the City of Longmont on the use of water stored in Button Rock Reservoir. Water is treated in Longmont and provided back to the Town through pipelines. The Town also has shares in water rights from the Colorado-Big Thompson project, further diversifying supply. Water restrictions and other conservation measures are typically implemented during extended droughts, which can have an economic impact and affect turf and plants within the local park system. Drought conditions can also cause soil to compact and not absorb water well, potentially making an area more susceptible to flooding.

Another useful resource to determine the impacts of drought is the Drought Impact Reporter (DIR), launched by the National Drought Mitigation Center in July 2005 as the nation's first comprehensive database of drought impacts. The Drought Impact Reporter is an interactive webbased mapping tool designed to compile and display impact information across the United States in near real-time from a variety of sources such as media, government agencies, and the public. Information within the Drought Impact Reporter is collected from a variety of sources including the media, government agencies and reports, and citizen observers. Each of these sources provides different types of information at different spatial and temporal scales.

A search of the database for Boulder County from 1999 to 2016 (which includes the most recent severe droughts) shows a total of 38 reported impacts. The most reported impacts (15) are in the Water Supply and Quantity category and the Relief, Response & Restriction category (12). The Relief, Response & Recovery category refers to drought effects associated with disaster declarations, aid programs, requests for disaster declaration or aid, water restrictions, or fire restrictions.

Table 4.5. Boulder County Drought Impacts 1/1/1999 through 4/6/2017

Category	Number of Recorded Impacts*
Agriculture	8
Business and Industry	1
Fire	9
Plants & Wildlife	6
Relief, Response, and Restrictions	12
Society and Public Health	3
Tourism and recreation	1
Water Supply and Quality	15
Total	**69**

*Impacts may overlap across sectors
Source: National Drought Mitigation Center http://drought.unl.edu/monitoringtools/droughtimpactreporter.aspx

Using the NDMC Drought Impact Reporter impacts to determine relative exposure/vulnerability to drought has limitations because the methodology can double-count impacts that are recorded at the state level, then counted again for each county within that state. Rather, the NDMC data should be used to develop an ongoing record of drought impacts to sector assets that relate the specific impacts to different intensity and duration droughts at a location. Over time a detailed impact profile could be developed for vulnerable sectors so that the impact of future drought vulnerability could be better defined based on historic impacts

People

The most significant qualitative impacts associated with drought in the Planning Area are those related to water intensive activities such as wildfire protection, municipal usage, commerce, tourism, recreation, and wildlife preservation. Mandatory conservation measures are typically implemented during extended droughts, which can affect people.

Drought may cause health problems related to low water flows and poor water quality; it may also cause health problems due to dust. Generally, drought may require conservation of water resources, which could mean that water use is restricted to critical uses; this could impact how people use water on a daily basis.

Built Environment

Direct structural damage from drought is rare, though it can happen. Drought can affect soil shrinking and swelling cycles, and can result in cracked foundations and infrastructure damage.

Critical Facilities and Infrastructure

Because of their long-lasting nature, the biggest impact of drought is on the water supply. Because of this, critical facilities that rely on a steady supply of water could see the greatest impacts if a long-term drought occurred. Examples of these facilities include power plants and hospital and medical facilities. Drought can also directly impact water storage, treatment and distribution systems.

Economy

Drought could have a devastating impact on the Town of Lyons' economy. As water resources become impacted, effects may be felt by any industry that uses large amounts of water. Prolonged drought would intensify these issues. The lack of water could potentially also impact the Town's tourism industry, and negatively impact the ability to provide water to Town parks and large groups of people including the Town's summer festivals. Lyons would also be affected by any fluctuation in food prices due to availability issues affecting the surrounding areas.

Natural, Cultural and Historic Resources

Severe, prolonged drought can impact the natural environment. Wildlife and natural habitats can be affected, including the shrinkage of habitat, dwindling of food supplies and the migration of wildlife to more palatable areas. Prolonged drought can cause poor soil quality and increased soil erosion. One of the prevailing impacts of drought to the natural environment is the increased risk of wildfires that burn larger and more intensely during dry conditions. Drought conditions can also cause soil to compact and not absorb water well, potentially making an area more susceptible to flooding.

Future Development

The Town of Lyons has identified growth areas. While these areas should not see any unique impacts from drought that aren't felt in the overall planning area, any new additions to the Town increase the need for water resources. New development should be encouraged to implement water conservation strategies to limit the overall impact to finite local, regional, and state water resources.

Summary

- Drought has a cyclical occurrence in the Town of Lyons and typically every decade has multiple years of drought; climate change could impact the nature and frequency of future droughts.
- The recreation and tourism industry is vulnerable to drought induced snowpack shortages, water-based recreation, and forest closures due to wildfires or elevated wildfire risk;
- The dependence of the regional economy on agriculture and tourism makes the area more susceptible to drought impacts.
- The municipal water system has a senior diversified water rights portfolio that has a high degree of reliability and thus the overall drought significance is medium.

4.3 Earthquakes

Hazard/Profile Description

An earthquake is caused by a sudden slip on a fault. Stresses in the earth's outer layer push the sides of the fault together. Stress builds up and the rocks slip suddenly, releasing energy in waves that travel through the earth's crust and cause the shaking that is felt during an earthquake. The amount of energy released during an earthquake is usually expressed as a Moment magnitude and is measured directly from the earthquake as recorded on seismographs. Another measure of earthquake severity is intensity. Intensity is an expression of the amount of shaking at any given location on the ground surface as felt by humans and defined in the Modified Mercalli scale (see Table 4.6). Seismic shaking is typically the greatest cause of losses to structures during earthquakes.

Table 4.6. Earthquake Intensities with Approximate Corresponding Magnitudes

Modified Mercalli Intensity	Description	Moment Magnitude
I	Instrumental: detected only by seismographs	3.5
II	Feeble: noticed only by sensitive people	4.2
III	Slight: like the vibrations due to a passing train; felt by people at rest, especially on upper floors	4.3
IV	Moderate: felt by people while walking; rocking of loose objects, including standing houses	4.8
V	Rather strong: felt generally; most sleepers are awakened and bells ring	4.9-5.4
VI	Strong: trees sway and all suspended objects swing; damage by overturning and falling of loose objects	5.5-6.0
VII	Very strong: general alarm; walls crack; plaster falls	6.1
VIII	Destructive: car drivers seriously disturbed; masonry fissured; chimneys fall; poorly constructed buildings damaged	6.2
IX	Ruinous: some houses collapse where ground begins to crack, and pipes break open	6.9

Modified Mercalli Intensity	Description	Moment Magnitude
X	Disastrous: ground cracks badly; many buildings destroyed and railway lines bent; landslides on steep slopes	7.0-7.3
XI	Very disastrous: few buildings remain standing; bridges destroyed; all services (railways, pipes and cables) out of action; great landslides and floods	7.4-8.1
XII	Catastrophic: total destruction; objects thrown into air; ground rises and falls in waves	> 8.1

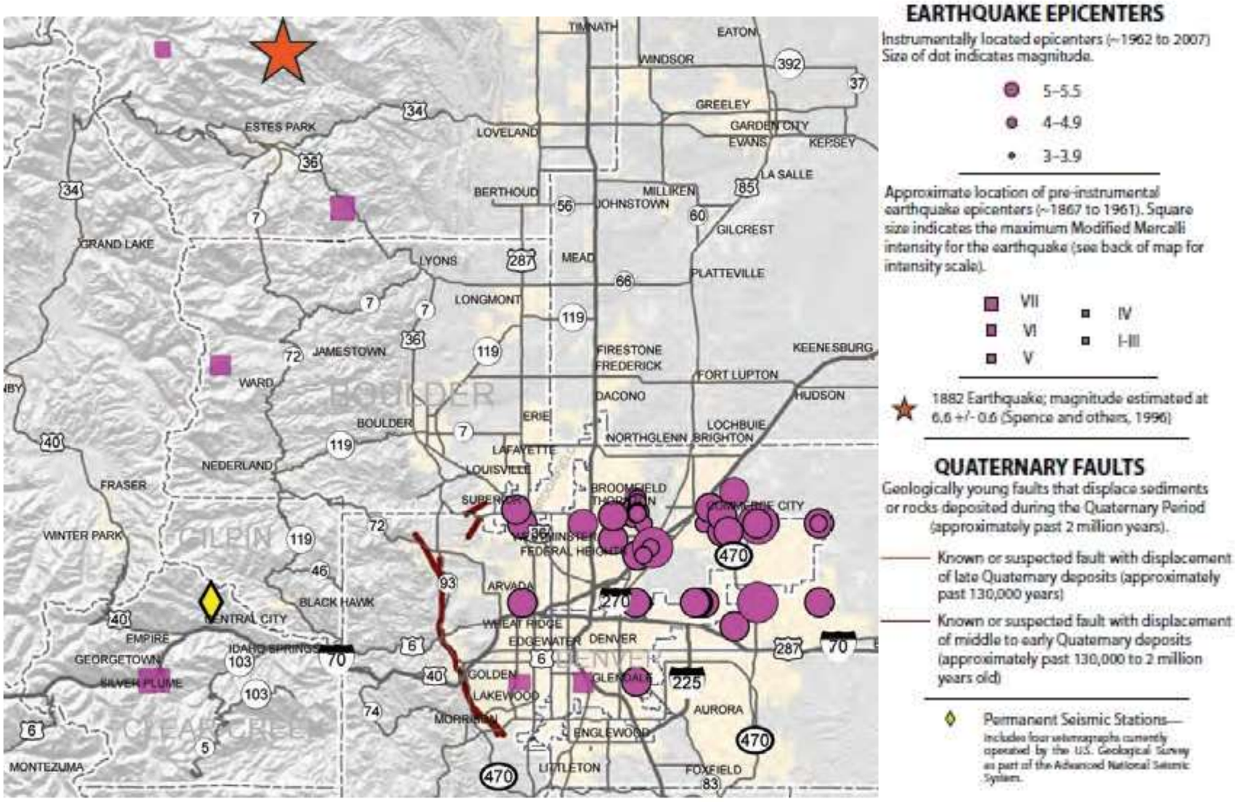
Source: Math/Science Nucleus.Org

Earthquakes can cause structural damage, injury, and loss of life, as well as damage to infrastructure networks, such as water, power, communication, and transportation lines. Other damage-causing effects of earthquakes include surface rupture, fissuring, settlement, and permanent horizontal and vertical shifting of the ground. Secondary impacts can include landslides, seiches, liquefaction, fires, and dam failure.

Location

Colorado is considered a region of minor earthquake activity. Geologic studies indicate there are about 90 potentially active faults in Colorado with documented movement within the last 1.6 million years. Faults with evidence of movement during the past 130,000 years are often considered active faults. These faults are shown in red on Figure 4.6. Faults that last moved between 130,000 and 2 million years ago may be considered potentially active. Locations of these faults are depicted on the map by the dark red-brown lines. Thousands of other faults exist in Colorado, but few have been studied in sufficient detail to determine their activity during the recent geologic past. Some of these faults also may be a potential concern. Figure 4.6 shows the location of faults and past earthquake epicenters in Colorado. Since earthquakes affect large areas the earthquake hazard extent within town limits is considered extensive, potentially impacting 100% of the planning area.

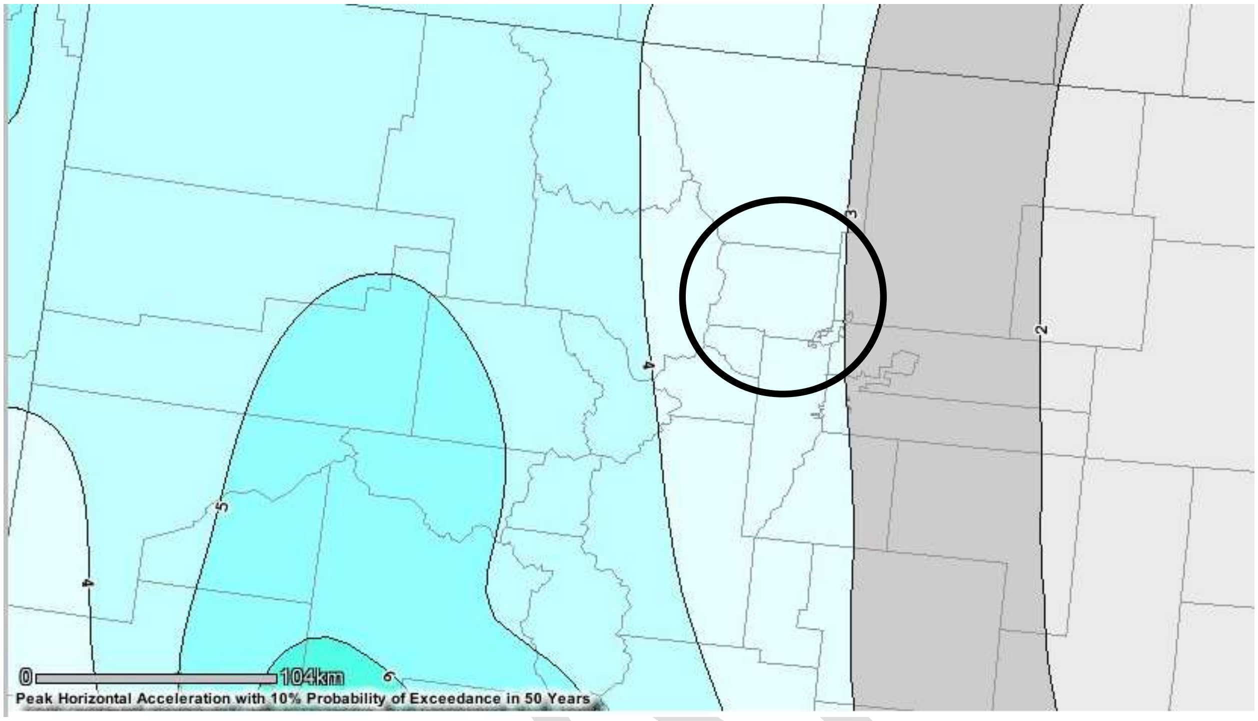
Figure 4.6. Colorado Earthquake and Fault Map Excerpt



Source: Colorado's Earthquake and Fault Map, CGS 2007

The U.S. Geological Survey (USGS) issues National Seismic Hazard Maps as reports every few years. These maps provide various acceleration and probabilities for time periods. Figure 4.7 depicts the peak horizontal acceleration (%g) with 10% probability of exceedance in 50 years for the planning region. The figure demonstrates that the town falls in the 3%g area. This data indicates that the expected severity of earthquakes in the region is fairly limited, as damage from earthquakes typically occurs at peak accelerations of 30%g or greater. However, as demonstrated by the HAZUS modeling documented earlier, the potential, though remote, does exist for damaging earthquakes.

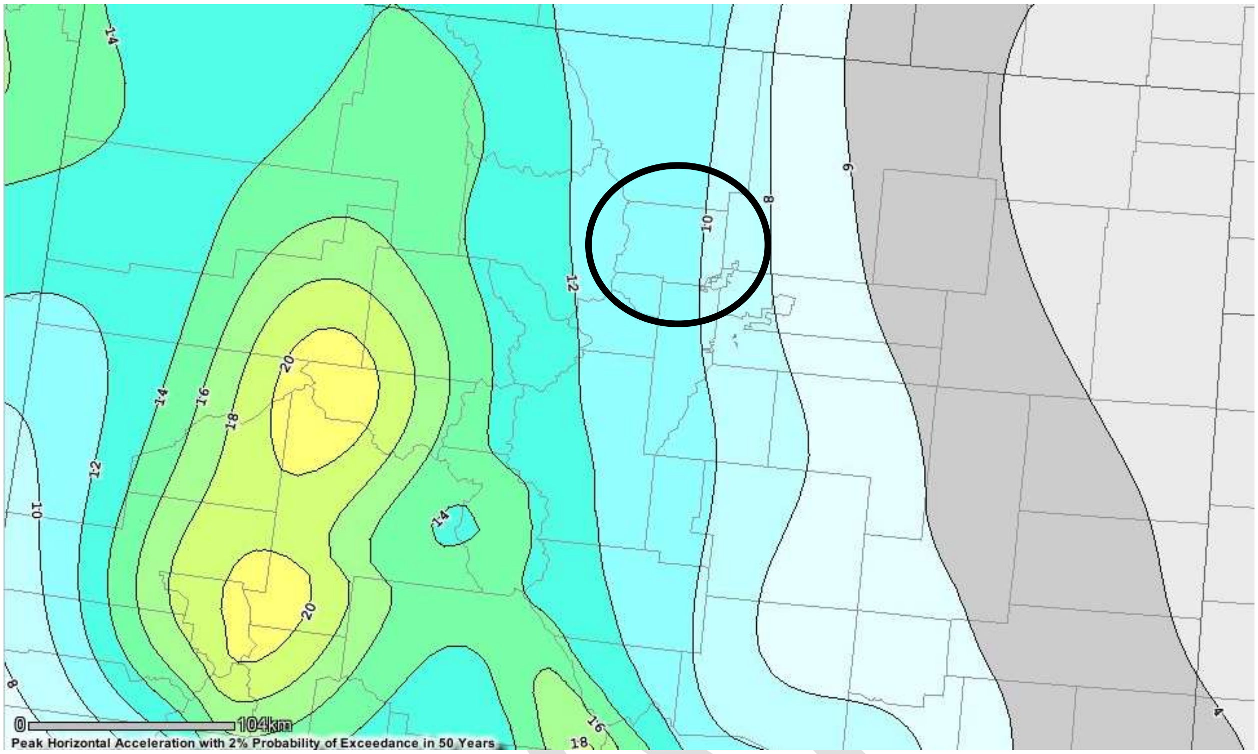
Figure 4.7. Peak Horizontal Acceleration with 10% Probability of Occurrence in 50 Years



Source: USGS National Seismic Hazard Maps – 2008 Interactive Tool. Available online at http://gldims.cr.usgs.gov/nshmp2008/viewer.htm

Figure 4.8 depicts the peak horizontal acceleration (%g) with 2% probability of exceedance in 50 years for the Town. The figure demonstrates that the Town falls in the 10-12%g area.

Figure 4.8. Peak Horizontal Acceleration with 2% Probability of Occurrence in 50 Years



Source: USGS National Seismic Hazard Maps – 2008 Interactive Tool. Available online at http://gldims.cr.usgs.gov/nshmp2008/viewer.htm

Past Occurrences

Colorado's earthquake hazard and risk has historically been rated lower than most knowledgeable scientists in the state consider justified. As a result, local emergency managers are generally unaware of the size and consequences of an earthquake that could occur in the state. Most shocks in the history of Colorado have been centered west of the Rocky Mountain Front Range. The first seismographs in Colorado of sufficient quality to monitor earthquake activity were installed in 1962. Newspaper accounts are the primary source of published data for earthquake events before that time. The following is a summary of known earthquake activity in Colorado with a focus on the Boulder County region.

- **Since 1867**—More than 400 earthquake tremors of magnitude 2.5 or greater have been recorded in Colorado.
- **November 7, 1882**—On this day, the largest recorded earthquake in the state and the first to cause damage in Denver occurred. The epicenter is thought to have been located in the Front Range near Rocky Mountain National Park; the magnitude was estimated to be about 6.2 on the Richter scale. In Boulder County, the walls of the train depot cracked and plaster fell from walls at the University at Colorado. The earthquake was felt as far away as Salina, Kansas, and Salt Lake City, Utah.

- **1962-1967**—A series of earthquakes occurred in the Denver–Boulder area from 1962-1967. The earthquakes were felt by cities and towns within a 100-mile radius of Denver. Some people attribute this earthquake activity to deep-well injections conducted at the Rocky Mountain Arsenal starting in 1962. A few notable occurrences are detailed below.
  - **1965**—Shocks on February 16, September 29, and November 20 caused intensity VI damage in the Commerce City area.
  - **January 4, 1966**—A magnitude 5.0, intensity V earthquake occurred northeast of Denver.
  - **April 10, 1967**—The Colorado School of Mines rated this earthquake of magnitude 5.0. The earthquake broke 118 windowpanes in buildings at the Rocky Mountain Arsenal, cracked an asphalt parking lot in the Derby area, and caused school officials in Boulder to dismiss schools because of cracked walls. Legislators quickly moved from beneath chandeliers in the Denver Capitol Building, fearing they might fall.
  - **April 27, 1967**—Boulder sustained minor damage to walls and acoustical tile ceilings as a result of this magnitude 4.4 earthquake.
  - **August 9, 1967**—Located northeast of Denver, this magnitude 5.2, intensity VI earthquake caused more than $1 million in damage and is considered the most economically damaging earthquake in Colorado history.
  - **November 27, 1967**—A magnitude 5.1, intensity VI earthquake occurred northeast of Denver.
- **Since 1971**, there have been 12 to 15 earthquakes located north and northeast of Denver that were large enough to be felt in Boulder County.

Likelihood of Future Earthquake Occurrences

Occasional: Because the occurrence of earthquakes is relatively infrequent in Colorado and the historical earthquake record is short (only about 150 years), it is not possible to accurately estimate the timing or location of future dangerous earthquakes in Colorado. Research based on Colorado's earthquake history suggests that an earthquake of magnitude 6.3 or larger has a 1 percent probability of occurring each year somewhere in Colorado (Charlie, Doehring, and Oaks Colorado Earthquake Hazard Reduction Program Open File Report 93-01, 1993). The major factor preventing the precise identification of the time or location of the next damaging earthquake is the limited knowledge of potentially active faults.

Fracking for oil and gas development has been associated with increase earthquake activity, notably in Oklahoma in 2015 and along the southern Front Range near Trinidad. While most of this activity is on the eastern plains in eastern Boulder and Weld counties there is the potential for human-induced seismicity, though it is unlikely that any earthquakes generated would be large enough to do damage in Lyons.

Climate Change Considerations

Climate change is not likely to have direct impact of on the frequency and severity of earthquakes.

Magnitude/Severity (Extent)

Earthquake vulnerability is primarily based upon population and the built environment. Urban areas in high hazard zones are the most vulnerable, while uninhabited areas are less vulnerable. The ability to accurately estimate the timing, location, and severity of future earthquake activity in Colorado is limited due to the lack of good historical data and the relative infrequent occurrence of earthquakes in Colorado.

Ground shaking, the principal cause of damage, is the major earthquake hazard. Many factors affect the potential damageability of structures and systems from earthquake-caused ground motions. Some of these factors include proximity to the fault, direction of rupture, epicentral location and depth, magnitude, local geologic and soils conditions, types and quality of construction, building configurations and heights, and comparable factors that relate to utility, transportation, and other network systems. Ground motions become structurally damaging when average peak accelerations reach 10 to 15 percent of gravity, average peak velocities reach 8 to 12 centimeters per second, and when the Modified Mercalli Intensity Scale is about VII (18-34 percent peak ground acceleration), which is considered to be very strong (general alarm; walls crack; plaster falls).

The U.S. Geological Survey's (USGS) Probabilistic Seismic Hazard Map of Colorado in 0 depicts a 2 percent probability over 50 years of shaking intensity. The Town lies in the range of 10-12 percent acceleration. Shaking is measured in a variety of ways, including peak ground acceleration, peak ground velocity, and spectral acceleration. This map is spectral acceleration at one second frequency. The reason for looking at different frequencies is due to building response. In general, taller buildings may experience more damage by energy released in longer waveforms due to the harmonics of building sway and ground shaking. Natural or artificially filled areas tend to experience amplified motions, liquefaction, and associated ground failures that can cause extensive damage. Subsurface soils in the Town of Lyons vary and are site-specific.

Fault rupture itself contributes very little to damage unless the structure or system element crosses the active fault. There are no known potentially active faults in the planning area, but some, such as the Valmont and Rock Creek faults are near enough to be cause damage if they were to cause an earthquake. In general, newer construction is more earthquake resistant than older construction because of improved building codes and their enforcement. Manufactured housing is very susceptible to damage because rarely are their foundation systems braced for earthquake motions. Locally generated earthquake motions, even from very moderate events, tend to be more damaging to smaller buildings, especially those constructed of unreinforced masonry.

Common impacts from earthquakes include damage to infrastructure and buildings (e.g., crumbling of unreinforced masonry, failure of architectural facades, rupturing of underground utilities, gas-fed fires, landslides and rock falls, and road closures). Earthquakes also frequently trigger secondary effects, such as dam failures, explosions, and fires that can become disasters themselves.

Vulnerability Assessment and Potential Losses

HAZUS Earthquake Scenarios Methodology, Interpretation, and Results

In the 2008 State Hazard Mitigation Plan, extensive discussion about earthquake hazards indicates that the historical assumption about earthquake vulnerability in the state (namely, that said vulnerability is low) may be false. The "Earthquake Evaluation Report" issued by the Colorado Geological Survey (CGS) is included as an Annex in the 2008 State Plan. This report extensively reviews the history of earthquake analysis in the State, and indicates that significant funding and time investments are required to determine a more realistic evaluation of the earthquake threat to the State.

Using HAZUS, FEMA's loss-estimation software, the state identified the five most potentially damaging faults in Colorado: Rocky Mountain Arsenal, Golden, Rampart Range, Ute Pass, and Walnut Creek. Of these five faults, Rocky Mountain Arsenal, Golden, and Walnut Creek are within close proximity to Boulder County (see Figure 4.9). According to the Colorado Geological Survey, the only known fault in Boulder County, located along North 75th Street near Valmont Drive, has been quiet for over 10,000 years. The state plan also identifies the Rock Creek fault in Boulder County. The Rock Creek fault is considered a Quaternary fault (and therefore may not be considered an active fault), while the Valmont fault is considered a middle to late Quaternary fault. In estimating potential earthquake hazards in Boulder County, the state analyzed impacts associated with the Frontal, Golden, Mosquito, Ute Pass, Valmont, Walnut Creek, and Williams Fork faults. Only the Valmont fault is in Boulder County; the others are in nearby counties.

As part of the report, the CGS ran HAZUS (FEMA's Hazards United States software) to perform several different loss prediction analyses. One of these is presented in a county summary format. Table 4.7 summarizes this information.

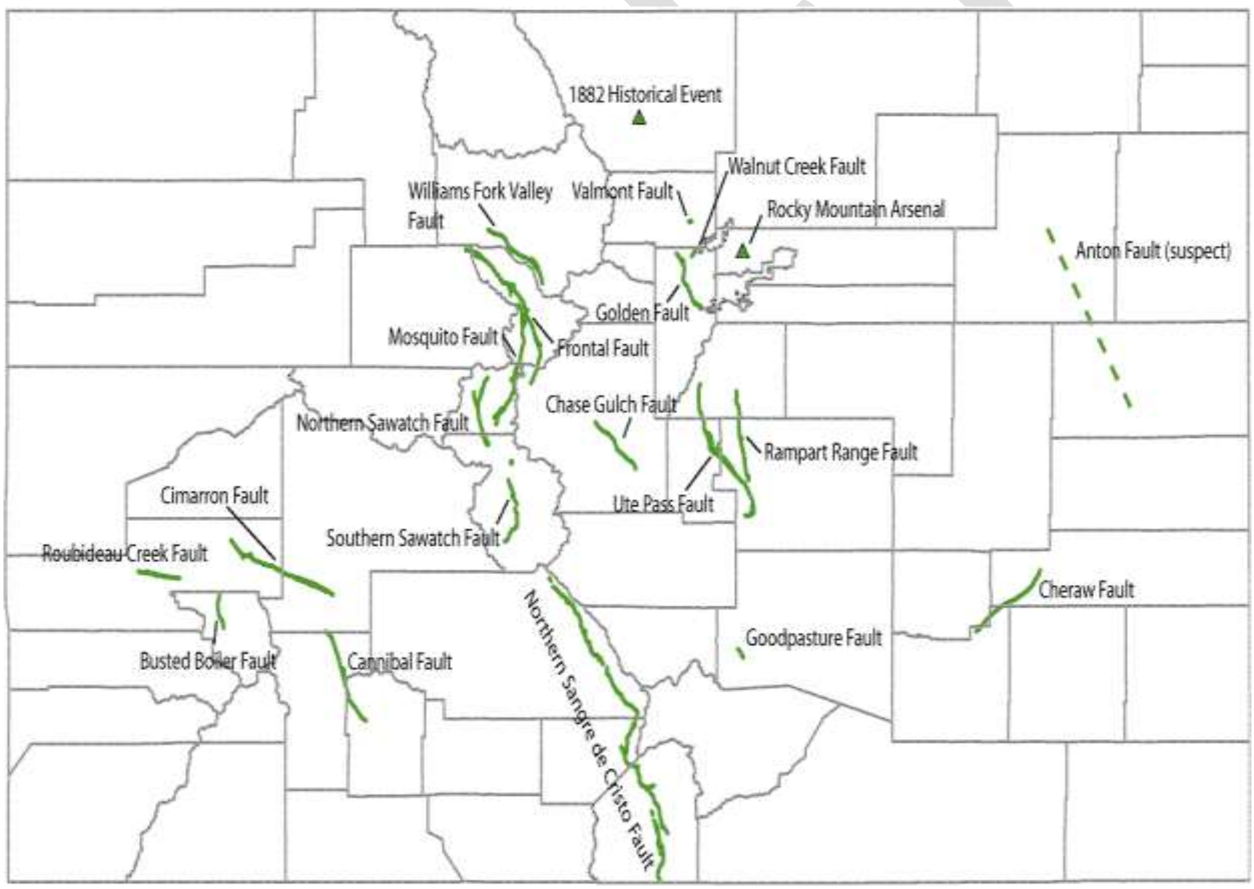
Table 4.7. Potential Earthquake Losses in Boulder County by Fault

Fault	Magnitude	Default Attenuation Function	Estimated Fatalities	Estimated Total Damages	Loss Ratio of Total Building Stock	Previous Events
Frontal	M7.0	-	0 fatal	$31.8 Million	0.14%	
Golden	M6.5	Reverse WUS	41 fatal	$1.44 Billion	6.1%	
	M6.0	Reverse WUS	5 fatal	$467.5 Million	2.0%	
	M5.5	Reverse WUS	1 fatal	$135 Million	0.6%	
	M5.0	Reverse WUS	0 fatal	$33.5 Million	0.14%	
Mosquito	M7.0	-	0 fatal	$31.7 Million	0.13%	
Ute Pass	M7.0	-	0 fatal	$42.2 Million	0.18%	
Valmont	M5.0	-	1 fatal	$256 Million	1.1%	
Walnut Creek	M6.0	CEUS	42 fatal	$2.14 Billion	9.1%	

Fault	Magnitude	Default Attenuation Function	Estimated Fatalities	Estimated Total Damages	Loss Ratio of Total Building Stock	Previous Events
Williams Fork	M6.75	-	0 fatal	$29.3 Million	0.12%	
	M6.5	-	0 fatal	$18 Million	0.08%	
	M6.0	-	0 fatal	$4.8 Million	0.02%	
	M5.5	-	0 fatal	$0.2 Million	0.00%	
1882 Earthquake	M6.2		0 fatal,	$53.8Million	0.23%	

WUS: Western U.S. Attenuation Function
CEUS: Central U.S. Attenuation Function
Loss Ratio of Total Building Stock: This refers to the percentage of total building stock value damaged. The higher the ratio, the more difficult it is to restore a community to viability.
Source: Colorado Geological Society Earthquake Evaluation Report

Figure 4.9. Faults Analyzed for Potential Losses, Statewide



Source: Colorado Geological Survey Earthquake Evaluation Report

Probabilistic Scenario

A 2,500 year probabilistic HAZUS earthquake scenario was performed as part of this mitigation plan's update to analyze the impacts to Lyons specifically. The results can be referenced in the following table. This scenario takes into account worst case ground shaking from a variety of seismic sources and analyzed data aggregated to census tracts for the Town. According to this probabilistic scenario, there is the potential for roughly 120 buildings experiencing at least moderate damage and $11.39 million in economic losses, mostly associated with residential occupancies. Due to the low probability of a damaging earthquake occurring, as discussed below, the planning significance of earthquakes is considered low by the Advisory Committee.

Table 4.8. Lyons HAZUS-MH 2,500-year Earthquake Scenario Results

Impact Category	Modeled Impacts	
Residential Buildings Damaged (Based upon 1,000 buildings)	Slight: 235 Moderate: 100 Extensive: 19 Complete: 1	
Building Related Loss	$11.35M	
Total Economic Loss	$11.39M	
Injuries	Without requiring hospitalization: 1 Requiring hospitalization: 0 Life Threatening: 0 Fatalities: 0	
Essential Facility Damage (Based upon 59 buildings)	None with at least moderate damage	
Transportation and Utility Lifeline Damage	None with at least moderate damage	
Households w/out Power & Water Service (Based upon 48,604 households)	Power loss @ Day 1: 0 Power loss @ Day 3: 0 Power loss @ Day 7: 0 Power loss @ Day 30: 0	Water loss @ Day 1: 0 Water loss @ Day 3: 0 Water loss @ Day 7: 0 Water loss @ Day 30: 0
Displaced Households	2	

Source: HAZUS 3.2; Amec Foster Wheeler

Critical Facilities and Infrastructure

Based on the HAZUS run previously described there would be minimal impacts to critical facilities and infrastructure.

Economy

Based on the HAZUS run there could potentially be $11.39 million in economic losses, mostly associated with residential occupancies.

Natural, Cultural and Historic Resources

The older and more historic buildings located downtown may be more vulnerable to earthquake damage, particularly unreinforced masonry structures.

Future Development

Any new construction built to modern codes and construction standards in Lyons should generally be able to withstand earthquakes. It will be important that buildings are securely attached to their foundations to avoid potential shifting.

Summary

Based on the HAZUS modeling, Lyons could withstand moderate damages from a large earthquake, but the probability of that occurring is small. What makes the Town vulnerable to earthquakes is the presence of older, unreinforced masonry structures in the downtown business district. Since Colorado does not experience many earthquakes, the public generally perceives that there is little risk, and therefore they are less likely to know what to do during an earthquake or how to prepare and protect themselves and their property from one. Scientists are unable to predict when the next major earthquake will happen in Colorado - only that one will occur. Due to the low probability the overall significance is considered low.

