City of Boulder
Multi-Hazard Mitigation Plan

Comprehensive Update
October 2012

City of Boulder, Colorado
Multi-Hazard Mitigation Plan

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Developed in compliance with the Disaster Mitigation Act of 2000
by the City of Boulder Department of Public Works

with professional planning services provided by:

AMEC Environment and Infrastructure, Inc.
Boulder, Colorado

EXECUTIVE SUMMARY

The purpose of hazard mitigation and this plan is to reduce or eliminate long-term risk to people and property from natural hazards and their effects in the City of Boulder, Colorado. This plan has been prepared to meet the Disaster Mitigation Act of 2000 (DMA 2000) requirements in order to maintain the city's eligibility for FEMA Pre-Disaster Mitigation (PDM) and Hazard Mitigation Grant Programs (HMGP). More importantly, this plan update and planning process lays out the strategy that will enable the city to become less vulnerable to future disaster losses.

The process followed a methodology prescribed by FEMA. It began with the formation of a Hazard Mitigation Planning Committee (HMPC) comprised of key city departments and stakeholder representatives. The planning process examined the recorded history of losses resulting from natural hazards, and analyzed the future risks posed to the city by these hazards. The City of Boulder is vulnerable to several natural hazards that are identified, profiled, and analyzed in the plan. Floods, wildfires, and severe weather are some of the hazards that can have a significant impact on the city.

The plan identifies several mitigation goals and objectives that are based on the results of the risk assessment. The plan includes specific actions that the city can implement over time to reduce future losses from hazards. The plan also includes a review of the city's current capabilities to reduce hazard impacts. This plan has been formally adopted by the Boulder City Council and is required to be updated a minimum of every five years. The plan was originally prepared between 2005 and 2007, approved by FEMA in 2008, and underwent its first major update in 2012.

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1 INTRODUCTION

1.1 Purpose

The City of Boulder Colorado has prepared this multi-hazard mitigation plan to guide hazard mitigation planning to better protect the people and property of the City of Boulder from the effects of hazard events. The plan was originally prepared in 2007-2008 and updated in 2012. It demonstrates the city's commitment to reducing risks from hazards and serves as a tool to help decision makers direct mitigation activities and resources. Other purposes include making the City of Boulder eligible for certain federal disaster assistance, specifically, the Federal Emergency Management Agency's (FEMA) Hazard Mitigation Grant Program (HMGP), Hazard Mitigation Assistance (HMA) grant program, and Pre-Disaster Mitigation (PDM) program, as well as earning points for the National Flood Insurance Program's (NFIP) Community Rating System (CRS) to lower flood insurance premiums communitywide.

1.2 Background and Scope

Each year in the United States, natural disasters take the lives of hundreds of people and injure thousands more. Nationwide, taxpayers pay billions of dollars annually to help communities, organizations, businesses, and individuals recover from disasters. These monies only partially reflect the true cost of disasters, because additional expenses to insurance companies and nongovernmental organizations are not reimbursed by tax dollars. Many natural disasters are predictable, and much of the damage caused by these events can be alleviated or even eliminated.

Hazard mitigation is defined by FEMA as "any sustained action taken to reduce or eliminate long-term risk to human life and property from a hazard event." The results of a three-year, congressionally mandated independent study to assess future savings from mitigation activities provides evidence that mitigation activities are highly cost-effective. On average, each dollar spent on mitigation saves society an average of $4 in avoided future losses in addition to saving lives and preventing injuries (National Institute of Building Science Multi-Hazard Mitigation Council 2005).

Hazard mitigation planning is the process through which natural hazards that threaten communities are identified, likely impacts of those hazards are determined, mitigation goals are set, and appropriate strategies to lessen impacts are determined, prioritized, and implemented. This plan documents the City of Boulder's natural hazards mitigation planning process, identifies relevant natural hazards and risks, and identifies the strategy the city will use to decrease its vulnerability and increase its resiliency and sustainability.

The City of Boulder Multi-Hazard Mitigation Plan Update is a single-jurisdiction plan that covers the incorporated community of the City of Boulder. It documents the city's natural

hazards mitigation planning process, identifies natural hazards and associated risks to the city, and develops a hazards mitigation strategy to lessen vulnerability and improve resiliency to natural disasters, thereby enhancing the city's long-term sustainability.

The city prepared this multi-hazard mitigation plan update pursuant to the requirements of the Disaster Mitigation Act of 2000 (Public Law 106-390) and the implementing regulations set forth by the Interim Final Rule published in the Federal Register on February 26, 2002 (44 CFR §201.6), finalized on October 31, 2007, and updated in 2012. Hereafter, these requirements and regulations will be referred to collectively as the DMA. While the act emphasized the need for mitigation plans and more coordinated mitigation planning and implementation efforts, the regulations established the requirements that local hazard mitigation plans must meet in order for a local jurisdiction to be eligible for certain federal disaster assistance and hazard mitigation funding under the Robert T. Stafford Disaster Relief and Emergency Act (Public Law 93-288). Because the City of Boulder is subject to many kinds of natural hazards, access to these programs is vital.

This plan addresses natural hazards only. Although the hazard mitigation planning committee (HMPC) recognizes that FEMA encourages communities to address manmade and technological as well as natural hazards, the scope of this effort was limited to natural hazards for two reasons: 1) many of the planning activities for manmade and technological hazards are either underway or complete and were developed by a different set of organizations and 2) the DMA requires extensive public information and input, which is in direct conflict with the confidentiality necessary in planning for the fight against chemical, biological, and radiological terrorism. The HMPC determined it was not in the community's best interest to publicly share specific information about the area's vulnerability to manmade hazards.

Information in this plan will be used to help guide and coordinate mitigation activities and decisions for local land use policy in the future. Proactive mitigation planning will help reduce the cost of disaster response and recovery to the city and its property owners by protecting critical community facilities, reducing liability exposure, and minimizing overall community impacts and disruption. Boulder has been affected by natural hazards in the past and is thus committed to reducing future disaster impacts and maintaining eligibility for federal funding.

1.3 Plan Organization

The City of Boulder's Multi-Hazard Mitigation Plan is organized as follows:

- Chapter 1: Introduction
- Chapter 2: Community Profile
- Chapter 3: Planning Process
- Chapter 4: Risk Assessment
- Chapter 5: Mitigation Strategy
- Chapter 6: Plan Adoption

- Chapter 7: Plan Implementation and Maintenance
- Appendix A – Adoption Resolution
- Appendix B – HMPC Member List
- Appendix C – Mitigation Categories
- Appendix D – References
- Appendix E – Planning Process Documentation
- Appendix F – Public Participation Plan
- Appendix G – Critical Facilities
- Appendix H– Historic Properties

2 COMMUNITY PROFILE

The City of Boulder, surrounded by a greenbelt of trails and open space, is known for its natural beauty, outdoor recreation, natural product retailers, restaurants, alternate transportation options, diverse businesses, and technological and academic resources. It is a home-rule municipality with a council-manager form of government. The elected City Council, which consists of the mayor, the deputy mayor, and seven council members, sets the policies for the operation of the city government and appoints the city manager, who is tasked with the administrative responsibilities of the city.

2.1 Geography and Climate

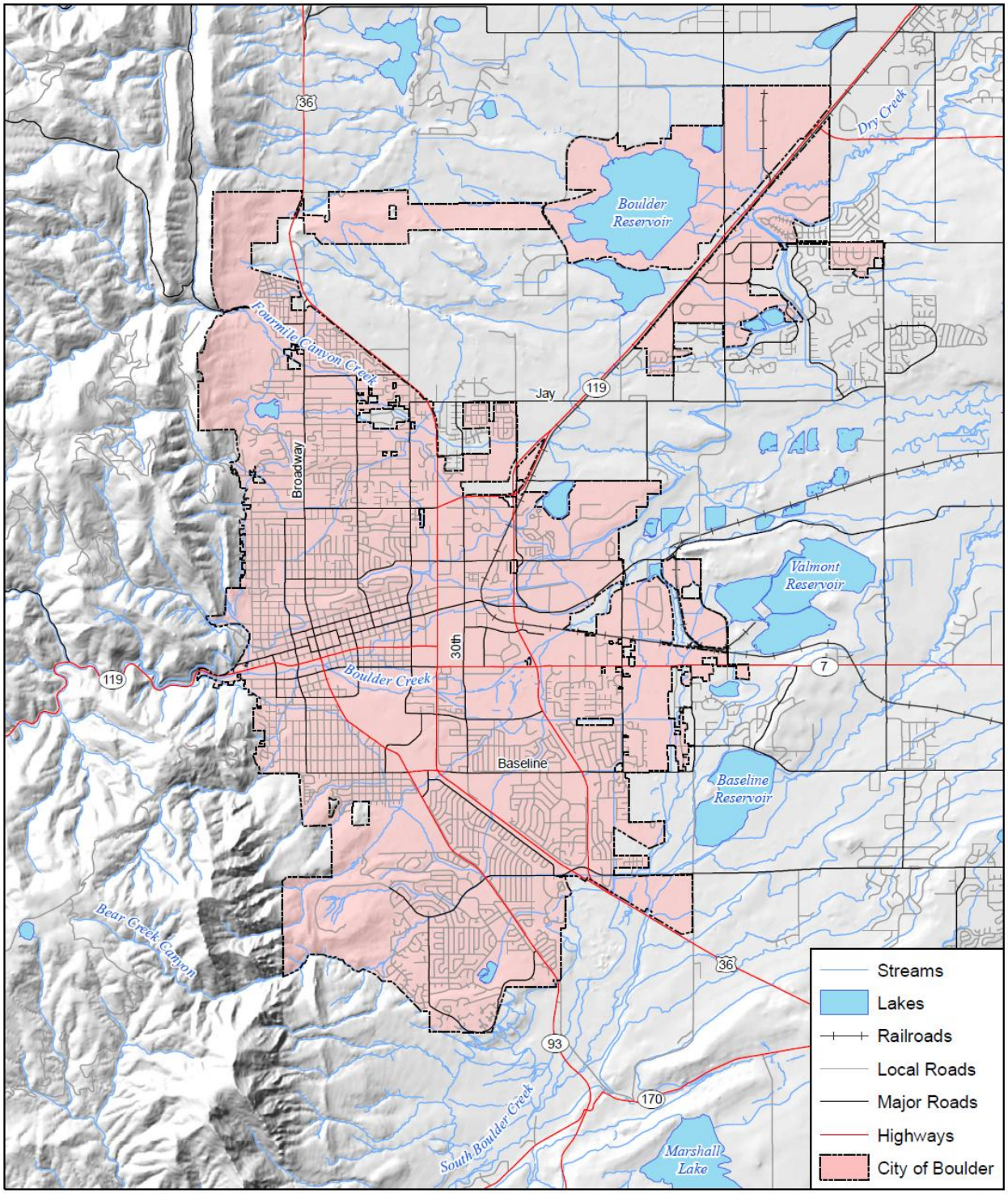
At an elevation of 5,340 feet above sea level, the city is located along Boulder Creek at the base of the foothills of the Rocky Mountains, roughly 185 miles east of the Continental Divide and about 35 miles northwest of Denver. The Boulder foothills are home to the Flatirons, slabs of sedimentary rock tilted up on the foothills, which are unique to Boulder and provides a dramatic backdrop to the city. Boulder covers approximately 25.4 square miles and is characterized by gently rolling terrain, interrupted by small ridges. Fifteen major drainageways or creeks pass through Boulder, including Boulder Creek, which flows through the center of the city. A map of the City of Boulder is represented in Figure 2.1.

The climate is generally semiarid with a series of extremes occurring throughout the winter and summer seasons. Most precipitation occurs during the winter and spring months with an average annual precipitation of 18.7 inches of rain and 79.4 inches of snow. In winter, temperatures can plunge to minus 30°F and hover below 0°F for days on end. These cold spells are often followed by periods of unseasonably warm weather. Temperatures often climb into the 60s in January and February.

Winter also brings snowstorms that regularly result in a foot or more of snow. Some of the most powerful winds recorded in the continental United States have occurred in or near the City of Boulder in December and January; gusts of more than 120 mph are not uncommon.

In summer, temperatures can be in the upper 90s for days. These hot temperatures are moderated by low humidity that can drop into the single digits at times. And the semiarid climate that produces an average of 18.7 inches of rain annually means that most days have at least some sunshine.

Figure 2.1. City of Boulder



Map compiled 4/2012; intended for planning purposes only
Data source: City of Boulder, Boulder County, CDOT

2.2 History

The Boulder Valley was first home to Native Americans, primarily the Southern Arapaho Tribe that maintained a village near Haystack Mountain. Utes, Cheyennes, Comanches, and Sioux were occasional visitors to the area. The first European settlers came to Boulder during the Pikes Peak Gold rush in 1858. These settlers established a permanent settlement at the head of Boulder Canyon, and in 1859, gold was discovered in Boulder in Gold Run Creek (Gold Hill). That same year, the Boulder City Town Company was formed.

Originally part of the Nebraska Territory, Boulder became part of the Colorado Territory when the territory was established by Congress in 1861. Boulder incorporated as a town in November of 1871 following its designation as the Boulder County seat in 1867. By 1882, Boulder City's population exceeded 3,000 and the town became a second class city.

In 1874, the University of Colorado opened its doors in the city after residents contributed $15,000 to the territorial government. That year also saw the building of the railroad that connected Boulder to Denver. In the early years of the following decade, rail service was extended to the mountain communities west of Boulder.

At the turn of the century, Boulder relied on tourism to strengthen its economy. The Chautauqua auditorium was built in 1897 and the Hotel Boulderado opened to the public in 1909. Tourism continued to dominate the Boulder economy for the next 40 years.

Boulder's population did not increase much between1920 and 1940, but the city saw an influx of people following World War II. The population rose from 12,958 in 1940 to 20,000 in 1950. By 1950, Boulder leaders were actively recruiting new "clean" industries and improved transportation, and they secured a new highway, the Boulder-Denver Turnpike, and the National Bureau of Standards in 1952. Other research and development industries soon followed. With the turnpike to downtown Denver, Boulder continued to expand. From 1950–1972, the population grew from 20,000 to 72,000.

With the purchase of thousands of acres of open space beginning in 1967, the adoption of the Boulder Valley Comprehensive Plan in 1970, passage of the building height restriction ordinance in 1972, and the residential growth management ordinance in 1977, Boulder began a period of infill and reuse of its past architectural development that continues to the present day. The Historic Preservation Code was passed in September 1974 and has been instrumental in preserving significant portions of Boulder's past while encouraging the rehabilitation of historic buildings.

2.3 Economy

Boulder has a diverse economy that is supported by a prominence of entrepreneurship, global business, and research institutions. The largest percent of employers in Boulder (26%) are in the

professional, scientific, and technical services industry (2.37 times the national average), followed by retail trade (9%) and health care and social assistance (9%). The largest percent of employees (20%) work for government entities including the University of Colorado and Federal labs. After government, the city's highest employment sectors are professional, scientific, and technical services (15%) and manufacturing (10%).

The city is home to numerous start-ups and small businesses and a number of major corporations, including Amgen, Ball, Cisco, Emerson, GE, Google, IBM, Lockheed Martin, Merck, Microsoft, and Northrop Grumman, have a presence in Boulder. Research institutions include the University of Colorado Boulder and more than a dozen federal research laboratories including the University Corporation for Atmospheric Research (UCAR), National Oceanic and Atmospheric Administration (NOAA), and National Institute of Standards and Technology (NIST). Education, healthcare, and government are also important sectors of the Boulder economy. This diversity has buffered the effects of the 2008 and ongoing recession and contributed to the area's economic vitality.

Of the roughly 96,000 people who work in the City of Boulder, approximately 1/3 live in the city limits. Another 1/3 of the city's workforce lives outside the city limits in Boulder County. An estimated 52,000 people commute into Boulder daily for work according to the 2010 Boulder Valley Comprehensive Plan (BVCP).

2.4 Demographics and Growth Trends

According to the U.S. Census Bureau, the City of Boulder's 2010 population was estimated at 97,385 a 2.8 percent increase from 94,673 in 2000. This population is exclusive of the student population at the University of Colorado, which includes a total enrollment of 31,600. The City of Boulder has estimated the 2012 population to be 99,070.

Table 2.1. Census 2010 Demographic Characteristics for the City of Boulder

Demographic	
Gender/Age	
Male	51.3%
Female	48.7%
Under 5 years	4.1%
65 years and over	8.9%
Race	
White	88.0%
Black or African American	0.9%
American Indian and Alaska native	0.4%
Asian	4.7%
Native Hawaiian or Pacific Islander	0.1%

Demographic	
Other	3.2%
Two or more races	2.6%
Other	
Average household size	2.16
Population with a disability	9.8%
Median family income, 2010	$92,540
Per capita income, 2010	$33,981
Families below poverty level, 2010	7.8%
Individuals below poverty level, 2010	21.1%
Median home value	$529,300

Source: U.S. Census Bureau, 2010

According to population projections by the City of Boulder Department of Community Planning and Sustainability Boulder's population is anticipated to grow to 114,025 by 2035. The number of dwelling units is expected to increase from a 2012 estimate of 43,617 to 49,981 by 2035, or 6,364 units. According to the 2010 BVCP the University of Colorado may have approximately 41,000 students by 2030. Since there is little vacant land remaining within Boulder's Urban Growth Boundary, new housing units are primarily being added through redevelopment. Slightly more than half (52%) of housing in Boulder is multi-family housing, compared to 33% in the region.

3 PLANNING PROCESS

Requirements §201.6(b) and §201.6(c)(1):
An open public involvement process is essential to the development of an effective plan. In order to develop a more comprehensive approach to reducing the effects of natural disasters, the planning process shall include:

1) **An opportunity for the public to comment on the plan during the drafting stage and prior to plan approval;**
2) **An opportunity for neighboring communities, local and regional agencies involved in hazard mitigation activities, and agencies that have the authority to regulate development, as well as businesses, academia, and other private and nonprofit interests to be involved in the planning process; and**
3) **Review and incorporation, if appropriate, of existing plans, studies, reports, and technical information.**

[The plan shall document] the planning process used to develop the plan, including how it was prepared, who was involved in the process, and how the public was involved.

3.1 Background on Mitigation Planning in the City of Boulder

The planning process and development of the City of Boulder Multi-Hazard Mitigation Plan has its roots in meetings and activities that began in September 2005 and continued through August of 2007. The first version of this plan was approved by FEMA in 2008. Since the original development of the plan, FEMA guidance for local hazard mitigation plans has been refined and updated. In 2011-2012, the City of Boulder Public Works Department Utilities Division recognized the need and importance of updating the city's multi-hazard mitigation plan and initiated the development of this plan update. The city then contracted with AMEC Environment and Infrastructure (AMEC) to facilitate and develop the plan. AMEC's role was to:

- Assist in establishing a hazard mitigation planning committee (HMPC) as defined by regulations in the Disaster Mitigation Act of 2000 (DMA),
- Meet the DMA requirements as established by federal regulations and following the Federal Emergency Management Agency's (FEMA) planning guidance,
- Support objectives under the National Flood Insurance Program's Community Rating System and the Flood Mitigation Assistance program,
- Facilitate the entire planning process,
- Identify the data requirements that HMPC participants could provide and conduct the research and documentation necessary to augment that data,
- Assist in facilitating the public input process,
- Produce the draft and final plan documents, and
- Coordinate the Colorado Office of Emergency Management and FEMA Region VIII plan reviews.

3.2 Plan Section Review and Analysis – 2012 Update

This multi-hazard mitigation plan update involved a comprehensive review and update of each section of the 2008 plan and includes an assessment of the success of the city in evaluating, monitoring and implementing the mitigation strategy outlined in the initial plan. The process followed to review and revise the chapters of the plan during the 2012 update is detailed in Table 3.1 As part of this plan update, all sections of the plan were reviewed and updated to reflect new data on hazards and risk, risk analysis processes, capabilities, participating stakeholders, and mitigation strategies. Only the information and data still valid from the 2008 plan was carried forward as applicable into this LHMP update.

Table 3.1. 2012 Plan Update Summary of Changes by Chapter

Plan Section	Update Review and Analysis
1.0 Introduction	Updated language to describe purpose and requirements of the City of Boulder Local Hazard Mitigation Plan update process.
2.0 Community Profile	Updated with 2010 Census data and current economy description.
3.0 Planning Process	Described and documented the planning process for 2008 and 2012 update, including coordination among agencies and integration with other planning efforts. Described any changes in participation in detail. Described 2012 public participation process.
4.1 Identifying Hazards and 4.2 Profiling Hazards	Revisited former hazards list for possible modifications. Reviewed hazards from the 2010 Colorado State Hazard Mitigation Plan (CSHMP) for consistency. Updated list of disaster declarations to include 2008-2012 data. Updated NCDC and SHELDUS tables to include 2008-2011 data. Updated past occurrences for each hazard to include 2008-2011 data. Incorporated new hazard studies since 2008, including the South Boulder Creek study, post-wildfire flash flood risk in the Four Mile burn area, etc. Considered consequences of climate change on hazard frequency and severity
4.3 Assessing Vulnerability and Estimating Potential Losses	Updated critical facilities definition and locations from the 2008 plan using definition in the proposed Critical Facilities Ordinance. Updated growth and development trends to include Census 2010 and local data sources. Updated historic and cultural resources using Colorado State Historic Preservation Office and other local/state/national sources. Using 2012 City of Boulder Assessor's parcel data, updated current property values. Estimated flood losses using the preliminary City of Boulder DFIRM. Updated NFIP data and Repetitive Loss structure data from the previous plan. Incorporated new hazard loss estimates since 2008, as applicable. Used new data to assess wildfire threat to the city. Changes in growth and development were examined; especially changes in the context of hazard-prone areas and how the changes may affect loss estimates and vulnerability. A HAZUS-MH Level I earthquake vulnerability analysis data was developed and incorporated. Updated information regarding specific vulnerabilities to hazards, including maps and tables of specific assets at risk, specific critical facilities at risk, and specific populations at risk Updated maps in plan where appropriate.

Plan Section	Update Review and Analysis
4.4 Assessing Capabilities	Reviewed city mitigation capabilities and updated to reflect current capabilities. Indicated what projects have been implemented that may reduce previously identified vulnerabilities
5.0 Mitigation Strategy	Updated Chapter 5 based on the results of the updated risk assessment, completed mitigation actions, and implementation obstacles and opportunities since the completion of the previous plan.
5.1 Goals and Objectives	Reviewed goals and objectives to determine if they are still representative of the city's mitigation strategy and aligned with CSHMP goals. Revised the goals and objectives based on HMPC input.
5.2 Identified Mitigation Measures and Alternatives	Revised to include more information on the categories of mitigation measures (structural projects, natural resource protection, emergency services, etc.) and how they are reviewed when considering the options for mitigation. Included more information on how actions are prioritized.
5.3 Mitigation Actions	Reviewed mitigation actions from the 2008 plan and developed a status report for each; identified if action has been completed, deleted, or deferred. Identified "Mitigation Success Stories" to highlight positive movement on actions identified in 2008 plan. Identified and detailed new mitigation actions proposed by the HMPC. Identified projects that will be likely candidates for pre vs. post disaster mitigation funding
6.0 Plan Adoption	No changes to section but updated with resolution in Appendix A.
7.0 Plan Implementation and Maintenance	Reviewed and updated procedures for monitoring, evaluating, and updating the plan. Revised to reflect current methods. Updated the system for monitoring progress of mitigation activities by identifying additional criteria for plan monitoring and maintenance.
Appendices	Appendix A – Updated adoption resolution Appendix B – Updated HMPC member list Appendix C– Updated mitigation categories as appropriate Appendix D – Updated references as appropriate Appendix E – Created new appendix to capture 2012 planning process documentation Appendix F - Created new appendix to capture Public Participation Plan Appendix G – Created new appendix to capture details of critical facilities Appendix H– Created new appendix to capture details of the historic properties in the city.

3.3 Local Government Participation

The DMA planning regulations and guidance stress that each local government seeking FEMA approval of their mitigation plan must participate in the planning effort in the following ways:

- Participate in the process,
- Detail areas within the planning area where the risk differs from that facing the entire area,
- Identify specific projects to be eligible for funding, and
- Have the governing board formally adopt the plan.

For the City of Boulder's HMPC members, "participation" meant:

- Attending and participating in the HMPC meetings,

- Providing available data requested of the HMPC,
- Reviewing and providing comments on the plan drafts,
- Advertising, coordinating, and participating in the public input process.

The city's Utilities Division within the Department of Public Works took the lead on the plan's initial development in 2005 and its update in 2012.

3.4 The 10-Step Planning Process

AMEC established the planning process for updating the City of Boulder's plan using the DMA planning requirements and FEMA's associated guidance. This guidance is structured around a four-phase process:

- Organize Resources
- Assess Risks
- Develop the Mitigation Plan
- Implement the Plan and Monitor Progress

Into this four-phase process, AMEC integrated a more detailed 10-step planning process used for FEMA's Community Rating System (CRS) and the Flood Mitigation Assistance program. The modified 10-step process used for this plan meets the requirements of several major programs: FEMA's Hazard Mitigation Assistance program including the Hazard Mitigation Grant Program and Pre-Disaster Mitigation program, Community Rating System, Flood Mitigation Assistance program, Repetitive Loss program, and flood control projects authorized by the U.S. Army Corps of Engineers.

Table 3.2 shows how the modified 10-step process fits into FEMA's four-phase process.

Table 3.2. FEMA's 4-Phase Process and the 10-Step Process Used to Develop the City of Boulder's Multi-Hazard Mitigation Plan

FEMA's 4-Phase DMA Process	Modified 10-Step CRS Process
1) Organize Resources	
201.6(c)(1)	1) Organize the Planning Effort
201.6(b)(1)	2) Involve the Public
201.6(b)(2) and (3)	3) Coordinate with Other Departments and Agencies
2) Assess Risks	
201.6(c)(2)(i)	4) Identify the Hazards
201.6(c)(2)(ii)	5) Assess the Risks
3) Develop the Mitigation Plan	
201.6(c)(3)(i)	6) Set Goals
201.6(c)(3)(ii)	7) Review Possible Activities

FEMA's 4-Phase DMA Process	Modified 10-Step CRS Process
201.6(c)(3)(iii)	8) Draft an Action Plan
4) Implement the Plan and Monitor Progress	
201.6(c)(5)	9) Adopt the Plan
201.6(c)(4)	10) Implement, Evaluate, and Revise the Plan

This planning process is similar to the planning process used in the creation of the original City of Boulder Multi-Hazard Mitigation Plan. That planning process may be found in Section 3.2 of the 2008 plan. The planning process that follows describes the process AMEC and the city used in the 2012 plan update.

3.4.1 Phase 1: Organize Resources

Planning Step 1: Organize the Planning Effort

With the City of Boulder's commitment to participate in the DMA planning process, AMEC worked with the city Utilities Division Engineering Project Manager to establish the framework and organization for development of the plan. The HMPC, which was comprised of key city, county, and other local government and stakeholder representatives, developed the plan with leadership from the city's Engineering Project Manager and facilitation by AMEC. The list of participating HMPC organizations is provided below:

City of Boulder

- Communications/Webmaster
- Education and Outreach
- Emergency Management
- Environmental Affairs
- Facilities and Asset Management
- Finance
- Fire Rescue
- Housing and Human Services
- Information Technology/Geographic Information Systems
- Office of Emergency Management
- Open Space and Mountain Parks
- Parks and Recreation
- Planning - Engineering
- Planning-Historic Preservation
- Planning-Long Range
- Police Department
- Public Works

- Risk Management
- Transportation
- Urban Forestry
- Wildland Fire Mitigation

Other Government and Stakeholder Representatives:

- American Red Cross
- Boulder Community Hospital
- Boulder County Office of Emergency Management
- Boulder County Public Health
- Boulder County Transportation
- Boulder Valley School District
- Colorado Department of Transportation
- Colorado Office of Emergency Management
- Colorado Water Conservation Board
- National Weather Service
- University of Colorado at Boulder, Emergency Management
- University of Colorado at Boulder, Facility Management
- University of Colorado at Boulder, Natural Hazards Center
- Urban Drainage and Flood Control District

A full list of HMPC participants is available in Appendix B.

During the planning process, the HMPC communicated through face-to-face meetings, e-mail, and a file transfer protocol (FTP) site. Draft documents were posted on this FTP site so that the HMPC members could easily access and review them. The HMPC met three times during the planning period (February 9, 2012 to June 26, 2012). The purpose of these meetings is described in Table 3.3. Agendas for each of the meetings and lists of attendees are included in Appendix E.

Table 3.3. Schedule of Meetings

HMPC Meeting	Meeting Topic	Meeting Date
1	Kick-off Meeting	February 9, 2012
2	Risk Assessment and Goals Update Meeting	May 31, 2012
3	Mitigation Strategy Development Meeting	June 26, 2012

During the kickoff meeting, AMEC presented information on the scope and purpose of the plan update, participation requirements of HMPC members, and the proposed project work plan and schedule. A plan for public involvement (Step 2) and coordination with other agencies and

departments (Step 3) were discussed. AMEC also introduced preliminary hazard identification information for the city, and HMPC members refined the list of identified hazards. Participants were provided a worksheet to facilitate the collection of information needed to support the plan, such as data on historic hazard events.

Planning Step 2: Involve the Public

At the kick-off meeting, the HMPC discussed options for public involvement and agreed to an approach using established public information mechanisms and resources within the community. Early in the process a Public Participation Plan (PPP) was developed. The purpose of the PPP was to outline the public participation requirements of the DMA and CRS program and identify ways to best engage the public. The PPP also served to document public outreach/involvement activities. The PPP is included as Appendix F. A public outreach subcommittee of the HMPC was formed to lead the implementation of the PPP and assist with public outreach efforts. The subcommittee was comprised of seven members representing private industry, outside governmental agencies and the City of Boulder including:

- Urban Drainage and Flood Control District
- National Weather Service
- American Red Cross
- Four Star Realty
- City of Boulder Department of Public Works – Utilities Division
- City of Boulder Fire-Rescue – Wildland Fire Management
- Boulder Office of Emergency Management
- Bank of Commerce Mortgage
- Boulder Valley School District
- Taggart Insurance
- AMEC

Invitations to participate in this subcommittee are provided in Appendix E; a list of the subcommittee membership is in Appendix B. The subcommittee met on July 18th separate from the primary HMPC meetings to strategize how to implement the PPP and provide guidance on public outreach materials. Public involvement activities included press releases, website postings, and the collection of public comments on the draft plan from a survey developed specifically for the plan update. The Utilities Division prepared a web page to describe the plan update and provide draft materials for public consumption, including summary tables of the hazards, capabilities, and updated mitigation action plan. The plan was made available to the public on the city's website for a three week period during August 27-September 21, along with the on-line survey. Boulder Valley School District advertised the on-line survey and open house through a direct email to 14,990 different email addresses. The meeting notice was published in 'News From City Hall' in the Boulder Daily Camera and a news release was sent out to the city's 'News' listserv which reached more than 6,000 residents. The Boulder Daily Camera published

a news brief about the meeting on Tuesday, Sept. 11 and the workshop notification was posted on the City's website. All public process documentation is included in Appendix E and is on file with the City of Boulder Utilities Division.

A public workshop was held prior to finalizing the plan on September 13th, 2012 at the City of Boulder Library Gallery Room. The workshop was an open house format where citizens could review the draft plan and ask questions of staff from various city departments including Public Works-Utilities and Fire-Rescue. Staff from Taggart Insurance was available to answer questions on flood insurance. The open house included stations summarizing information on the Plan's risk assessment, capabilities, mitigation actions, and flood insurance information. A feedback form/public survey was developed to collect public comments, of which eight were completed. Ten persons were documented on a sign-in sheet, but several additional members of the public browsed the workshop materials. Where appropriate, stakeholder and public comments were incorporated into the final plan, including the sections that address mitigation goals and strategies.

The public survey included a personal preparedness emphasis and queried the public on hazards of concern, preferred method of hazard notification, and what types of information would help them be better prepared for a significant natural event. The following questions were asked in the survey: 1) rank your perception of natural hazard risks, 2) rank your preferred method for hazard notification and 3) identify what would help you better prepare for a natural hazard event. Results indicate that people's ranking of hazard risk correlated well with the ranking presented in the plan. People's order of preference for notification of a natural hazard event ranked in the following order: text message, sirens, phone message, email, television and lastly radio. People's order of preference for additional information to better prepare for a hazard event ranked in the following order: evacuation planning information, emergency action planning information, flood proofing information, West Nile / Pandemic flu risk reduction information and lastly flood insurance information. Input received from this survey will help guide future outreach and notification efforts. Detailed information from the public survey is summarized in Appendix E.

A final open public meeting on the plan update was held October 15, 2012 as the plan was presented by City staff to the Water Resources Advisory Board (WRAB). A staff motion at this meeting requested that the WRAB recommend City Council acceptance of the flood related mitigation action items in the plan.

Planning Step 3: Coordinate with Other Departments and Agencies

Early in the planning process, the HMPC determined that data collection, mitigation strategy development, and plan approval would be greatly enhanced by inviting state and federal agencies and organizations to participate in the process. Based on their involvement in hazard mitigation planning, their landowner status in the county, and/or their interest as a neighboring jurisdiction, representatives from the following agencies were invited to participate on the HMPC:

- American Red Cross
- Boulder Community Hospital
- Boulder County Office of Emergency Management
- Boulder County Transpiration
- Boulder Valley School District
- Colorado Office of Emergency Management
- Colorado Department of Transportation
- Colorado Water Conservation Board
- FEMA Region VIII
- University of Colorado at Boulder, Emergency Management
- University of Colorado at Boulder, Facility Management
- Urban Drainage and Flood Control District

All of the entities listed above participated on the HMPC. A full list of HMPC participants is available in Appendix B.

In addition to those listed above, the HMPC used technical data, reports, and studies from the following agencies and groups. The HMPC obtained this information either through the web or directly from the organization.

- Boulder Daily Camera
- City of Boulder IT/GIS Department
- City of Boulder Open Space and Mountain Parks
- City of Boulder Parks and Recreation
- City of Boulder Planning Department
- City of Boulder Public Works
- Colorado Division of Wildlife
- Colorado Office of Emergency Management
- Colorado Geological Survey
- Colorado State Forest Service
- National Oceanic and Atmospheric Administration National Climatic Data Center
- Spatial Hazard Events and Losses Database for the United States
- National Oceanic and Atmospheric Administration/University of Colorado at Boulder Cooperative Institute for Research in Environmental Sciences Climate Diagnostics Center
- State and Federal Historic Preservation Districts
- Natural Resource Conservation Service
- U.S. Fish and Wildlife
- U.S. Geological Survey
- Western Regional Climate Center
- Various Department and Community Planning Efforts related to hazard mitigation

Other Community Planning Efforts and Hazard Mitigation Activities

Hazard mitigation planning involves identifying existing policies, tools, and actions that will reduce a community's risk and vulnerability from natural hazards. As such, this plan was coordinated with, and builds off of, other related planning efforts that help reduce hazard losses. The City of Boulder uses a variety of comprehensive planning mechanisms, such as a master plan, an emergency response plan, and city policies, to guide growth and development. Integrating existing planning efforts and mitigation policies and action strategies into this multi-hazard mitigation plan establishes a credible and comprehensive plan that ties into and supports other community programs. The development of this plan incorporated information from the following existing plans, studies, reports, and initiatives as well as other relevant data from Boulder County and the State of Colorado. These and other related plans are discussed further in Section 4.4 Capability Assessment.

- Boulder Valley Comprehensive Plan
- Boulder Climate Preparedness Plan
- FEMA Flood Insurance Study
- Various Flood Studies
- Comprehensive Flood and Stormwater Utility Master Plan
- Greenways Master Plan
- City of Boulder Drought Plan
- City of Boulder Community Wildfire Protection Plan
- St. Vrain Wildfire Watershed Assessment
- 2011 Barker Dam Overtopping Study
- Urban Open Lands Master Plan
- 2010 State of Colorado Hazard Mitigation Plan

Other documents were reviewed and considered, as appropriate, during the collection of data to support Planning Steps 4 and 5, which include the hazard identification, vulnerability assessment, and capability assessment.

3.4.2 Phase 2: Assess Risks

Planning Steps 4 and 5: Identify the Hazards and Assess the Risks

AMEC led the HMPC in a comprehensive research effort to identify and document all the natural hazards that have, or could, impact the city. Where data permitted, geographic information systems (GIS) were used to display, analyze, and quantify hazards and vulnerabilities. The HMPC also updated a mitigation capability assessment to review and document the city's current capabilities to mitigate risk and reduce vulnerability from natural hazards. By collecting information about existing government programs, policies, regulations, ordinances, and emergency plans, the HMPC can assess those activities and measures already in place that contribute to mitigating some of the risks and vulnerabilities previously identified. A

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

3.4.3 Phase 3: Develop the Mitigation Plan

Planning Steps 6 and 7: Set Goals and Review Possible Activities

AMEC facilitated brainstorming and discussion sessions with the HMPC that described the purpose and the process of developing planning goals and objectives, a comprehensive range of mitigation alternatives, and a method of selecting and defending recommended mitigation actions using a series of selection criteria. This information is included in Chapter 5: Mitigation Strategy. Additional documentation on the process the HMPC used to develop the goals and strategy is in Appendix C.

Planning Step 8: Draft an Action Plan

Based on input from the HMPC regarding the draft risk assessment and the goals and activities identified in Planning Steps 6 and 7, AMEC produced a complete draft of the updated plan. This draft was posted for HMPC review and comment on the FTP site. Other agencies were invited to comment on this draft as well. HMPC and agency comments were integrated into the second updated draft, which was advertised and distributed to collect public input and comments. AMEC integrated comments and issues from the public, as appropriate, along with additional internal review comments and produced a final draft for the Colorado Office of Emergency Management and FEMA Region VIII to review and approve, contingent on final adoption by the City Council.

3.4.4 Phase 4: Implement the Plan and Monitor Progress

Planning Step 9: Adopt the Plan

In order to secure buy-in and officially implement the plan, the plan was adopted by the City of Boulder City Council on the dates included in the adoption resolution in Appendix A: Adoption Resolution. Once the adoption is complete, final approval by FEMA occurs.

Planning Step 10: Implement, Evaluate, and Revise the Plan

The true worth of any mitigation plan is in the effectiveness of its implementation. Up to this point in the update process, all of the HMPC's efforts have been directed at researching data, coordinating input from participating entities, and developing appropriate mitigation actions. Each recommended action includes key descriptors, such as a lead manager and possible funding sources, to help initiate implementation. An overall implementation strategy is described in Chapter 7: Plan Implementation and Maintenance.

Finally, there are numerous organizations within the city whose goals and interests interface with hazard mitigation. Coordination with these other planning efforts, as addressed in Planning Step 3, is paramount to the ongoing success of this plan and mitigation in the City of Boulder and is addressed further in Chapter 7. A plan update and maintenance schedule and a strategy for continued public involvement are also included in Chapter 7.

4 RISK ASSESSMENT

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

Risk, as defined by the Federal Emergency Management Agency (FEMA), is a combination of hazard, vulnerability, and exposure. "It 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 followed the methodology described in the FEMA publication *Understanding Your Risks—Identifying Hazards and Estimating Losses* (FEMA 386-2, 2002), which breaks the assessment down to a four-step process:

1) Identify Hazards
2) Profile Hazard Events
3) Inventory Assets
4) Estimate Losses

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

- **Section 4.1: Identifying Hazards** identifies the hazards that threaten the planning area and describes why some hazards have been omitted from further consideration.
- **Section 4.2: Profiling Hazards** discusses the threat to the planning area and describes previous occurrences of hazard events and the likelihood of future occurrences.
- **Section 4.3: Assessing Vulnerability** assesses the city's total exposure to natural hazards, considering assets at risk, critical facilities, and future development trends.

While not required by FEMA, the Hazard Mitigation Planning Committee (HMPC) also conducted a mitigation capability assessment, which inventoried existing mitigation activities and existing policies, regulations, and plans that pertain to mitigation and can affect net vulnerability. The findings from this undertaking are in **Section 4.4: Mitigation Capabilities Assessment**.

4.1 Identifying Hazards

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

The HMPC conducted a hazard identification study to determine the hazards that threaten the planning area.

Methodology

Using existing natural hazards data and input gained through planning meetings, the HMPC agreed upon a list of natural hazards that could affect the City of Boulder. Hazards data from the Colorado Division of Emergency Management, the Natural Hazards Center at the University of Colorado at Boulder, the National Oceanic and Atmospheric Administration, and many other 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.

Certain natural hazards were identified and investigated for the City of Boulder Multi-Hazard Mitigation Plan. Table 4.1 was completed by the HMPC to identify, profile, and rate the significance of identified hazards.

Table 4.1. City of Boulder Hazard Identification Table

Hazard	Geographic Extent	Probability of Future Occurrences	Magnitude/Severity	Significance
Avalanche	Limited	Unlikely	Negligible	Low
Dam Failure	Significant	Unlikely	Catastrophic	High
Drought	Extensive	Likely	Critical	High
Earthquakes	Significant	Occasional	Limited	Medium
Floods	Significant	Occasional	Catastrophic	High
Human Health Hazards:				
Pandemic Flu	Extensive	Occasional	Critical	High
West Nile Virus	Extensive	Likely	Negligible	Low
Landslides & Rockfalls	Limited	Occasional	Negligible	Low
Severe Weather:				
Extreme Temperatures	Extensive	Highly Likely	Negligible	Low
Fog	Significant	Unlikely	Negligible	Low
Hailstorms	Extensive	Likely	Limited	Medium
Thunderstorms	Extensive	Highly Likely	Limited	Low
Lightning	Extensive	Highly Likely	Limited	Medium
Tornadoes	Limited	Occasional	Negligible	Low
Windstorms	Extensive	Highly Likely	Limited	Medium
Soil Hazards:				
Expansive Soils	No Data	No Data	No Data	Low
Land Subsidence	No Data	No Data	No Data	Low
Volcanoes	Limited	Unlikely	Negligible	Low
Wildfire	Limited	Likely	Critical	High
Winter Storms	Extensive	Highly Likely	Critical	Medium

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

During the 2012 update the HMPC reviewed the list of hazards from the previous plan. The HMPC decided that the current list of hazards is complete and acceptable. The only addition during the 2012 update was the inclusion of levee failure as an aspect of the flood hazard. Winter Storms, previously a subcategory of Severe Weather, is now a stand-alone hazard. Otherwise this list of hazards is the same as the list of hazards identified in the previous plan. Priority levels for each hazard were revisited and discussed by the HMPC, but ultimately they remained unchanged. Solar storms were also brought up in discussions as a growing concern due to more active space weather cycles. The HMPC felt this hazard is more of a regional/state concern and is best addressed in the state's Energy Assurance Emergency Plan that is in development Governor's Energy Office. During the 2012 update a number of improvements were made to the hazard profiles and the vulnerability assessment. This included summaries of disasters and hazard impacts between 2005 and 2011, improvements in the vulnerability assessments for wildfire, flood, and earthquakes, as well as improvements and additional maps and tables that portray the risk. An emphasis was placed on improving the information on the higher significance hazard data, or where new data was available.

One method the HMPC 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 2 presidential major disaster declarations between 1955 and 2012 and 3 emergency declarations (including one related to assistance for evacuees following Hurricane Katrina). Boulder County's disaster declaration history is summarized in Table 4.2.

Table 4.2. Boulder County Disaster Declaration History, 1969-2012

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

Year	Declaring Jurisdiction	Disaster Type
2007	FEMA Emergency Declaration	Snow
2009	FEMA Fire Mitigation Assistance Declaration	Wildfire (Olde Stage)
2010	FEMA Fire Mitigation Assistance Declaration	Wildfire (Four Mile Canyon).

Source: State of Colorado Natural Hazard Mitigation Plan, 2004; Federal Emergency Management Agency, PERI Presidential Disaster Declaration Site. U.S. Department of Agriculture

Previous occurrences are discussed in more detail by hazard in **Section 4.2: Profiling Hazards**.

4.2 Profiling Hazards

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

For each hazard, a generic description of the hazard and associated problems is provided along with details specific to Boulder County and the City of Boulder. Information on past occurrences and the extent or location of the hazard within or near the city and impacts, where known, are also discussed here. To assess the history of natural hazard events in Boulder, the HMPC evaluated the hazards history for both the city and county. Much of the existing data and statistics are maintained on a countywide basis; therefore, the HMPC relied heavily on Boulder County data. The HMPC and other local resources, such as newspaper articles, were used to refine the county data to more accurately indicate how hazards affected the city in the past. 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).

The following sections provide profiles (in alphabetical order) of the natural hazards that the HMPC identified in **Section 4.1: Identifying Hazards**.

4.2.1 Avalanche

Hazard/Problem Description

Avalanche hazards occur predominantly in the mountainous regions of Colorado above 8,000 feet. The vast majority of avalanches occur during and shortly after winter storms. Avalanches occur when loading of new snow increases stress at a rate faster than strength develops, and the slope fails. Critical stresses develop more quickly on steeper slopes and where deposition of wind-transported snow is common.

The combination of steep slopes, abundant snow, weather, snowpack, and an impetus to cause movement create an avalanching episode. According to the Colorado Avalanche Information Center (CAIC), about 90 percent of all avalanches start on slopes of 30-45 degrees; about 98 percent of all avalanches occur on slopes of 25-50 degrees. Avalanches release most often on slopes above timberline that face away from prevailing winds (leeward slopes collect snow blowing from the windward sides of ridges). Avalanches can run, however, on small slopes well below timberline, such as gullies, road cuts, and small openings in the trees. Very dense trees can anchor the snow to steep slopes and prevent avalanches from starting; however, avalanches can release and travel through a moderately dense forest. An average-sized avalanche travels around 80 mph; the typical range of impact pressure from an avalanche is from 0.5 to 5.0 tons per foot.

Historically in Colorado, avalanches have occurred during the winter and spring months between November and April. The avalanche danger increases with major snowstorms and periods of thaw. About 2,300 avalanches are reported to the CAIC in an average winter. More than 80 percent of these fall during or just after large snowstorms. The most avalanche-prone months are, in order, February, March, and January. Avalanches caused by thaw occur most often in April.

This hazard generally affects a small number of people, such as snowboarders, backcountry skiers, and climbers who venture into backcountry areas during or after winter storms. Motorists along highways are also at risk of injury and death due to avalanches. Road and highway closures, damaged structures, and destruction of forests are also a direct result of avalanches. Recognizing areas prone to avalanches is critical in determining the nature and type of development allowed in a given area.

Avalanche hazards exist in western Boulder County and in the City of Boulder's watershed, where combinations of the above avalanche conditions occur. The avalanche hazard extent within city limits is considered negligible.

Past Occurrences

Avalanches following significant snowstorms have resulted in fatalities in Boulder County. According to the CAIC, between the winters of 1950/51 and 2006/07, five avalanche fatalities occurred in Boulder County. There is no history of avalanche fatalities in the City of Boulder.

Likelihood of Future Occurrences

Unlikely: There is no recorded history of avalanches occurring within Boulder city limits. Except within limited areas, the topography of the city is well below the slopes of 25-50 degrees on which the CAIC data indicate that 98 percent of all avalanches occur.

4.2.2 Dam Failure

Hazard/Problem 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. According to the National Performance of Dams Program (NPDP) database, housed in the Department of Civil and Environmental Engineering at Stanford University, there are 7 high hazard and 5 significant hazard dams that could affect the city (see Table 4.3). The figure on page 10 displays the location of high and significant hazard dams that could affect the city.

Table 4.3. Dams Affecting the City of Boulder

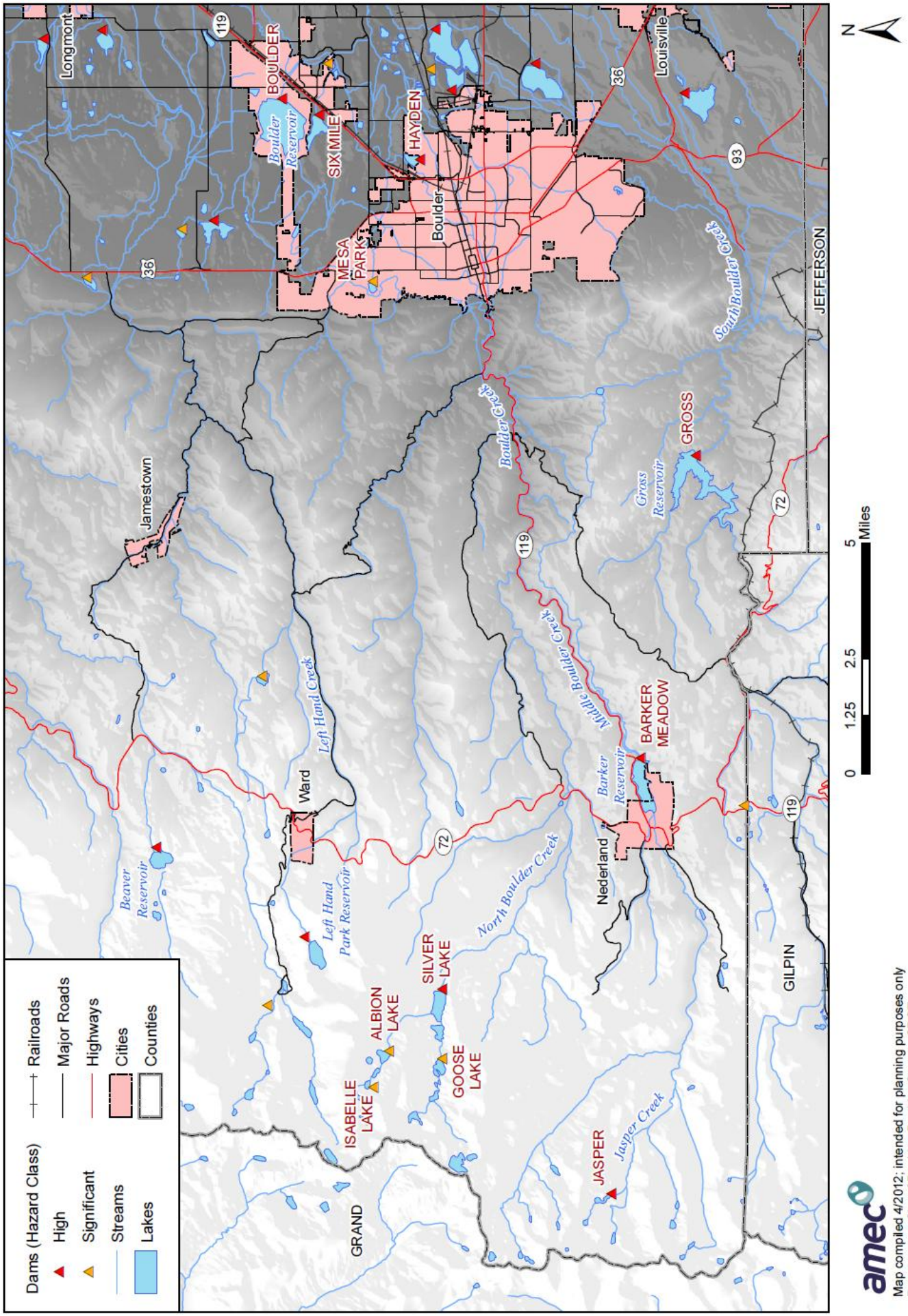
Name	Type of Dam	Year Built	Owner	River	Near City	Distance to City (miles)	Dam Height (ft)	Max Storage (acre-feet*)	Normal Storage (acre-feet*)	Hazard Class	EAP
Jasper	Rockfill	1896	Caribou Ranch - James Gue	Jasper Creek	Eldora	5	18	426	325	H	Y
Boulder	Earth	1955	City Of Boulder	Dry Creek	Boulder	1	44	17,700	13,300	H	Y
Hayden	Earth	1905	Boulder & Lefthand Irrigation	Boulder Creek-Os	Boulder	0	27	765	502	H	Y
Albion Lake	Concrete Gravity	1913	City Of Boulder	North Boulder Creek	Boulder	19	36	700	560	S	Y
Six Mile	Earth	1892	Boulder & White Rock Ditch	Little Dry Creek-Tributary	Boulder	1	35	2,186	1,367	H	Y

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
Silver Lake	Earth	1890	City Of Boulder	North Boulder Creek	Boulder	17	71	4,819	3,987	H	Y
Gross	Concrete Gravity Arch	1955	Denver Board Of Water Com	South Boulder Creek	Eldorado Springs	7	330	47,500	41,811	H	Y
Mesa Park	Earth	1907	City Of Boulder/Open Space	Fourmile Canyon Creek-Tr	Boulder	0	31	260	140	S	Y
Goose Lake	Timber Crib	1908	City Of Boulder	North Boulder Creek-Tributary	Boulder	18	32	1,170	940	S	Y
Davis No. 1	Earth	1886	Boulder & Lefthand Irrigation	Dry Creek-Os	Boulder	0	12	185	137	S	Y
Isabelle Lake	Rockfill	1919	Left Hand Ditch Co	South St Vrain Creek		0	9	0	46	S	N
Barker	Concrete Gravity	1910	Public Service Company of	Middle Boulder Creek	Boulder	14	175	12,400	11,700	H	Y

Source: City of Boulder, Boulder County, CDOT, National Performance of Dams Program

* One acre foot of water is equivalent to 325,000 gallons

Figure 4.1. Locations of Dams that Could Affect the City of Boulder



Barker Reservoir has the potential to have the worst impacts on the city if a dam failure occurred. The structural integrity of the dam during a Peak Maximum Flood (PMF) event was evaluated in a 2011 overtopping study by GEI consultants. The results of the study indicate that the stability of Barker Dam is not expected to be adversely affected due to overtopping in a PMF event. The dam failure hazard extent within city limits is considered significant, potentially impacting 10-50% of the planning area.

Past Occurrences

According to historical data, there have been no dam failures in Boulder. 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.

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 City of Boulder, 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.

4.2.3 Drought

Hazard/Problem Description

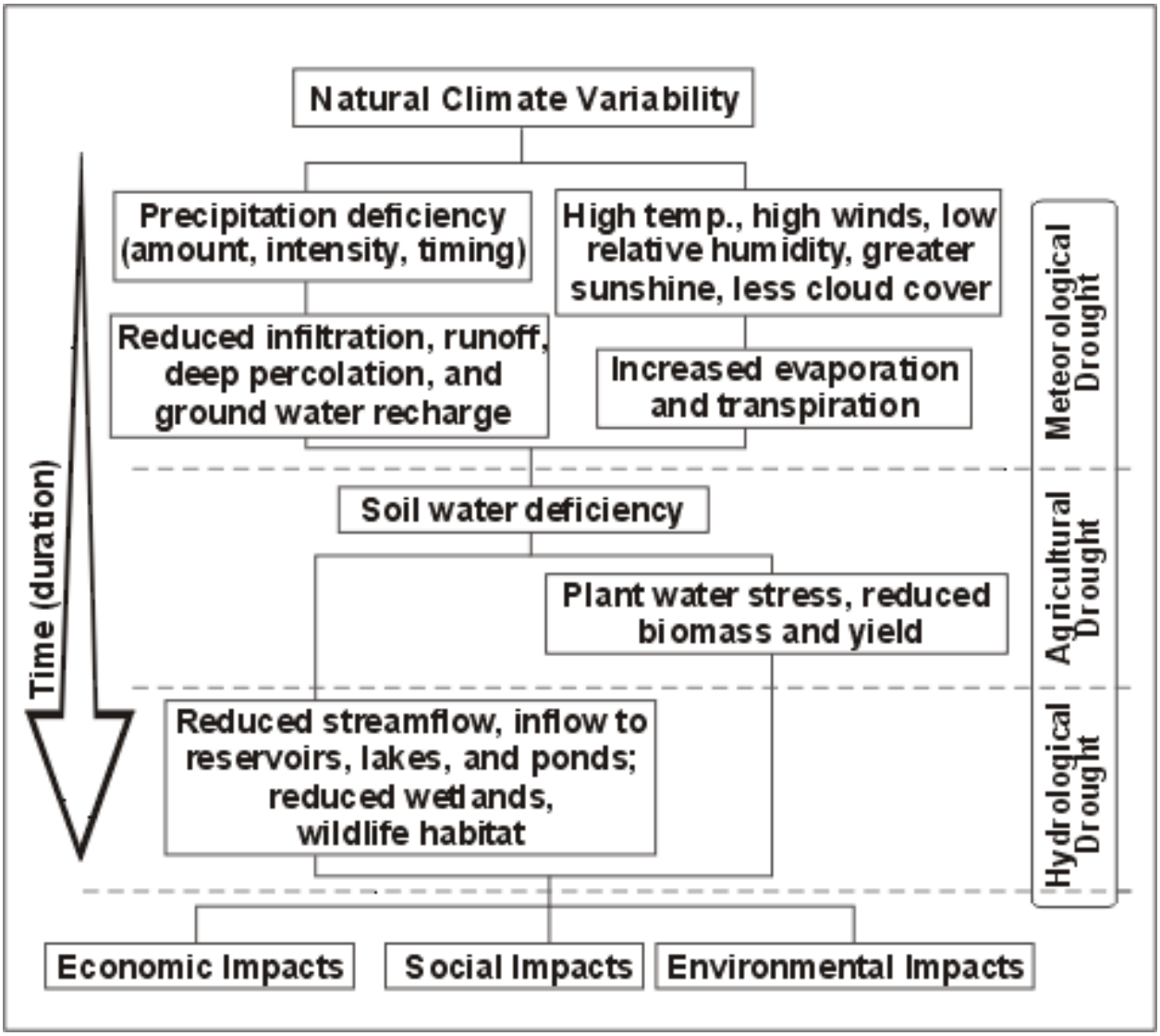
Drought is a gradual phenomenon. Although droughts are sometimes characterized as emergencies, they differ from typical emergency events. Most natural disasters, such as floods or forest fires, occur relatively rapidly and afford little time for preparing for disaster response. Droughts occur slowly, 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 (see Figure 4.2)—it 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

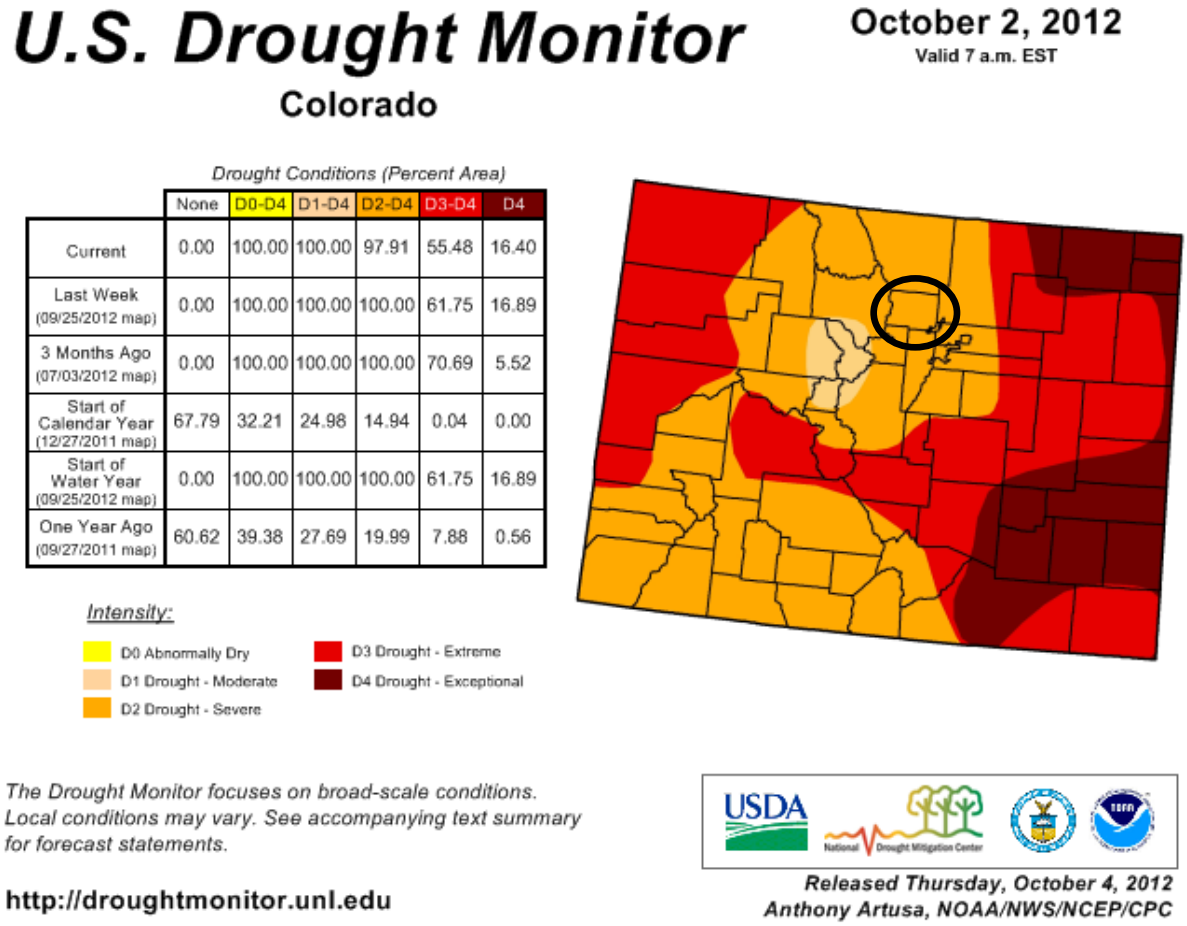


Source: National Drought Mitigation Center

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. Current Drought Status in Colorado and the City of Boulder



Drought Conditions (Percent Area)

	None	D0-D4	D1-D4	D2-D4	D3-D4	D4
Current	0.00	100.00	100.00	97.91	55.48	16.40
Last Week (09/25/2012 map)	0.00	100.00	100.00	100.00	61.75	16.89
3 Months Ago (07/03/2012 map)	0.00	100.00	100.00	100.00	70.69	5.52
Start of Calendar Year (12/27/2011 map)	67.79	32.21	24.98	14.94	0.04	0.00
Start of Water Year (09/25/2012 map)	0.00	100.00	100.00	100.00	61.75	16.89
One Year Ago (09/27/2011 map)	60.62	39.38	27.69	19.99	7.88	0.56

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

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 city limits is considered extensive, potentially impacting 50-100% of the planning area.