4.4 Extreme Temperatures

Description

Extreme temperature events, both hot and cold, can have severe impacts on human health and mortality, natural ecosystems, agriculture, and the economy. Since extreme temperatures affect large areas the hazard extent within Town limits is considered extensive, potentially impacting 50-100% of the planning area.

Extreme Heat

According to information provided by FEMA, extreme heat is defined as temperatures that hover 10 degrees or more above the average high temperature for the region and last for several weeks. Heat kills by taxing the human body beyond its abilities. In a normal year, about 175 Americans succumb to the demands of summer heat. According to the National Weather Service (NWS), among natural hazards, only the cold of winter—not lightning, hurricanes, tornadoes, floods, or earthquakes—takes a greater toll. In the 40-year period from 1936 through 1975, nearly 20,000 people were killed in the United States by the effects of heat and solar radiation. In the heat wave of 1980, more than 1,250 people died.

Heat disorders generally have to do with a reduction or collapse of the body's ability to shed heat by circulatory changes and sweating or a chemical (salt) imbalance caused by too much sweating. When heat gain exceeds the level the body can remove, or when the body cannot compensate for fluids and salt lost through perspiration, the temperature of the body's inner core begins to rise and heat-related illness may develop. Elderly persons, small children, chronic invalids, those on certain medications or drugs, and persons with weight and alcohol problems are particularly susceptible to heat reactions, especially during heat waves in areas where moderate climate usually prevails. Figure 4.10 illustrates the relationship of temperature and humidity to heat disorders.

Figure 4.10. Relationship of Temperature and Humidity to Heat Disorders

Temperature (°F)

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

Likelihood of Heat Disorders with Prolonged Exposure or Streuous Activity

Caution | Extreme Caution | Danger | Extreme Danger

Source: National Weather Service, 2004

Note: Since HI values were devised for shady, light wind conditions, exposure to full sunshine can increase HI values by up to 15°F. Also, strong winds, particularly with very hot, dry air, can be extremely hazardous.

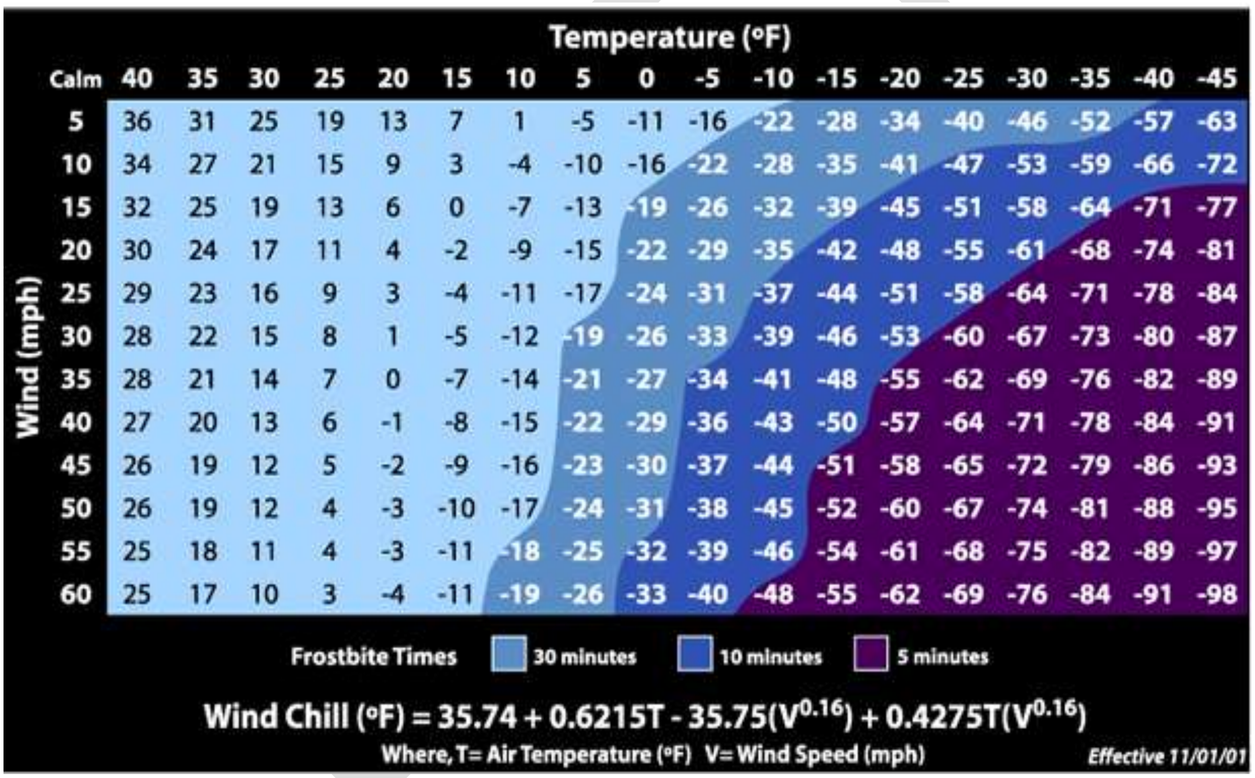
The NWS has in place a system to initiate alert procedures (advisories or warnings) when the Heat Index is expected to have a significant impact on public safety. The expected severity of the heat determines whether advisories or warnings are issued. A common guideline for the issuance of excessive heat alerts is when the maximum daytime high is expected to equal or exceed 105°F and a nighttime minimum high of 80°F or above is expected for two or more consecutive days.

Extreme Cold

Extreme cold often accompanies a winter storm or is left in its wake. Prolonged exposure to the cold can cause frostbite or hypothermia and can become life-threatening. Infants and the elderly are most susceptible. Pipes may freeze and burst in homes or buildings that are poorly insulated or without heat.

In 2001, NWS implemented an updated Wind Chill Temperature index (see Figure 4.11). This index was developed to describe the relative discomfort/danger resulting from the combination of wind and temperature. Wind chill is based on the rate of heat loss from exposed skin caused by wind and cold. As the wind increases, it draws heat from the body, driving down skin temperature and eventually the internal body temperature.

Figure 4.11. National Weather Service Wind Chill Chart



Temperature (°F)

Wind (mph) / 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: National Weather Service, www.nws.noaa.gov/om/windchill/index.shtml

The NWS will issue a Wind Chill Advisory for the Boulder County area when wind and temperature combine to produce wind chill values of 18°F below zero to 25°F below zero.

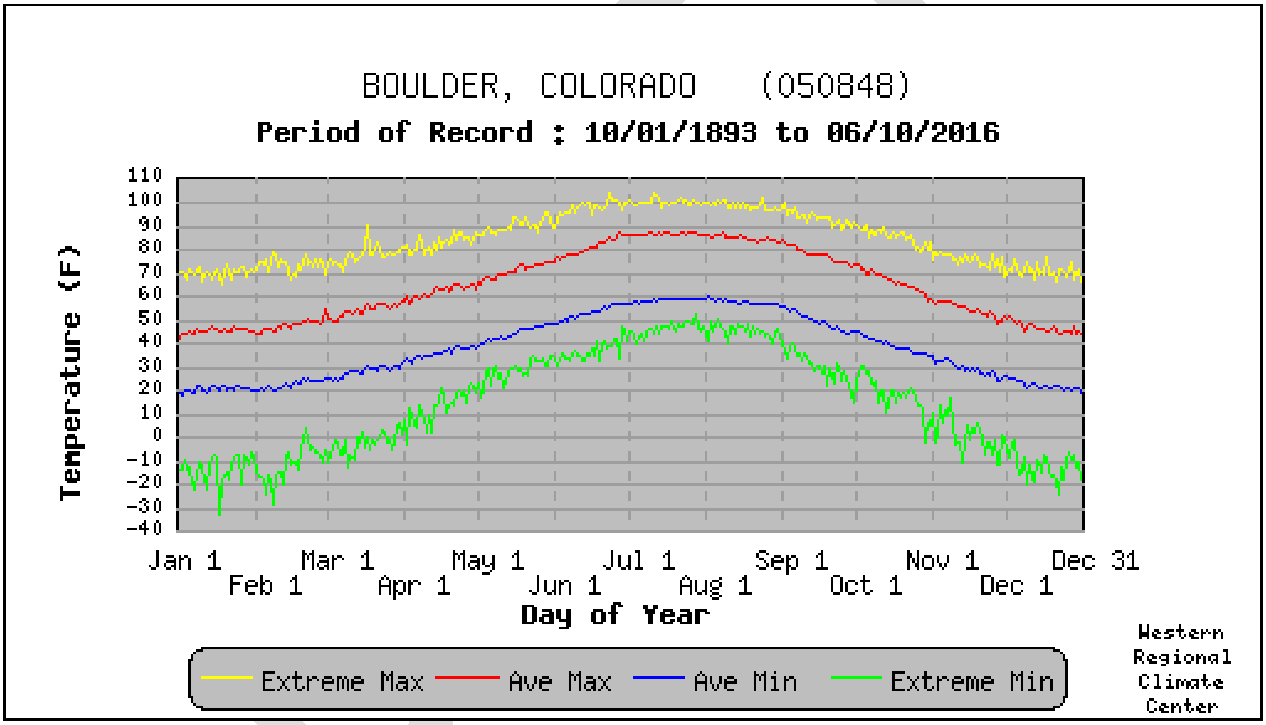
Location

Extreme cold can occur in river valley settings where the cold air ends to settle. This makes Lyons potentially susceptible to extreme cold.

Past Occurrences

In Boulder County, for the period of record October 1, 1893 to June 10, 2016, the monthly average maximum temperatures in the warmest months (May through October) ranged from the high 60s to the high 80s. Monthly average minimum temperatures from November through April ranged from the low 20s to mid-30s. The highest recorded daily extreme in eastern Boulder County was 104°F on June 23, 1954, and July 11, 1954. The lowest recorded daily extreme was -24°F on December 12, 1963, and December 22, 1990. For the period of record for maximum temperature extremes (on an annual basis), 31.8 days exceeded 90°F and 15.3 days were less than 32°F. For the same period of time for minimum temperature extremes (on an annual basis), 135.3 days were less than 32°F and 4.7 days were less than 0°F.

Figure 4.12. Boulder Daily Temperature Averages and Extremes 1893 to 2016



Source: Western Regional Climate Center, www.wrcc.dri.edu/

The October 1991 freeze ("Halloween Freeze") saw temperature extremes from 60°F to below 0°F. $51,250 in tree damage was tied to this event combined with the November 17, 1991, snowstorm.

Likelihood of Future Occurrences

Highly Likely: Given the history in Boulder County and the Town of Lyons, extreme temperature events will continue to occur annually.

Climate Change Considerations

Among the clearest signals from the existing climate change research is the projected warming in the county. The Boulder County Climate Change Preparedness Plan science summary shows that average temperatures are expected to rise by ~ 2–3°F by 2030 and ~ 3.5–5.0°F by 2050, with more warming in summer than in winter. This is expected to result in an increase in average temperatures, daily minimum and maximum temperatures, and the number of days exceeding 100°F. Climate models predict that Colorado could see 10 to 20 days per year over 100°F under the low-emissions scenario and between 20 and 30 days per year over 100°F under the high-emissions scenario. For context, Lyons currently experiences an average of 1 day over 100°F per year. This could have direct impacts on human health in terms of heat related illness. Cascading impacts include increased stress on water quantity and quality, degraded air quality, and increased potential for more severe or catastrophic natural events such as heavy rain, droughts, and wildfire.

Although heat waves will likely become more frequent, there is also the potential for continued cold outbreaks in winter, even in an overall warmer climate. Since the mid-1980s, warmer summers have increased the duration and intensity of wildfires across the western United States, a trend that is likely to continue.

Magnitude/Severity (Extent)

Overall, extreme temperature impacts would likely be limited in the planning area, with 10 to 25 percent of the planning area affected. Extreme cold can occasionally cause problems with communications facilities and utility transmission lines. Danger to people is highest when they are unable to heat their homes and when water pipes freeze. Extreme cold can also impact livestock and even crops if the event occurs during certain times of the year.

Vulnerability Assessment and Potential Losses

People

While everyone is vulnerable to extreme cold/wind chill events, some populations are more vulnerable than others. Extreme cold/wind chill pose the greatest danger to outdoor laborers, such as highway crews, police and fire personnel, and construction. The elderly, children, people in poor physical health, and the homeless are also vulnerable to exposure. Overall, the population has a medium exposure to severe cold.

Built Environment

Extreme cold/wind chill presents a minimal risk to the structures of the Town of Lyons. Property damage occurs occasionally when water pipes freeze and break. Homes without adequate insulation or heating may put owners at a higher risk for damages or cold-related injury. In cases of periods of prolonged cold, water pipes may freeze and burst in poorly insulated or unheated buildings. Vehicles may not start or stall once started due to the cold temperatures and the risks of carbon monoxide poisoning or structure fires increases as individuals attempt to warm cars in garages and use space heaters. Stalled vehicles, or those that fail to start, may result in minor economic loss if individuals are unable to commute between work, school, and home. Driving conditions may deteriorate if extreme cold/wind chill prolongs icy road conditions, which will impact commutes and emergency response times as well. Landscaping and agricultural products may be damaged or destroyed by unseasonable occurrences of extreme cold/wind chill, causing plants to freeze and die. This may increase the indirect vulnerabilities to severe cold by causing greater economic costs and losses for the year. The overall vulnerability of general property is low.

Critical Facilities and Infrastructure

Like general property, extreme cold/wind chill events have a limited impact on the physical property of essential infrastructures and facilities. Communications lines such as fiber optic cables can freeze. There may be incidents of delayed emergency response due to stalled vehicles, delays in dispatching due to frozen communications lines, or an increased volume in calls. Hospitals may see an increase in cold-related injuries directly or injuries associated as secondary effects of the cold (traffic accidents, broken bones or severe cuts due to slips, etc.) and a prolonged extreme cold/wind chill event may impact hospital personnel capabilities. Personnel working in the cold, such as firefighters, EMTs, police officers and construction workers, have a higher vulnerability due to exposure times, and response capabilities may be hindered. Human services programs that care for at-risk individuals and families may be stressed, but usually can still adequately provide services through the duration of the extreme cold/wind chill event. Unusually high volumes of individuals seeking shelter or food may overwhelm some facilities if the event is prolonged. There may be an increased number of displaced individuals or families due to flooding caused by ruptured pipes, which may strain local aid organizations such as the Red Cross. Older venues or historical properties suffer the same vulnerabilities associated with private and general properties that are older, with the added vulnerability of damaging historic and often irreplaceable property in the process. If the event is extremely extended and impacts multiple other counties and states, which in turn impacts the availability of mutual assistance, the risk factors may increase. The overall vulnerability of essential infrastructure and community assets is medium.

Future Development

Future residential or commercial buildings built to modern codes should be able to withstand extreme temperatures. Population growth in the Town and growth in visitors can create additional exposure to temperature extremes.

Summary

- Both hot and cold extremes can have severe impacts on human health, the natural ecosystem and the economy
- The very young, the very old, people with poor physical health and the homeless or more susceptible to the impacts of extreme temperatures

- Extreme temperatures are an annual occurrence
- Overall significance is low

4.5 Floods

Description

Floods can be among the most frequent and costly natural disaster in terms of human hardship and economic loss and can be caused by a number of different weather events. Floods can cause injuries and deaths and substantial damage to structures, landscapes, and utilities. Certain health hazards are also common to flood events. Standing water and wet materials in structures can become a breeding ground for microorganisms such as bacteria, mold, and viruses. This can cause disease, trigger allergic reactions, and damage materials long after the flood. Direct impacts 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 critical to reduce life and safety impacts. Lyons is susceptible to various types of flood events as described herein.

Riverine or Overbank Flooding

This type of flooding is defined as when a watercourse exceeds its "bank-full" capacity and is usually the most common type of flood event. Riverine flooding generally occurs as a result of prolonged rainfall, or rainfall that is combined with soils or drainage systems that are already saturated or overloaded from previous rain events. The duration of riverine floods may vary from a few hours to several days.

Factors that directly affect the amount of flood runoff include precipitation amount, intensity, and spatial and temporal distribution; the amount of soil moisture; seasonal variation in vegetation; snow depth; and the water resistance of the surface due to urbanization. Other factors, such as wildfire burn scars in the watershed west of Town, can further aggravate a flood event.

The most serious overbank flooding occurs during flash floods that result from intense rainstorms or following a dam failure. The term "flash flood" describes localized floods of great peak flow and magnitude and short duration. In contrast to riverine flooding, this type of flood usually results from a heavy rainfall on a relatively small drainage area. Flash floods by definition occur very quickly and may occur with little or no warning.

Irrigation Ditches/Canals Flooding

Irrigation ditches and canals are used to convey water collected in the mountain reservoirs to downstream users. Ditches convey irrigation water along hillsides, following contours and, as a result, cut across the natural drainage pattern of stormwater runoff flowing down hillsides. Although efforts are made to separate stormwater runoff and irrigation water, excessive runoff can flow into an irrigation ditch causing overbank flooding or a collapse of the ditch itself. Similar to flash floods, there is often little warning for these types of events.

Stormwater Drainage Flooding

Urban and stormwater drainage floods typically occur due to the development of land from open or natural areas to buildings, roads and parking lots, which cause the land to lose its ability to absorb rainfall. Urbanization increases runoff two to six times over what would occur on natural terrain. Street flooding and yard ponding usually do not exceed more than a foot or two and are often viewed more as a nuisance than a major hazard. However, during periods of urban flooding, high velocity flows can occur in streets, even in areas with only shallow flooding.

Existing drainage in the Town consists of open channel drainageways in combination with storm sewer conveyance for more urbanized areas. Most of the Town's existing drainage infrastructure is undersized due to the increase in development within the Town during the 1990s. The existing conveyance system has the capacity to convey nuisance flows, but it does not have the capacity to convey even the minor (5-year) storm events (Stormwater Masterplan).

Erosion and Deposition

Erosion and deposition are among the natural processes of a river. The science of fluvial geomorphology provides an understanding of how a river evolves and adjusts to environmental changes, whether caused by natural processes or human actions. As the stream system rebalances in response to changed conditions, the hazard from flooding or erosion may also change. For example, if the amount of sediment being transported into the stream system increases, in excess of the capacity of the stream to transport that sediment, more sediment than previously may be deposited, resulting in a braided channel pattern, which could cause inundation in areas previously thought to be outside of the flood hazard area. Another example would be of a stream with erosion protection, such as riprap or gabions, along its banks. Over time, or in an unexpectedly large flood event, the bank protection may fail, resulting in erosion and flooding in areas not previously thought vulnerable.

The 2013 flooding included considerable damage in Lyons and surrounding areas from both erosion and channel migration (or 'avulsion' in geomorphologic terms) and deposition. Due to the Town's location at the confluence of the St Vrain creeks and associated flat topography deposition has been and will continue to be an issue that could cause property damage and impacts to the floodplain. Avulsion was dramatically illustrated by the migration of the St Vrain channel in the vicinity of the McConnell Dr Bridge. During September 2013 the channel migrated from below the bridge to a new location. Erosion and avulsion hazards have been mitigated in many areas of town through stream restoration and bank stabilization efforts post-2013.

Location

Floodplains

The area adjacent to a channel is the floodplain. Floodplains are illustrated on inundation maps like those in Figure 4.11, which show areas of potential flooding and water depths. In its common usage, the floodplain most often refers to that area that is inundated by the 100-year flood, the flood that has a 1- percent chance in any given year of being equaled or exceeded. The 100-year flood is the federal minimum standard to which communities regulate their floodplains through the National Flood Insurance Program. Other floodplain zones include:

- Floodway Zone—All areas in the floodplain that would be required for the passage or conveyance of the entire flood flow (measured in cubic feet per second) resulting from the encroachment (or blocking out) of the floodplain from the edges, allowing no greater than a maximum six-inch increase in the depth of flood waters. (The conveyance zone is usually a narrowed corridor within the floodplain.) This conveyance zone definition is more restrictive than that used by FEMA, which allows a maximum one-foot increase in floodwater depth. The State of Colorado floodplain rules require only a six inch increase allowance.
- Flood Fringe—Those portions of the floodplain that are not in the floodway/conveyance zone.

Also of concern to the Town is the 500-year flood. The 500-year flood is the flood that has a 0.2 percent chance of occurring in any given year. This is also shown as ‘Shaded Zone X’ on FEMA flood maps.

Major Sources of Flooding

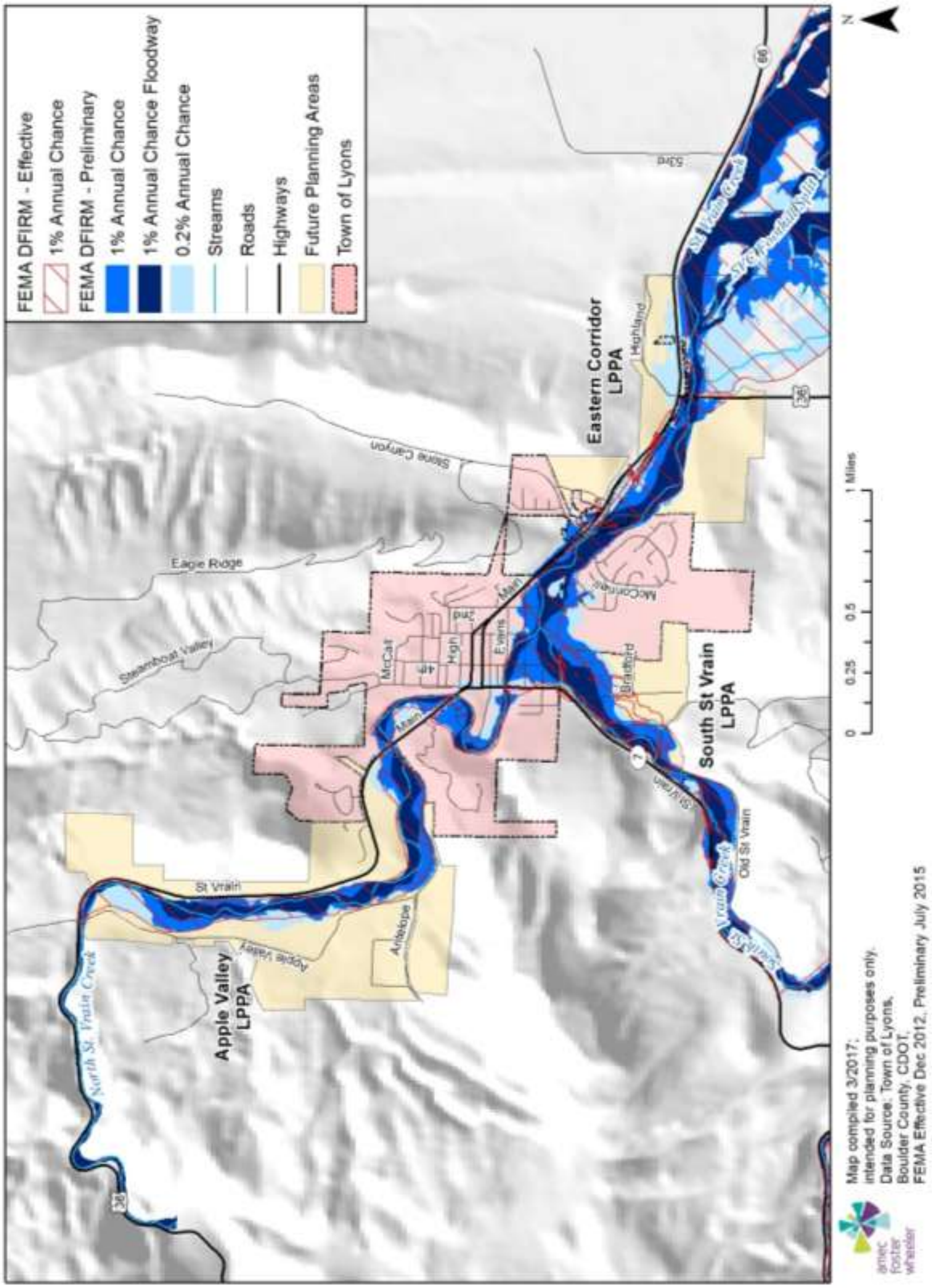
The Town of Lyons has two major creeks, the North and South St Vrain that have a confluence in the core of the Town, and smaller watersheds that are prone to flash flooding. The Town is situated in a watershed that drops in elevation dramatically, where excess rain and snow can contribute to downstream flooding. Other basins within or draining into the Town include Red Hill Gulch, Eagle Canyon, Steamboat Valley, Third Avenue, Ewald Avenue, North St Vrain, South St Vrain, Lyons valley Park and Stone Canyon.

The Town’s location at the base of the foothills of the Rocky Mountains makes it vulnerable to flash flooding that can occur with little or no warning. Within the Town, two types of flooding are of concern: flash flooding that is likely to result in damage to property and life-safety issues and stormwater drainage flooding, which results from more frequent minor storm events that occur every year but are less damaging in nature.

The 100-year floodplain boundaries cover more than 25 percent of the lands inside the city limits, which falls within the geographic extent rating of significant (10-50% of the area affected).

Figure 4.13 illustrates the town’s mapped flood hazard areas.

Figure 4.13. Town of Lyons Flood Hazards



Past Occurrences

The St. Vrain watershed flood history dates back to 1844. Flooding also occurred in 1864, 1876, 1894, 1914, 1919, 1921, 1938, 1949, 1951, 1957, 1969, 1973, 1976 and 2013. Floods along the North and South St. Vrain have destroyed farmland, roads, and bridges. Flood season in Boulder County and Lyons is generally April 15 through September 15, but floods can happen at any time. Historically, the most frequent mountain stream flooding occurs in May and June when snowmelt increases runoff. However, the most dangerous flooding in Boulder County seems to occur from late June through early September due to heavy precipitation from thunderstorms. Creeks with mountainous, upstream watersheds are subject to flash floods as are urban streams and drainageways. Colorado's worst flash flood occurred on July 31, 1976, in the Big Thompson Canyon west of Loveland, claiming over 400 houses and 144 lives.

Major flooding events recorded within Boulder County and along the Front Range include the following detailed by area/drainage:

- **1844 -** No details
- **May 1876 -** The flood was severe and much valley farmland was flooded.
- **May 31, 1894**—All of the lower parts of Lyons were washed away and 20 houses were destroyed or ruined. The St. Vrain Valley looked like a lake three miles wide. Peak discharge was estimated at 9,800 cfs, which made it greater than a 50-year event.
- June 1-2, 1914—Flooding
- **August 2, 1919**—Bridges on the North St. Vrain for about a ten mile stretch were destroyed. Longmont and Lyons water mains up the canyon were torn out in many places. People living on the lowlands along the banks of the St. Vrain were flooded out. Peak discharge was estimated at 9,400 cfs.
- **June 2, 1921**—North and South St. Vrain creeks carried large volumes of water. Damage was done to bridges, sheds, and barns. The peak discharge at Lyons of 2,020 cfs was not indicative of conditions at Longmont because of heavy rain downstream from Lyons. Longmont recorded 5.9 inches.
- **September 4, 1938**— Precipitation for the three-day period totaled 4.5 inches at Longmont. The peak discharge at Lyons was only 1,650 cfs, while it was estimated to be 8,360 cfs near the mouth of the St. Vrain Creek. Highways were underwater, some bridges were washed out, and many residents near the creek were forced from their homes.
- **June 2 1941**—Overbank flooding as a result of four inches of rain in the Longmont area caused damage or destruction of homes, businesses, bridges, roads, water lines, crops, livestock, and irrigation structures. The peak discharge was 10,500 cfs.
- **June 4, 1949**—All bridges between Longmont and Lyons were impassable when the St. Vrain peaked at 6,700 cfs. A total of 16 bridges were damaged. Two were completely destroyed.
- **August 3, 1951**—Lyons received 6.3 inches of rain from a cloudburst, causing flooding from Lyons to the mouth of St. Vrain Creek. The peak discharge was 3,700 cfs at Lyons and 6,200 cfs at a point seven miles east of Longmont. Railroad and highway bridges near Longmont

were severely damaged. The flood lasted for less than 12 hours. Severe damage resulted to Colorado Highway 7 along South St. Vrain Creek. In the rural areas downstream from Lyons, many grain shocks were washed from the fields.

- **May 8-9 1957**—Three to five inches of rain fell over the entire St. Vrain basin, peaking at 3,060 cfs in Lyons. Irrigation works and bridges between Lyons and Longmont were damaged or destroyed.
- **May 4-8, 1969**— Three days of heavy snow and rain along with spring snow melt / runoff caused flooding which damaged two bridges in Lyons, 14 bridges outside of town, numerous town streets and other property. Highways 7 and 36 were closed. Roads and bridges along streams were damaged, stream banks were eroded, and farmlands were flooded. The peak discharge at Lyons was 2,900 cfs on May 7 and 10,300 cfs on May 8.
- **June 15-21, 1969**—Roads and bridges along the stream were extensively damaged, stream banks were eroded, and farmlands were flooded. August 10, 1994—approximately three inches of rain fell in a period of 30 minutes in Lyons. An urban flash flood resulted when the drainage system was unable to manage the large amounts of water. Damage to streets alone was $65,000. There were no reported deaths or injuries. The property damage was estimated at $213,000 and other damage to streets was $65,000. Highways 7 and 36 were closed as a result.
- **1973**—No details
- **1976**—No details
- **August 10, 1994**—approximately three inches of rain fell in a period of 30 minutes in Lyons. An urban flash flood resulted when the drainage system was unable to manage the large amounts of water. Damage to streets alone was $65,000. There were no reported deaths or injuries. The property damage was estimated at $213,000 and other damage to streets was $65,000. Highways 7 and 36 were closed as a result.
- **September 11, 2013—**The Town of Lyons was severely damaged during the September 2013 flood event. Three days of rain saturated the ground prior to September 11, 2013 causing high surface runoff and landslides/ debris flows throughout Boulder County. The rainfall totals during this event delivered 17 inches causing wide spread flooding. In the Saint Vrain Basin 17 inches of rain fell 54 over this period and sustained approximately 25,000 cfs causing flooding to the Town of Lyons, Hygiene, and Longmont. 1 person died while evacuating their home. The flood destroyed critical segments of the Town's electrical, sewage, and potable water systems, as well as damaging or destroying nearly 30% of the Town's housing stock. The floodwaters breached the wastewater treatment facility, contaminating Lyon's water supply. Multiple sections of the St. Vrain left the original channel and the flood permanently damaged many of the Town's roads, bridges, parks, trails, and stream channels. Floodwaters also destroyed Lyons Public Works facilities and equipment, and inundated the Town Hall and Library building. The total amount of damage to the Town of Lyons is estimated at $50 million, including $5 million in temporary measures (source: St Vrain Watershed Master Plan).

Flood Insurance Statistics

Information on the Town of Lyons's participation in the National Flood Insurance Program (NFIP) provides some detail on damage associated with flood events since the Town joined the program on 8/01/1980. From 1980 through February 2017, the Town had 63 NFIP closed paid losses totaling $3,539,753. Twenty four substantial damage losses have occurred, which indicates damage equaling or exceeding 50% of the structure value. There are no repetitive loss properties as defined by FEMA as having two more losses in any running 10 year period.

As of February 2017, the Town had 86 NFIP policies in force with $21,520,400 in total coverage (Source: FEMA as requested through CWCB). Fifty four (54) policies are located in A zones; 31 policies are located in the B, C, and X zones.

Likelihood of Future Occurrences

Based on the flood history noted previously the Town has experienced flooding 16 times since 1844, a period of 172 years (1844-2016). This equates to a frequency of approximately every 11 years or annual probability of 9%. The 100-year flood is the flood that has a one percent chance in any given year of being equaled or exceeded. Localized stormwater flooding at some location in the Town could occur on a more frequent basis. The extent of damage varies.

With respect to stormwater flooding, depending on the amount of rainfall, stormwater flows may exceed ditch and storm sewer system capacity and spill out in an uncontrolled manner. The frequency and nature of maintenance of the system also affects the location and degree of localized flooding activity, but even minor (5-year) storm events can create problems.

Climate Change Considerations

According to the Boulder County Climate Change Preparedness Plan, the nature and frequency of flooding could be altered by climate change, but is difficult to quantify. Heavy precipitation events that lead to flooding occur at the short-term time scales of weather, rather than the multi-year time scales of climate that most climate models examine. However, extreme events are, by their very nature, uncommon. Quantifying trends at a given location is quite difficult, and no trends in the historical record of extreme climate events have been definitively detected in Boulder County. Globally, precipitation extremes and their hydrological impacts (e.g., the magnitude of 100-year floods) are expected to get larger because in most places, higher temperatures will result in increased atmospheric water vapor available to form precipitation. There is no comprehensive assessment of how climate change might affect flooding in the County and Lyons, but research summarized in the Climate Preparedness Plan indicates a trend toward less frequent, but more intense rain events. In that circumstance, rainy days would become less frequent, but if conditions are right for an extreme event, and more moisture is available in the atmosphere, then larger extreme events are possible. The 100-year flood of today might become a more frequent event in the future (i.e., a 50-year event), meaning that current design levels and regulatory practices might be less adequate in the future.

Vulnerability to Floods

People

Vulnerable populations in the Town include residents living in known flooding areas or near areas vulnerable to flash floods. Certain populations are particularly vulnerable. This may include the elderly and very young; mobile homes; low-income housing areas; tourists and visitors; and those with developmental, physical, or sensory disabilities. These populations may be more vulnerable to flooding due to limitations of movement, fiscal income, challenges in receiving and understanding warnings, or unfamiliarity with surroundings.

As part of this plan's preparation, an estimate of the population exposed to flooding was created using a GIS overlay of existing DFIRMs (preliminary dated July 2015) on potentially flooded parcels. The flood-impacted population for the Town was then calculated by taking the number of parcel units in the 1% annual chance and .02% annual chance floodplains and multiplying that number by the average household size based on the Census Bureau's estimate for the county. The average household factor was 2.55 in Boulder County. The results indicate approximately 178 persons reside in the 1% annual chance and approximately 158 additional live in .02% annual chance floodplains. Including those that live in elevated homes results in 262 persons reside in the 1% annual chance and approximately 168 additional in .02% annual chance floodplains. This does not include those that may live within non-regulatory stormwater flood hazard areas.

Built Environment

The following section discusses the results of an effort to quantify the Town's vulnerability to both the 100- and 500-year flood events. The first step was to identify what is exposed to the flood hazard zones. During the 2017 HIRA development this entailed using FEMA's Preliminary DFIRM data as the most current 100- and 500-year floodplains, including revised St Vrain 100 year floodplains completed in 2015. The latest parcel-level data and structure footprints were used in the analysis to quantify structure counts and values. The methodology described below was performed for each floodplain.

GIS analysis was used to estimate the Town's potential property and economic losses. The parcel layer was used as the basis for the inventory of developed parcels. A building footprint layer was used to represent buildings, which was overlaid on the floodplain layer. For the purposes of this analysis, the flood zone that intersected the building footprint was assigned as the flood zone for the entire parcel. In some cases, there are parcels in multiple flood zones, such as Zone A and X 500. Only improved parcels, and the value of those improvements, were analyzed and aggregated by town boundary and LPPA, property type and flood zone. The summarized results for the planning area are shown in the table and maps below.

Table 4.9 shows the count and improved value of parcels in the planning area, broken out by the Town boundary and LPPA, that fall in a floodplain, by 1% annual chance flood and 0.2% annual chance flood. The table also shows loss estimate values which are calculated based upon the improved value and estimated contents value. Potential losses from flooding are related to a variety of factors, including flood depth, flood velocity, and building type and construction. Based on FEMA's flood depth-damage functions, the percent of damage is directly related to the flood depth. FEMA's flood benefit-cost module uses this simplified approach to model flood damage based on building type and flood depth. The estimated contents value is 50% of the improved value; the total value is the sum of the improved and estimated contents values; the loss estimate is 25% of the total value based on FEMA's depth-damage loss curves. For example, a two-foot flood generally results in about 25% damage to the structure (which translates to 25% of the structure's replacement value).

Table 4.9 and Table 4.10 summarize the results of this analysis. Buildings footprints that are in the 100-year and 500-year floodplains are shown in Figure 4.14 following the tables. The results indicate approximately 119 buildings are in the 1% annual chance and approximately 100 additional are in .02% annual chance floodplain. Approximately $6.4 million in losses could result from the 1% annual chance event. Building exposure and potential losses are also shown by LPPA in the tables.

Table 4.9. FEMA 1% Annual Chance Flood Risk Summary

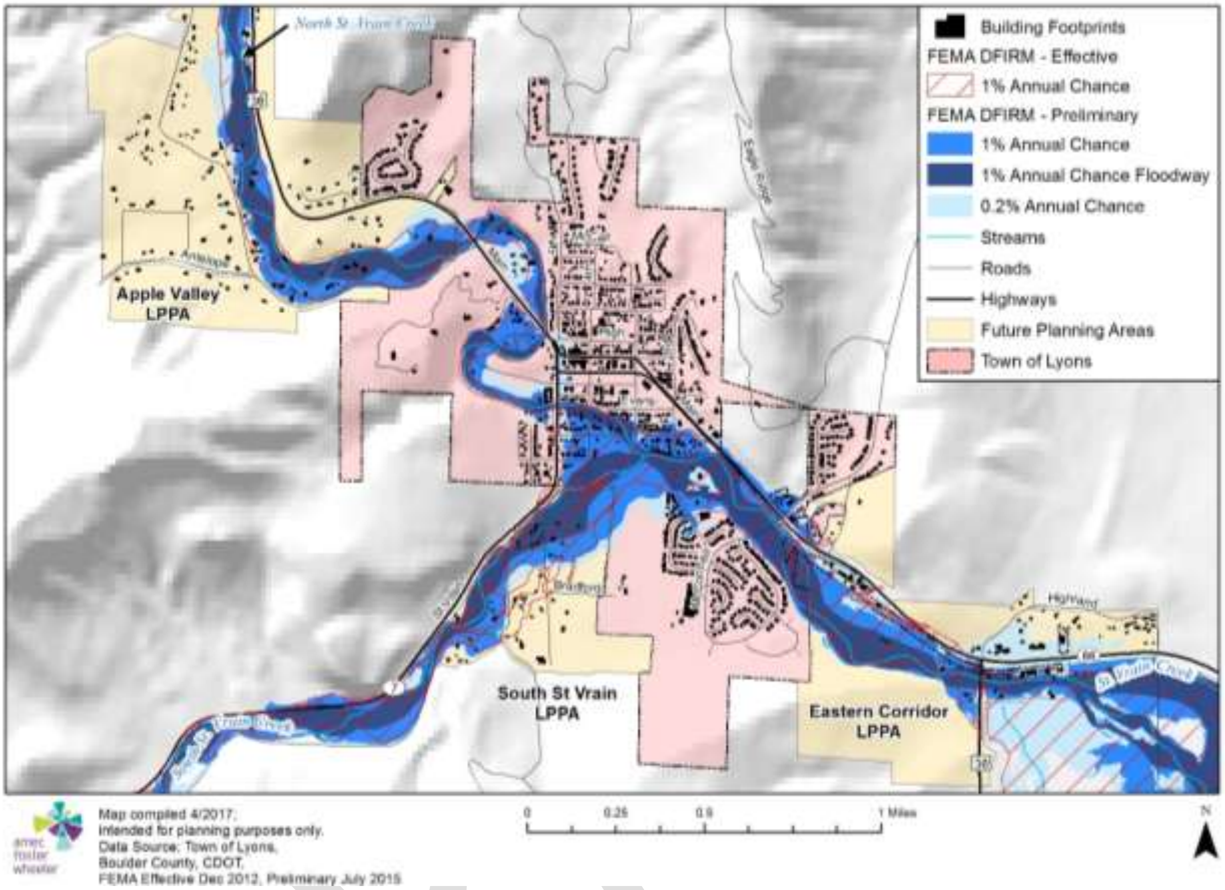
Area	Property Type	Parcel Count	Building Count	Improved Value	Est. Content Value	Total Exposure	Potential Loss	Population
Town of Lyons	Commercial	3	5	$385,100	$385,100	$770,200	$192,550	
	Exempt	4	4	$1,689,900	$1,689,900	$3,379,800	$844,950	
	Mixed Use	3	7	$1,296,200	$1,296,200	$2,592,400	$648,100	
	Residential	54	70	$9,456,400	$4,728,200	$14,184,600	$3,546,150	178.5
	Total	**64**	**86**	**$12,827,600**	**$8,099,400**	**$20,927,000**	**$5,231,750**	
Apple Valley LPPA	Ag Mixed	1	2	$196,100	$196,100	$392,200	$98,050	
	Exempt	6	9	$511,400	$511,400	$1,022,800	$255,700	
	Residential	10	19	$2,769,000	$1,384,500	$4,153,500	$1,038,375	48.5
	Total	**17**	**30**	**$3,476,500**	**$2,092,000**	**$5,568,500**	**$1,392,125**	
Eastern Corridor LPPA	Ag Mixed	1	4	$19,600	$19,600	$39,200	$9,800	
	Exempt	1	2	$0	$0	$0	$0	
	Mixed Use	1	3	$157,500	$157,500	$315,000	$78,750	
	Residential	4	7	$1,295,300	$647,650	$1,942,950	$485,738	17.9
	Total	**7**	**16**	**$1,472,400**	**$824,750**	**$2,297,150**	**$574,288**	
South St Vrain LPPA	Residential	11	21	$1,604,310	$802,155	$2,406,465	$601,616	53.6
	Total	**11**	**21**	**$1,604,310**	**$802,155**	**$2,406,465**	**$601,616**	
	Grand Total	**99**	**153**	**$19,380,810**	**$11,818,305**	**$31,199,115**	**$7,799,779**	**298.4**

Table 4.10. FEMA .02% Annual Chance Flood Risk Summary

Area	Property Type	Parcel Count	Building Count	Improved Value	Est. Content Value	Total Loss Estimate	Total Loss Estimate	Population
Town of Lyons	Commercial	9	11	$1,455,480	$1,455,480	$2,910,960	$727,740	
	Exempt	6	9	$1,539,900	$1,539,900	$3,079,800	$769,950	
	Industrial	1	2	$147,400	$221,100	$368,500	$92,125	
	Mixed Use	4	12	$1,597,500	$1,597,500	$3,195,000	$798,750	
	Residential	57	62	$14,642,700	$7,321,350	$21,964,050	$5,491,013	158.1
	Total	**77**	**96**	**$19,382,980**	**$12,135,330**	**$31,518,310**	**$7,879,578**	
Apple Valley LPPA	Exempt	2	2	$254,700	$254,700	$509,400	$127,350	
	Residential	8	11	$2,767,790	$1,383,895	$4,151,685	$1,037,921	28.1
	Total	**10**	**13**	**$3,022,490**	**$1,638,595**	**$4,661,085**	**$1,165,271**	
Eastern Corridor LPPA	Commercial	3	8	$468,400	$468,400	$936,800	$234,200	
	Exempt	2	8	$0	$0	$0	$0	
	Mixed Use	1	4	$218,300	$218,300	$436,600	$109,150	
	Total	**6**	**20**	**$686,700**	**$686,700**	**$1,373,400**	**$343,350**	
	Grand Total	**93**	**129**	**$23,092,170**	**$14,460,625**	**$37,552,795**	**$9,388,199**	**186.2**

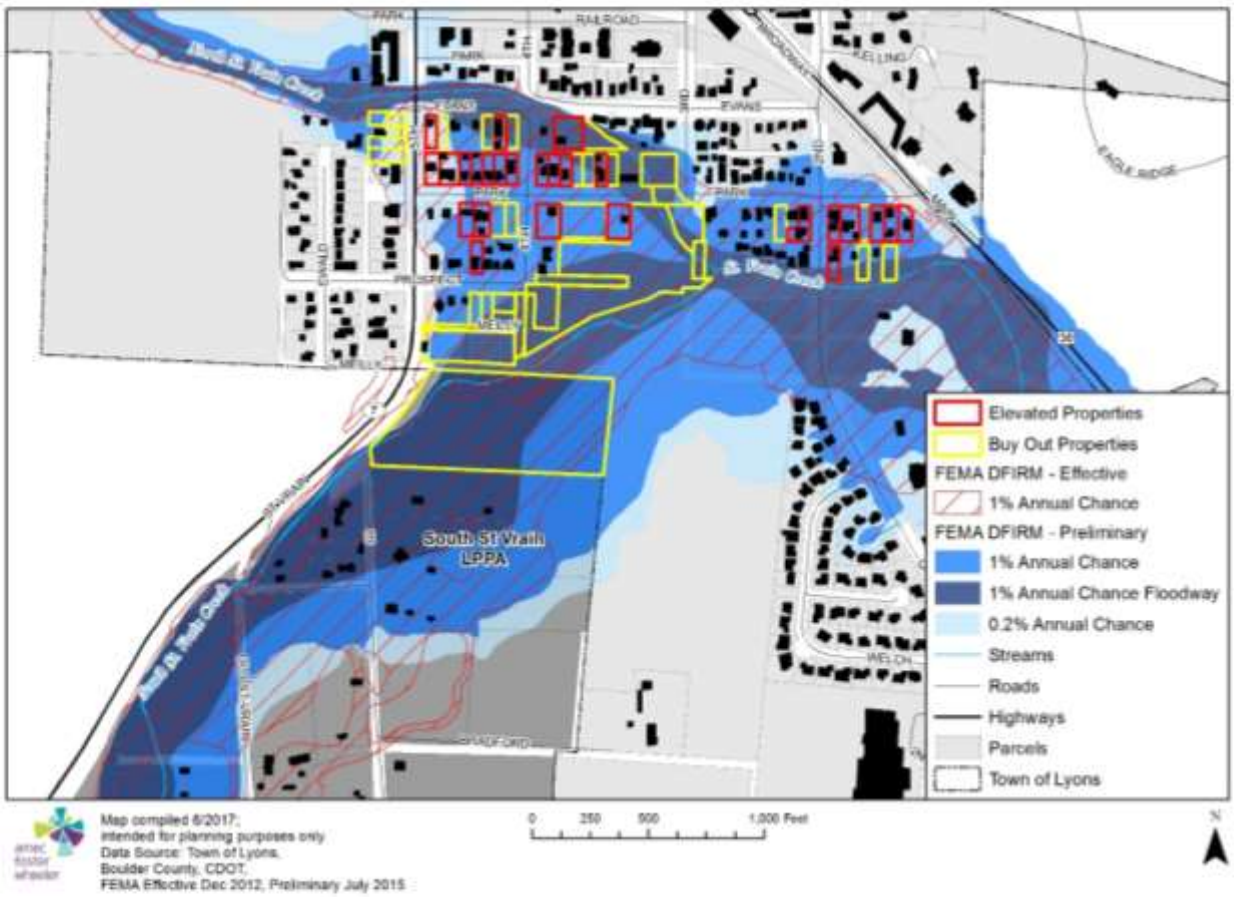
This analysis does not include loss estimates for properties at risk in non-regulatory flood hazard areas. Based on an analysis of 1% annual chance floodplains modeled as part of the Town's 2016 Stormwater Master Plan an additional 410 buildings that intersect the stormwater flood hazard area.

Figure 4.14. Flood Risk Map



This analysis assumes elevated structures are not at risk. Post 2013 flooding there were 27 properties that have been elevated with a two foot freeboard above the 1% annual chance flood base flood elevation. The two foot freeboard should provide some level of protection from the 0.2% annual chance flood as well. This losses avoided can be measured for these 27 properties, which equates to $4.8M in exposure, and approximately $1.2M in losses avoided if these properties were not elevated. There were 27 other properties that were purchased with FEMA and HUD funding and deed restricted as open space following the 2013 flood. These are illustrated on the map below, along with the locations of elevated parcels. The total market value of the structures on these parcels was $5,022,890 when acquired in 2015, based on information from the Town. Assuming an estimated contents value of $2.5M, based on the FEMA practice of 50% of structure value for residential structures, this equates to $7.5 M in property exposure that has been permanently removed from the floodplain. This represents approximately $1.8M of potential flood loss that will be permanently avoided in the next 1% annual chance event, using a conservative loss factor of 25%. Many of these structures were substantially damaged during the 2013 flood.

Figure 4.15. Map of Deed Restricted Buy Out Parcels and Elevated Properties



Critical Facilities and Infrastructure

Critical facilities in the 0.2% annual chance floodplain are summarized in the following table. An analysis of the 1% flood zone did not result in any facilities at risk.

Table 4.11. Critical Facilities at Risk to 1% and 0.2% Annual Chance Flooding

Category	Facility Name
1% Annual Chance	
Bridge	South St. Vrain Creek & Old St Vrain Rd
Bridge	St. Vrain Creek & McConnell Dr
Bridge	St. Vrain Creek & McConnell Dr
Bridge	St. Vrain Creek & 2nd Ave
Bridge	St. Vrain Creek & US Hwy 36
Bridge Scour Critical	North St. Vrain Creek & St Hwy 7
Bridge Scour Critical	St. Vrain Creek & 51st St
0.2% Annual Chance	
Bridge	North St. Vrain Creek & US Hwy 36
Bridge	North St. Vrain Creek & US Hwy 36
Communications	Warning Siren
Government Building	Town Hall
Municipal Wastewater	Pump Station (Eagle Canyon)
Municipal Wastewater	Pump Station (Stone Canyon)
Municipal Wastewater	Treatment Plant
Police	Boulder County Substation
Public Facility	Library
Public Facility	Planet Bluegrass

Some of these structures are elevated out of the floodplain. For example the Boulder County Sheriff Substation did not receive flooding in 2013.

Scour Critical Bridges

A database of bridges called the National Bridge Inventory (NBI) developed by the Federal Highway Administration was analyzed for flood risk. One of the database items is a "scour index", which is used to quantify the vulnerability of a bridge to scour during a flood. Bridges with scour index between 1 and 3 are considered "scour critical", or a bridge with a foundation element determined to be unstable for the observed or evaluated scour condition. Scour critical bridges are noted in the previous table.

Economy

Based on the risk assessment, it is evident that floods will continue to have potentially devastating economic impacts to Lyons. In addition to the damage losses previously quantified, there are impacts that are not quantified, but can be anticipated in future events, which include:

- Disruption of and damage to public infrastructure

- Injury and loss of life;
- Health hazards associated with mold and mildew;
- Damage to roads/bridges resulting in loss of mobility and compromised access/egress;
- Significant economic impact (jobs, sales, tax revenue) upon the community;
- Negative impact on commercial and residential property values;
- Deposition of sediment in confluence area
- Transportation egress/access issues, and
- Significant disruption to students and teachers as temporary facilities and relocations would likely be needed.

Natural, Cultural and Historic Resources at Risk

Cultural resources at risk include the library and Planet Bluegrass in 0.2% annual chance zone.

Future Development

Future annexations of unincorporated areas adjacent to the Town limits could significantly add to the number of flood-prone structures. These are quantified by each LPPA in the previously discussed flood loss tables. Based on this analysis each LPPA has more than 10 structures at risk (an additional 67 structures in the 1% annual chance zone and 43 total in the 0.2% annual chance zone). Growth in the confluence area of town will be constrained by deed restricted buy-out properties as shown in the previous map. Future growth within the Town limits in 1% annual chance flood hazard areas will be mitigated in accordance with local floodplain regulations.

Summary

Flooding continues to be a significant hazard for the Town and a considerable amount of property is exposed to both FEMA and non-regulatory flood hazard areas. Much of the historical growth in the Lyons area occurred adjacent to streams. While some of this property was bought out or elevated since 2013 there still is the potential for significant damage to property, losses from disruption of community activities, and potential loss of life when large floods occur on the St Vrain creeks. Other problems include significant exposure to stormwater runoff as well as deposition of sediments.

4.6 Hail

Hazard/Problem Description

Hail is formed when water droplets freeze and thaw as they are thrown high into the upper atmosphere by the violent internal forces of thunderstorms. Hail is usually associated with severe summer storms, which occur throughout the spring, summer, and fall in the Town of Lyons. Hailstorms generally occur more frequently during the late spring and early summer. Hailstones are usually less than two inches in diameter and can fall at speeds of 120 mph.

The National Weather Service classifies hail by diameter size, and corresponding everyday objects to help relay scope and severity to the population. Table 4.12 indicates the hailstone measurements utilized by the National Weather Service.

Table 4.12. Hailstone Measurements

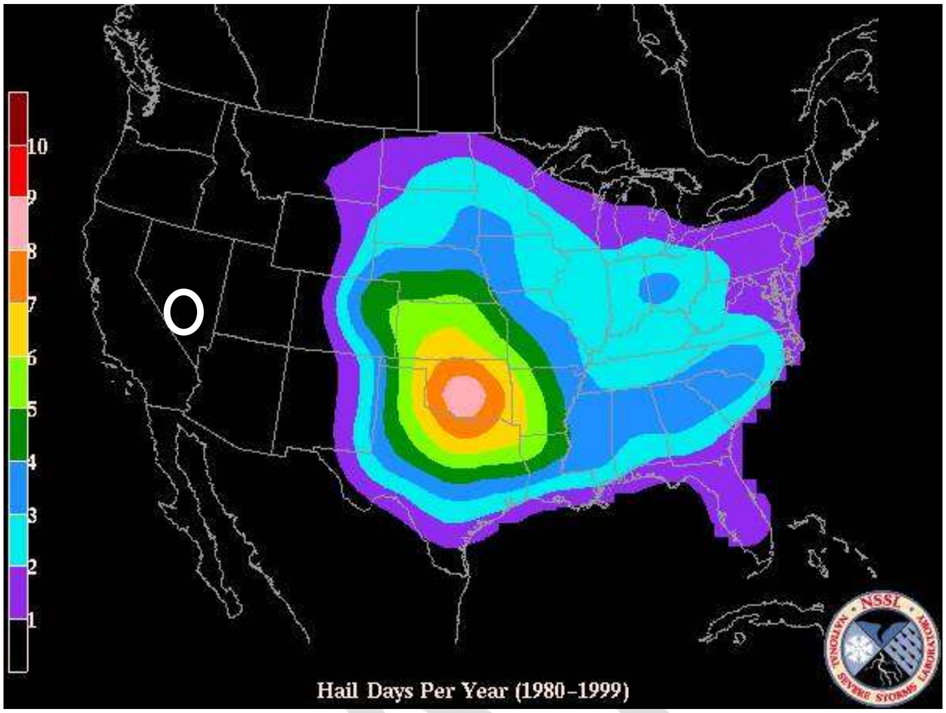
Average Diameter	Corresponding Household Object
.25 inch	Pea
.5 inch	Marble/Mothball
.75 inch	Dime/Penny
.875 inch	Nickel
1.0 inch	Quarter
1.5 inch	Ping-pong ball
1.75 inch	Golf-Ball
2.0 inch	Hen Egg
2.5 inch	Tennis Ball
2.75 inch	Baseball
3.00 inch	Teacup
4.00 inch	Grapefruit
4.5 inch	Softball

Source: National Weather Service

There is no clear distinction between storms that do and do not produce hailstones. Nearly all severe thunderstorms probably produce hail aloft, though it may melt before reaching the ground. Multi-cell thunderstorms produce many hailstones, but not usually the largest hailstones. In the life cycle of the multi-cell thunderstorm, the mature stage is relatively short so there is not much time for growth of the hailstone. Supercell thunderstorms have sustained updrafts that support large hail formation by repeatedly lifting the hailstones into the very cold air at the top of the thunderstorm cloud. In general, hail 2 inches (5 cm) or larger in diameter is associated with supercells (a little larger than golf ball size which the NWS considers to be 1.75 inch.). Non-supercell storms are capable of producing golf ball size hail.

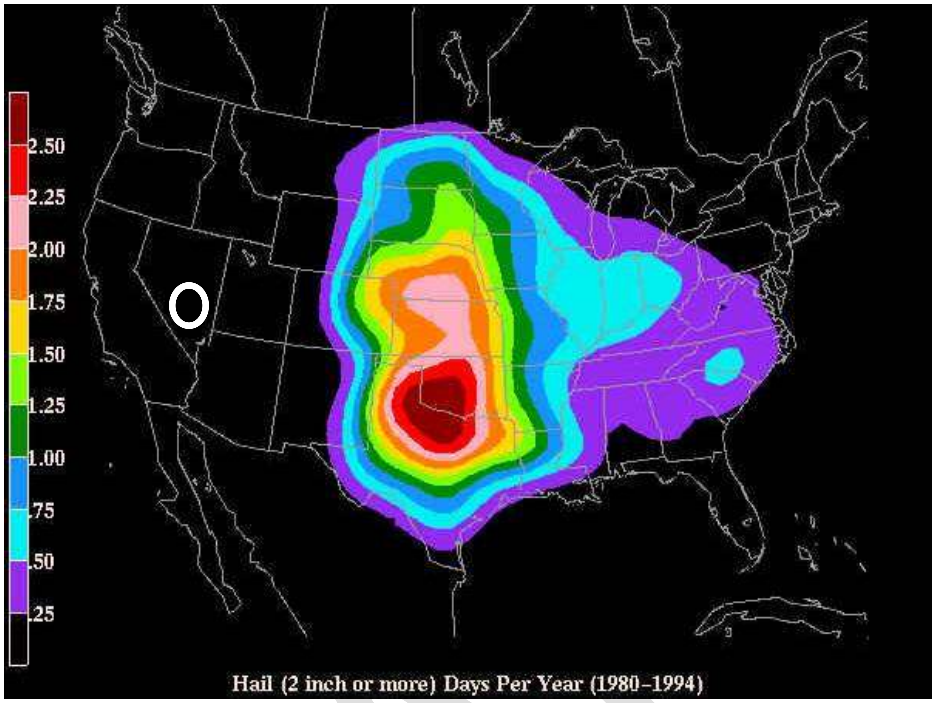
In all cases, the hail falls when the thunderstorm's updraft can no longer support the weight of the ice. The stronger the updraft the larger the hailstone can grow. When viewed from the air, it is evident that hail falls in paths known as hail swaths. They can range in size from a few acres to an area 10 miles wide and 100 miles long. Piles of hail in hail swaths have been so deep, a snow plow was required to remove them, and occasionally, hail drifts have been reported. Figure 4.16 shows the average number of days of hail per year in the United States, with Boulder County outlined in a white oval. Figure 4.17 shows the average number of days of severe hail (over two inches in diameter) per year in the United States, with Boulder County outlined in a white oval. The geographic extent rating for hail is considered extensive since the entire Town limits is exposed.

Figure 4.16. Average Number of Days of Hail per Year



Source: NOAA National Severe Weather Laboratory; White oval indicates approximate location of Town

Figure 4.17. Average Days of Large Hail in the Planning Area



Source: NOAA National Severe Weather Laboratory; White oval indicates approximate location of Town

Location

The entire Town of Lyons is susceptible to the impacts of a hailstorm. The Advisory Committee noted two particularly damaging hailstorms in the between 2011 and 2016 that caused widespread damage throughout the Town.

Past Occurrences

A study conducted in 1994 by the Colorado state climatologist looked at recorded hail statistics from 1973 to 1985 and from 1986 to 1993. The data used for this study is limited as systematic observations of hail are taken only at a small number of weather stations. Therefore, this study relied on point weather station data from a small number of sites in and near Colorado along with statewide data on severe hailstorms obtained from the national publication, *Storm Data*. Further, since hail occurs only briefly and tends to be very localized, many storms go undetected by the official weather stations. Regardless, by analyzing the existing data, this study uncovered the following statistics regarding hailstorms in Colorado:

- The hail season in Colorado begins in March and ends in October.
- There has been an average of more than 130 reported severe hailstorms each year since 1986.
- Overall, June has the highest frequency of days with hail with slightly more than 10 on average.
- Hail in Colorado is primarily an afternoon or evening phenomenon; 90 percent of all severe hailstorms reported between 1986 and 1993 occurred between 1:00 and 9:00 p.m.

- Hail usually only falls for a few minutes. Hail that continues for more than 15 minutes is unusual.
- A study of 60 Fort Collins hail events showed the median duration to be six minutes.
- The vast majority of hailstones that fall in Colorado are ½ inch in diameter or smaller.
- The most common size range for damaging hail in Colorado is 1 to 1.5 inches in diameter.
- Six percent of the reported severe hailstorms had maximum hailstone diameters of 2.5 inches or greater.
- The maximum hailstone size reported in this study was 4.5 inches.
- Hail frequency can be very variable. For example, there were only 25 severe hail days in 1988 compared with 51 in 1993.
- Severe hail is not a statewide problem. It is limited to eastern Colorado beginning in the eastern foothills and extending across the eastern plains.

Hail is a major cause of property damage in the plains just east of the Rockies. The past 40 years have brought one catastrophic hailstorm after another to the Front Range. Costly hailstorms identified by the Colorado Division of Homeland Security and Emergency Management include those listed in Table 4.13. The extent of damage in the Boulder County area from these storms could not be determined from available data.

Table 4.13. Costly Hailstorms in Colorado

Date	Location	Cost When Occurred (Millions)
July 20, 2009	Denver Metro	$767.6
July 11, 1990	Denver Metro	$625.0
June 6-15, 2009	Denver Metro	$353.3
June 13-14, 1984	Denver Metro	$276.7
July 29, 2009	Pueblo	$232.8
October 1, 1994	Denver Metro	$225.0
May 22, 2008	Windsor	$193.5
June 8-9, 2004	Denver Metro	$146.5
August 11, 1997	Denver Metro	$128.0
May 22, 1996	Denver Metro	$122.0

Source: Rocky Mountain Insurance Information Association, 2010
*2009 estimated cost calculations based on the Consumer Price Index

Data from the National Climatic Data Center identified nine hail events specifically affecting the Town of Lyons between 1996 and 2016 with hailstones at least ¾ inch in diameter. The largest hailstone size had a circumference of 2.5 inches. NCDC did not record any injuries or fatalities from these storms, however the Advisory Committee noted that a large number of roofs were replaced following a hailstorm on June 4, 2015; a number of cars were also damaged. The database also didn't record any property damage from these storms, though this is normally due to the fact that hail damage loss is insured and often not included. The following table shows hail events recorded on the NCDC database; the storms in 2013 and 2015 recorded multiple events.

Table 4.14. Historical Hailstorms in Lyons 1996-2016

Location	Date	Time	Hail Size	Deaths	Injuries	Property Damage	Crop Damage
Lyons	5/29/1996	1735	0.75	-	-	-	-
Lyons	5/14/2007	1627	1	-	-	-	-
Lyons	6/9/2009	1610	0.75	-	-	-	-
Lyons	7/13/2011	1817	1	-	-	-	-
Lyons	6/28/2013	1837	1.25	-	-	-	-
Lyons	6/28/2013	1845	1.75	-	-	-	-
Lyons	6/4/2015	1803	2.5	-	-	-	-
Lyons	6/4/2015	1813	2	-	-	-	-
Lyons	6/4/2015	1930	2.5	-	-	-	-

Source: National Climatic Data Center

Data for the surrounding areas within Boulder County show that between 1962 and 2016, the county had 226 separate recorded hail incidents; these storms caused a cumulative $1,005,000 in property damage and seven injuries across the County.

Likelihood of Future Occurrences

Likely: The Town of Lyons has experienced nine NCDC-recorded hail incidents between 1996 and 2016, which means that the town can expect an incident every other year. Given the history of severe weather events in Lyons and the surrounding County, severe weather, including hailstorms, will continue to occur on an annual basis; however, the extent of impact to the Town will vary depending on the location and severity of any given storm and associated hail event.

Climate Change Considerations

NASA’s Earth Observatory provides an analysis on how climate change could, theoretically, increase potential storm energy by warming the surface and putting more moisture in the air through evaporation. The presence of warm, moist air near the surface is a key ingredient for summer storms that meteorologists have termed “convective available potential energy,” or CAPE. With an increase in CAPE, there is greater potential for cumulus clouds to form. The study also counters this theory with the theory that warming in the Arctic could lead to less wind shear in the mid-latitude areas prone to summer storms, making the storms less likely. Based on these differing theories it is difficult at this point in time to summarize the effects climate change may have on hail.

The Boulder County Climate Change Preparedness Plan notes that as precipitation increases during extreme events, it can have an opposite impact on hail formation, thus there is the potential for the amount of hail to decrease.

Magnitude/Severity (Extent)

Magnitude and severity of hail is impacted by Lyons' size, location, and vulnerable infrastructure, and the size of the hail and duration of the storm. The NCDC doesn't record any property damage, injuries or fatalities for the Town of Lyons in its database, though that isn't necessarily an indicator that impacts haven't taken place. In surrounding Boulder County, hailstorms have caused up to $1,000,000 in damage from a single storm; the maximum number of injuries sustained during one storm is six, though the database didn't provide further explanation on the nature of these injuries.

Vulnerability Assessment and Potential Losses

People

Exposure is the greatest danger from hail to the general population. Although rare, persons caught unawares and unprotected by storms with larger hailstones can suffer significant injuries and even death. While hailstorms that cause fatalities are very rare, a violent hailstorm struck Fort Collins on July 30, 1979 with up to grapefruit size hail, injuring 25 people and killing one.

Lyons has multiple open recreational areas including LaVern M. Johnson Park, Sandstone Park, the Lyons Dog Park, Lyons Bike Park and Bohn Park; some of these parks are void of shelter areas or adequate cover. The mountains and hiking areas around the periphery of the Town also provide open areas devoid of cover. Hikers and outdoor enthusiasts need to pay attention to changing weather conditions and seek cover and shelter immediately if needed. Every year, Lyons hosts community-based festivals, including the RockyGrass Festival in July and the Rocky Mountain Folks Festival in August, as well as concerts at the Wildflower Pavilion. These events attract large numbers of people increasing risk to impacts from hail.

Built Environment

Hail can severely damage buildings and other infrastructure. As stated in the Past Occurrences section of this plan, NCDC doesn't record much property damage, though this is largely due to most hail damage being insured. Hail can do severe damage to roofs, windows, vehicles and anything else exposed. Many of the homes in Lyons do not have garages, increasing the vulnerability to vehicle damage during a hailstorm.

Critical Facilities and Infrastructure

Because of the unpredictability of the strength and path of a hailstorm, most critical infrastructure that is above ground is equally exposed to the storm's impacts. Due to the random nature of these hazards, a more specific risk assessment was not conducted.

Economy

Any widespread economic impacts of hail are typically short term. Hail can damage infrastructure and destroy public and private property but losses are tempered by insurance.

Natural, Cultural and Historic Resources

Severe thunderstorms are a natural environmental process. Environmental impacts include flattening of plants and stripping of leaves on trees. As a natural process, the impacts of most hailstorms by themselves are part of the overall natural cycle and do not cause long-term consequential damage.

Future Development

New critical facilities, such as communication towers should be built to withstand hail damage. Future development projects should consider hail hazards at the planning, engineering and architectural design stage with the goal of reducing vulnerability; mitigation measures for hail can include hail-resistant roofing, shutters and laminated glass windows. Development trends in the Town of Lyons are not expected to increase overall vulnerability to the hazard.

Summary

- Lyons has a history of damaging hailstorms
- Most hail damage is insured loss
- Because of Lyons' size, impacts from hail usually affect the entire Town
- Between open space and outdoor festivals, exposure risk to people is increased
- Overall significance is medium

4.7 Hazardous Materials Incidents

Description

Generally, a hazardous material is a substance or combination of substances which, because of quantity, concentration, or physical, chemical, or infectious characteristics, may either (1) cause or significantly contribute to, an increase in mortality or an increase in serious, irreversible, or incapacitating reversible, illness; or (2) pose a substantial present or potential hazard to human health or environment when improperly treated, stored, transported, disposed of, or otherwise managed. Hazardous material incidents can occur while a hazardous substance is stored at a fixed facility, or while the substance is being transported.