Past Occurrences

Several times since the late 1800's, Colorado has experienced conditions of drought. The most dramatic occurred in the 1930s and 1950s when many states, Colorado included, were affected for several years at a time. Table 4.4, drawn from a study done by McKee, Pielke, and Doesken, shows six multi-year droughts experienced in Colorado since 1893. The 2002 drought occurred after the study was published, but the table has been modified to reflect Colorado's most recent and intense drought from 2002 to 2006.

Table 4.4. 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

Source: McKee, et al. *modified for the Colorado State Drought Plan in 2010 based on input from the Colorado Climate Center

The HMPC identified the following as drought events of significance to the city and Boulder County. Some of these droughts may not appear in Table 4.4, as they affected the city and County, but not the entirety of the State.

- **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.
- **2002-2006**—Damage to trees as a result of early twenty-first century drought conditions resulted in pruning and removal costs for both parks and streets estimated at approximately $122,660 in the City of Boulder.
- **2011-2012** – As of the writing of this plan, and as shown in Figure 4.3, the City of Boulder has experienced drought conditions. The extent and depth of the drought is still being determined.

Likelihood of Future Occurrences

Likely: According to historical data, Boulder 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 city 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 City of Boulder in the future.

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 City of Boulder relies primarily on snowpack in the watersheds feeding Middle and North Boulder creeks for its water supply. Higher temperatures can lead to declining snowpacks 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 city 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.

4.2.4 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 Richter 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 4.5). Seismic shaking is typically the greatest cause of losses to structures during earthquakes.

Table 4.5. Earthquake Intensities with Approximate Corresponding Magnitudes

Modified Mercalli Intensity	Description	Richter 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

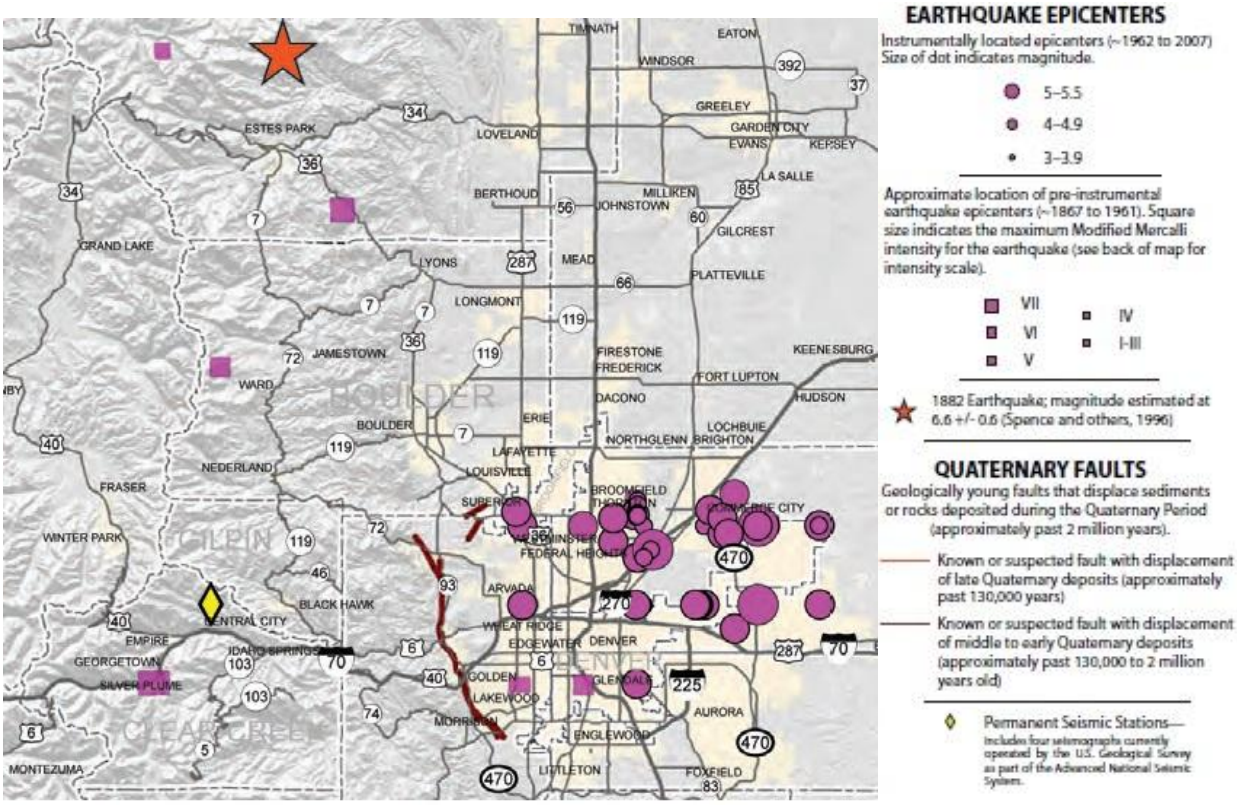
Modified Mercalli Intensity	Description	Richter Magnitude
IV	Moderate: felt by people while walking; rocking of loose objects, including standing houses	4.8
V	Rather strong: felt generally; most sleepers are awakened and bells ring	4.9-5.4
VI	Strong: trees sway and all suspended objects swing; damage 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
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.

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 4.4. 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 4.4 shows the location of faults and past earthquake epicenters in Colorado. Since earthquakes affect large areas the earthquake hazard extent within city limits is considered extensive, potentially impacting 50-100% of the planning area.

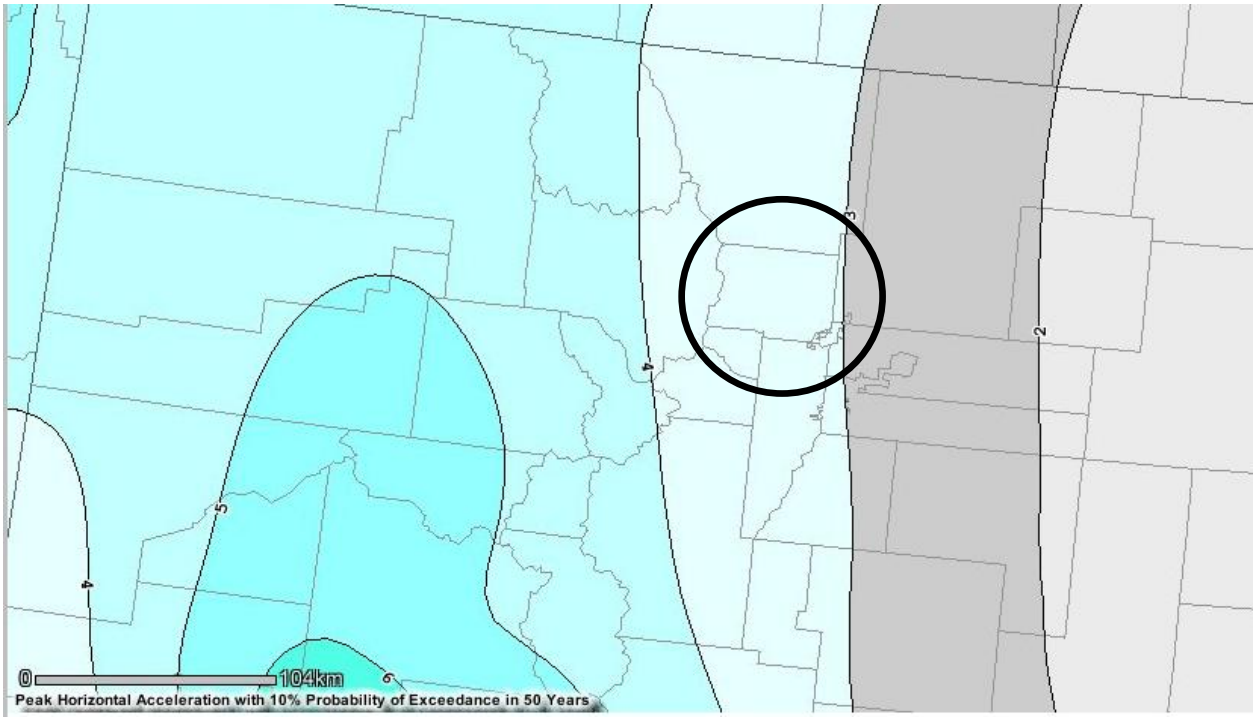
Figure 4.4. Colorado Earthquake and Fault Map



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 4.5 depicts the peak horizontal acceleration (%g) with 10% probability of exceedance in 50 years for the planning region. The figure demonstrates that the city 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.

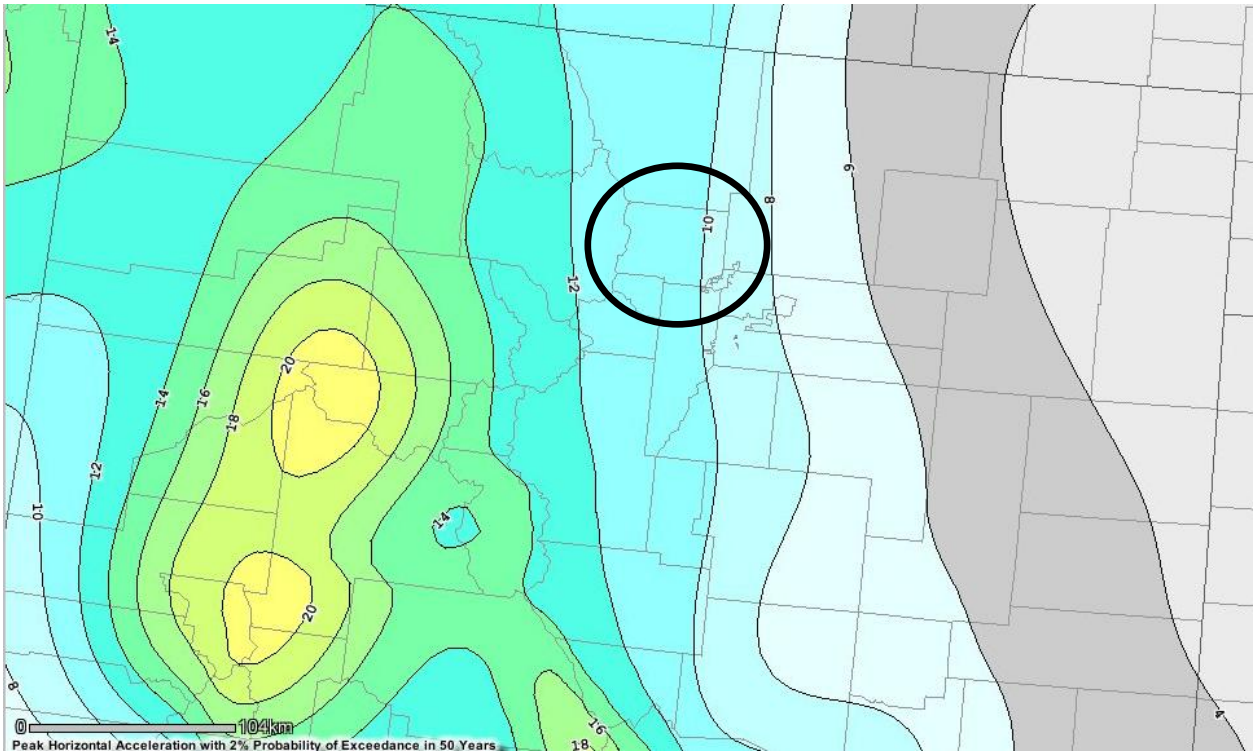
Figure 4.5. Peak Horizontal Acceleration with 10% Probability of Occurrence in 50 Years



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

Figure 4.6 depicts the peak horizontal acceleration (%g) with 2% probability of exceedance in 50 years for the city. The figure demonstrates that the city falls in the 10-12%g area.

Figure 4.6. 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 the City of Boulder.

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 144 years), it is not possible to accurately estimate the timing or location of future dangerous earthquakes in Colorado. Seismologists predict that Colorado will again experience a magnitude 6.5 earthquake at some unknown point in the future. 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.

4.2.5 Floods

Hazard/Problem 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. Communities in Boulder County, including the City of Boulder, are 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 debris blocking a waterway or channel, can further aggravate a flood event. In Boulder, development has altered the natural environment, changing and interrupting some of the natural drainageways. As a result, drainage systems can become overloaded more frequently.

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

The eastern portion of Boulder County has more than 100 irrigation ditches and canals 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. Except at underpasses, 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.

The city's stormwater collection system consists of a variety of storm sewers and open drainage ditches that collect water and divert it to major drainageways. Irrigation ditches collect stormwater in many places in the city. Depending on the amount of rainfall, stormwater flows may exceed ditch capacity and spill out in an uncontrolled manner. Figure 4.12 and Figure 4.13 show the locations of storm sewer mains greater than 24-inches in diameter and irrigation ditches within the city's stormwater system, respectively.

The City of Boulder, in coordination with the Urban Drainage and Flood Control District, controls urban and street flood events with a storm drain system. The Urban Storm Drainage Criteria Manual Volume 3 lays out a four step process for the City of Boulder to help reduce flooding: Employ Runoff Reduction Practices; Implement Best Management Practices that Provide a Water Quality Capture Volume (WQCV) with Slow Release; Stabilize Drainageways; and Implement Site Specific and Other Source Control BMPs. The Criteria Manual recommends storm water collection design to handle the 2 to 10 year event for all land uses. A basic policy of the District, and city, is that major drainage systems, regardless of type, should be capable of conveying water without flooding buildings and remain relatively stable during the major runoff event (e.g., the 100-year flood) and be based on fully urbanized conditions.

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. Specific to the City of Boulder, the following floodplain zones:

- **Floodway (AKA Conveyance) 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 now require only a six inch increase allowance.
- **High Hazard Zone**—All areas in the floodplain where floodwater depth would equal or exceed four feet (or where the product number of the floodwater velocity (in feet per second) multiplied by the floodwater depth (measured in feet) would equal or exceed four). Because of life safety concerns, development in the high hazard zone is the most restricted.
- **Flood Fringe**—Those portions of the floodplain that are not in the conveyance zone or in the high hazard zone.

Also of concern to the City of Boulder 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.

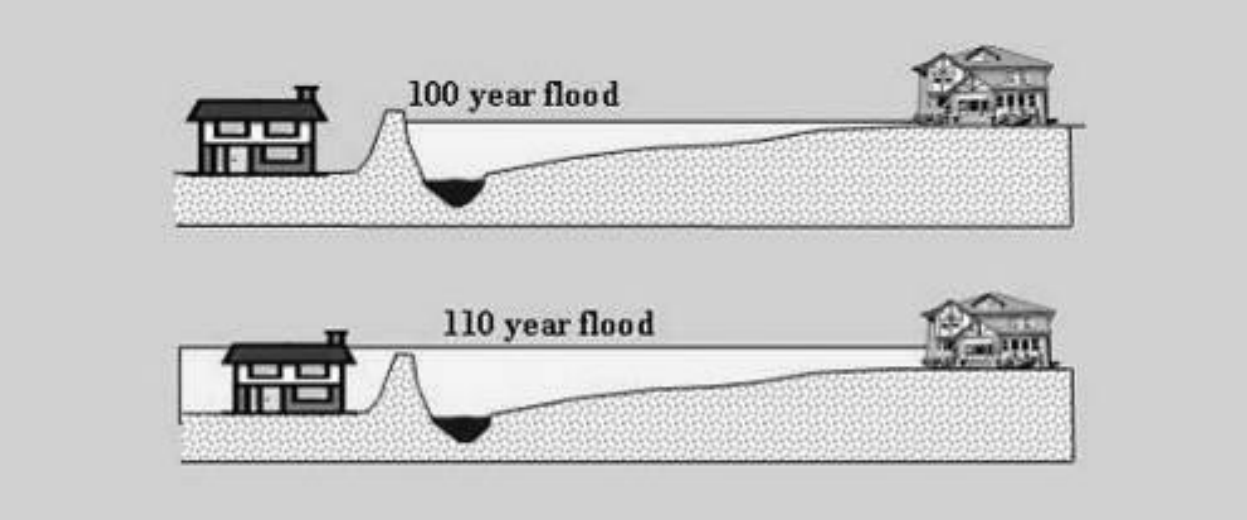
Levee Failure

A levee is a type of dam that runs along the banks of a river or canal. Levees reinforce the banks and help prevent flooding. By confining the flow, levees can also increase the speed of the water. Levees can be natural or man-made. A natural levee is formed when sediment settles on the river bank, raising the level of the land around the river. To construct a man-made levee, workers pile dirt or concrete along the river banks, creating an embankment. This embankment is flat at the top, and slopes at an angle down to the water. For added strength, sandbags are sometimes placed over dirt embankments.

Levees provide strong flood protection, but they are not failsafe. Levees are designed to protect against a specific flood level and could be overtopped during severe weather events. Levees only reduce the risk to individuals and structure behind them, they do not eliminate risk.

Unfortunately, in the rare occurrence when a levee system fails or is overtopped, severe flooding can occur due to increased elevation differences associated with levees (see Figure 4.7) and the increased water velocity that is created. It's also important to remember that no levee provides protection from events for which it was not designed, and proper operation and maintenance are necessary to reduce the probability of failure.

Figure 4.7. Flooding from Levee Overtopping

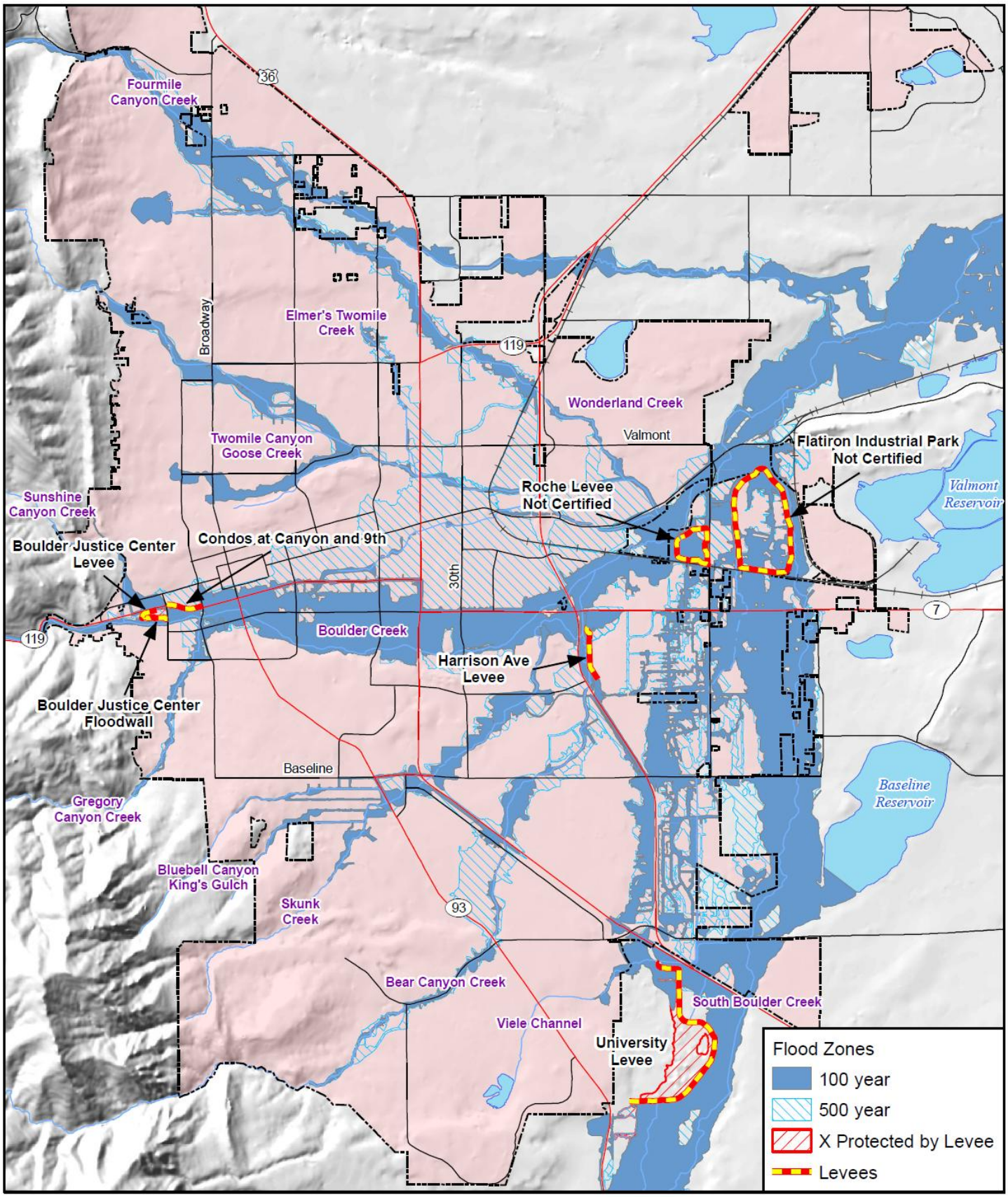


Source: Levees in History: The Levee Challenge. Dr. Gerald E. Galloway, Jr., P.E., Ph.D., Water Policy Collaborative, University of Maryland, Visiting Scholar, USACE, IWR.
http://www.floods.org/ace-files/leveesafety/lss_levee_history_galloway.ppt

The current DFIRMs identify both those levees that have been fully accredited as providing protection from the 100-year flood and those included on the DFIRMs as Provisionally

Accredited Levees (PAL). To best address the issue of levees in the DFIRM process, FEMA provided guidance for the issuance of PAL agreements that would allow for identified levees to be provisionally accredited for purposes of mapping while communities/levee owners are compiling and submitted data and documentation necessary for full accreditation. Fully accredited, PAL designated, and uncertified levees are identified are shown on Figure 4.1 and also included on the Table 4.26 provided in Section 4.1.1 of this document.

Figure 4.8. City of Boulder Levees



0 0.5 1 2 Miles

N

amec

Map compiled 8/2012; intended for planning purposes only
Data source: City of Boulder, CDOT, FEMA Preliminary DFIRM,
*Boulder Creek revised mapping 2012

Major Sources of Flooding

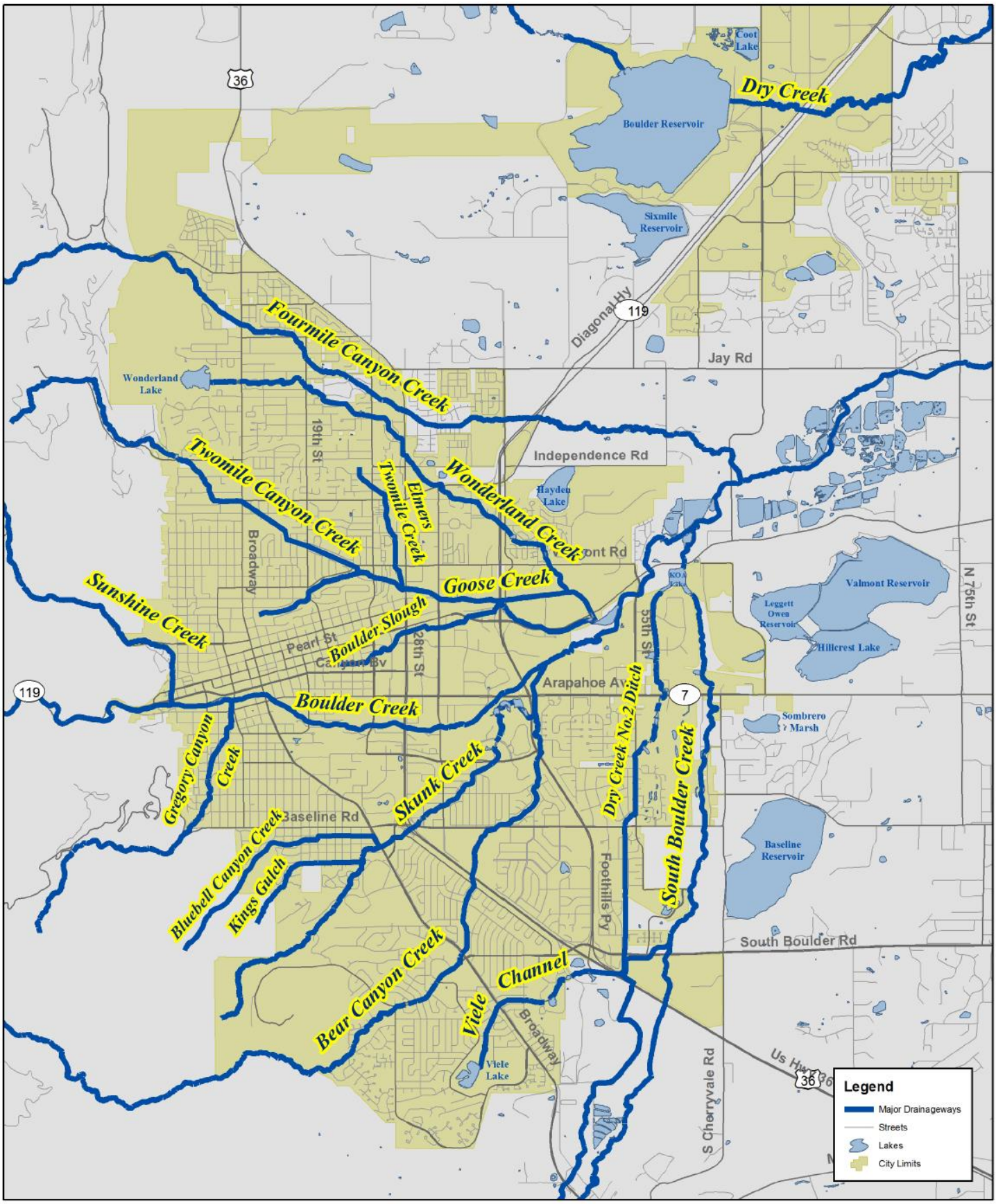
Boulder County has multiple creeks, tributaries, and associated watersheds. The City of Boulder is situated in a region that drops in elevation dramatically from the western foothills at approximately 5,600 feet to the western plains with elevations near 5,200 feet, where excess rain and snow can contribute to downstream flooding. According to data in the 2004 Comprehensive Flood and Stormwater Utility Master Plan, the city is generally split by the west to east flow direction of the main stem of Boulder Creek. The Boulder Creek watershed encompasses 440 square miles and extends from the Continental Divide to the high plains east of the city.

Boulder is crossed by 15 major drainageways or creeks. The primary drainageway through the city is Boulder Creek with its headwaters at the Continental Divide near Arapahoe Pass and Diamond and Jasper Lakes. The tributary drainageways all eventually feed into Boulder Creek north of the Valmont Reservoir. Each of the watersheds for the respective drainages is highly urbanized as a result of the "built-out" condition of the study area. As such, the natural hazards related to stormwater and flood management are particularly complicated by the fact that space is at a premium and thus many structures are within the floodplain.

All drainageways are subject to periodic flooding. The following major drainageways are depicted in Figure 4.9 and the city's basins are shown in Figure 4.10:

- Boulder Creek
- Bear Canyon Creek
- Bluebell Canyon Creek
- Dry Creek
- Dry Creek Ditch No.2 (part of the South Boulder Creek floodplain)
- Elmer's Twomile Creek
- Fourmile Canyon Creek
- Goose Creek/Upper Goose Creek
- Gregory Canyon Creek
- King's Gulch
- Skunk Creek
- South Boulder Creek
- Sunshine Creek
- Twomile Canyon Creek
- Viele Channel
- Wonderland Creek

Figure 4.9. City of Boulder Major Drainageways



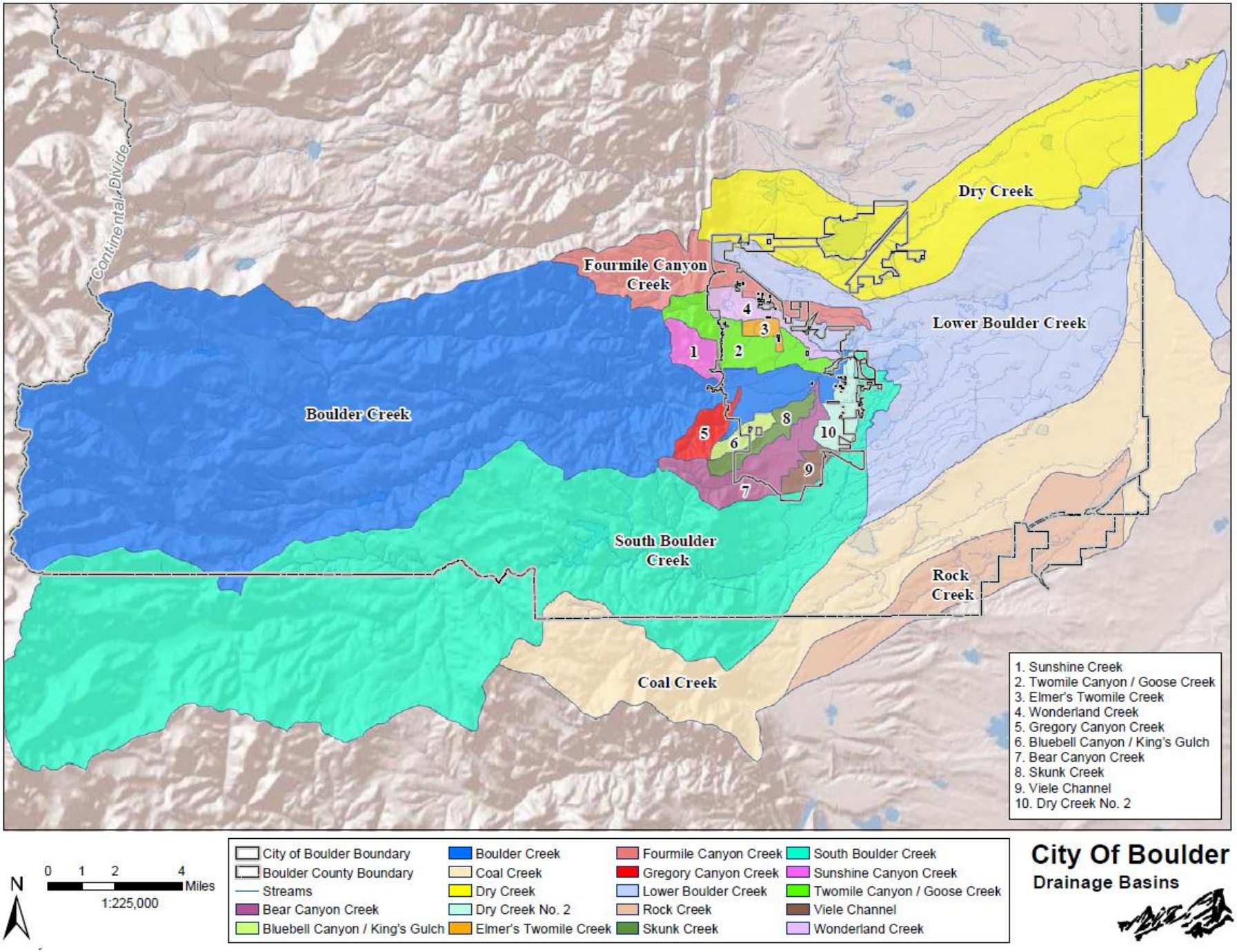
N

0 0.5 1 2 3 Miles

1:60,000

City Of Boulder
Major Drainageways

Figure 4.10. City of Boulder Basins



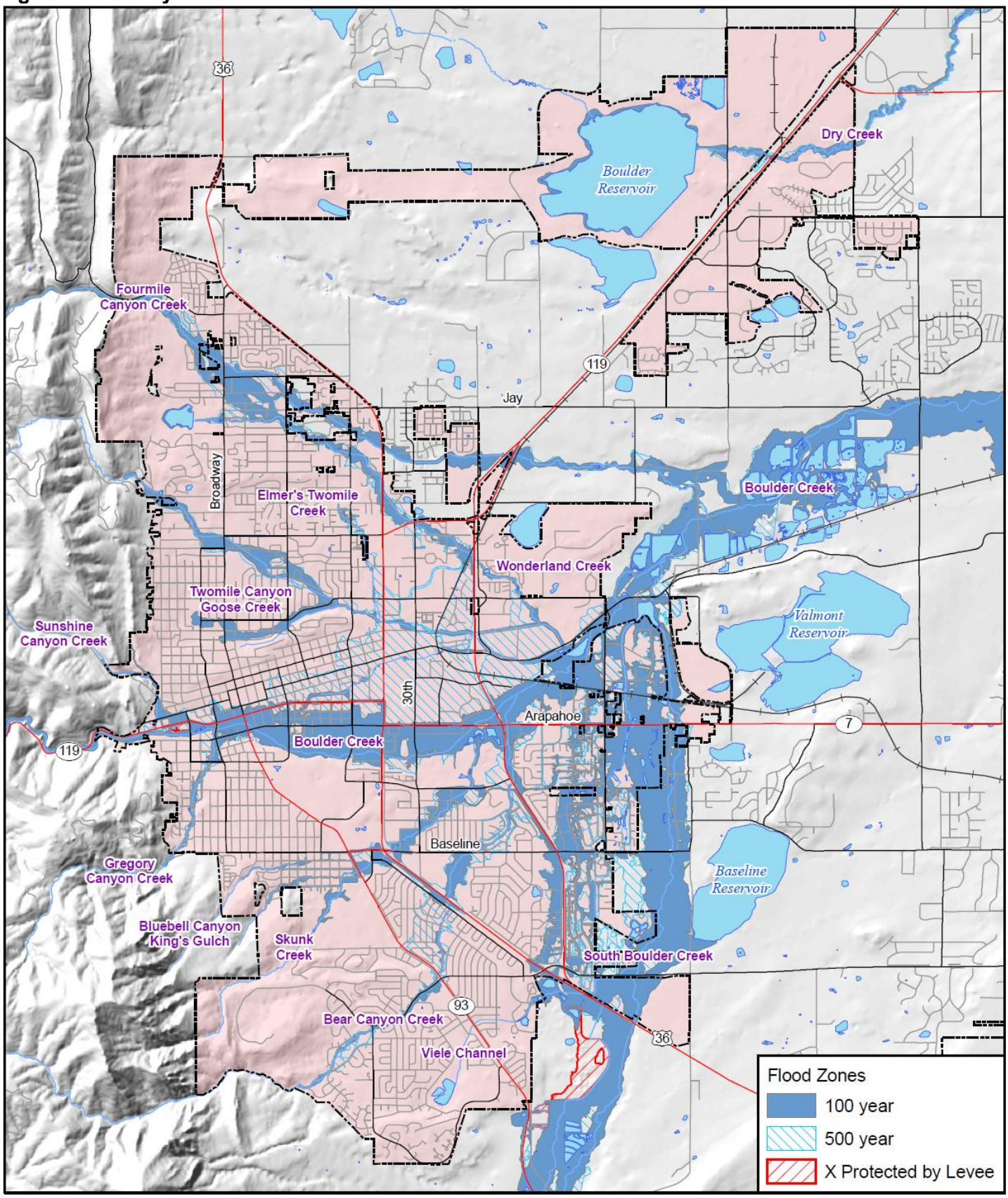
The state considers Boulder to be the city with the highest flood risk in Colorado. Its location at the base of the foothills of the Rocky Mountains makes it vulnerable to flash flooding that can occur with little or no warning (2004 Comprehensive Flood and Stormwater Utility Plan).Within the city, two 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.

According to the HMPC and a flood vulnerability assessment detailed later in Section 4.3 the drainages most likely to experience the most damaging flooding within the City of Boulder are:

- Boulder Creek
- South Boulder Creek
- Fourmile Canyon Creek
- Gregory Canyon Creek
- Twomile Canyon Creek
- Goose Creek
- Bear Canyon Creek
- Skunk Creek

Of the 15 major drainageways, 100-year floodplain boundaries cover more than 15 percent of the lands inside the city limits, which falls within the geographic extent rating of significant (10-50% of the area affected). Figure 4.11 illustrates the city's mapped flood hazard areas. The areas likely to flood are based on mapping that assumes future build-out conditions. Flood hazard areas periodically change to reflect improved and updated mapping techniques as well as areas that may have been altered by flood mitigation projects, typically reflected in the development of Conditional Letters of Map Revision (CLOMR) or Letters of Map Revision (LOMR).

Figure 4.11. City of Boulder Flood Hazards



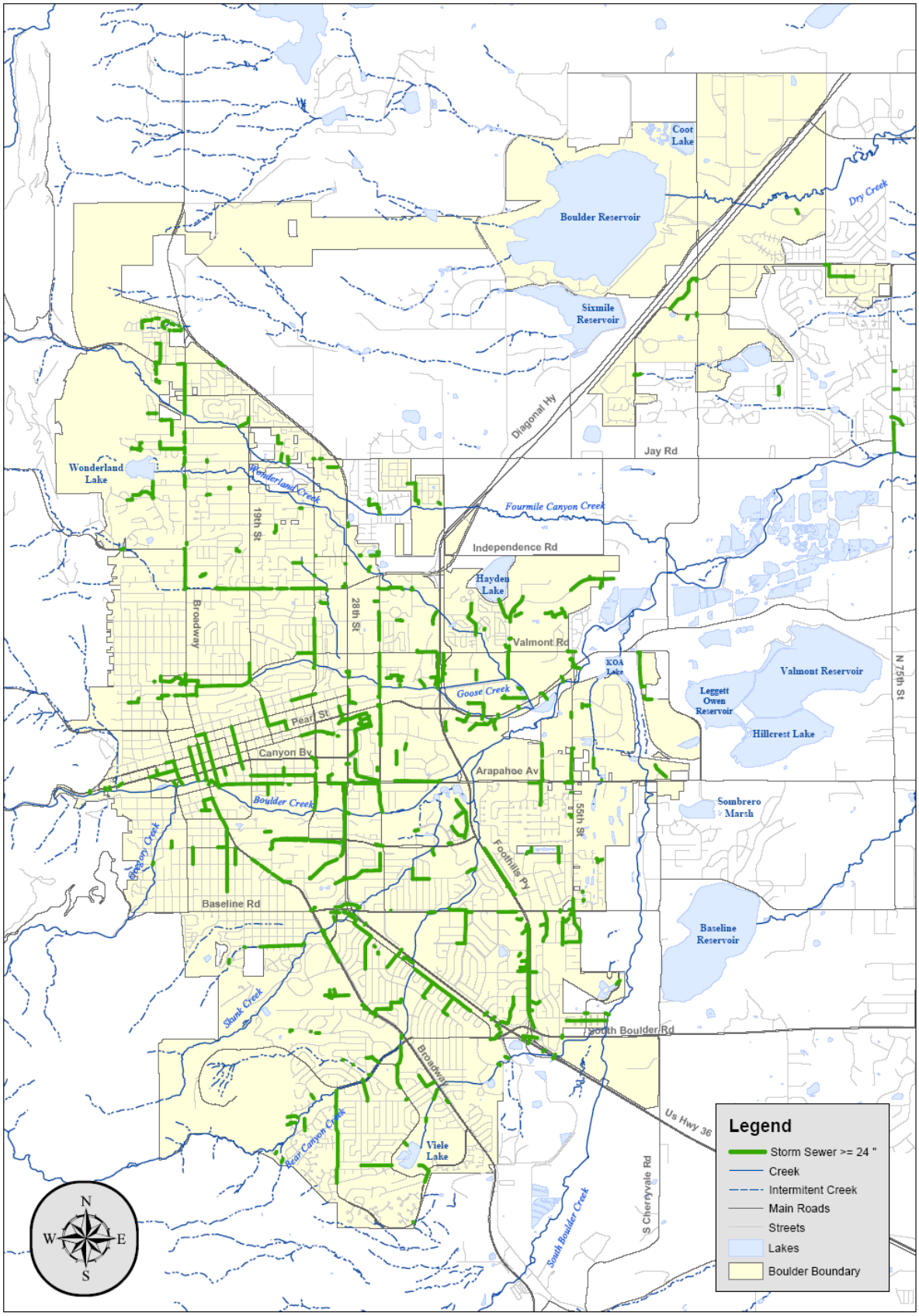
0 1 2 3 Miles

N

amec

Map compiled 8/2012; intended for planning purposes only
Data source: City of Boulder, CDOT, FEMA Preliminary DFIRM,
*Boulder Creek revised mapping 2012

Figure 4.12. City of Boulder Storm Sewer Mains

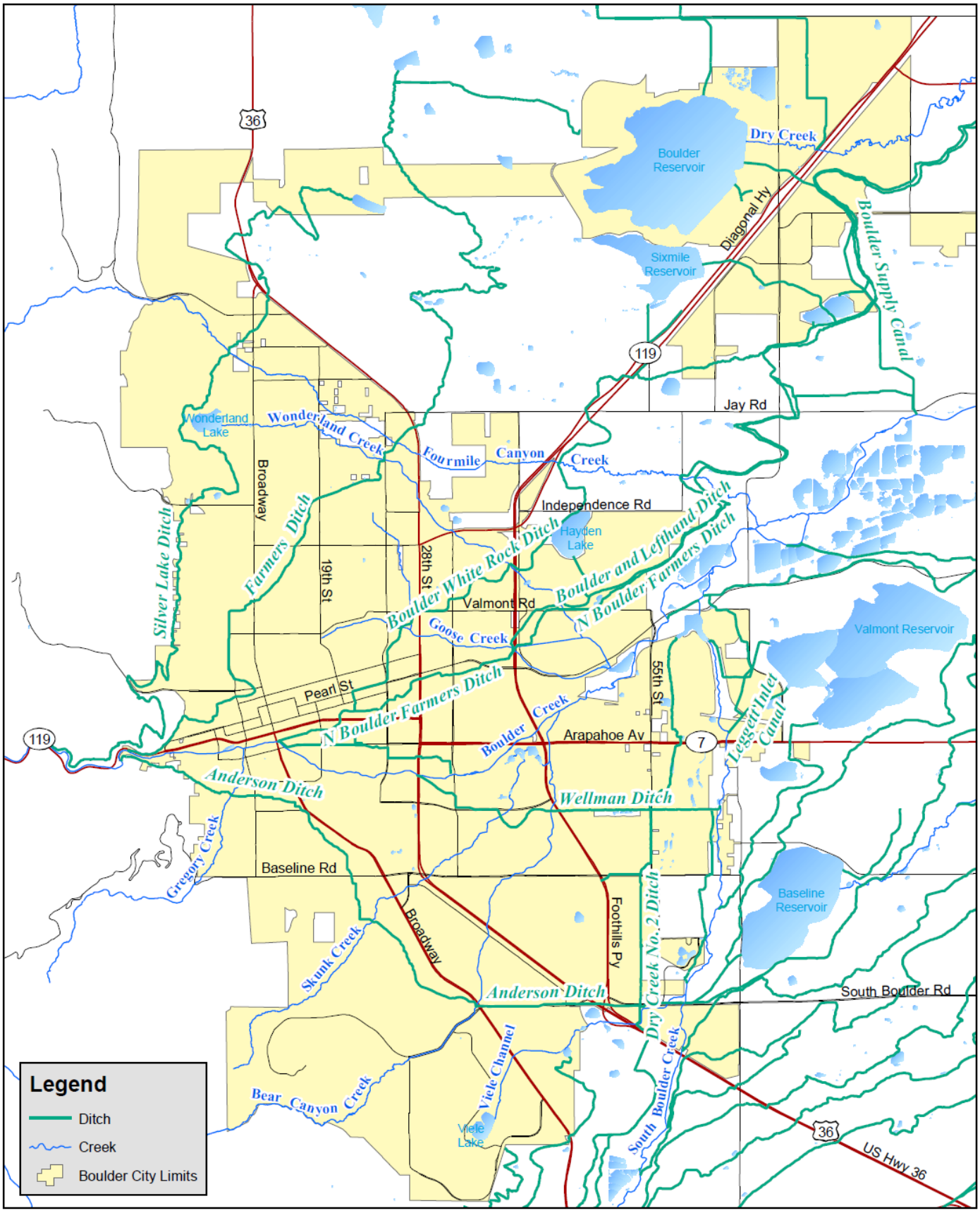


0 0.5 1 2 3 Miles

City Of Boulder

Storm Sewer Mains

Figure 4.13. City of Boulder Irrigation Ditches



N

0 0.5 1 2 3 Miles

1:60,000

City Of Boulder
Irrigation Ditches

Past Occurrences

The official flood season in Boulder County and the City of Boulder is 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 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:

Boulder Creek

Boulder Creek has a long history of severe flooding:

- **May 23, 1876**—A general storm over the Boulder Creek basin created flooding on the plains of Boulder County up to one and a half miles wide.
- **May 29 to June 2, 1894**—This flood, caused by a downpour, washed away much of Boulder's downtown. Mountain rainfall, combined with snowmelt runoff, produced the greatest flood known in Boulder and inundated the valley. Bridges, buildings, roads, and railroads were washed away. Every bridge in Boulder Canyon was swept away destroying the highway and railroads as far up the canyon as Fourmile Canyon Creek. Buildings were destroyed at Crisman, Sunset, and Copper creeks. The town was isolated from other Colorado communities for five days. Only one person was killed. Records indicate that the floodplain was inundated by water over an area as much as one-mile wide for several days. Floodwater covered the entire area between Canyon Boulevard (previously Water Street) and University Hill to depths as great as eight feet. The rainfall amount has been estimated at 5.5 inches. Computations made 18 years later produced estimates of the peak discharge ranging from 9,000 cubic feet per second (cfs) to 13,600 cfs. This was considered a slow-rising flood and designated as a 100-year event. Agricultural damage included loss of livestock, crops, pastures, fences, and roads, and the deposition of sand and silt on floodplain lands. Although damage was extensive, a dollar amount was not estimated at that time.

Source: City of Boulder

- **July 8, 1906**—Heavy rains over Sunshine Canyon (an estimated 2.8 inches Saturday night through Sunday) led to extensive flooding. The water spread out at the point where the dry gulch comes into Pearl Street, rushed down through gardens at the corner of Third Street,

through Pearl, and down into Walnut and Railroad streets. Vast quantities of sand and debris were deposited on lawns and gardens. Water stood two-feet deep on the platform at the Colorado and Southern passenger depot and the yards were so flooded that the tracks were not visible. By building a temporary wall at Third Street, people were able to direct the water in its natural channel across Pearl and down into Boulder Creek. The flooding did considerable damage to the Silver Lake ditch, which broke and contributed a considerable quantity of water to the flood and affected the west part of town.

- **June 1-2, 1914**—The peak discharge on the creek was estimated at 5,000 cfs. Numerous bridges were washed out between Colburn Mill and Boulder Falls. A portion of the main line for Boulder's water system was destroyed.
- **June 2-7, 1921**—Rainfall totaled 3.36 inches in Boulder. A peak discharge of 2,500 cfs was recorded on June 6, 1921.
- **September 4, 1938**—A maximum discharge of 4,410 cfs occurred near the mouth of Boulder Creek. Numerous bridges were destroyed.
- **May 6-8, 1969**—This flood was the result of a combination of snowmelt in the mountains and four days of continuous rainfall. Total precipitation for the storm amounted to 7.6 inches in Boulder and 9.3 inches at the hydroelectric plant in Boulder Canyon. Bear Canyon Creek, Skunk Creek, and Twomile Canyon Creek overflowed their banks. Damage from this storm was estimated at $325,000. Schools were closed. The gaging records show that floods the size of the May 1969 flood occur on an average of about once every five years on Boulder Creek. The picture at right shows the damage at Bear Canyon Creek.

Source: City of Boulder

South Boulder Creek

- **September 2, 1938**—In the mountains west of Eldorado Springs, six inches of rain fell resulting in flooding that destroyed many buildings in the Eldorado Springs community and exceeded previous flood records dating back to 1895. Eldorado Springs recorded 4.4 inches of rainfall. This resulted in a peak discharge of 7,390 cfs, which is the highest recorded flood on South Boulder Creek. The picture at right shows the destroyed dancehall at the Eldorado Springs Resort.

Source: City of Boulder

- **May 7, 1969**— A HDR Hydrology/Climatology Report described this event as a long duration, low intensity general rain. This storm was widespread across the basin and resulting in up to 13 inches of rain over 72 hours. Flood flows at US-36 backed up and eventually overtopped the highway, spreading into the West Valley.

Fourmile Canyon Creek

Fourmile Canyon Creek experiences occasional flooding with notable events occurring in 1916, 1941, and 1951. Railroad bridges were washed out in 1916 and 1941. Localized flooding along the lower reaches of Fourmile Canyon Creek occurs frequently. Damage and losses have generally been low because the area is undeveloped.

- **July 23, 1909**—Heavy rains caused two injuries and two deaths as flash flooding occurred in Twomile Canyon and Fourmile Canyon creeks northwest of Boulder. Damage to bridges and pipelines also resulted. Boulder Creek was not highly affected.
- **July 30, 1916**—Heavy rain (one to three inches) centered over Fourmile Canyon caused a brief but strong flash flood causing flooding of farms and damage to roads, railroad, bridges, and irrigation ditches. Though the Folsom Street (then 26th Street) bridge crossing was covered with three feet of water, it was not damaged by the flood. The flood water was from 10 to 12 feet deep on the Terry ranch. Damage was estimated at several thousand dollars (1916).
- **July 2-7, 1921**—Flooding in Coal Creek and Fourmile canyons occurred destroying numerous structures, injuring and killing livestock, and damaging bridges. The maximum recorded rainfall was 5.3 inches and the greatest recorded rainfall intensity was 4.3 inches in six hours at Longmont. This flood was produced by a combination of rainfall and snowmelt.

Goose Creek

Significant flooding occurred in September 1951 and July 1954. The 1954 event damaged an addition to the community hospital that was under construction.

Twomile Canyon Creek

The worst flood on Twomile Canyon Creek occurred in September 1933. Other flooding events occurred in 1909 (see Fourmile event above), 1941, 1942, 1949, and 1965.

Miscellaneous

- **August 19, 1896**—A cloudburst over Magnolia tore up the road beyond Salina and made Fourmile Canyon Creek impassable. Considerable damage was done to property in Salina. According to reports, "Boulder has not had such a dashing rain storm as that of yesterday afternoon for a long time." The lightning burned out the telephone of the *Daily Camera* office. The rise of the creek in the south part of town was so rapid and of such threatening proportions as to cause great anxiety for two or three hours to the people living in that section.
- **July 31, 1929**—Nearly five inches of rain fell causing flooding in Fourmile Creek, Boulder Creek, and South Boulder Creek. Water ran in streams down Boulder streets and across University Hill lawns and sidewalks. Damage was estimated at $4,000 to roads, bridges, and culverts in Boulder. Principal damage was on 10th Street from Chautauqua to University Avenue and 12th Street from University Avenue to Arapahoe. A large section of the Armstrong Bridge in Gregory Canyon was washed out and 150 feet of Baseline Road in front of the Chautauqua golf course was covered with rock and gravel. A cement sidewalk across Gregory ditch on Marine Street was washed out.
- **June 22, 1941**—Heavy rains caused flooding in areas of Fourmile Canyon Creek, St. Vrain Creek, Twomile Canyon Creek, and Boulder Creek. Flash floods swept a Longmont man to his death. The storm dropped one inch of rain in Boulder and more to the north and west. Roads, gullies, and some structures were damaged in several areas. Damage estimates were in the thousands of dollars (1941). The storm was centered over Sugarloaf Mountain just west of Boulder and primarily affected Fourmile and St. Vrain canyons. Numerous roads were partially or completely destroyed, most west and north of Boulder.
- **May of 1995**—Boulder received record rainfall (9.4 inches) that combined with above average snowfall in the mountains and caused flooding throughout Boulder County. Boulder Creek ran at its highest level of the year, but did not overtop its banks within the city limits. The biggest threat was a related mudslide at the base of Flagstaff Road that threatened six homes.
- **July 20, 1990**—A thunderstorm caused localized flooding in the City of Boulder. Bear Canyon Creek in the Table Mesa area overflowed its banks. Large rocks tumbled down onto Highway 119 at the mouth of Boulder Canyon.
- **June 1993**—Heavy rain caused low-lying flooding and Boulder Creek overflowed its banks onto the creek path where it passes under Broadway. Heavy rain fell in the mountains near Ward and Nederland. Rockslides were reported on Flagstaff Road. The storm dumped 2½ inches of rain in two days in Boulder County, setting records for rainfall and cool temperatures.

- **August 1994**—A severe thunderstorm accompanied by heavy rain caused street flooding in the Cities of Boulder and Longmont. In Boulder, rivers of water more than a foot deep were reported along Canyon Boulevard, Valmont Road, and Folsom Street. On 17th street between Canyon and Arapahoe, the rushing water washed out part of the street creating a deep pit. Lyons was hit the hardest and suffered the most damage. A gas main burst when street flooding caused the road to collapse. Power outages occurred, and many trees were blown down.
- **July 30, 1997**— Heavy rain and hail triggered a flash flood that sent a wall of water through the window of the financial aid office at the University of Colorado (CU). A pipe draining rainwater at the Coors Event Center broke and damaged ceiling tiles, carpets, and dressing rooms. In all, 10 CU buildings received water damage estimated at a total of $100,000.
- **August 4, 1999**—Flooding and flash flooding problems developed over portions of the Front Range urban corridor as slow moving thunderstorms dumped from 2 to 3.5 inches of rain in approximately three hours. Widespread street flooding was reported in Boulder as was damage to the University Memorial Center at CU.
- **August 15, 2007** – This sudden storm hit the southern part of Boulder producing upwards of 1.5 inches of rain between 5:00 and 5:30 PM, and causing alarming water levels on Bear Canyon Creek. This normally small stream runs between the east and westbound lanes of Table Mesa Drive west of Broadway (Colorado Highway 93). The photo on the left below shows that roadway culverts had reached their capacity. Another inch of rain could have resulted in flood damages to adjacent properties as shown by the aerial photo depicting the extents of the 100-year floodplain. The intersection of Table Mesa Drive and Broadway is in the upper right corner of the lower right image.

Source: Urban Drainage and Flood Control District

- **Wednesday/Thursday, June 4-5, 2008** — A general rainfall with embedded thunderstorms began around 3 p.m. lasting overnight and into the afternoon of the second day. Rainfall amounts of up to 2¼ inches occurred across the Urban Drainage and Flood Control District over a 36-hour period. The heaviest rains of ¾" to 1.6" occurred during a 2.5-hour period on Wednesday afternoon when three thunderstorms lined-up, each producing between ¼" and ½" in 10 to 20 minutes over northern Jefferson, SE Boulder, Broomfield and NW Adams

Counties. The NWS issued an urban and small stream flood advisory for Boulder and reported 1.5-inch diameter hail near Standley Lake in Jefferson County. While the ALERT system remained relatively quiet with no rainfall alarm thresholds (½" in 10min, 1" in 1hr) exceeded anywhere in the network, June 4 turned out to be Boulder's biggest rain day of the 2008 flood season. (Source: UDFCD)

- **Thursday-Saturday, April 16-18, 2009** – The first big precipitation event of the 2009 flood season accompanied a winter storm. Precipitation totals from a combination of melted snow and rain exceeded 4-inches in SE Boulder County. A number of ALERT stations elsewhere measured more than 3-inches while one gage in Jefferson County (West Metro Fire Station 12) recorded more than 5-inches. Many streams were flowing well above normal and four stormwater detention basins recorded annual peaks: Kelly Road Dam in Denver, Flying-J in Aurora, Gunbarrel in Boulder and Basin 3207/Pond 6 in Broomfield. The storm forced closure of many schools as well as the District's office. No flood watches or warnings were issued for this event. (Source: UDFCD)

- **Tuesday, June 8, 2010** – High snowmelt runoff rates are common in mountain streams at this time of year. What is not common is the issuance of a flash flood watch for snowmelt runoff without any threat of heavy rainfall, but that's precisely what happened on this particular day. The circumstance that led to this decision by the NWS was the partial failure of a private road crossing of Boulder Creek at the Red Lion Inn in the canyon west of Boulder. The main concern was for areas immediately downstream in the event that runoff waters would pile-up against the bridge and release suddenly. Fortunately, nothing serious developed. Peak flows on Boulder Creek were approaching 1,000 cfs when the runoff waters did an end-around leaving the culverts in place with the road crossing impassable. The privately owned bridge ultimately had to be replaced by the owner. For five consecutive days following for Red Lion incident (June 9-13), a heavy rain threat did exist for the region prompting the NWS to issue subsequent flash flood watches for the 12th and 13th. From June 11-13, the rainfall totals in the Boulder Creek watershed upstream of Boulder ranged from 2 to 3 inches but the intensities were quite low and the resulting runoff remained within the banks (Source: UDFCD).
- **Tuesday, July 6, 2010** – In Boulder County north of the city, an ALERT rain gage south of Lyons in the Red Hill Gulch basin measured the year's most intense 10-minute rainfall of 5.4 in/hr during a 10 pm storm that lasted only 17 minutes. Earlier that same evening the NWS issued a flash flood warning at 7:27 pm for another intense storm that dropped 2 to 3 inches east and southeast of the District in northern Elbert and central Arapahoe and Adams Counties.
- **Wednesday, July 28, 2010 –**A very impressive severe thunderstorm in the Nederland area west of Boulder dropped over 8 inches of pea-to-marble-sized hail near the Eldora ski area with radar-estimated rainfall totaling 2-4 inches and prompting the NWS at 3:55 pm to issue its second flash flood warning of the year for Boulder County. Runoff from this storm caused streams to overflow their banks and wash over bridges and roadways, flooding streets

in Nederland and causing car accidents. Roads were closed until they could be reopened by snowplows. Like the July 6 storm, the District was not impacted by this event.

- **Monday, August 16, 2010** – Although this was not the final flood threat day of 2010, it did mark the second most intense downpour measurement of the year—0.96" in 10 minutes at 5:47 pm, Station No. 4840 (South Boulder Creek at South Boulder Ditch) near CU-Boulder's South Campus site.

2011 Flood Season

The 2011 flood season had an above average number of threat days. To some extent this resulted from the elevated risk associated with the Fourmile Burn Area (FMBA), but was coupled with an above average snowpack runoff. A storm on July 13 was the most serious, which threatened lives and damaged homes in the mountains of Boulder County less than three miles west of the city boundary in the FMBA.

Twenty-four hour precipitation totals exceeded three inches on three days in 2011 (May 11 & 18 and July 7). Nine other days (Jun19; Jul 8, 11, 12, 13, and 14; Aug 20; Sep 2 and 14) had rain totals ranging from 2 to 3 inches with July 13 resulting in the greatest damage from just over an inch of rain

Spring and summer 2011 had an unusually late runoff season with melting snow from the mountains affecting Colorado streamflows well into July. The plot below shows data from the Boulder Creek stream gage near Orodell with records that date back 104 years. Note the difference between the 104-year averages from mid-June to mid-July. When the Fourmile Creek flash flood occurred on July 13, the runoff from snowmelt was as least three times its normal rate. The plot below shows that the South Platte River basin held on to its snowpack through late May into early June, then the runoff became aggressive, nearly matching the maximum recorded event. Consequently, streams like Boulder Creek were flowing well above normal when the monsoon rains arrived in early July.

Fourmile Burn Area Events

In describing the 2011 flood season, this recap begins in mid-January when dire predictions were being made concerning the elevated flash flood threat posed by the Fourmile Burn Area (FMBA). While there was general agreement that the risk was extremely high for those living in or traveling through the FMBA during a heavy summer downpour, opinions varied widely with respect to how such a relatively small burn area of less than 6,200 acres could seriously threaten the City of Boulder. Post- Fourmile burn hydrologic models indicated that a short duration rainstorm of 2-inches or more over the FMBA could certainly cause problems in Boulder along Boulder Creek. It was also suggested that Fourmile Canyon Creek on the north side of Boulder may actually pose a greater threat.

Paleoflood investigations conducted by Bob Jarrett of the USGS suggested that the Fourmile Creek minor flood events of 1995 and 2003, with estimated peaks of less than 500 cfs, were

likely the largest floods experienced by this area in at least the past 75 years. The Boulder Creek flood of 1969, the largest in recent memory, resulted from four days of moderate intensity rainfall in the mountains that exceeded 9 inches at the Boulder Hydroelectric Plant and produced a peak flow on May 7 through Boulder of 2,500 to 3,000 cfs. The May 30, 1894 flood is the historic flood of record for this area, caused extensive damage along Boulder Creek and Fourmile Creek, and generated an estimated peak through Boulder of 12,000 cfs. Paleoflood studies of the 1894 event revealed that most of the rain-driven runoff came from the 25 square mile Fourmile Creek watershed and that Boulder Creek above the Fourmile Creek confluence showed little geologic evidence of high flows.

A post-fire threat assessment was conducted to evaluate potential impacts for a range of rainfall intensities. A flood hazard inventory for Fourmile Creek and Gold Run suggested that flow rates as small as 100 cfs could overtop and potentially wash-out many private drive crossings, and that larger capacity road crossings like Colorado Highway 119 could handle no more than 2,000 cfs prior to overtopping, and that as many as 80 structures were at risk, with approximately 20 of those—mostly private homes—potentially threatened by flow rates of less than 1,500 cfs.

The National Weather Service made use of these investigations, advice from the USGS, and their own past experience with post-wildfire Colorado floods like Hayman and Buffalo Creek to establish initial criteria for issuing public advisories, watches and warnings. With a high danger for mud, rock and debris slides, a very low ¼-inch per hour rain rate was established as the advisory threshold for road problems and minor flooding. The warning threshold for flash flooding in the FMBA was set for one hour rainfalls exceeding ½-inch. For the City of Boulder more rain would be required to cause a serious threat and therefore, the initial warning threshold for the city was set for an hourly amount of 1.5 inches. Prior to the fire, less than 2 inches of rain in the mountains would not likely have posed any serious flooding threat.

With the technical resources in place and the research/study results in hand, emergency management officials, fire districts and other agencies in Boulder County undertook a major public education effort to prepare people for what might happen. These measures proved life-saving by July when the summer monsoon rains arrived.

On late afternoon of July 7th a small amount of rain fell over the FMBA causing a 100-yard wide by 4-foot deep debris/rock/mud slide, forcing the closure of Fourmile Canyon Drive near Emerson Gulch where the 2010 fire started. The burn area rain was on the northern edge of a much larger storm cell that prompted the NWS to issue a flash flood warning for the FMBA at 6:19 pm as it approached. Fortunately the intense portion of the storm missed its target. Had the storm cell in Boulder County centered over the FMBA, the impacts in the burn area and downstream through Boulder would have been devastating.

July 7 also caused the biggest rain-related impact to the FMBA to date and drew considerable media attention. It is interesting to note just how low the rain measurements were, ranging from only 0.12 to 0.35 inches. To the south and southwest rainfall amounts in the Sugarloaf and

Nederland areas totaled 1.73 and 2.01 inches respectively. One observer in the FMBA near Long Gulch did provide a report of 0.96" in 16-minutes. The Fourmile Creek gage at Logan Mill Road measured a rapid half-foot rise that was of little consequence. The largest rainfall measurements exceeded 3-inches in Denver and Aurora, and the ALERT system logged 117 rainfall rate alarms from 44 locations. As of 7:50 pm, the WebEOC status board indicated no reports of any infrastructure damage other than road debris blockage in the FMBA, no homes impacted, electricity and phones working. The event summary also noted that people did evacuate to high ground with no injuries reported.

The flash flood of July 13 was the most devastating Boulder County flood of the 2011 flood season. A flash flood warning for the FMBA was issued at 6:17 pm. At 8:08 pm the warning was extended to include Boulder Canyon west of Boulder. Four-foot surges in water levels on Fourmile Creek were observed and publically reported. Sirens were sounded in the City of Boulder at 8:17 pm and people reacted, some properly while others could have done better. At 8:37 pm the NWS issued a flood advisory (not a warning) that included the City of Boulder. Boulder Creek and Fourmile Canyon Creek on the north side presented concerns. Fortunately the impacts in the City of Boulder were minimal with Boulder Creek rising less than a foot and Fourmile Canyon Creek keeping within its flood channel for the most part with some basement damage reported.

Some of the impacts of the event included these observations from the field:

- 12 people stranded behind a washed out road were found safe.
- Lots of debris and rock on roads.
- Cars trapped between mud and trees.
- Sheriff Deputies saw debris flows and water over roads.
- Bridges and roads washed out.
- Large debris being carried by Fourmile Creek.
- At least 10 private properties, including some homes, were damaged.
- 4 people were treated for exposure and minor injuries at Gold Hill after being rescued. They were covered head-to-toe with mud.
- A fire department vehicle in route to a rescue was washing off Gold Run Road by raging floodwaters. Damages to the vehicle totaled $1,500. No one was hurt.
- Walls of water 6' to 10' high were observed by fire and Sheriff Department officials at a number of locations in both the Fourmile Creek and Fourmile Canyon Creek drainages. Ingram Gulch was one of those locations.
- Surprisingly slow movement of "walls of water" was observed.

Many YouTube videos are available of this flood and its impacts. The UDFCD has also archived many local news broadcasts of the event. In hindsight, the siren sounding in Boulder may not have been necessary but that action did provide a unique opportunity to assess the public's response to the warning. This experience may help save lives in the future.

City of Boulder Flood Insurance Statistics

Information on the City of Boulder's participation in the National Flood Insurance Program (NFIP) provides some detail on damage associated with flood events since the program's inception in 1978. From 1978 through February 2012, the City of Boulder had 29 NFIP closed paid losses totaling $159,197. As of February 2012, the city had 3,196 NFIP policies in force with $711,927,400 in total coverage.

Likelihood of Future Occurrences

Occasional: The 100-year flood is the flood that has a one percent chance in any given year of being equaled or exceeded.

Likely: Localized stormwater flooding at some location in Boulder generally occurs on an annual basis. The extent of damage varies.

According to the HMPC, it only takes three inches of rain over a few hours to trigger a 100-year flood. A devastating flash flood has never occurred on Boulder Creek in the City of Boulder; however, because of its large population and location at the mouth of the narrow Boulder Canyon, the city has the greatest potential for loss of life from a flash flood of any community in Colorado. An estimated 6,000 people live and work in the floodplain of Boulder Creek, which runs through the heart of the city. Since the city and county have a history of flooding, the potential exists for more flooding in the future. This likelihood has increased (for up to the next eight years) due to the Fourmile burn, as evidenced by the relatively small amounts of rain in 2011 creating flood problems in the watershed, but thus far only minor impacts downstream in Boulder along Boulder Creek.

With respect to stormwater flooding, according to the 2004 Comprehensive Flood and Stormwater Utility Plan, depending on the amount of rainfall, stormwater flows may exceed ditch 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.

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 at this point in time it 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 Boulder County, 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.

4.2.6 Human Health Hazards: Pandemic Flu

Hazard/Problem Description

A pandemic is a global disease outbreak. A pandemic flu is a virulent human flu that causes a global outbreak, or pandemic, of serious illness. A flu pandemic occurs when a new influenza virus emerges for which people have little or no immunity, and for which there is no vaccine. This disease spreads easily person-to-person, causes serious illness, and can sweep across the country and around the world in very short time. The U.S. Centers for Disease Control and Prevention has been working closely with other countries and the World Health Organization to strengthen systems to detect outbreaks of influenza that might cause a pandemic and to assist with pandemic planning and preparation.

Most recently, health professionals are concerned by the possibility of an avian (or bird) flu pandemic associated with a highly pathogenic avian H5N1 virus. Since 2003, avian influenza has been spreading through Asia. A growing number of human H5N1 cases contracted directly from handling infected poultry have been reported in Asia, Europe, and Africa, and more than half the infected people have died. There has been no sustained human-to-human transmission of the disease, but the concern is that H5N1 will evolve into a virus capable of human-to-human transmission.

An especially severe influenza pandemic could lead to high levels of illness, death, social disruption, and economic loss. Impacts could range from school and business closings to the interruption of basic services such as public transportation, health care, and the delivery of food and essential medicines. Since the hazard can affect 50-100% of the planning area it was given an extensive geographic extent rating.

Past Occurrences

There were three acknowledged pandemics in the twentieth century:

- **1918-19 Spanish flu (H1N1)**—This flu is estimated to have sickened 20-40 percent of the world's population. Over 20 million people lost their lives. Between September 1918 and April 1919, 500,000 Americans died. The flu spread rapidly; many died within a few days of infection, others from secondary complications. The attack rate and mortality was highest among adults 20-50 years old; the reasons for this are uncertain.

- **1957-58 Asian flu (H2N2)**—This virus was quickly identified due to advances in technology, and a vaccine was produced. Infection rates were highest among school children, young adults, and pregnant women. The elderly had the highest rates of death. A second wave developed in 1958. In total, there were about 70,000 deaths in the United States. Worldwide deaths were estimated between 1 and 2 million.
- **1968-69 Hong Kong flu (H3N2)**—This strain caused approximately 34,000 deaths in the United States and more than 700,000 deaths worldwide. It was first detected in Hong Kong in early 1968 and spread to the United States later that year. Those over age 65 were most likely to die. This virus returned in 1970 and 1972 and still circulates today.

To date, the 21st century has seen one acknowledged pandemic.

- **2009 Swine Flu (H1N1)**—This strain caused more than 14,700 deaths worldwide to date, according to the WHO. It was first detected in the United States in early 2009 and spread to the world later that year. About 70 percent of people who have been hospitalized with this 2009 H1N1 virus have had one or more medical conditions previously recognized as placing people at "high risk" of serious seasonal flu-related complications. This included pregnancy, diabetes, heart disease, asthma, and kidney disease. Young children were also at high risk of serious complications from 2009 H1N1, just as they are from seasonal flu. And while people 65 and older were the least likely to be infected with 2009 H1N1 flu, if they got sick, they were also at "high risk" of developing serious complications from their illness.

Likelihood of Future Occurrences

Occasional: According to historical data, four influenza pandemics have occurred since 1918. This is an average of a pandemic approximately every 24 years or an approximate 4 percent chance of pandemic in any given year.

Although scientists cannot predict when the next influenza pandemic will occur or how severe it will be, wherever and whenever it starts, everyone around the world will be at risk. If an influenza pandemic does occur, it is likely that many age groups would be seriously affected. The greatest risks of hospitalization and death—as seen during the last two pandemics in 1957 and 1968 as well as during annual outbreaks of influenza—will be to infants, the elderly, and those with underlying health conditions. However, in the 1918 pandemic, most deaths occurred in young adults. Few people, if any, would have immunity to the virus.

4.2.7 Human Health Hazards: West Nile Virus

Hazard/Problem Description

The impact to human health that wildlife, and more notably, insects, can have on an area can be substantial. Mosquitoes transmit the potentially deadly West Nile virus to livestock and humans alike. West Nile virus first struck the western hemisphere in Queens, New York, in 1999 and

killed four people. Since then, the disease has spread across the United States. In 2003, West Nile virus activity occurred in 46 states and caused illness in over 9,800 people.

Most humans infected by the virus have no symptoms. A small proportion develop mild symptoms that include fever, headache, body aches, skin rash, and swollen lymph glands. Less than 1 percent of those infected develop more severe illness such as meningitis or encephalitis, symptoms of which include headache, high fever, neck stiffness, stupor, disorientation, coma, tremors, convulsions, muscle weakness, and paralysis. Of the few people who develop encephalitis, fewer than 1 out of 1,000 infections die as a result.

There is no specific treatment for the infection or a vaccine to prevent it. Treatment of severe illness includes hospitalization, use of intravenous fluids and nutrition, respiratory support, prevention of secondary infections, and good nursing care. Medical care should be sought as soon as possible for persons who have symptoms suggesting severe illness. People over 50 years of age appear to be at high risk for the severe aspects of the disease.

West Nile virus is a fairly recent natural hazard to affect Colorado. Boulder County and the City of Boulder recognize the potential for West Nile virus to occur within the area. A public outreach campaign is in place throughout the city and county to educate the public, and efforts have been made to reduce the mosquito population. Since the hazard can affect 50-100% of the planning area it was given an extensive geographic extent rating.

Past Occurrences

Information from the Colorado Department of Public Health (CDPHE) indicated that West Nile virus was first detected in Colorado in 2002. The county did not have its first case of the virus in humans until 2003. Table 4.6 summarizes historical West Nile virus information in Colorado and Boulder County. Based on the information in Table 4.6, the virus peaked in 2003, with another spike in 2007, but has steadily declined since then. There have been some concerns that West Nile could return in 2012 associated with stagnant water and drought conditions, which is being observed in other areas of the Midwest undergoing severe drought.

Table 4.6. Summary of West Nile Virus Cases in Colorado and Boulder County 2001 to 2011

	Humans		Birds		Mosquitoes		Veterinary		Sentinel Flock	
Year	CO	Boulder	CO	Boulder	CO	Boulder	CO	Boulder	CO	Boulder
2001	0	0	0	0	0	0	0	0	0	0
2002	14	0	137	5	15	0	380	3	3	0
2003	2,947 (63)	421** (7)	766	50	639	118	393	18	213	22
2004	291	14	55	0	168	8	30	0	0	0
2005	106	5	40	1	122	0	0	13	0	0
2006	345 (7)	74 (1)	50	12	419	106	7	1	0	0

Year	Humans		Birds		Mosquitoes		Veterinary		Sentinel Flock	
	CO	Boulder	CO	Boulder	CO	Boulder	CO	Boulder	CO	Boulder
2007	555 (6)	95 (2)	121	2	636	55	29	0	0	0
2008	71	13	–	–	–	–	–	–	–	–
2009	68	12	–	–	–	–	–	–	–	–
2010	55	6	–	–	–	–	–	–	–	–
2011	7	2	–	–	–	–	–	–	–	–

Source: U.S. Geological Survey, http://diseasemaps.usgs.gov/; Colorado Department of Public Health and Environment, www.cdphe.state.co.us/dc/zoonosis/, Boulder County Public Health, www.co.boulder.co.us/health/hpe/wnv/
Notes:
*73 were in the City of Boulder
Numbers in parentheses indicate deaths.
After 2007, the CDPHE publishes only human incidents of West Nile Virus

Likelihood of Future Occurrences

Occasional: According to the Boulder County Health Department, Boulder County and the City of Boulder will continue to be at risk to West Nile virus. However, the severity of the virus is expected to change from year to year, depending on variables such as weather patterns, the mosquito population, the bird population, and immunity in humans. The state will continue their surveillance for the disease. The number of incidents of the disease has been declining since 2007.

Climate Change Considerations

According to the Boulder County Climate Change Preparedness Plan milder weather in the current "cold" seasons and warmer weather in the summer could make the county a more suitable habitat for new mosquito species, increasing the potential for additional cases of some mosquito-borne diseases that are already established in the county. At the same time, increases in the precipitation associated with extreme events could increase the habitat suitable for supporting mosquitoes. Drawing definitive conclusions about public health risk changes associated with vector-borne illnesses as a result of climate change are complicated by the need to also account for any associated changes in human behavior that would accompany the associated impacts to seasonal and daily weather conditions. For example, increased temperatures could result in more time spent indoors during extreme heat days, which could potentially reduce exposure to disease carrying vectors.

4.2.8 Landslides and Rockfalls

Hazard/Problem 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.

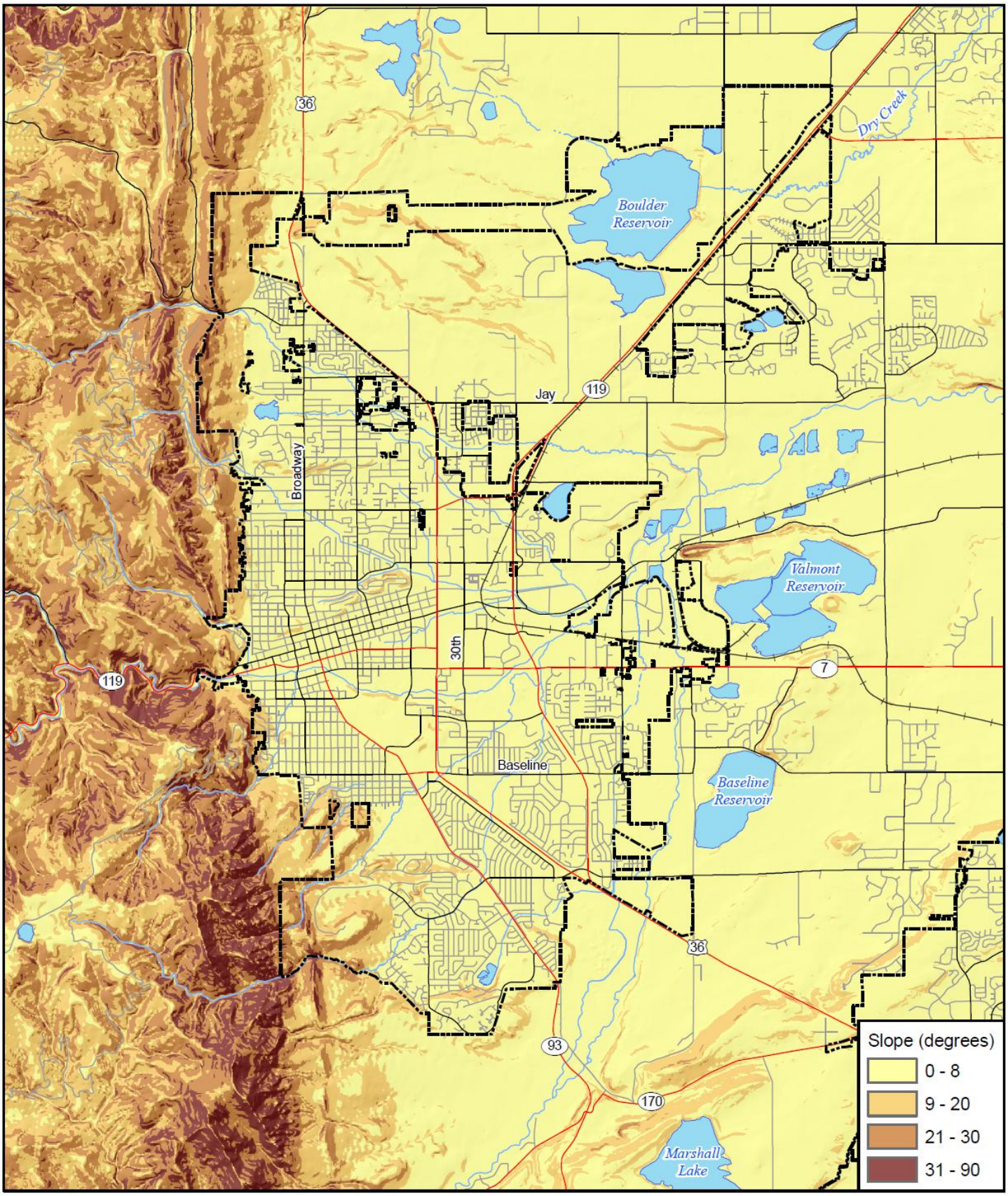
Rockfalls are the fastest type of landslide and occur most frequently in mountains or other steep areas during early spring when there is abundant moisture and repeated freezing and thawing. The rocks may freefall or carom down in an erratic sequence of tumbling, rolling and sliding. When a large number 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.

Past Occurrences

There has been no loss of life from landslides and rockfalls in the city limits. However, damage to structures and highways has occurred, but mostly to the west and north of the city in unincorporated Boulder County. Development in areas vulnerable to landslides increases the potential for destructive landslides and rockfalls. Most historical landslides that have occurred in Boulder were a secondary impact associated with wildfires and/or heavy rains. For instance, the highway in Boulder Canyon below Sugarloaf Mountain was closed at least six times during the months following the Black Tiger fire in July 1989 after mud, boulders, and other debris slid down onto the highway. One home was destroyed, and two others were damaged. A mudslide also occurred at the base of Flagstaff Road during a period of heavy rains in May and June of 1995. Approximately six homes were threatened by the slide.

Figure 4.1 depicts areas in Boulder with steep slopes, which could be potentially prone to landslides. It was created for the purposes of the Denver Regional Council of Governments Regional Mitigation Plan from a 10 meter resolution digital elevation model. Any areas with slopes greater than 30 degrees were classified as a potential risk area. As illustrated in the following map, areas with slopes greater than 30 degrees are limited to the western edge of the city limits. Figure 4.15 denotes Boulder's geological hazards and constraints. Since the hazard affects less than 10% of the planning area it was given limited geographic extent rating.

Figure 4.14. Boulder Steep Slope Hazards



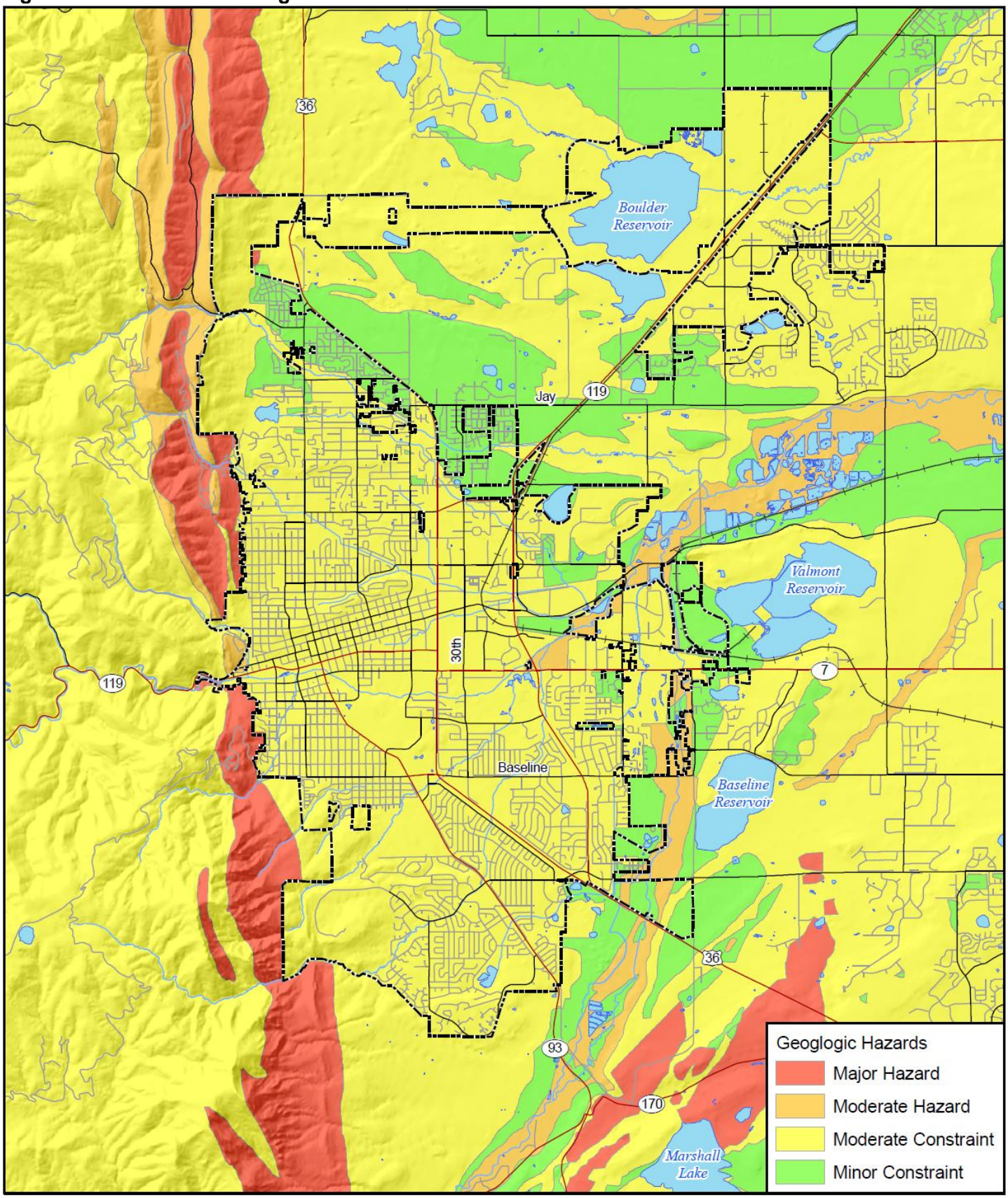
0 1 2 3 Miles

N

amec

Map compiled 4/2012; intended for planning purposes only
Data source: City of Boulder, Boulder County, CDOT

Figure 4.15. Boulder Geologic Hazards



0 1 2 3 Miles

N

Map compiled 8/2012; intended for planning purposes only
Data source: City of Boulder, CDOT

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.

4.2.9 Severe Weather: General

Severe weather conditions occur each year in Boulder County and the City of Boulder. A database maintained by the National Oceanic and Atmospheric Administration National Climatic Data Center (NCDC) is normally queried to give severe weather events on a county by county basis. During the creation of this plan, the NCDC database was temporarily down. NCDC data was downloaded from and ftp site. This data was in an Access format, and was queried for severe weather events. Data was available from 1950 to July 31, 2011 in the downloaded data. This NCDC search identified 337 weather events in Boulder County between January 1, 1950, and July 31, 2011 (see Table 4.7). It was noted by the HMPC and plan writers that severe winter weather events such as snow, blizzards, and winter storms were absent from the downloaded NCDC data.

Table 4.7. Boulder County Severe Weather Events, January 1, 1950 to July 31, 2011

Type of Weather Event	Number of Occurrences*
Dry Microburst	6
Flash Floods	10
Funnel Cloud	3
Hail	202
Heavy Rain	0
High Winds	5
Lightning	44
Thunderstorm Wind	54
Tornado	11
Urban/Small Stream Flood	1
Winds	1
Totals	**3378**

Source: National Climatic Data Center (NCDC) Storm Events database,
Note: Not all types of weather event are tracked back to 1950. The NCDC database includes: All weather events from 1993-present as entered into Storm Data plus additional data from the Storm Prediction Center, including tornadoes 1950-1992, thunderstorm winds 1955-1992, and hail 1955-1992.
* Blizzard, snow, and winter storms were absent from the downloaded NCDC dataset.

For the 337 events listed above, the reported number of deaths totaled 1, injuries totaled 20, and property damage totaled $167 million. These totals do not include snow, blizzard, or winter storm events as noted above. Details on notable events identified in the table are included in the plan sections that follow.

This plan discusses the following types of severe weather:

- Extreme temperatures
- Fog
- Hailstorms
- Thunderstorms
- Lightning
- Tornadoes
- Windstorms

Weather conditions can vary greatly from the western portion to the eastern portion of Boulder County due to topographical changes and variance in elevation. The City of Boulder is located at the base of the foothills in an area of lower elevation.

Climate Change Considerations

The Boulder County Climate Change Preparedness Plan mentions that climate change could alter the nature and frequency of severe weather hazards. There presently is not enough data or research to quantify the magnitude of change for some of these events such as severe windstorms, lightning, tornadoes and fog. Future updates to the mitigation plan should include the latest research on how these hazard vulnerabilities could change. The level of significance of these hazards should be revisited over time. During the 2012 update level of significance for extreme temperatures was evaluated since the available science concludes that average temperatures are expected to increase into the future.

4.2.10 Severe Weather—Extreme Temperatures

Hazard/Problem 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 city 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 4.16 illustrates the relationship of temperature and humidity to heat disorders.

Figure 4.16. 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 4.17). 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 4.17. National Weather Service Wind Chill Chart

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

Frostbite Times: 30 minutes, 10 minutes, 5 minutes

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

Where, T= Air Temperature (°F) V= Wind Speed (mph)

Effective 11/01/01

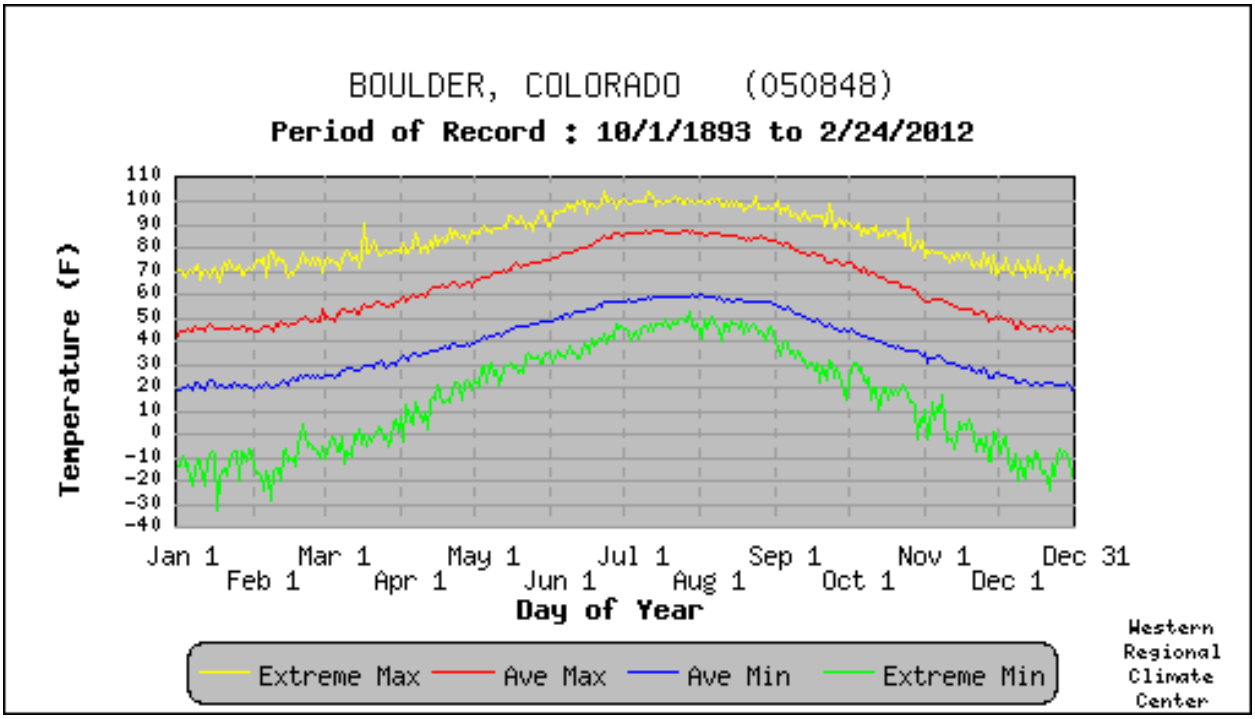
Source: National Weather Service, www.nws.noaa.gov/om/windchill/index.shtml

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.

Past Occurrences

In eastern Boulder County, for the period of record August 1, 1948, through April 30, 2007, 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 4.18. Boulder Daily Temperature Averages and Extremes 1893 to 2012



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 City of Boulder, 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, Boulder 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.

4.2.11 Severe Weather: Fog

Hazard/Problem Description

Dense fog events can significantly reduce visibility. Fog results from air being cooled to the point where it can no longer hold all of the water vapor it contains. For example, rain can cool and moisten the air near the surface until fog forms. A cloud-free, humid air mass at night can lead to fog formation where land and water surfaces that have warmed up during the summer are still evaporating a lot of water into the atmosphere—this is radiation fog. A warm moist air mass blowing over a cold surface can also cause fog to form—this is advection fog. Severe fog incidents can close roads, cause accidents, and impair the effectiveness of emergency responders. The fog hazard extent within city limits is considered significant, potentially impacting 10-50% of the planning area and most commonly in low lying areas along creeks.

Past Occurrences

The National Climatic Data Center data shows no severe fog incidents for Boulder County. Other data sources consulted during this planning process did not identify any notable fog events for Boulder County and the City of Boulder.

Likelihood of Future Occurrences

Unlikely: Given the lack of reportable fog history, severe fog events are not of significant concern to the City of Boulder.

4.2.12 Severe Weather: Hailstorms

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 City of Boulder. 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 4.8 indicates the hailstone measurements utilized by the National Weather Service.

Table 4.8. Hailstone Measurements

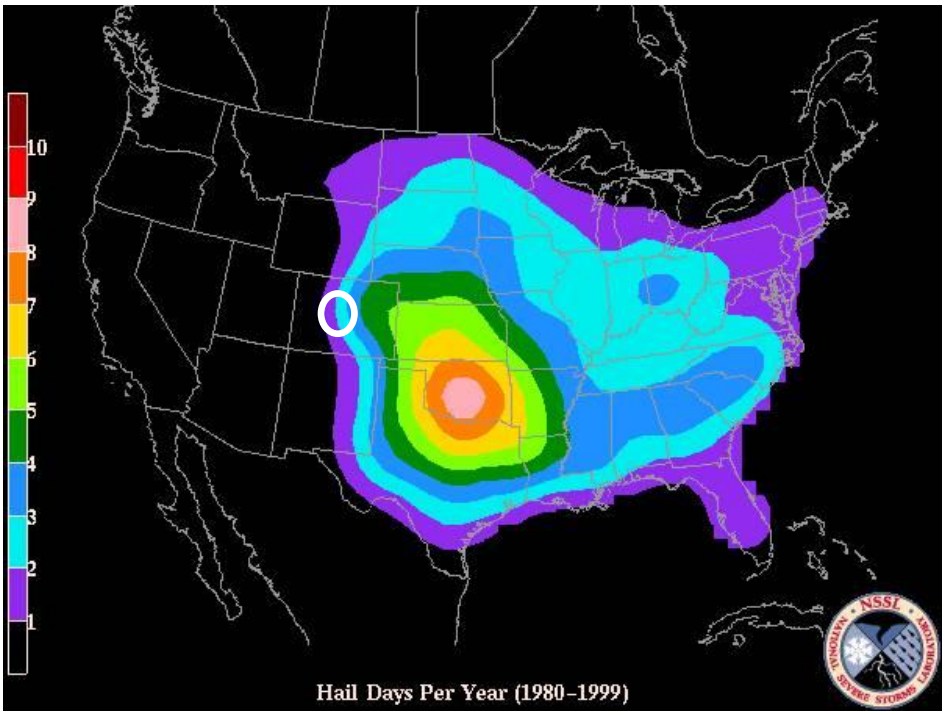
Average Diameter	Corresponding Household Object
.25 inch	Pea
.5 inch	Marble/Mothball
.75 inch	Dime/Penny
.875 inch	Nickel
1.0 inch	Quarter
1.5 inch	Ping-pong ball
1.75 inch	Golf-Ball
2.0 inch	Hen Egg
2.5 inch	Tennis Ball
2.75 inch	Baseball
3.00 inch	Teacup
4.00 inch	Grapefruit
4.5 inch	Softball

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.

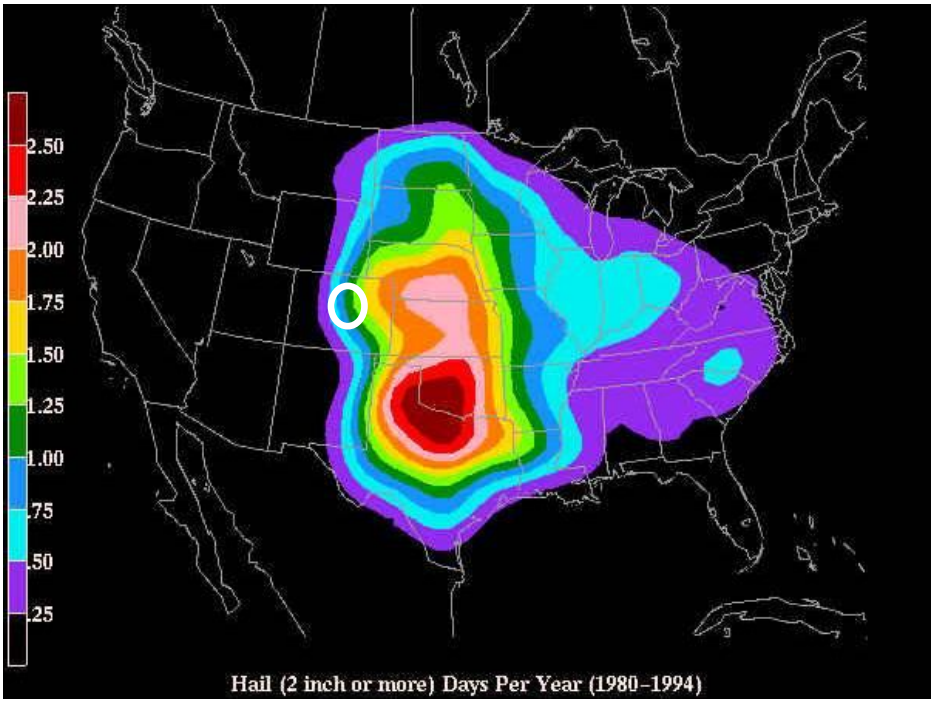
In all cases, the hail falls when the thunderstorm's updraft can no longer support the weight of the ice. The stronger the updraft the larger the hailstone can grow. When viewed from the air, it is evident that hail falls in paths known as hail swaths. They can range in size from a few acres to an area 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 4.19 shows the average number of days of hail per year in the United States, with the city outlined in a white oval. Figure 4.20 shows the average number of days of severe hail (over two inches in diameter) per year in the United States, with the city outlined in a white oval. The geographic extent rating for hail is considered extensive since the entire city limits is exposed.

Figure 4.19. Average Number of Days of Hail per Year



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

Figure 4.20. Average Days of Large Hail in the Planning Area



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

Past Occurrences

A study conducted in 1994 by the 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 35 years have brought one catastrophic hailstorm after another to the Front Range. On the night of July 20th, 2009, a strong storm hit the northwest suburbs of Denver, dumping as much as an inch of rain in less than an hour and hail that was one-inch in diameter. The storm damaged numerous cars, windows and roofs. A greenhouse containing plants worth more than $250,000 was destroyed. Straight-line winds of 80 miles per hour uprooted mature trees and damaged roofs. The storm also left 50,000 residents without power. The Rocky Mountain Insurance Information Association lists the July 20th storm as the costliest hazard event since 1990 in terms of insured losses in the Rocky Mountain Region. To date, RMIIA has identified $767.6 million in damages from the storm.

Costly hailstorms identified by the Colorado Division of Emergency Management include those listed in Table 4.9. The extent of damage in the Boulder area from these storms could not be determined from available data.

Table 4.9. 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

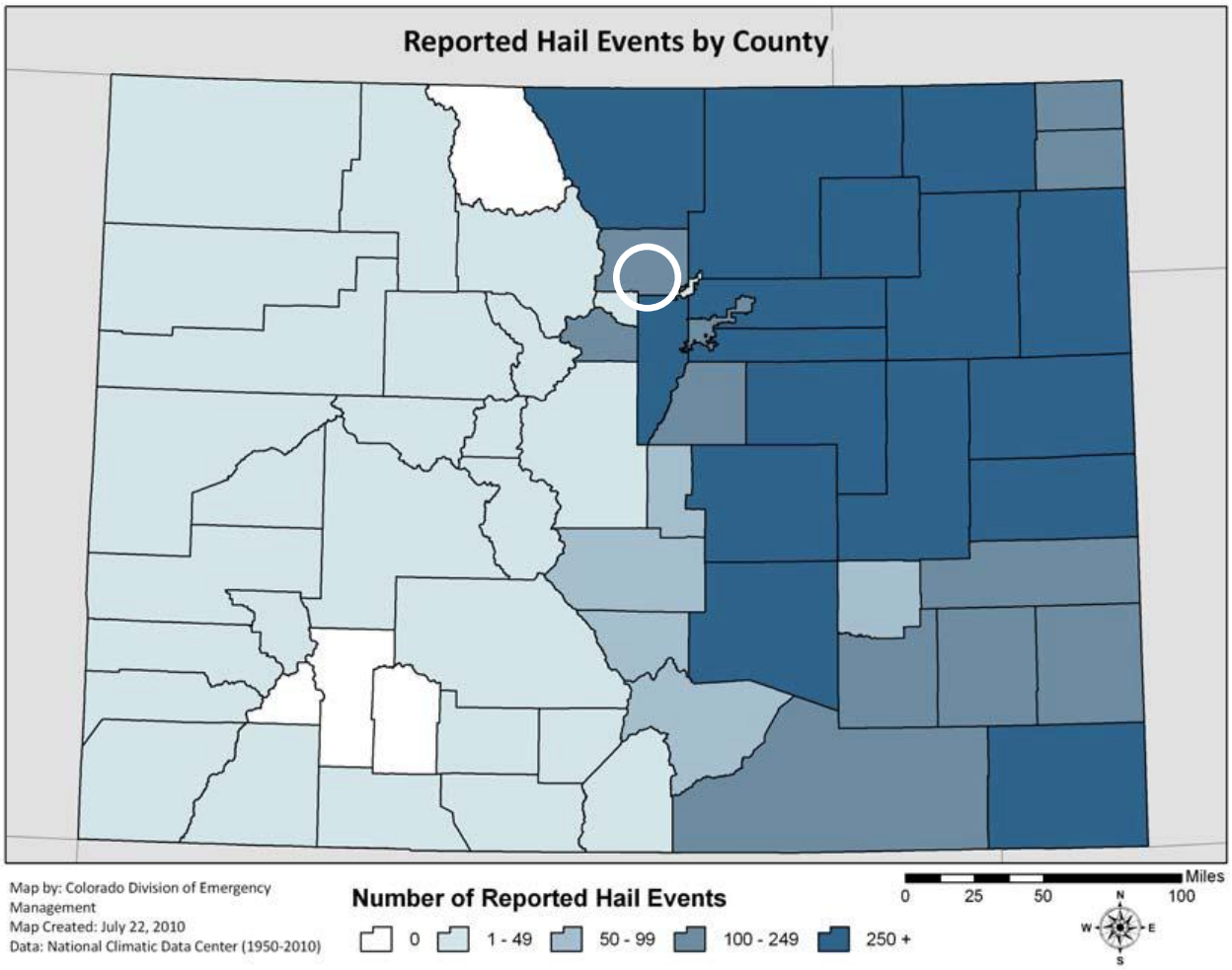
Source: Rocky Mountain Insurance Information Association, 2010
*2009 estimated cost calculations based on the Consumer Price Index

Data from the National Climatic Data Center identified 202 hail events in Boulder County between January 1, 1955, and February 29, 2012, with hailstones at least ¾ inch in diameter. Of these, the following four hail events resulted in reported damage to people or property:

- **August 2, 1986, 4:30 p.m.—**Hailstones of 1.75 inches caused six injuries.
- **August 2, 1986, 4:35 p.m.**—Hailstones of 1.75 inches caused one injury.
- **September 17, 1993, 5:06 p.m.—**Hailstones of 0.75 inches (in Lafayette) caused $5,000 in property damage.
- **July 12, 1996, 7:46 p.m.**—Hailstones of 1.25 inches (in Broomfield) caused $1 million in property damage. Large hail, strong winds, and heavy rain caused substantial damage to property in portions of Boulder and northern Jefferson counties. Damage estimates in the Broomfield area alone were approximately $1 million.

The State of Colorado Natural Hazard Mitigation Plan reports that Boulder County experienced 193 hailstorm events between January 1, 1993, and January 31, 2010, that resulted in $1 million in damage. This likely includes the events identified above. Figure 4.21 depicts Colorado's reported hail events by County.

Figure 4.21. Colorado's Reported Hail Events by County



Source: 2010 State of Colorado Natural Hazard Mitigation Plan; White oval indicates approximate location of City of Boulder

Likelihood of Future Occurrences

Likely: Given the history of severe weather events in the City of Boulder and Boulder County, severe weather, including hailstorms, will continue to occur on an annual basis; however, the extent of impact to the city will vary depending on the location and severity of any given storm and associated hail event.

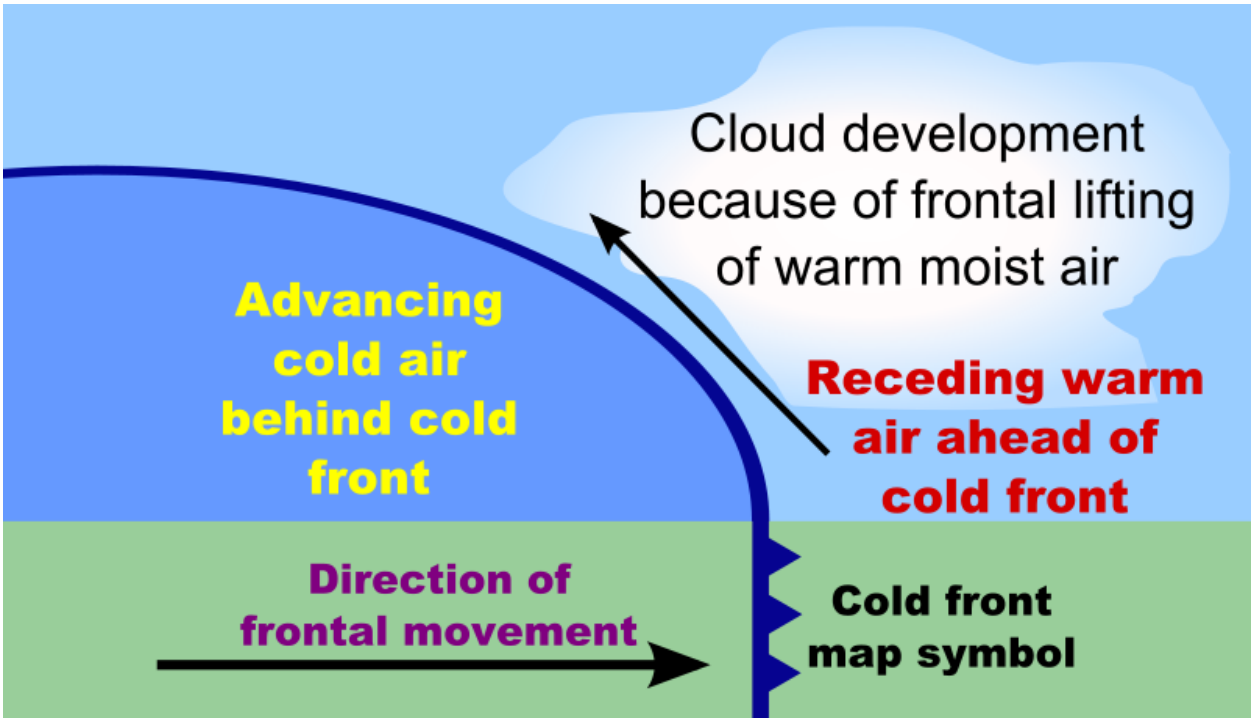
4.2.13 Severe Weather: Thunderstorms

Hazard/Problem Description

Storms in the planning area are generally characterized by heavy rain often accompanied by strong winds and sometimes lightning and hail. Approximately 10 percent of the thunderstorms that occur each year in the United States are classified as severe. A thunderstorm is classified as severe when it contains one or more of the following phenomena: hail that is 1 inch or greater, winds in excess of 50 knots (57.5 mph), or a tornado (profiled in Section 4.2.15).

Thunderstorms result from the rapid upward movement of warm, moist air (see Figure 4.22). They can occur inside warm, moist air masses and at fronts. As the warm, moist air moves upward, its cools, condenses, and forms cumulonimbus clouds that can reach heights of greater than 35,000 ft. As the rising air reaches its dew point, water droplets and ice form and begin falling the long distance through the clouds towards earth's surface. As the droplets fall, they collide with other droplets and become larger. The falling droplets create a downdraft of air that spreads out at Earth's surface and causes strong winds associated with thunderstorms.

Figure 4.22. Formation of a Thunderstorm



Source: NASA. http://rst.gsfc.nasa.gov/Sect14/Sect14_1c.html

There are four ways in which thunderstorms can organize: single cell, multicell cluster, multicell lines (squall lines), and supercells. Even though supercell thunderstorms are most frequently associated with severe weather phenomena, thunderstorms most frequently organize into clusters or lines. Warm, humid conditions are favorable for the development of thunderstorms. The average single cell thunderstorm is approximately 15 miles in diameter and lasts less than 30 minutes at a single location. However, thunderstorms, especially when organized into clusters or lines, can travel intact for distances exceeding 600 miles.

Thunderstorms are responsible for the development and formation of many severe weather phenomena, posing great hazards to the population and landscape. Damage that results from thunderstorms is mainly inflicted by downburst winds, large hailstones, and flash flooding caused by heavy precipitation. Stronger thunderstorms are capable of producing tornadoes and waterspouts.

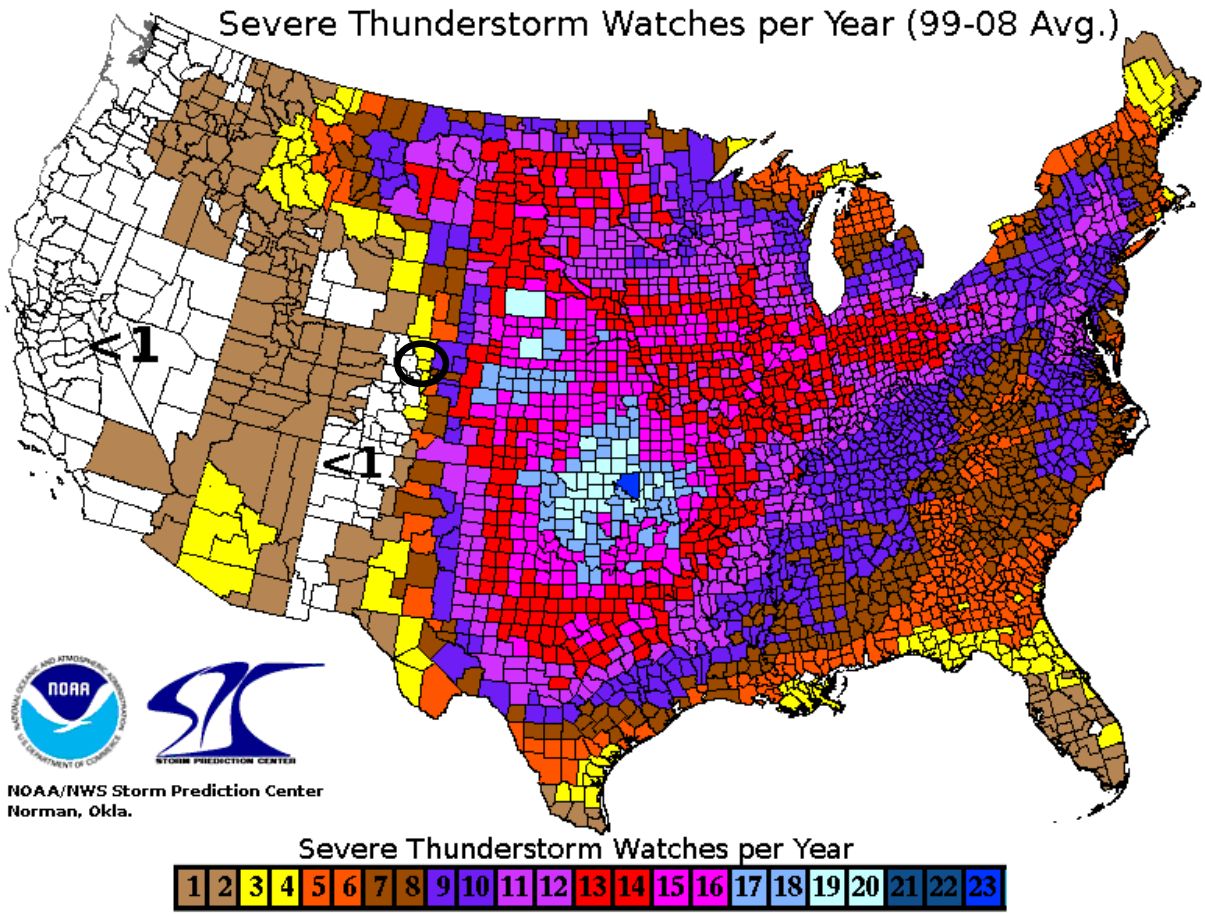
The National Weather Service issues two types of alerts for severe thunderstorms:

- A Severe Thunderstorm Watch indicates when and where severe thunderstorms are likely to occur. Citizens are urged to watch the sky and stay tuned to NOAA Weather Radio, commercial radio, or television for information. Severe Thunderstorm Watches are issued by the Storm Prediction Center in Norman, OK.
- A Severe Thunderstorm Warning is issued when severe weather has been reported by spotters or indicated by radar. Warnings indicate imminent danger to life and property to

those in the path of the storm. Severe Thunderstorm Warnings are issued by the National Weather Service in Pueblo.

The planning area sees 3-4 severe thunderstorm watches per year. This can be seen in Figure 4.23. The geographic extent rating for severe thunderstorms is considered extensive since the entire city limits is exposed.

Figure 4.23. Severe Thunderstorm Watches per Year in the Planning Area



Source: NOAA/NWS Storm Prediction Center; Black oval indicates approximate location of City of Boulder

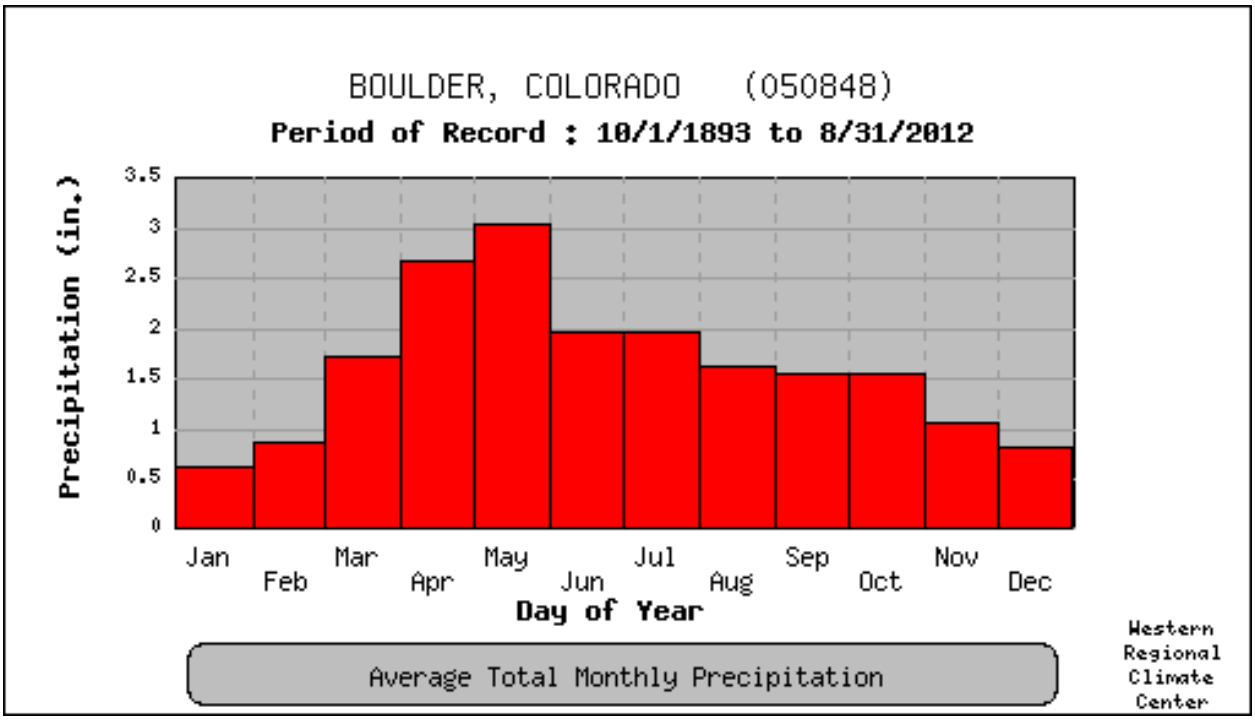
Past Occurrences

Heavy rains and severe thunderstorms occur in Boulder County and the City of Boulder primarily during the spring, summer, and early fall seasons. The bulk of the rain occurs between March and September but can vary by regions of the county.