The U.S. Department of Transportation, U.S. Environmental Protection Agency (EPA) and the Occupational Safety and Health Administration (OSHA) all have responsibilities in regards to hazardous materials and waste.

The U.S. Department of Transportation has identified the following classes of hazardous materials:

- Explosives
- Compressed gases: flammable, non-flammable compressed, poisonous

- Flammable liquids: flammable (flashpoint below 141 degrees Fahrenheit) combustible (flashpoint from 141 - 200 degrees)
- 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

Location

Hazardous materials incidents can occur anywhere hazardous materials are stored or transported, including hazardous materials routes running through the Town and fixed facilities with hazardous substances within Town limits.

Hazardous materials run through the Town on major transportation routes, including U.S. 36, and Highways 7 and 66. The Advisory Committee noted the prevalence of fuel tankers and propane trucks through the Town, and also noted that some of these roads run along or intersect the St. Vrain Creek, creating a potential spill hazard in the adjacent waterway. They also noted that asphalt trucks run up into the canyons, transporting materials for repairs from the 2013 flood.

The Town of Lyons contains no facilities requiring a Risk Management Plan.

Past Occurrences

The Advisory Committee noted that there had been three semi-truck rollover accidents on Highway 36 north and west of town within a 6 month period prior to April 2017. There was some speculation that the post-2013 flood reconstruction of the highway may have made a certain curve more dangerous.

Likelihood of Future Occurrences

Based on limited historic incidents the likelihood of a hazardous materials within Lyons is considered Occasional: Between 1 and 10% chance of occurrence in the next year.

Climate Change Considerations

Hazardous materials is a man-made hazard, and as such would probably not be affected by the effects of climate change.

Magnitude/Severity (Extent)

Because of the variability of hazardous materials transported across the Town of Lyons, a general extent measure is difficult to determine. As a general rule, any hazardous materials release is anticipated to have impacts no more than one mile around the incident site. Specific incident parameters including material released, method of release, time of day, weather patterns and location factor into incident impacts.

Vulnerability Assessment and Potential Losses

People

The public's general vulnerability to hazardous materials incidents depends on the hazardous material, the location of the incident and environmental factors. There are three exposure pathways for a person to come into contact with a hazardous materials: inhalation, ingestion and skin contact. Effects to people can include burns, breathing problems, and contamination. In general, there aren't many hazardous materials being transported through town and a worst case scenario may be a fuel truck exploding in town. Impacts to persons are expected to be minimal.

Built Environment

Impacts on the built environment are dependent on the site of the hazardous materials spill, weather and environmental conditions, and the material itself. The Town does not have routes designated for hazardous materials transport, meaning that hazardous materials could be transported along routes near residential populations, commercial zones and critical infrastructure. Should a hazardous materials spill occur near the built environment, impacts could include reduced or limited access for a short period of time, or building and ground contamination.

Critical Facilities and Infrastructure

The Boulder Multi-Hazard Mitigation Plan lists seven critical facilities in the Town of Lyons, including major bridges, schools, shelters and winter shelters. Critical facilities located within a half mile radius of major roadways could see impacts from a transportation incident, but the risk of such an event occurring would be low.

Economy

The Town's economy could see an impact from a hazardous materials incident, though this would most likely be short term, with minimal long-term effects. The most likely impact to the Town's overall economy would be an incident that requires closure of one of the access routes into the community, cutting off entrance or exit from the community and causing the re-routing of traffic.

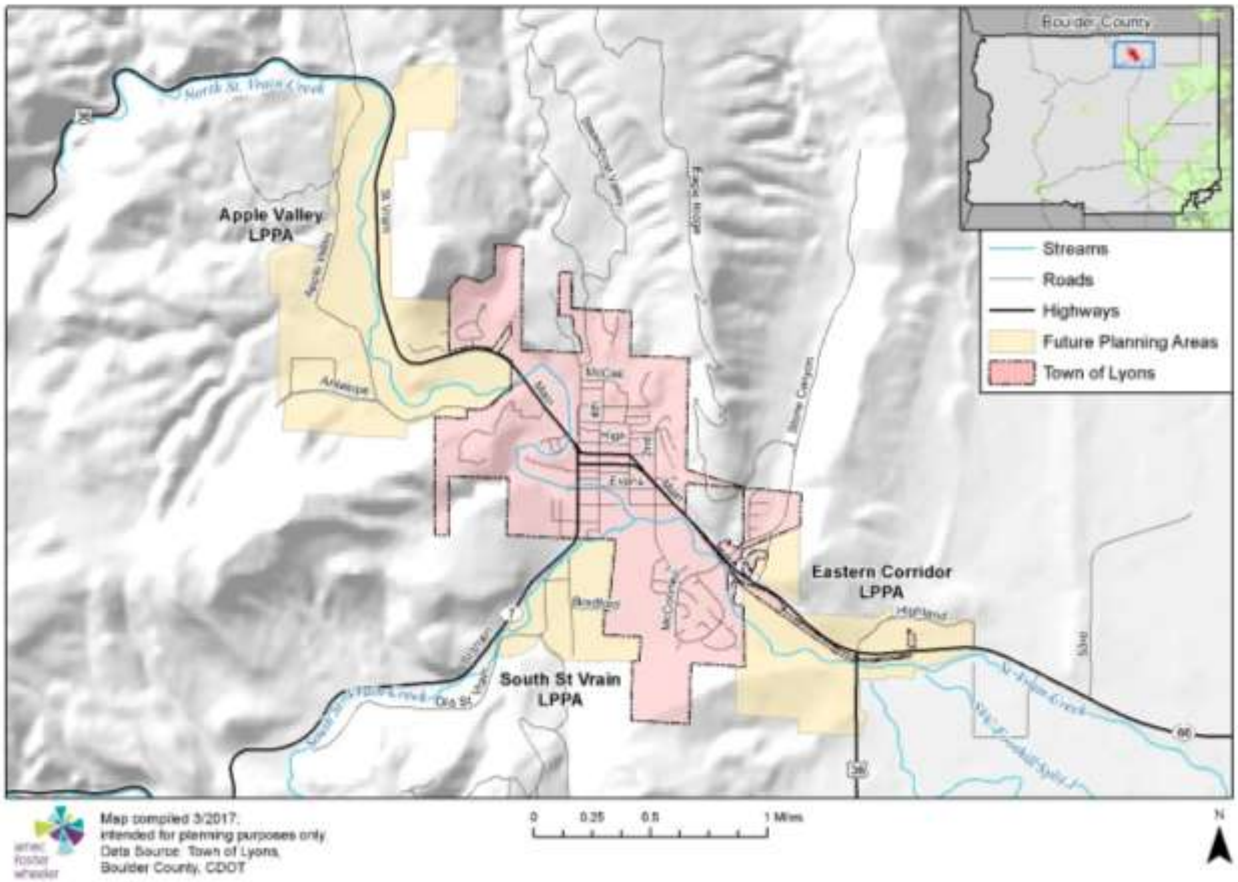
Natural, Cultural and Historic Resources

The biggest natural risk to hazardous materials is the creek running along and intersecting major transportation routes; an incident close to the creek could cause hazardous materials to enter the waterway, which could cause short-term contamination.

Future Development

As noted previously, hazardous materials run along major roadways in the Town, specifically U.S. 36, and Highways 66 and 7. Planned development areas (shown in the following figure) show development along these routes, on U.S. 36 north of town, along U.S. 6 and Highway 66 southeast of town, and along Highway 7 southwest of town.

Figure 4.18. Lyons Planning Areas and Major Roads



Summary

- Impacts of hazardous materials releases are highly contingent on location, environmental factors and the material released
- Transportation routes intersect and parallel waterways in the Town, creating an increased risk for environmental contamination
- Areas within a half mile of potential hazardous materials incidents are especially vulnerable to impacts
- Asphalt trucks carry materials through Lyons for flood repairs in the surrounding canyons
- Overall significance is low

4.8 High Winds and Downbursts

Description

High winds are a frequent occurrence throughout the Lyons area, and can result in property damage and injury. Strong gusts can rip roofs from buildings, snap power lines, shatter windows, down trees, and sandblast paint from cars. Other associated hazards include utility outages, arcing power lines, debris blocking streets, dust storms, and occasional structure fires.

Boulder County has some of the highest peak winds of any area in the United States. The peak of the wind season is December and January, but downslope windstorms have been recorded in every month except July. The Lyons Advisory Committee noted that straight-line winds of up to 100 mph have been recorded. Table 4.15 provides a scale describing the damaging effects of wind speed.

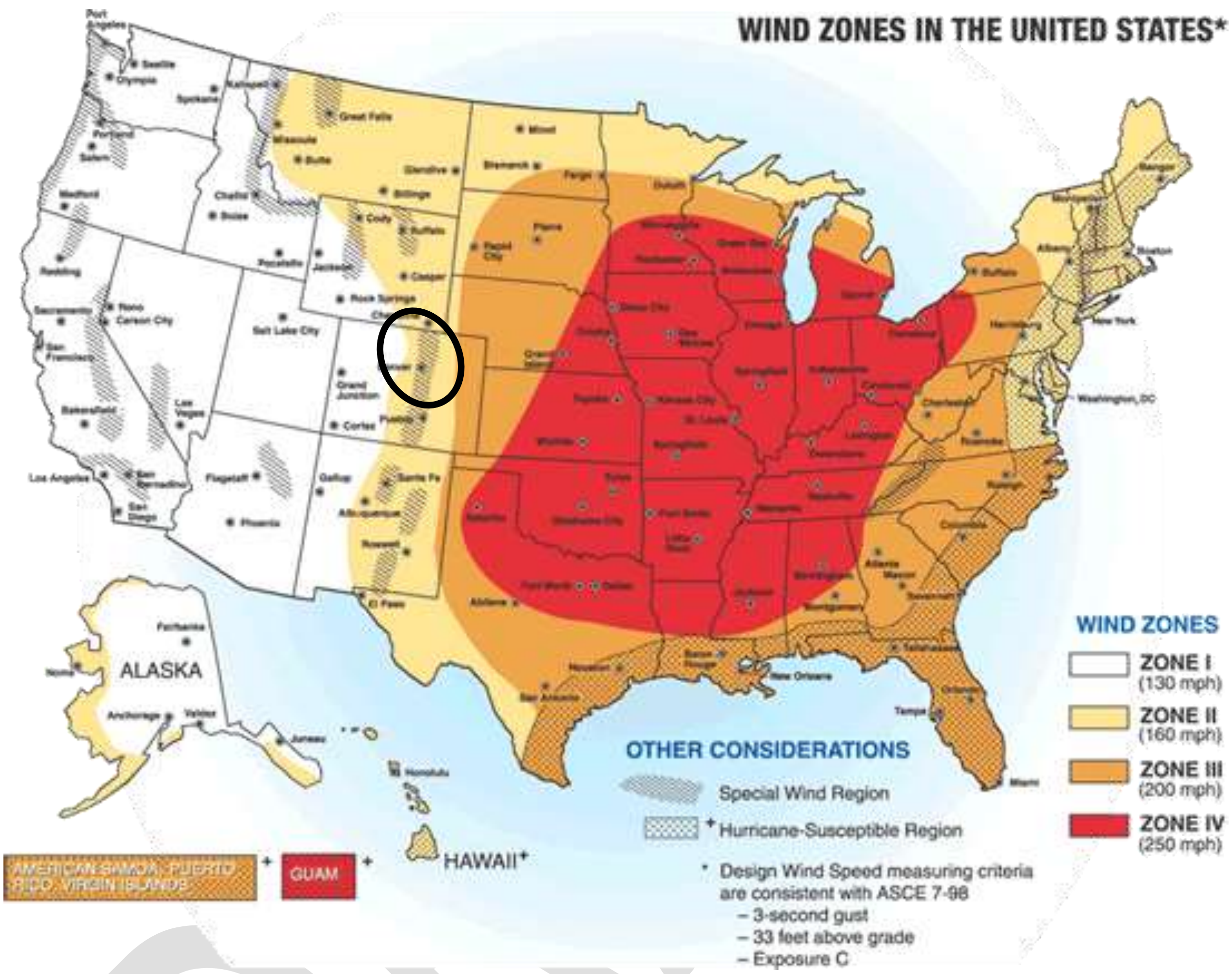
Table 4.15. Beaufort Wind Scale

Wind Speed (mph)	Description—Visible Condition
0	Calm; smoke rises vertically
1-4	Light air; direction of wind shown by smoke but not by wind vanes
4-7	Light breeze; wind felt on face; leaves rustle; ordinary wind vane moved by wind
8-12	Gentle breeze; leaves and small twigs in constant motion; wind extends light flag
13-18	Moderate breeze; raises dust and loose paper; small branches are moved
19-24	Fresh breeze; small trees in leaf begin to sway; crested wavelets form on inland water
25-31	Strong breeze; large branches in motion; telephone wires whistle; umbrellas used with difficulty
32-38	Moderate gale whole trees in motion; inconvenience in walking against wind
39-46	Fresh gale breaks twigs off trees; generally impedes progress
47-54	Strong gale slight structural damage occurs; chimney pots and slates removed
55-63	Whole gale trees uprooted; considerable structural damage occurs
64-72	Storm very rarely experienced; accompanied by widespread damage
73+	Hurricane devastation occurs

Source: NOAA

Figure 4.19 depicts wind zones for the United States. The map denotes that the Town of Lyons falls into Zone II and is in a special wind region; Zone II is characterized by high winds of up to 160 mph, and special wind regions are characterized by winds exceeding 200 mph. Special winds that affect the Town are Chinook and Bora Winds. The geographic extent rating for windstorms is considered extensive since the entire Town of Lyons is exposed.

Figure 4.19. Wind Zones in the United States

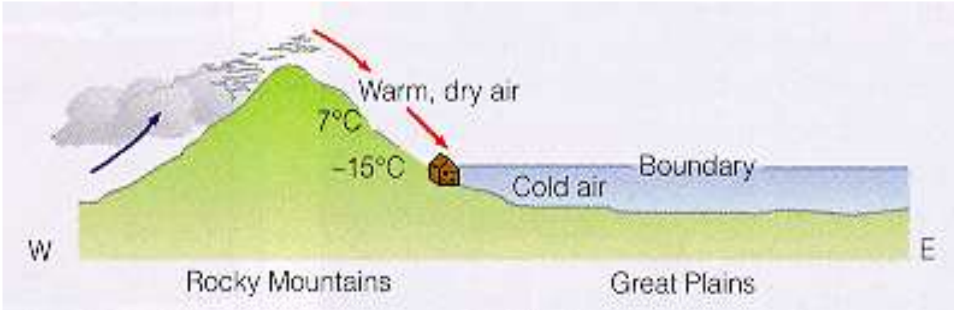


Source: Federal Emergency Management Agency; Black oval indicates approximate location of Lyons

Chinook Winds

The Front Range's violent, downslope winds are referred to as Chinook winds, after Native Americans of the Pacific Northwest. These downslope winds, typically warm and dry, occur in areas where mountains stand in the path of strong air currents. These warm, downslope winds occur when the winds blow across the Continental Divide from the west and descend the foothills into Lyons (see Figure 4.20). They are caused by high pressure west of Lyons, low pressure over or east of Lyons, and strong westerly winds in the mountains. During these Chinooks, wind speeds can reach extreme values and do quite a bit of damage.

Figure 4.20. Chinook Wind Pattern



Source: University of Colorado at Boulder ATOC Weather Lab http://wxpaos09.colorado.edu/windstorms/windstorms.htm

Bora Winds

Bora winds, downslope winds that replace relatively warm light wind conditions with cold temperatures and strong wind gusts may also be observed in Lyons. Bora winds that strike Lyons blow from the west, are relatively dry, but are also cold. The arrival of a Bora in Lyons can be similar to the onset of a Chinook, with strong westerly, but colder and drier air, whereas a Chinook brings warmer and drier air. Generally, Bora winds are less extreme than winds generated during Chinook events.

Location

Any area of the town is vulnerable to high winds or tornadoes. Geographic features can affect the amount of wind in different areas of the county.

Past Occurrences

High wind events are one of the most notable natural hazards affecting the Lyons area. According to NOAA’s Climate Diagnostics Center, nearby Boulder has some of the highest peak winds of any city in the United States. High winds during a severe thunderstorm in January 1982 resulted in more than $10 million in damage and damaged nearly half of the buildings in Boulder.

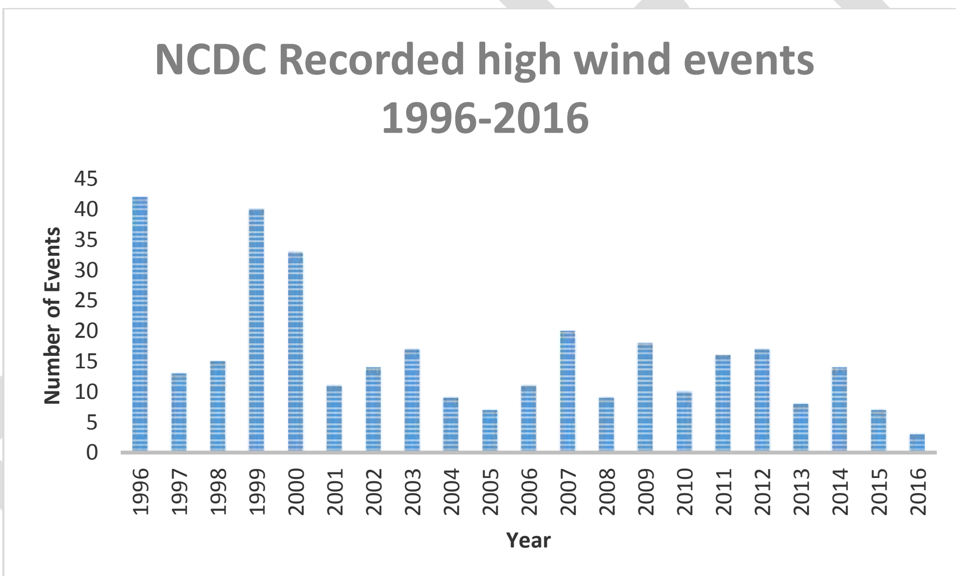
The National Climatic Data Center provides data on past high wind events, though the data is provided regionally centered on Boulder County, and is not targeted to specific locations. The NCDC records 370 separate events with high winds between 1996 and 2016, which occurred over 231 separate days. Overall, regional wind impacts include $22.252M in property damage, as well as 12 recorded injuries and 2 recorded fatalities. The average speed of all recorded gusts was almost 85 mph, with the highest recorded at 133.5 mph on November 12, 2005.

Table 4.16. Boulder County Wind Incident Summary

NCDC-Recorded Wind Incident Summary	
Total incidents	370
Separate days with incident	231
Property damage	20
Fatalities	2
Injuries	12

High wind data specific to Lyons is very limited. Regional wind data provides examples of the types of impacts wind has caused in the surrounding area. Historical property damage includes damaged trees and secondary damage caused to homes by falling trees, roof and siding damage, and damage to vehicles from flying debris. Historical injuries were caused mostly by flying debris or lost footing, and historical fatalities were caused by flying debris. It can be extrapolated that these types of impacts could occur in the Town of Lyons.

Figure 4.21. Regional Wind Events 1996-2016



Source: NCDC

Other significant wind events identified include the following:

- **January 11, 1972**—Winds gusting to 97 mph damaged 40 trailers at Boulder Valley Village, including three that burned. Damage was estimated near $3 million.
- **January 17, 1982**—In one of the most devastating windstorms in Boulder County, winds were clocked at 137 mph at NCAR. Twenty gusts in excess of 120 mph were measured during a 45-minute period. South Boulder was the hardest hit area of the county. At least 15 people were treated for cuts and bruises at Boulder Community Hospital after being struck with flying debris and glass. Trees were uprooted, power lines toppled, roofs blown off, houses torn apart, and cars damaged. Damage totaled approximately $17 million.

Wind-related deaths in Boulder County include the following:

- **January 7, 1969**—One half of all the houses in the city were damaged by wind. Winds clocked at 96 mph downtown and 130 mph at NCAR. One person died when he was blown off a Cherryvale fire department truck that was responding to a grass fire near the Boulder Airport.
- **June 1969**—A University of Colorado at Boulder student died while sailing under a parachute in 80 mph winds.
- **December 4, 1978**—148 mph, one death
- **January 10, 1990**—One person was killed in a three-car accident on the Boulder Turnpike two miles west of Broomfield. Winds gusting to 107 mph caused poor visibility.
- **October 29, 1996**—A Boulder County man died as he was trying to secure his pop-up camper trailer during winds in excess of 100 mph. The trailer blew over on top of him. Trees were downed and cars and property damaged.
- **December 31, 2011**—A Lyons man was killed when high winds caused a tree branch to smash through his car windshield while driving on US 36 north of Boulder.

Other significant storms with wind velocities above 90 mph or where damage occurred include the following:

- **October 1949**—85 mph, 300-ton crane toppled Valmont Plant
- **January 15, 1967**—125 mph, NCAR
- **June 25, 1969**—123 mph, NCAR
- **January 24, 1970**—122 mph, NCAR
- **January 25, 1971**—147 mph, NCAR
- **December 11, 1973**—120 mph, Marshall Mesa
- **November 26, 1977**—119 mph, Davidson Mesa
- **January 24, 1982**—140 mph, Wondervu
- **December 25, 1984**—112 mph, $100,000 damage
- **September 24, 1986**—131 mph, $100,000 damage
- **January 23, 1988**—90 mph, damaged bridge on Highway 157
- **February 9, 1988**—96 mph, 1,600 homes without power

- **May 7, 1988**—110 mph, 12,000 residents without power; annual Boulder Kinetics event canceled
- **January 8, 1990**—110 mph, minor damage
- **December 14, 1990**—120 mph, roof, trees, and cars damaged
- **January 24, 1992**—143 mph, NCAR, minor damage
- **January 3, 1995**—104 mph, Boulder Airport
- **December 4, 1995**—95 mph, NCAR, minor damage
- **November 13, 1995**—124 mph, NCAR, power outages in Nederland, a downed power line started a wildfire in Pine Brook Hills
- **February 16, 2007**—101 mph, National Wind Technology Center. Roads closed from blowing snow. Large scale winds from Berthoud Pass to Front Range.
- **June 6, 2007**—92 mph. Boulder. 101 Carter Lake.

Likelihood of Future Occurrences

Highly Likely: High winds are common in the Lyons area. Given historical data, topography of the area, and weather patterns, high winds in the Town of Lyons will continue to occur annually.

Climate Change Considerations

There presently is not enough data or research to quantify the magnitude of potential change that climate change may have on windstorms. Future updates to the mitigation plan should include the latest research on how the windstorm hazard frequency and severity could change. The level of significance of this hazard should be revisited over time.

Magnitude/Severity (Extent)

While scales exist to measure the effects of wind, they can be conflicting or leave gaps in the information. For the purposes of this plan, the Beaufort Wind Scale was used because it is specifically adapted to wind effects on land. The Beaufort Wind Scale can be found in Table 4.15. The entire Town of Lyons is susceptible to all twelve Beaufort Wind categories.

Vulnerability Assessment and Potential Losses

People

People directly exposed to high winds or tornadoes should seek shelter immediately, as winds can pick up debris and injure the public. Some segments of the population are especially vulnerable to the indirect impacts of damaging wind, particularly the loss of electrical power. The highest risk demographic is to first responders who are dealing with emergency situations resulting from the windstorm. Those working or recreating outdoors can be susceptible to injury from wind borne debris.

Built Environment

In terms of property losses, the actual damages will depend on the building density in the impacted area; this is variable across the Town. A severe thunderstorm with high winds, or a tornado path in an older residential area with older homes, large trees, and overhead utility lines will have a significantly greater impact with the same storm in a new development with lower building density, modern constructed buildings, small or newly planted trees, and underground power lines.

Critical Facilities and Infrastructure

Because of the unpredictability of high wind, most critical infrastructure that is above ground is equally exposed to the hazard. Power lines, communications networks, and other above-ground infrastructure are vulnerable to the effects of windstorms both directly and indirectly.

The wind itself may damage the infrastructure, or the wind may damage tree branches and throw other debris into the air, which may cause secondary damage to buildings and critical facilities or capabilities. Occasionally tree limbs on powerline cause outages in the planning area.

Emergency response vehicles with high profiles may be more exposed to high winds, which may hinder response times. In addition, wind may exacerbate dangerous conditions, such as fires, making response more difficult and dangerous. Due to the random nature of this hazard, a more specific risk assessment was not conducted for this plan.

Economy

Winds typically don’t have long-term impacts on the economy. Both winds and tornadoes may impact exposed critical infrastructure such as power lines; depending on the impact and the function, this could cause a short-term economic disruption.

Natural, Cultural and Historic Resources

High winds can have many impacts on the environment, including erosion, flattening of trees and plants. The Lyons Advisory Committee specifically noted the prevalence of older cottonwood trees throughout the Town; due to their typically weak roots, these trees and branches could become hazards and sources of debris. Winds can cause wildfire to spread at a faster rate and exacerbate the impacts of winter storms, ice storms and severe cold.

Future Development

Future growth is gradual and is not expected to increase exposure or vulnerability to this hazard. If new construction activity picks up these sites can be particularly vulnerable to windstorms. Wind-borne construction materials can become hazards to life and property. New development should be able to withstand or at least resist wind damage if properly constructed.

Summary

- The Town of Lyons is vulnerable to both Bora and Chinook winds
- Wind gusts of up to 133.5 mph have been recorded in the areas around Lyons; the HMPC noted wind gusts of up to 100 mph in the Town
- Wind gusts can cause both direct impacts to people and infrastructure, and indirect impacts such as power outages
- Wind can increase impacts from heavy snow, ice, cold and wildfire
- Overall significance is medium

4.9 Landslides, Debris Flows and Rockfalls

Description

Landslides refer to a wide variety of processes that result in the perceptible downward and outward movement of soil, rock, and vegetation under gravitational influence. According to the Colorado Geological Survey, common names for landslide types include slump, rockslide, debris slide, lateral spreading, debris avalanche, earth flow, and soil creep. Although landslides are primarily associated with steep slopes, they may also occur in areas of generally low relief and occur as cut-and-fill failures, river bluff failures, lateral spreading landslides, collapse of waste piles, and failures associated with quarries and open-pit mines. Landslides may be triggered by both natural and manmade changes in the environment resulting in slope instability.

Human activities, such as mining, construction, and changes to surface drainage areas, also affect the landslide potential. Landslides often accompany other natural hazard events, such as floods, wildfires, or earthquakes. They can occur slowly or very suddenly and may damage or destroy structures, roads, utilities, and forested areas and can cause injuries or death.

Rockfalls are the fastest type of landslide and occur most frequently in mountains or other steep areas during early spring when there is abundant moisture and repeated freezing and thawing. The rocks may freefall or carom down in an erratic sequence of tumbling, rolling and sliding. When a large number of rocks plummet downward at high velocity, it is called a rock avalanche. Rockfalls are caused by the loss of support from underneath or detachment from a larger rock mass. Ice wedging, root growth, or ground shaking, as well as a loss of support through erosion or chemical weathering may start the fall.

Location

Available hazard mapping for Lyons includes three sources, a statewide landslide layer available in GIS, a geologic hazards/constraints mapping for Boulder County, and Colorado Geological Survey study titled "Foothill and Mountainous Regions in Boulder County, Colorado that may be Susceptible to Debris/Mud Flows during Extreme Precipitation Events." The red polygons on the map below represent areas where conditions (e.g. slope angle, channel curvature) are favorable for the generation of debris flows/mudflows, especially during extreme precipitation events. Initial source areas and run-out zones were calculated using a flow-path modeling program. The resulting areas were then subject to verification by professional geologists, and geoprocessing functions using GIS, to produce the final hazard polygons. The figure below shows areas of concern in Steamboat Valley, Stone Canyon, along the N. St. Vrain Creek, and along Antelope Dr. A Boulder County Geologic Hazard Study (March 2017) was also reviewed during the HIRA development but did not include further specifics on landslide, debris flow or rockfall hazards specific to Lyons.

Figure 4.22. Lyons Landslide and Debris Flow Hazards

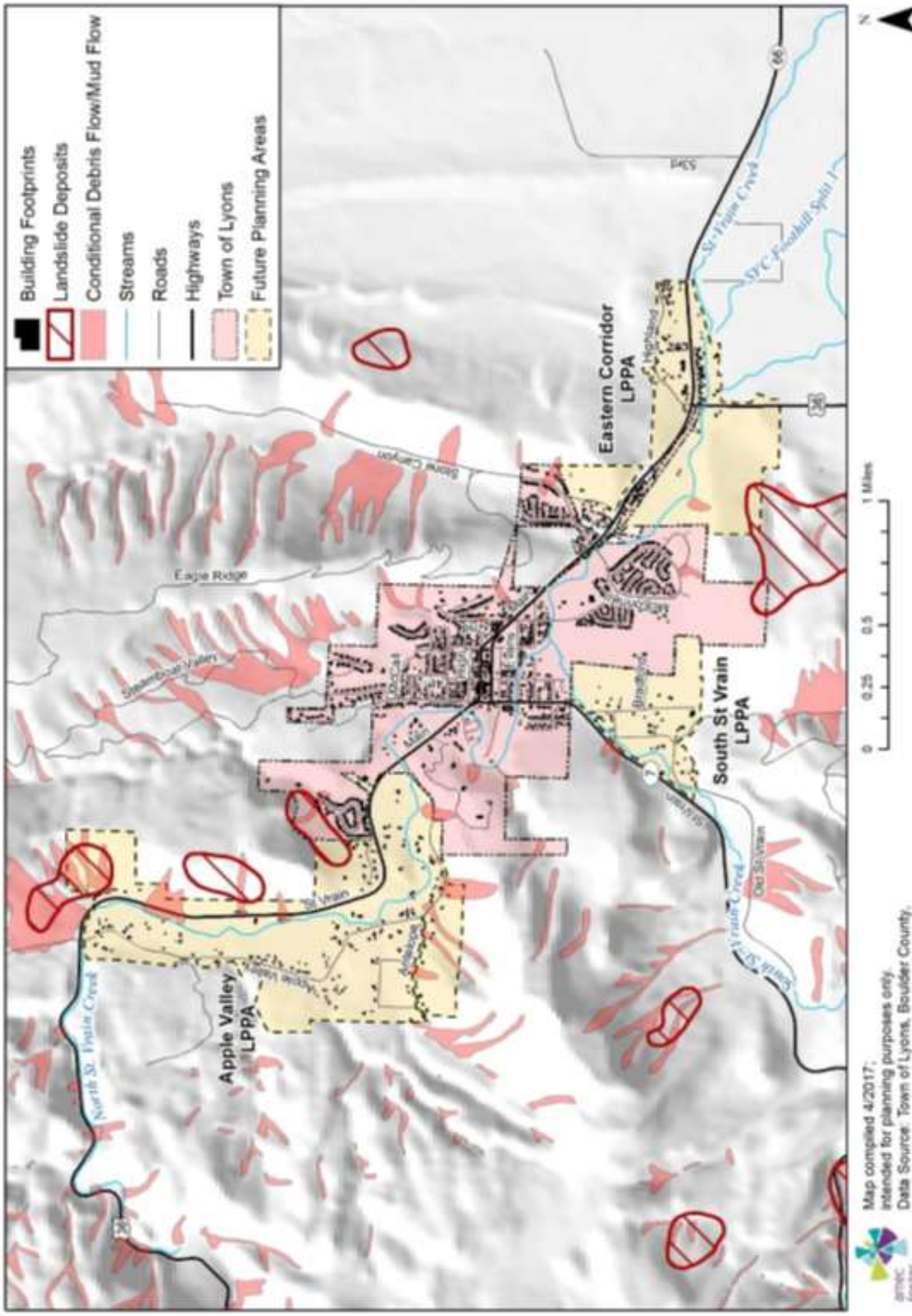
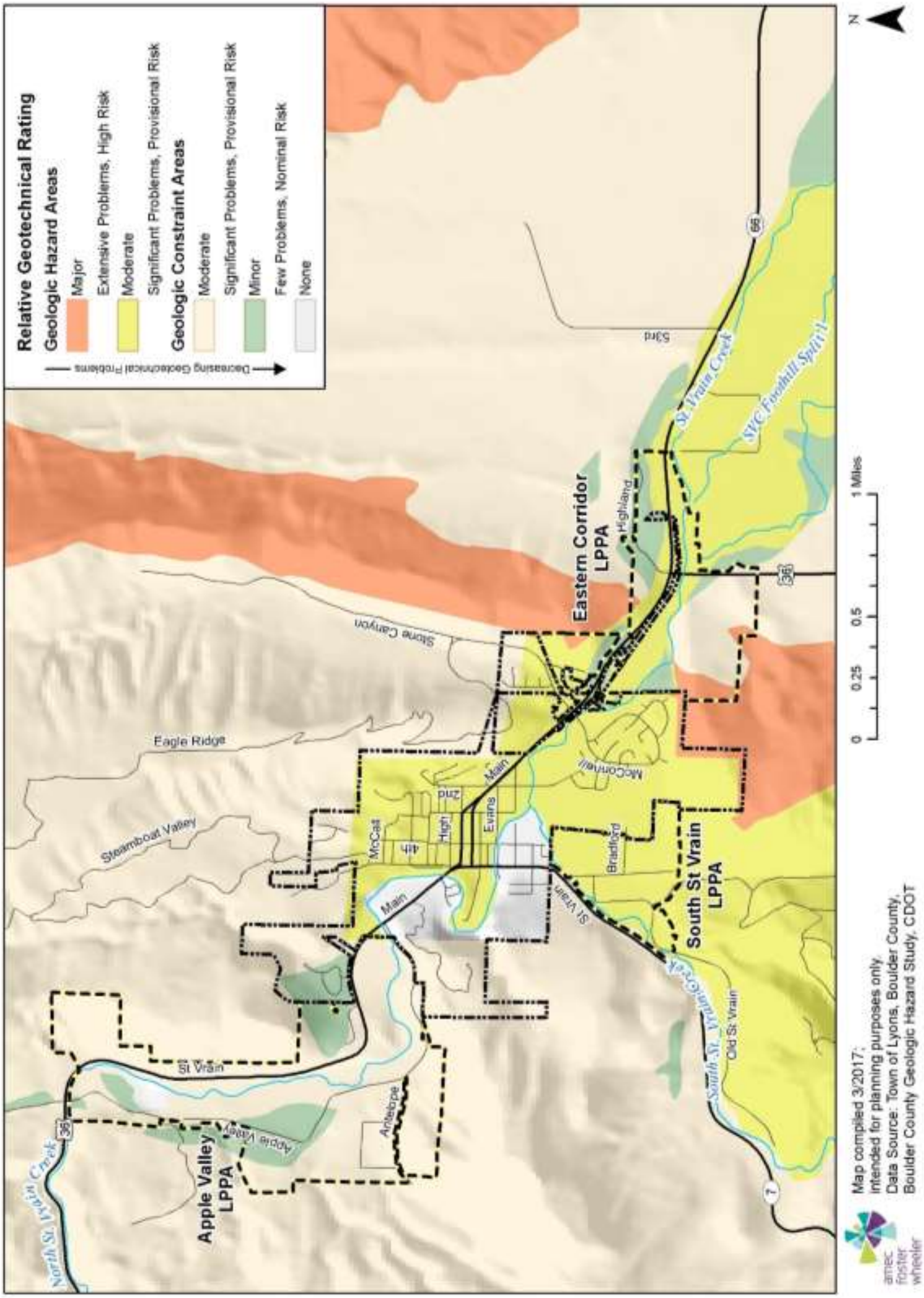


Figure 4.23. Lyons Geologic Hazards



Past Occurrences

Research did not indicate that there has been any impacts from landslides and rockfalls in the Town limits. Figure 4.23 denotes geological hazards and constraints based on countywide mapping, and depicts areas in or near Lyons with steep slopes, which could be potentially prone to landslides and rockfalls.