According to the Western Regional Climate Center, the average annual precipitation in the City of Boulder for the period of record 1893 to 2012 was 19.16 inches per year. The highest recorded annual precipitation was 29.43 inches in 1995; the highest recorded precipitation for a 24-hour period was 4.8 inches on July 31, 1913. The lowest annual precipitation total was 10.91 inches

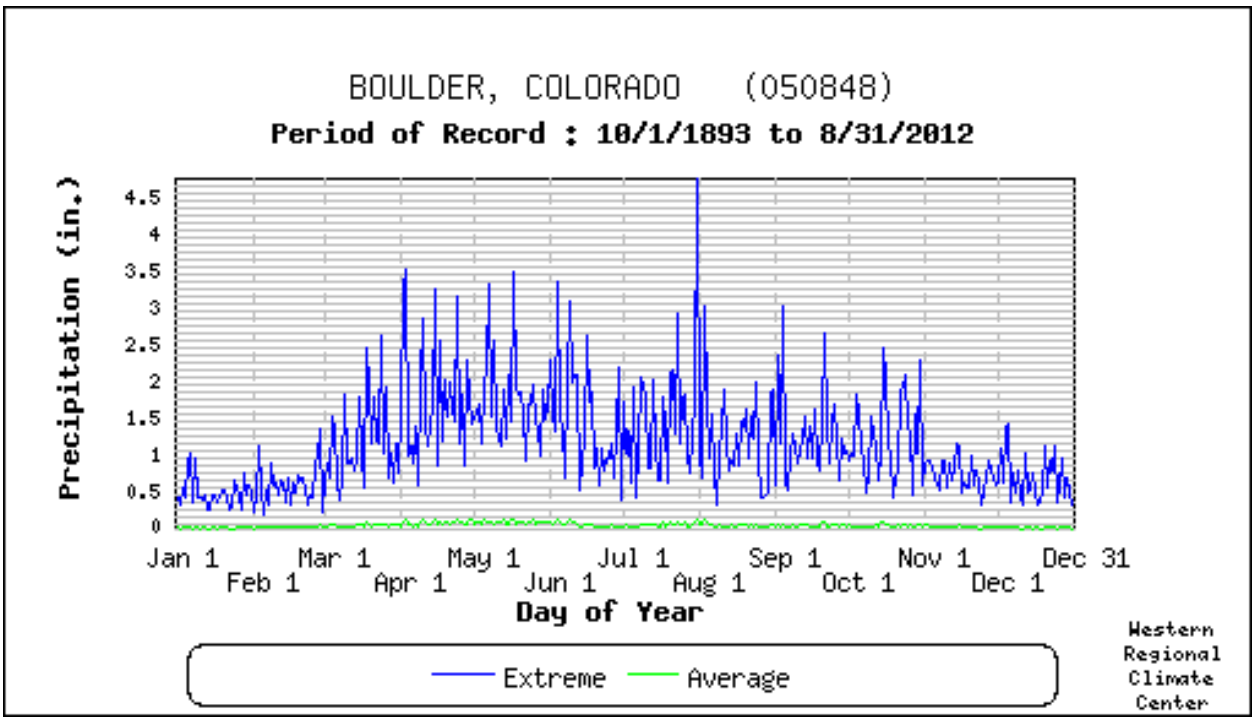
in 1954. Figure 4.24 illustrates the average total monthly precipitation for this same time period and Figure 4.25 illustrates the average and extreme daily precipitation amounts, also for the same time period.

Figure 4.24. Boulder Monthly Average Total Precipitation, 1893 to 2012



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

Figure 4.25. Boulder Daily Precipitation Average and Extreme, 1893 to 2012



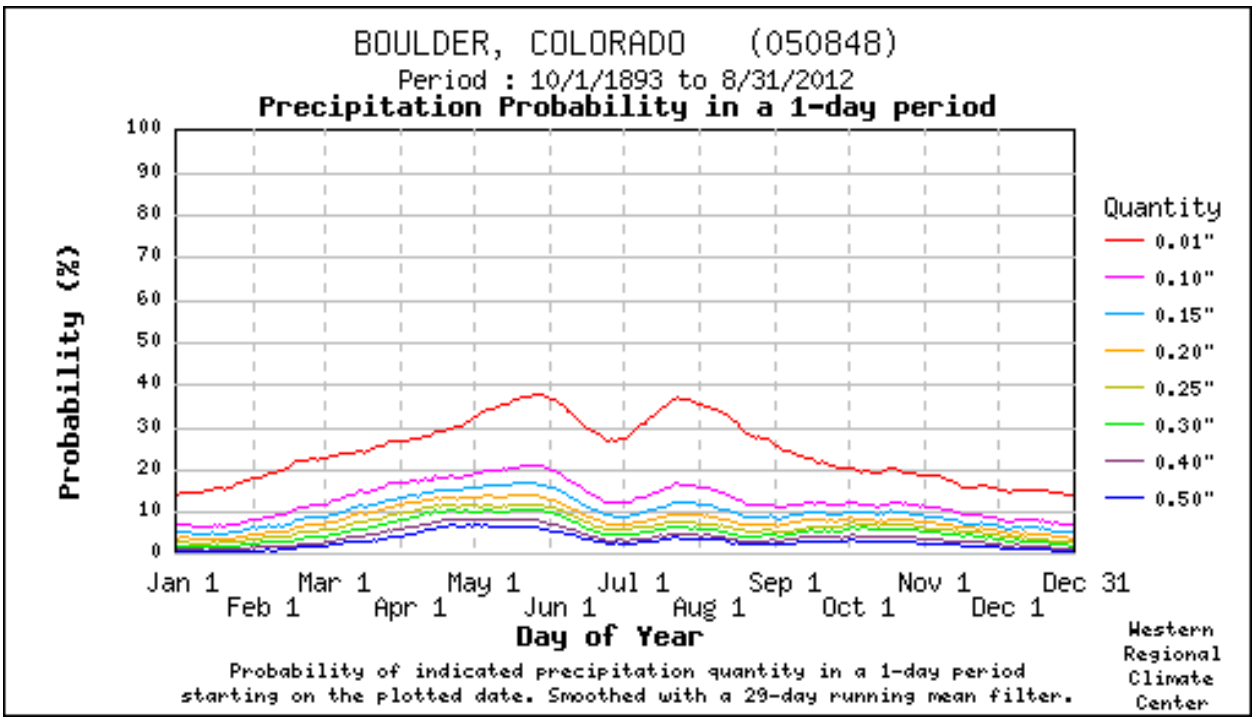
Source: Western Regional Climate Center, www.wrcc.dri.edu/

Severe thunderstorms on record with the city and Boulder County include those identified in Table 4.7 in **Section 4.2.9: Severe Weather—General.** More information on severe storms that have caused flooding can be found in Section 4.2.5.

Likelihood of Future Occurrences

Highly Likely: Given the history of severe weather events in Boulder County and the City of Boulder, severe weather, including thunderstorms and heavy rain will continue to occur annually. Figure 4.26 illustrates precipitation probability in a one-day period based on the time period 1893 to 2012.

Figure 4.26. Precipitation Probability in a One-Day Period 1893 to 2012



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

4.2.14 Severe Weather: Lightning

Hazard/Problem 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.

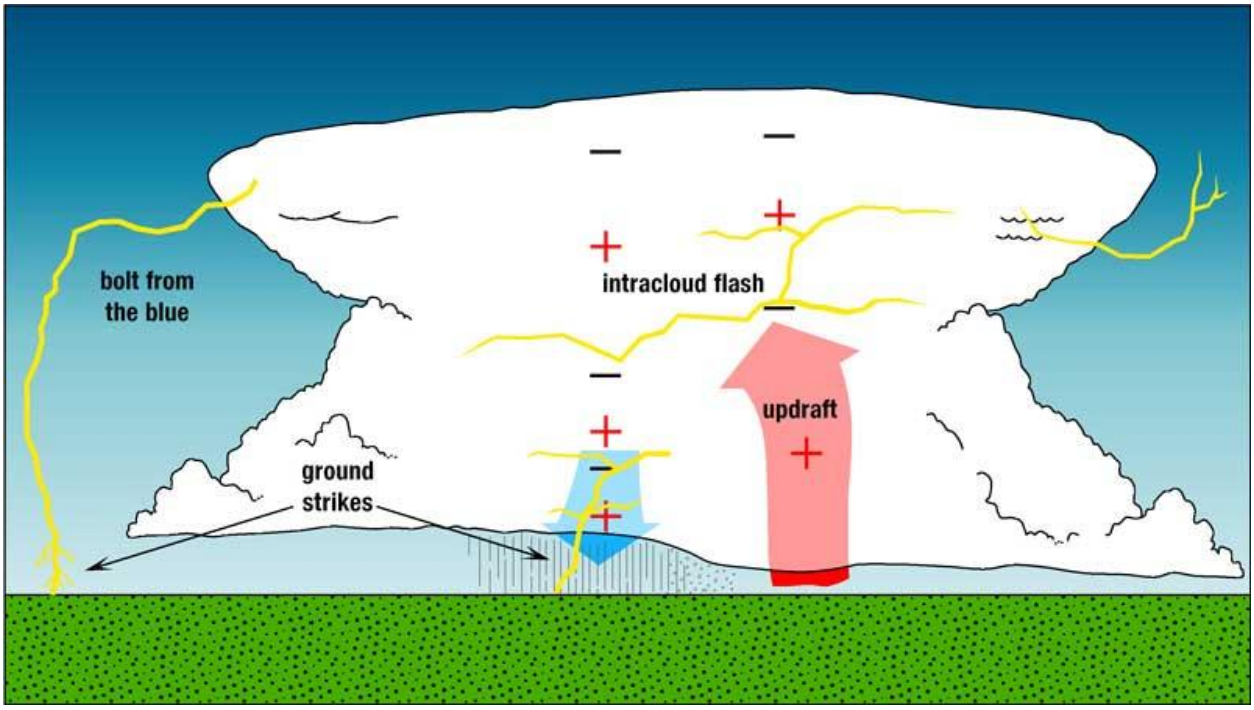
Lightning is one of the more dangerous weather hazards in the United States and in Colorado. Each year, lightning is responsible for deaths, injuries, and millions of dollars in property damage, including damage to buildings, communications systems, power lines, and electrical systems. Lightning also 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 4.27). 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 4.27. Cloud to Ground Lightning

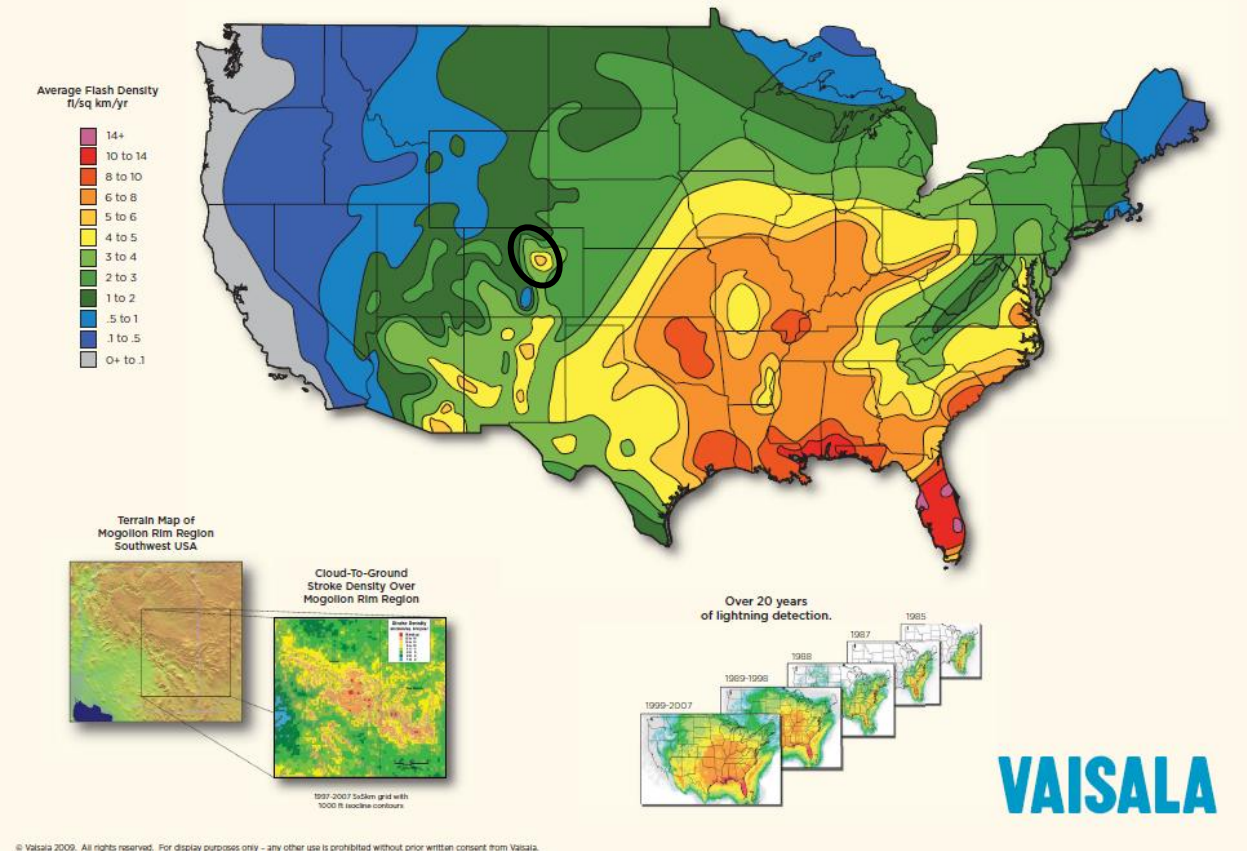


Source: National Weather Service Pueblo Office

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 4.28 depicts cloud to ground lightning in the United States and the City of Boulder

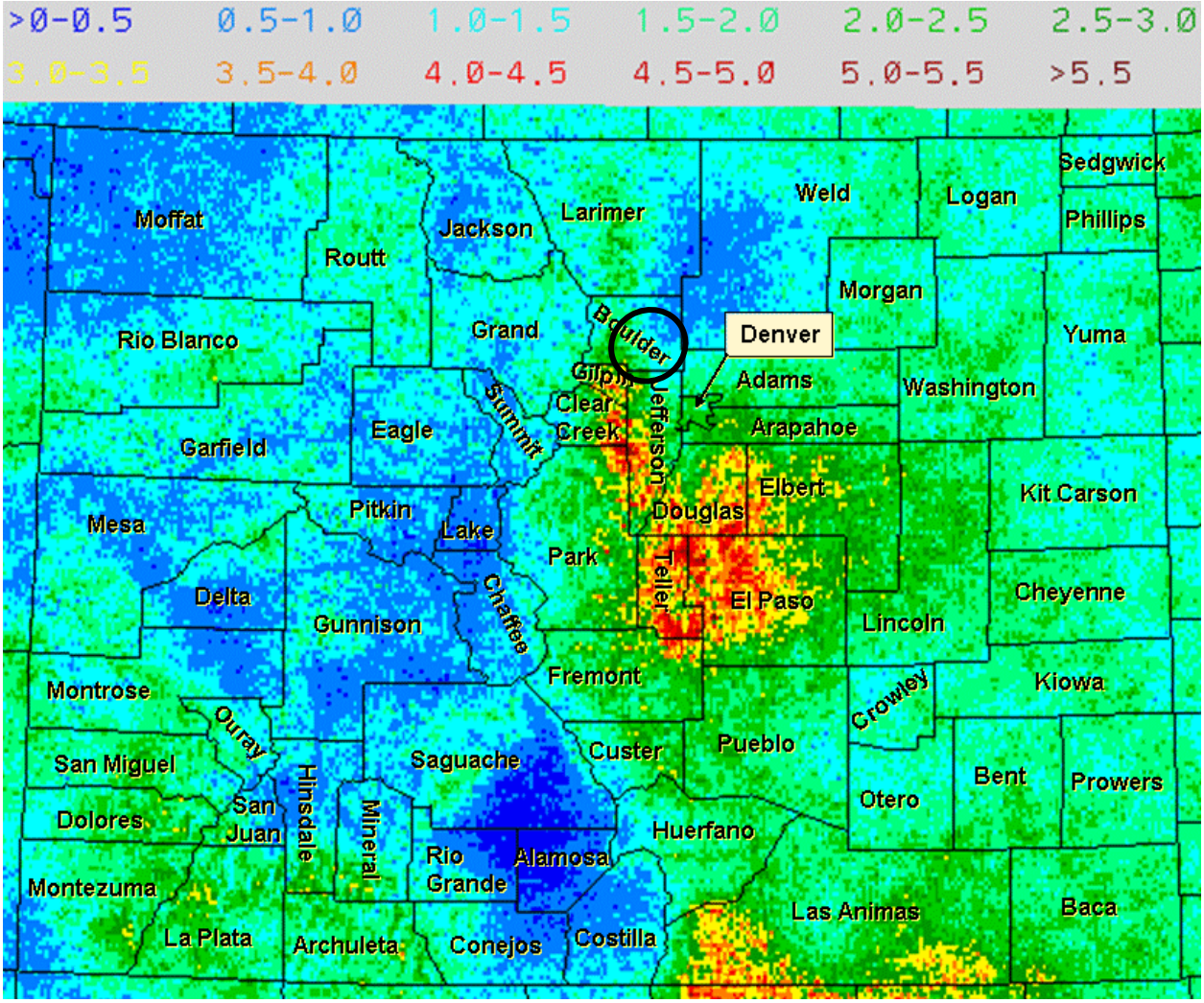
(circled in black). Figure 4.29, from the National Weather Service in Pueblo, depicts a more detailed lightning flash density map for the State of Colorado and the planning area (boxed in black). The geographic extent rating for lightning is considered extensive since the entire city limits is exposed.

Figure 4.28. Lightning Flash Density Map 1997-2007



Source: Vaisala's US National Lightning Detection Network

Figure 4.29. 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 City of Boulder

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. Table 4.10 contains information from the National Weather Service on lightning casualties in Boulder County:

Table 4.10. Lightning Casualties in Boulder County, 1980-2010

Date	Time	Killed	Injured
June 27, 1980	2:12 p.m.	0	4
June 3, 1981	12:00 p.m.	1	2
August 22, 1981	Morning	0	2
August 5, 1983	5:00 p.m.	0	1
July 2, 1987	5:34 p.m.	0	4
August 7, 1987	7:30 p.m.	0	1
August 19, 1989	12:35 p.m.	1	1
June 25, 1988	3:30 p.m.	1	1
June 13, 1991	2:00 p.m.	0	1
August 30, 1992	11:30 a.m.	0	1
June 27, 1995	3:30 p.m.	0	1
June 5, 1997	2:00 p.m.	0	1
June 7, 1997	12:00 p.m.	0	1
June 19, 1997	2:04 p.m.	0	1
July 10, 2000	3:40 p.m.	0	3
July 12, 2000	2:00 p.m.	1	0
July 24, 2000	3:00 p.m.	0	2
August 3, 2009	12:00 p.m.	0	1
August 3, 2010	3:00 pm	0	1
Totals		**4**	**29**

Source: National Weather Service, www.crh.noaa.gov/pub/?n=/ltg/ltg_stats_index.php

Data from the National Climatic Data Center (NCDC) identified 44 lightning events in Boulder County between January 1, 1993, and February 29, 2012 (note: since this data is from a different source, it does not track exactly with the incidents reported in Table 4.10). The 8 lightning events that resulted in death/injury and/or property damage in or near the City of Boulder are detailed below:

- **May 15, 1993, 4:00 p.m**.—Lightning resulted in property damage of $5,000.
- **July 27, 1994, 4:00 p.m**.—Lightning resulted in property damage of $5 million. (The damage occurred when lightning struck a furniture store in Boulder, igniting a fire which caused major damage to the building and contents).
- **June 2, 1995, 5:30 p.m.**—Lightning resulted in property damage of $20,000.
- **July 10, 2000, 3:40 p.m.**—Lightning resulted in three injuries.
- **June 19, 2002, 5:30 p.m.**—Lightning resulted in property damage of $25,000.
- **August 5, 2002, 2:00 p.m.**—Lightning resulted in one injury.
- **May 21, 2007** –Lightning sparked a fire at a Boulder home and caused a fuel tank in a farm field to explode, near Teller Farm Open Space on Valmont Road. Lightning struck the roof

of the residence, causing the rafters in the attic to catch fire. $15,000 in property damages were reported as a result.

- **August 3, 2009** – Lightning injured a bicyclist in Boulder and sparked a fire in a wheat field near Deer Trail.

Likelihood of Future Occurrences

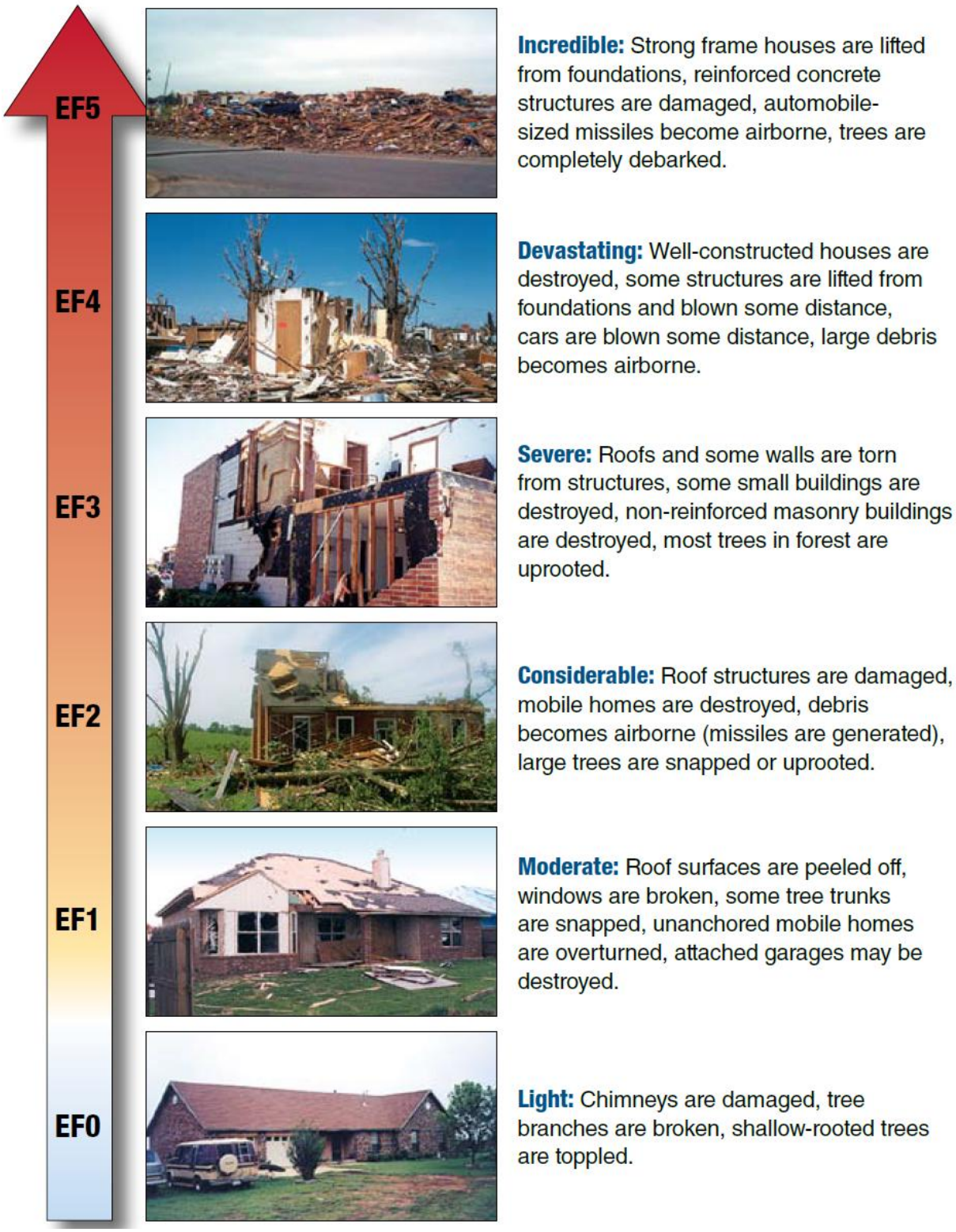
Highly Likely: Given the history of lightning occurrences in Colorado and the Boulder area, lightning is an annual occurrence and will continue to be a concern.

4.2.15 Severe Weather: Tornadoes

Tornadoes also affect Boulder County and the City of Boulder. 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 4.30. Potential Impact and Damage from a Tornado



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 4.11 shows the wind speeds associated with the original Fujita scale ratings and the damage that could result at different levels of intensity. Table 4.12 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 4.11. 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 4.12. 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

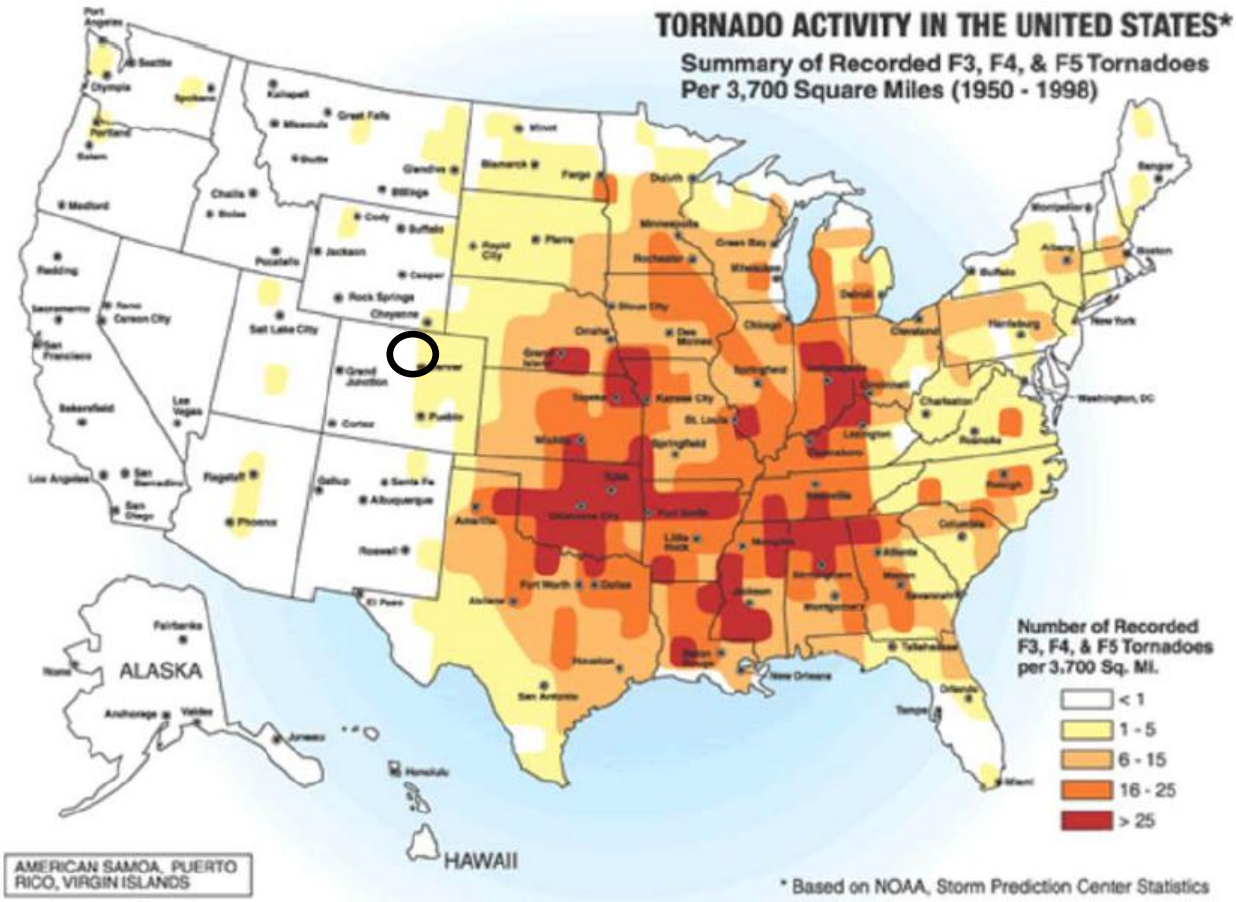
Source: National Oceanic and Atmospheric Administration Storm Prediction Center, www.spc.noaa.gov/faq/tornado/ef-scale.html

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.

Figure 4.31 shows tornado activity in the United States based on the number of recorded tornadoes per 1,000 square miles. Eastern Boulder County is generally more susceptible than central and western Boulder County. 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 4.31. Tornado Activity in the United States



Source: NOAA; Black oval indicates approximate location of City of Boulder

Past Occurrences

According to data obtained by the HMPC, tornadoes are rare and usually only affect the lower elevations in the eastern portion of Boulder County. The National Climatic Data Center documents 4 incidents of tornadoes in or near the city between January 1, 1950, and February 29, 2012. Information on these events is detailed below:

- **September 17, 1953, 3:00 p.m**.—Magnitude F1, property damage of $3,000
- **October 15, 1980, 6:22 p.m.**—Magnitude F2, property damage of $25,000 (roof at Vo-Tech on East Arapahoe)
- **June 1, 1990, 5:03 p.m.**—Magnitude F0, no property damage
- **June 6, 1997, 1:15 p.m.**—Magnitude F1, no property damage (Other sources indicate a home was damaged in the vicinity of Baseline Reservoir during this event.)

While not in Boulder County, the Windsor tornado of May 22, 2008 occurred just to the northeast of the County and followed an unusual north-south path. Damage from the tornado resulted in a presidential disaster declaration.

Likelihood of Future Occurrences

Occasional: 4 tornadoes occurred in Boulder County during a 62 year period of record keeping, which equates to one tornado every 15.5 years, on average, and a 6.4 percent chance of a tornado occurring in any given year. Based on this data, tornadoes will continue to occur in Boulder County; the risk to the city is dependent upon the nature and location of any given tornado.

4.2.16 Severe Weather: Windstorms

Hazard/Problem Description

High winds are a frequent occurrence throughout the Boulder area. High winds 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 has some of the highest peak winds of any city 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. Damage from Boulder's winds averages about a million dollars per year. One exceptionally strong storm on January 17, 1982, caused more than $10 million in damage. Table 4.13 provides a scale describing the damaging effects of wind speed.

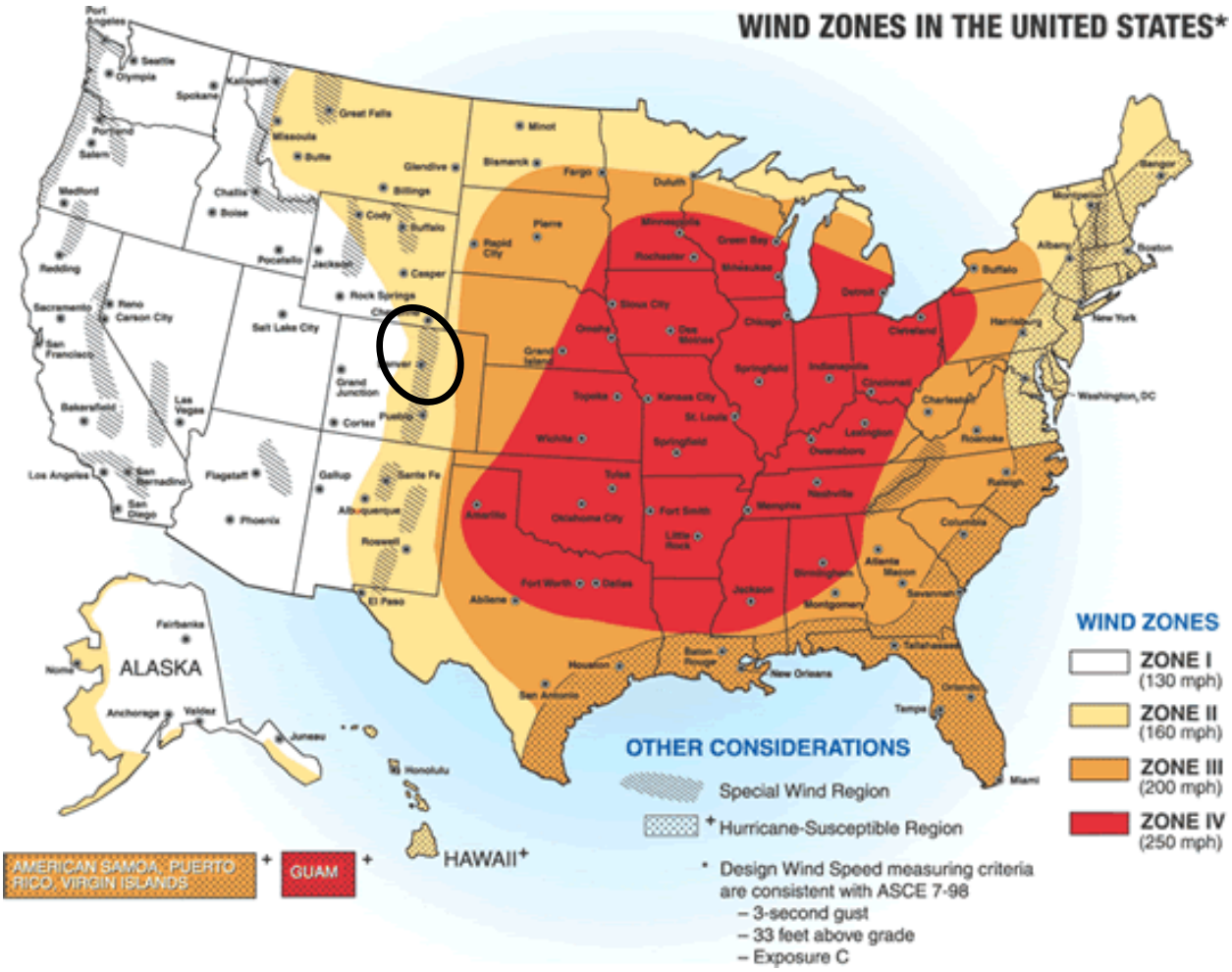
Table 4.13. Beaufort Wind Scale

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

Figure 4.32. Wind Zones in the United States

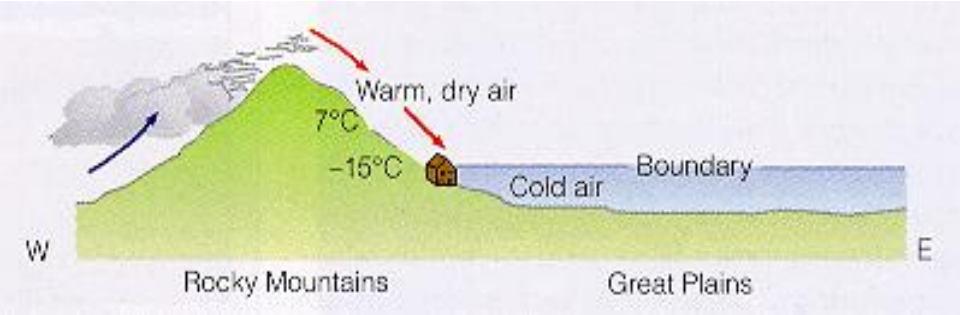


Source: Federal Emergency Management Agency; Black oval indicates approximate location of City of Boulder

Chinook Winds

Boulder's often 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. In Boulder, these warm, downslope winds occur when the winds blow across the Continental Divide from the west and descend the foothills into Boulder (see Figure 4.33). They are caused by high pressure west of Boulder, low pressure over or east of Boulder, and strong westerly winds in the mountains. During these Chinooks, wind speeds can reach extreme values and do quite a bit of damage.

Figure 4.33. Chinook Wind Pattern



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

Bora Winds

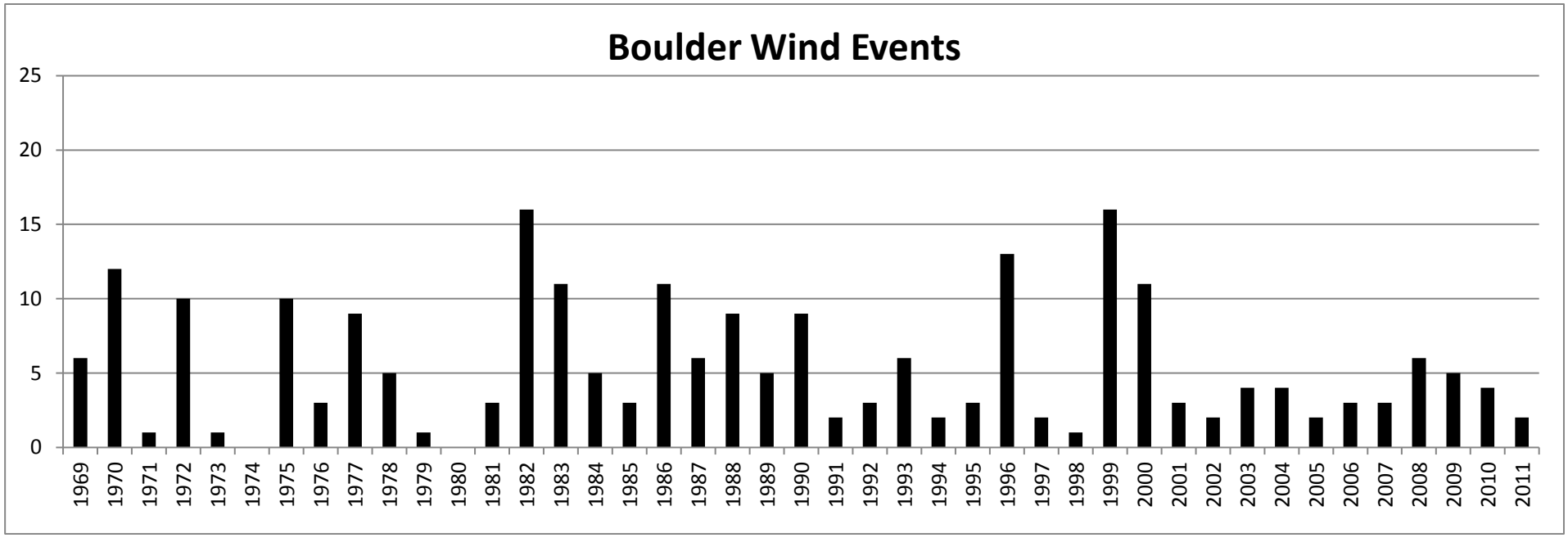
Bora winds, downslope winds that replace relatively warm light wind conditions with cold temperatures and strong wind gusts may also be observed in Boulder. Bora winds that strike Boulder blow from the west, are relatively dry, but are also cold. The arrival of a Bora in Boulder can be similar to the 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.

Past Occurrences

High wind events are one of the most notable natural hazards affecting the Boulder area. According to NOAA's Climate Diagnostics Center, Boulder has some of the highest peak winds of any city in the United States. One location in or near the City of Boulder experiences wind gusts in excess of 100 mph almost every year. Gusts have been measured as high as 147 mph. The National Center for Atmospheric Research (NCAR) reports that a severe windstorm in January 1982, comparable to the landfall of a Category 2-3 hurricane, resulted in more than $10 million in damage and damaged nearly half of all buildings in Boulder.

To define this hazard, information was extracted from NOAA's Earth System Research Laboratory (ERSL) website. There were 233 notable Boulder wind events from 1969 through 2011. The data generally focuses on days in which wind gusts above 70 mph were reported somewhere in the area. Figure 4.34 shows the individual events over the whole time period.

Figure 4.34. Boulder Wind Events over 70 MPH, 1969-2011



Source: NOAA, http://www.esrl.noaa.gov/psd/boulder//wind.html

Other significant wind events identified by the HMPC 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 Boulder area. Given historical data, topography of the area, and weather patterns, high winds in Boulder County and the City of Boulder will continue to occur annually.

4.2.17 Soil Hazards: Expansive Soils

Hazard/Problem Description

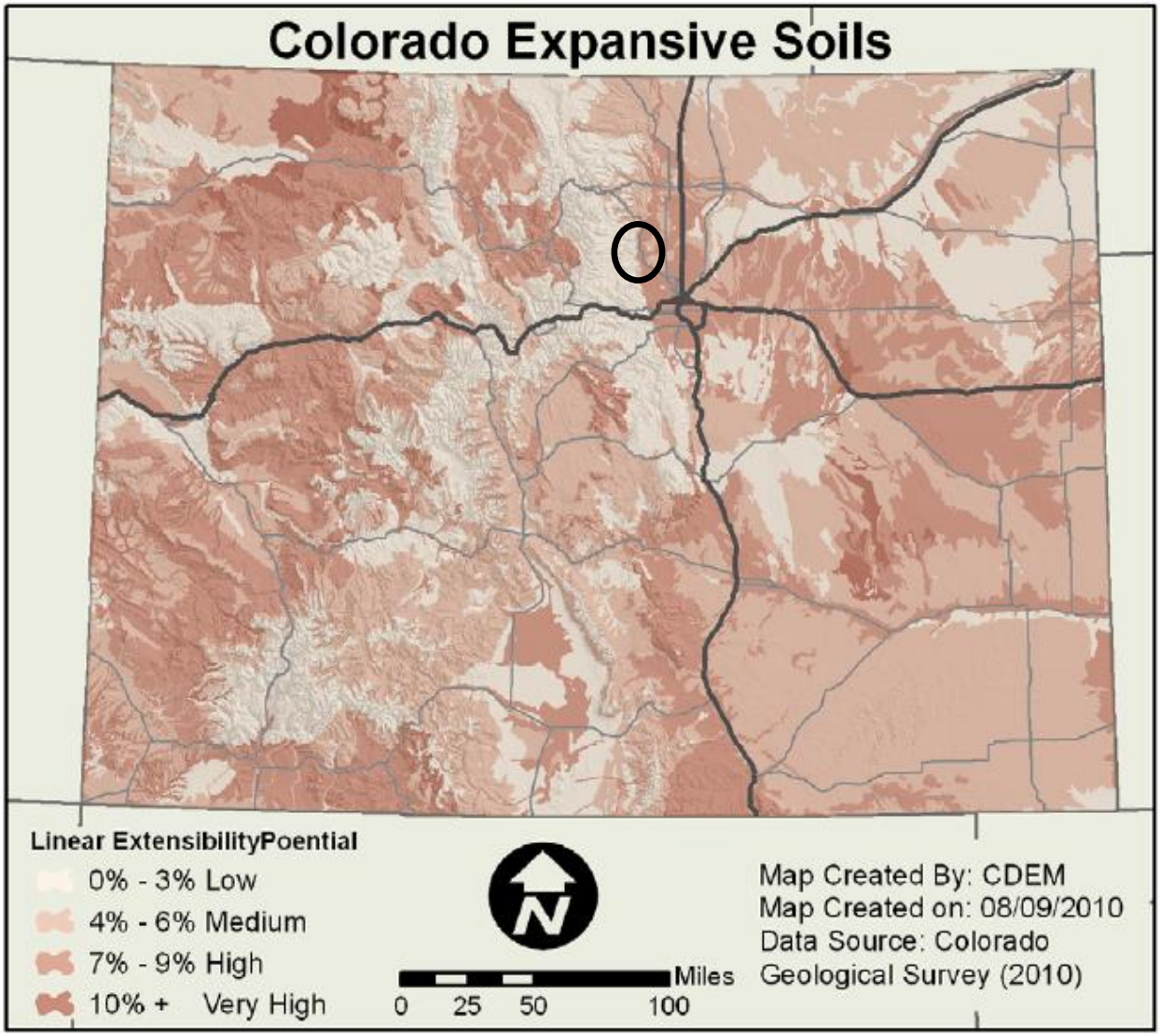
Expansive (swelling) soils or soft bedrock are those that increase in volume as they get wet and shrink as they dry. Commonly, they are known as bentonite, expansive, or montmorillinitic soils. Swelling soils contain high percentages of certain kinds of clay particles that are capable of absorbing large quantities of water and expanding up to 10 percent or more as the clay becomes wet. The force of expansion is capable of exerting pressures of 20,000 pounds per square foot or greater on foundations, slabs, and other confining structures.

In Colorado, swelling soils tend to be at a constant moisture content in their natural state and are usually relatively dry prior to any construction disturbance. Exposure to water sources during or after development generally results in swelling. Colorado, with its arid or semiarid areas and seasonal changes in soil moisture, experiences a much higher frequency of swelling problems than eastern states that have higher rainfall and more constant soil moisture. Rocks that contain swelling clay are generally softer and less resistant to weathering and erosion than other rocks; therefore, expansive soil events occur more often along the sides of mountain valleys and on the plains than in the mountains.

Rocks containing swelling clay are generally softer and less resistant to weathering and erosion than other rocks and therefore, more often occur along the sides of mountain Valleys and on the plains than in the mountains. However, the potential for shrinking and swelling soils in

Colorado is evaluated state-wide. Figure 4.35 shows expansive soils across the state. The darker the red coloring is shown on the map, the greater potential for shrinking and swelling soils.

Figure 4.35. Colorado Expansive Soils



Source: 2010 Colorado State Natural Hazards Mitigation Plan; Black oval indicates approximate location of City of Boulder

Swelling soils are one of the nation's most prevalent causes of damage to buildings. Annual losses are estimated in the range of $2 billion. In Colorado, the cost is estimated at $16 million annually. Damage can include severe structural damage; cracked driveways, sidewalks, and basement floors; heaving of roads and highway structures; condemnation of buildings; and disruption of pipelines and other utilities. Destructive forces may be upward, horizontal, or both. Buildings designed with lightly loaded foundations and floor systems often incur the greatest damage and costly repairs from expansive soils. Building in and on swelling soils can be done successfully, although more expensively, as long as appropriate construction design and mitigation measures are followed.

Past Occurrences

The HMPC had no data on the historic occurrences of expansive soils within the City of Boulder.

Likelihood of Future Occurrences

Without historic data, the HMPC was unable to determine the nature and extent of future occurrences of expansive soils.

4.2.18 Soil Hazards: Land Subsidence

Hazard/Problem Description

The Colorado Geological Survey defines land subsidence as the sinking of the land over manmade or natural underground voids. In Boulder County, the type of subsidence of greatest concern is the settling of the ground over abandoned mine workings. Past coal and clay mining activities have created surface subsidence in some areas and created the potential for subsidence in other areas. Collapsing and settling soils are relatively low density materials that shrink in volume when they become wet, and/or are subjected to great weight such as from a building or road fill. The process of collapse with the addition of water is also known as hydrocompaction.

Natural and human activities cause subsidence. Activities that lead to subsidence include underground mining, pumping groundwater or petroleum out of the ground, hydrocompaction, and draining organic soils. Natural causes of subsidence include the development of sinkholes, rock sliding downward along faults, natural sediment compaction, and melting of permafrost.

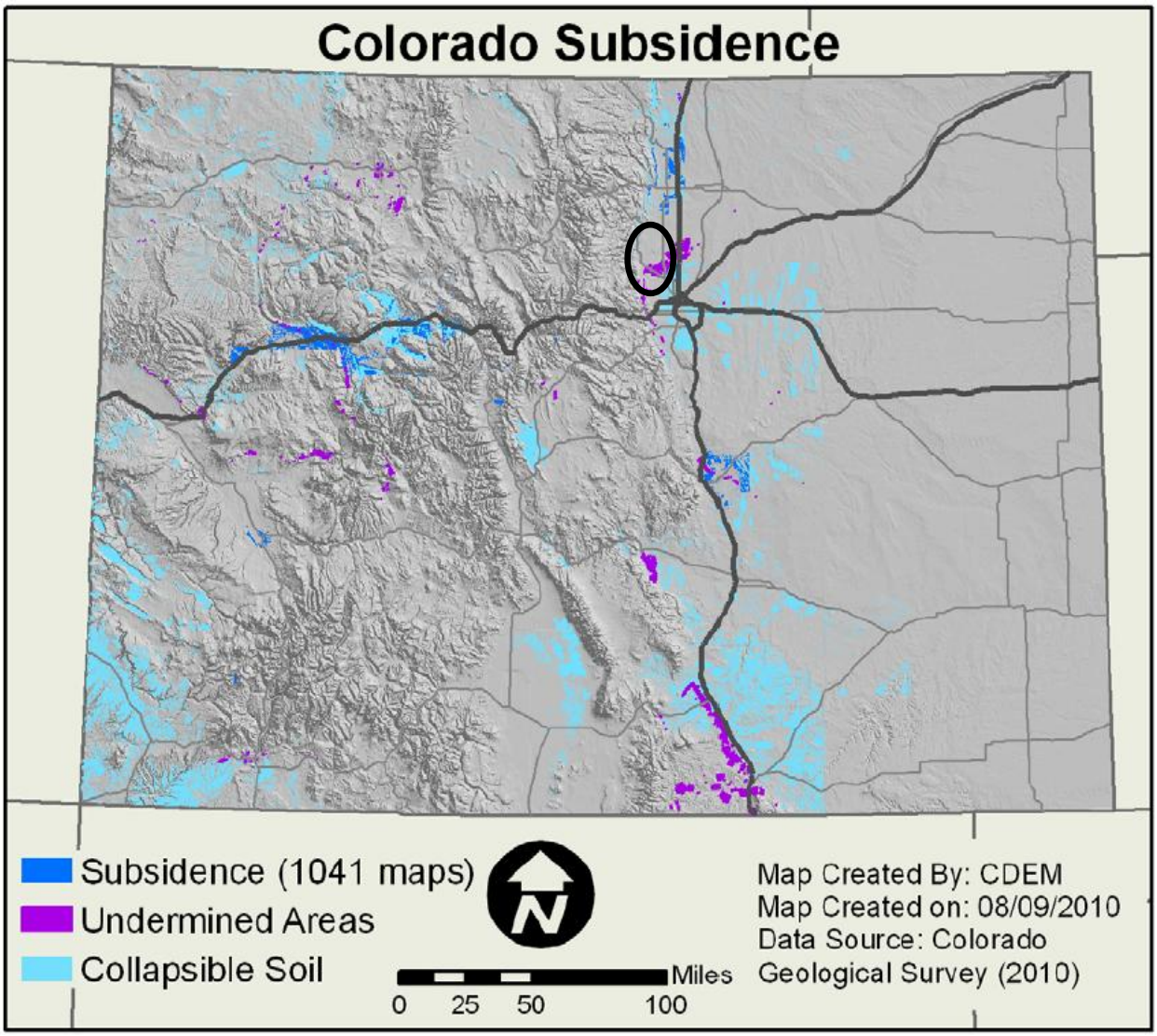
Subsidence may occur abruptly-virtually instantly—or gradually over many years. It may occur uniformly over a wide area as local depressions or pits separated by areas which have not visibly subsided. In Colorado, it is most common in the sedimentary rocks over abandoned coal and clay mines. The crystalline rocks in which most metals are mined have greater strength and are less likely to settle or collapse. Subsidence can also occur where underground water has dissolved subsurface materials or has been withdrawn by wells. Although serious in other western states, these latter types of subsidence are less common in Colorado than sinking caused by the caving in of underground mine workings.

Collapsing and settling soils have considerable strength when dry and generally are not a problem to structures and improvements. When they become wet, they are subject to rapid collapse and can be reduced in volume as much as 10 to 15 percent. Surface ground displacement of several feet can result. Similar processes frequently affect old landfills or poorly placed earth fills.

Subsidence and collapsible soils tends to be problematic along the Front Range, as shown in Figure 4.36. The largest concern for subsidence generally occurs where land with sedimentary rock is undermined around historic coal and clay mines. In addition to undermined areas, ground

subsidence hazards also occur where evaporitic bedrock (gypsum, anhydrite, and rock salt) dissolves. Subsidence sags and ground downwarping, caverns and opens fissures, ground seepage and streams flowing from bedrock, and various types of sinkholes, are landforms collectively called karst morphology. Figure 4.36 shows a comprehensive look at subsidence and collapsible soils in Colorado.

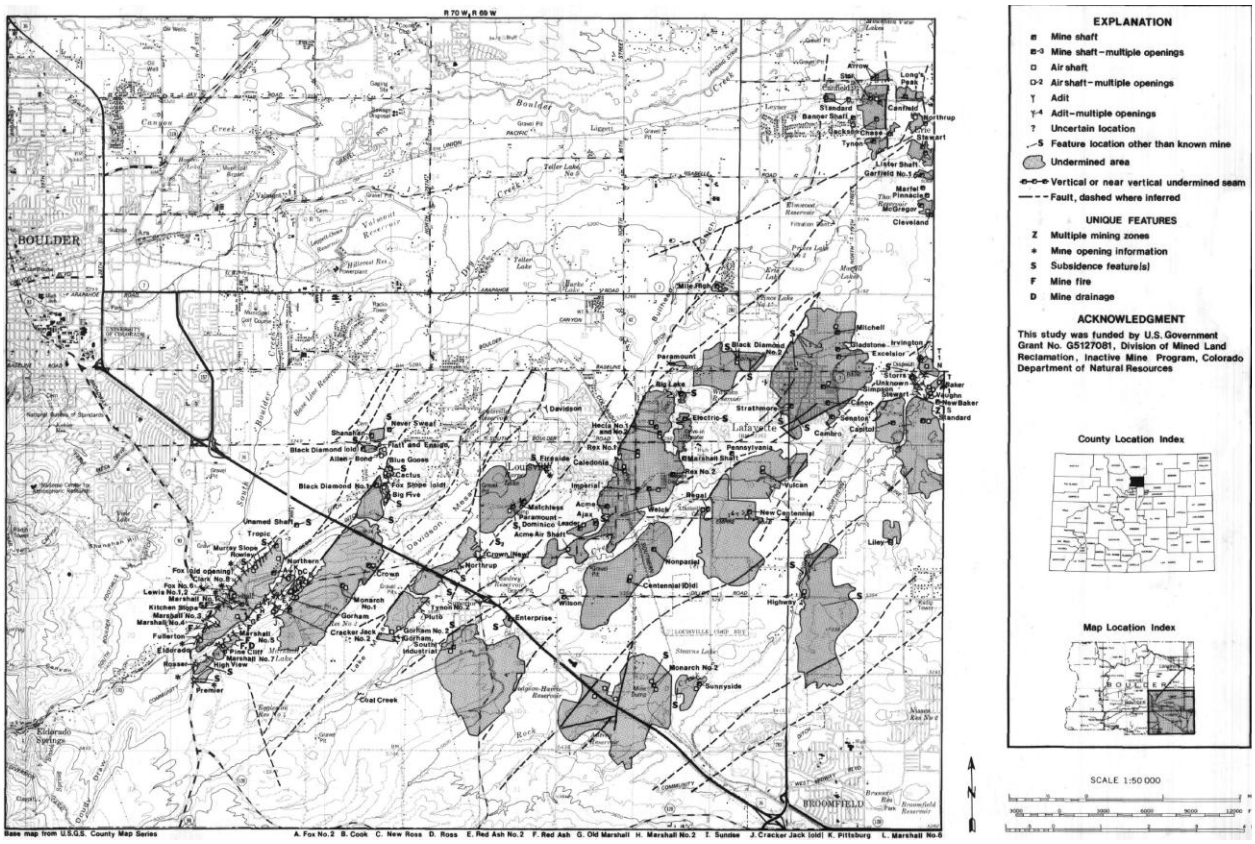
Figure 4.36. Subsidence Areas in Colorado



Source: CO OEM; Black oval indicates approximate location of City of Boulder

The Colorado Geological Survey has a series of maps available showing the extent of coal mining in communities along the Front Range. Figure 4.37 provides a map from Boulder County. They gray areas on the maps indicate the location of undermined land.

Figure 4.37. Boulder County Undermined Land Map



Source: 2011 State of Colorado Natural Hazards Mitigation Plan

Subsidence can result in serious structural damage to buildings, roads, irrigation ditches, underground utilities, and pipelines. It can disrupt and alter the flow of surface or underground water. Weight, including surface developments such as roads, reservoirs, and buildings and manmade vibrations from such activities as blasting or heavy truck or train traffic can accelerate the natural processes of subsidence. Fluctuations in the level of underground water caused by pumping or by injecting fluids into the earth can initiate sinking to fill the empty space previously occupied by water or soluble minerals. The consequences of improper use of land subject to ground subsidence can be excessive economic losses, including the high costs of repair and maintenance for buildings, irrigation works, highways, utilities, and other structures. This results in direct economic losses to citizens as well as indirect economic losses through increased taxes and decreased property values.

Past Occurrences

Subsidence has occurred in Boulder County. Based on information included in the state hazards mitigation plan, a substantial area within Boulder County is a major mining district and a portion of the eastern county is a coal region. Boulder County is second in the state in terms of number of abandoned mines with 183 abandoned coal mines and 3,600 abandoned mines of other types.

In Lafayette in 1974, an abandoned coal mine created a sinkhole in a trailer park area that expanded to 25 feet deep and 25 feet in diameter in about a 24-hour period.

The HMPC had no data on the historic occurrences of subsidence within the City of Boulder.

Likelihood of Future Occurrences

Without historic data, the HMPC was unable to determine the nature and extent of future occurrences of subsidence within the city.

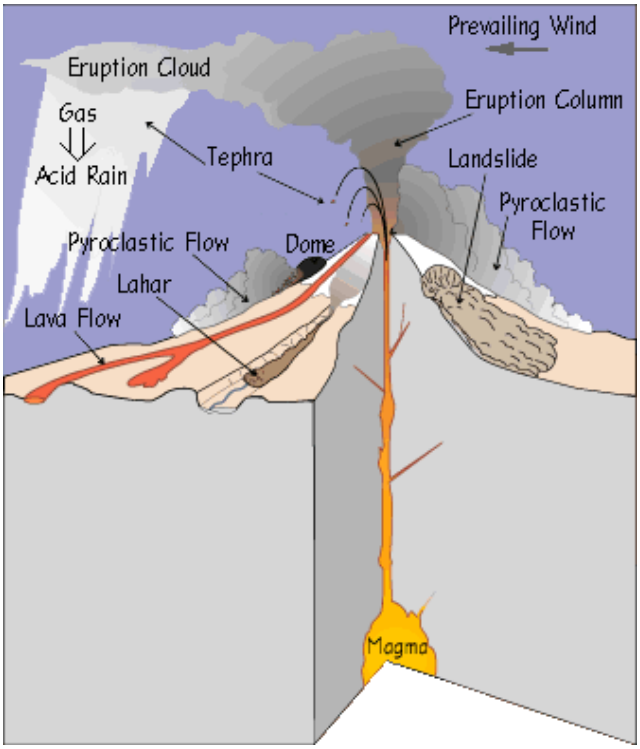
4.2.19 Volcanoes

Hazard/Problem Description

Of the almost 70 active and potentially active volcanoes in the United States, more than 50 have erupted one or more times in the past 200 years. Volcano hazards are the greatest in five western states: Alaska, Hawaii, California, Oregon, and Washington. Volcanoes create a wide variety of hazards that can kill people and destroy property.

Populations living near volcanoes are most vulnerable to volcanic eruptions and lava flows; although, large explosive eruptions can endanger people and property hundreds of miles away and even affect global climate. Volcanic ash can also travel and affect populations many miles away. The ash from the 1980 eruption of Mount St. Helens in Washington fell over a large area of the western United States. Heavy ash fall can collapse buildings, and even minor ash fall can damage crops, electronics, and machinery. Some volcanic hazards, such as landslides, can occur even when a volcano is not erupting. Figure 4.38 depicts a volcano typical of those found in the western United States.

Figure 4.38. Typical Western U.S. Volcano



Source: http://pubs.usgs.gov/fs/fs002-97/

The only volcano of concern in Colorado is Dotsero, which, according to the U.S. Geological Survey is a moderate threat volcano. The Dotsero crater, about a half-mile north of I-70 on the east side of Glenwood Canyon has not erupted in 4,000 years. Should Dotsero erupt again, it would likely not have much of an impact on the Boulder area.

Another volcanic risk in the Rocky Mountain region is the Yellowstone Caldera. This large but somewhat distant area of volcanic activity could pose regional ash fall threats. Very large-scale explosive volcanic activity has occurred in the Yellowstone area within the past 2.5 million years, which, in geologic time, is very recent. Because of this, the Yellowstone volcanic area is considered a substantial threat across Wyoming and much of the western United States. It is possible that another eruption of similar magnitude will occur, but probably not within the next 20,000 or more years. In the event that another large-scale eruption did occur, thickness of the volcanic material produced would be immense. Some studies predict that ash in southeastern Wyoming would be over three feet deep. Because of the overly long expected occurrence of frequency (greater than 10,000 years) for explosive volcanism at Yellowstone, and the fact that effective mitigation for an event of this low frequency and magnitude is difficult, it was not analyzed in further this document.

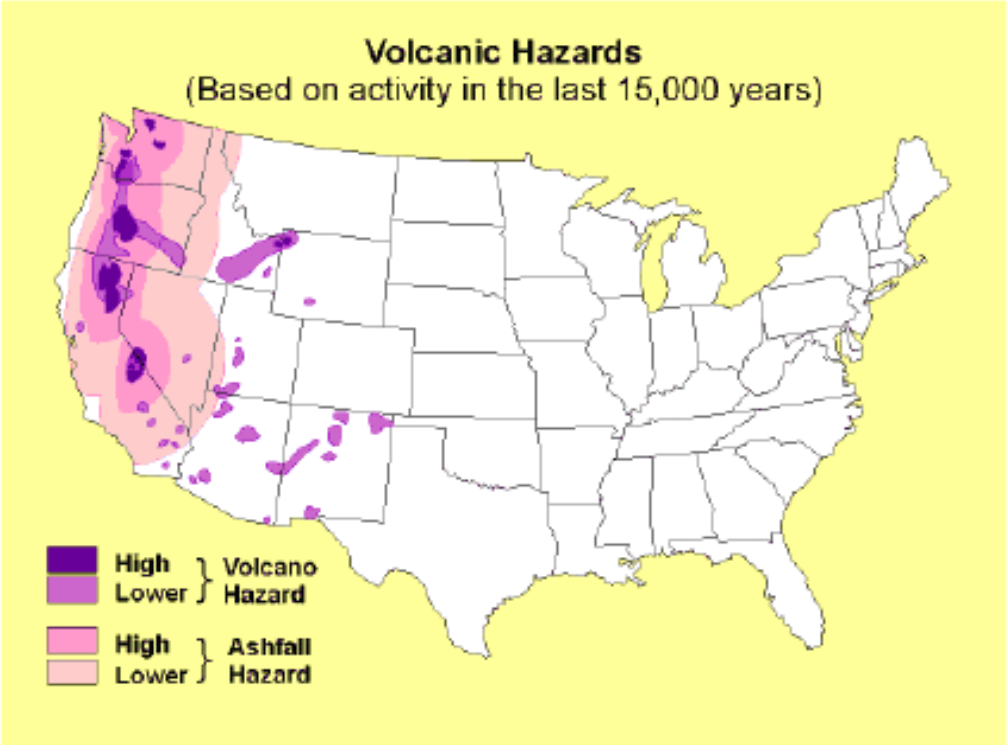
Past Occurrences

The HMPC indicated that the only evidence of volcanic activity in the Boulder area occurred during the 1980 eruption of Mt. St. Helens when ash fell in the city.

Likelihood of Future Occurrences

Unlikely: Given its location in regard to potentially active volcanoes in the United States, the Boulder area is not at great risk to volcanic hazards. Volcanic hazards would likely be limited to ash fall from a large eruption of a volcano in the western United States. Figure 4.39 illustrates volcanic hazards based on activity in the last 15,000 years. Areas in blue or purple show regions at greater or lesser risk of local volcanic activity, including lava flows, ashfall, lahars (volcanic mudflows), and debris avalanches. Areas in pink show regions at risk of receiving five or more centimeters of ashfall from large or very large explosive eruptions originating at the volcanic centers shown in blue. An eruption of an active volcano in the western United States is not likely to adversely impact the City of Boulder. For the purposes of this plan volcanoes were considered to have a 'limited' geographic extent rating.

Figure 4.39. Volcanic Hazards Ash Dispersion Map



Source: U.S. Geological Survey

4.2.20 Wildfire

Hazard/Problem Description

Wildfire and urban wildfire are an ongoing concern for Boulder County and the City of Boulder. Generally, the fire season extends from spring to late fall. Fire conditions arise from a combination of 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 wildfire to occur. The wildfire risk is predominantly associated with the wildland-urban interface, 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 Boulder County, including areas of the city, due to increased residential development in semi urban and rural areas.

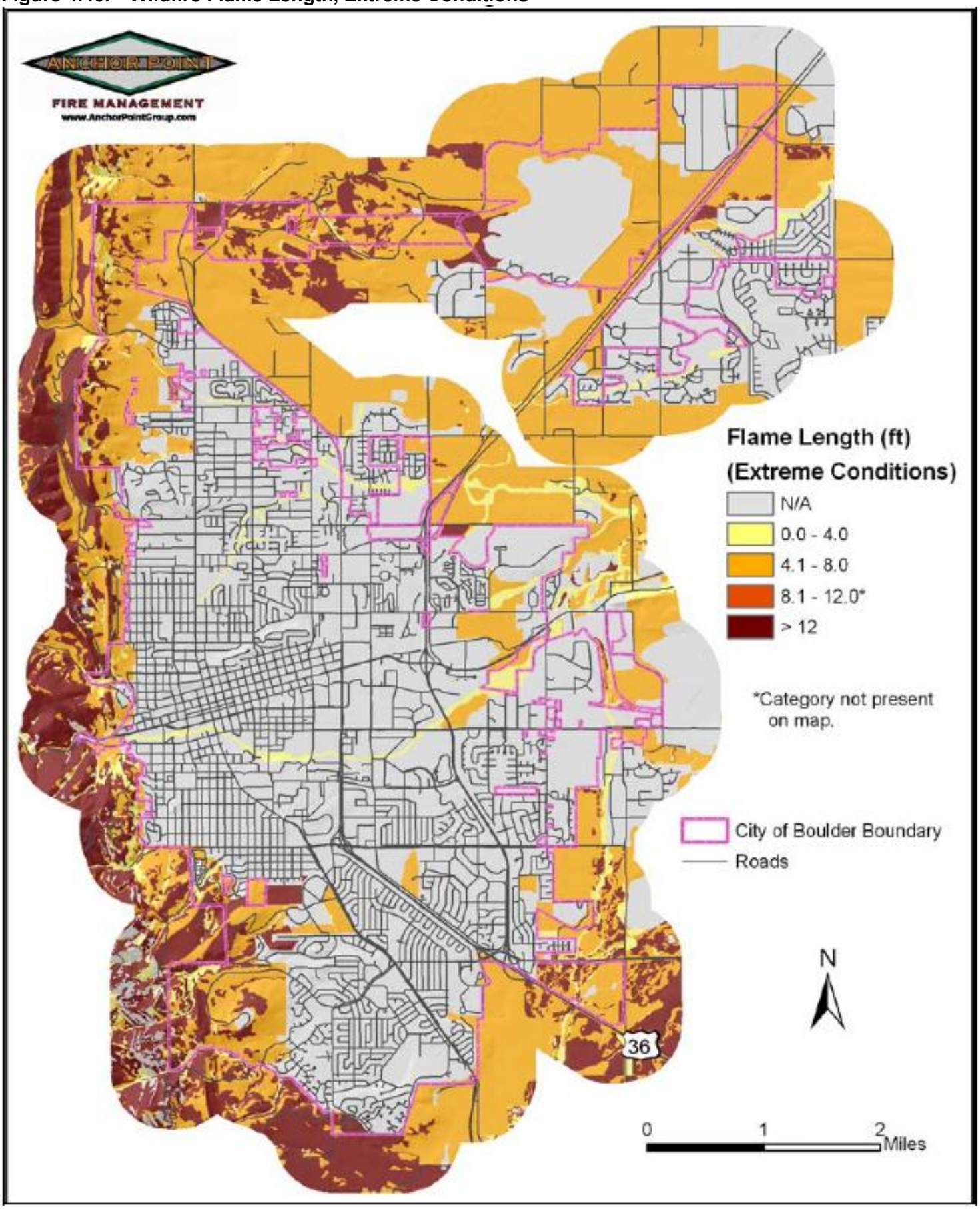
Generally, there are three major factors that sustain wildfires and predict a given area's potential to burn. These factors are fuel, topography, and weather.

- **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. Also to be considered as a fuel source are manmade structures, such as homes and associated combustibles. 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 burns in the upper canopy and cannot be controlled. The volume of available fuel is described in terms of fuel loading. Certain areas in and surrounding Boulder County are extremely vulnerable to fires as a result of dense vegetation combined with a growing number of structures being built near and within rural lands. 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 Boulder County has added to the fuel loading in the area. Fuel is the only factor 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**—Weather components such as temperature, relative humidity, wind, and lightning also affect the potential for wildfire. High temperatures and low relative humidity dry out the fuels that feed the 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 Boulder. 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.

Figure 4.1 represents a classification of the expected relative wildfire severity based on modeled flame lengths under extreme weather conditions. The figure is from the City Community Wildfire Protection Plan (CWPP) and is representative of fire behavior from weather conditions on the five most severe fire weather days in each season for a thirty-year period averaged together. This information was used to generate "areas of concern" and for the CWPP. The geographic extent rating for wildfire is considered limited with less than 10% of the planning area affected, but the entire western edge of city is potentially exposed.

Figure 4.40. Wildfire Flame Length, Extreme Conditions



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).

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, Boulder County has experienced numerous wildfires dating back to June 29, 1916. Details are provided below.

- **June 29, 1916**—1,000 acres burned around Bear Mountain.
- **July 5, 1924**—1,600 acres burned near Nederland.
- **August 9, 1978**—Fire caused by lightning burned more than 1,000 acres in the northwestern portion of Boulder County in Rocky Mountain National Park.
- **October 6, 1980**—A fire caused by an arsonist burned 150 acres in the Pine Brook Hills subdivision, destroying a $150,000 home.
- **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**—Olde 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.
- **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. This area had previously undergone fuels treatment, which mitigated the severity of the fire.
- **October 29, 2003**—The Overland fire likely started when the top half of a tree that was sheared off by 60 mph winds fell onto a power line on or near the Burlington Mine cleanup site in Jamestown. 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.

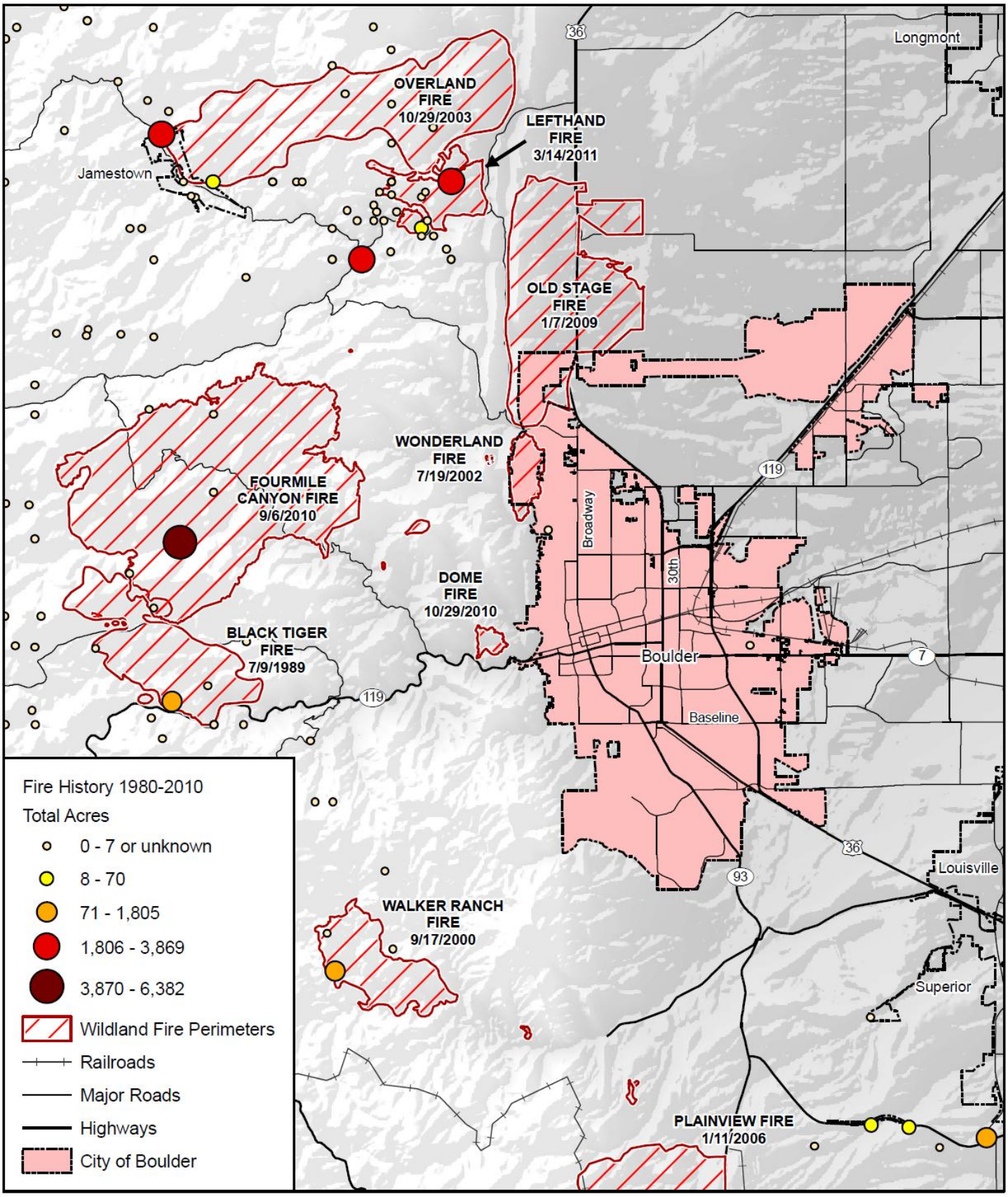
- **February 14, 2006**—The Elk Mountain fire consumed an estimated 600 acres of brush and grassland north of Boulder. The fire originated in a pile of fireplace ashes that had been dumped outside of a mobile home. The gusting winds spread the hot ash, igniting nearby grasses that were tinder-dry after a prolonged period of dry, hot weather. Winds pushed the fire into a blaze that expanded rapidly, threatening at least three homes. No structures were lost, and damage was largely limited to fences, an apple orchard, and two old farm trucks.
- **January 7, 2009** – At about 1:00 pm on Wednesday, 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. Due to the extreme wind event, a home at 45th St. was quickly consumed by the fire. Flying embers started a series of running grass fires to the east of the structure. 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 in excess of $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.
- **October 29, 2010** – Following the Fourmile Canyon Fire was the Dome Fire. The Dome Fire forced the evacuation of more than 1,800 people and threatened the city's western edge near downtown. It began around 8 a.m. Friday near the Dome Rock formation in Boulder Canyon and quickly burned north, cresting the ridge between Boulder and Sunshine canyons after a few hours. Boulder Community Hospital's Maxwell and Mapleton facilities were also evacuated and were temporarily closed. The hospital's north Broadway location was not affected. Xcel Energy temporarily cut power to about 10,000 Boulder-area homes on Friday afternoon as the company rerouted power from the burn area. Xcel later cut power to residences in the Knollwood and Seven Hills areas. Periodic outages also affected downtown Boulder. Fortunately firefighters were able to contain the fire before it spread to structures near downtown Boulder.
- **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.

Other notable fires (greater than 50 acres in size) in the Boulder area include the following:

- **November 1, 1964**—Near Eldorado Springs (100 acres)
- **May 28, 1974**—Near Gold Hill (160 acres)
- **June 1976**—Comforter Mountain (256 acres)
- **August 1979**—Coal Creek Canyon (50 acres)
- **September 21, 1984**—U.S. Forest Service land near Lyons (60 acres)
- **August 1, 1987**—Between Boulder and Lyons (50 acres)
- **November 4, 1987**—Southwest of Highway 36 (100 acres)
- **February 21, 1988**—Sunshine Canyon (200 acres)
- **September 7, 1988**—North of Ward (160 acres)
- **July 15,1991**—West of Boulder Hills subdivision, six miles north of Boulder (135 acres)
- **July 14, 1994**—Near Ward (50 acres)
- **September 3, 1996**—Rabbit Mountain, Lyons (50 acres)
- **September 1, 2005**—North Foothills fire, Foothills Ranch subdivision above Mt. Ridge/Lake of the Pines area (55 acres)
- **June 26, 2011** – Maxwell fire, burned 60 acres.

Figure 4.1 shows some of the above described fire perimeters. The map shows known fire perimeters near the City of Boulder from 1980 to 2010.

Figure 4.41. Fire Perimeters near the City of Boulder 1980 to 2010



Map compiled 4/2012; intended for planning purposes only
Data source: City of Boulder, Boulder County, CDOT, DOI (BIA, BLM, NPS), USFWS, and USFS

Likelihood of Future Occurrences

Likely: Based on historical data, Boulder County experienced at least 29 significant (>50 acres) fires since 1916. This is an average of one fire every 3.31 years and a 30.2 percent chance of a fire in any given year. Depending on the severity and location of a fire, Boulder County and the City of Boulder are at risk to future fires.

From spring through fall each year, Boulder County faces a serious wildland fire threat. Much of the county 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 Boulder 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 affect 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 sixfold 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.

Intense wildfires can produce highly erodible soils that can lead to increased sediment loading in reservoirs and streams, damaging water infrastructure and degrading water quality. Although most of the city's water supplies are in low or moderate fire risk areas, a catastrophic fire would have serious impacts on higher-elevation water supplies, notably Barker Reservoir. In addition, the City of Boulder's main water treatment plant at Betasso, located in the foothills, leaves it vulnerable to fire. During the Fourmile Canyon fire, the city was nearly forced to evacuate and shut down the Betasso Treatment Plant. This shut down would have resulted in the city relying entirely on treated water from Boulder reservoir and the 63rd St. treatment plant.

4.2.21 Winter Storms

Hazard/Problem 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 city 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.

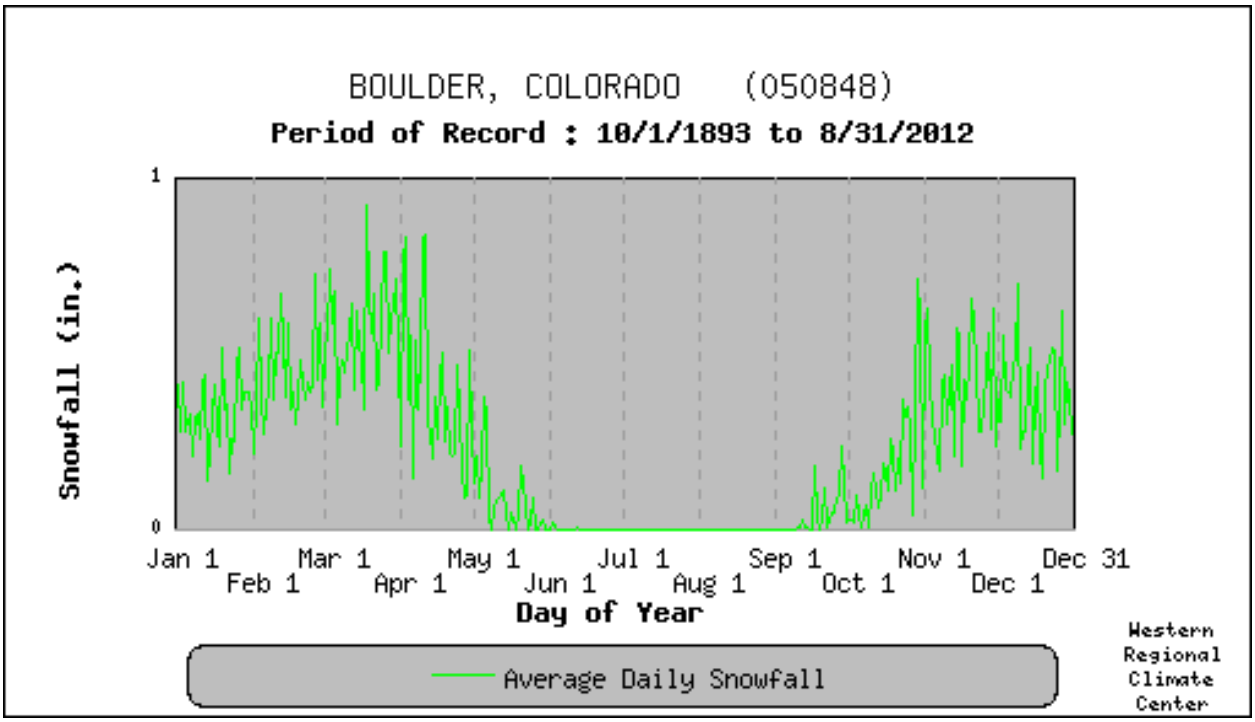
Past Occurrences

Both the western and eastern portions of Boulder County receive snowfall on a regular seasonal basis, predominantly from October through April; however, the western portion of the county receives substantially more snow than the eastern portion. The following summarizes the effects of snow in the City of Boulder based on data from the Western Regional Climate Center.

According to the Western Regional Climate Center, for the period of record of 1893 to 2012, the average annual total snowfall for the Boulder area was 79.7 inches. The two snowiest months were November and March, with 11.6 and 16.3 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.

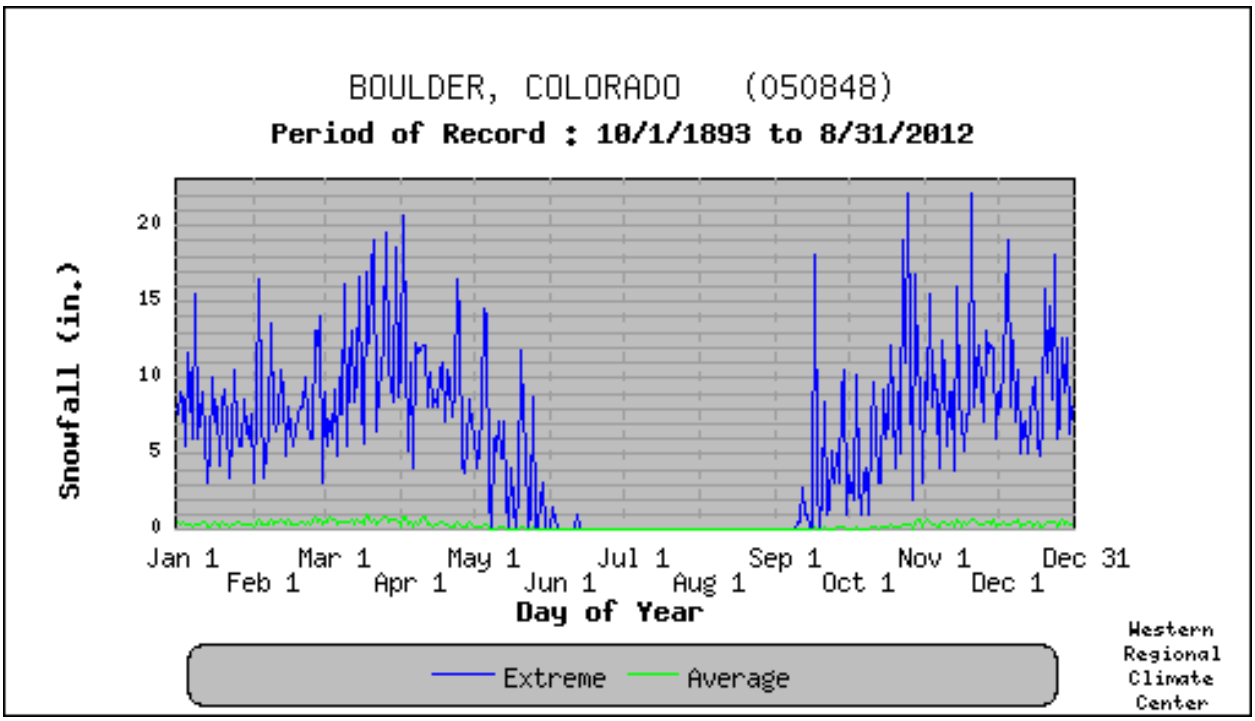
The average snow depth ranged from 0-1 inches during the winter months; however, daily extremes include snow depths up to 27 inches. Figures 4.42 and 4.43 show Boulder's daily snowfall averages and extremes between 1893 and 2012.

Figure 4.42. Boulder Daily Snowfall Average 1893 to 2012



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

Figure 4.43. Boulder Daily Snowfall Average and Extreme, 1893 to 2012



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

In the previous plan, data from the NCDC identified 67 winter storm events between 1993 and 2007 that impacted Boulder. Since NCDC data regarding winter storm was not available during the writing of this plan, SHELDUS provided one more storm to affect the City of Boulder since 2007. Of these, the following events resulted in reported injuries and/or property damage:

- **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; the Palmer Divide; in the area from just south of Denver, east and northeast into northern Lincoln and Washington counties; and near the Nebraska state line. Sustained winds from 35 to 58 mph with gusts to around 75 mph were recorded. Denver International Airport was completely shut down for the first time in its brief history. Power surges and outages constantly crippled the airport's massive computer system. The airport was closed at 5:00 a.m. and did not reopen until midafternoon. Power outages affected nearly all of northeast Colorado. Some areas only had scattered outages for a few hours, while more remote areas were blacked out for over a week. As a result, most businesses were closed and school classes canceled. The only businesses that remained open during the storm were those using backup generators. Overall, 220,000 Xcel Energy customers were affected, making it the worst outage in the company's history.

- **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.

Other winter storm events identified by the HMPC include the following:

- **December 4-5, 1913**—43 inches
- **November 2-5, 1946**—31 inches
- **January 23-27, 1948**—21 inches
- **April 7-11, 1959**—26 inches
- **March 29-31, 1970**—26 inches
- **September 17-18, 1971**—21 inches
- **November 20, 1979**—22 inches
- **May 1978**—The spring storm of 1978 dropped 30 inches of snow over Boulder and was responsible for at least one death and a serious injury. It also collapsed an old hotel building (the Arnett Hotel) on Pearl Street across from the *Daily Camera*. The snow started before dawn on Friday, May 5, accumulating about 8 inches in town and 26 in the foothills by later that day. It snowed all day Saturday and into Sunday.
- **Winter of 1978-1979** – A series of winter storms collapsed the roof of the Fairview High School.
- **Christmas storm of 1982**—The storm began on Christmas Eve, lasting through Christmas Day. Winds created large drifts, closing roads and stranding travelers.
- **November 26-27, 1983**—23 inches
- **December 24-29, 1987**—20 inches of snow fell over a period of a few days. Countywide snow removal operations were estimated at $280,000.
- **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.
- **November 17, 1991**—The October 1991 freeze ("Halloween Freeze") saw temperature extremes from 60°F to below 0°F. This snowstorm, combined with a freeze the previous month caused $51,250 in tree damage.
- **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. The storm caused $32,045 in tree damage (an additional $20,000 was spent on pruning and $23,600 on removal).
- **September 20, 1995**—This storm damaged 80-90 percent of the tree population. Total damage and associated costs equaled $363,710.
- **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.

- **Fall 2000**—Tree cleanup costs were estimated at $2,000.
- **December 28, 2006**—This large storm arrived a mere week after another winter storm of significance (see above).

Likelihood of Future Occurrences

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

4.3 Assessing Vulnerability

Requirement §201.6(c)(2)(ii):

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

Requirement §201.6(c)(2)(ii)(A):

The plan should describe vulnerability in terms of the types and numbers of existing and future buildings, infrastructure, and critical facilities located in the identified hazard areas.

Requirement §201.6(c)(2)(ii)(B):

[The plan should describe vulnerability in terms of an] estimate of the potential dollar losses to vulnerable structures identified in paragraph (c)(2)(i)(A) of this section and a description of the methodology used to prepare the estimate.

Requirement §201.6(c)(2)(ii)(C):

[The plan should describe vulnerability in terms of] providing a general description of land uses and development trends within the community so that mitigation options can be considered in future land use decisions.

With the City of Boulder's hazards identified and profiled, the HMPC conducted a vulnerability assessment to describe the impact that each hazard would have on the City of Boulder. The vulnerability assessment quantifies, to the extent feasible, assets at risk to natural hazards and estimates potential losses.

This vulnerability assessment followed the methodology described in the FEMA publication *Understanding Your Risks—Identifying Hazards and Estimating Losses*. The vulnerability assessment first describes the total vulnerability and values at risk and then discusses vulnerability by hazard.

4.3.1 Total Vulnerability and Values at Risk

As a starting point for analyzing the City of Boulder's vulnerability to identified hazards, the HMPC 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 city, 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.

Total Values and Assets at Risk

The Boulder County Assessor's Office provided data to support an analysis of total values and assets at risk in the City of Boulder. 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 city's total structure exposure is provided in Table 4.14 and is based on County Assessor's data as of December 2011.

Table 4.14. City of Boulder Structure Exposure

Land Use	Parcel Count	Acres	Improved Building Value
Agriculture	3	25	$379,000
Commercial	1,681	710	$1,327,339,000
Community	689	3,153	$962,873,000
Industrial	754	1,803	$876,707,000
Natural Lands	534	2,642	$119,177,000
Residential	31,781	5,526	$9,675,898,000
Unclassified	343	180	$21,696,000
Total	**35,785**	**14,039**	**$12,984,069,000**

Source: Boulder County Assessor's Office

Critical Facility Inventory

The definition of a 'Critical Facility' was updated in 2012 based on proposed Ordinance no. 7815. This ordinance amends floodplain regulations to protect critical facilities and mobile populations in the 100 and 500 year floodplains. 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, and (3) At-risk Populations Facility. "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.

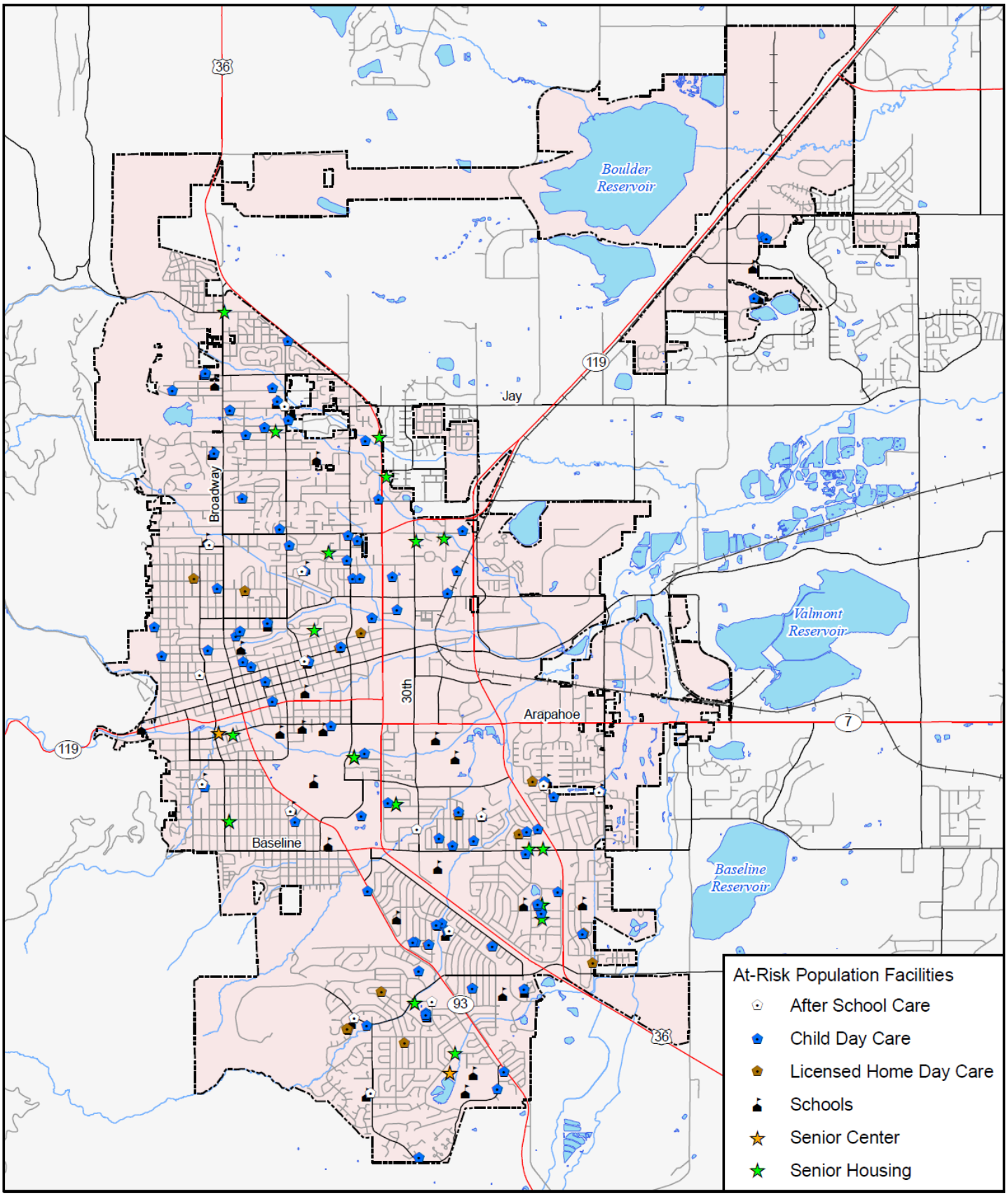
Facilities layers were obtained from the City of Boulder and the City of Boulder COG/COOP plan was used to fill in gaps of facility layers. Facilities were grouped by the ordinance categories and then sorted by facility sub-classifications. A summary of Boulder's critical facilities are shown in Table 4.15. Figures 4.1, 4.45, and 4.46 show the same facilities grouped by the three critical facility classifications. More detail on the critical facilities is provided in Appendix G.

Table 4.15. City of Boulder Critical Facility Summary

Aggregate	Classification	Classification Count
At Risk Population Facilities	After School Care	15
	Child Day Care	100
	Licensed Home Day Care	19
	Schools	40
	Senior Center	4
	Senior Housing	25
	Total	203
Essential Services Facilities	Airport	1
	Communications	64
	Emergency Medical Services	2
	Emergency Operation Centers	3
	Emergency Warning Systems	16
	Fire Station	7
	Government Buildings	17
	Hospitals	3
	Police	5
	Shelters	19
	Urgent Care Facility	2
	Utility - Power Plant	5
	Utility - Substation	4
	Utility - Wastewater Facilities	2
	Utility - Water Facilities	12
	Total	162
Hazardous Material Facilities	Hazmat Facilities	82
	Total	82
	Grand Total	447

Source: City of Boulder, Boulder County, CDOT, HAZUS-MH 2.1

Figure 4.44. At-Risk Population Critical Facilities



0 1 2 3 Miles

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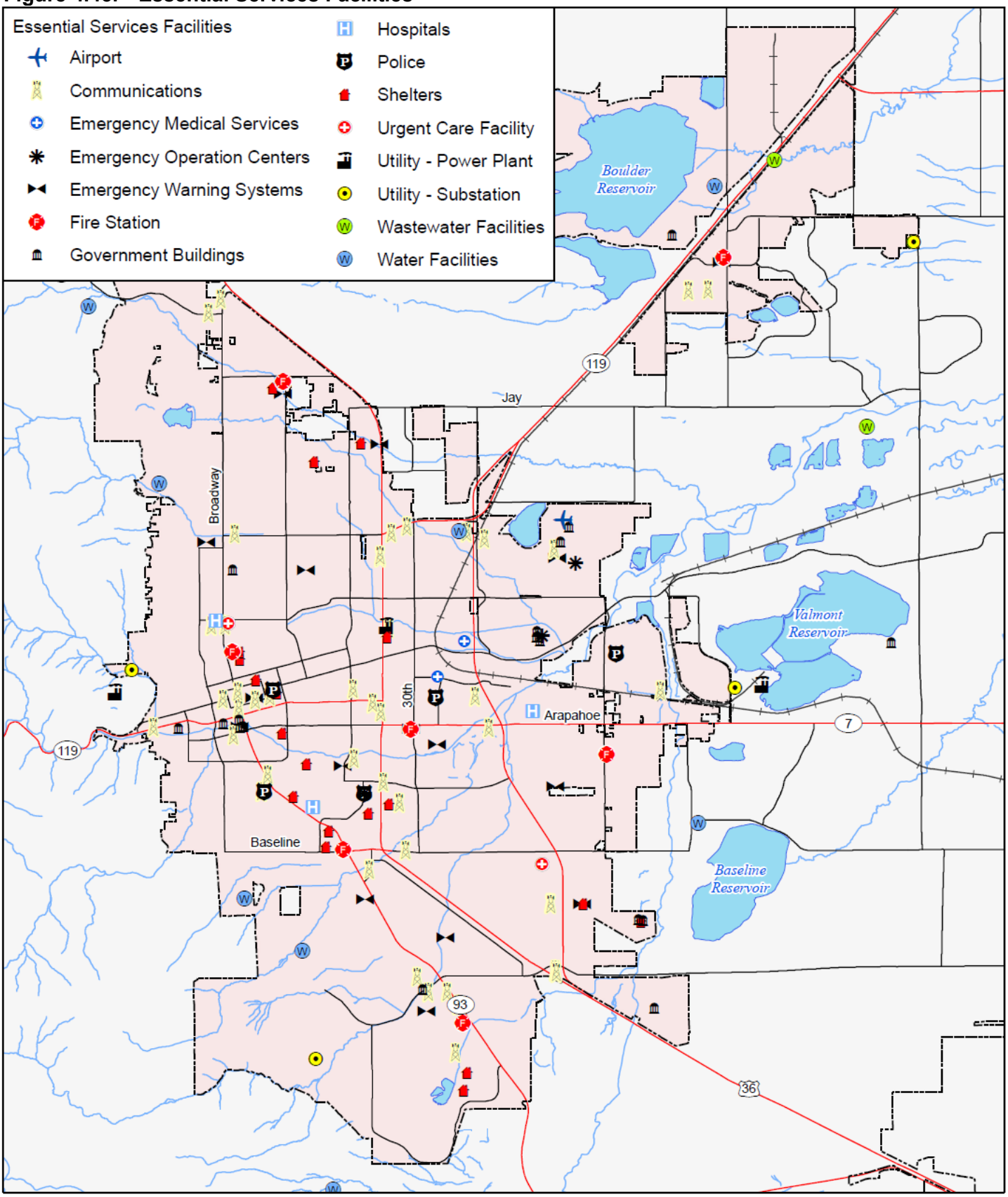
Map compiled 8/2012; intended for planning purposes only
Data source: City of Boulder, CDOT

Figure 4.45. Essential Services Facilities



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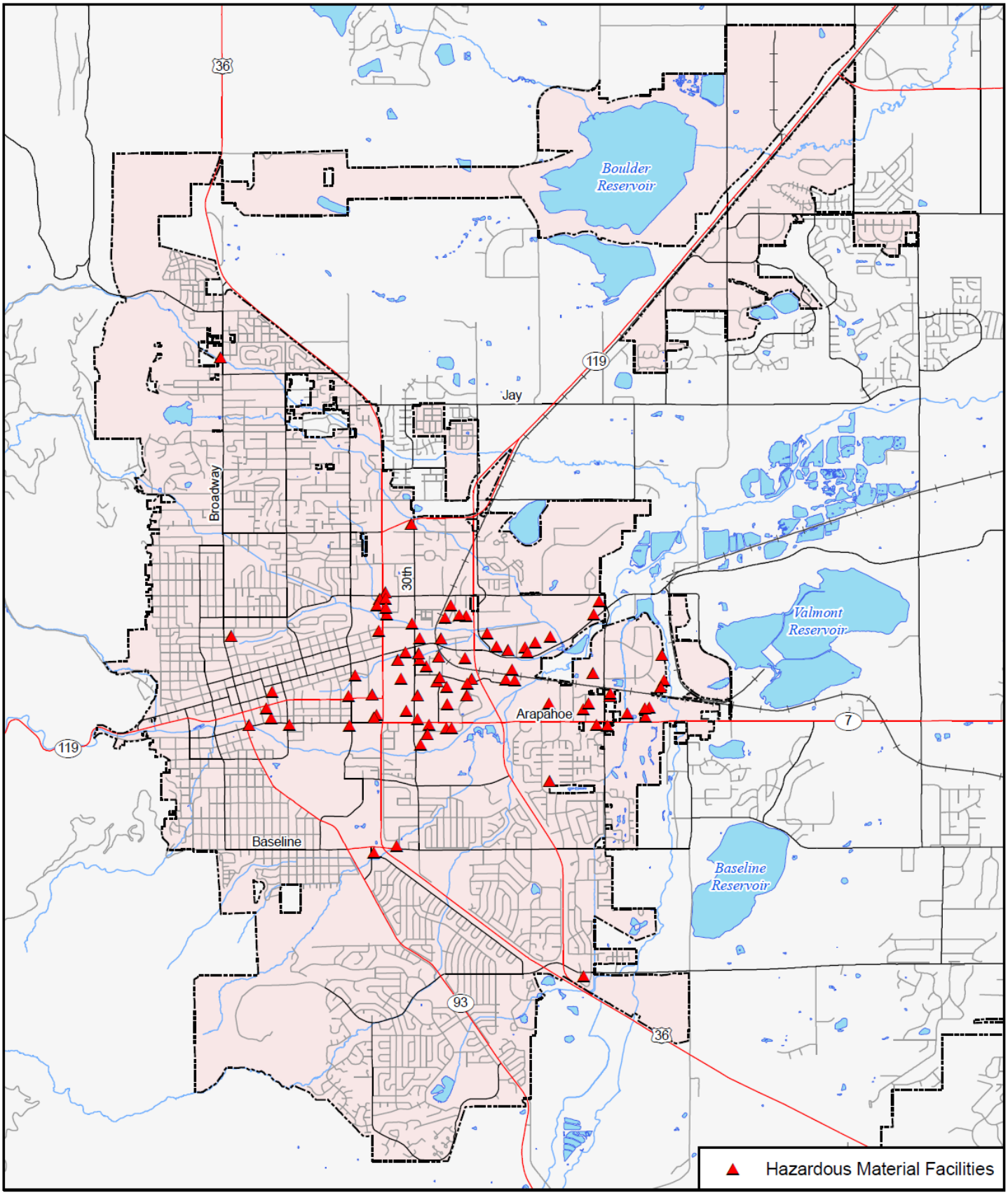
Map compiled 8/2012; intended for planning purposes only
Data source: City of Boulder, CDOT

Figure 4.46. Hazardous Materials Facilities



0 1 2 3 Miles

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amec

Map compiled 8/2012; intended for planning purposes only
Data source: City of Boulder, CDOT

Separate summary tables were created based on each aggregate to show individual facility risk to mapped hazards including flood and wildfire. These are shown in Appendix G and 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 city 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 Resources

The City of Boulder, with its history extending back to 1859, has an extensive inventory of architectural and historical resources. This inventory includes neighborhoods with late-nineteenth century to early-twentieth century buildings and scattered individual landmarks. In 1974, recognizing the value of these resources, the city passed the Boulder Historic Preservation Ordinance, creating authority to designate and prevent the demolition or destruction of historical, architectural, and cultural resources considered valuable assets to the community as a whole.

There are two basic types of landmark designations. An "individual" landmark designation recognizes the significance of a particular building and its site. Individual landmarks are evaluated based on criteria relating to historical, architectural, and environmental significance. "District" designation recognizes a particular area or neighborhood that has a collection of buildings that have architectural or historical significance to the community and are also judged against established criteria.

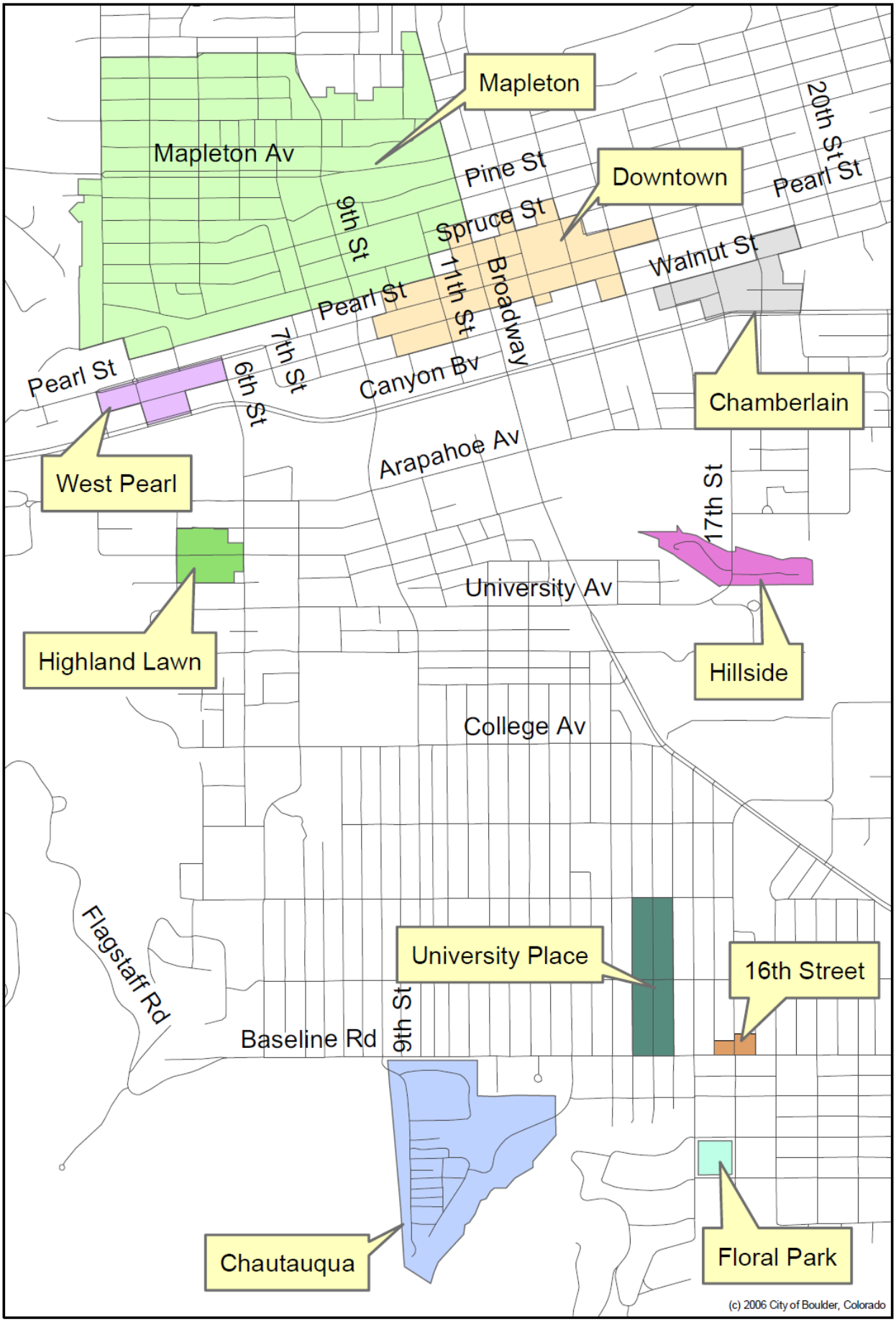
Both types of designations have the same protection and require the same procedures for renovation, though buildings within districts are further differentiated as "contributing" and "noncontributing." Buildings in the noncontributing category are held to less strict standards for alterations.

To inventory the city's cultural resources, the HMPC collected information from the City of Boulder Historic Preservation Office. The inventory of cultural resources included:

- Local historic designations
  - 162 landmark designations
  - 10 historic district designations
- State and national designations
  - 23 historic properties on the Colorado and/or National Register of Historic Places

These properties are identified in the Tables 1 and 2 in Appendix H. Figure 4.1 depicts the City of Boulder's designated local historic districts.

Figure 4.47. Designated Local Historic Districts, City of Boulder



Natural Resources

With the goal of preserving or restoring natural resources in the area, Boulder County and the City of Boulder have many ongoing programs defining the protection and management of significant agricultural lands, wildlife and plant habitats, wetlands, and natural areas. For purposes of this plan, natural resource inventories primarily focus on threatened and endangered species, wetlands, and resources unique to their urban forest.

Threatened and Endangered Species

To further evaluate the city's vulnerability to a disaster, it is important to inventory key natural resources such as threatened and endangered species.

- **Endangered species** means any species of fish, plant life, or wildlife that is in danger of extinction throughout all or a significant part of its range and is protected by law.
- **Threatened species** means any species that is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range and is protected by law.
- **Special concern** means any species about which problems of status or distribution are suspected but not documented. This is not considered a statutory category; however, many animal species listed as special concern can be protected under other state and federal laws addressing hunting, fishing, collecting, and harvesting.

State and federal species of concern lists were used to create the Boulder Valley List of Species of Special Concern as set forth in the Boulder Valley Comprehensive Plan (BVCP), which covers the City of Boulder planning area. Information was collected from the U.S. Fish and Wildlife Service, Colorado Division of Wildlife, and Colorado Natural Heritage Program. At least one of these agencies recognizes each species on the list as having a global, federal, or state ranking of concern. Table 4.16 and Table 4.17, which are from the BVCP, identify plant and wildlife species of concern, respectively, within the Boulder Valley area.

Table 4.16. Boulder Valley Comprehensive Plan Plant Species of Concern

Common Name	Scientific Name
Utes Ladies'-tresses	Spiranthes diluvialis
Colorado Butterfly Plant	Gaura neomexican ssp. coloradensis
Dwarf Leadplant	Amorpha nana
Chaffweed	Anagallis minima
American Groundnut	Apios americana
Fork-tip Three-awn	Aristida basiramea
Black Spleenwort	Asplenium adiantum-nigrum
Paper Birch	Betula papyrifera
Rattlesnake Fern	Botrypus virginianus ssp. Europaeus
Rocky Mountain Sedge	Carex saximontana
Sprengel's Sedge	Carex sprengelii
Torrey Sedge	Carex torreyi
Yellow Hawthorn	Crataegus chrysocarpa
Small-headed Rush	Juncus brachycephalus
Gay-feather	Liatris ligulistylis
Broad-leaved Twayblade	Listera convallarioides
White Adder's-mouth	Malaxis monophyllos ssp. Brachypoda
Wavy-leaf Stickleaf	Nuttallia sinuata
Bell's Twinpod	Physaria bellii
Western Polypody	Polypodium saximontanum
Toothcup	Rotala ramosior
Prairie Violet	Viola pedatifida

Table 4.17. Boulder Valley Comprehensive Plan Wildlife Species of Concern

Common Name	Scientific Name	Criteria for Listing
American Peregrine Falcon	*Falco peregrinus anatum*	LE, S2
American Redstart	*Setophaga ruticilla*	S1
Argos Skipper	*Atrytone argos*	S2
Bald Eagle	*Haliaeetus leucocephalus*	LT, S1, state threatened
Banded Physa	*Physa utahensis*	G1, S1
Black-tailed Prairie Dog	*Cynomys ludovicianus*	C
Blue-Ringed Dancer	*Argia sedula*	S2
Burrowing Owl	*Athene cunicularia*	state threatened
Chestnut-sided Warbler	*Dendroica pensylvanica*	S2
Colorado Blue	*Euphilotes rita coloradensis*	S2
Common Shiner	*Notropis cornutus*	S2
Cylindrical Papershell	*Anodontoides ferussacianus*	S2
Great Egret	*Ardea alba*	S1
Greenback cutthroat trout	*Oncorhynchus clarki virginalis*	LT, S2, state threatened
Hops Azure	*Celastrina humulus*	G2, S2
Lake Chub	*Couesius plumbeus*	LE, S1
Lake Darner	*Aeshna eremita*	S1
Long-billed Curlew	*Numenius americanus*	S2
Moss's Elfin or Schryver's Elfin	*Callophrys mossii schryveri*	C, S2
Mottled Duskywing	*Erynnis martialis*	S2
Mountain Plover	*Charadrius montanus*	S2
Northern Goshawk	*Accipiter gentilis*	S2
Northern Redbelly Dace	*Phoxinus eos*	S1, state endangered
Ottoe Skipper	*Hesperia ottoe*	S2
Ovenbird	*Seiurus aurocapillus*	S2
Plains sharp-tailed Grouse	*Tympanuchus phasianellus jamesi*	S1, state endangered
Plains Topminnow	*Fundulus sciadicus*	C, S2
Preble's Meadow Jumping Mouse	*Zapus hudsonius preblei*	LT, S1, state threatened
Regal Fritillary	*Speyeria idalia*	C, S1
Rhesus Skipper	*Polites rhesus*	S2
Rocky Mountain Arctic Jutta	*Oeneis jutta reducta*	S1
Rocky Mountain Capshell	*Acroloxus coloradensis*	S2
Sharp Sprite	*Promenetus exacuous*	S2
Short-eared Owl	*Asio flammeus*	S2
Stonecat	*Noturus flavus*	S1
Two-spotted Skipper	*Euphyes bimacula*	S2
White-winged Crossbill	*Loxia leucoptera*	S1

Common Name	Scientific Name	Criteria for Listing
Extirpated species		
American Bison	*Bison bison*	
Black-footed Ferret	*Mustela frenata*	G1, LE, S1, state endangered
Grizzly Bear	*Ursus arctos horribilis*	LT, state endangered
Northern River Otter	*Lutra canadensis*	state endangered
Pronghorn Antelope	*Antilocapra americana*	
Timber Wolf	*Canis lupus lycaon*	

Source: Boulder Valley Comprehensive Plan

1The species is listed under the provisions of the federal Endangered Species Act as; LE – Listed Endangered; LT – Listed Threatened; PT – Proposed threatened; or C – Candidate for listing

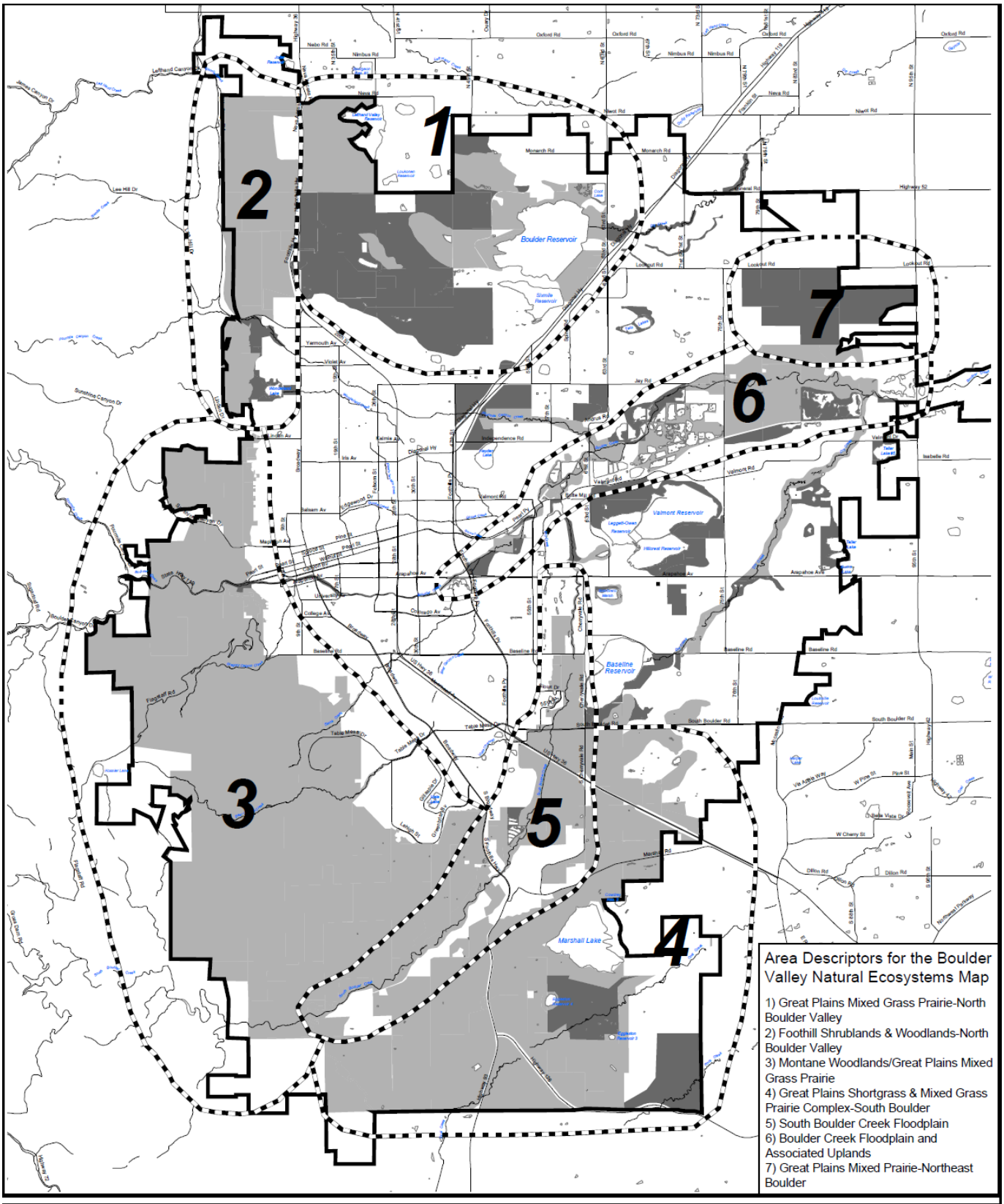
2. The species is listed by the Colorado Department of Natural Resources, Division of Wildlife as: Threatened or Endangered

3. The species is listed by the Colorado Natural Heritage Program as: G1 – Globally critically imperiled; typically 5 or fewer occurrences; G2 – Globally imperiled; typically 6 to 20 occurrences; S1 – State critically imperiled; typically 5 or fewer occurrences or; S2 – State imperiled; typically 6 to 20 occurrences.

Staff from Planning, Parks and Recreation, and Open Space and Mountain Parks have created an Urban Wildlife Management Plan. The plan establishes a set of policies and procedures for managing wildlife, including species of special concern, within Boulder on both public and private land. Phase I of the planning process established a vision statement, guiding principles, and goals for the plan. Phase II, which is ongoing, involves the development of individual species management plans. The Black-Tailed Prairie Dog Component of the plan, approved in August 2006, was the first species plan. On October 18, 2011 the Bear and Mountain Lion Component of the plan was added.

In order to encourage environmental preservation, a Natural Ecosystem overlay is applied over Comprehensive Plan Land Use Designations throughout the Boulder Valley Planning Area. Natural ecosystems are defined as areas that support native plants and animals or possess important ecological, biological or geological values that represent the rich natural history of the Boulder Valley. The Natural Ecosystems overlay also identifies connections and buffers that are important for sustaining biological diversity and viable habitats for native species, for protecting the ecological health of certain natural systems, and to buffer potential impacts from adjacent land uses. This map is shown in Figure 4.48.