Likelihood of Future Occurrences

Occasional: The Colorado Landslide Hazard Mitigation Plan developed in 1988 identified 49 areas within Colorado where landslides could have the "most serious or immediate potential impact on communities, transportation corridors, lifelines, or the economy." No areas in Boulder County were identified. Based on analysis conducted for the 2010 State of Colorado Natural Hazards Mitigation Plan using HAZUS-MH data, most of Boulder has low landslide potential. However, minor landslides will likely continue in susceptible areas as a result of post-fire conditions or when heavy precipitation occurs.

Climate Change Considerations

Climate change projections for more intense precipitation events has the potential to increase landslide incidence, particularly debris flows. It is not expected to affect landslide risk considerably within the Lyons planning area.

Magnitude/Severity (Extent)

The magnitude severity ratings for landslide, debris flow, and rockfall are considered **limited**.

Vulnerability Assessment and Potential Losses

People

People are susceptible if they are caught in a landslide or rockfall; falling debris can cause injury or death. There is also a danger to drivers operating vehicles, as rocks and debris can strike vehicles passing through the hazard area or cause dangerous shifts in roadways.

Built Environment

According to Colorado Geological Survey landslide data, while the county has areas susceptible to landslides and rockfall, the greatest risk occurs in locations without much development. Some areas with development include Antelope Drive, Highway 36 near the North St. Vrain Creek, and development in Steamboat Valley or Stone Canyon.

During the 2017 development of this plan a GIS analysis of exposure to landslide hazard areas was performed. The table below summarizes landslide exposure in the county, based on an intersect of improved parcels with landslide hazard areas. There are 74 properties in landslide hazard zones based on this analysis.

Table 4.17. Conditional Debris Hazard Area

Area	Property Type	Parcel Count	Building Count	Improved Value	Est. Content Value	Total Exposure	Population
Town of Lyons	Residential	16	17	$4,859,100	$2,429,550	$7,288,650	43
	Total	**16**	**17**	**$4,859,100**	**$2,429,550**	**$7,288,650**	
Apple Valley LPPA	Exempt	1	2	$27,400	$27,400	$54,800	
	Mixed Use	1	7	$312,743	$312,743	$625,486	
	Residential	7	10	$1,528,200	$764,100	$2,292,300	26
	Total	**9**	**19**	**$1,868,343**	**$1,104,243**	**$2,972,586**	
	Grand Total	**25**	**36**	**$6,727,443**	**$3,533,793**	**$10,261,236**	**69**

Table 4.18. Colton Landslide Deposits Hazard Area

Area	Property Type	Parcel Count	Building Count	Improved Value	Est. Content Value	Total Exposure	Population
Town of Lyons	Residential	2	2	$842,700	$421,350	$1,264,050	5
	Total	**2**	**2**	**$842,700**	**$421,350**	**$1,264,050**	
Apple Valley LPPA	Mixed Use	1	7	$312,743	$312,743	$625,486	
	Total	**1**	**7**	**$312,743**	**$312,743**	**$625,486**	
	Grand Total	**3**	**9**	**$1,155,443**	**$734,093**	**$1,889,536**	**5**

Critical Facilities and Infrastructure

GIS analysis of critical facilities in landslide risk areas did not yield any specific risk with the exception of the Boulder County Geologic Hazards mapping, which has most of the downtown in a moderate geologic hazard area. Transportation networks are the most exposed aspect of the Planning area to landslide and debris flow incidents. Residents and visitors alike are impacted by landslides when roads are blocked or damaged by landslides. This includes Highway 36 in the Apple Valley Area, Highway 7 west of Town, and roads in the Stone Canyon and Steamboat Valley areas. The loss of transportation networks could potentially cause secondary damage to the overall town’s infrastructure, including revenue, transportation availability, emergency response mechanisms and other essential capabilities by preventing the means of these resources from activating or moving between locations.

Economy

Economic impacts would likely center around transportation routes temporarily closed by debris flow, rockfall or slide activity. These roads may be used to transport goods across the county. Depending on the amount of damage, the road may simply need to be cleaned off, or may need some level of reconstruction, but little evidence of slide risk was noted in this assessment.

Natural, Cultural and Historic Resources

Landslides and rockfalls have minimal impacts to the natural environment; these impacts would be confined to a small area. There is a slight chance that a rockfall or landslide in the St Vrain drainages above the Town could cause blockage and water backup from temporary landslide dams.

Future Development

Development in areas vulnerable to landslides increases the potential for destructive landslides and rockfalls. Future development in the Apple Valley and Eastern Corridor LPPAs should consider landslide/rockfall areas shown on the hazard map.

Summary

Landslide, debris flow and rockfall have had limited past impacts directly to the Town. However the presence of identified hazard areas within Town limits and in the LPPAs, some with identified property potentially at risk, warrants this as medium significance hazard. Future planning and development decisions should take into account the potential for these hazards.

4.10 Lightning

Description

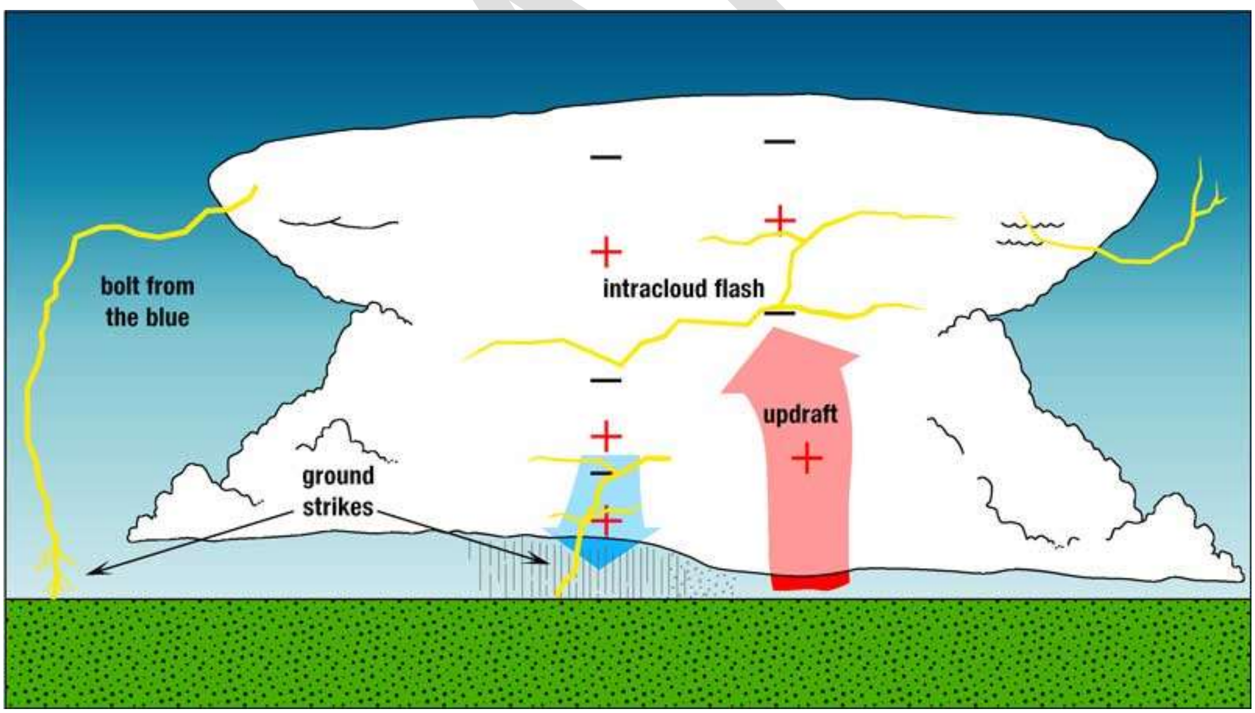
Lightning is an electrical discharge between positive and negative regions of a thunderstorm. A lightning flash is composed of a series of strokes with an average of about four. The length and duration of each lightning stroke vary, but typically average about 30 microseconds.

Lightning is one of the more dangerous weather hazards in the United States and in Colorado. Each year, lightning is responsible for deaths, injuries, and millions of dollars in property damage, including damage to buildings, communications systems, power lines, and electrical systems. Lightning also causes forest and brush fires, and deaths and injuries to livestock and other animals. According to the National Lightning Safety Institute, lightning causes more than 26,000 fires in the United States each year. The institute estimates property damage, increased operating costs, production delays, and lost revenue from lightning and secondary effects to be in excess of $6 billion per year. Impacts can be direct or indirect. People or objects can be directly struck, or damage can occur indirectly when the current passes through or near it.

Intra-cloud lightning is the most common type of discharge. This occurs between oppositely charged centers within the same cloud. Usually it takes place inside the cloud and looks from the outside of the cloud like a diffuse brightening that flickers. However, the flash may exit the boundary of the cloud, and a bright channel, similar to a cloud-to-ground flash, can be visible for many miles.

Cloud-to-ground lightning is the most damaging and dangerous type of lightning, though it is also less common. Most flashes originate near the lower-negative charge center and deliver negative charge to earth. However, a large minority of flashes carry positive charge to earth. These positive flashes often occur during the dissipating stage of a thunderstorm's life. Positive flashes are also more common as a percentage of total ground strikes during the winter months. This type of lightning is particularly dangerous for several reasons. It frequently strikes away from the rain core, either ahead or behind the thunderstorm. It can strike as far as 5 or 10 miles from the storm in areas that most people do not consider to be a threat (see Figure 4.24). Positive lightning also has a longer duration, so fires are more easily ignited. And, when positive lightning strikes, it usually carries a high peak electrical current, potentially resulting in greater damage.

Figure 4.24. Cloud to Ground Lightning



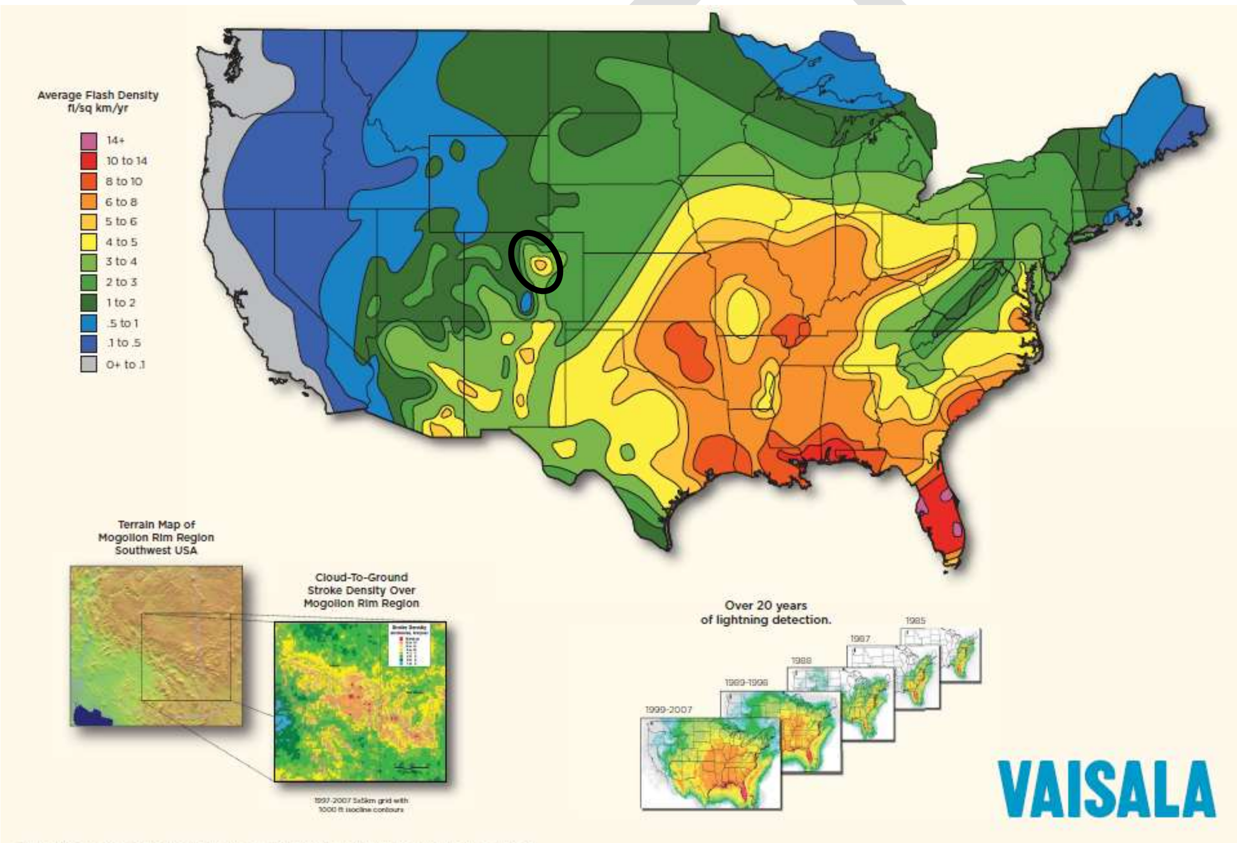
Source: National Weather Service Pueblo Office

The ratio of cloud-to-ground and intra-cloud lightning can vary significantly from storm to storm. Depending upon cloud height above ground and changes in electric field strength between cloud and earth, the discharge stays within the cloud or makes direct contact with the earth. If the field strength is highest in the lower regions of the cloud, a downward flash may occur from cloud to earth. Using a network of lightning detection systems, the United States monitors an average of 25 million strokes of lightning from the cloud-to-ground every year. Figure 4.24 depicts cloud to ground lightning in the United States and Boulder County (circled in black). Figure 4.26 from the National Weather Service in Pueblo, depicts a more detailed lightning flash density map for the State of Colorado and the planning area (boxed in black). The geographic extent rating for lightning is considered extensive since the entire Town limits is exposed.

Location

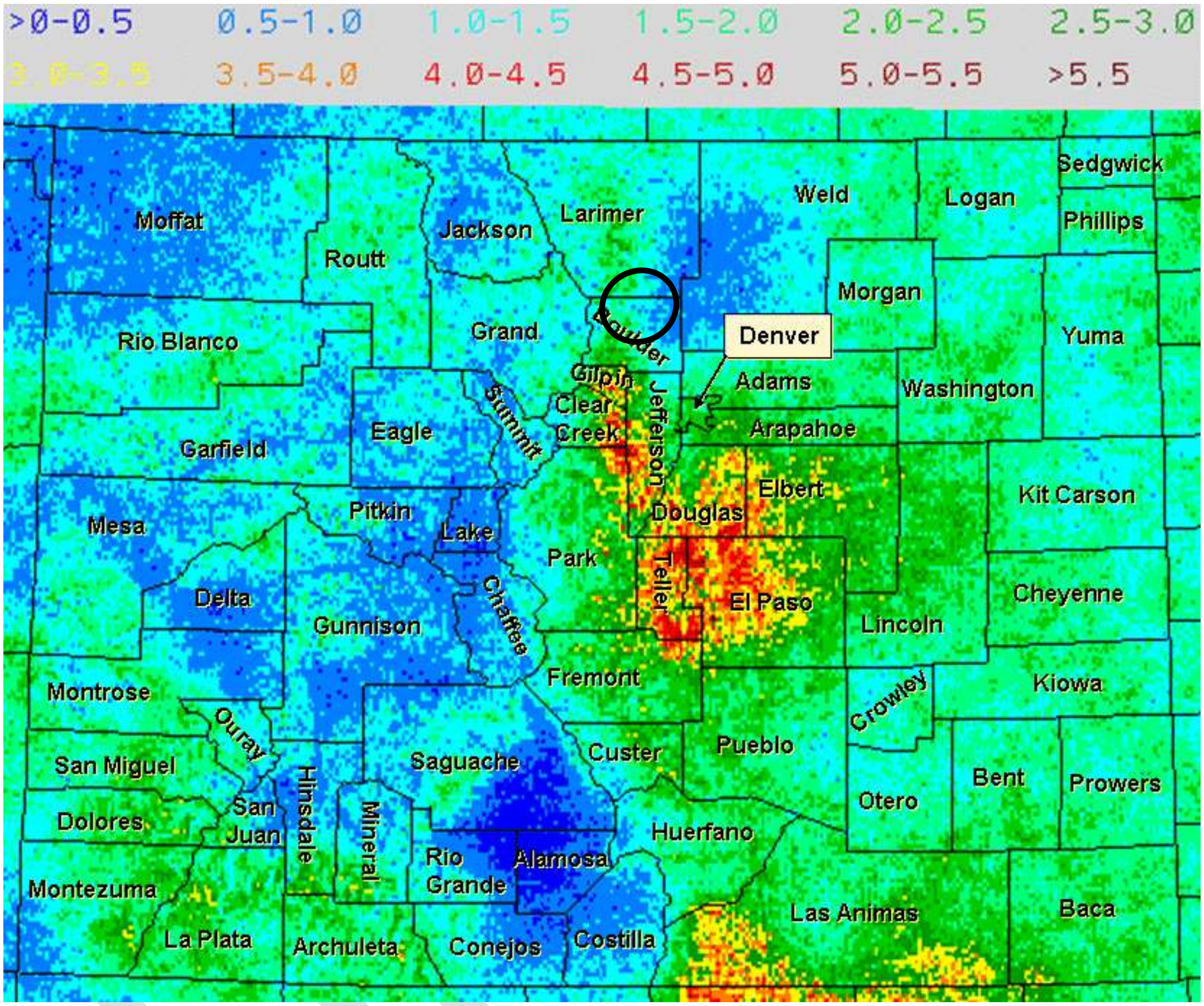
Lightning can occur anywhere in the town, with higher elevation and exposed areas being more vulnerable.

Figure 4.25. Lightning Flash Density Map 1997-2007



Source: Vaisala's US National Lightning Detection Network

Figure 4.26. Colorado Lightning Flash Map 1989-2005



Source: National Weather Service Pueblo Office. http://www.crh.noaa.gov/pub/?n=/ltg/flash_density_maps_index.php
Black oval indicates approximate location of Lyons

Past Occurrences

According to the National Weather Service, an average of 62 people are killed each year by lightning in the United States. The true injury number is likely higher than this, because many people do not seek help, and not all lightning-related injuries are reported as such by doctors. According to the NCDC, the Boulder County Multi-Hazard Mitigation Plan and the Town's Advisory Committee, lightning is not a significant hazard in the Town of Lyons, however the NCDC and the County plan note impacts from lightning in the surrounding areas, including injuries, fatalities, fire ignitions and property damage.

Likelihood of Future Occurrences

Highly Likely: Given the history of lightning occurrences in Colorado and the Boulder area, lightning is an annual occurrence and will continue to be a concern.

Climate Change Considerations

With additional heat in the atmosphere storms are projected to become more severe in the future, and thus lightning may become more prevalent, though Lyons' geographic setting may still temper the likelihood of direct strikes.

Magnitude/Severity (Extent)

Lightning is measured by the Lightning Activity Level (LAL) scale, created by the National Weather Service to define lightning activity into a specific categorical scale. The LAL is a common parameter that is part of fire weather forecasts nationwide. The LAL is reproduced below and the planning area is susceptible to all levels:

Table 4.19. 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: National Weather Service. Boulder County is at risk to experience lightning in any of these categories.

Vulnerability Assessment and Potential Losses

People

Exposure is the greatest danger to people from lightning.

While national data shows that lightning causes more injuries and deaths than any other natural hazard except extreme heat, there doesn't seem to be any trend in the data to indicate that one segment of the population is at a disproportionately high risk of being directly affected. Anyone who is outside during a thunderstorm is at risk of being struck by lightning. Aspects of the population who rely on constant, uninterrupted electrical supplies may have a greater, indirect vulnerability to lightning. As a group, the elderly or disabled, especially those with home health care services relying on rely heavily on an uninterrupted source of electricity. Resident populations in nursing homes, residential facilities, or other special needs housing may also be vulnerable if electrical outages are prolonged. If they do not have a back-up power source, rural residents and agricultural operations reliant on electricity for heating, cooling, and water supplies are also especially vulnerable to power outages.

Built Environment

Damage and disaster declarations related to severe weather have occurred and will continue to occur in the future. Heavy rain and thunderstorms are the most frequent type of severe weather occurrences in the County. Utility outages, downing of trees, debris blocking streets and damage to property can be a direct result of these storm events. Given the nature of these types of storms, the entire County is potentially at risk.

Critical Facilities and Infrastructure

Because of the unpredictability of lightning, most critical infrastructure that is above ground is equally exposed to lightning. Due to the random nature of these hazards, a more specific risk assessment was not conducted for this plan.

Economy

Lightning can cause power outages and fires. Generally, long-term economic impacts center more on hazards that cascade from a severe thunderstorm, including wildfires ignited by lightning.

Natural, Cultural and Historic Resources

Environmental impacts include the sparking of potentially destructive wildfires by lightning. As a natural process, the impacts of most severe thunderstorms by themselves are part of the overall natural cycle and do not cause long-term consequential damage.

Future Development

Future development projects should consider severe weather hazards at the planning, engineering and architectural design stage with the goal of reducing vulnerability to lightning. Development trends in the County are not expected to increase overall vulnerability to the hazard, but population growth will increase potential exposure to lightning.

Summary

- Sixty-two people killed annually by lightning in the United States; Colorado experiences the third-highest rate of lightning fatalities in the Country

- Areas at higher elevation with more exposure are more susceptible to a lightning strike
- People recreating, including those attending outdoor events may be farther away from shelter, increasing their risk of being struck
- Lightning can cause kill or injure persons, ignite structure fires or wildfires, and cause power outages
- Overall significance is medium

4.11 Severe Winter Weather

Description

Heavy snow, ice, severe winter storms, and blizzards are common occurrences in Colorado. The size of such events varies and may range in size from isolated (impacting only a portion of a county) to statewide. Generally, severe winter storm events are considered to be a regional occurrence, impacting multiple counties simultaneously and for extended time periods.

The National Weather Service Glossary defines common winter storm characteristics as follows:

- **Blizzard**: A blizzard means that the following conditions are expected to prevail for a period of 3 hours or longer:
  - Sustained wind or frequent gusts to 35 miles an hour or greater; and
  - Considerable falling and/or blowing snow (i.e., reducing visibility frequently to less than ¼ mile).
- **Heavy Snow**: This generally means:
  - Snowfall accumulating to 4" or more in depth in 12 hours or less; or
  - Snowfall accumulating to 6" or more in depth in 24 hours or less.
  - In forecasts, snowfall amounts are expressed as a range of values, e.g., "8 to 12 inches." However, in heavy snow situations where there is considerable uncertainty concerning the range of values, more appropriate phrases are used, such as "up to 12 inches" or alternatively "8 inches or more"
- **Ice Storm**: An ice storm is used to describe occasions when damaging accumulations of ice are expected during freezing rain situations. Significant accumulations of ice pull down trees and utility lines resulting in loss of power and communication. These accumulations of ice make walking and driving extremely dangerous. Significant ice accumulations are usually accumulations of ¼" or greater.

Heavy snow can immobilize a region, stranding commuters, stopping the flow of supplies, and disrupting emergency and medical services. Accumulations of snow can collapse roofs and knock down trees and power lines. The cost of snow removal, damage repair, and business losses can have a tremendous impact on cities and towns. Heavy accumulations of ice can bring down trees, electrical wires, telephone poles and lines, and communication towers. Communications and power can be disrupted for days until damages are repaired. Even small accumulations of ice may cause extreme hazards to motorists. The geographic extent rating for winter storms is considered extensive since the entire Town limits can be impacted.

Some winter storms are accompanied by strong winds, creating blizzard conditions with blinding wind-driven snow, severe drifting, and dangerous wind chills. Strong winds with these intense storms and cold fronts can knock down trees, utility poles, and power lines. Blowing snow can reduce visibilities to only a few feet in areas where there are no trees or buildings. Serious vehicle accidents can result with injuries and deaths. Heavy snowfall during winter can also lead to flooding or landslides during the spring if the area snowpack melts too quickly.

Location

Blizzards and severe winter storms are regional in nature, typically occurring across large areas of the county at once; higher elevations are more prone to deeper snow accumulations, avalanches, and more intense storms.

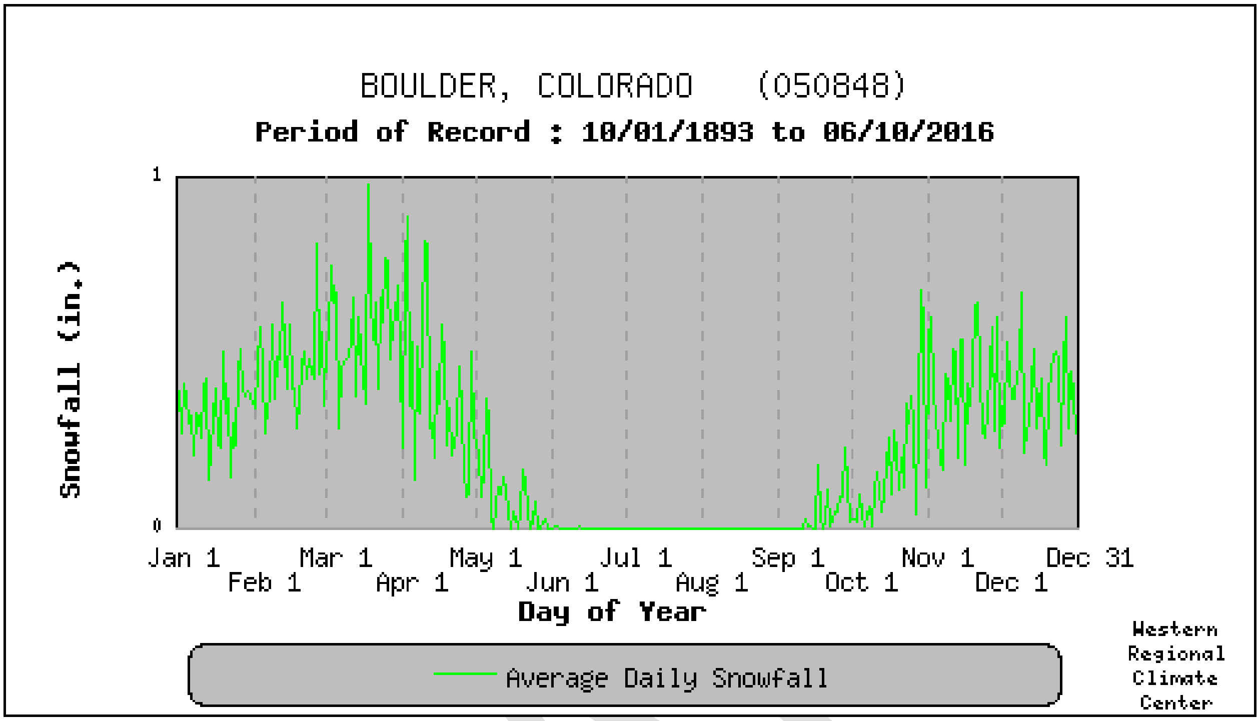
Past Occurrences

Both the western and eastern parts of the planning area receive snowfall on a regular seasonal basis, predominantly from October through April; however, the western portion of the town of Lyons receives substantially more snow than the eastern portion. The following summarizes the effects of snow in the town of Lyons based on data from the Western Regional Climate Center. The Boulder COOP station is the closest station to the town of Lyons.

According to the Western Regional Climate Center, for the period of record of 1893 to 2016, the average annual total snowfall for the Boulder area was 84.07 inches. The two snowiest months were February and March, with 11.98 and 16.18 average inches of snow, respectively. The highest recorded monthly snowfall for the period of record was 56.7 inches for the month of March in 1970. The highest annual snowfall for the same time period was 125.4 inches over the 1986-1987 winter season.

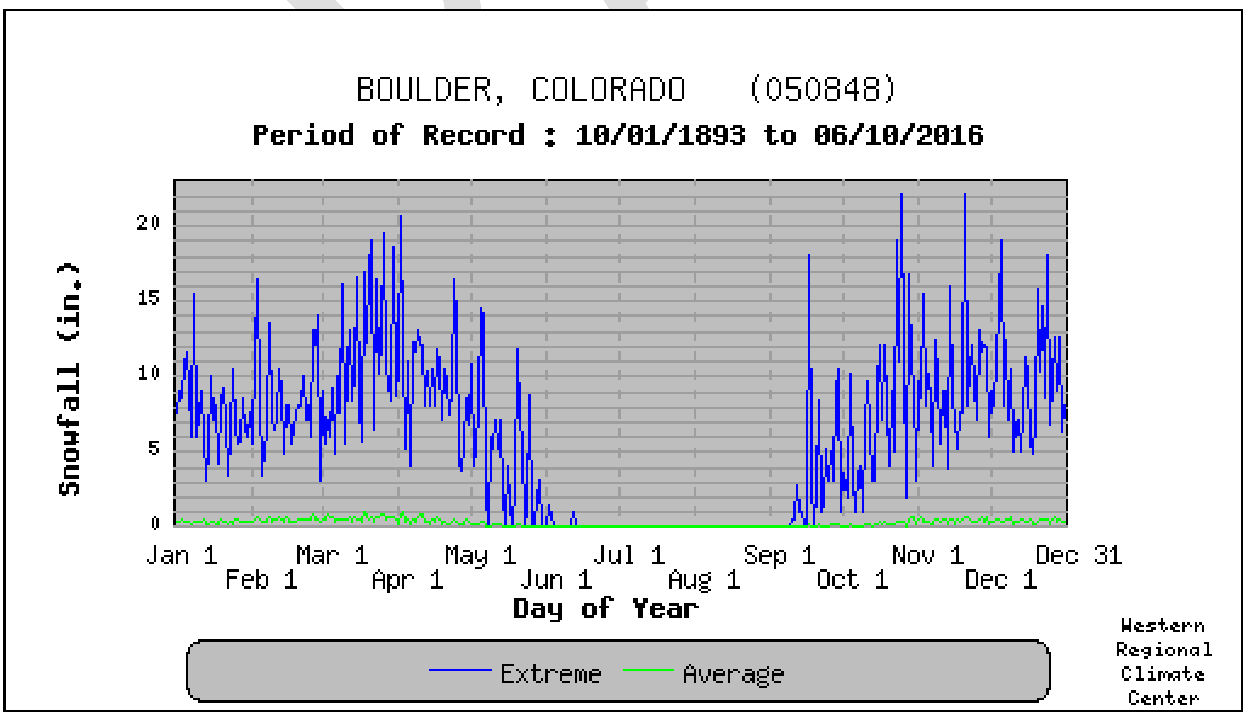
The average snow depth ranged from 0-1 inches during the winter months; however, daily extremes include snow depths up to 27 inches. Figure 4.27 and Figure 4.28 show Boulder’s daily snowfall averages and extremes between 1893 and 2016.

Figure 4.27. Boulder Daily Snowfall Average 1893 to 2016



Source: Western Regional Climate Center, www.wrcc.dri.edu/

Figure 4.28. Boulder Daily Snowfall Average and Extreme, 1893 to 2016



Source: Western Regional Climate Center, www.wrcc.dri.edu/

NCDC does not provide data specific to towns, but includes events that affect counties. The following table provides a list of winter weather events in Boulder County reported by NCDC.

Table 4.20. Severe Winter Weather Events in Boulder County 1996-2016

Year	# of Winter Storm Events	# of Blizzard Events	# of Winter Weather Events	# of Heavy Snow Events	Total Events
1996	7	0	0	70	77
1997	11	1	0	38	50
1998	27	3	0	12	42
1999	10	0	0	28	38
2000	7	0	0	21	28
2001	7	1	0	16	24
2002	6	0	0	7	13
2003	14	1	0	4	19
2004	15	0	1	0	16
2005	22	0	0	0	22
2006	20	1	1	4	26
2007	11	0	9	4	24
2008	13	0	8	1	22
2009	20	0	7	0	27
2010	18	0	27	0	45
2011	23	0	31	0	54
2012	4	2	20	0	26
2013	19	0	11	3	33
2014	20	0	12	3	35
2015	9	0	20	2	31
2016	8	0	15	4	27
Totals	291	12	163	217	683

Source: NCDC

Of these, the following events resulted in reported injuries and/or property damage:

- **March 6, 1990**—More than two feet of wet snow dumped in the foothills, paralyzing traffic, stranding travelers, preventing mail delivery, and causing hundreds of accidents and power outages in Boulder County. Winds of 37 mph qualified the storm as a blizzard.