Figure 4.48. City of Boulder Natural System Overlay



LEGEND:

AREA DESCRIPTOR BOUNDARY

GROUP ONE NATURAL ECOSYSTEMS (PUBLIC & PRIVATE LANDS)

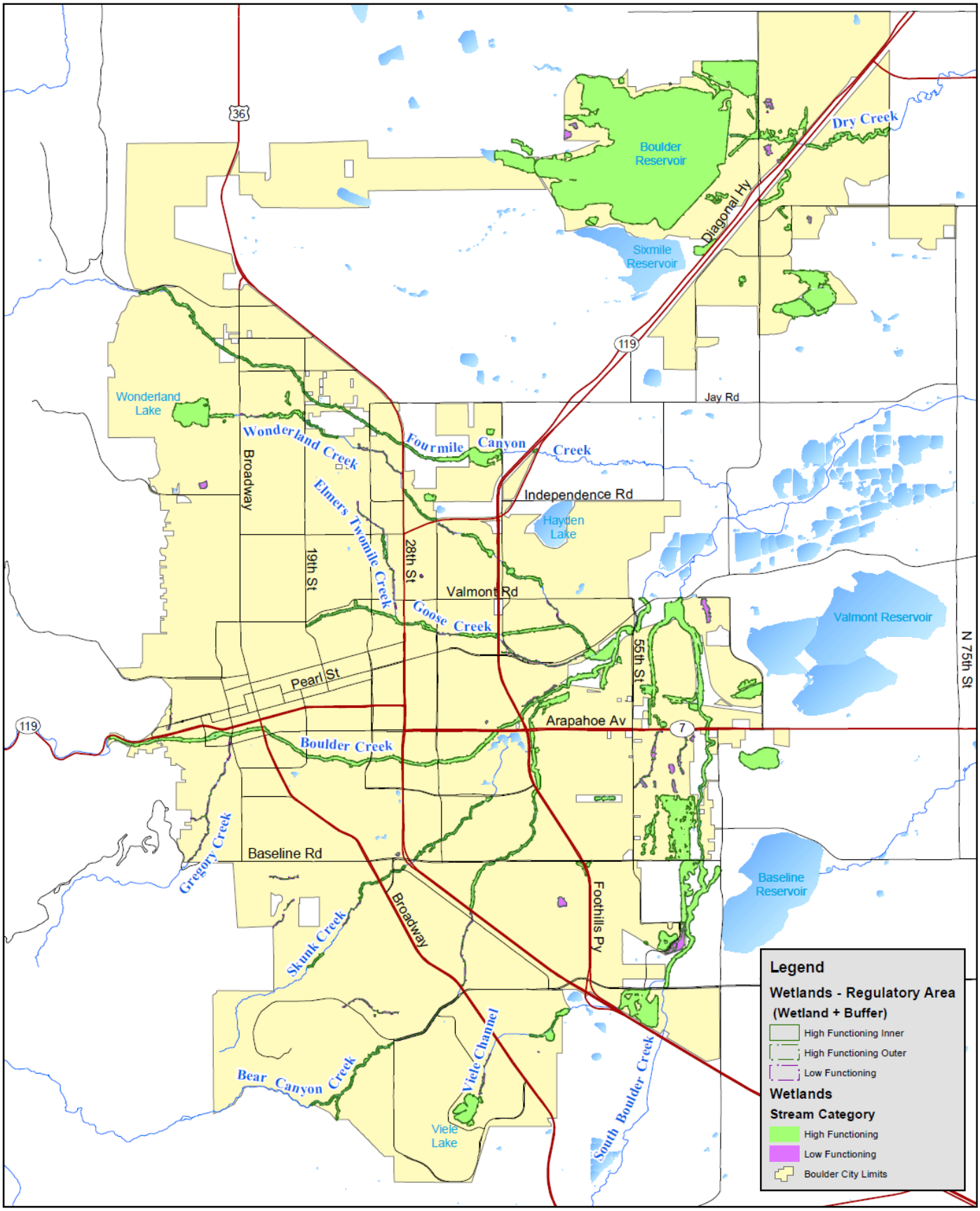
GROUP TWO NATURAL ECOSYSTEMS (PUBLIC & PRIVATE LANDS)

Map is not to scale

Wetlands

Wetlands are also an important and legally protected resource. Wetland communities play a vital role in groundwater recharge and water quality protection and provide habitat for dependent plant and wildlife species. Wetlands also help absorb excess runoff and precipitation, and thus reduce flood magnitudes. A variety of wetlands can be found throughout the City of Boulder. This includes those wetlands meeting the regulatory definition of wetlands under Section 404 of the Federal Clean Water Act and those defined by Boulder's Wetlands Protection Ordinance, which was first adopted in 1992. Boulder's ordinance regulates a 50-foot buffer area around the wetland boundary and is generally more stringent than the federal regulations. The city ordinance adopts a wetlands map as the official determination of wetland boundaries within the city limits. The wetlands areas are shown in the regulatory map in Figure 4.1. Section 4.4 of this plan contains more discussion on the Wetlands Protection Ordinance and Wetlands Protection Program.

Figure 4.49. Regulatory Wetlands, City of Boulder



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City Of Boulder
Wetlands

Other Natural Resource Assets

The trees that make up the urban forest are also considered major capital assets in the city. The City of Boulder's Parks and Recreation Urban Forestry Section maintains approximately 40,000 trees in city parks and public street rights-of-way. In addition, there are over 400,000 trees on both public and private property within Boulder's urban forest that contribute to the city's quality of life. It is estimated that there are over 100 different species of trees in the city.

Boulder's urban forest provides many environmental benefits to the community. Aside from the obvious aesthetic benefits, trees within the urban forest improve the air, protect valuable water resources, save energy, improve economic sustainability, and provide food and shelter for wildlife. The following information quantifying the value of this asset is based on several different studies conducted for the city:

- Trees remove carbon dioxide from the atmosphere through photosynthesis and return oxygen back to the atmosphere as a byproduct. About half of the greenhouse effect is caused by carbon dioxide. Trees act as a carbon sink by removing the carbon and storing it in their trunk, branches, leaves, and roots. Boulder's urban forest stores approximately 112,000 tons of carbon and removes an additional 2,250 tons per year, removing a significant amount of vehicle and industrial emissions from the air. This carbon storage is valued at over $1,000,000.
- Trees also remove other air pollutants, such as sulfur dioxide, nitrogen dioxide, ozone, carbon monoxide, and particulate matter, through the photosynthetic process. The filtration provided by Boulder's urban trees is valued at approximately $730,000 per year.
- During a major rainstorm, trees intercept the rain on their leaves, branches, and trunks and thereby reduce stormwater runoff by preventing the water from reaching the ground. The tree cover in Boulder reduces stormwater runoff by approximately 12.2 million cubic feet (the volume of a 20-story building the size of a football field) per two-inch rain storm. For every 5 percent of tree cover added to a community, stormwater runoff is reduced by approximately 2 percent.
- Trees reduce topsoil erosion, prevent harmful land pollutants contained in the soil from getting into the waterways, and ensure that the groundwater supplies are continually being replenished.
- Trees lower local air temperatures by transpiring water and shading surfaces. It is six to 19 degrees cooler under a tree canopy during the summer months. Because they lower air temperatures, shade buildings in the summer, and block winter winds, trees can reduce building energy use and cooling costs. Boulder's urban forest reduces energy costs citywide by approximately $1,400,000 per year.
- A community's trees and, collectively, its urban forest are usually the first impression a community projects to its visitors. A community's urban forest is an extension of its pride and community spirit. People linger and shop longer along tree-lined streets, and businesses with offices surrounded by trees find their workers are more productive and absenteeism is reduced.

- Urban trees provide honeybees, birds, squirrels, raccoons, and deer, just to name a few, with shelter and food needed to survive in the City of Boulder.
- Trees in native areas such as stream corridors provide food, shelter, and nesting habitats to many diverse and sometime rare species.

Development Trends

Managing growth in the City of Boulder has long been a priority to retain the city's small-town character and natural setting. In the 1950s, Boulder's population grew from 25,000 to 37,000, and during the 1960s, it reached 66,000. The U.S. Census Bureau estimated that 97,385 people resided in the city in 2010. In response to such rapid growth, the city created a system for controlling the rate of population growth by limiting building permits, enacted special taxes to finance acquisition of 27,000 acres of open space around the city, and established a defined urban growth boundary (i.e., the "blue line") to control development in the surrounding foothills. Due to the growth restrictions and open space, much of the city is "built out." Development that occurs is typically re-development of a previously developed area. The 2006 redevelopment of the Crossroads Mall into the 29th Street shopping district is an example. This development considers flood hazard risk from Boulder Creek and includes a Home Depot elevated to provide protection from the 100 year flood.

Based on established community goals and policies as set forth in the Boulder Valley Comprehensive Plan (BVCP), the city implements these growth management tools to control the scale, location, type, intensity, and timing of new development as well as redevelopment. As described in the BVCP, future land use and growth is categorized in the BVCP Future Land Use and Area I, II, and III maps. The Future Land Use map defines the desired future land use pattern for the Boulder Valley (see Figure 4.1). The Area I, II, III map defines the city's service area, which sets the city's urban growth boundary and ensures a logical extension of urban services (see Figure 4.51).

Figure 4.50. Future Land Use Map Boulder Valley Comprehensive Plan

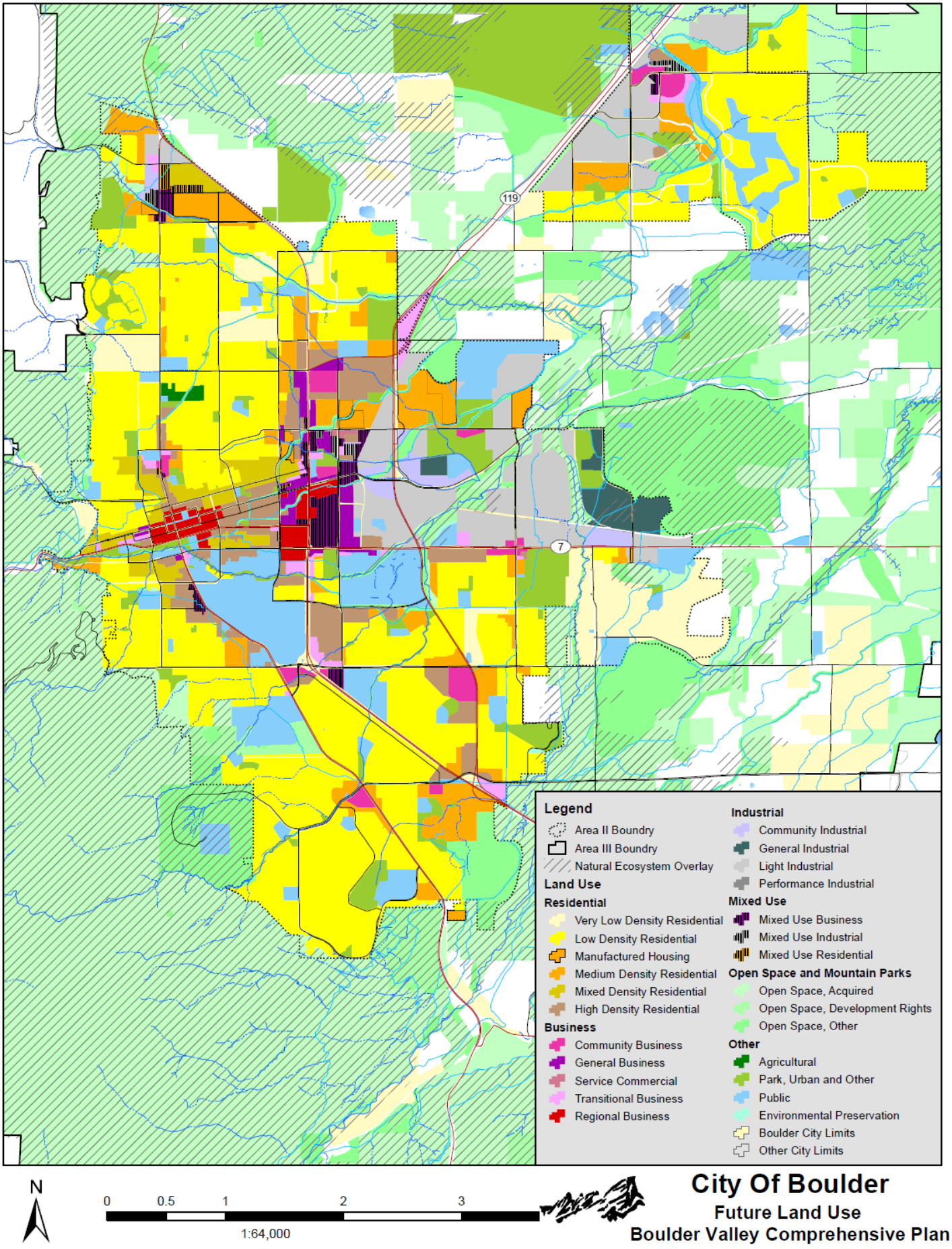
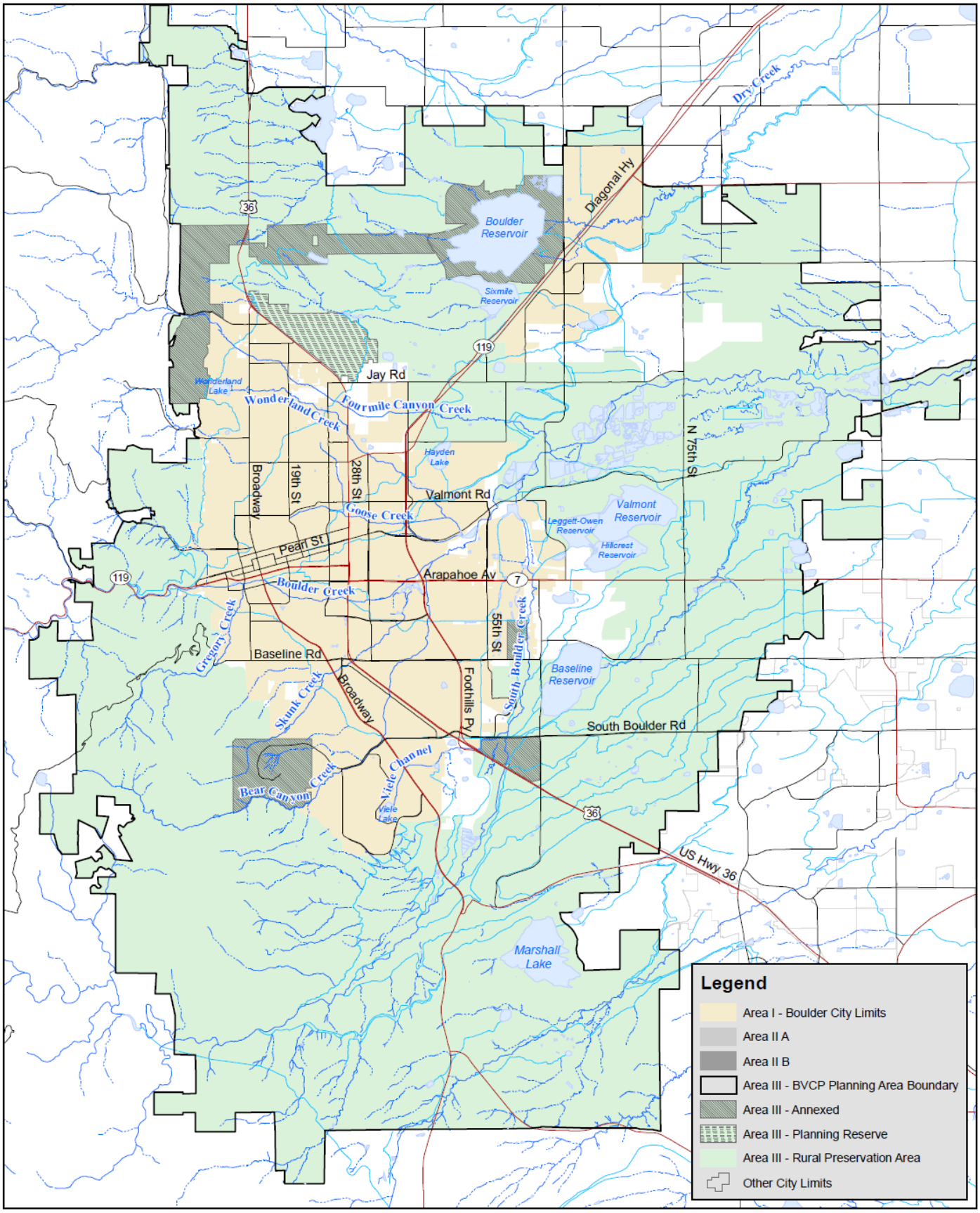


Figure 4.51. Area I, II, III Map Boulder Valley Comprehensive Plan



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City Of Boulder

Boulder Valley Comprehensive Plan

Area I, Area II, Area III

4.3.2 Vulnerability of the City to Specific Hazards

The Disaster Mitigation Act regulations require that the HMPC evaluate the risks associated with each of the hazards identified in the planning process. This section summarizes the possible impacts and quantifies, where data permits, the vulnerability of the city to each of the hazards identified as a risk. The HMPC has determined that the risk of avalanche, fog, landslides and rockfalls, and volcanoes to the City of Boulder is minimal or nonexistent and they are no longer addressed in this plan.

The hazards that the city continues to consider are the following:

- Dam Failure
- Drought
- Earthquakes
- Floods
- Human Health Hazards
  - Pandemic Flu
  - West Nile Virus
- Severe Weather
  - Extreme Temperatures
  - Hailstorms
  - Thunderstorms
  - Lightning
  - Tornadoes
  - Windstorms
- Soil Hazards
  - Expansive Soils
  - Land Subsidence
- Wildfire
- Winter Storms

An estimate of the vulnerability of the city 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 HMPC identified two hazards in the City of Boulder for which specific geographical hazard areas have been defined: flood and wildfires. For these two hazard areas, the HMPC has inventoried the following for the city, 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.

The sections that follow present the vulnerability analysis for the City of Boulder.

Vulnerability to Floods

Likelihood of Occurrence—Occasional
Vulnerability—High to Very High

Flooding and floodplain management are significant issues for the City of Boulder. The potential or likelihood of a flood event in the city increases with the annual onset of heavy rains in April combined with snowmelt runoff from May through June. Much of the historical growth in the Boulder area occurred adjacent to streams. This leaves the potential for significant damage to property, losses from disruption of community activities, and potential loss of life when the

streams overflow. Other problems connected with flooding and stormwater runoff include erosion, sedimentation, degradation of water quality, losses of environmental resources, and certain health hazards.

National Flood Insurance Program/Community Rating System

The City of Boulder has participated in the regular phase of the National Flood Insurance Program (NFIP) since July 17, 1978 by administering floodplain management regulations that meet the minimum requirements of the NFIP. The Community Rating System (CRS) was created in 1990 to recognize communities, whose floodplain management activities go above and beyond the NFIP's minimum requirements. Under the CRS, if a community implements certain program activities, such as public information, mapping, regulatory, loss reduction, and/or flood preparedness activities, then its residents can qualify for a flood insurance premium rate reduction. The City of Boulder entered the CRS on October 1, 1992. More detail on NFIP and CRS participation is provided in Section 4.4.

Insurance Coverage, Claims Paid, and Repetitive Losses

NFIP data indicates that as of February 29, 2012, there were 3,196 flood insurance policies in the City of Boulder representing $711,927,400 of insurance coverage in force. Of these, 1,642 are located in the A zones (100-year flood); 755 standard and 799 preferred policies are located in the B, C, and X zones (the area between the limits of the 100 and 500 year, including the 500-year flood). Historically, there have been 30 claims for flood losses (closed paid losses) totaling $159,395. These included 10 claims for properties in A zones, and 12 standard and seven preferred policies were for properties located in B, C, and X zones, and one was in an unknown zone. Only 6 were for post-FIRM structures; 23 were for pre-FIRM structures, and one was unknown. There were no repetitive loss properties, as defined by the NFIP, in the City of Boulder as of this plan update in 2012.

Values at Risk

The following section discusses the results of an effort to quantify the city's vulnerability to both the 100- and 500-year flood events. The HMPC used data provided by the city to quantify the potential flood losses within the mapped floodplain areas. The first step was to identify what is exposed to the various flood hazards. During the 2012 update this entailed using FEMA's Preliminary DFIRM data as the most current 100- and 500-year floodplains, including revised Boulder Creek 100 year floodplains completed in 2012. The City's high hazard and floodway (AKA conveyance) zones were also analyzed as these zones represent the highest risk areas. 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 of the four types of floodplain.

Methodology

Due to the numerous drainages in the city, it was necessary to develop a methodology that allowed loss estimates to be summarized by creek to show how the risk varies across the planning area. The city prepared a spatial overly of structure footprints in the various flood hazard zones within the city limits using GIS. Only structures larger than 725 square feet were included in the analysis so that garages and outbuildings would not be considered as individual structures. The city attributed the building footprint layer with the names of the stream that poses the flood risk. The structure counts by flood zone are presented in Table 4.18. In some cases a structure may be at risk from more than one stream where the floodplains merge (i.e. Sunshine Canyon and Boulder Creek). In those cases the structure is accounted for twice in the table. It is noted that it would be unlikely for each of these streams to flood during any single event, but the table gives an indication of the magnitude of impacts should a flood occur on any single or multiple drainages.

Based on this analysis the Boulder Creek and South Boulder Creek floodplains contain the greatest number of structures in the 100 and 500-year floodplains. Goose, Boulder, and Skunk creeks have the largest numbers of structures at risk in the high hazard zone.

Table 4.18. Structures at Risk to the 100 yr, 500 yr, High Hazard and Floodway Zones

Creek	100 yr	500 yr	High Hazard	Floodway
Bear Canyon Creek	56	503	1	10
Bluebell Canyon Creek	14	21	2	2
Boulder Creek	526	1,446	36	40
Boulder Slough	34	N/A*	N/A	N/A
Dry Creek	0	1	N/A	N/A
Elmer's Two Mile Creek	2	71	0	1
Fourmile Canyon Creek	133	213	19	24
Goose Creek	123	214	44	91
Gregory Canyon Creek	91	145	33	48
Kings Gulch	23	23	3	3
Skunk Creek	136	230	25	71
South Boulder Creek	528	1,120	4	58
Sunshine Canyon Creek	56	57	4	4
Twomile Canyon Creek	202	306	20	20
Wonderland Creek	97	238	16	33
****Total**	**2,021**	**4,588**	**207**	**405**

Source: City of Boulder Public Works & Utilities GIS
Only structures larger than 725 sq ft counted
*included in Boulder Creek 500 yr
**structures in multiple floodplains counted twice

Estimating Potential Losses

Estimating potential losses requires quantifying additional information about the structure inventory within the floodplain, including property types and value. Using GIS, a spatial overlay (union) was performed to merge the various flood zones with the parcels. This layer was intersected with the building footprint layer attributed with the creek name. Any flooded parcels with a building footprint in the floodplain were identified in the GIS database. The intent of this was to be able to discern between floodprone parcels that have their structure in the floodplain versus those that have structures located outside of the floodplain. This also allows for analysis of acres at risk with and without structures.

The result of the flood hazard analysis summarizes the values at risk in the various floodplains by flood zone and creek in terms of total building exposure. The next step was to estimate potential losses. 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. FEMA's depth-damage functions indicate that a one-story structure with no basement flooded to two feet will incur damage of at least 22 percent of the value of the structure and 20 percent of the contents value. While there are several limitations to this model, it does present a methodology to estimate potential damage for this planning level analysis.

The following assumptions were also made:

- Building content values were estimated as a percentage of the building structure value, based on guidance used in FEMA HAZUS models (Section 14.2.2 HAZUS-MH Flood Technical Manual) to estimate contents based on building occupancy classes. The percentages of building value used to estimate contents are listed below. In some occupancy classes, such as Industrial, the value of the contents is considered greater than the building value itself.
  - Agriculture – 100%
  - Commercial – 100%
  - Community – 100%
  - Industrial – 150%
  - Natural Lands – 0%
  - Residential – 50%
  - Unclassified – 50%
  - Natural Lands (includes Parks and Open Space) - considered as having no structures and thus no content value for the purposes of this plan.
- Boulder's Land Use classifications were simplified into HAZUS occupancy classifications.
- A total value was calculated equaling structure + contents
- An assumed flood damage of 20% of the structure total value was calculated, based on flood depth-damage curves assuming a 2 foot flood depth. The 2 foot flood depth was assumed for all flood hazard areas for this planning level analysis.

The results show an estimate of the flood damages for a 100-year (1% Annual Chance) flood on the various creeks in Boulder. The above steps were repeated for the 500-year (0.2% Annual Chance) flood analysis.

An analysis of Pre-FIRM structures was also performed. These are structures built before floodplain management regulations went into effect July 17th, 1978. The pre-FIRM structure count represents the most-at risk structures, as the post-FIRM structures should be mitigated to withstand the 100 year flood. Roughly one half of Boulder's structures in the 100 year floodplain are pre-FIRM structures.

Results

Tables 4.19 and 4.20 summarize the results of this analysis. The loss ratio column shows the ratio of the loss estimate for a particular creek divided by the total loss across all the creeks. This allows for a creek by creek comparison of the loss potential and may help in prioritizing mitigation projects. Boulder Creek has the potential for the greatest loss from a 100-year flood (approximately $224 M), followed by South Boulder Creek. The total loss from a 500-year event would be almost double that of a 100-year event. Buildings footprints that are in the 100-year and 500-year floodplains are shown in Figure 4.52 and Figure 4.53 following the tables.

Limitations

This analysis does not account for multi-story structures and assumes all structures and values are at ground level. Condominiums create a limitation to the structure and value analysis because the parcel layer uses a "Condo Box" system where small individual boxes within the main condo parcel represent each unit owner, but not a structure location. When intersecting these parcels with a hazard the location of these boxes can sway results as all-in or all-out of the hazard zone. Thus losses may be inflated as some properties may be on a higher level and not prone to flooding. The analysis does not separate out structures that may be elevated or floodproofed according to the local floodplain management regulations (i.e. the post-FIRM structures), and thus they are assumed to be at-risk. Structures and values at risk that straddle two floodplains are represented in each stream group as a result of this methodology. There are also several properties in the Boulder Creek and Skunk Creek floodplains that are "Exempt" and do not have assessed valuations. Some of these are associated with University of Colorado properties located in the floodplain.

Table 4.19. 100-Year Floodplain Structure Values by Creek

Creek Name	Structure Count	Flood-Prone Structures at Risk Values	Estimated Contents Value	Estimated 100-Year Flood Loss (20% of total value)	Loss Ratio*
Bear Canyon Creek	56	$37,060,000	$24,371,000	$12,286,000	2.5%
Bluebell Canyon Creek	14	$4,757,000	$2,379,000	$1,427,000	0.3%
Boulder Creek	526	$657,352,000	$464,111,000	$224,293,000	45.8%
Boulder Slough	34	$30,175,000	$12,438,000	$8,523,000	1.7%
Elmer's Two Mile	2	$675,000	$338,000	$203,000	0.04%
Fourmile Canyon Creek	133	$42,428,000	$21,995,000	$12,885,000	2.6%
Goose Creek	123	$73,052,000	$27,229,000	$20,056,000	4.1%
Gregory Canyon Creek	91	$52,660,000	$14,951,000	$13,522,000	2.8%
Kings Gulch	23	$7,099,000	$3,550,000	$2,130,000	0.4%
Skunk Creek	136	$72,886,000	$38,562,000	$22,290,000	4.5%
South Boulder Creek	528	$343,261,000	$276,537,000	$123,960,000	25.3%
Sunshine Canyon Creek	56	$27,974,000	$14,680,000	$8,531,000	1.7%
Twomile Canyon Creek	202	$59,117,000	$28,960,000	$17,615,000	3.6%
Wonderland Creek	97	$69,466,000	$41,772,000	$22,248,000	4.5%
Total	**2,021**	**$1,477,962,000**	**$971,873,000**	**$489,967,000**	

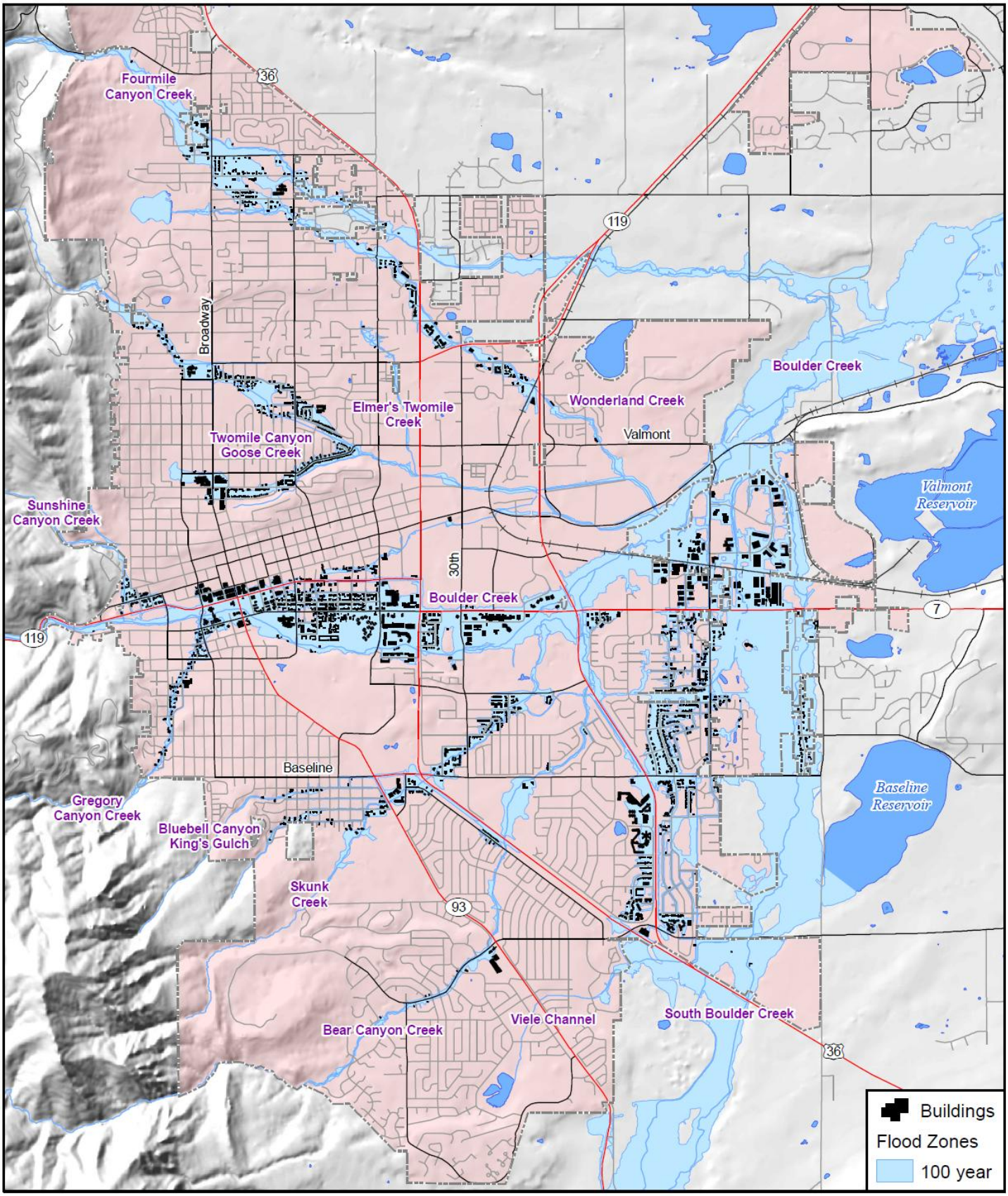
Source: City of Boulder with valuation analysis by AMEC; * indicates ratio of the loss estimate for a particular creek divided by the total loss across all the creeks

Table 4.20. 500-Year Floodplain Structure Values by Creek

Creek Name	Structure Count	Flood-Prone Structures at Risk Values	Estimated Contents Value	Estimated 100-Year Flood Loss (20% of total value)	Loss Ratio
Bear Canyon Creek	503	$161,257,000	$83,359,000	$48,923,000	4.0%
Bluebell Canyon Creek	21	$11,223,000	$8,614,000	$3,967,000	0.3%
Boulder Creek	1,446	$1,826,804,000	$1,399,507,000	$645,262,000	53.3%
Dry Creek	1	$3,094,000	$4,641,000	$1,547,000	0.1%
Elmer's Two Mile	71	$39,186,000	$30,634,000	$13,964,000	1.2%
Fourmile Canyon Creek	213	$80,830,000	$43,326,000	$24,831,000	2.1%
Goose Creek	214	$183,357,000	$170,017,000	$70,675,000	5.8%
Gregory Canyon Creek	145	$82,796,000	$33,513,000	$23,262,000	1.9%
Kings Gulch	23	$7,099,000	$3,550,000	$2,130,000	0.2%
Skunk Creek	230	$120,926,000	$64,042,000	$36,994,000	3.1%
South Boulder Creek	1,120	$627,106,000	$507,024,000	$226,826,000	18.7%
Sunshine Canyon Creek	57	$58,832,000	$16,198,000	$15,006,000	1.2%
Twomile Canyon Creek	306	$86,226,000	$42,267,000	$25,699,000	2.1%
Wonderland Creek	238	$193,370,000	$163,342,000	$71,342,000	5.9%
Total	**4,588**	**$3,482,106,000**	**$2,570,034,000**	**$1,210,428,000**	

Source: City of Boulder with valuation analysis by AMEC; * indicates ratio of the loss estimate for a particular creek divided by the total loss across all the creeks

Figure 4.52. Buildings in the 100-Year Floodplain



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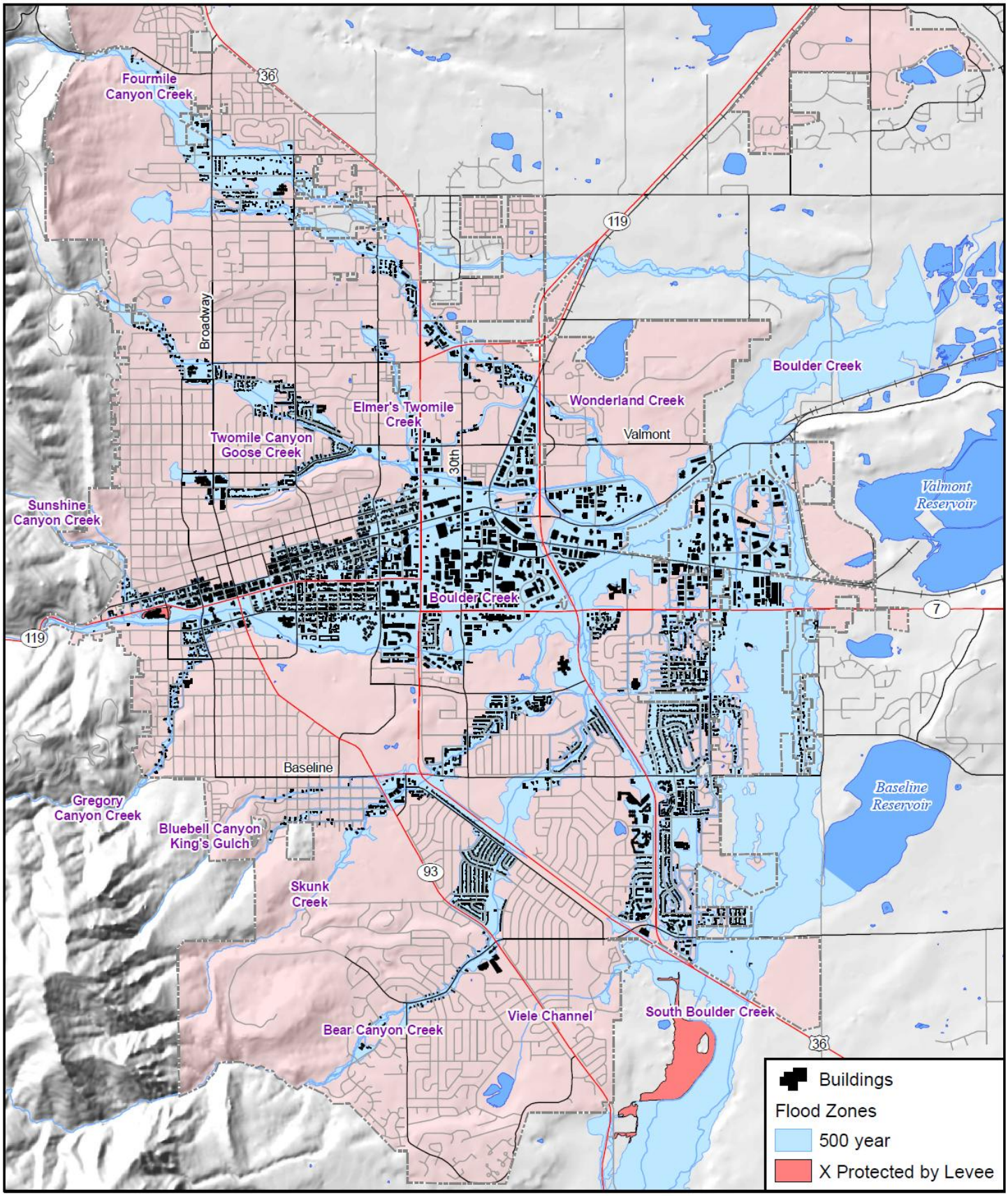
amec

Map compiled 8/2012; intended for planning purposes only
Data source: City of Boulder, CDOT, FEMA Preliminary DFIRM,
*Boulder Creek revised mapping 2012

Figure 4.53. Buildings in the 500-Year Floodplain



0 0.5 1 2 Miles

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amec

Map compiled 8/2012; intended for planning purposes only
Data source: City of Boulder, CDOT, FEMA Preliminary DFIRM,
*Boulder Creek revised mapping 2012

Analyzing Property Types and Development Trends in the Flood Hazard Areas

Another type of analysis was performed to quantify property types and development trends within the floodplain. This is useful for identifying the occupancy types and further refining the risk for definition of mitigation projects. The parcel layer used in the previous analysis contained a land use code field. The codes were simplified into six categories, based on HAZUS occupancy classes. These classes are shown in the right hand column in Table 4.21. The "unclassified" and "right of way/street" classes were additional classes developed to track where there are parcel gaps or streets in the floodplain. The CU Boulder Campus covers a substantial area of Boulder and is accounted for in the Community summary code.

Table 4.21. Land Use Codes, Description, and Summary Cross Reference

Code	Description	Summary
AG	Agricultural	Agriculture
CB	Community Business	Commercial
CI	Community Industrial	Industrial
EP	Environmental Protection	Natural Lands
GB	General Business	Commercial
GI	General Industrial	Industrial
HR	High Density Residential	Residential
LI	Light Industrial	Industrial
LR	Low Density Residential	Residential
MH	Manufactured Housing	Residential
MR	Medium Density Residential	Residential
MUB	Mixed Use Business	Commercial
MUI	Mixed Use Industrial	Industrial
MUR	Mixed Use Residential	Residential
MXR	Mixed Density Residential	Residential
PI	Performance Industrial	Industrial
PUB	Public	Community
RB	Regional Business	Commercial
SC	Service Commercial	Commercial
TB	Transitional Business	Commercial
TB	Transitional Business	Commercial
VLR	Very Low Density Residential	Residential
ROW*	Right of Way/Street	Right of Way/Street
UNK*	Unclassified	Unclassified

Note:
*Additional codes added for the planning process

Tables 4.1 and 4.23 summarizes total property exposure by occupancy class in the 100 year and 500 year floodplains. The analysis indicates that residential structures comprise almost 80% of

the structures at risk for both the 100 year and 500 year floods. Commercial and industrial properties make up the remainder. For the CRS and floodplain management, it is important to quantify areas that are not, or will not be, developed in the floodplain. Open Space makes up about a third of the land use of the total flooded acreage in the 100-year floodplain in Boulder based on this analysis.

Table 4.22. City of Boulder Floodplain Occupancy – 100-year Floodplain

Occupancy Based on Land Use	Structure Count	% of total structures
Commercial	155	7.8
Community	125	6.3
Industrial	109	5.5
Natural Lands	22	1.1
Residential	1,572	79.1
Unclassified	3	0.2
Total	**1,986**	

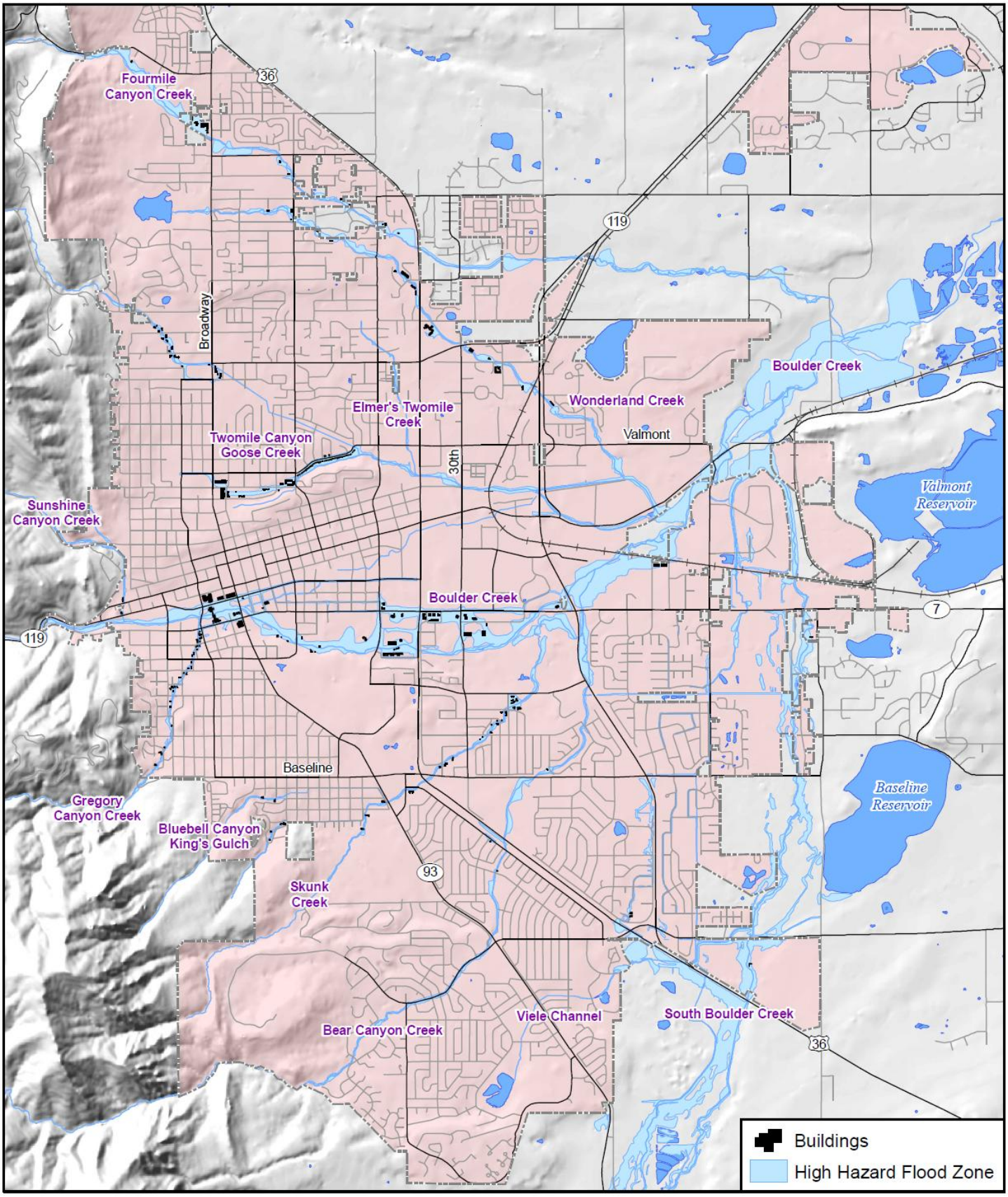
Source: City of Boulder and AMEC

Table 4.23. City of Boulder Floodplain Occupancy – 500-year Floodplain

Occupancy Based on Land Use	Structure Count	% of total structures
Commercial	454	10.2
Community	165	3.7
Industrial	298	6.7
Natural Lands	57	1.3
Residential	3,461	77.9
Unclassified	8	0.2
Total	**4,443**	

Source: City of Boulder and AMEC

Figure 4.54. Buildings in the High Hazard Flood Zone

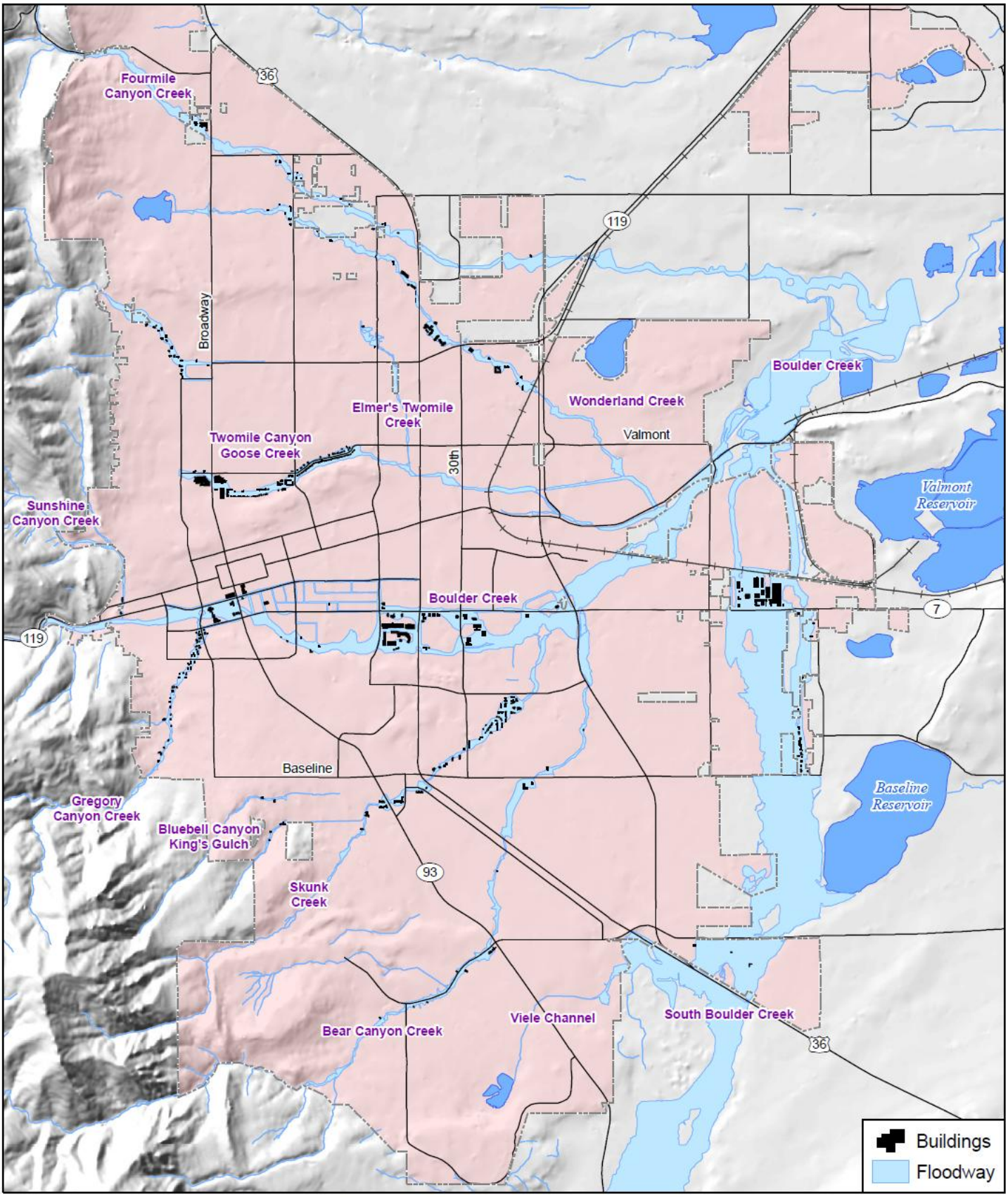


0 0.5 1 2 Miles

N

Map compiled 8/2012; intended for planning purposes only
Data source: City of Boulder, CDOT,
*Boulder Creek revised mapping 2012

Figure 4.55. Buildings in the Floodway



0 0.5 1 2 Miles

N

amec

Map compiled 8/2012; intended for planning purposes only
Data source: City of Boulder, CDOT,
*Boulder Creek revised mapping 2012

Critical Facilities at Risk

As described earlier, critical facilities are located throughout the City of Boulder. Critical facilities in the floodplain are summarized in Table 4.24 by each of the four floodplains. More detail on each facility can be found in Appendix G.

Table 4.24. Critical Facilities at Risk to Flooding in the City of Boulder

Aggregate	Classification	1% Annual Chance Flood Prone	0.2% Annual Chance Flood Prone	Prone to Conveyance Flooding	Prone to High Hazard Flooding
At Risk Population Facilities	After School Care	5	1	1	0
	Assisted Living	1	0	0	0
	Day Care	9	6	3	2
	Preschool	0	7	0	0
	Private K-12 Schools	2	4	0	0
	Public K-12 Schools	4	2	0	0
	Senior Housing	4	1	1	1
	Total	**25**	**21**	**5**	**3**
Essential Services Facilities	Administration and Management	3	0	2	2
	Clinic	1	0	1	0
	Communication	0	1	0	0
	Courts and Jails	0	1	0	0
	Emergency Medical	0	1	0	0
	Emergency Responders	0	1	0	0
	Federal Government	1	0	0	0
	Fire	1	2	0	1
	Hospital	1	1	0	0
	Maintenance and Equipment	1	0	1	1
	Permitting and Inspection	1	0	1	1
	Police	0	4	0	0
	Public Records	0	1	0	0
	Public Transportation	2	1	0	0
	Warning Systems	4	1	2	3
	Total	**15**	**14**	**7**	**8**
Hazardous Material Facilities	Hazmat Facilities	1	2	0	0
	Total	**1**	**2**	**0**	**0**
	Grand Total	**41**	**37**	**12**	**11**

Source: City of Boulder Utilities Division

Some of these structures are elevated out of the floodplain. Boulder Community Hospital is elevated above the 100-year floodplain as is its access road. Most of the municipal buildings are

either elevated or floodproofed. All of these buildings are in the 500-year floodplain as well. The Boulder County Justice Center, municipal building, and library are adjacent to the 100-year floodplain but floodproofed. The facilities in the high hazard or conveyance zones would be good targets for mitigation.

Scour Critical Bridges

Included with HAZUS-MH is a database of bridges called the National Bridge Inventory (NBI) developed by the Federal Highway Administration. 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. Those with a scour index of 3 are potentially susceptible to damage from the 100-year flood. The date of the database is 2001, and therefore it may not reflect current conditions, but is the best available data. Scour critical bridges in the City of Boulder are shown in Table 4.25.

Table 4.25. Scour Critical Bridges in the City of Boulder

Name	Owner	Width	Year Built	Scour Index
30TH STREET	City Highway Agency	21.6	1963	3
SH 7 ML WBND	State Highway Agency	15.8	1938	3
US 36 FR RD	State Highway Agency	7.3	1952	3
US 36 ML EBND	State Highway Agency	10.4	1960	3
US 36 ML WBND	State Highway Agency	10.4	1952	3
US 36 ML	State Highway Agency	10.4	1957	3

Source: HAZUS 2.1

Levee Failure Risk

During the 2012 update levees within the city were inventoried based on available GIS data. The following levees and floodwalls were identified, as shown in Table 4.26, with an indication of what is protected and if the levee is certified or not. A certified, or "Accredited Levee or provisionally accredited levee" means a system of artificial embankment(s) or flood control structure(s) used for property protection, flood control, and flood hazard mitigation accredited or provisionally accredited and mapped Zone X (shaded) by the Federal Emergency Management Agency (FEMA) under the National Flood Insurance Program (NFIP). This means that it has been certified, or not, to provide 100 year flood protection. Note that levees or floodwalls protect the Boulder Justice Center and condos from Boulder Creek flooding. It should also be noted that repair and improvement work is occurring on the Boulder Justice Center levee and floodwall to lower the risk of levee failure to the Justice Center and surrounding buildings. The City of Boulder is seeking for levee accreditation on this levee. Roche Industries is a hazardous materials facility located along the Boulder Creek floodplain in the eastern portion of the city. The data indicates that the levee protecting the facility is not certified to provide 100 year protection.

Table 4.26. City of Boulder Levees and Floodwall Inventory

Levee	Creek or Water Source
Harrison Ave Levee	Bear Canyon Creek
Boulder Justice Center - Floodwall	Boulder Creek
Boulder Justice Center - Levee	Boulder Creek
Flatiron Industrial Park-Not Certified	Boulder Creek
Condos at Canyon and 9th	Canyon Boulevard Overflow
Roche - Floodwall-Not Certified	Boulder Creek
Roche - Levee East-Not Certified	Boulder Creek
Roche - Levee West-Not Certified	Boulder Creek
Harrison Ave Levee	Bear Canyon Creek

Source: FEMA, USACE

Cultural and Natural Resources at Risk

Cultural and natural resources are located throughout the city. Table 4.27 identifies the historic districts and structures in the 100-year floodplain.

Table 4.27. Historic Districts and Structures in the 100-Year Floodplain

District Name	Building Count	Building Value	Flood-Prone Acres
Boulder High School	3	N/A	1.95
Downtown	2	$1,300,000	0.04
Hillside	6	$3,280,660	0.06
Mapleton	11	$6,660,018	0.31
West Pearl	36	$14,225,800	0.83
Total	**58**	**$25,466,478**	**3.20**

Source: City of Boulder

Historic preservation reviews are required by the city for alterations of any structures within the historic districts. Under state and local historic preservation laws, modifications, repairs to, or demolition of any building over 50-years old may be subject to review by the city Landmarks Board and State Historic Preservation Office. In the event of a flood, there could be restrictions on how these structures are rebuilt, such as building materials used. GIS was used to query how many structures are in the city's 100-year floodplain that are older than 50 years or built before 1962. According to this query, there are approximately 1,134 parcels with structures that could be considered historic, but not necessarily landmark, structures.

Population at Risk

The number of residential parcels with structures in the high hazard, conveyance, 100-year, and 500-year floodplains was obtained using the methods previously described. The total number of

residential properties in each floodplain was multiplied by the average household size of 2.16 persons for the City of Boulder (2010 census), and that total was multiplied by the City of Boulder Occupancy Factor (95%) to estimate resident population. Based on this analysis, which accounts for residents only and not workers:

- Approximately 1,693 people live in the high hazard zone (based on 825 residential structures),
- Approximately 1,709 people live in the conveyance zone (based on 833 residential structures),
- Approximately 7,851 people live in the 100-year floodplain (based on 3,826 residential structures), and
- Approximately 15,144 people live in the 500-year floodplain (based on 7,380 residential structures).

The numbers do not tell the entire story. Based on the mapping of land uses and structures within the high hazard floodplain, it is evident that the majority of the people in a floodplain live in the Gregory Canyon and Twomile Canyon/Goose Creek drainages. The Boulder Creek high hazard zone is predominantly parks and open space or otherwise undeveloped as a result of mitigation projects and land use planning done by the city. Due to the remapping of South Boulder Creek, Dry Creek No. 2 has a significant number of residences and population exposed to the 100 year event that was not previously recognized.

Impacts from a Flood Similar to the Big Thompson Flood

In April 2006, the City of Boulder held a functional emergency exercise based on a worst-case scenario similar to the flood in Big Thompson Canyon in 1976. The exercise was designed to both evaluate and train county and city administrators, emergency responders, and support agencies in preparing for, responding to, and managing such an event. The exercise was planned around actual flood and damage modeling to make the activity as real as possible. The flooding produced by this event is equivalent to the 1,000-year flood.

The city used GIS during the development of this exercise to model the impacts of a flood on the population, building stock, and vehicles in Boulder. The first step was to generate a polygon layer for the flood. Hydraulic and hydrologic modeling based on the simulated rainfall event was performed to generate a flood extent polygon. This flood extent polygon was subdivided into depth polygons that showed the general depth of flooding expected. This was combined with FEMA's HAZUS inventory data to model flood damage.

The floodplain depth was overlaid on the HAZUS census blocks to create a new layer. A proportional division was performed to account for blocks that were split by flood boundaries and to better model values in the floodplain. For example, a census block that was split in two by a floodplain (half in, half out) had its population and building attributes multiplied by .50. From this layer, information on the number of buildings, type of building, building replacement and

content value, number of vehicles, and population could be summarized by flood depth. Damage estimates were calculated by multiplying a percent of damage based on depth taken from FEMA's depth-damage functions.

Limitations: HAZUS building data is based on average housing costs and 2000 census counts. There may be errors in the HAZUS data itself.

Modeled Impacts

- **People**—An estimated 37,738 people would be forced to evacuate or shelter in place—this includes both the resident and working population.
- **Buildings**—An estimated 5,606 buildings would be affected; 700 would be substantially damaged (damage would exceed 50 percent of building value), and total losses, including structure and contents, would equal approximately $718,657,424.
- **Vehicles**—An estimated 12,586 vehicles would be affected; 5,657 would be total losses, and dollar losses would approximate $38,513,733.

Specific Impacts

- **Justice Center**—Six feet of flooding, flood wall overtopping on west side
- **St. Julien Hotel**—Four feet of flooding over top of main floor level, floodproofing breached, parking structure flooded
- **Main Library**—Six feet of flooding, heavy damage, interior library bridge crossing the creek washed out and collapsed
- **Municipal Building**—Six feet of flooding, floodproofing overtopped, entire main level damaged
- **Park Central and New Britain Buildings**—Eight feet of flooding, structural damage to both, buildings cannot be repaired
- **Broadway Bridge**—Five feet overtopping
- **Boulder High School**—Four feet of flooding, main levels sustain damage
- **CU Married Student Housing on Marine**—Eight feet of flooding, structural failures and collapse, nonrepairable
- **CU Newton Court Student Housing**—Four feet of flooding, damage to main level units
- **Millennium Harvest House Hotel**—Eight feet of flooding south of building, major damage to main level, some structural failures
- **Twenty Ninth Street Center**—Three feet of flooding, exceeds site flood protection fill, damage to businesses
- **Cordry Court Neighborhood**—Six feet of flooding, major damage to multiple dwellings and structural failures, permanent losses for many
- **Fire Station No. 3**—Six feet of flooding, major damage to structure, nonrepairable
- **CU East Campus on Marine Street**—Six feet of flooding, significant structural and content losses

- **Public Safety Building**—Three feet of flooding, main level flooded, building functions impaired
- **Boulder Foothill Community Hospital**—Three feet of flooding, main and lower levels flooded and unusable, emergency trauma center and surgical units nonoperational
- **Roche Industries**—Eight feet of flooding along flood protection levee, levee failure, major damage, chemical hazard exposed
- **Boulder County Humane Society**—Three feet of flooding, animal shelters flooded
- **75th Street Wastewater Treatment Plant**—Flood levee system fails, plant nonoperational, untreated wastewater flows downstream

General Notes

- Approximately half of all local grocery outlets (such as Arapahoe Avenue Safeway, 30th Street King Soopers, Whole Foods, Walnut Street Albertson's, and Downtown Wild Oats) would be closed by flooding.
- All north-south roadway crossings of Boulder Creek would be washed out with multiple bridge failures.
- Canyon Boulevard would channel water to the east (becoming Water Street again).
- Railroad service through Boulder would be lost by wash-out of tracks.

Not only is the magnitude of this scenario frightening, but the time frame in which to warn and evacuate people would be an hour at best, and likely a lot less. Even with advance warning, an estimated 300 people would lose their lives in this scenario (based on roughly doubling the loss of life in the Big Thompson Flood, which was 144).

Overall Community Impact

Floods and their impacts will vary by location and severity of any given flood event and will likely only affect certain areas of the county during specific times. Based on the risk assessment, it is evident that floods will continue to have potentially devastating economic impacts to certain areas of the city. Impacts that are not quantified, but can be anticipated in future events, include:

- Injury and loss of life;
- Commercial and residential structural damage;
- Disruption of and damage to public infrastructure;
- Health hazards associated with mold and mildew;
- Damage to roads/bridges resulting in loss of mobility;
- Significant economic impact (jobs, sales, tax revenue) upon the community;
- Negative impact on commercial and residential property values; and
- Significant disruption to students and teachers as temporary facilities and relocations would likely be needed.

Development Trends

Growth in Boulder is restricted, largely by open space and park land surrounding the city limits. The city has been actively managing growth to preserve the quality of life and decrease urban sprawl. The resulting development pressures are typically focused on existing areas within the city limits, often in the form of redevelopment. An example is the redevelopment of the Crossroads Mall area into the 29th street shopping district. Some of this development is within the floodplain, which has been developed according to the city's floodplain management regulations. Another example is the Foothills Hospital, which is sited and elevated in the 500-year floodplain as there were few alternative sites for this large facility. Former Boulder County enclave areas in the vicinity of Four Mile Canyon Creek have seen grouped annexations in recent years.

Future annexations of unincorporated enclaves within the city limits as well as near the eastern edge of town could significantly add to the number of flood-prone structures in Boulder. Boulder County enclaves in the Fourmile Canyon Creek drainage contain several flood-prone properties. The same is true for South Boulder Creek flood-prone properties located just east of the city limits along the southeastern part of the city. Some of this flood-prone land has since been annexed in 2010. The Gapter Road annexation in east Boulder included 30 properties, with 28 primary structures in the 100 year floodplain and 13 of those within the conveyance zone of South Boulder Creek.

Elements of the city's floodplain regulations that pertain to development, redevelopment, and stormwater drainage are in **Section 4.4: Assessing Capabilities**.

Vulnerability to Wildfires

Likelihood of Occurrence—Likely
Vulnerability—Medium

In the larger Boulder County area, high fuel loads, along with geographical and topographical features of the foothills area, create the potential for both natural and human-caused fires that could result in loss of life and property. These factors, combined with natural weather conditions common to the area, including periods of drought, high temperatures, low relative humidity, and periodic high wind conditions, can result in frequent and sometimes catastrophic fires.

The City of Boulder is at risk to wildfire because of large areas of potentially flammable vegetation in the open space surrounding the city, plus the potential for natural and human-caused ignitions. Any wildland fire, once ignited, has the potential to quickly become a large, out-of-control fire if weather and fuel conditions are favorable. The 2007 City Community Wildfire Protection Plan further describes the city wildfire risk situation.

Values at Risk

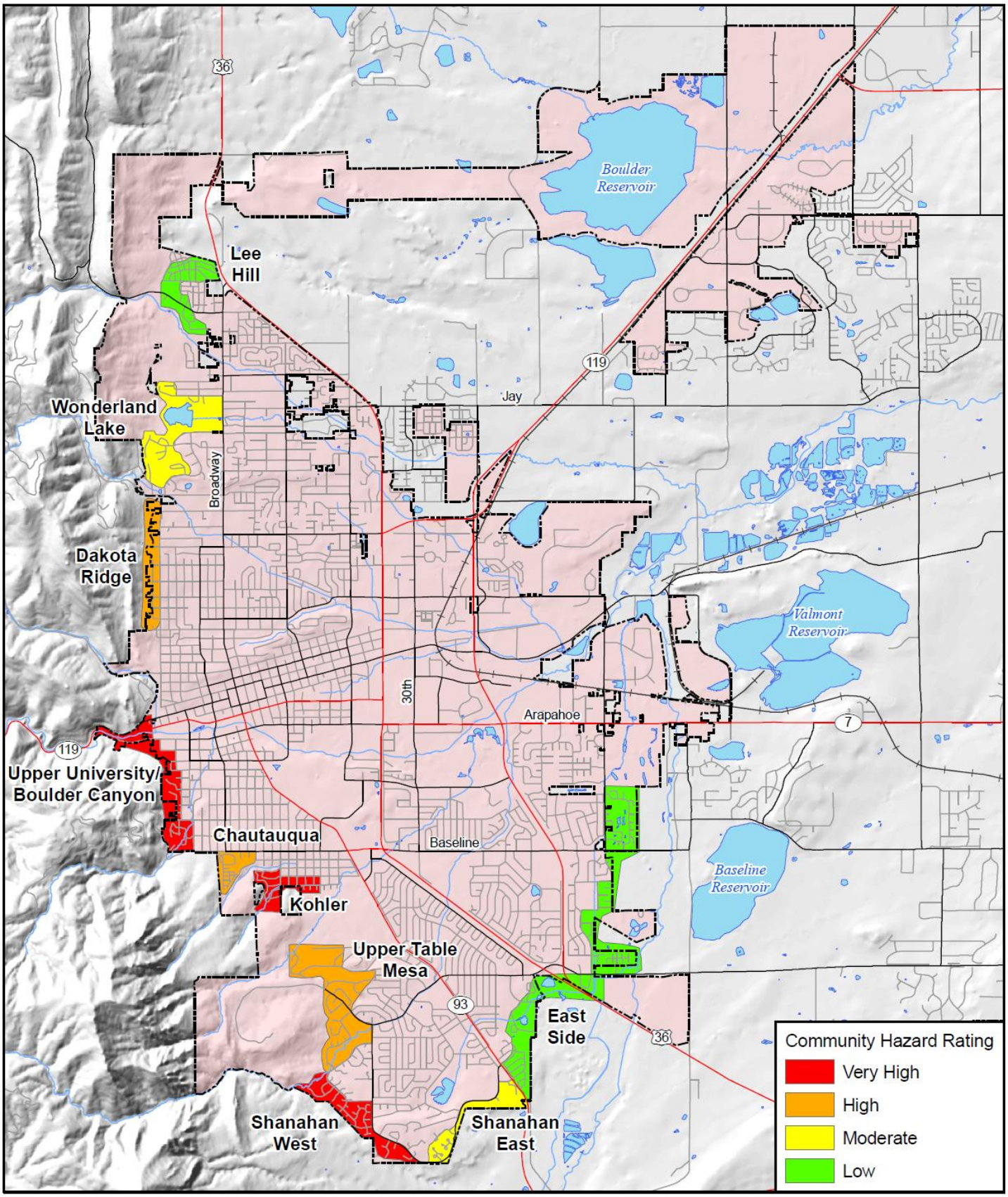
This section attempts to further quantify the impacts that wildland fire could have on people, property, and critical infrastructure in the city. The 2007 CWPP identified 10 communities within the city that have wildland urban interface areas. Each community was designated a hazard rating (very high, high, moderate, and low) during the CWPP development process based on local fire behavior modeling and community assessments of existing defensible space, emergency access/egress, typical construction and other factors. The communities are shown on Figure 4.56. During the update of this mitigation plan an effort was made to further quantify the population at risk as well as the number and value of structures at risk within these CWPP communities. GIS was used to analyze the communities at risk based on the number of improved parcels (i.e. those that have a structure). Contents values were also estimated (assumed to be 50% of the structure value based on FEMA values for residential structures). The amount of improved values and estimated structure value exposed was grouped by community and is shown in Table 4.28. The table includes two sets of structure counts by community. The first shows the interface structure count which represents those structures that border the interface and thus are most at-risk. The second set of structure counts represents the additional structures within the CWPP community boundary. Of the 3,907 total structures within these communities 643, or 16%, are located in communities with a 'very high' hazard rating. The majority of these structures are residential. Using a methodology similar to that used for the floodplain analysis in this plan, an estimated 7,868 people live within a CWPP community in Boulder.

Table 4.28. Summary of Structures and Populations at Risk in CWPP Communities

CWPP Community	Community Hazard Rating	Interface Structure Count*	Interface Building Value	Additional Structure Count**	Additional Structure Value	Total Structure Count	Total Structure Value	Community Population Estimate***
Chautauqua	High	52	$23,864,000	67	$27,848,000	119	$51,712,000	239
Dakota Ridge	High	27	$23,831,000	120	$60,380,000	148	$84,212,000	298
East Side**	Low	0	$0	974	$292,265,000	974	$292,265,000	1,962
Kohler	Very High	25	$22,502,000	109	$37,155,000	134	$59,657,000	270
Lee Hill	Low	29	$18,193,000	388	$158,948,000	417	$177,141,000	840
Shanahan East	Moderate	9	$2,300,000	507	$125,770,000	516	$128,070,000	1,039
Shanahan West	Very High	108	$68,063,000	106	$57,469,000	214	$125,532,000	431
Upper Table Mesa	High	97	$51,130,000	497	$188,875,000	594	$240,005,000	1,196
Upper University/Boulder Canyon	Very High	47	$31,576,000	248	$113,577,000	295	$145,154,000	594
Wonderland Lake	Moderate	131	$62,952,000	301	$140,043,000	432	$202,995,000	870
Other	-	64	$23,861,000	0	$0	64	$23,861,000	129
Totals		**589**	**$328,272,000**	**3,317**	**$1,202,330,000**	**3,907**	**$1,530,604,000**	**7,868**

Source: Boulder Community Wildfire Protection Plan
* Interface structures are those structures that are immediately adjacent to open space
** No Red Zone analyses performed
*** Based on US Census average household size of 2.16

Figure 4.56. Boulder CWPP Communities



0 1 2 3 Miles

N

Map compiled 8/2012; intended for planning purposes only
Data source: City of Boulder, CDOT, FEMA Preliminary DFIRM,
*Boulder Creek revised mapping 2012

The City of Boulder completed a detailed, parcel-level evaluation of wildfire risk potential In 2004 prior to the development of the CWPP. The city defines the wildland-urban interface, or "Red Zone," as parcels that are adjacent to the Open Space and Mountain Parks land bordering the western city limits. The city used GIS to identify and inventory all the parcels and structures in the Red Zone that are predominantly single family residential properties. This inventory includes 637 properties. Of these properties, 588 are within the city limits. The city used software and a handheld computer to complete a detailed risk assessment of the wildfire risk for each property in the Red Zone. Each property was evaluated on multiple factors, including access, terrain, vegetation adjacent to the structure, construction type, siding material, roofing material, and water availability, among others. The software allowed for the calculation of a relative hazard score for each property with respect to wildfire vulnerability. For the purposes of this plan, relative hazard is defined in Table 4.29.

Table 4.29. Relative Hazard Classification from Red Zone assessment

Relative Hazard Score	Classification	Structure Count by Category
9-25	Low	30
26-50	Medium	213
51-75	High	275
76-105	Very High	70

This data can help prioritize and track mitigation efforts. Maps displaying properties with hazard rankings are not included in this plan due to privacy concerns and private property rights.

Estimating Potential Losses

Wildland-urban interface fires cause physical damage to buildings, contents, and infrastructure and may result in casualties. Based on observations in wildland-urban interface fires, structures and contents are often completely destroyed, thus the estimated total building value exposed in Table 4.28 also represents potential dollar losses. Note: a wildland fire is not likely to burn all the wildland-urban interface areas in the city at once. Although the physical damage and casualties arising from wildland-urban interface fires may be severe, it is very important to recognize that wildland-urban interface fires may also cause significant economic impacts on communities when damage results in loss of function of buildings and infrastructure. In some cases, the economic impact of such loss of function may be comparable to the economic impact of physical damage. In some cases it may be even greater.

Examples of economic impacts arising from wildland-urban interface fires damage include displacement costs, loss of public services, business and rental income losses, and loss of transportation and utility services. Displacement costs are the cost of temporary quarters when occupants of damaged residential, commercial, or public buildings are displaced during repairs. Displacement costs include rent; other monthly costs of displacement, such as furniture rentals; and one-time costs, such as those associated with moving and utility hookup. Economic impacts

of loss of transportation and utility services include traffic delays/detours from road and bridge closures and loss of electric power, potable water, and wastewater services.

Fire suppression and rehabilitation costs have totaled millions of dollars based on past events in the City of Boulder, with the occasional loss of structures. According to FEMA guidance, standard loss estimation tables do not currently exist for wildfires. Most wildfire-related deaths are the result of fire suppression activities. However, if access is impaired and warning time is insufficient, citizens could be injured or killed. Homes that are ignited by wildfires often result in a complete loss.

Critical Facilities at Risk

Much of Boulder's critical facilities at risk are outside of the city limits. Using GIS overlays of the wildfire hazard from the 2011 County CWPP, Boulder's Water Treatment Plant at Betasso was identified as a critical facility in an area of concern for wildfire. Three hydroelectric plants were identified in areas of severe wildfire concern, including the Boulder Hydro Plant, Barker Hydroelectric Generator, and Orodell Hydroelectric Generator. More details on these facilities can be referenced in Appendix G.

Natural and Cultural Resources at Risk

In addition to previously identified wetlands and threatened and endangered species, there are other natural resources at risk to wildfire. These include watersheds and other ecological functions, the forest and ground cover assets that support the area's recreational lifestyle, and the aesthetic value of the area. Major fires that result in visible damage detract from aesthetic value. Given the location of the city and the importance of assets such as watershed health, wildlife, recreation, and tourism are all critical to the city and are all at risk from the wildfire hazard.

One of Boulder's historic districts, Chautauqua Park, is located in the wildland-urban interface. This district is characterized by historic cottage homes (36) and includes seven historic landmark designations, including the Chautauqua Auditorium and Dining Hall. Another historic landmark located in the wildland-urban interface is in Mapleton Hill.

Overall Community Impact

Potential impacts to the community from a wildfire include:

- Injury and loss of life;
- Commercial and residential structural damage;
- Decreased water quality in area watersheds;
- Increase in post-fire hazards such as flooding, sedimentation, and mudslides;
- Damage to natural resource habitats and other resources;
- Loss of water, power, roads, phones, and transportation, which could impact, strand, and/or impair mobility for emergency responders and/or area residents;

- Economic losses (jobs, sales, tax revenue) associated with loss of commercial structures;
- Negative impact on commercial and residential property values;
- Loss of churches, which could severely impact the social fabric of the community;
- Loss of schools, which could severely impact the entire school system and disrupt families and teachers, as temporary facilities and relocations would likely be needed; and
- Impact on the overall mental health of the community.

Development Trends

Boulder's growth into wildland-urban interface areas is restricted by the Open Space and Mountain Parks land that borders the city along its western limit. The majority of the parcels along the western city limit are already developed. Thus, structure exposure to wildland fire is not anticipated to increase, except when development occurs on the few remaining undeveloped parcels next to the wildland-urban interface. Boulder's past purchases of Open Space and Mountain Parks land has helped keep development out of forested interface areas surrounding the city.

Vulnerability to Dam Failures

Likelihood of Occurrence—Unlikely
Vulnerability—High

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. Of the 24 Class I and 16 Class II dams identified in Boulder County, 12 (according to the HMPC) have the potential to adversely impact the City of Boulder planning area should they fail:

- High Hazard: Barker, Boulder, Gross, Hayden, Jasper, Six Mile, and Silver Lake
- Significant Hazard: Davis #1, Isabelle Lake, Mesa Park (also known as Wonderland Lake), Albion, and Goose Lake

Many of these reservoirs are located in mountain drainages several miles west of the city (see Figure 4.1). Albion, Goose, Isabelle Lake, Silver Lake, and Jasper are near the Continental Divide. Of all these dams, a failure of Barker Dam would have the most catastrophic impacts on the city. Boulder, Six Mile, Mesa Park, and Hayden Reservoirs are other high hazard dams in the city limits, but impacts from a failure of either of these dams would largely be outside of the city.

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 for nearly all of the state-regulated high- and significant-hazard dams. Inundation maps for some dams have also been developed and exist for Barker Dam and Gross Dam in a GIS format. Results of a GIS analysis using these inundation maps are discussed below.

Assets at Risk to Barker Dam Failure

According to GIS overlays of the inundation zone from a catastrophic failure of Barker Dam, approximately 4,511 structures with a total structure value of $2.6 billion would be affected, primarily in the Boulder Creek basin. Adding an additional 50 percent of the structure value to estimate contents value leads to a total value of $3.9 billion. Assuming 30 percent as the damage estimate, total potential losses would be approximately $1.2 billion. This does not take into account damage to bridges, roads, utilities, and other infrastructure. Results are shown in Table 4.30. Results of the previous plan estimates are shown at the end of the table to show differences in values affected.

Table 4.30. Barker Dam Inundation Estimated Damages

Land Use	Total Flood-Prone Parcels	Parcels with Structures at Risk	Flood-Prone Structures at Risk Values	Estimated Contents Value	Estimated Loss (30%)
Commercial	1,075	936	$905,415,000	$1,358,122,000	$407,437,000
Community	215	107	$211,791,000	$317,687,000	$95,306,000
Industrial	387	311	$397,470,000	$596,205,000	$178,862,000
Natural Lands	195	146	$47,157,000	$70,736,000	$21,221,000
Residential	3,421	2,988	$1,051,148,000	$1,576,723,000	$473,0167000
Unclassified	47	23	$5,645,000	$8,468,000	$2,540,000
Total	**5,340**	**4,511**	**$2,618,626,000**	**$3,927,941,000**	**$1,178,382,000**

Source: City of Boulder GIS, Boulder County Assessor's Office

Assets at Risk to Gross Dam Failure

An analysis of GIS overlays of the inundation zone from a catastrophic failure of Gross Dam yields approximately 3,699 structures with a total structure value of $1.5 billion at risk. Adding an additional 50 percent of the structure value to estimate contents value leads to a total value of $2.2 billion. Assuming 30 percent as the damage estimate, total potential losses would approximate $686 million. This does not take into account damage to bridges, roads, utilities, and other infrastructure. Results are shown in Table 4.31.

Table 4.31. Gross Dam Inundation Estimated Damages

Land Use	Total Flood-Prone Parcels	Parcels with Structures at Risk	Flood-Prone Structures at Risk Values	Estimated Contents Value	Estimated Loss (30%)
Commercial	263	175	$87,184,000	$130,775,000	$39,233,000
Community	165	107	$96,916,000	$145,374,000	$43,612,000
Industrial	242	195	$295,455,000	$443,182,000	$132,955,000
Natural Lands	37	7	$2,592,000	$3,888,000	$1,166,000
Residential	3,931	3,206	$1,034,284,000	$1,551,426,000	$465,428,000
Unclassified	33	9	$8,428,000	$12,641,000	$3,792,000
Total	**4,671**	**3,699**	**$1,524,859,000**	**$2,287,286,000**	**$686,186,000**

Source: City of Boulder GIS, Boulder County Assessor's Office

Population at Risk to Dam Inundation

A separate analysis was performed to determine population in the dam inundation area of both the Barker and Gross Dams. Using GIS, both dam inundation zones were overlaid on the improved residential parcel data. Those residential parcels with structures at risk that intersect the dam inundation area were counted and multiplied by the City of Boulder 2010 Census household factor (2.16), which was then multiplied by the City of Boulder Occupancy Factor (95%). According to this analysis, there is a total population of 9,000 in the Barker Dam inundation zone and 6,579 in the Gross Dam inundation zone. This does not account for workforce or transient population in downtown Boulder. Depend on the time of day a much larger population could be at risk from a Barker Dam failure because it would impact much of downtown Boulder.

Summary

The overall impacts to the city from a dam failure include those previously identified for 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.

Vulnerability to Drought

Likelihood of Occurrence—Likely
Vulnerability—Medium

Drought is different than many of the other natural hazards in that it is not a distinct event and usually has a slow onset. Drought can severely impact a region both physically and economically. A drought's effects impact various sectors in different ways and with varying intensities. Adequate water is the most critical issue. As an area's population continues to grow, so will the demand for water.

Based on historical information, the occurrence of drought in Boulder County and the City of Boulder planning area is cyclical, driven by weather patterns. Drought has occurred in the past and will continue to occur in the future. The periods of actual drought with adverse impacts can vary from short to long term; often the period between droughts is extended. Although an area may be under an extended dry period, defining when a drought occurs is a function of drought impacts to individual water users. Since 1893, Colorado has experienced roughly six multi-year droughts throughout the state. The HMPC identified eight drought events that have impacted the area since 1930. During this plan's update in 2012 much of the state, and Boulder County, was entering into drought conditions that was similar to 2002. For Boulder, drought status can be determined by looking at several factors, including mountain snowpack, streamflows, water rights yields, soil moisture, spring and summer precipitation both at high elevations and in the city, and the influence of the weather on water demands within the municipal water system. During a drought year, the total volume of water flowing in streams from one spring snowmelt to the next spring snowmelt will be much lower than the volume of streamflow over the course of an average year.

Like most Colorado communities, Boulder depends on stored water most of the year. According to the 2003 City of Boulder Drought Plan, the city treats and delivers approximately 24,000 acre-feet of water (7.8 billion gallons) to its customers each year. Water provided by the city serves purposes ranging from critical uses that require an assured supply, such as water for drinking or firefighting, to those uses which can tolerate occasional restrictions, such as landscaping or car washing.

The City of Boulder obtains water from two distinct sources: the watershed of Boulder Creek via Middle and North Boulder Creeks (native basin—eastern slope) and the upper Colorado River via the Colorado-Big Thompson and Windy Gap projects (western slope). Boulder's ability to obtain water from both eastern slope and western slope sources provides some reliability against localized droughts; although widespread droughts may affect all of Boulder's sources. The city owns approximately 23,000 acre-feet of reservoir storage capacity plus its share of the Colorado-Big Thompson storage.

The vulnerability to the City of Boulder planning area from drought is usually citywide, and, depending on the area, includes reduction in water supply and an increase in dry fuels and wildfire potential. In evaluating the reliability of the city's water supply in times of drought, the 2003 drought plan established standards for the city that assures a reliable water supply to the community. These reliability standards vary for the types of uses. For example, according to the plan, the city has determined the following:

- The city provides sufficient water to meet all municipal water needs up to and through a drought severe enough to occur only once every 20 years on average. However, water for landscaping needs may be restricted for droughts of a severity that occurs less frequently than once every 20 years.

- Water for landscaping may be curtailed to the point that some landscaping die-back occurs for droughts that occur no more often than once every 100 years.
- As droughts increase in severity, the amount of restrictions also increase to the point that outdoor water use (with the exception of emergency uses) is totally eliminated during droughts that occur once every 1,000 years.

According to the drought plan, the 2002-2003 drought was considered to be a 1-in-300-year drought within Boulder Creek and Colorado River basins. Despite the severity of this drought, the city was able to supply all essential health and safety water needs and still provide nearly 60 percent of the normal supply of water for landscaping and other essential outdoor uses.

The need for water use limitations due to drought is not expected to happen often to Boulder's municipal water system given the city's diversified water rights portfolio that has a high degree of reliability. However, Boulder is located in a semiarid climate, and drought is and will continue to be an expected part of the natural hydrologic cycle in the region. As discussed in the Drought hazard profile, climate change could impact the nature and frequency of future droughts.

Vulnerability to Earthquakes

Likelihood of Occurrence—Occasional
Vulnerability—Medium

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 Figure 4.6 depicts a 2 percent probability over 50 years of shaking intensity. The City of Boulder 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 City of Boulder 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, Rock Creek, and Golden faults, 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.

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 4.4 and Figure 4.57). According to the City of Boulder, 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.

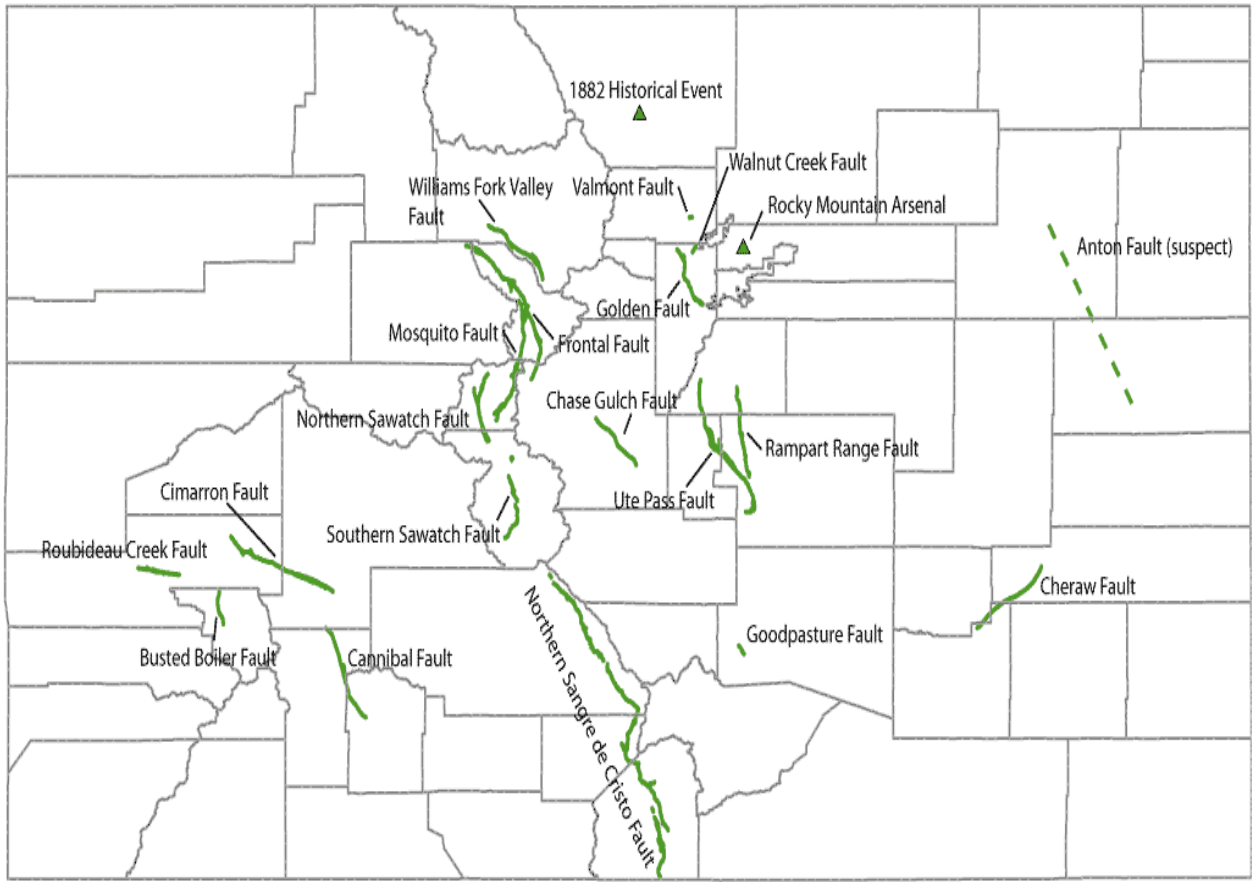
As part of the report, the CGS ran HAZUS (FEMA's Hazards United States software) to perform several different loss prediction analyses. One of these is presented in a county summary format. Table 4.32 summarizes this information.

Table 4.32. 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%	
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 4.57. 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 Boulder specifically. The results can be referenced in Table 4.33. This scenario takes into account worst case ground shaking from a variety of seismic sources and analyzed data aggregated to census tracts for the city. According to this probabilistic scenario, there is the potential for 9% of the total number of buildings in the city to be affected; roughly 3,687 buildings experiencing at least moderate damage and $333 million in economic losses. Due to the low probability of a damaging earthquake occurring, as discussed below, the planning significance of earthquakes is considered low by the HMPC.

Table 4.33. City of Boulder HAZUS-MH 2,500-year Earthquake Scenario Results

Impact Category	Modeled Impacts
Residential Buildings Damaged (Based upon 40,000 buildings)	Slight: 6,471 Moderate: 3,083 Extensive: 570 Complete: 34
Building Related Loss	$333,750,000
Total Economic Loss	$334,270,000
Injuries (Based upon 2am time of occurrence)	Without requiring hospitalization: 54 Requiring hospitalization: 7 Life Threatening: 0 Fatalities: 1
Injuries (Based upon 2pm time of occurrence)	Without requiring hospitalization: 85 Requiring hospitalization: 13 Life Threatening: 1 Fatalities: 2
Injuries (Based upon 5pm time of occurrence)	Without requiring hospitalization: 68 Requiring hospitalization: 13 Life Threatening: 1 Fatalities: 2
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 Water loss @ Day 1: 0 Power loss @ Day 3: 0 Water loss @ Day 3: 0 Power loss @ Day 7: 0 Water loss @ Day 7: 0 Power loss @ Day 30: 0 Water loss @ Day 30: 0
Displaced Households	272
Shelter Requirements	176
Debris Generation	120,000 tons

Source: HAZUS 2.1; AMEC

Annualized Loss Scenario

A level 1 HAZUS annualized loss scenario was performed as part of the plan update process. The annualized loss scenario represents the estimated long-term average losses the city could endure from earthquakes any given year based on the aggregate of seismic sources in the area. This scenario is recommended in the FEMA How-To Guide 433, "Using HAZUS-MH for Risk Assessment." Based on the HAZUS modeling annualized losses for Boulder County are on the order of $0.95 million in total economic losses, with $0.43 million in building related losses. Transportation inventory damage is estimated at $0.50 million.

Summary

Based on the HAZUS modeling, Boulder could withstand significant damages from a large earthquake, but the probability of that occurring is small. What makes the City of Boulder 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 occur in Colorado, only that one will occur. 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).

Development Trends

As Boulder is largely built out, exposure will remain relatively constant, except where redevelopment and infill development occurs. Any new construction built to code in Boulder should generally be able to withstand earthquakes.

Vulnerability to Human Health Hazards: Pandemic Flu

Likelihood of Occurrence—Occasional
Vulnerability—High

Based on historical occurrences, the risk to the City of Boulder planning area is occasional, but the vulnerability is high. Many scientists believe it is a matter of time until the next influenza pandemic occurs. Influenza pandemics occurred three times in the twentieth century—1918-19, 1957-58, and 1968-69— and once in the twenty-first century which suggests a 3 percent chance of a global pandemic in any given year. Nevertheless, the timing and severity of the next pandemic cannot be predicted. Vulnerable populations, those under 5 and those over 65, are particularly at risk. Because Boulder has a well traveled population, risk to pandemic flu during times of outbreak would increase.

Vulnerability to Human Health Hazards: West Nile Virus

Likelihood of Occurrence—Likely
Vulnerability—Low

Based on historical data the risk of occurrence is likely, but the vulnerability of the City of Boulder planning area to West Nile Virus is considered low, based on the percentage of total population that actually contracts the disease; less than 1 percent of those infected actually develop severe illness.

In Colorado, the worst year on record was in 2003, where 2,947 cases of human West Nile Virus were confirmed. Of the 421 cases in Boulder County, seven people died. In 2004, Colorado had 291 cases, 14 of which were in Boulder County. There were no human deaths in 2004. In 2005, animal, mosquito, and human populations were less affected by West Nile Virus than in previous years with 106 human cases, 5 of which were in Boulder County. There were no deaths and only

one case of West Nile Virus-related meningitis. In 2006, reports of West Nile Virus in humans surpassed those of 2004. There were 345 cases and 7 deaths in Colorado; 74 of the cases and one of the deaths were in Boulder County. The numbers went up again in 2007 with 555 cases and 6 deaths in the state; 95 of the cases and two of the deaths were in Boulder County. Since 2007, West Nile Virus cases have fallen substantially. In 2011, only 7 cases were reported in the State, with one case in Boulder and no statewide cases of death.

Although the potential for exposure does exist in the city, the vulnerability should be considered in terms of adverse effects due to exposure. The county and city have an active surveillance and vector control program in place for mosquitoes. And most important, protective measures to prevent exposure are relatively simple and cost effective. Given the nature of protective measures, such as wearing long-sleeved clothing and using bug spray, the responsibility for protection can and should be an individual responsibility.

The virus will be present in Colorado into the future, but the severity changes from year to year, depending on variables such as weather patterns, the mosquito population, the bird population, and immunity in humans.

Vulnerability to Severe Weather: General

Looking at historical hazard data for Boulder County and the City of Boulder, severe weather is an annual occurrence; damage and disaster declarations related to severe weather events have occurred in the past and will continue to occur in the future. The severe weather evaluated as part of this risk assessment included extreme temperatures, fog, hailstorms, thunderstorms, lightning, tornadoes, and windstorms. As previously indicated, due to the lack of historical occurrences and/or negligible damage, fog is not discussed further in this risk assessment. The historical damage associated with the primary effects of severe weather has been limited within the planning area. It is the secondary effects of weather such as flood and fire that have had the greatest impact on the city. The risk and vulnerability associated with these secondary impacts are discussed in the associated sections.

Extreme Temperatures

Likelihood of Occurrence—Highly Likely
Vulnerability—Low

Extreme temperature events occur within the City of Boulder on an annual basis. Young children and the elderly are most vulnerable to temperature extremes. Water infrastructure can be vulnerable to damage from freezing temperatures. Power outages can also occur when an area's power infrastructure is overwhelmed during extended periods of excessive heat. However, the HMPC did not identify any historical events related to extreme temperatures within the City of Boulder planning area. Based on historical data, the vulnerability of the city to extreme temperatures is low. However, as discussed in the hazard profile section, this vulnerability could increase in the future as a result of climate change, particularly for extreme heat.

Hailstorms

Likelihood of Occurrence—Highly Likely
Vulnerability—Medium

According to the National Data Climatic Center, Boulder County experienced 202 hailstorm events between 1950 and 2012 resulting in $1 million in damage. The HMPC did not specifically identify any historical insurance claims for hail within the City of Boulder. However, given the magnitude of historical hailstorms and associated losses in Boulder County and the Denver Front Range, the entire City of Boulder planning area remains at risk and is vulnerable to future hailstorms.

Thunderstorms

Likelihood of Occurrence—Highly Likely
Vulnerability—Low

Boulder County and the City of Boulder planning area experience heavy rains and severe thunderstorms during the spring, summer, and early fall on an annual basis. Both global and regional climate patterns determine the potential severity of these storms from year to year. The entire planning area is equally at risk; it is a matter of chance as to which drainage area a slow-moving storm might linger over. Based on historical information, the primary affect of these storms has not resulted in significant injury or damage to people or property. It is the secondary effect of flooding caused by heavy thunderstorms to which the city is most vulnerable (see the flood vulnerability discussion).

Lightning

Likelihood of Occurrence—Highly Likely
Vulnerability—Medium

There were 8 lightning fatalities and 27 lightning injuries in Boulder County between 1960 and 2012. Cloud-to-ground lightning is the most dangerous form of lightning. Boulder County averages 3.5 thousand cloud-to-ground flashes per year. Additional statistics for Colorado estimate that one out of 52 lightning flashes results in an insurance claim. The City of Boulder has historically incurred damage associated with lightning events. It is difficult to quantify where specific losses will occur due to the random nature of this hazard. Given the lightning statistics for Colorado and Boulder County, the City of Boulder planning area remains at risk and is vulnerable to the effects of lightning.

Tornadoes

Likelihood of Occurrence—Occasional
Vulnerability—Low

Since 1915, there are reports of 40 deaths and 554 injuries resulting from tornadoes in Colorado. The majority of deaths (35) occurred prior to 1950. The number of deaths has significantly decreased as warning technology has advanced, and since 1950 only five deaths are attributed to this hazard. During a 62-year period (1950-2012), 10 tornadoes occurred in Boulder County, which equates to one tornado every 6.2 years, on average. Of these 10 tornadoes, two were magnitude F0, six were F1, and two were F2. Further, tornadoes in the front range of Colorado tend to be small, short-lived, and relatively weak as compared with plains states' tornadoes. Given the low frequency and nature of tornadoes near the foothill areas of Colorado, tornadoes pose a low risk to the City of Boulder planning area.

Windstorms

Likelihood of Occurrence—Highly Likely
Vulnerability—Medium

Boulder has some of the highest peak winds of any city in the United States. According to data compiled by the University Corporation for Atmospheric Research, damage from Boulder's winds averages about a million dollars per year. Given historical data, topography of the area, and weather patterns, the entire City of Boulder planning area is vulnerable to high wind events.

Vulnerability to Winter Storms

Likelihood of Occurrence—Highly Likely
Vulnerability—Medium

Impacts to the City of Boulder planning area as a result of winter snowstorms include damage to infrastructure, frozen pipes, utility outages, road closures, traffic accidents, and interruption in business and community activities. Delays in emergency response services can also be of significant concern. Further, there are economic impacts associated with areas prone to heavy snow. Depending on the nature of a given storm, the entire planning area is at risk to winter storms.

Vulnerability to Soil Hazards: Expansive Soils

Likelihood of Occurrence—Occasional
Vulnerability—Low

Expansive soils in Colorado are a common problem. Little data exists on damage associated with expansive soils in the City of Boulder. With proper testing and mitigation during construction of

new structures, adverse impacts from expansive soils should be minimal. It is assumed that any potential problems are being addressed during construction of new buildings.

Vulnerability to Soil Hazards: Land Subsidence

Likelihood of Occurrence—Occasional
Vulnerability—Low

Subsidence is a known occurrence in Boulder County. In the City of Boulder, subsidence issues have been minimal. Since subsidence in the county is predominantly attributable to past mining activities outside of the city, the risk to properties within the city limits is considered occasional and the vulnerability low.

4.4 Assessing Capabilities

Thus far, the planning process has identified the natural hazards posing a threat to the City of Boulder and described, in general, the vulnerability of the city to these risks. The next step is to identify what loss prevention mechanisms are already in place. Doing so provides an assessment of Boulder's "net vulnerability" to natural disasters and more accurately focuses the goals, objectives, and proposed actions of this plan. This part of the planning process is referred to as the mitigation capability assessment.

The HMPC took two approaches to conducting this assessment for the city. First, an inventory of common mitigation activities was made through the use of a matrix. The purpose of this effort was to identify activities and actions that were either in place, needed improvement, or could be undertaken, if deemed appropriate. Second, the HMPC conducted an inventory of existing policies, regulations, and plans. These documents were collected and reviewed to determine if they contributed to reducing hazard-related losses or if they inadvertently contributed to increasing such losses. This section summarizes the city's mitigation capabilities currently in place.

Similar to the HMPC's effort to describe hazards, risks, and vulnerability of the City of Boulder planning area, this mitigation capability assessment describes the city's existing mitigation policies, procedures, and plans. Table 4.35 summarizes the results of the mitigation capability assessment. Excerpts from applicable plans, rules, and regulations follow, which provide more detail on the existing policies related to hazard mitigation and highlight where the city has made efforts above and beyond the standard policies.

Table 4.35. Mitigation Capabilities Overview Matrix

Capability	In Place?	Comments
Comprehensive Plan	Y	Boulder Valley Comprehensive Plan
Special Plans	Y	Drought, Drainage, CWPP
Subdivision Ordinance	Y	Chapters 9-3 and 9-12 Boulder Revised Code
Zoning Ordinance	Y	Chapter 9-5 Boulder Revised Code
NFIP/Floodplain Management Ordinance	Y	Chapter 9-3 Boulder Revised Code
- Substantial Damage Language?	Y	
- Administrator/Certified Floodplain Manager	Y	
- # of Flood Insurance Policies		3,196 as of February 2012
- Maintain Elevation Certificates	Y	For new construction since 1991
- # of Repetitive Flood Loss Properties	N/A	No properties as defined by FEMA/NFIP
CRS Rating	Y	6, working towards Class 5

Capability	In Place?	Comments
Stormwater Program	Y	Comprehensive Flood and Stormwater Utility Master Plan, Stormwater and Flood Management Utility Program
Erosion or Sediment Controls	Y	
Hospitals Built before 1973 (for HSSA)	Y	
Building Code Version	Y	2006 International Building Code
Full-Time Building Official	Y	
- Conduct "as-built" Inspections	Y	
Building Code Effectiveness Grading System Rating	Y	3 for 1 and 2 family residential properties 3 for commercial and industrial properties
Local Emergency Operations Plan	Y	Emergency Operations Plan Boulder County–City of Boulder
Fire Department ISO Rating	Y	Class 2
Fire Safe Programs	Y	
Other Mitigation Plans	Y	Comprehensive Flood and Stormwater Utility Master Plan, Greenways Master Plan, Raw Water Master Plan, Fire and Emergency Medical Services Master Plan, West Nile Virus Mosquito Management Plan, Drought, CWPP, Climate Preparedness, Wetlands Protection Program
Warning Systems in Place	Y	
- StormReady Designated	in progress	Application has been submitted 2012
- Weather Radio Coverage	Y	Reliable Coverage
- Outdoor Warning Sirens	Y	Yes, with voice-over at select locations.
- Emergency Notification (R-911)	Y	
- Other Warning Capabilities	Y	Flood Warning Detection System, Emergency Warning and Evacuation System, Citizens Alert System, Cable Television Interrupt, Emergency Alert System, Metropolitan Emergency Telephone System, National Warning System
GIS System	Y	
- Hazard Data	Y	Flood, wildfire, subsidence, swelling soils, steep slope
- Building Footprints	Y	
- Tied to Assessor Data	Y	
- Land Use Designations	Y	
Structural Protection Projects	Y	
Property Owner Protection Projects	Y	
Critical Facilities Protected	Y	Draft ordinance developed for 500 year flooding protection
Natural Resources Inventory	Y	
Cultural Resources Inventory	Y	
Public Information Program/Outlet	Y	
Environmental Education Program	Y	

4.4.1 City Mitigation Capabilities by Organization

The section begins with a discussion of city departments that have a role in reducing hazard losses within the City of Boulder. These departments include the Boulder Office of Emergency Management (OEM), Department of Public Works, Planning and Development Services, Open Space and Mountain Parks, Parks and Recreation, Police and Fire. OEM has the primary responsibility for all-hazards preparedness, response, mitigation and recovery for the city. The primary city division/department responsible for flood hazard mitigation is the Stormwater and Flood Management Utility in the Department of Public Works. The Fire Department has the lead for wildfire mitigation activities. The specific loss prevention capabilities and planning mechanisms associated with these agencies are discussed later in this section.

Boulder Office of Emergency Management

Emergency preparedness is part of the city's strategy to protect life and property from floods and other disasters. The Office of Emergency Management (OEM) is a joint office of the City of Boulder and Boulder County and coordinates the activities of public, private and volunteer agencies in emergency planning, mobilizing, and direction of emergency preparedness personnel in mitigation, preparing for, responding to and recovery from disasters or emergencies. The OEM develops plans, programs, and training for response to emergencies in the City of Boulder and Boulder County. The OEM obtains assistance and resources from federal, state, local, public, and private sources. The OEM is funded and staffed jointly by the Boulder County Sheriff and City of Boulder with additional support from FEMA through the Colorado Division of Emergency Management. OEM has four full-time staff dedicated to improving operations plans, continuity of operations/continuity of government plans (COOP/COG), hazardous materials preparedness planning, and leadership of the Multi Agency Coordination (MACs) group.

Department of Public Works

The Public Works Department sustains and improves the quality of life in Boulder and provides many basic services. The department oversees the city's water resources, maintains the city's infrastructure, completes a variety of street, sewer, and construction projects each year; and keeps roadways safe for passage. The department also serves as first responders in emergency situations where Public Works services are required. The department oversees several divisions including Transportation, Utilities, Facilities and Asset Management (FAM), and Fleet Services, and jointly oversees the Planning & Development Services workgroups.

Utilities Division

The City of Boulder's Utilities Division manages the city's three municipal utilities (water, wastewater and flood control). The division manages the city's raw water supplies and provides high-quality treated water that meets all standards in a cost-effective manner. The Utilities Division effectively collects and treats wastewater and mitigates the potential loss from floods through the development of flood channels and the installation and maintenance of storm sewers.

Stormwater and Flood Management Utility Program

The Stormwater and Flood Management Utility was established in 1973 and is responsible for the city's flood management, stormwater quality, and stormwater drainage programs. Its responsibilities include the following:

- Administration and operations
- Utility rates and finance
- Program development and management
- Flood and stormwater regulation and compliance
- System master planning and design
- Public education and community outreach
- Flood prediction and response
- Stormwater quality management
- Emergency preparedness and day-to-day operations
- Capital improvements and land management

The Stormwater and Flood Management Utility provides funding for both stormwater and flood channel maintenance activities. In 2002, there was approximately $201,000 budgeted for maintenance of the flood carrying capacity of the creek channels within the city. The budget provided for 1.8 FTE (full-time equivalent), approximately $103,000 in personnel costs, and $98,000 for nonpersonnel costs. In 2012, the budget provides for 2.55 FTE with $298,000 in available funds. Flood utility staff remove sediment from channels, stabilize banks, and remove trees or tree limbs that have fallen into the creeks. Adjacent landowners are required to handle leaning trees or trees that have fallen away from the creek channel.

Management of information is an important component of the city's Stormwater and Flood Management Utility program. Since 1989, significant advances have been made in computerized information management techniques, including GIS.

Capital Improvement Program

The Capital Improvement Program covers a six-year time period within which funding priorities are reflected in the staging and timing of projects. In the Stormwater and Flood Management Utility, the majority of the project funding is focused on life safety and critical facility hazard mitigation issues. Capital Improvement Program expenditures are prioritized based on the following criteria:

- Life safety (high hazard) mitigation
- Flood emergency response capability
- Critical facility (vulnerable population) hazard mitigation
- Property damage mitigation
- Collaboration with other Greenways Program Objectives
- Potential for operation and maintenance cost savings

- Accommodating new growth and development

Water Resources Advisory Board

The Water Resources Advisory Board (WRAB) consists of five members appointed to five-year terms by City Council that meet monthly. The WRAB was formed to review capital improvement programs, the community and environmental assessment process, and the utilities master plan; advise City Council, the Planning Board, and city staff; and provide recommendations concerning policy issues on operating programs.

Greenways Program

The City of Boulder Greenways System is a series of riparian corridors, including Boulder Creek and 14 of its tributaries that integrate the multiple city objectives of habitat protection, water quality enhancement, storm drainage and floodplain management, trails, and recreation and cultural resources protection.

The total 2013 Greenways budget is $345,000, with $105,000 in the operating budget. Greenways projects are funded from the Transportation Fund, Stormwater and Flood Management Utility Fund, and the Lottery Fund. Annual funding distribution for the Greenways Program for 2013-2014 is as follows:

- Transportation - $97,500
- Flood Utility - $97,500
- Lottery Fund - $150,000

Starting in 2015, the Lottery contribution is expected to be reduced to $125,441, based on Greenways receiving 15% of the city's funding allocation, with a projection of total Lottery proceeds being $836,275.

The activities of the program are coordinated by the Greenways Coordinator who works under the direction of the Utilities Project Coordinator in the Public Works Department.

In 1984, the city adopted the Boulder Creek Corridor Plan, which recommended development of a continuous path and other improvements along the entire length of Boulder Creek. These improvements provided flood hazard mitigation, a linear urban park for recreational and transportation use, and restoration and enhancement of wetlands and fish and wildlife habitat. Design guidelines were established to set standards for appearance, quality, and placement of elements that were incorporated into the Boulder Creek corridor.

When completed in 1987, the Boulder Creek corridor provided recreational and transportation opportunities as well as a buffer zone between the stream channel and nearby development. Wetlands were restored along the corridor to provide stormwater and flood retention and filtering. The project also restored the riparian habitat along the creek, which had become

considerably degraded. Natural vegetation was planted and corridor use was redirected to the Boulder Creek path to reduce ongoing damage. Aquatic habitat, which had been severely affected by diminished stream flows and creek channelization, was restored. A self-sustaining creek channel and healthy aquatic habitat were established with the implementation of minimum streamflow agreements for Boulder Creek.

The Greenways Program was an outgrowth of the Boulder Creek Corridor Plan. The basis of the program is the understanding that stream corridors are a vital link in the larger ecosystem, and that each stream is an important natural and cultural resource in the community. The public support of the Boulder Creek Corridor Plan led to an interest in expanding the program to include six additional tributaries within the city. The city designated over 20 miles of stream corridors along the following tributaries of Boulder Creek for inclusion in the original Greenways Program:

- South Boulder Creek
- Bear Canyon Creek
- Skunk Creek
- Goose Creek
- Wonderland Creek
- Fourmile Canyon Creek
- Elmer's Twomile Creek (this creek was later added as a tributary to Goose Creek because it was considered an important transportation corridor)

Funding for a Greenways Master Plan was approved by City Council in December 1987. The plan was developed by staff from the Planning, Public Works, Parks and Recreation, and Open Space and Mountain Parks, and Real Estate departments and adopted by City Council in January 1989. A refined master plan, design guidelines, a capital improvement program, and a more detailed reproducible map were approved in September 1990. An interdepartmental staff group, under the direction of the Greenways Coordinator updated the Greenways Master Plan in December 2001. The plan included an evaluation of the program to date and historical information about the program, an identification and evaluation of projects and opportunities for each of the Greenways objectives, and a maintenance strategy, organization structure, procedures and processes for project planning and public involvement, and a proposed financing plan.

The latest update was in 2011 and includes two key components:

- The expansion of the Greenways Program to include all of the fourteen major tributaries to Boulder Creek within the City of Boulder;
  - Bear Canyon Creek
  - Bluebell Canyon Creek
  - Dry Creek No. 2
  - Elmer's Two Mile Creek
  - Fourmile Canyon Creek

- Goose Creek
- Gregory Canyon Creek
- Kings Gulch
- Skunk Creek
- South Boulder Creek
- Sunshine Creek
- Two Mile Canyon Creek
- Viele Canal
- Wonderland Creek, and;

- A summary of current changes to policies and plans that affect implementation of the Greenways Program. The update also provides descriptions of current conditions based on changes that have occurred within the system since the last plan update in 2001. The purpose and objectives of the Greenways Program have not changed.

Transportation Division

The Transportation Division and the Transportation Master Plan acknowledge that trails and bikeways are an important planning consideration, which, when in keeping with other program goals, may be accommodated in or near creek corridors. In many cases, stream corridors can be creatively developed to function as efficient bicycle and pedestrian transportation systems while simultaneously functioning as storm drainage and flood channels, open space and wildlife corridors, and attractive recreation corridors. The Stormwater and Flood Management Utility, the Transportation Department, and the Greenways Program frequently cooperate to achieve goals and objectives in common areas.

Loss prevention capabilities include:

- Numerous major access routes for emergency preparedness response
- Airport access
- All new bridges and underpasses are designed to convey 100-year flood event flows

Transportation Advisory Board

The Transportation Advisory Board (TAB) consists of five members appointed by City Council, each to five-year terms that meet on a monthly basis. The TAB advises City Council, Planning Board and city staff on transportation issues, reviews transportation community environmental assessments, reviews plans for capital improvements, reviews and recommends changes to the Transportation Master Plan and works with neighborhood groups, residents and staff on traffic mitigation issues

Planning and Development Services Comprehensive Planning Programs

The Planning and Development Services Comprehensive Planning is responsible for citywide and subcommunity and area planning. The Planning Department and portions of the Public

Works Department together form Planning and Development Services (P&DS). P&DS is a service area that was formed to support its customers and the delivery of services. The P&DS Center provides customers with building and construction permits and applications, GIS mapping services, development review, inspections, licensing, zoning information, long range planning, and historic preservation.

Parks and Recreation Department

The Parks and Recreation Department and the Parks and Recreation Master Plan recognize the importance of undeveloped open land and natural parks in the city for quiet, passive recreation and hazard mitigation. Where park lands occur along the city's drainageways, the Stormwater and Flood Management Utility may cooperate with the Parks and Recreation Department and the Greenways Program to achieve open land/natural park objectives while promoting drainage and flood control objectives.

Working with the Boulder OEM, the City of Boulder Parks and Recreation Department completed emergency action plans for each recreation facility and program in 2009. This project was an action recommendation in the 2008 Multi-Hazard Mitigation Plan. These plans were developed with the assistance and input from staff at each facility and program. In addition, program supervisory staff attended training on emergency preparedness and hazard awareness, and each facility and program created an emergency plan that can be used by staff to inform park users to shelter-in-place or evacuate (including signage and instructions). Each plan discusses the appropriate actions to take during a flood and identifies possible evacuation sites (high ground).

Open Space and Mountain Parks Department

The Open Space and Mountain Parks Department operates in accordance with city charter provisions and missions, among which are to preserve and restore natural areas with associated unusual, spectacular, historically important, scientifically valuable, or rare examples of native flora and fauna; preserve water resources in their natural or traditional state, including wildlife habitats or fragile ecosystems; promote utilization of program lands for passive recreational use; preserve agricultural land uses and land suitable for agricultural production; and use lands wisely to prevent encroachment on floodplains. The Open Space and Mountain Parks Department, through area management planning, provides guidance and direction for management of specific areas, develops a framework for evaluating and incorporating appropriate uses of open space, prepares inventories and analyses of resources; provides opportunities for public participation, and coordinates resource management, protection, and planning with other city departments and public and private landowners.

Police Department

The Boulder Police Department (BPD) has adopted a policing philosophy that is built around the provision of service, as represented by proactive problem solving through the establishment of community partnerships, and safety, as represented by the aggressive application of modern law

enforcement techniques. This philosophical shift from the traditional 911-driven, pure reactive approach to the delivery of police services emphasizes community-based, prevention-oriented policing. The issues and concerns in need of police attention emerge from ongoing discussion and interaction between the BPD and the community. The department defines its fundamental responsibilities as encompassing six general functions:

- Enforcing laws and preserving public safety and order
- Reducing crime and disorder through prevention and intervention
- Responding to community needs through partnerships and joint problem-solving
- Investigating and reporting serious and nonserious crimes for prosecution
- Providing information and service referrals
- Managing and administering BPD operations

The BPD acknowledges the common practice of estimating police staffing based on the number of officers per 1,000 people. In 2012, the department's officer per capita ratio was 1.75 officers per 1,000 inhabitants, which is up from 1.7 officers per 1,000 inhabitants in 2009. The BPD recognizes that this ratio is not the only consideration when determining sufficient staffing levels. Additional factors used for consideration are community-policing philosophy, a decentralized service delivery model, expressed community needs as articulated in the master plan, and analysis of quarterly public satisfaction surveys. Many of these standards tend to be more staffing-intensive than merely responding to traditional law enforcement calls. In 2011, the clearance rate for major crimes was 30 percent, which is consistent with the national average. By 2010, the department had met most of the objectives set in the 2001 master plan. The department will submit a revised 2013 master plan to council by the end of 2012.

Fire-Rescue Department

The City of Boulder Fire–Rescue Department is responsible for the protection of life and property through fire prevention, education, fire suppression, and emergency medical and rescue services. The Fire–Rescue Department has a staff of 116, seven fire stations, and a budget of approximately $15.5 million to provide fire suppression, rescue, emergency medical care, fire prevention services, and public education for the population within Boulder's city limits. All addresses in the City of Boulder limits are within two miles of a fire station. The fire chief reports to the city manager and oversees the department's five divisions: Emergency Services, Fire Prevention, Training, Wildland, and Administration. Two permanent wildland fire positions including a wildland fire crew supervisor have been added in 2012. This additional staffing was an action recommendation in the 2008 Multi-Hazard Mitigation Plan.

Boulder's firefighters do a lot more than fight fires. Every firefighter is a state certified emergency medical technician. Every engine crew is equipped with, and trained to operate, a cardiac defibrillator. The city's firefighters are also prepared to deal with flooding in a business or house, extricate someone from a vehicle accident, rescue people from a stalled elevator or a collapsed trench, and effectively deal with carbon monoxide alarms or tree branches on power

lines. Many of Boulder's firefighters have advanced training in dive rescue, hazardous material spills, wildland firefighting, or fire safety education.

Boulder's firefighters also provide proactive services for the safety and well-being of the public. The engine crews and Fire Prevention Division inspect Boulder businesses to ensure they comply with the International Fire Code and Boulder Revised Code. The fire safety education team reaches virtually every elementary school student in the city during October, fire prevention month, through the school system. College students are taught fire safety through the Greek and Residence Assistants Fire Academies.

The Fire Prevention Division not only promotes fire safety and education, but also investigates fire, performs plan reviews for new or remodeled buildings, and performs building inspections to ensure compliance with the fire code. The department also has a training division that concentrates on recruit training, continuing education to the entire department, and emergency medical services training.

The Wildland Division was established in 1998 to help protect residents, visitors, and city lands form wildland fire. The response area of the division covers approximately 400 square miles. The division's purpose is to manage wildland fire activities on or threatening City of Boulder land. Another reason the division was established was to carry on and expand the prescribed fire program on city lands. To help accomplish this, the division assists the Open Space and Mountain Parks Department with their ecosystem management and forest health projects. The division educates the public on wildfire prevention, mitigation, and safety and provides training to city employees and local, state, and federal cooperators. The Public Safety Tax approved by voters in 1997 added seasonal personnel to respond to wildland fires occurring on and around Boulder's open lands. That crew is also available to conduct wildland fire mitigation, forest thinning, and prescribed burning.

The Fire–Rescue Department has seven fire stations strategically located around the city:

- Station One (Central Station)—2441 13th Street
- Station Two—2225 Baseline Road
- Station Three—1580 30th Street,
- Station Four—4100 Darley Avenue
- Station Five—4365 19th Street
- Station Six—5145 North 63rd Street
- Station Seven—1380 55th Street

Each station operates 24 hours per day, seven days per week and is equipped to respond to fire, medical, and other emergencies. Medical calls accounted for 62 percent of the total calls for service in 2011. The Fire–Rescue Department also participates in a countywide joint training center. The current facility is at 960 Lee Hill Road.

An update to the Fire and Emergency Medical Service Master Plan was adopted in June 2012. The master plan service standards are as follows:

- Emergency Services: Arrival of 1st unit dispatched to an emergency within 6 minutes 80% of the time. Arrival of all units dispatched to an emergency within 11 minutes 80% of the time.
- Hazardous Materials Team: Arrival of 1st unit dispatched to an emergency within 6 minutes 80% of the time. Arrival of all units dispatched to an emergency within 11 minutes 80% of the time.
- Wildland Coordination: Arrival of 1st unit dispatched to an emergency within 6 minutes 80% of the time. Arrival of all units dispatched to an emergency within 11 minutes 80% of the time.
- Dive Team: Arrival of 1st unit dispatched to an emergency within 6 minutes 80% of the time. Arrival of all units dispatched to an emergency within 11 minutes 80% of the time.

Traffic congestion and various traffic mitigation measures have impacted the department's ability to continue to meet the emergency response service standards. To ease the impact, the department activated traffic control devices that were installed at signaled intersections around the city. The department has also initiated an aggressive public education program funded by the Public Safety Tax of 1997. One purpose of the public education program is to reduce the demand for service by promoting a higher awareness of personal safety. As traffic congestion and the number of service calls increase, the addition of new fire stations will be necessary in areas where the response times are adversely impacted.

4.4.2 Hazards Management Capabilities of Other State and Regional Agencies

Colorado Water Conservation Board

The Colorado Water Conservation Board (CWCB) is an agency of the State of Colorado. The CWCB Flood Protection Program is directed to review and approve statewide floodplain studies and designations prior to adoption by local governments. The CWCB is also responsible for the coordination of the National Flood Insurance Program (NFIP) in Colorado and for providing assistance to local communities in meeting NFIP requirements. This includes CWCB prepared or partnered local floodplain studies. The CWCB has promulgated new floodplain rules and regulations that became effective on January 14, 2011. Increased protection for public health, safety and welfare in the state is the primary reason for updating Colorado's floodplain rules. The CWCB's rules aim to reduce flood losses through sound flood protection actions, which are implemented at the local level and supported by State and Federal programs. Key provisions of the new floodplain rules include: higher freeboard for structures, a 0.5 foot floodway and additional protection for "critical facilities" in the 100-year floodplain. The city supported the adoption of higher standards, and in fact was already enforcing a 6-inch floodway and a 2-ft freeboard criterion. The city is currently updating its floodplain ordinance to incorporate greater protection for critical facilities in the 500-year floodplain.

Urban Drainage and Flood Control District

The Urban Drainage and Flood Control District (UDFCD) was established by the Colorado legislature in 1969 to help local governments in the Denver metropolitan area with multi-jurisdictional drainage and flood control problems. The UDFCD covers 1,608 square miles and includes all or parts of 34 incorporated cities and towns, including the City of Boulder. There are about 1,600 miles of "major drainageways" that are defined as draining at least 1,000 acres. The population of the district is approximately 2.3 million.

The district operates four programs: Master Planning; Design, Construction and Maintenance; Floodplain Management; and Information Services and Flood Warning. The district helps local governments in maintaining and preserving floodways and floodplains in areas eligible for UDFCD maintenance. UDFCD maintenance is limited to facilities that are publicly owned or are in a public drainageway easement and are categorized into routine, restoration, and rehabilitation projects. Routine maintenance consists of scheduled mowings and trash and debris pickup on major drainageways during the growing season. It may also include small revegetation efforts and limited weed control. Restoration projects address local erosion problems, existing structure repair, detention pond restoration, tree thinning, removal of sediment deposits from flood control facilities, and revegetation work. Rehabilitation projects are major reconstruction efforts that would be included as capital improvement program projects in the City of Boulder. The district also assists with developing community flood warning capabilities, including implementation of early flood detection systems and providing early notifications concerning potential and imminent flood threats.