- **March 9, 1992**—Twenty inches of snow fell in Boulder County. The storm began early in the afternoon with spring-like thunder and lightning and turned winter-like in about one hour. More than 25,000 residents were without electricity when wet, wind-driven snow toppled power lines. Many cars were stranded on Highway 36 between Boulder and Denver, and on Highway 93 between Boulder and Golden.
- **February 11, 1994**—Heavy snow, two injuries, property damage of $50,000. Moist upslope winds and an upper-level system produced heavy snow over portions of the Front Range. Amounts ranged from 6 to 12 inches.
- **January 28, 1995**—Heavy snow, two deaths, property damage of $25,000. All mountains, northeast Front Range. A strong, very moist, and slow moving winter storm system struck Colorado. In the high country, all mountain ranges received at least three feet of snow with some locations in the Elk Mountains collecting six to eight feet. Two people were killed by avalanches during the week. Road closures were common in the high country due to poor visibilities and avalanches. Interstate 70 was closed when an avalanche crossed the westbound lanes west of the Eisenhower Tunnel. At lower elevations, including the foothills and northern Front Range, the snow started falling the morning of the 10th. Most of the snow fell during the 24-hour period after onset. Locations in and near the foothills received the most snow as they collected between 10 and 15 inches. Golden and south sections of Boulder collected 15 and 14 inches, respectively.
- **February 8, 1995**—Blizzard, property damage of $3.1 million. The storm that moved into eastern Colorado developed into a blizzard across the northeast plains as an intense surface cyclone formed. The combination of freezing rain, followed by heavy snow and damaging winds led to widespread electrical outages. Snowfall totals generally ranged from 6 to 18 inches. The heaviest snow occurred near the Front Range foothills.
- **April 24, 1997**—A snowstorm dumped over 16 inches of snow in Boulder; mountain areas received around 30 inches.
- **October 24, 1997**—During this "Blizzard of 1997," Boulder received 30 inches of snow in 48 hours. A total of 51 inches fell in Coal Creek Canyon, just west and south of Boulder. Power outages were sporadic and tree breakage was minimal. Areas south and east of Boulder County were impacted more by the storm than Boulder County due to high winds that created blizzard conditions. The storm resulted in five deaths, two injuries, and significant dollar losses. This storm was the largest October storm in Boulder history and ranked as the fourth largest snowstorm on record. Snow totals made the 1997 calendar year the snowiest on record with a total of approximately 130 inches. Estimated tree cleanup costs were $7,000.
- **March 17, 2003**— A very moist, intense, and slow moving Pacific storm system made its way across the four corners area and into southeastern Colorado from March 17-19, allowing for a deep easterly upslope flow to form along the Front Range. The storm dumped 31.8 inches of snow at the former Stapleton International Airport, enough for second place in the Denver weather history record book. The storm also placed March 2003 in first place for the snowiest March in Denver history and fifth place for the wettest March on record. In addition, the storm broke a 19-month streak of below normal precipitation in Denver. The heavy wet snow caused roofs of homes and businesses to collapse across the urban corridor. The snow also downed

trees, branches, and power lines. Up to 135,000 people lost power at some point during the storms, and it took several days in some areas to restore power. Avalanches in the mountains and foothills closed many roadways, including Interstate 70 in both directions, stranding hundreds of skiers and travelers. Denver International Airport was also closed, stranding approximately 4,000 travelers. In all, the estimated cost of the damage to property alone (not including large commercial buildings) was $93 million, making it easily the costliest snowstorm ever in Colorado. According to this NCDC report, the second costliest snowstorm was the 1997 blizzard, where damage totaled $10.5 million (see description in the following grouping of events). The areas hardest hit by heavy snow were the northern mountains east of the Continental Divide, the Front Range foothills, and Palmer Divide, where snowfall totals ranged from three feet to more than seven feet. Boulder received 22.5 inches of snow. Tree cleanup costs for this storm and a subsequent storm in May were estimated at $3,000.

- **December 20, 2006—**This storm resulted in a presidential emergency declaration. Some of the largest snowfall totals during this event ranged from 21 inches in Fort Collins to 42 inches at Conifer, southwest of Denver. Meteorologists at the National Weather Service office in Boulder measured 19 inches of snowfall. This blizzard forced the closure of interstates, businesses, schools, and airports, stranding thousands of holiday travelers.

Likelihood of Future Occurrences

Highly Likely: Based on historical data, winter storms are an annual occurrence in the Boulder area including Lyons. The potential exists for a severe winter storm to occur during any year in Lyons due to its geographic location.

Climate Change Considerations

Climate change has the potential to exacerbate the severity and intensity of winter storms, including potential heavy amounts of snow. A warming climate may also result in warmer winters, the benefits of which may include lower winter heating demand, less cold stress on humans and animals, and a longer growing season. However these benefits are expected to be offset by the negative consequences of warmer summer temperatures.

Magnitude/Severity (Extent)

The extent of winter storms and cold that cause issues in Boulder County includes storms forecasted to be Winter Storm Warnings, Wind Chill Warnings or Blizzard Warnings. The National Weather Service in Albuquerque issues a Winter Storm Warning when conditions that can quickly become life threatening and are more serious than an inconvenience are imminent or already occurring. Heavy snows, or a combination of snow, freezing rain or extreme wind chill due to strong wind, may bring widespread or lengthy road closures and hazardous travel conditions, plus threaten temporary loss of community services such as power and water. Deep snow and additional strong wind chill or frostbite may be a threat to even the appropriately dressed individual or to even the strongest person exposed to the frigid weather for only a short period.

The most dangerous of all winter storms is the blizzard. A blizzard warning is issued when winds of 35 miles an hour will occur in combination with considerable falling and/or blowing snow for at least 3 hours. Visibilities will frequently be reduced to less than 1/4 mile and temperatures are usually 20 degrees Fahrenheit or lower.

Vulnerability Assessment and Potential Losses

People

While virtually all aspects of the population are vulnerable to severe winter weather, there are segments of the population that are more vulnerable to the potential indirect impacts of a severe winter storm than others, particularly the loss of electrical power. If they do not have a back-up power source, rural residents reliant on electricity for heating and water supplies are also especially vulnerable to power outages. As a group, the elderly or disabled, especially those with home health care services that rely heavily on an uninterrupted source of electricity. Resident populations in nursing homes, residential facilities, or other special needs housing may also be vulnerable if electrical outages are prolonged.

Public education efforts may help minimize the risks to future populations by increasing knowledge of appropriate mitigation behaviors, clothing, sheltering capacities, and decision making regarding snow totals, icy roads, driving conditions, and outdoor activities (all of which are contributors to decreased public safety during severe winter storms.) New establishments or increased populations who are particularly vulnerable to severe winter storms (such as those with health concerns or those who live in communities that may be isolated for extended periods of time due to the hazard) should be encouraged to maintain at least a 72-hour self-sufficiency as recommended by FEMA. Encouraging contingency planning for businesses may help alleviate future economic losses caused by such hazards while simultaneously limiting the population exposed to the hazards during commuting or commerce-driven activities.

Built Environment

Property vulnerabilities to severe weather include damage caused by high winds, ice, or snow pack and subsequently melting snow. Vehicles may be damaged by the same factors, or temporarily un-useable due to the driving conditions created by severe winter weather. Contents of homes, storage units, warehouses and storefronts may be damaged if the structures are compromised or fail due to the weather, or during potential flooding caused by melting snow. The density of very wet snow packs may create strains on structures, causing partial or entire collapses of walls, roofs, or windows. Vulnerability is influenced both by architecture (flat roofs being more vulnerable), age and type of construction material, and should be assessed on a building-by-building basis. Research did not yield significant issues with building collapse associated with winter storms.

Critical Facilities and Infrastructure

Because of the unpredictability of severe winter storm strength and path, most critical infrastructure that is above ground is equally exposed to the storm's impacts. Roads are especially susceptible to the effects of a winter storm.

Economy

Most economic impacts would be short term in duration. Impacts to the economy would center around road closings, travel restrictions, temporary power losses and pressure on power surge capacity.

Natural, Cultural and Historic Resources

Natural resources may be damaged by the severe winter weather, including broken trees and death of wildlife. Unseasonable storms may damage or kill plant and wildlife, which may impact natural food chains until the next growing season. Most of these impacts would be short-term.

Future Development

Future residential or commercial buildings should be built to be able to withstand snow loads from severe winter storms. Population growth in the Town and growth in visitors will increase problems with road, business, and school closures, and increase the need for snow removal and emergency services related to severe winter weather events. Development in the Town will increase the number of vehicles and persons vulnerable to this hazard.

Population and commercial growth in the Town will increase the potential for complications with traffic and commerce interruptions associated winter storms, as well as increased exposed populations vulnerable to the impacts of a severe winter storm such as power outages or delays in vital services. Future power outages or delays in power delivery to future developments may be mitigated by construction considerations such as buried power lines. Future development will also require future considerations for snow removal capacity including equipment, personnel, and logistical support. Adequate planning will help establish the cost-effective balance.

Summary

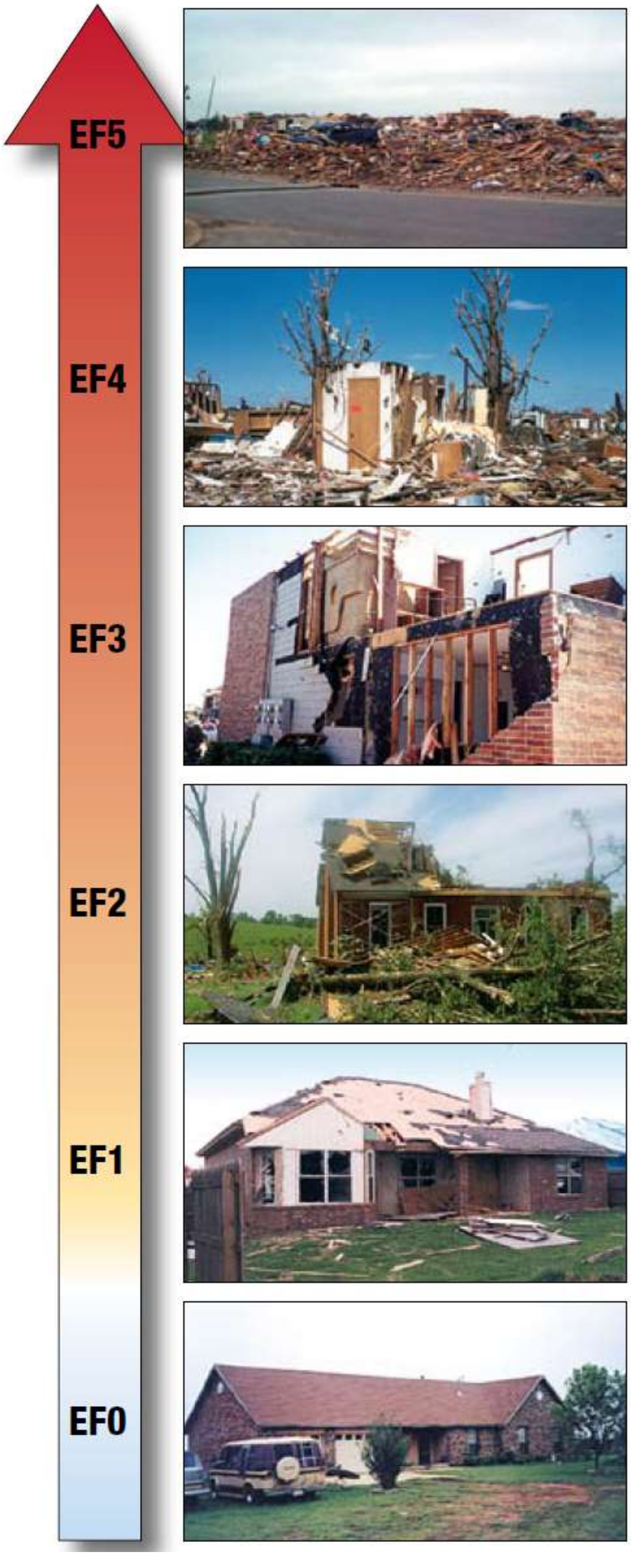
- Heavy snow, ice, winter storms and blizzards are a common occurrence in Colorado
- Severe winter weather can isolate residents and close roads into, out of and around Lyons
- Severe winter storm could have many impacts, including structural damage and power outages
- Overall significance is medium

4.12 Tornadoes

Like the rest of the Front Range, Lyons is susceptible to tornadoes and their impacts, though the community's proximity to the mountains reduces the likelihood of damaging events. Tornadoes form when cool, dry air sits on top of warm, moist air. In the plains areas of Colorado, this most often happens in the spring and early summer (i.e., May, June, and July) when cool, dry mountain air rolls east over the warm, moist air of the plains.

Tornadoes are rotating columns of air marked by a funnel-shaped downward extension of a cumulonimbus cloud whirling at destructive speeds of up to 300 mph, usually accompanying a thunderstorm. Tornadoes are the most powerful storms that exist. They can have the same pressure differential that fuels 300-mile-wide hurricanes across a path only 300-yards wide or less.

Figure 4.29. Potential Impact and Damage from a Tornado



Incredible: Strong frame houses are lifted from foundations, reinforced concrete structures are damaged, automobile-sized missiles become airborne, trees are completely debarked.

Devastating: Well-constructed houses are destroyed, some structures are lifted from foundations and blown some distance, cars are blown some distance, large debris becomes airborne.

Severe: Roofs and some walls are torn from structures, some small buildings are destroyed, non-reinforced masonry buildings are destroyed, most trees in forest are uprooted.

Considerable: Roof structures are damaged, mobile homes are destroyed, debris becomes airborne (missiles are generated), large trees are snapped or uprooted.

Moderate: Roof surfaces are peeled off, windows are broken, some tree trunks are snapped, unanchored mobile homes are overturned, attached garages may be destroyed.

Light: Chimneys are damaged, tree branches are broken, shallow-rooted trees are toppled.

Source: FEMA

Prior to February 1, 2007, tornado intensity was measured by the Fujita (F) scale. This scale was revised and is now the Enhanced Fujita scale. Both scales are sets of wind estimates (not measurements) based on damage. The new scale provides more damage indicators (28) and associated degrees of damage, allowing for more detailed analysis, better correlation between damage and wind speed. It is also more precise because it takes into account the materials affected and the construction of structures damaged by a tornado. Table 4.21 shows the wind speeds associated with the original Fujita scale ratings and the damage that could result at different levels of intensity. Table 4.22 shows the wind speeds associated with the Enhanced Fujita Scale ratings. The Enhanced Fujita Scale's damage indicators and degrees of damage can be found online at www.spc.noaa.gov/efscale/ef-scale.html.

Table 4.21. Original Fujita Scale

Fujita (F) Scale	Fujita Scale Wind Estimate (mph)	Typical Damage
F0	< 73	Light damage. Some damage to chimneys; branches broken off trees; shallow-rooted trees pushed over; sign boards damaged.
F1	73-112	Moderate damage. Peels surface off roofs; mobile homes pushed off foundations or overturned; moving autos blown off roads.
F2	113-157	Considerable damage. Roofs torn off frame houses; mobile homes demolished; boxcars overturned; large trees snapped or uprooted; light-object missiles generated; cars lifted off ground.
F3	158-206	Severe damage. Roofs and some walls torn off well-constructed houses; trains overturned; most trees in forest uprooted; heavy cars lifted off the ground and thrown.
F4	207-260	Devastating damage. Well-constructed houses leveled; structures with weak foundations blown away some distance; cars thrown and large missiles generated.
F5	261-318	Incredible damage. Strong frame houses leveled off foundations and swept away; automobile-sized missiles fly through the air in excess of 100 meters (109 yards); trees debarked; incredible phenomena will occur.

Source: National Oceanic and Atmospheric Administration Storm Prediction Center, www.spc.noaa.gov/faq/tornado/f-scale.html

Table 4.22. Enhanced Fujita Scale

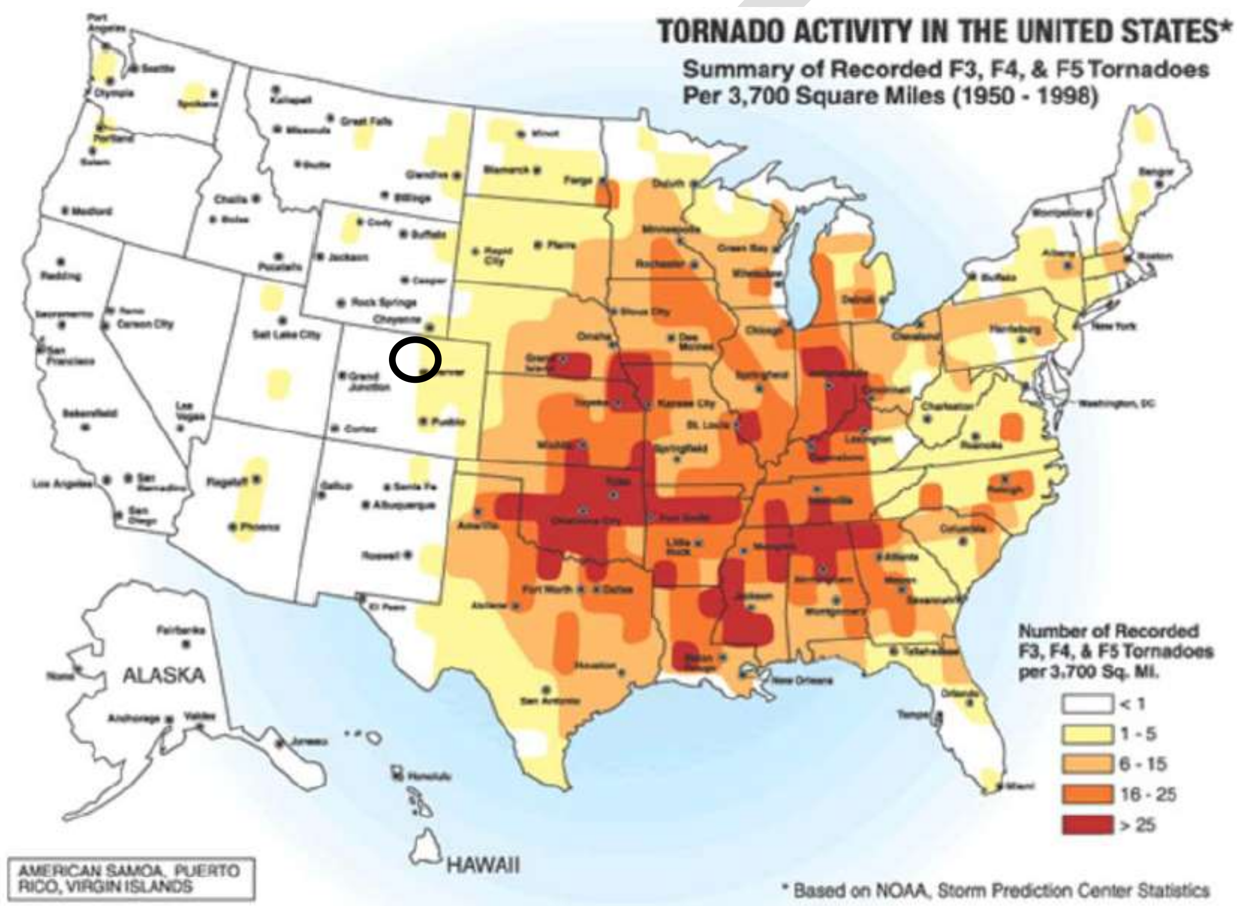
Enhanced Fujita (EF) Scale	Enhanced Fujita Scale Wind Estimate (mph)
EF0	65-85
EF1	86-110
EF2	111-135
EF3	136-165
EF4	166-200
EF5	Over 200

Source: National Oceanic and Atmospheric Administration Storm Prediction Center, www.spc.noaa.gov/faq/tornado/ef-scale.html

Tornadoes can cause damage to property and loss of life. While most tornado damage is caused by violent winds, most injuries and deaths result from flying debris. Property damage can include damage to buildings, fallen trees and power lines, broken gas lines, broken sewer and water mains, and the outbreak of fires. Agricultural crops and industries may also be damaged or destroyed. Access roads and streets may be blocked by debris, delaying necessary emergency response. This is especially concerning in Lyons due to only two access routes in and out of the town.

Figure 4.30 shows tornado activity in the United States based on the number of recorded tornadoes per 1,000 square miles. The geographic extent rating for tornadoes is considered limited since a tornado is not anticipated to impact more than 10% of the planning area.

Figure 4.30. Tornado Activity in the United States



Source: NOAA; Black oval indicates approximate location of Lyons

Location

The entire Town of Lyons is susceptible to the impacts of a tornado. Because of the potential size of a tornado and the potential length and location of a tornado path, a large percentage of the Town could be impacted by a single storm.

Past Occurrences

According to data provided by the Advisory Committee, tornadoes are rare in the Town of Lyons and usually occur in the flatter areas east of the mountains. The National Climatic Data Center does not document any tornadoes going impacting Lyons specifically between 1950 and 2016.

Likelihood of Future Occurrences

Occasional: While the Town of Lyons doesn't have any recorded history of tornado damage, the probability is high that this is just a function of luck, and not a trend that can be guaranteed in the future. While tornadoes are rare in the community, they aren't rare in the surrounding area, which means that Lyons runs the risk of seeing a tornado in any given year.

Climate Change Considerations

There presently is not enough data or research to quantify the magnitude of change that climate change may have related to tornado frequency and intensity. NASA's Earth Observatory has conducted studies which aim to understand the interaction between climate change and tornadoes. Based on these studies meteorologists are unsure why some thunderstorms generate tornadoes and others don't, beyond knowing that they require a certain type of wind shear. Tornadoes spawn from approximately one percent of thunderstorms, usually supercell thunderstorms that are in a wind shear environment that promotes rotation. Some studies show a potential for a decrease in wind shear in mid-latitude areas. Because of uncertainty with the influence of climate change on tornadoes, future updates to the mitigation plan should include the latest research on how the tornado hazard frequency and severity could change. The level of significance of this hazard should be revisited over time.

Magnitude/Severity (Extent)

Historical impacts cannot be used to identify an extent ranking for tornadoes, as the Town of Lyons has not experienced a tornado. Should the Town be hit by an EF-4 or EF-5 tornado, it can be extrapolated that because of its relative size and the potential size and length of a tornado's path a significant portion of the Town could be impacted through property damage and loss of life.

Vulnerability Assessment and Potential Losses

People

Populations are the most vulnerable to tornados. The availability of sheltered locations such as basements, buildings constructed using tornado-resistant materials and methods, and public storm shelters, all reduce the exposure of the population. However, there are also segments of the population that are especially exposed to the indirect impacts of tornadoes, particularly the loss of electrical power. These populations include the elderly or disabled, especially those with medical needs and treatments dependent on electricity.

Built Environment

General damages are both direct (what the tornado physically destroys) and indirect, which focuses on additional costs, damages and losses attributed to secondary hazards spawned by the tornado, or due to the damages caused by the tornado. Depending on the size of the tornado and its path, a tornado is capable of damaging and eventually destroying almost anything. Construction practices and building codes can help maximize the resistance of the structures to damage. Because of the relative size of Lyons, a tornado cutting a path through the Town would probably cause damages to a high percentage of built structures.

Secondary impacts of tornado damage often result from damage to infrastructure. Downed power and communications transmission lines, coupled with disruptions to transportation, create difficulties in reporting and responding to emergencies. These indirect impacts of a tornado can put tremendous strain on a community.

Critical Facilities and Infrastructure

Public gathering places including (but not limited to) schools, community centers, shelters, nursing homes and churches, may have increased impacts at certain times of day if struck by a tornado. Due to the random nature of these hazards, a more specific risk assessment was not conducted for this plan.

Economy

Economic impacts are dependent on the size and path of the tornado, though even a small tornado scoring a direct hit on the Town of Lyons would cause damage to a large percentage of property; this would adversely affect the economy.

Natural, Cultural and Historic Resources

Tornadoes can cause massive damage to the natural environment, uprooting trees and other debris. This is part of a natural process, however, and the environment will return to its original state in time.

Future Development

As the County continues to add population, the number of people and housing developments exposed to the hazard increases. Proper education on building techniques and the use of sturdy building materials, basements, attached foundations, and other structural techniques may minimize the property vulnerabilities. Public shelters at parks and open spaces may help reduce the impacts of tornadoes on the recreational populations exposed to storms.

Summary

- Low frequency event in the foothill areas of Colorado; no historical tornadoes in Lyons

- Most property damage is caused by high winds; most injuries and fatalities are caused by flying debris
- Depending on the size and path of the tornado, a large portion of the Town of Lyons could be impacted by an incident
- Overall significance is low

4.13 Wildfire

Hazard/Problem Description

Wildfire and urban wildfire are an ongoing concern for the Town of Lyons, as the community is surrounded by high risk wildfire areas. Generally, the fire season extends from spring to late fall, though fire can occur at any time of year depending on weather conditions.

Fire conditions arise from a combination of warm or hot weather, an accumulation of vegetation, and low moisture content in air and fuel. These conditions, especially when combined with high winds and years of drought, increase the potential for large-scale wildfires to occur. Wildfire risk is predominantly associated with the Wildland-Urban Interface (WUI), areas where development is interspersed or adjacent to landscapes that support wildland fire. A fire along this wildland-urban interface can result in major losses of property and structures. Significant wildfires can also occur in heavily populated areas. Rangeland and grassland fires are a concern in the eastern portion of the Town of Lyons due to increased residential development in semi-urban and rural areas.

Generally, there are three major factors that sustain wildfires and predict a given area's potential to burn. These factors are fuel, topography, and weather.

- **Fuel**—Fuel is the material that feeds a fire and is a key factor in wildfire behavior. Fuel is generally classified by type and by volume. Fuel sources are diverse and include everything from dead tree needles and leaves, twigs, and branches to dead standing trees, live trees, brush, and cured grasses. Manmade structures such as homes and associated combustibles are also considered fuel sources. The type of prevalent fuel directly influences the behavior of wildfire. Light fuels such as grasses burn quickly and serve as a catalyst for fire spread. In addition, "ladder fuels" can spread a ground fire up through brush and into trees, leading to a devastating crown fire that burn in the upper canopy and cannot be controlled. The volume of available fuel is described in terms of fuel loading. The presence of fine fuels, 1,000 hour fuels (1,000-hour dead fuel moisture levels are computed from a 7-day average boundary condition composed of day length, hours of rain, and daily temperature/humidity ranges; fuel sizes range from 3 to 6 inches in diameter), and needle cast, combined with the cumulative effects of previous drought years, vegetation mortality, tree mortality, and blowdown across the Town of Lyons has added to the fuel loading in the area. Fuel is the only factor of wildfire that is under human control.
- **Topography**—An area's terrain and land slopes affect its susceptibility to wildfire spread. Both fire intensity and rate of spread increase as slope increases due to the tendency of heat

from a fire to rise via convection. The arrangement of vegetation throughout a hillside can also contribute to increased fire activity on slopes.

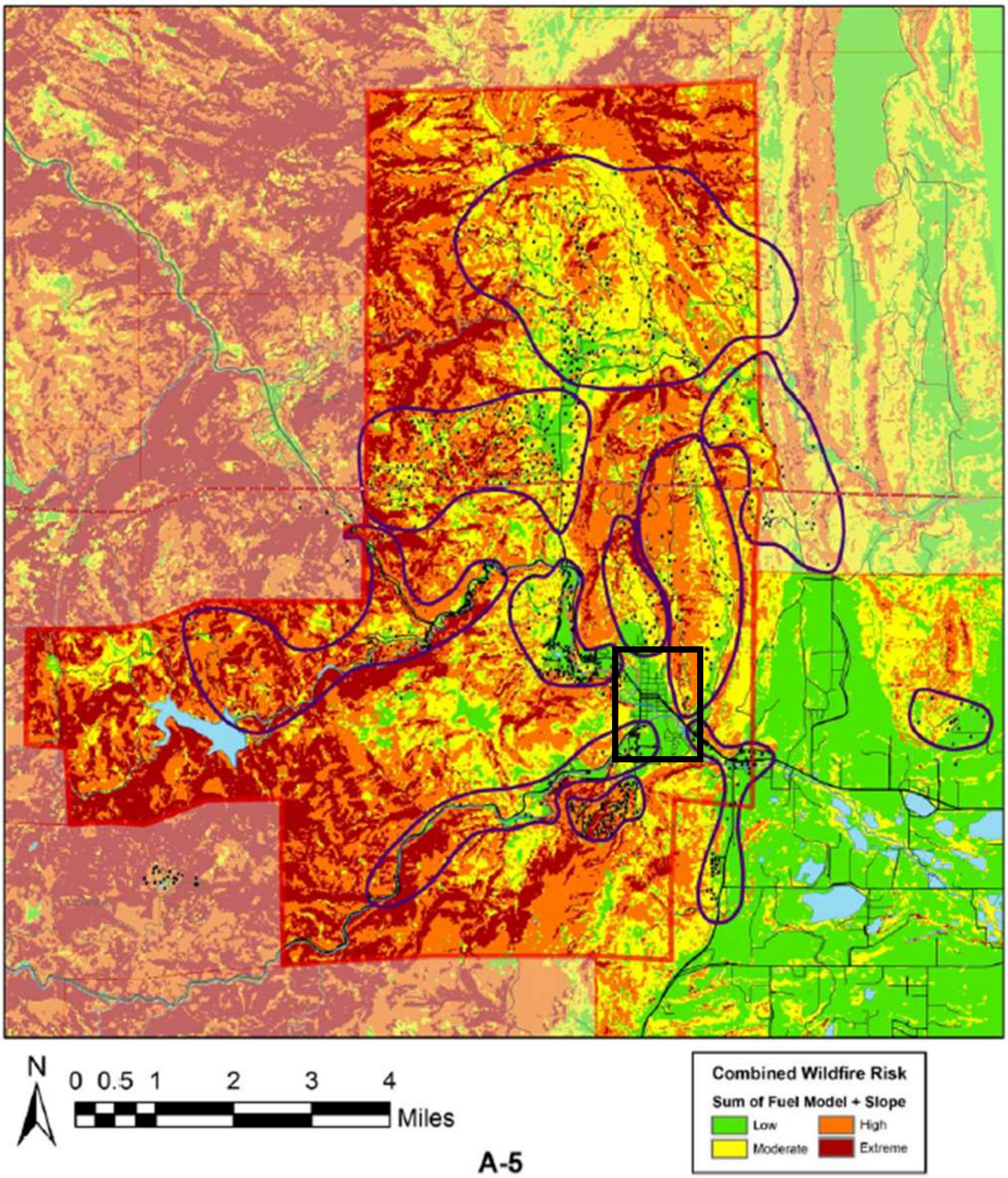
- **Weather**—Temperature, relative humidity, wind, and lightning also affect the potential for wildfire. High temperatures and low relative humidity dry out the fuels that feed wildfire, creating a situation where fuel will more readily ignite and burn more intensely. Wind is the most treacherous weather factor. The greater the wind, the faster a fire will spread, and the more intense it will be. Winds can be significant at times in Lyons. In addition to wind speed, wind shifts can occur suddenly due to temperature changes or the interaction of wind with topographical features such as slopes or steep hillsides. Lightning also ignites wildfires, which are often in terrain that is difficult for firefighters to reach. Drought conditions contribute to concerns about wildfire vulnerability. During periods of drought, the threat of wildfire increases.

Location

Figure 4.31 represents a classification of the expected relative wildfire severity based on slope and fuel. The figure is from the Lyons Fire Protection District (FPD) Community Wildfire Protection Plan (CWPP). This information was used to generate "combined wildfire risk." The geographic extent rating for wildfire is considered significant with 10-50% of the planning area affected, and the entire western edge of town is potentially exposed. Polygons encircle WUI communities or groups of housing. While not circled, downtown Lyons is considered its own community in the CWPP and is rated as having High wildfire risk due to its proximity to the WUI areas surrounding the Town. For clarity the downtown area is noted by a black rectangle on the map.

The Boulder County Community Wildfire Protection Plan includes a similar map of "Areas of Wildfire Concern." GIS data layers were provided and overlaid on the town boundaries in Figure 4.32. This mapping depicts much of the town in a severe hazard area. For the purposes of further analysis this more conservative layer was used to quantify vulnerability later in this section.

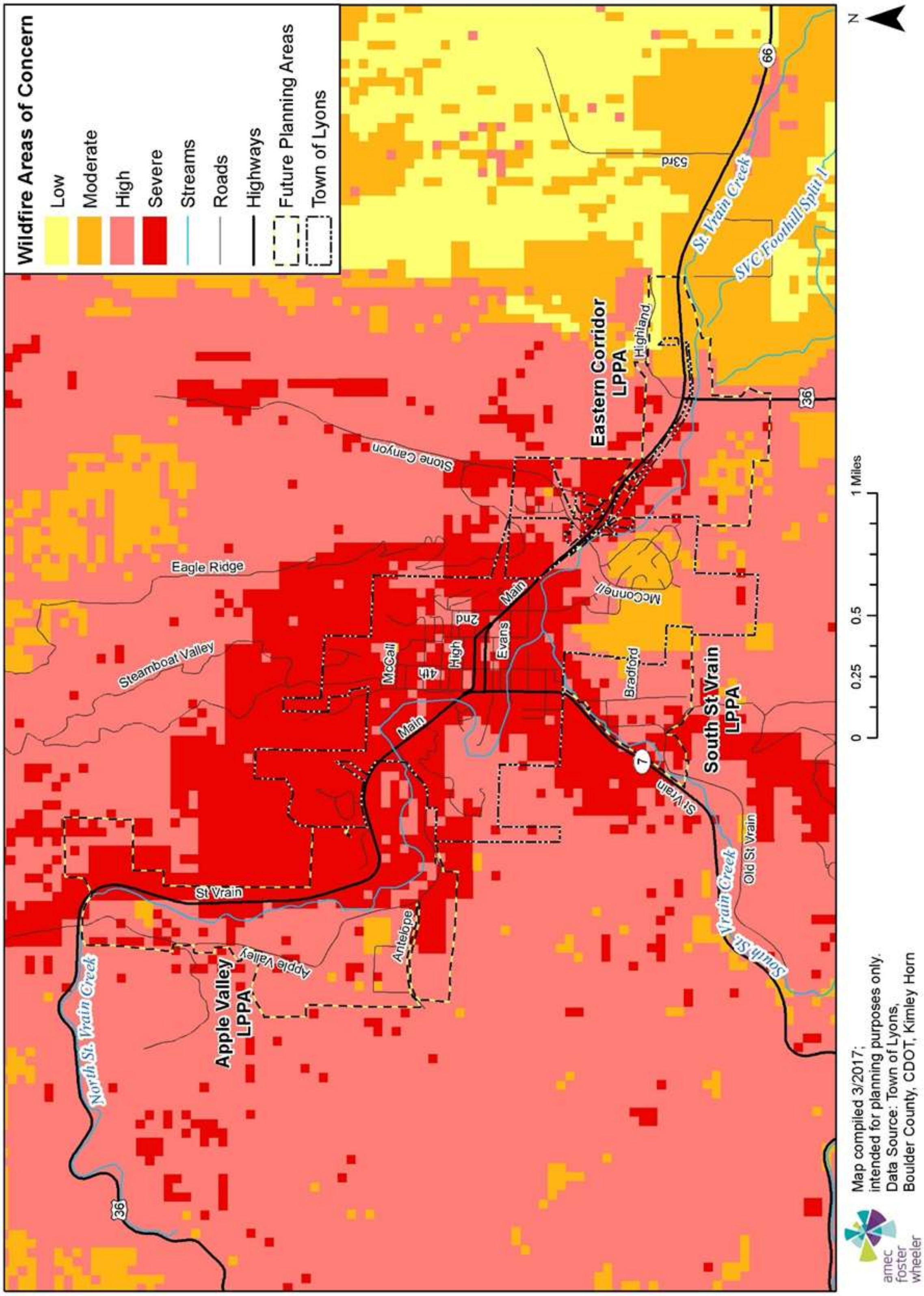
Figure 4.31. Combined Wildfire Risk (Sum of Slope + Fuel Model)



Source: Town of Lyons CWPP

Potential losses from wildfire include human life; structures and other improvements; natural and cultural resources; quality and quantity of the water supply; assets such as timber, range and crop land, and recreational opportunities; and economic losses. Smoke and air pollution from wildfires can be a severe health hazard. In addition, catastrophic wildfire can lead to secondary impacts or losses, such as future increased flooding and landslides debris flows during heavy rains (see related discussion in the flood hazard profile and landslide/debris flow profile).

Figure 4.32. Wildfire Areas of Concern



Past Occurrences

Wildfires are of significant concern throughout Colorado. According to the Colorado State Forest Service, vegetation fires occur on an annual basis; most are controlled and contained early with limited damage. For those ignitions that are not readily contained and become wildfires, damage can be extensive. There are many causes of wildfire, from naturally caused lightning fires to human-caused fires linked to activities such as smoking, campfires, equipment use, and arson. Historically, the areas surrounding Lyons has experienced numerous recorded wildfires dating back to 1987. The map and table below provide recorded fires in the Lyons area from the Federal Fire Occurrences database. Not shown on the map are fires that occurred in non-federally owned lands, such as Boulder County Open Space (e.g. the February 2017 Rabbit Mountain Fire occurred just east of Lyons).

Figure 4.33. Wildfire History in and Around Lyons

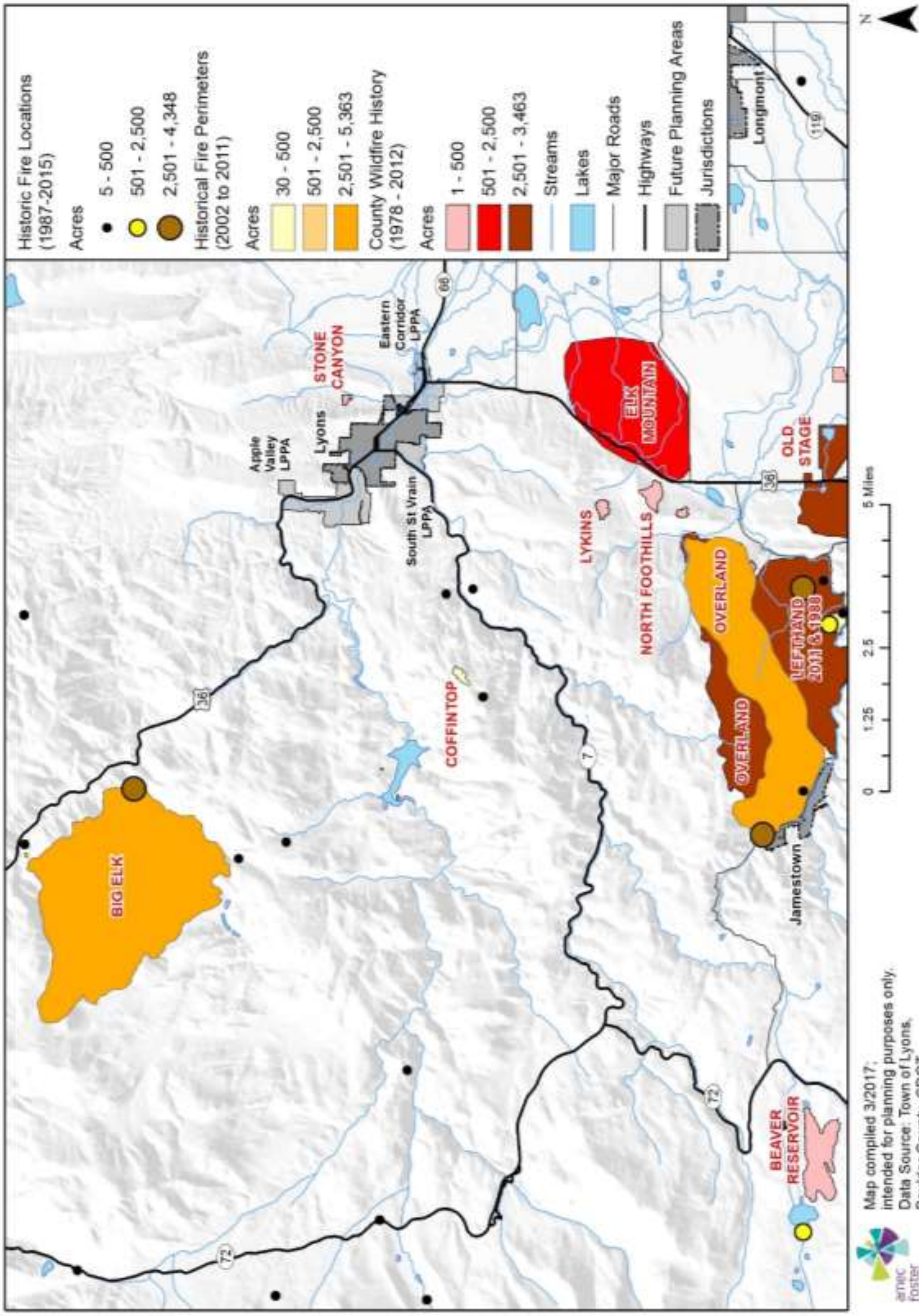


Table 4.23. Wildfire History in Lyons

Organization	Fire Name	Cause	Size Class	Year	Total Acres
BLM	Canyon	Human	F	1988	2552
FS		Natural	E	1988	757
FS	Hells Canyon	Natural	C	1994	50
BLM	Narrows	Human	C	1995	80
BLM	Thirty-One	Human	C	1995	12
FS	Little Narrows	Human	C	1995	40
FS	Elk Creek	Natural	C	1995	30
FS	Deer Ridge	Natural	B	1995	5
FS	Canyon	Human	C	1996	30
NPS	Baldpate	Human	B	1997	5
NPS	Tahosa	Human	C	1997	10
NPS	Allenspark	Human	B	1998	6
FS	Button Rock	Natural	B	2001	5
FS	Big Elk	Human	F	2002	4348
FS	Lefthand	Human	C	2002	40
FS	Overland	Human	F	2003	3869
FS	Lefthand	Human	B	2006	6.9
FS	Big Elk	Human	B	2008	7
FS	Coffintop	Natural	C	2011	29.5
FS	Lefthand Canyon	Human	E	2011	622
FS	Maxwell	Human	C	2011	60
NPS	Wild Basin Rx	Human	C	2011	16
FS	Lyons Gulch Fire	Human	A	2015	6.12

The Lyons FPD has recorded 48 Class A wildfires, 49 Class B, 10 Class C, 1 Class D and 1 Class E since 1998.

The Lyons FPD CWPP listed the following larger fires that have been recorded in the foothills surrounding the district.

- **September 1988**—The Lefthand Canyon fire (1,500 acres) and Beaver Lake fire (700 acres) occurred in the canyon above Buckingham Park and close to Beaver Lake near Ward. Houses were threatened, but no structures were lost. Both were thought to be human-caused fires.
- **July 9, 1989**—The Black Tiger fire destroyed 44 homes on Sugarloaf Mountain and burned over 2,100 acres. Hot temperatures, low humidity, and gusty winds contributed to this human-caused fire. Costs were estimated at $10 million.
- **November 24, 1990**—Old Stage Road fire, considered the fourth major wildfire in Boulder County, started when a man threw a burning mattress out his front door. Wind gusts up to 80 mph fanned the fire out of control. Ten homes, five out-buildings, and approximately 3,000 acres were burned in the fire.
- **June, 2000**—Bobcat Gulch Fire. 10,700 acres

- **September 15, 2000**—Walker Ranch/Eldorado fire, likely a human-caused fire, burned approximately 1,000 acres. No structures were lost; but over 250 homes were threatened. Firefighting costs were estimated at $1.5 million. A FEMA fire management assistance declaration was made to help cover firefighting costs.
- **July 2002**—Big Elk Fire. 4,350 acres.
- October 29, 2003—High winds and dry weather conditions existed. 3,500 acres were burned; 12 residences and several outbuildings were destroyed. Firefighting costs were approximately $400,000. FEMA approved a request from the governor for federal fire management assistance.
- **January 7, 2009**—60 + mile per hour winds snapped a power pole, dropping its energized power line onto a wire fence at 45th and Neva road. The sparks from the line on the fence ignited a fire in the grasses, shrubbery and subsequently, a home. This was the first in a series of events, which would be known as the Olde Stage Fire Complex. As these fires were being fought, large plumes of smoke became visible to the west of Hwy 36. A second fire had started on Olde Stage Road and was rapidly spreading through the Crestview community, Joder Ranch and east towards the community of Lake Valley. The fire consumed 3,169 before being extinguished.
- **September 13, 2010**—The Fourmile Canyon Fire, which destroyed 169 homes and other personal property in the foothills just northwest of Boulder, was the most expensive wildfire in Colorado history, according to early insurance estimates. Preliminary damage estimates totaled more than $217 million from insurance claims that include smoke damage, additional living expenses, damaged and destroyed homes, as well as personal belongings and vehicles. The estimated insured losses make the Fourmile Canyon Fire Colorado's most expensive wildfire with an insurance price tag four times higher than 2002's Hayman Fire which resulted in $46.1 million in insured damage when adjusted for inflation.
- **March 11, 2011**—The Lefthand Canyon Fire Started around 10:35 a.m. in Chaos Canyon and was believed to be human-caused. Residents of Lake of the Pines, North Foothills Ranch and Mountain Ridge were evacuated. In total, 622 acres were burned.
- **February 23, 2017**—The Rabbit Mountain Fire east of Lyons near Hygiene was started by target shooters when a fragment from one of the rounds ignited nearby grasses. The fire burned 150 acres, including three outbuildings, one barn, and one horse trailer before it was contained. It also came close to several homes.

Likelihood of Future Occurrences

Likely: As noted in the Past Occurrences section, the Town of Lyons has never experienced a wildfire in its borders. Based on historical data, Boulder County experienced at least 8 significant (>50 acres) fires since 1987. This is an average of one fire every 3.75 years and a 26.6 percent chance of a fire in any given year. Depending on the severity and location of a fire, the Town of Lyons is at risk to future fires.

Year round, but increasing in the spring through fall each year, Lyons faces a serious wildland fire threat. Much of the town and surrounding open space is susceptible to wildland fires. According to the State of Colorado Natural Hazard Mitigation Plan, a century of aggressive fire suppression combined with cycles of drought and changing land management practices has left many of Colorado's forests unnaturally dense and ready to burn. Further, the threat of wildfire and potential losses are constantly increasing as human development and population increases and the wildland-urban interface expands. Due to the existing fuel loads, semiarid conditions, and continued development, the planning area continues to be at risk from wildfire.

Climate Change Considerations

The Boulder County Climate Preparedness Plan notes that climate change could have an adverse effect on future wildfires. Although there are no studies on wildfires in Boulder County in particular, there is good evidence that wildfires across the western United States have been increasing and will likely continue to increase in the future. A 2006 study found a fourfold increase in the number of wildfires since 1986 compared to the 1970–1986 period, with a six fold increase in burned acreage. Those results were attributed to a 78-day increase in active wildfire season and a fivefold increase in average fire duration. Much of that, in turn, can be attributed to earlier snowmelt and hotter summertime temperatures. Tree-ring records of fire scars and debris found in alluvial fans show that warmer and drier periods are associated with more frequent and severe wildfires. Given that climate projections indicate continued advance in snowmelt timing and increasing summer temperatures, wildfire conditions across the West are likely to worsen in the future.

Magnitude/Severity (Extent)

The extent of impacts from a wildfire to the Town of Lyons was extrapolated using a GIS-based vulnerability analysis. In a worst-case scenario where fire burns through the entire town and surrounding LPPA areas, and potential property losses of $400,660,766. The potential for loss of life is also high, as certain fire locations and conditions could conceivably isolate the Town and make evacuations difficult or impossible. More information on potential losses and potential impacts to people, property, critical infrastructure and the environment is included in the Vulnerability and Potential Loss section.

Fires occurring in the surrounding areas could also cause smoke, ash and air quality issues.

Vulnerability Assessment and Potential Losses

People

The most exposed population are those living in the "Wildfire Areas of Concern." The exposure of the population in these zones increases with the exposure of the corresponding general property, examined in the section below. Other exposed groups include children, the elderly, or those with breathing conditions who may be exposed to high levels of smoke.

GIS analysis was completed to show populations living in areas prone to wildfire, based on a count of residential structure within the Wildfire Areas of Concern and applying the average household population estimate of 2.55 from the Census. The following tables show total population in wildfire areas of concern in the Town of Lyons.

Table 4.24. Population in Severe Wildfire Areas of Concern

Area	Population
Town of Lyons	1,675
Apple Valley LPPA	153
Eastern Corridor LPPA	5
South St Vrain LPPA	61
Total	**1,895**

Table 4.25. Population in High Wildfire Areas of Concern

Area	Population
Town of Lyons	446
Apple Valley LPPA	217
Eastern Corridor LPPA	23
South St Vrain LPPA	38
Total	**724**

Table 4.26. Population in Moderate Wildfire Areas of Concern

Area	Population
Town of Lyons	247
Apple Valley LPPA	18
Eastern Corridor LPPA	71
Total	**337**

Table 4.27. Population in Low Wildfire Areas of Concern

Area	Population
Eastern Corridor LPPA	8
Total	**8**

Built Environment

Any flammable materials are vulnerable during a wildfire, including structures and personal property. The vulnerability of general property increases as the distance of the property to wildfire-prone areas decreases, and is particularly high for structures located in the Severe Wildfire Areas of Concern. These structures receive an even higher level of vulnerability if the properties surrounding them are not properly mitigated for fire. Appropriate mitigation techniques include using non-flammable materials such as ignition-resistant construction, leaving appropriate spaces between buildings and vegetation, landscaping with non-flammable materials (such as decorative rock or stone), and clearing of underbrush and trees. If a wildland fire were to cross completely into an urban zone, the damage could be extensive and there would likely be a higher exposure of property and homes themselves become fuel in extreme fire weather conditions.

The Lyons FPD CWPP identifies lack of defensible space and close exposures of adjacent wood houses and structures to areas with high vegetation as features exacerbating wildfire risk in the Town. As an outcome of the CWPP development, Lyons now offers free one-on-one wildfire mitigation consultations to all of its residents. The Lyons FPD has a wildfire mitigation team that will perform mitigation projects such as thinning, limbing, removal of hazard trees, and constructing fuel breaks for a fee.

A wildfire vulnerability assessment was performed for Lyons using GIS. The county‘s parcel layer and associated assessor’s building improvement valuation data were used as the basis for the inventory. The Wildfire Areas of Concern layer was used as the hazard layer. GIS was used to intersect the parcel boundaries with a structure location layer to obtain number of buildings per parcel. The WAC layer was overlaid in GIS on the structure data to identify structures in areas of concern. Structure improvement values and counts for those points were then extracted from the parcel/assessor‘s data and summed for the areas of concern. Contents values were also estimated using HAZUS methods (see discussion in flood vulnerability discussion).

The tables below provide a summary of total structures exposed to severe, high, moderate and low Wildfire Areas of Concern which totals around $226 million in the severe areas alone, and $400 million including the Town and surrounding LPPA. The risk is summarized by Town of Lyons and LPPA areas in the following tables.

Table 4.28. Exposure in Severe Wildfire Areas of Concern

Area	Parcel Count	Building Count	Improved Value	Est. Content Value	Total Exposure
Town of Lyons	615	778	$145,625,612	$81,247,512	$226,873,124
Apple Valley LPPA	46	77	$8,310,543	$4,694,743	$13,005,286
Eastern Corridor LPPA	2	6	$121,400	$121,400	$242,800
South St Vrain LPPA	13	30	$2,499,010	$1,369,155	$3,868,165
Total	**676**	**891**	**$156,556,565**	**$87,432,810**	**$243,989,375**

Table 4.29. Exposure in High Wildfire Areas of Concern

Area	Parcel Count	Building Count	Improved Value	Est. Content Value	Total Exposure
Town of Lyons	169	190	$52,417,048	$27,182,748	$79,599,796
Apple Valley LPPA	54	102	$11,479,590	$6,009,495	$17,489,085
Eastern Corridor LPPA	8	17	$2,082,300	$1,275,350	$3,357,650
South St Vrain LPPA	8	17	$1,254,100	$694,350	$1,948,450
Total	**239**	**326**	**$67,233,038**	**$35,161,943**	**$102,394,981**

Table 4.30. Exposure in Moderate Wildfire Areas of Concern

Area	Parcel Count	Building Count	Improved Value	Est. Content Value	Total Exposure
Town of Lyons	96	102	$32,636,640	$16,441,720	$49,078,360
Apple Valley LPPA	3	7	$1,064,800	$532,400	$1,597,200
Eastern Corridor LPPA	9	45	$1,918,800	$1,147,300	$3,066,100
Total	**108**	**154**	**$35,620,240**	**$18,121,420**	**$53,741,660**

Table 4.31. Exposure in Low Wildfire Areas of Concern

Area	Parcel Count	Building Count	Improved Value	Est. Content Value	Total Exposure
Eastern Corridor LPPA	1	3	$356,500	$178,250	$534,750
Total	**1**	**3**	**$356,500**	**$178,250**	**$534,750**

Critical Facilities and Infrastructure

A GIS analysis was conducted to determine the number of critical facilities located in Wildfire Areas of Concern hazard zones; these facilities are at increased risk from a wildfire. Table 4.32 shows the facilities by hazard level and Area; the severity levels correspond to the levels shown on the map in Figure 4.32. Wildfire Areas of Concern

Table 4.32. Analysis of Critical Infrastructure in the Severe Wildfire Areas of Concern

Category	Facility Name
Bridge	North St. Vrain Creek
Bridge	South St. Vrain Creek
Bridge	St. Vrain Creek
Bridge	Supply Ditch
Bridge Scour Critical	North St. Vrain Creek
Communications	Microwave Service Towers

Category	Facility Name
Communications	Warning Siren
Government Building	Town Hall
Medical Facility	Milestone Medical
Medical Facility	Stillwater Healing Arts
Municipal Wastewater	Pump Station (Eagle Canyon)
Municipal Wastewater	Pump Station (Stone Canyon)
Municipal Wastewater	Treatment Plant
Municipal Water	Water Tower (inactive)
Police	Boulder County Substation
Public Facility	Library
Public Facility	Museum
Public Facility	Planet Bluegrass
School	Lyons Elementary School
Shelter	Lyons Elementary School

Table 4.33. Analysis of Critical Infrastructure in the High Wildfire Areas of Concern

Category	Facility Name
Bridge	Highland Canal
Bridge	North St. Vrain Creek
Bridge	St. Vrain Creek
EMS Station	Lyons Fire Protection District Station 1
Fire Station	Lyons Station 1
Municipal Water	Water Tower (active)
Public Facility	Visitor Center

Table 4.34. Analysis of Critical Infrastructure in the Moderate Wildfire Areas of Concern

Category	Facility Name
Bridge Scour Critical	St. Vrain Creek
Municipal Water	Pump House
School	Lyons Middle & High School

Economy

A major wildfire can cause many economic impacts, depending on the parameters and size of the fire. Most of the populated areas in Lyons fall under medium to extreme risk for wildfire.

Economic impacts could include direct fire damage to buildings and facilities, road closures and the accumulation of fire suppression costs.

Natural, Cultural and Historic Resources

Fire is a keystone process in the natural environment, providing many benefiting impacts to the surrounding habitat. Some natural resources and natural areas may benefit from wildland fire, as at some level they must also be exposed to wildfire for a healthy ecological development of the area. However, extremely hot fires can result in habitat loss, watershed damage and increased erosion, and other impacts that could take decades to recover.

The St. Vrain watershed and the Buttonrock Reservoir are among the areas around Lyons that could be impacted by wildfire. Large-scale wildfire could result in the degradation of the watershed, which could result in deposition of debris into water sources.

Future Development

Development areas have been identified for the Town of Lyons, specifically to the west in the Apple Valley LPPA, and to the southeast in the Eastern Corridor LPPA. Both LPPAs are majority high risk wildfire areas, with areas of severe and moderate risk. Because of this high level of risk, proactive mitigation is essential to reduce the risk of wildfire to new and each area.

Summary

- The Town of Lyons has never experienced a large-scale wildfire within its borders, but several that were close enough to cause concern
- The landscape and available fuels surrounding and within the Town of Lyons increase the risk of wildfire impacts
- Wildfires are a high risk throughout the surrounding areas of Boulder County
- Wildfire risk may increase with climate change and could create exacerbate flood and debris flow hazards
- The overall significance of wildfire is high due to the potential for extensive property loss and life safety implications as well as impacts to critical facilities.

5 MITIGATION ACTION PLAN

The HIRA process allowed for an opportunity to update and refine the Town's mitigation action plan. The Lyons Annex (Annex G) to the 2014 Boulder County Hazard Mitigation Plan contains the hazard mitigation strategy specific to the Town that has been in place since 2008. The Lyons Annex G provided the basis for the mitigation action plan, but was supplemented with additional new mitigation actions that were developed during the HIRA process. This HIRA mitigation action plan should be considered an interim update of the actions for Lyons from the Boulder County Hazard Mitigation Plan, and should be revisited again and integrated as appropriate in the next five year update in 2018-2019.

Mitigation Goals

The Boulder County Hazard Mitigation Plan has the following broad goals which also apply to Lyons as a participant in that planning effort. For the purposes of mitigation planning, goals are broad-based public policy statements. Mitigation actions define strategies to attain the goals and are more specific and measurable.

- Goal 1: Reduce the loss of life and personal injuries from hazard events
- Goal 2: Reduce impacts of hazard events on property, critical facilities/infrastructure, and the environment
- Goal 3: Strengthen intergovernmental coordination, communication, and capabilities in regard to mitigating hazard impacts
- Goal 4: Improve public awareness regarding hazard vulnerability and mitigation

Identification and Analysis of Mitigation Actions

The next step in the mitigation strategy was to identify and analyze a comprehensive range of specific mitigation actions and projects to reduce the effects of each hazard on new and existing buildings and infrastructure. As part of the HIRA process the Advisory Committee reviewed the previously identified actions in the 2014 Lyons Annex to the County Hazard Mitigation Plan to assess progress on implementation. These reviews were completed using a worksheet and a facilitated discussion to capture information on each action including if the action was completed or deferred to the future. In addition action strategies with a hazard mitigation component were identified in related planning mechanism including the St Vrain Watershed Master Plan, the Lyons FPD Community Wildfire Protection Plan, and Lyons Recovery Action Plan. Another important reference included mitigation and planning policy recommendations in the American Planning Association's 'Living with the Saint Vrain' Community Assistance Planning Team Report developed in 2014 following the flood (APA CPAT 2014).

New mitigation actions were also developed during the HIRA process. The Advisory Committee considered and reviewed viable mitigation options, or alternatives, that supported reducing losses from the hazards profiled in the HIRA. The Advisory Committee was provided with the following categories of mitigation actions, which originate from the NFIP Community Rating System:

- **Prevention**: Administrative or regulatory actions or processes that influence the way land and buildings are developed and built.
- **Property protection**: Actions that involve the modification of existing buildings or structures to protect them from a hazard or remove them from the hazard area.
- **Structural**: Actions that involve the construction of structures to reduce the impact of a hazard.
- **Natural resource protection**: Actions that, in addition to minimizing hazard losses, also preserve or restore the functions of natural systems.
- **Emergency services**: Actions that protect people and property during and immediately after a disaster or hazard event.
- **Public information/education and awareness:** Actions to inform and educate citizens, elected officials, and property owners about the hazards and potential ways to mitigate them.

At a mitigation strategy workshop and through email the Advisory Committee was provided a matrix showing examples of potential mitigation action alternatives for each of the identified hazards. Another reference document titled "Mitigation Ideas" developed by FEMA was provided. This document lists the common alternatives for mitigation by hazard grouped by the FEMA categories of Plans and Regulations, Structure and Infrastructure Projects, Education and Awareness, Natural Systems Protection and Emergency Services. The Advisory Committee was also provided the results of the public survey for consideration of mitigation actions proposed by the public. The HMPC was asked to consider both future and existing buildings in considering possible mitigation actions. A facilitated discussion then took place to examine and analyze the options. A list of potential strategies was an outcome of this process, which was further refined through email and subsequent input from the Advisory Committee and discussion with Town staff.

Prioritization Process

Once the mitigation actions were identified, the Advisory Committee was provided 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 is an acronym for the following:

- Social: Does the measure treat people fairly? (e.g., different groups, different generations)
- Technical: Is the action technically feasible? Does it solve the problem?
- Administrative: Are there adequate staffing, funding, and other capabilities to implement the project?
- Political: Who are the stakeholders? 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?
- 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?

Other criteria used to assist in evaluating the priority of a mitigation action includes:

- Does the action address hazards or areas with the highest risk?
- Does the action protect lives?
- Does the action protect infrastructure, community assets or critical facilities?
- Does the action meet multiple objectives (Multiple Objective Management)?

At the mitigation strategy workshops, the Advisory Committee used STAPLEE to determine which of the new identified actions were most likely to be implemented and effective, which translated into ‘high,’ ‘medium’ and ‘low’ relative priority. The results of the STAPLEE evaluation process produced prioritized mitigation actions for implementation.

Mitigation Action Plan

The mitigation action plan presents the updated recommendations developed by the Advisory Committee, outlining how Lyons can reduce the risk and vulnerability of people, property, infrastructure, and natural resources to future disaster losses. The actions are captured in the following tables. Over time the implementation of these projects will be tracked as a measure of demonstrated progress on meeting the plan's goals. The first table includes Lyon’s projects identified in the town’s annex to the 2014 Boulder County Hazard Mitigation Plan. Some of have been completed and are noted in the table, and some are in progress and continuing. The second table lists actions that were identified through the 2017 HIRA development process.

Table 5.1. Lyons Mitigation Action Strategy – Completed and Continuing Projects from the Lyons Annex to the County Hazard Mitigation Plan

Action Description	Responsible Office	Achieved	In progress	Date /Timeframe	Priority Then	Priority (2017)	Comments
Develop community wildfire protection plan for Lyons	Lyons Fire Protection District	Y / N	Y / N	8/3/2011	High	-	Complete; Plan was completed August 2011.
Develop flood protection for the Lyons wastewater treatment plant	Lyons Public Works	**Y** / N	**Y** / N	01/01/2015	High	-	Complete: This has been completed for the 100 year flow with the construction of an overflow channel. The plant remains in 500 year floodplain.
Continue to implement sound floodplain management practices as a community participating in the NFIP	Lyons Administration Building Dept.	**Y** / N	**Y** / N	Ongoing	High	High	Ongoing. FEMA and state community assistance visit in 2016 to review and ensure compliance. 2 foot freeboard requirement added for elevations in the 100 year floodplain.
Improve storm drain conveyance in Lyons	Lyons Public Works	Y / **N**	**Y** / N	2017-2021	Medium	Medium/High	Stormwater Master Plan draft complete but not approved as of 5/24/17. Next step would be to establish a stormwater utility fee to develop a funding source for the recommended flood reduction projects in the plan.

Action Description	Responsible Office	Achieved	In progress	Date /Timeframe	Priority Then	Priority (2017)	Comments
Develop water system loop and install additional fire hydrants in Lyons	Lyons Public Works	Y / N	**Y** / N	2015-2018	Medium	Medium	Water system loop improvements in process 5/2017; Further evaluation did not indicate a need for additional fire hydrants.

Table 5.2. Lyons Mitigation Action Strategy –New Actions Identified in 2017

Action ID	Action Description	Responsible Department and Partners (lead in bold text)	Hazard(s) Mitigated	Timeframe	Priority	Background and Implementation Details
MH-1	Develop a town evacuation plan with improved coordination on shelters	**Boulder County OEM** **ESF 6 Emergency Coordinator** Lyons Fire Protection District Community Development	Multi- Flood, wildfire, dam failure	2017-2018	Medium	Several hazards identified in the HIRA could result in evacuations of large portions of the town including wildfire, flood and dam failure. Evacuation and shelter planning is needed to ensure that there are cooperative agreements with facilities that could be used for sheltering purposes. There also needs to be an evaluation of shelter locations such as churches and schools to ensure they are accessible during flood events with formalized agreements and have adequate capacity. Shelters and evacuation routes need to be strategically located so there are options in case the town is split by flooding. Lessons learned from the 2013 flood and recent wildfire events should be considered in the planning. Town staff will work with County OEM who will facilitate the evacuation planning and the Emergency Support Function (ESF) 6 Emergency Coordinator will address the sheltering aspect.
MH-2	Build the HIRA into development review checklists for new construction in the Lyons Primary Planning Areas and Town to reduce impacts to future development	**Community Development**	Multi- wildfire, flood, debris flows, landslide and rockfall susceptibility, steep slopes	2017-2018	High	This project would formally acknowledge the HIRA to ensure that hazards are considered when planning, siting and approving new development to ensure a safe and resilient community. At a minimum hazard maps within the HIRA should be reviewed as part of the development review process. A checklist will be developed to ensure the HIRA is considered. This would include a checklist for staff and PCDC review and would include at a minimum if the development is within or near stormwater flooding, wildfire hazard, debris

Action ID	Action Description	Responsible Department and Partners (lead in bold text)	Hazard(s) Mitigated	Timeframe	Priority	Background and Implementation Details
						flows, landslide and rockfall susceptible areas, and steep slopes.
MH-3	Develop a Hazard Overlay District that may include the wildfire, flood, debris flows, landslide and rockfall susceptibility, steep slopes, and drainage.	**Community Development**	Multi- wildfire, flood, debris flows, landslide and rockfall susceptibility, steep slopes	2018-2019	High	Development of a hazard overlay district is another way that the Town can formally acknowledge the HIRA to ensure that hazards are considered when planning, siting and approving new development. Individual hazard layers will be utilized in GIS. Available GIS will be reviewed for level of detail and applicability. Restrictions or recommendations for various hazard areas will be developed and implemented as appropriate.
MH-4	Develop ordinance on post-disaster building moratorium	**Lyons Public Works** Community Development Lyons Administration Building Dept.	Flood, wildfire, earthquake	2017-2018	High	An ordinance to place a temporary moratorium on re-building needs to be developed to ensure that mitigation is incorporated into the post-disaster environment. The ordinance would become effective when the Board of Trustees and Mayor declare a local disaster in coordination with Boulder County (typically when outside resources are needed for response and recovery). This moratorium will be all-hazard. As an example a wildfire could trigger the need for conformance with the floodplain regulations if structures are deemed substantially damaged. See also related recommendation in APA CPAT Report 2014.
MH-5	Develop critical facility protection including back-up power and floodproofing the Town Hall, Depot Building, Waste Water Treatment Plant, SCADA System, Water Treatment Plant	**Lyons Public Works**	Multi – Dam Failure, Flood, Extreme Temperatures High Winds, Lightning, Severe	2017-2022	Medium	Many of the hazards identified in the HIRA have the potential to cause power outages to critical facilities within town and limit critical services and functions when needed most. This project would identify backup power needs and options for facilities and determine cost effective solutions such as mobile generators that could deployed where needed. The HIRA indicates flood risk to some town facilities,

Action ID	Action Description	Responsible Department and Partners (lead in bold text)	Hazard(s) Mitigated	Timeframe	Priority	Background and Implementation Details
			Winter Weather, Wildfire, Tornadoes, Hail			notably from the 0.2% annual chance flooding or dam failure flooding. This would evaluate options to minimize risk to Town Hall and the water and wastewater infrastructure.
MH-6	Develop a Continuity of Operations Plan (COOP)	**Community Development** Boulder County Emergency Management	Multi – Dam Failure, Flood, Extreme Temperatures High Winds, Lightning, Severe Winter Weather, Wildfire, Tornadoes, Hail	2019-2020	Medium	Many of the hazards identified in the HIRA have the potential to limit the Town's critical services and functions when needed most. A continuity of operations plan would establish protocols to ensure staffing and key operations are maintained in the response and recovery environment. The plan would be led with expertise from Boulder OEM and incorporate lessons learned from the 2013 flood.
MH-7	Reverse 911 Enhancements and Adaptation for Lyons	**Boulder County Emergency Management** County Sheriff Town Administration	Multi- Dam Failure, flood, wildfire, tornado	2017-2018	High	Boulder County's R911 system notifies highly populated areas first. In 2013 during the flood Lyons was one of the last to received R911 notification due to this limitation. This project would work with County OEM and Sheriff's office to adapt the system so communities higher in a watershed such as Lyons receive notifications first for events such as flooding.
F-1	Formally adopt the Stormwater Master Plan	**Lyons Public Works**	Flood	2017	High	The stormwater master plan contains information on the significant risk to stormwater drainage flooding within the Town. The first step towards implementation would be adoption by the Town.

Action ID	Action Description	Responsible Department and Partners (lead in bold text)	Hazard(s) Mitigated	Timeframe	Priority	Background and Implementation Details
F-2	Evaluate and adopt a stormwater ordinance and determine a funding mechanism.	**Lyons Public Works** Town Administration	Flood	2017-2019	High	A stormwater drainage ordinance would set criteria to mitigate runoff associated with new development. Stormwater mitigation through encouragement of low impact development/green infrastructure techniques would be considered in the ordinance development. The stormwater master plan contains information on projects needed to mitigate risk to the town. A funding source for projects is needed; this action would evaluate the options to fund stormwater projects including the feasibility of a stormwater utility and incentivize low impact development and best management practices by incorporation into the land development Code.
F-3	Consider joining the National Flood Insurance Program's Community Rating System (CRS)	**Lyons Public Works** Community Development Lyons Administration	Flood	2018	Medium	The CRS rewards communities that enhance their floodplain management program by reducing flood insurance costs for residents. The town has a substantial number of properties with flood insurance thus there could be a potential benefit to joining the CRS. This project would evaluate the merits and administrative requirements of joining CRS. Recommendations from a Community Assistance Visit from the Colorado Water Conservation Board and FEMA should also be reviewed in regards to enhancing the town's floodplain management program and NFIP compliance. See also related recommendation in APA CPAT Report 2014.
F-4	Evaluate flood prone property for buyout or flood mitigation as funding allows.	**Lyons Public Works** Community Development	Flood	2017-2022	Low	The HIRA indicates that considerable flood risk to residential property remains, despite multiple buy-outs and elevations in the confluence area in Town following the 2013 flood. Funding sources should

Action ID	Action Description	Responsible Department and Partners (lead in bold text)	Hazard(s) Mitigated	Timeframe	Priority	Background and Implementation Details
		Lyons Administration Building Dept.				be evaluated for long term implementation of elevation or buyouts, including FEMA Flood Mitigation Assistance, Hazard Mitigation Assistance including Hazard Mitigation Grant Program and CDBG_DR funding following future disasters in Colorado. This should be revisited annually and following a presidential disaster declaration anywhere in the state as HMGP funding could be available.
LS-1	Review setback requirement on steep slopes and amend to account for rockfall and landslide hazards.	**Community Development**	Landslides/ Debris flow/ Rockfall, wildfire	2017-2019	Low	The Town has steep slope regulations that could be broadened to mitigate landslide, debris flow and rockfall hazards. This would also review HB1041-Areas of state interest within Lyons for applicability to hazard areas including considerations for landslides and rockfall.
WF-1	Evaluate Lyons FPD CWPP implementation of recommendations for Lyons	**Community Development** Lyons Fire Protection District	Wildfire	2017-2018	High	The Lyons FPD CWPP identifies lack of defensible space and close exposures of adjacent wood houses and structures to areas with high vegetation as features exacerbating wildfire risk in the Town. Ingress and egress issues as well as building construction types were some areas of concern when the CWPP was completed. As an outcome of the CWPP development, Lyons now offers free one-on-one wildfire mitigation consultations to all of its residents. The Lyons FPD has a wildfire mitigation team that will perform mitigation projects such as thinning, limbing, removal of hazard trees, and constructing fuel breaks for a fee. This project would assess progress on implementation and where additional effort should be focused.

Action ID	Action Description	Responsible Department and Partners (lead in bold text)	Hazard(s) Mitigated	Timeframe	Priority	Background and Implementation Details
WF-2	Increase coordination with Lyons FPD regarding wildfire mitigation and transition to land use code	**Community Development** Lyons Fire Protection District Town Administration	Wildfire	2017-2018	Medium	The Lyons Fire Protection District has a wildland code adopted as of 2017 and has considered adopting a newer version- which could be affected by potentially moving to the 2015 IFC in 2017. Some of the Fire Wise guidelines and principles with regards to fire mitigation, defensible space, egress and other areas are employed. This project would further coordinate with Lyons FPD on these issues in regards to wildfire mitigation and integration into Lyons building and land use codes and regulations.
HM-1	Evaluate intersection improvements at Hwy 7 and US36 corner to mitigate the potential for a hazardous materials spill in town.	**Community Development** Colorado Department of Transportation	Hazardous Materials	2017-2018	Medium	This project would entail coordination with CDOT on evaluation of safety at this intersection and implement potential improvements, such as fresh paint, increased width of turning lane, and divider.
HM-2	Update designated emergency response authority (DERA) agreement with Lyons FPD with the intent to ensure capabilities are in place to minimize the effects of a hazardous materials incident.	**Town Administration** Lyons Fire Protection District	Hazardous Materials	2017-2018	Medium	Colorado Revised Statutes 29-22-102 provides for the designation of emergency response authorities for hazardous substance incidents. Once designated, a DERA is responsible for providing and maintaining the capability for emergency response to a hazardous materials incident occurring within its jurisdiction. The agreement with Lyons FPD needs to be reviewed and updated.

5.1 Status of Implementation of Mitigation Actions in Related Planning Mechanisms

The Town has been active in implementing actions identified in the County Hazard Mitigation Plan, thus, working steadily towards meeting the plan's goals. Progress on mitigation actions previously identified in other related planning mechanisms are detailed in this section. As noted in the flood section of the HIRA there is considerable risk to flooding within the Town, including erosion and deposition. Several projects were identified in the recovery from the 2013 flood that have the intent of reducing further streambank erosion and deposition and flood damage. The related projects from the 2014 Lyons Recovery Action Plan and their status as of June 2017 are noted below.

Table 5.3. Lyons Recovery Action Plan 2014 - Stream Restoration and Flood Project Recommended Actions

Lyons Recovery Action Plan 2015 - Stream and Flood Project Recommended Actions	Status 2017
1. Re-vegetate the N., S., and combined Creek corridor in Lyons	Mostly complete with some areas still in progress as of 5/2017
2. Improve riparian habitats and bank stabilization from the confluence to McConnell Bridge	In progress as of 5/2017
3. Restore and improve North, South and combined St. Vrain corridor in Lyons	The North and South St Vrain corridors were completed in 2016. The combined corridor is in the design phase.
6. Design & implement the ponds and associated wetlands to promote increased natural areas, and provide a variety of recreational and hazard mitigation	In process
7. Mitigate high water mark debris and sediment deposits	Mostly complete. Some areas still need to be addressed on the deed-restricted buy-out properties.
8. Mitigate Highway 36 CDOT bridges near the Planet Bluegrass property	The Rainbow Bridge mitigation is complete and CDOT is working on the other bridge to address problems.
9. Mitigate channelization of the North St. Vrain from 5th Ave to confluence	Complete
10. Develop detention and retention units on South St. Vrain Creek to Boulder County Open Space as a means of flood mitigation	Two phases are under construction in 2017; includes floodplain re-connection and overflow channels.

The following table includes projects identified in the Status of St Vrain Watershed Master Plan projects for Reach 4 (St Vrain, N St Vrain and S St Vrain near Lyons) that have a flood mitigation and stream restoration component. Input from the St Vrain Creek Coalition is summarized by sub-reach project below.

Table 5.4. St Vrain Watershed Master Plan Projects for Reach 4 Implementation Status June 2017

Lyons Recovery Action Plan 2015 - Stream and Flood Project Recommended Actions	Status 2017
4a Apple Valley Restoration	- Apple Valley (managed by the SVCC) - 30% design is complete. The project area has been split into two - Apple Valley North and Apple Valley South - due to funding. Both projects are moving forward. The projects are both design-build with different teams. Working through permitting and contracting with the consultants now. Projects targeted to be complete by December 31, 2017. - Apple Valley Pocket Park, Road, and Bridge reconstruction - managed by Boulder County. This project has been completed.
4b Hall Meadows/S. St. Vrain Restoration	- Hall Meadows/SSV - managed by Boulder County Parks and Open Space. 80% design complete. A construction team has been selected through a competitive RFP process. Moving into construction in early June.
4c Lyons Proper	- South Saint Vrain 3 - managed by the Town of Lyons. The 30% design is complete and the team to complete the project has been selected. Construction will begin soon. - LaVern M. Johnson Park - managed by the Town of Lyons. Included both creek work and park reconstruction. This project has been fully completed and installed. - St. Vrain Creek Restoration Project - managed by the Town of Lyons. This was the work that went through town, and it was completed in 2016. - Confluence - managed by the Town of Lyons. Work was completed in 2016/2017. - Bohn Park - managed by the Town of Lyons. The stream restoration portion of this project has been completed, but is a small portion of the overall reconstruction of Bohn Park. Work is currently taking place. - 2nd Ave Bridge- managed by the Town of Lyons. Currently at the 30% design stage and will be submitted to FEMA for review. The project will go into construction in 2018. - McConnell Bridge - managed by the Town of Lyons. Is in final design and will go to construction this year. - Lyons Valley River Park - managed by the Town of Lyons. Moving into preliminary design. The project will be constructed in 2018. - McConnell to 36 Creek Restoration Work - managed by the SVCC. This project's limits begin below the Highland Diversion and goes downstream to Hwy 36. The project is an Emergency Watershed Protection project, and is currently beginning design, with project end date likely to be in March 2018.

Source: St Vrain Creek Coalition

5.2 Mitigation Capabilities

The HIRA describe hazards, risks, and vulnerabilities of the Town of Lyons. This mitigation capability assessment describes the Town's existing capabilities, programs, and policies currently in use to reduce hazard impacts or that could be used to implement hazard mitigation activities. This assessment is divided into three sections: regulatory mitigation capabilities; administrative and technical mitigation capabilities; and fiscal mitigation capabilities. The basis for the capability assessment was the Lyons Annex (Annex G) to the 2014 Boulder County Hazard Mitigation Plan.

Table 5.5 lists planning and land management tools typically used by local jurisdictions to implement hazard mitigation activities and indicates those that are in place in Lyons.

Table 5.5. Lyons Regulatory Mitigation Capabilities

Regulatory Tool (ordinances, codes, plans)	Yes/No	Comments
Master plan	Yes	Town of Lyons Comprehensive Plan 2010 Lyons Primary Planning Area Master Plan 2017 Addendum to Comprehensive Plan
Zoning ordinance	Yes	Lyons Municipal Code Chapter 16
Subdivision ordinance	Yes	Lyons Municipal Code Chapter 17
Growth management ordinance	Yes	Controlled with water tap sales for new home construction and sales
Floodplain ordinance	Yes	Lyons Municipal Code Chapter 18 Article 13
Site plan review requirements	Yes	SAFEbuilt Colorado
Other special purpose ordinance (stormwater, steep slope, wildfire)	Yes	Stormwater, steep slope (Lyons Municipal Code Chapter 17 Article 11)
Building code	Yes	International Building Code 2006
BCEGS Rating	No	SAFEbuilt Colorado
Fire department ISO rating	Yes	Lyons Fire Protection District Rating: 3
Erosion or sediment control program	Yes	
Stormwater management program	Yes	
Capital improvements plan	Yes	
Economic development plan	Yes	Downtown Improvement Plan
Local emergency operations plan	Yes	Emergency Operations Plan Boulder County
Other special plans	Yes	Lyons Annex to Boulder County Hazard Mitigation Plan 2014 Recovery Action Plan 2014; Storm Drainage Master Plan, 1997 and updated in 2016; St Vrain Watershed Master Plan; Sustainable River Corridor Action Plan 2014; Lyons Flood Hazard Mitigation Plan, 1994; Lyons Fire Protection District Community Wildfire Protection
Flood insurance study or other engineering study for streams	Yes	FEMA Flood Insurance Study, December 18, 2012; Post 2013-flood floodplain studies and mapping
Elevation certificates	Yes	Required before and after construction

Table 5.6 identifies the personnel responsible for mitigation and loss prevention activities as well as related data and systems in Lyons.

Table 5.6. Lyons Administrative and Technical Mitigation Capabilities

Personnel Resources	Yes/No	Department/Position
Planner/engineer with knowledge of land development/land management practices	Yes	Director of Community Development
Engineer/professional trained in construction practices related to buildings and/or infrastructure	Yes	Consultant hired as needed
Planner/engineer/scientist with an understanding of natural hazards	Yes	Director of Community Development
Personnel skilled in GIS	Yes	Boulder County GIS Coordinator Consultant hired as needed
Full-time building official	Yes	Consultant hired as needed
Floodplain manager	Yes	Building Dept./Building Official
Emergency manager	Yes	Boulder County Sheriff's Office
Grant writer	Yes	Town Administrator
GIS Data – Hazard areas	Yes	Boulder County GIS Coordinator
GIS Data – Critical facilities	Yes	Boulder County GIS Coordinator
GIS Data – Building footprints	Yes	Boulder County GIS Coordinator
GIS Data – Land use	Yes	Boulder County GIS Coordinator
GIS Data – Links to assessor's data	Yes	Boulder County GIS Coordinator
Warning systems/services (Reverse 9-11, cable override, outdoor warning signals)	Yes	Contract with Boulder Regional Communications Center, Boulder County Sheriff's Office

Table 5.7 identifies financial tools or resources that Lyons could potentially use to help fund mitigation activities.

Table 5.7. Lyons Fiscal Mitigation Capabilities

Financial Resources	Accessible/Eligible to Use (Yes/No)	Comments
Community Development Block Grants	Yes	Grant cycle and availability of funds
Capital improvements project funding	Yes	Limited resources
Authority to levy taxes for specific purposes	Yes	With voter approval
Fees for water, sewer, gas, or electric services	Yes	By ordinance
Impact fees for new development	Yes	By ordinance
Incur debt through general obligation bonds	Yes	With voter approval
Incur debt through special tax bonds	Yes	With voter approval
Incur debt through private activities	Yes	With Town Board approval
Withhold spending in hazard-prone areas	Yes	

5.3 Implementation

The Town of Lyons has made demonstrated progress toward successful implementation of multiple planning mechanism. Continued implementation will be accomplished by adhering to the schedules identified for each action and through constant, pervasive, and energetic efforts to network and highlight the benefits to the Town and stakeholders. This effort is achieved through the routine actions of monitoring meeting agendas for hazard mitigation related initiatives, coordinating on the topic at meetings, and promoting a safe, sustainable and resilient community. Additional mitigation strategies could include consistent and ongoing enforcement of existing policies and vigilant review of programs for coordination and multi-objective opportunities. Mitigation is most successful when it is incorporated into the day-to-day functions and priorities of government and development.

Simultaneous to these efforts, it is important to maintain a constant monitoring of funding opportunities that can be leveraged to implement some of the more costly recommended actions. This will include creating and maintaining a bank of ideas on how to meet local match or participation requirements. When funding does become available, the Town will be in a position to capitalize on the opportunity. Funding opportunities to be monitored include FEMA pre- and post-disaster funds, state and federal earmarked funds, and other grant programs, including those that can serve or support multi-objective applications.

Where possible, plan participants will use existing plans and/or programs to implement hazard mitigation actions. These existing mechanisms could include:

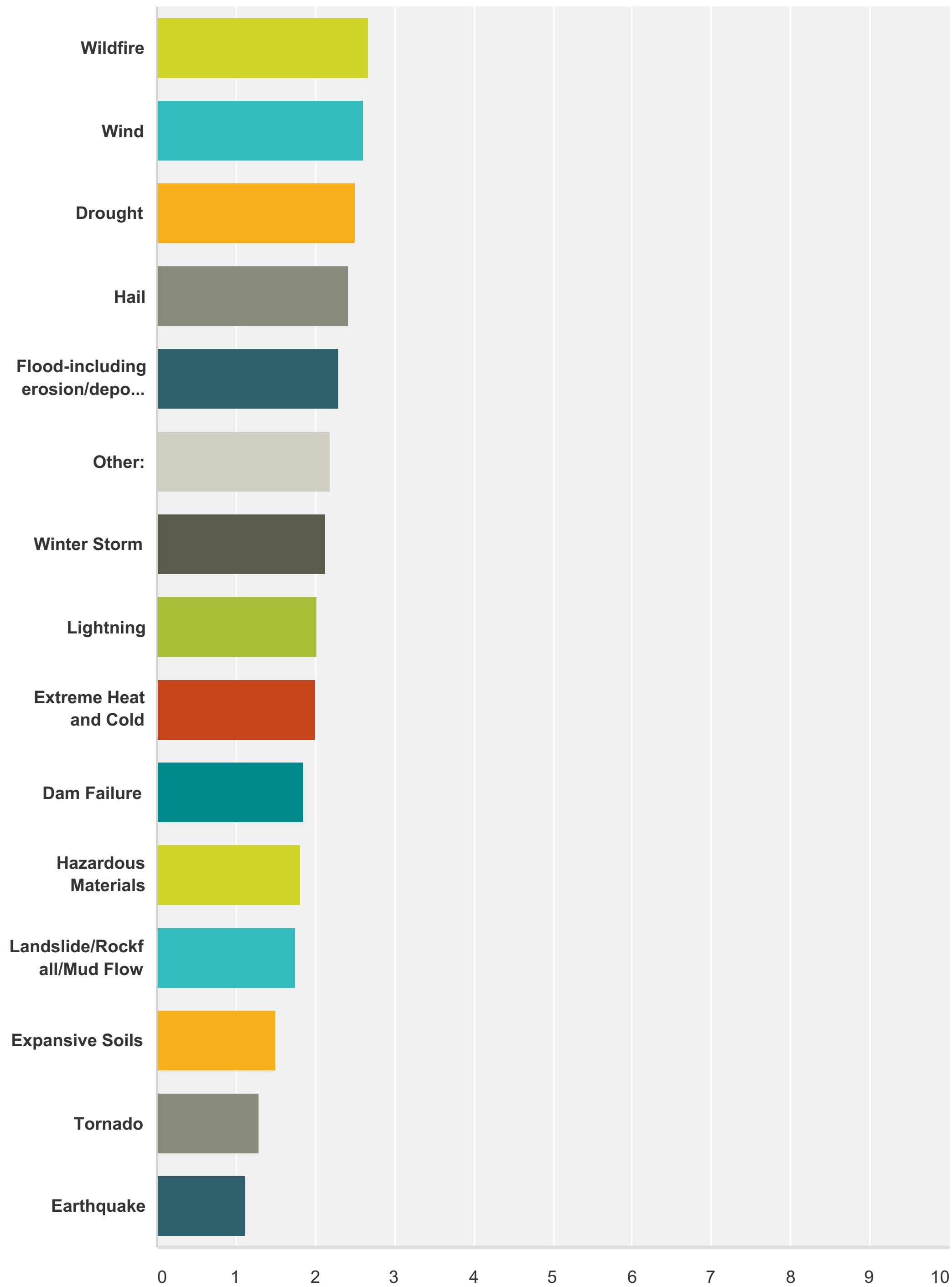
- Comprehensive plan and LPPA Master Plan
- Land development regulations
- Community Wildfire Protection Plans (CWPP)
- Boulder County Hazard Mitigation Plan
- Lyons Recovery Action Plan
- St Vrain Stream Corridor Master Plan.
- Transportation plans
- Capital Improvement Plans

Efforts should continuously be made to monitor the progress of mitigation actions implemented through these other planning mechanisms and, where appropriate, their priority actions should be incorporated into updates of the County Hazard Mitigation Plan and this HIRA document.

APPENDIX A: PUBLIC SURVEY RESULTS

Q1 The hazards being addressed in the Hazard Identification and Risk Assessment (HIRA) are listed below. Please indicate the level of significance that you perceive for each hazard. Please rate these hazards 1 through 3 as follows: 1=low, 2=moderate, 3=high.

Answered: 43 Skipped: 0



	1=Low	2=Moderate	3=High	Total	Weighted Average
Wildfire	**4.65%** 2	**23.26%** 10	**72.09%** 31	43	2.67
Wind	**4.65%** 2	**30.23%** 13	**65.12%** 28	43	2.60
Drought	**7.14%** 3	**35.71%** 15	**57.14%** 24	42	2.50
Hail	**16.28%** 7	**25.58%** 11	**58.14%** 25	43	2.42
Flood-including erosion/deposition	**14.63%** 6	**41.46%** 17	**43.90%** 18	41	2.29
Other:	**20.00%** 2	**40.00%** 4	**40.00%** 4	10	2.20
Winter Storm	**18.60%** 8	**51.16%** 22	**30.23%** 13	43	2.12
Lightning	**30.23%** 13	**37.21%** 16	**32.56%** 14	43	2.02
Extreme Heat and Cold	**33.33%** 14	**33.33%** 14	**33.33%** 14	42	2.00
Dam Failure	**41.86%** 18	**30.23%** 13	**27.91%** 12	43	1.86
Hazardous Materials	**37.21%** 16	**44.19%** 19	**18.60%** 8	43	1.81
Landslide/Rockfall/Mud Flow	**35.71%** 15	**52.38%** 22	**11.90%** 5	42	1.76
Expansive Soils	**53.66%** 22	**41.46%** 17	**4.88%** 2	41	1.51
Tornado	**76.19%** 32	**19.05%** 8	**4.76%** 2	42	1.29
Earthquake	**88.10%** 37	**11.90%** 5	**0.00%** 0	42	1.12

#	Other (please specify)	Date
1	air and noise pollution - particulate and cemex noise. Also invasive weeds and preservation of native vegetation - native biosphere. Greenhouse Gasses	4/20/2017 2:53 AM
2	Loud and Continuous Motorcycles and Gun shooting on weekends. Overpopulation.	4/19/2017 1:34 PM
3	Use of herbicides and pesticides	4/10/2017 11:02 AM
4	traffic	4/5/2017 1:40 PM
5	Pesticides that the Town of Lyons uses for spraying	4/2/2017 12:17 PM
6	features on properties that are not occupied since the 2013 flood. Also, have whoever is the Lyons liaison with the Button Rock/Ralph Price Dam report on the progress there & safety status.	4/2/2017 10:53 AM
7	Pollution and traffic	3/28/2017 12:40 PM
8	Safety crossing the road on third and high to the elementary school	3/28/2017 12:28 PM

Q2 Do you have information on specific hazard issues/problem areas that you would like the planning committee to consider? Note the area of town to which it applies.

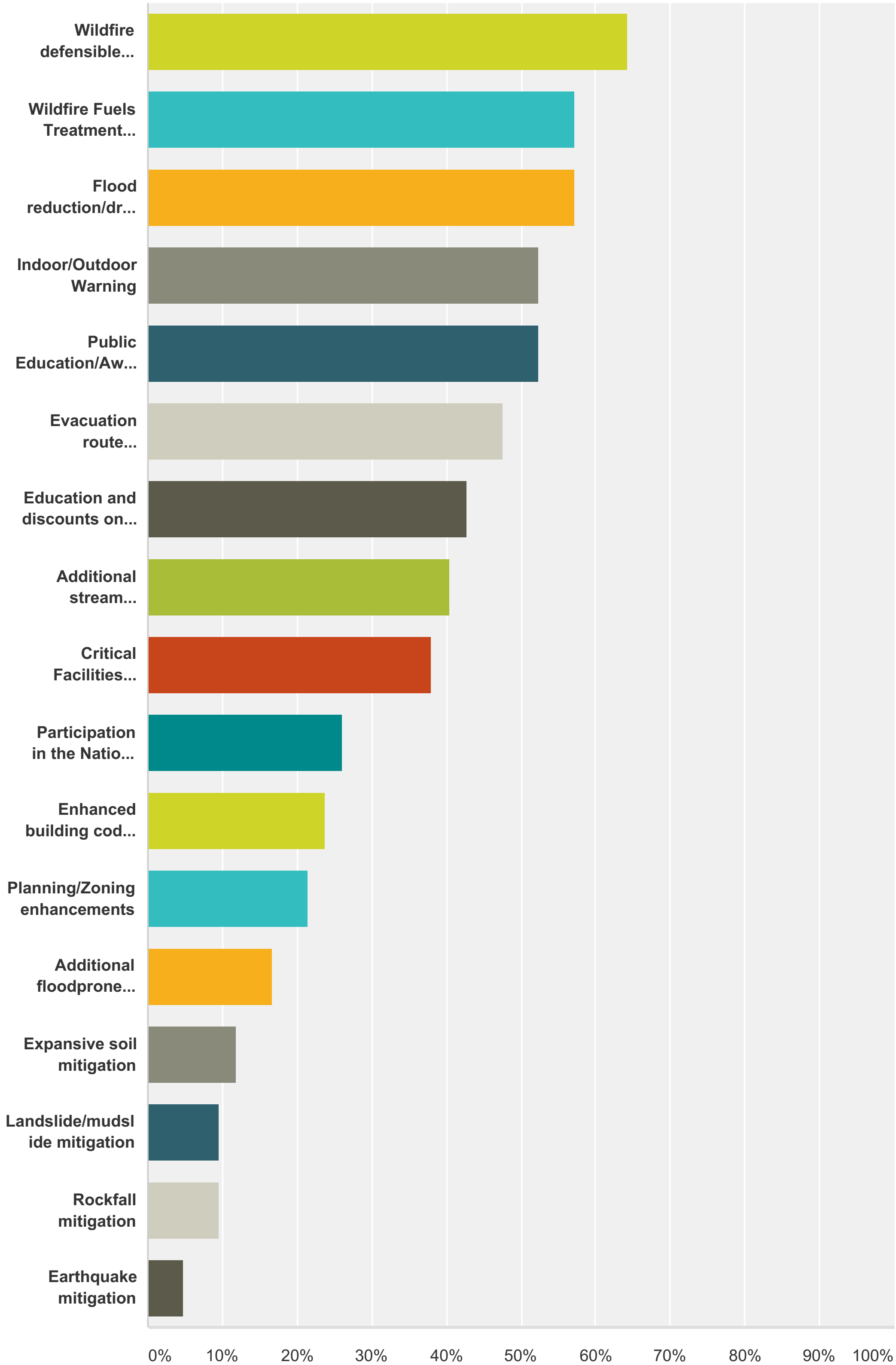
Answered: 20 Skipped: 23

#	Responses	Date
1	no	5/8/2017 9:00 AM
2	I'm concerned about the aged water/sewer system. I often wonder if there's a grant the Town can apply for, to update infrastructure to modern standards.	5/4/2017 9:46 AM
3	Storm water plan is grossly inadequate. Town needs this to be a high priority for fixing.	4/28/2017 9:40 AM
4	Take down the dead trees from buy-out properties. They are a hazard during windstorms or if we were to have a heavy wet snow.	4/20/2017 4:06 AM
5	The old trailer park between 4th and 5th on Prospect is a pretty hazardous place. I saw kids wandering there last week, and told them to get out that it wasn't safe. I realize that is FEMA flood crap, but its time to address.	4/20/2017 3:57 AM
6	Side walks in various areas of town	4/20/2017 2:51 AM
7	Cemex. Air quality	4/19/2017 2:05 PM
8	Noise Ordinances targeting motorcyclists and gunfire. Prohibit immigration into Town (border wall?). Encourage people not to live in fear of nature and status quo.	4/19/2017 1:34 PM
9	The bridge on Hwy disabled, mothers with babies and bicycle us all have to go out into the highway to cross over the bridge. The bridge is not disabled accessible according to ADA regulations and should be replaced before someone gets killed going out in the street to cross that damn bridge	4/19/2017 1:21 PM
10	No	4/19/2017 1:16 PM
11	no	4/19/2017 11:15 AM
12	Unmanaged (and perhaps unauthorized) use of open space properties throughout much of town (e.g., Lyons L; Conora Hill; Steamboat Mtn.) increases the sources and potential for wildfire ignition. Most of these areas have dried grass for much of the year providing a good fuel load.	4/19/2017 11:12 AM
13	I am concerned about the use of herbicides to control weeds around town. I am currently not aware of use of pesticides but am equally concerned. I witnessed spraying of herbicides late last summer that was not flagged and where the summer tech was spraying all over and exposing folks passing by. I spoke to Public Works about this and they responded well. I would love to see the town move towards ecologically safe alternatives for both human health and environmental health. I am a mother of young children and our family has a genetically prone to not be able to process toxins. So I am naturally wanting to limit exposure. There are many towns across the nation committing to healthy safe alternatives including Boulder. A good resource is Beyond Pesticides.org I want our town to make positive choices for our environment and health of our residents.	4/10/2017 11:02 AM
14	Dangerous traffic through main street. Flood houses that have not been raised	4/6/2017 3:41 AM
15	traffic	4/5/2017 1:40 PM
16	Dead/dying trees that have not been maintained. Areas south of Main Street, east of Hwy 7.	4/2/2017 10:53 AM
17	Damn breaking- indicating safe zone high water marks for all aspects of town and up the canyon- aplenty valley etc.	4/2/2017 9:04 AM
18	Curious if this only applies within town limits. If so, very small area.	3/28/2017 2:39 PM
19	Wildfire urban interface at all OS/town and FD interfaces. Auto ped accidents, particularly at the 36 and 7 corridors when leaving/entering town	3/28/2017 12:40 PM
20	Just crossing the freaking road into Meadowpark is taking your life in your hands and playing Frogger	3/28/2017 12:28 PM

Q3 The following types of mitigation actions are used or are being considered for enhancement based on the results of the HIRA. Please place a check next to the types of mitigation actions that you think should have the highest priority in the plan.

Answered: 42 Skipped: 1

Town of Lyons Hazard Identification and Risk Assessment Public Survey



Answer Choices	Responses	
Wildfire defensible space projects	**64.29%**	27
Wildfire Fuels Treatment projects	**57.14%**	24

Flood reduction/drainage improvement	**57.14%**	24
Indoor/Outdoor Warning	**52.38%**	22
Public Education/Awareness	**52.38%**	22
Evacuation route development	**47.62%**	20
Education and discounts on flood insurance	**42.86%**	18
Additional stream restoration	**40.48%**	17
Critical Facilities Protection	**38.10%**	16
Participation in the National Flood Insurance Program	**26.19%**	11
Enhanced building codes for wind and snow loads	**23.81%**	10
Planning/Zoning enhancements	**21.43%**	9
Additional floodprone Property Buyout	**16.67%**	7
Expansive soil mitigation	**11.90%**	5
Landslide/mudslide mitigation	**9.52%**	4
Rockfall mitigation	**9.52%**	4
Earthquake mitigation	**4.76%**	2
Total Respondents: 42		

Q4 Please comment on any other pre-disaster strategies that the planning committee should consider for reducing future losses caused by hazards.

Answered: 17 Skipped: 26

#	Responses	Date
1	n/c	5/8/2017 9:00 AM
2	Funding for reverse 911 texts, specific to Town (not County).	5/4/2017 9:46 AM
3	Education of all hazards. Mitigation of runoff. Tighter zoning restrictions in the floodway and floodplain-this is not popular but needed. Restricting growth in these areas without mitigation should be done.	4/28/2017 9:40 AM
4	If the Town considers NFIP, please vet the cost/benefits of other flood ins. also. I have Lloyd's of London and it supported my repairs from the 2013 flood very well.	4/20/2017 4:06 AM
5	Greenhouse gas and climate change mitigation. Climate change will impact most of these areas in a negative way	4/20/2017 2:53 AM
6	Better/more clear warning system and what should we do when it sounds.	4/20/2017 2:51 AM
7	Relax and stop encoursging federal grant $.	4/19/2017 1:34 PM
8	People are allowed to park in cul-de-sacs and dead-ends sticking out luke spokes inna wheel when there should be parallel or no parking especially when there is a fire hydrant there. Ewald street has a dead end with the fire hydrant and in the case of a wildfire they couldn't even get firetrucks up here without blocking cars and then no one could get out and there would be a risk of life loss and firetrucks could not turn around, it is a mess and should be in parallel or no parking.	4/19/2017 1:21 PM
9	As part of my profession, I have seen a report on the high fire risks around Lyons but I have never seen that report advertised around town. Likewise, I have never seen any facts on the hazard of Buttonrock Dam failure. Only recently did the Watershed Board create a map showing the possible damage from various flood events. Education and facts for town residents is important.	4/19/2017 11:12 AM
10	Water conservation (voluntary & involuntary)	4/3/2017 5:39 AM
11	Let's be realistic. Many homes in town should never have been built near the river. In today's environment, much of the Confluence building would be either unwise or not allowed. An ongoing buyout program should be in place to eventually make the Confluence the floodplain it is supposed to be.	4/2/2017 11:46 PM
12	I'm not sure what you mean by "Critical Facilities Protection" or what "Indoor/Outdoor Warning" means (don't we have that already)? I don't know what this means.	4/2/2017 12:17 PM
13	Maybe require home owners to secure loose structures or building materials in case of high winds, etc.	4/2/2017 10:53 AM
14	Wildfire plan and damn breaking plans.	4/2/2017 9:04 AM
15	Ensure strong connection with local fire and emergency districts.	3/28/2017 2:39 PM
16	Everbridge sign up campaigns. Increased staffing/funding for sheriff and fire. Mitigation and other grants (SAFER) pub-ed, etc.	3/28/2017 12:40 PM
17	One major thing that comes to mind that during the flood town officials came door-to-door asking for basic supplies like candles gasoline and food	3/28/2017 12:28 PM