Colorado Office of Emergency Management

The Colorado Office of Emergency Management (CO OEM) is responsible for the state's comprehensive emergency management program, which supports local and state agencies. Activities and services cover all aspects of emergency management. Assistance to local governments includes financial and technical assistance as well as training and exercise support. Services are made available through local emergency managers supported by CO OEM staff assigned to specific areas of the state. CO OEM also provides guidance and technical assistance on mitigation grant applications.

Colorado State Forest Service

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

Colorado Geological Survey

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

Colorado Department of Water Resources – Office of State Engineer

The Colorado Division of Water Resources (DWR), also known as the Office of the State Engineer, administers water rights, issues water well permits, represents Colorado in interstate water compact proceedings, monitors streamflow and water use, approves construction and repair of dams and performs dam safety inspections, issues licenses for well drillers and assures the safe and proper construction of water wells, and maintains numerous databases of Colorado water information. As it relates to hazard mitigation it is the department's mission to ensure public safety through safe dams and properly permitted and constructed water wells.

The Dam Safety branch is responsible for the safety of all existing dams in the state of Colorado. The branch carries out two principal duties of the State Engineer: to determine the safe storage level of the reservoir dams in the state and to approve the plans and specifications for the construction and repair of Jurisdictional dams. Dam Safety engineers regularly inspect jurisdictional dams throughout the state.

Whenever there is a dam emergency, dam owners are requested to immediately follow their *Emergency Action Plan,* notify the local enforcement authority (ex. sheriff or 911), notify the Colorado Division of Emergency Management and notify the State of Colorado's Dam Safety Branch.

Colorado Department of Transportation

The Colorado Department of Transportation (CDOT) conducts planning and projects that relate to hazard mitigation. These include design of bridges to withstand scouring and convey flood flows in addition to rockfall hazard identification and mitigation along the State's highway system. CDOT employs message signs, road closure devices, and radio advisories to warn motorists of dangerous driving conditions and road closures due to severe weather or rockfall incidents. CDOT has developed a US 36 Traffic Incident Management Plan for the Boulder Turnpike.

4.4.3 Hazard-Related Policies, Regulations and Codes

The City of Boulder has several policies, regulations and codes that guide how the city manages development of hazard-prone areas. Many of these policies have multiple objectives. Those that are directly related to reducing losses to future development or the protection of critical facilities and/or vulnerable populations are summarized here.

Boulder Valley Comprehensive Plan

First adopted in 1978 and recently update in 2010, the Boulder Valley Comprehensive Plan (BVCP) is a joint plan between the City of Boulder and Boulder County providing shared land use decision making in the Boulder Valley. The plan sets a course for the future growth and development of the city and the lands just outside the city's boundaries. The plan is adopted by four bodies: the City of Boulder Planning Board, the City Council, the County Planning Commission, and the Board of County Commissioners. The following is a summary of the core components of this plan:

- The BVCP policies guide decisions about growth, development, preservation, environmental protection, economic development, affordable housing, culture and the arts, neighborhood character, and transportation. The policies also inform decisions about the manner in which services are provided, such as police, fire, emergency medical services, water utilities, flood control, and human services.
- The BVCP Land Use Designation and Area I, II, III Maps define the desired land use pattern for the Boulder Valley regarding location, type, and intensity of development.

Boulder Valley Comprehensive Plan Policies

The general policies and principles that relate to mitigating the impacts of natural hazards are detailed below. These policies provide overarching direction for planning, development, and programs in the Boulder Valley.

General Policies

- Sustainability as a unifying framework to meet environmental, economic and social goals.
- Environmental stewardship and climate action.

Urban Design Linkages Policies

- **Urban Open Lands** (2.19)—Open lands within the fabric of the city provide recreational opportunities, transportation linkages, gathering places and density relief from the confines of the city as well as protection of the environmental quality of the urban environment. The city will promote and maintain an urban open lands system to serve the following functions: active and passive recreation, environmental protection, flood management, multimodal transportation, enhancement of community character and aesthetics.

- Boulder Creek, Tributaries and Ditches as Important Urban Design Features (2.20)—Boulder Creek, its tributaries and irrigation ditches will serve as unifying urban design features for the community. The city and County will support the preservation or reclamation of the creek corridors for natural ecosystems, wildlife habitat, and cultural resources; for recreation and bicycle and pedestrian transportation; to provide flood management; to improve air and water quality; and to provide a contrast to urban development. Path development will be sensitive to the ecology, terrain, and privacy of adjacent residents and surroundings.

Community Conservation Policies

- Preservation of Historic and Cultural Resources (2.24)—The city and county will identify, evaluate and protect buildings, structures, objects, districts, sites and natural features of historic, architectural, archaeological, or cultural significance with input from the community. The city and county will seek protection of significant resources through local designation when a proposal by the private sector is subject to discretionary development review.

Preserve and Enhance Biodiversity and Native Ecosystems Policies

- **Natural Ecosystems** (3.03)—The city and county will protect and restore significant native ecosystems on public and private lands through land use planning, development review, conservation easements, acquisition, and public land management practices. The protection and enhancement of biological diversity and habitat for federal endangered and threatened species and state, county, and local species of concern will be emphasized. Degraded habitat may be restored, and selected extirpated species may be reintroduced as a means of enhancing native flora and fauna in the Boulder Valley. (See policy 2.05 Open Space Preservation.)
- **Maintain and Restore Ecological Processes** (3.05)—Recognizing that ecological processes, such as wildfire and flooding, are integral **t**o the productivity and health of natural **eco**systems, the city and county will work to ensure that, when appropriate precautions have been taken for human safety and welfare, ecological processes will be maintained or mimicked in management of natural lands.
- **Wetland Protection** (3.06)—Natural and human-made wetlands are valuable for their ecological and, where appropriate, recreational functions, including their ability to enhance water and air quality. Wetlands also function as important wildlife habitat, especially for rare, threatened, and endangered plants and wildlife. The city and county will continue to develop programs to protect and enhance wetlands in the Boulder Valley. The city will strive for no net loss of wetlands by discouraging their destruction or requiring the creation and restoration of wetland in the rare cases when development is permitted and the filling of wetlands cannot be avoided.
- **Invasive Species Management** (3.07)—The city and county will promote efforts, both public and private, to prevent the introduction or culture of invasive plant and animal species

and seek to control their spread. High priority will be given to managing invasive species that have, or potentially could have, a substantial impact on city and county resources.

Protect and Enhance the Quality of the Urban Environment Policies

- **Urban Environmental Quality** (3.10)—To the extent possible, the city and County will seek to protect the environmental quality of areas under significant human influence, such as agricultural and urban lands, and will balance human needs and public safety with environmental protection. The city will develop community-wide programs and standards for new development and redevelopment so that negative environmental impacts will be mitigated and overall environmental quality of the urban environment will not worsen and may improve.
- **Urban Forests** (3.11)—The city will support, promote and, in some cases regulate, the protection of healthy existing trees and the long-term health and vitality of the urban forest in the planning and design of public improvements and private development. The city will encourage overall species diversity, native and low water demand tree species where appropriate.
- **Water Conservation** (3.12)—The city and county will promote the conservation of water resources through water quality protection, public education, monitoring, and policies that promote appropriate water usage. The city will endeavor to minimize water waste and reduce water use during peak demand periods. New development and redevelopment designed to conserve water will be encouraged.

Protect Geologic Resources and Manage Natural Hazards Policies

- **Unique Geological Features** (3.14)—Due to its location at the interface of the Great Plains and the Rocky Mountains, Boulder Valley has a number of significant or unique geological and paleontological features. The city and county will attempt to protect these features from alteration or destruction through a variety of means, such as public acquisition, land use planning and regulation, and density transfer within a particular site.
- **Hazardous Areas** (3.16)—Hazardous areas that present danger to life and property from flood, forest fire, steep slopes, erosion, unstable soil, subsidence, or similar geological development constraints will be delineated, and development in such areas will be carefully controlled or prohibited.
- **Wildfire Protection and Management** (3.18)—The city and county will require on-site and off-site measures to guard against the danger of fire in developments adjacent to natural lands and consistent with forest and grassland ecosystem management principles and practices. Recognizing that fire is a widely accepted means of managing ecosystems, the city and county will integrate ecosystem management principles with wildfire hazard mitigation planning and urban design.
- **Preservation of Floodplains** (3.19)—Undeveloped floodplains will be preserved or restored where possible through public land acquisition of high hazard properties, private land dedication, and multiple program coordination. Comprehensive planning and management of

floodplain lands will promote the preservation of natural and beneficial functions of floodplains whenever possible.

- **Flood Management** (3.20)—The city will protect the public and property from the devastating impacts of flooding in a timely and cost-effective manner while balancing community interests with public safety needs. The city will manage the potential for floods by implementing the following guiding principles: preserve floodplains, be prepared for floods, help people protect themselves from flood hazards, prevent unwise uses and adverse impacts in the floodplain, and seek to accommodate floods, not control them. The city will manage flood recovery by protecting critical facilities in the 500-year floodplain and implementing multi hazard mitigation and flood response and recovery plans.
- **Nonstructural Approach** (3.21)—The city will seek to preserve the natural and beneficial functions of floodplains by emphasizing and balancing the use of nonstructural measures with structural mitigation. Where drainageway improvements are proposed, a nonstructural approach should be applied wherever possible to preserve the natural values of local waterways while balancing private property interests and associated cost to the city.
- **Protection of High Hazard Areas** (3.22)—The city will prevent redevelopment of significantly flood-damaged properties in high hazard areas. The city will prepare a plan for property acquisition and other forms of mitigation for flood-damaged and undeveloped land in high hazard flood areas. Undeveloped high hazard flood areas will be retained in their natural state whenever possible. Compatible uses of riparian corridors, such as natural ecosystems, wildlife habitat and wetlands will be encouraged wherever appropriate. Trails or other open recreational facilities may be feasible in certain areas.
- **Larger Flooding Events** (3.23)—The city recognizes that floods larger than the 100-year event will occur resulting in greater risks and flood damage that will affect even improvements constructed with standard flood protection measures. The city will seek to better understand the impact of larger flood events and consider necessary floodplain management strategies including the protection of critical facilities.

Protect and Improve Water and Air Quality Policies

- **Protection of Water Quality** (3.24)—Water quality is a critical health, economic, and aesthetic concern. The city and county will protect, maintain, and improve water quality within the Boulder Creek watershed as a necessary component of existing ecosystems and as a critical resource for the human community. The city and county will seek to reduce point and nonpoint sources of pollutants protect and restore natural water system, and conserve water resources. Special emphasis will be placed on regional efforts such as watershed planning and priority will be placed on pollution prevention over treatment.
- **Water Resource Planning Acquisition** (3.25)—Water resource planning efforts will be regional in nature and incorporate the goals of water quality protection, and surface and ground water conservation. The city will continue to obtain additional municipal water supplies to insure adequate drinking water, maintain instream flows and preserve agricultural uses. The city will seek to minimize or mitigate the environmental, agricultural, and economic impacts to other jurisdictions in its acquisition of additional municipal water

supply to further the goals of maintaining instream flows and preventing the permanent removal of land from agricultural production elsewhere in the state.

- **Drinking Water** (3.26)—The city and county will continually seek to improve the quality of drinking water and work with other water and land use interests as needed to assure the integrity and quality of its drinking water supplies. The city and county will employ a system-wide approach to protect drinking water quality from sources waters to the water treatment plant and throughout the water distribution system.
- **Minimum Flow Program** (3.27)—The city will pursue expansion of the existing in-stream flow program consistent with applicable law and manage stream flows to protect riparian and aquatic ecosystems within the Boulder Creek watershed.
- **Surface and Groundwater** (3.28)—Surface and groundwater resources will be managed to prevent their degradation and to protect and enhance aquatic, wetland and riparian ecosystems. Land use and development planning and public land management practices will consider the interdependency of surface and groundwater and potential impacts to these resources from pollutant sources, changes in hydrology, and dewatering activities.
- **Wastewater** (3.29)—The city will pursue sustainable wastewater treatment processes to achieve water quality improvements with greater energy efficiency and minimal chemical use. Pollution prevention and proactive maintenance strategies will be incorporated in wastewater collection system management. The county will discourage the installation of private on-site wastewater systems where municipal collection systems are available or where a potential pollution or health hazard would be created.
- **Protection of Air Quality** (3.30)—Air quality is a critical health, economic, and aesthetic concern. The city and county will seek to reduce stationary and mobile source emissions of pollutants. Special emphasis will be placed on local and regional efforts to reduce pollutants, which cause adverse health effects and impair visibility.

Community Health

- **Safety** (8.07)-The city will promote safety by fostering good neighborhood relations, building a sense of community pride and involvement, and promoting safe and attractive neighborhoods. The city and county will provide police, fire protection and emergency management services and preparedness education to ensure a safe community**.**

Fire Protection Considerations

The following seven philosophies provide general direction when establishing goals and objectives for fire protection in the City of Boulder:

- **Shared Responsibility for Fire Protection**—The city emphasizes private sector self-protection through code regulations and design incentives. Installation of automatic fire sprinkler systems is now required by ordinance for many uses.
- **Balance between Built-In Fire Protection and Public Fire Protection Service**—Municipal fire protection requires a balance between services provided by the city through fire stations, apparatus, and personnel and that provided by built-in automatic fire systems.

Automatic systems offer a high degree of protection from fire originating in those protected properties. City-provided protection supplements the built-in systems and is designed to handle fires in nonprotected buildings, outside fires, medical emergencies, and nonfire emergencies and events.

- **Generalist Theory of Operation**—The Fire–Rescue Department believes that each fire apparatus should have diverse equipment and that the firefighters should be generalists rather than specialists. Every front-line fire truck has firefighting and rescue equipment along with emergency medical supplies. Each firefighter must pass a comprehensive training program that supports that generalist approach. State of Colorado emergency medical technician certification is required, and every firefighter's training includes firefighting, hazardous materials response, and training for rescues involving vehicle accidents, fires, water, and ice incidents.
- **Basic Level of Emergency Medical Service**—The Fire–Rescue Department provides basic life saving services. The emergency medical care system in the city is a multi-tiered system involving Fire–Rescue, public/private partnership with a private ambulance service, and area hospitals, each providing a respectively higher degree of medical support.
- **Specialist Capabilities**—In addition to the general capabilities, the Fire–Rescue Department provides more specialized services:
  - The Dive Team responds to emergencies at the Boulder Reservoir, Boulder Creek, and other bodies of water within the city.
  - The Hazardous Materials Team responds to hazardous chemical releases, including chemical spills on manufacturing sites and during transport.
  - The Wildland Fire Team, with the help of additional seasonal wildland firefighters, responds to fires in open space and on the edges of the city, including the foothills.
  - The Public Education Team works with the department's fire-safety coordinator to provide public education in fire prevention.
- **Training**—The Fire–Rescue Department offers a wide variety of services to the citizens of Boulder. To maintain an adequate level of proficiency in many areas of emergency service, the department conducts extensive training in all service areas including firefighting, fire prevention, emergency medical care, hazardous materials, rescue, and public education. Joint training exercises are conducted with other county agencies.
- **Impact of Infill**—City fire stations are strategically located to meet the emergency response service standards. As population within service area increases, the number of calls for fire and emergency service will increase. When one fire response unit in a station exceeds 1,500 calls per year, additional apparatus and staffing needs to be provided.

The BVCP describes the following future activities and projects of the Fire-Rescue Department:

- **Anticipate and prepare for year-round wildfire risk** - Consider new codes for wildland interface and residential construction practices. Continue to focus on wildland fire planning, mitigation and protection, including more coordination with other city departments and

regional partnerships with the Sheriff's Office and service providers. Continue to replace seasonal wildland fire crews with full-time employees.

- **Implement a plan to identify remaining wood roofs by the end of 2012**: One of the key wildfire mitigation polices enacted by the city is the passage of an ordinance banning wood roofs and requiring existing wood roofs to be replaced by 2014. The city will work with property owners to facilitate their replacement by the January 2014 deadline.
- **Apparatus Replacement**—The city is developing a planned fire truck replacement program.

Floodplain Regulations

The city has numerous codes and regulations in place governing floodplains. Some of the following descriptions are taken directly from the regulations and others are taken from existing plans and documents summarizing key regulatory elements of floodplain management including the 2004 Comprehensive Flood and Stormwater Utility Master Plan and Background Documents.

Stormwater and Flood Management Utility (Boulder Revised Code—Title 11 Utilities and Airport: Chapter 5)

As previously discussed, the city has established and operates the Stormwater and Flood Management Utility pursuant to Title 11 Chapter 5 of the Boulder Revised Code. The purpose of this code section is to protect public health, safety, and welfare from damage associated with stormwater runoff and floods by requiring that property owners in the city pay for a share of the cost of the drainage facilities necessary to manage such stormwater and floods.

Also included in this section is the requirement to develop a master drainage plan for the city, based on engineering studies, that indicates the location of all city drainage facilities. The intent is to identify and alleviate present and future drainage and flooding problems in the city by means of presenting the general data and information essential in understanding the relationship between rainfall and storm runoff.

Regulations Governing the Floodplain (Boulder Revised Code—Title 9 Land Use Regulations: Chapter 3)

The city has had floodplain policies in place for over 50 years. During this time, the city has mapped 100-year floodplains to identify flood hazard areas and developed master plans to pursue mitigation of flood impacts.

The many critical environmental factors predominant in floodplains suggest that the approach to floodplain management should be oriented more toward preservation of floodplains and their beneficial environmental functions and less toward structural flood control measures. There is evidence that the city's floodplain policy is moving towards nonstructural flood mitigation measures as much as possible.

The floodplain is considered to include all land areas subject to inundation by floodwaters. The adopted regulatory floodplain is based on a predicted flood which has a 1 percent chance of

being equaled or exceeded in any given year. This area is commonly called the 100-year floodplain. Development within the floodplain must include flood protection measures that mitigate the risk of property loss or damage resulting from a 100-year flood. Within the floodplain, the following zones are defined:

- **Conveyance Zone**— Also known as the floodway, this includes 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 or floodway is usually a narrowed corridor within the floodplain.) This conveyance zone definition is more restrictive than that used by FEMA (but consistent with the new State of Colorado regulations), which allows a maximum one-foot increase in floodwater depth.
- **High Hazard Zone**—All areas in the floodplain where floodwater depth would equal or exceed four feet (or where the product number of the floodwater velocity (in feet per second) multiplied by the floodwater depth (measured in feet) would equal or exceed four). Because of life safety concerns, development in the high hazard zone is the most restricted.
- **Flood Fringe**—Those portions of the floodplain that are not in the conveyance zone or in the high hazard zone.

The city requires new development to be elevated or floodproofed 2 feet above the base, or 1% annual chance, flood event. This elevation is referred to as the 'flood protection elevation' in the Code. This concept of "freeboard" provides added protection for floods that exceed the base flood. Regulations that pertain to the entire floodplain include the following:

- A floodplain development permit must be acquired prior to any development within the floodplain.
- Floodproofing of buildings or structures must meet city standards.
- No hazardous materials may be stored at or below flood protection elevation with the exception of existing or replacement underground fuel storage tanks that are constructed to prevent discharge into floodwaters and that are adequately anchored against a flood.
- Parking areas may not be located in areas where flood depths exceed 18 inches.
- Rental properties in the floodplain must be posted with appropriate informational signs to warn tenants of flood hazards.
- Manufactured housing must be elevated on a permanent foundation so that the lowest floor is above the flood protection elevation, and the structure must be sufficiently anchored.
- New structures should be oriented with longitudinal axis parallel to the predicted direction of flow of floodwaters.
- Existing structures will be rehabilitated to conform with regulations when substantially expanded, enlarged, modified, or improved.
- New residential structures must be elevated so that the lowest floor is at or above the flood protection elevation.

- New nonresidential structures must be floodproofed or have the lowest finished floor elevated above the flood protection elevation.
- Any new structure must be adequately anchored, constructed of material resistant to flood damage, and designed and located so that electrical, heating and ventilation, plumbing, and air conditioning systems are not inundated.
- Fully enclosed areas that are subject to flooding must also allow for automatic equalization of flood forces by providing for entry and exit of floodwaters.

In addition to the regulations governing the floodplain, uses, structures, or developments in the conveyance zone that result in any rise in the elevation of the 100-year flood are prohibited. Proposed changes to the regulations in 2012 may allow an exception to this. Localized rises within flood channels or on specific properties may be permissible if all impacted property owners agree in writing to accept the rise and there is no adverse impact on any insurable structure or any other property. Construction of new, or expansion, enlargement, or substantial modification of existing structures intended for human occupancy in the high hazard zone, is not allowed.

Critical Facility and Mobile Population Ordinance

The city's Comprehensive Flood Study Master Plan (CFS MP, 2004) calls for the development of 500-year protection standards for critical facilities in line with Federal guidance to ensure access to, use of and uninterrupted service for critical facilities such as fire and police stations, water and wastewater treatment facilities, utility infrastructure for water, sewer, gas, electric and communications, schools, day care and senior care facilities, hospitals, major roads and bridges, and hazardous material storage. The development of a critical facilities ordinance was identified as a mitigation action as part of the original development of this Multi-Hazard Mitigation Plan which was originally adopted in 2008. The action item outlined the need for the development and adoption of an ordinance that regulates new construction and improvements for critical facilities to the 500-year flood level to protect these facilities from flood losses and damages that could render them unusable during times of need. A draft ordinance has been in development since 2009.

The proposed ordinance will expand the regulation of mobile populations and the critical facility categories of essential service, at-risk population and hazardous materials facilities to areas encompassed by the 500-year floodplain.

In the 500-year floodplain:

- Substantial improvements or modifications to, or development of, new at-risk population and essential service facilities will be constructed so that the lowest floor of the entire building is protected to the level of the 500-year flood elevation plus one foot. Smaller building additions will also protect the new construction to that level.
- Existing hazardous materials buildings with modifications requiring a floodplain development permit or a building permit which exceeds 25 percent of the market value of the

existing structure are required to secure the hazardous material from flooding within a 10 year implementation window. New hazardous material facilities would be required to secure the hazardous materials from flooding as a condition of the permit.

In the 500- and 100-year floodplains, emergency management plans will be required for:

- Critical facilities and mobile population facilities requiring building permits for new construction, development requiring a floodplain development permit, the addition of any floor area, or any building permit for a substantial improvement and must be developed as a condition of the permit.
- All other existing critical facility and mobile population facilities will be required to develop emergency management plans within a 10 year implementation window from the ordinance adoption.

Emergency management plans will include either shelter in place or evacuation plans. The most appropriate method of protection will be defined, and evacuation routes or sheltering locations will be posted in the building, similar to requirements for fire response. This requirement will ensure that necessary flood education and protection information is available during times of flooding.

Critical facilities and mobile population facilities will continue to be regulated within the area encompassed by the 100-year floodplain, consistent with other types of buildings, with the exception of the requirement to develop an emergency management plan. Existing 100-year regulations will remain in place and a revision of the definition of hazardous materials is included in the recommended ordinance. Existing critical and mobile population facilities can continue to operate in their current capacity.

Adoption of the ordinance is pending a public hearing by the City Council. This may occur in 2012.

Floodplain Development Permits (Boulder Revised Code—Title 9 Land Use Regulations: Chapter 3)

The city requires that a floodplain development permit be acquired for any development within the floodplain. The City Manager, through the Public Works Department, is responsible for review and approval or denial of floodplain development permits and the development of conditions of approval where appropriate. Developments that propose a change in a watercourse must be referred to the Planning Board for recommendation. Permit approvals for development in the conveyance or high hazard zone do not become effective for fourteen days following issuance and are subject to Planning Board review, public noticing, and appeal procedures.

The city assesses fees for the processing of floodplain development permits, variances, and flood map revisions. The city also coordinates its floodplain regulations with several other agencies,

each of which regulate to the 100-year floodplain standard. These agencies include FEMA, the Colorado Water Conservation Board, the UDFCD, and Boulder County.

Floodplain development permit applications are reviewed by city staff within the Public Works Department, who provide public notice of the application if high hazard or conveyance zones are affected and make a recommendation of application approval, with or without conditions, or denial. Concerns considered in the review of a floodplain development permit application include compliance with regulations governing floodplains, conveyance zones, and high hazard areas; effects on drainage efficiency or capacity; whether the project will have an adverse environmental effect on the watercourse, including banks and streamside vegetation; effect of the project on adjacent, upstream, and downstream properties; the relationship of the project to the BVCP and applicable floodplain management programs; and whether the cumulative effects of the project with other existing and anticipated uses will increase flood heights.

Design and Construction Standards (Boulder Revised Code—Title 9 Land Use Regulations: Chapter 9)

The city's Design and Construction Standards (DCS) regulate the design and construction of public infrastructure, improvements, and landscaping within the city's public rights-of-way and public easements. The DCS requirements for stormwater management are primarily based on the UDFCD drainage criteria manuals. The updated DCS was adopted by City Council on October 17, 2000, with the passage of City of Boulder Ordinance No. 7088.

Stormwater issues related to land development and redevelopment are addressed through a variety of review processes coordinated by the Planning and Development Services workgroup. Most development and redevelopment projects are required to submit a stormwater report and plan prepared by a licensed professional engineer. The report and plan are required to address how the identified project will maintain historical runoff rates and mitigate water quality impacts. On-site detention storage is required for all developments other than individual single-family lots that are not part of a larger development where the runoff coefficient for the site is increased.

Natural Resource Protection Considerations

The City of Boulder has many regulations to protect the valuable resources within Boulder Valley. Taken directly from the regulations, highlights of these provisions are provided below.

Streams, Wetlands and Water Body Protection (Boulder Revised Code—Title 9 Land Use Regulations: Chapter 3)

The City of Boulder has adopted a streams, wetlands and water body protection ordinance to preserve, protect, and enhance streams, wetlands and water bodies by discouraging development activities in streams, wetlands, water bodies and adjacent areas. The ordinance establishes a goal of no net loss of wetland acreage and function by regulating activities in and around streams,

wetlands and water bodies. These rules apply to all streams, wetlands and water bodies that are mapped within Boulder's city limits as well as all streams, wetlands and water bodies on city-owned land and all city activities affecting streams, wetlands or water bodies regardless of location.

City streams, wetlands and water body permits are required for projects that affect streams, wetlands, water bodies and associated buffer zones surrounding streams, wetlands and water bodies. The surrounding buffer zones vary in size based upon the functional classification of the stream, wetland and water body. Low functioning streams, wetlands and water bodies have a 25-foot outer buffer. High functioning streams, wetlands and water bodies have a 50-foot buffer area which consists of a 25-foot inner buffer and a 25-foot outer buffer. The regulations and permitting requirements are most restrictive for activities that directly impact streams, wetlands and water bodies and are the least restrictive for activities that only impact outer buffer areas. Maintenance of an existing public or private road, structure, or facility, including drainage facilities, water conveyance structures, dams, fences, or trails are permissible subject to the requirement of best management practices as identified in city Wetlands Protection Program Best Management Practices (May 1995). The maintenance activities may not materially change or enlarge any existing facility, structure, or road.

Protection of Trees and Plants (Boulder Revised Code—Title 6 Health, Safety, and Sanitation: Chapter 6)

The purpose of this chapter is to protect the public health, safety, and welfare by prescribing requirements for the protection of trees and plants within the city, including, without limitation, trees, shrubs, lawns, and all other landscaping. The City Council finds that all trees, plants, and other landscaping, located, standing, or growing within or upon city property, including, without limitation, any city-owned or city-controlled street, alley, rights-of-way, or other public place or city or mountain park, recreation area, or open space, belong to the city and are a community asset comprising a part of the public infrastructure. The City Council finds that the requirements of this chapter are necessary to ensure the continued protection, maintenance, replacement, and management of city-owned trees, plants, and other landscaping.

Building and Construction Considerations

Boulder's adopted building codes are:

- 2006 International Building Code
- 2006 International Residential Code
- 2006 International Fire Code
- 2006 International Mechanical Code
- 2006 International Plumbing Code
- 2006 International Fuel Gas Code
- 2008 National Electrical Code

Building Code (Boulder Revised Code—Title 10 Structures: Chapter 5)

The intent of the Building Code is to protect the public health and safety by regulating the construction, alteration, repair, wrecking, and moving of structures in the city. The City Council adopted the 2006 edition of the International Building Code and the 1997 edition of the Uniform Code for the Abatement of Dangerous Buildings with certain amendments and deletions found to be in the best interests of the residents of the city.

Elements of the 2006 International Building Code (IBC) amended by the city that are particular to natural hazards mitigation are described below.

Roofing (10-5-2(u))

All roof assemblies and roof coverings required to be listed by this section shall be tested in accordance with ASTM Standard E 108 or UL Standard 790. Class A roofs and the exceptions noted in IBC 1505.3 for Class B roofs as described in IBC chapter 15 are the only roof assemblies and roof coverings allowed to be installed on any new or existing building within the City of Boulder. Wood shakes, wood shingles, and wood roof covering materials are prohibited except as provided in Section 10-5-5, "Wood Roof Covering Materials Prohibited," for certain minimal repairs.

Wood Roof Covering Materials Prohibited (10-5-5)

No person shall install or cause to be installed any wood roof covering materials, including, without limitation, wood shakes or wood shingles. This prohibition includes wood roof covering materials with fire retardant treatments of any kind.

No person owning a building with wood roof covering materials shall fail to remove or cause to be removed from the building all wood roof covering materials before January 1, 2014, and to replace the removed roofing with approved roof covering materials that conform to the IBC as adopted, and no person shall thereafter take possession or ownership of a building with wood roof covering materials.

"Wood roof covering material" means an exterior surface material used as a top covering and made of wood. "Wood," for the purposes of this definition, means any natural or composite material containing at least fifty percent wood by volume.

Snow Load (10-5-2(v))

The minimum roof snow load shall be thirty pounds per square foot, but the design roof load shall not be less than that determined by IBC Section 1607.

Wind Velocities (10-5-2(w))

In IBC Table 1609.3.1, the three-second gust wind speed for the city shall be 110 miles per hour.

Residential Building Code (Boulder Revised Code—Title 10 Structures: Chapter 5.5)

The purpose of this chapter is to protect the public health and safety by regulating the construction, alteration, repair, wrecking, and moving of residential structures in the city. The City Council adopted the 2006 edition of the International Residential Code with certain amendments found to be in the best interests of the city.

Elements of the 2006 International Residential Code (IRC) amended by the city that are particular to natural hazards mitigation are described below.

Climatic and Geographic Design (10-5.5-2(e))

The climatic and geographic design criteria applicable to IRC Table R301.2.1 are as follows:

- Roof snow load = thirty pounds per square foot
- Three second wind gust velocity = 110 miles per hour
- Seismic design category = B
- Weathering = severe
- Frost line depth = 32 inches
- Termite = slight
- Decay = none to slight
- Winter design temperature = 2 degrees Fahrenheit
- Ice shield underlayment = No

The building code does not specifically spell out seismic criteria for non-residential structures, specifically critical facilities. The design of critical facilities is based on criteria stated in the International Building Code and ASCE 7 Design Loads for Buildings and Other structures.

Roof Covering Materials (10-5.5-2(g))

All roof covering materials shall be listed as Class A or B as tested in accordance with UL Standard 790 or ASTM Standard E 108. Roof assemblies with covering of brick, masonry, slate, clay, or concrete roof tile; exposed concrete roof deck; ferrous or copper shingles or sheets; and metal sheets and shingles shall be considered Class A roof coverings.

Wood Shingles (10-5.5-2(h))

Wood shakes, wood shingles, and wood roof covering materials are prohibited except as provided in Section 10-5-5, “Wood Roof Covering Materials Prohibited” (see above).

Wood Shakes (10-5.5-2(i))

Wood shakes, wood shingles, and wood roof covering materials are prohibited except as provided in Section 10-5-5, “Wood Roof Covering Materials Prohibited” (see above).

Fire Prevention Code (Boulder Revised Code—Title 10 Structures: Chapter 8)

The purpose of this chapter is to protect public health and safety by regulating the use, condition, construction, alteration, and repair of property, structures, and occupancies in the city in order to prevent the ignition and spread of fire and risk of harm to persons or property from fire and other causes. The City Council adopted the 2006 edition of the International Fire Code with certain amendments, additions, and deletions found to be in the best interests of the city.

Elements of the 2006 International Fire Code amended by the city that are particular to natural hazards mitigation are described below.

Accessible Private Drive (10-8-2(b.9))

"Accessible private drive" means a 20-foot unobstructed clear width with a 12-foot hard, all-weather, drivable surface that can support 40 tons on 10 wheels and has an SU 30 turning radius for the fire department's fire apparatus.

Open Burning and Recreational Fires (10-8-2(b.10))

No person shall kindle or maintain outside of a habitable building any bonfire or burn or permit to be burned any trash, paper, rubbish, wastepaper, wood, weeds, brush, plants, or other combustible or flammable material anywhere within the city limits or anywhere on city property outside of the city limits, except when:

- The burning is in the course of an agricultural operation in the growing of crops as a gainful occupation and presents no fire hazard to other property in the vicinity;
- The burning is a smokeless flare or a safety flare used to indicate some danger to the public;
- The burning is a training fire conducted by the fire department or is a training fire conducted by another fire department or privately for industrial or commercial fire training purposes and approved in writing by the fire chief; or
- The burning is solely for the purpose of fuels mitigation to alleviate wildland fire potential or weed abatement to assist restoration of native plants.

Mobile or portable type outdoor fire places are prohibited within the city limits or anywhere on city property outside of the city limits.

Historic Preservation (Boulder Revised Code—Title 9 Land Use Regulations: Chapter 11)

The purpose of this chapter is to promote the public health, safety, and welfare by protecting, enhancing, and perpetuating buildings, sites, and areas of the city reminiscent of past eras, events, and persons important in local, state, or national history or providing significant examples of architectural styles of the past. It is also the purpose of this chapter to develop and maintain appropriate settings and environments for such buildings, sites, and areas to enhance property values, stabilize neighborhoods, promote tourist trade and interest, and foster knowledge of the city's living heritage.

Historic Preservation Program and Ordinance

In the early 1970s, reacting to the demolition of a number of important buildings, concerned Boulder citizens initiated a grassroots effort to protect the city's historic resources. The resulting Boulder Historic Preservation Ordinance was the first such document in Colorado with the authority to designate and protect historic, architectural, or cultural resources considered valuable to the community as a whole. Many excellent examples of architecture from the turn-of-the twentieth century survive in these neighborhoods, in part, as a result of the city's adoption of the ordinance in 1974.

The purpose of this code is to protect, enhance, and perpetuate buildings, sites, and areas of the city reminiscent of past eras, events, and persons important in local, state, or national history or to provide significant examples of architectural styles of the past. The purpose of the code is also to develop and maintain appropriate settings and environments for such buildings, sites, and areas to enhance property values, stabilize neighborhoods, promote tourist trade and interest, and foster knowledge of the city's living heritage.

The code established the Landmarks Board charged with the responsibility of carrying out its provisions and goals. The code has four areas of focus:

- Designation of landmarks and historic districts
- Review and approval authority of proposed alterations to these buildings and to new construction or proposed demolition in these areas
- Review of applications for demolition or moving of non-landmarked buildings over 50 years old to prevent the loss of buildings that may have historical or architectural significance and to provide the time necessary to initiate designation or to consider alternatives for the building
- Requirement of prior approval of exterior changes to buildings or sites or proposed demolitions to preserve the historic integrity of individual landmarks and properties within historic districts

Urban Service Criteria and Standards

Also included in the BVCP, the Urban Service Standards set the benchmark for providing a full range of urban services in the Boulder Valley. These standards are intended to be minimum requirements or thresholds for facilities and services that must be delivered to existing or new urban development to be considered adequate. Included in the standards are criteria for stormwater and flood management as detailed below:

- Responsiveness to public objectives
  - Have personnel on call 24 hours per day for stormwater and flood emergencies
- Sufficiency of financing
  - Have revenue sources that are guaranteed so that revenues are available for stormwater and flood management related projects, materials, equipment, facilities, and personnel

  - Be organized to request and receive Urban Drainage and Flood Control District, state, and federal funds, if available, for projects, facilities, and equipment
- Operational effectiveness
  - Use annual budget for personnel, equipment, projects, facilities, and materials
  - Meet standards as exemplified by the Urban Drainage and Flood Control District
  - Adopt regulations consistent with FEMA
  - The following are standards for stormwater and flood management criteria for new urban development within the Boulder Valley:
    - Runoff analysis will be based upon proposed land use and will take into consideration all contributing runoff from areas outside the study area
    - Storm runoff will be determined by the Rational Method or the Colorado Urban Hydrograph Procedure
    - All local collection systems shall be designed to transport the following storm frequency:
      - Single-family residential—two-year storm
      - All other areas—five-year storm
    - The major drainageway system will be designed to transport the 100-year event or a modified standard in an approved plan
    - Storm runoff quantity greater than the "historical" amount will not be discharged into irrigation ditches without the approval of the flood regulatory authority or the appropriate irrigation ditch company
    - The type of pipe to be installed will be determined by the flood regulatory authority and will be based upon flows, site conditions, and maintenance requirements
    - All new urban development in the Boulder service area, which will be annexed, will be required to meet the intent of the adopted City of Boulder floodplain regulations.
    - Erosion and sedimentation control will be exercised
    - Detention storage requirements will be reviewed by the flood regulatory authority
- Proficiency of personnel
  - All flood control maintenance crews will be staffed by personnel trained and capable of operating the equipment necessary to maintain the stormwater and flood management system
- Location and adequacy of equipment and facilities
  - Provide essential equipment and vehicles for stormwater and flood management maintenance activities

4.4.4 Flood Mitigation Capabilities

This section describes the City of Boulder's flood program based primarily on the 2004 Comprehensive Flood and Stormwater Utility Master Plan, including the Background Materials to the Master Plan, and input from the HMPC.

Floodplain Management Program Background

The city's flood management program works to reduce flood hazards, adopt floodplain policies, map floodplains, develop master plans for floodplains, regulate floodplain activities, prepare for flood events, educate the public on floods and floodplains, and mitigate flood potential. The city's local guiding principles for flood management include:

- **Preserve floodplains** where possible to recognize the beneficial functions of floodplains for hazard reduction, water quality enhancement, wetland protection, wildlife habitat, riparian corridors, recreation, alternate modes travel, environmental relief, aesthetics, and greenway areas.
- **Be prepared for floods** by developing advanced floodplain mapping, detailed risk assessments, enhanced early warning systems, multiple emergency notification measures, understandable response plans, workable recovery plans, and ongoing storm monitoring.
- **Help people protect themselves from flood hazards** through public interaction and involvement, available flood information, community outreach and education, self-help measures, flood proofing options, affordable flood insurance, and emergency preparedness.
- **Prevent adverse impacts and unwise uses in the floodplain** through appropriate regulation and land use, open land preservation and acquisition, multi-objective planning, relocation or elimination of high hazard structures, prohibiting unacceptable encroachments, and establishing ongoing maintenance practices that preserve and enhance environmental functions.
- **Seek to accommodate floods, not control them**, through planned and monitored system maintenance, nonstructural flood proofing, opening noncontainment corridors, overbank land shaping to train flood waters, and limited structural (channelization) measures at constrained locations or where no alternatives are available.

The City of Boulder initiated its flood control program in the decade following the 1969 flood. That flood resulted in $5 million in damage to the city. During that time, the city adopted its first floodplain ordinance and first drainageway master plan. The floodplain ordinance, by requiring floodproofing of new buildings, was designed to ensure that new flooding problems would not be created. The master plan proposed improvements that would address future development and remedy existing problems. The ordinance regulated parcels that would be flooded during a 100-year flood, but enforcement was difficult due to the lack of floodplain delineation maps.

NFIP and CRS Program Participation

The city joined the NFIP on July 17, 1978, which allows private property owners to purchase affordable flood insurance and enables the community to retain its eligibility to receive certain federally backed monies and disaster relief funds. The city also participates in the NFIP's Community Rating System (CRS). The CRS is a voluntary program for NFIP-participating communities. It provides flood insurance discounts to policyholders in communities that provide extra measures of flood protection above the minimum NFIP requirements. The City of Boulder

entered the CRS on October 1, 1992. Since 2007 the city has improved its CRS rating from a Class 8 to a Class 6. The Class 6 rating will provide a 20 percent discount for flood insurance policyholders within a special flood hazard area (SFHA) and a 10 percent discount for those outside of an SFHA. With the Class 8 rating the discount was 10 percent and 5 percent, respectively. The city continues to work towards improving its CRS rating, with a goal of becoming a Class 5 community.

Floodplain Mapping Overview

To provide further direction on floodplain management in the city, numerous flood studies were conducted over the years on drainages throughout the County. In 1974, the city developed floodway and floodplain maps for flood-prone areas within the city.

Floodplain studies on various drainageways are an ongoing part of the city's floodplain management program. These studies, which may be approved by FEMA, include federally funded studies; studies developed by state, city, and regional public agencies; and technical studies generated by private interests as part of property annexation and land development efforts. These studies are conducted on entire drainages or limited stream sections depending on the scope of a study. Once approved and adopted by FEMA, they act to modify the regulatory floodplain of a given study area. The Background Information to the Comprehensive Stormwater and Flood Management Utility Master Plan provides a summary of flood studies conducted to date on Boulder's 15 major drainageways.

Presently, the City of Boulder has FEMA flood insurance rate maps (FIRMs) that cover the geographical extent of the city. These maps are identified in Table 4.36.

Table 4.36. City of Boulder Flood Insurance Rate Maps

Map Number	Effective Date	# of LOMCs[1]
08013C0385F	06/02/1995	3
08013C0395F	06/02/1995	111
08013C0405F	06/02/1995	2
08013C0410F	06/02/1995	2
08013C0415F	06/02/1995	41
08013C0535F	06/02/1995	21
08013C0555G	10/04/2002	3

[1] LOMCs—Letter of map changes and includes letter of map amendments (LOMAs) and letter of map revisions (LOMRs)

As of March 2012, there had been 183 FEMA-approved letters of map changes for the seven FIRMs covering the City of Boulder. The city, through their GIS department, has been able to electronically incorporate all final map revisions into the original FIRM data. This HMP used the city's most current GIS flood layers to model the city's vulnerability to both the 100-year and 500-year floods. The city is part of the nationwide Flood Map Modernization effort, which has produced Digital Flood Insurance Rate Maps (DFIRMs) that will replace the older FIRMs. A

preliminary DFIRM for the city was available in early 2012, which will be formally adopted on December 18, 2012.

Flood Preparedness and Detection System

Flood preparedness is a critical element in the city's floodplain management program. The more prepared a community can be with pre-flood preparedness, ongoing monitoring, effective warning systems, trained response, and post-flood recovery, the better chance the risks of flooding may be managed.

During the peak flood season the Urban Drainage and Flood Control District (UDFCD) contracts to have 24-hour meteorologist coverage for the Denver metro area. The UDFCD meteorologists forward daily forecasts to the city and the Boulder Office of Emergency Management (Boulder OEM). The UDFCD also operates and maintains a network of stream and rainfall gages in and around the city. This information provides real-time data that is monitored by city staff and the Boulder OEM during the flood season. In addition, the UDFCD emails daily forecasts and updates during severe weather, including the quantitative precipitation forecasts and storm tracks.

Due to the very short time frame that flooding can occur, there is often limited time available to provide adequate warning. This is particularly true for the city's smaller creek systems. In addition, thunderstorm cells can move and intensify very rapidly and often unpredictably. It is for these reasons that flood education, regulations and ordinances are critical components to the city's flood emergency preparedness program.

City of Boulder Flood Monitoring Cameras

The City of Boulder maintains cameras at Barker dam and at the lodge at Fourmile Creek. This allows for remote access during high water events. Conditions may be monitored from a safe distance.

Flood Awareness and Flood Safety Outreach

The city's annual flood education program elements include flood awareness advertisements in local news papers, brochure inserts in April utility bills, and door hanger distribution to high risk properties. Ongoing but varying elements of the city's flood education program include items such as outreach to camps and daycares that use city facilities located in floodplains or outreach to down town businesses on the importance of flood emergency plan development. In addition, the city maintains a wealth of flood-related information on a website located at www.boulderfloodinfo.net.

Gilbert White Memorial Flood Level Marker

The Gilbert White Memorial Flood Level Marker is an 18-foot tall LED-illuminated structure that shows the creek's 50-year, 100-year, 500-year and Big Thompson historic flood levels. The

structure was installed in 2011 in Central Park near where the Broadway Avenue bridge crosses Boulder Creek. The structure was planned, designed and constructed by a committee of Gilbert's colleagues, friends and family, who also helped raise funds for the marker with private contributions and fundraising events. The marker was donated to the city and is maintained by the Parks and Recreation Department. A flood awareness interpretive display accompanies the memorial at the site.

"Flash Flood Alley" and "The Water's Edge"

The nonprofit Flood Safety Education Project, in coordination with local, state, and national partners, produced a series of highly detailed, interactive flood hazard maps and videos that explain the significant flash flood risks affecting decision makers, public safety personnel, and citizens of Boulder. These maps are GIS-based and use precisely crafted 3D views to display the 100-year and 500-year floodplains. A series of broadcast-quality videos were also produced that have aired on public access television.

The goal of this map/video project is twofold: 1) help increase awareness of the specifics of Boulder's worst flash flood zones and stream crossings (where people are most likely to die) and 2) the videos (12 short clips) explain what to do (and not do) before, during, and after a flood in and near these areas. Maps such as these can also be used to highlight other hazards and evacuation routes. A web-based version of this project can be accessed at www.boulderfloods.org/.

Flood Mitigation Efforts Overview

The City of Boulder has taken many steps to reduce the threat from floods. The purchase of wetlands and open space not only helps preserve a unique way of life, it helps protect the community from the dangers of flooding. And, many of the flood mitigation efforts have benefits beyond keeping Boulder safe; they provide parks and trails, purify air, keep streams healthy, and make Boulder attractive.

- The city is active in the acquisition of open space and wetlands that give flood waters somewhere safe to go. Greenways provide wildlife habitat, trail systems, and flood protection.
- City requirements for tree planting help reduce the risk of urban flooding. Boulder's urban forest reduces stormwater runoff by approximately 12.2 million ft3 per 2-inch storm event (enough water to fill Folsom Field, the university's football field several times).
- Floodplain regulations encourage safe development and may prohibit additional development in some areas.
- The city has purchased a number of structures in high hazard areas to be demolished or converted. The acquisition of structures creates park space and moves buildings out of danger.

- The city and County actively monitor local streams for flood danger. The city and County of Boulder Office of Emergency Management provides information about emergency preparation efforts.
- Pedestrian bridges in flood hazard areas are designed to break away in heavy flooding to minimize damage to the city's infrastructure.

Comprehensive Flood and Stormwater Utility Master Plan, 2004

The Comprehensive Flood and Stormwater Utility Master Plan provides a framework for evaluating, developing, and implementing various programs and activities in the utility. This plan replaced the 1989 Comprehensive Drainage Utility Master Plan. The plan's main objectives are to address flash flood hazards, stormwater quality, stormwater drainage, program integration and implementation, and financial considerations. The following provides a status update on the flood mitigation recommendations from the 2004 Comprehensive Flood and Stormwater Plan and other subsequent planning efforts and master planning studies.

Boulder Creek

Significant flood mitigation improvements to Boulder Creek were implemented as part of a joint use project with the Boulder Valley School District. Nine properties were purchased in the vicinity of Boulder High School and 13th Street. The structures were removed and the overbank area on the north side of the creek south of Arapahoe was excavated and graded to provide for additional flood conveyance and the construction of park and athletic fields. This work was completed in 1993. The following properties along Boulder Creek were also acquired and removed since 1989:

- City Tree House office structure on the south side of Boulder Creek east of the library
- Residence at 1234 18th Street along the north side of Boulder Creek
- 18-unit apartment complex at 299 Arapahoe just east of the Eben G. Fine Park site on the south side of Boulder Creek

Other flood control improvements that have been made along Boulder Creek since 1989 include the following:

- Lower Arapahoe Avenue bridge structure replaced just east of Broadway
- 17th Street bridge replaced with a structure designed to pass 100-year flows
- Conveyance/detention storage improvements made along the creek through the University of Colorado's Research Park
- Railroad underpass structure at Cottonwood Grove
- Upper Arapahoe bridge structure replaced above Eben Fine Park
- 55th Street bridge replaced with a structure designed to pass 100-year flows
- Fixed concrete footbridge at Boulder High School replaced with a breakaway structure
- Broadway bridge over Boulder Creek replaced a structure designed to pass 100-year flows

The 2012 Boulder Creek Flood Mapping Study (BC FMS) will update the Boulder Creek Floodplain maps. The new study will establish floodplain boundaries, water surface elevations, conveyance zones and high hazard zones using current methodologies and will include improvements and changes along BC that have occurred since the maps were approved by FEMA in 1983. The BC FMS evaluates the floodplain from the area east of the confluence with Fourmile Canyon Creek, approximately three-quarters of a mile east of 61st Street, upstream to the mouth of Boulder Canyon west of Boulder's city limits. This model encompasses a stream reach length of 7 miles.

The 100- and 500-year floodplain, conveyance zone, and high hazard zone hazard boundaries have been updated and changed from the existing floodplain map. The changes to the hazard boundaries have caused some structures to be removed from the floodplain, conveyance and high hazard zones, while others have been identified as being newly located in these zones. The proposed mapping will provide the basis for floodplain land use regulation. A preliminary review of the final floodplain mapping indicates that there will be 646 structures in the proposed 100-year floodplain as compared to 680 structures in the existing 100-year floodplain.

To date, the Water Resources Advisory Board and Planning Board have reviewed and recommended approval of the flood mapping study. The floodplain study will be presented to the City Council at a regularly scheduled council meeting in 3rd quarter of 2012. The city mapping will be submitted to FEMA for review in the 4th quarter of 2012 and approval is anticipated 8 to 18 months after submittal. Once approved by FEMA, the Boulder Creek floodplain mapping will be incorporated into FEMA's Digital Flood Insurance Rate Map.

Recognizing the value of protecting its own facilities from hazards, the Boulder Emergency Operations Center (EOC) was relocated in 2009 from a location within the Boulder Creek floodplain to a location on higher ground near the county airport. Other enhancements to the EOC have occurred as a result of the move.

South Boulder Creek

In 1996, the University of Colorado commissioned a flood study as part of its due-diligence review to purchase the 315-acre CU-Boulder South Campus. This study identified significant flood spills would impact east Boulder areas in what has subsequently been called the "West Valley Overflow" area.

In 1997, the city, Boulder County, the UD&FCD and the Colorado Water Conservation Board, in cooperation with FEMA, commissioned another flood study (called the Taggart study) to verify the results of the CU study and to compare the results to the adopted floodplain mapping. Ultimately, the Taggart study was not approved and a new flood study, using more advanced hydraulic modeling and hydrology techniques, was commissioned by the city and the UD&FCD. This study was performed by HDR Engineering and included a Climatology and Hydrology Report with reviews by an independent review panel, citizen advisory group and a hydrology advisory panel. The HDR Engineering study was completed in 2007 and resulted in a new flood

map and formally identified the flood hazard that would impact the West Valley neighborhoods west of South Boulder Creek and north of US 36.

On April 17, 2007, City Council approved a motion authorizing the submittal of the flood study to FEMA. The flood mapping study was submitted in August 2007 and is anticipated to be adopted late 2011. If the revised mapping is officially adopted by FEMA, there will be 700 structures (with a total of approximately 1,200 dwelling units) in the 100-year floodplain. Currently, there are approximately 460 structures (with approximately 500 total dwelling units) in the 100-year floodplain. Most structures within the existing regulatory mapping are also affected under the new study results; therefore, approximately 240 additional structures (with approximately 700 total dwelling units) will be impacted. The majority of these structures are located within existing developed areas of the city within the West Valley area. A Risk Assessment completed in June 2009 estimated a 100-year event would result in $215 million in property damages.

The 2008 City of Boulder Multi-Hazard Mitigation Plan stated the need to prepare a master plan to evaluate flood mitigation alternatives for SBC as a high priority. The South Boulder Creek Flood Mitigation Planning Study began in early 2010 and is being funded by the city and the UD&FCD. A consulting team from CH2MHill was selected to perform the study. The study is focused on developing and evaluating alternatives designed to mitigate flood hazards affecting structures and areas within the current incorporated city limits, primarily within the West Valley area. A short list of project alternatives has been refined and an engineering recommendation made. The plan and recommended alternative will be presented to the public, city boards and City Council in late 2012 and early 2013.

Bear Canyon Creek

Significant flood mitigation improvements to Bear Canyon Creek have been implemented since 1989, including the following:

- Underpass and trail connections to CU main campus, Apache Trail, and Williams Village (1991)
- Trail reconstruction from Wellman Canal to Mohawk Drive (1992)
- Two underpasses, riparian habitat widening and restoration, wetland creation, landscaping, and trail reconstruction from Mohawk Drive to Gilpin Avenue (1993)
- Floodway improvements, two underpasses, and trail connections between Martin Drive and Moorhead (1994)
- Mohawk underpass and flood capacity improvements (1995)
- Gilpin underpass and flood control improvements (1997)
- Replacement of Broadway underpass, reconstruction of Anderson ditch crossing, and channel improvements (1999)
- Martin Park channel improvements to contain 100-year flows and storm sewer improvements including water quality pond construction (1999)

Anticipated future projects include the following:

- Table Mesa Drive box culvert and separated grade crossing
- Foothills Parkway to Arapahoe drainageway and greenway improvements

Skunk Creek

The following projects were completed in the Skunk Creek drainage since 1989:

- The University of Colorado completed Skunk Creek stream channel reconstruction, flood control improvements, wetland and pond creation, water quality improvements, and trail construction from Foothills Parkway to Colorado Avenue in conjunction with the development of the CU Research Park (1991)
- Trail construction and wetlands creation from Colorado Avenue to Wellman Canal (1992)
- Underpasses beneath Baseline, U.S. Highway 36, and the U.S. Highway 36 on-ramp at Baseline (1995/1996)
- Developer constructed improvements from Colorado Avenue to Wellman Canal, including channel improvements, drop structure, and wetland creation (1996)
- Broadway pedestrian underpass increased channel capacity to 100-yr event and integrated a greenways trail segment. (2000)
- 27th Way pedestrian underpass increased channel capacity to 100-yr event and integrated a greenways trail segment. (2006)

Flood mitigation and property acquisition was considered in the community and environmental assessment process for the segment of Skunk Creek between Broadway and U.S. Highway 36, which was approved in 2001. However, flood mitigation work or property acquisition was not selected for implementation at the time. The city is currently conducting a remapping study of Skunk Creek. Completion of the study is anticipated in 2013.

Bluebell Canyon Creek/King's Gulch

No flood mitigation improvements or property acquisition along Bluebell Canyon Creek/King's Gulch have been initiated or planned.

Gregory Canyon Creek

Several flood mitigation improvements to Gregory Canyon Creek have been implemented since 1989, including the following:

- Construction of box culverts under Willowbrook Road (1996)
- Construction of rock drop structures in the creek bottom between University Avenue and Pleasant Street (1995)
- Replacement of an existing culvert crossing under Pleasant Street (1995)
- Reconstruction of a rock wall upstream of Pleasant Street (1995)

- Inlet improvements to the existing culvert under 7th Street (1995)
- Construction of rock drop structures between 7th Street and Pennsylvania Avenue (1995)
- Replacement of an existing culvert under Aurora Avenue and construction of associated rock drop structures, rock walls, and erosion protection upstream and downstream of Aurora Avenue (1995)

Additional property acquisition is planned along Gregory Canyon Creek as identified in the High Hazard Zone Property Acquisition Analysis (originally completed by Love & Associates in 1997and updated by city staff in 2009). The city has purchased a high hazard residential structure located at 810 Marine St. in 2012. The demolition is anticipated to occur in late 2012. There is also the potential for additional flood mitigation work along this drainageway. The city commissioned two mini master plans to evaluate feasibility of mitigation measures along Gregory Canyon in 2010 and 2012. No feasible mitigation measures were identified other than opportunistically acquiring properties located in the high hazard zone.

Dry Creek

Flood mitigation improvements to Dry Creek, including the following, were implemented as part of the 55th Street roadway improvement project:

- Separating the crossing at the Wellman Canal
- Drainageway improvements upstream of the Wellman Canal to approximately Euclid Avenue
- Replacing a railroad bridge over the Dry Creek channel to meet 100-year flood carrying capacity (1998)

Additional flood mitigation measures are proposed in conjunction with the South Boulder Creek Flood Mitigation Plan recommended alternative.

Sunshine Canyon Creek

No flood mitigation improvements or property acquisition along Sunshine Canyon Creek have been initiated or planned.

Goose Creek

The following Phase II flood mitigation improvements for Goose Creek between Foothills Parkway and 30th Street were completed in 1995:

- Property acquisition
- Separated crossing of the Boulder and Left Hand and North Boulder Farmer’s ditches
- Foothills Parkway to 30th Street channel and greenway improvements
- Box culvert and separated grade crossing at the Burlington and Santa Fe Railway
- Box culvert and separated grade crossing at 30th Street

Phase III flood mitigation improvements for Goose Creek between just west of 30th Street and just downstream of the Boulder White Rocks ditch were completed in 2002. This project included the following:

- Significant property acquisition
- Separated crossing of 28th Street
- 100-year channel and greenway improvements between just west of 30th Street to just downstream of the Boulder White Rocks ditch

Previously, no drainageway existed between downstream of the Boulder White Rocks ditch and 30th Street. The project created a drainageway through this area that removed numerous properties from the 100-year floodplain. The project also added a critical non-auto connection between the central area subcommunity and East Boulder, providing access to a major employment center, the Boulder Creek trail system, and what will eventually be the city's largest park. Several properties were acquired as part of the Phase III project:

- For the area between just west of 30th Street to 28th Street, the entire Fowler property was acquired under eminent domain proceedings. A portion of the Crouch and City Electric properties were also acquired based on a negotiated agreement.
- The Branding Iron Mobile Home Park was acquired under eminent domain proceedings, and a 1992 settlement agreement stipulated that the city complete the flood mitigation project on the west half of the mobile home park by December 31, 2000. A subsequent agreement extended this date, and the completion of the Phase III work fulfilled this requirement.
- For the area west of 28th Street, the Tebo/Chaknova property was acquired along with portions of the Chey Thuy and Credit Union properties.

The Goose Creek Phase IV project involves the area located within the Mapleton Mobile Home Park west to Folsom Avenue. The Phase IV project will include 100-year channel and greenway improvements through the mobile home park and separated crossing of the Boulder and White Rocks ditch.

To facilitate this project, the city purchased the Mapleton Mobile Home Park in 1998. The Phase IV project was completed in 2005. Other property acquisition along Goose Creek since 1989 includes a single-family residence at 1650 Alpine Street.

The city has contracted with ICON Engineering to develop updated floodplain maps for Upper Goose Creek and Twomile Canyon Creek. Hydraulic modeling of the project area is in progress. Draft revised floodplain mapping is anticipated to be available in fall 2012. Submittal to FEMA for review and approval is expected in early 2013. There is the potential for flood mitigation work upstream of Folsom Street following the remapping study.

Elmer's Twomile Creek

In 1994, the city identified the reach of Elmer's Twomile Creek behind the Willowbrook Townhomes just south of Glenwood Avenue for channel improvements to increase channel capacity, reduce perpetual maintenance activities, create wetland areas, and alleviate a persistent mosquito problem due to stagnant water in the channel. The city solicited the assistance of the UDFCD's Maintenance Program to complete this work in 1994. The work involved the cleaning and widening of the creek channel bottom, lining of one side of the channel with large boulders, installing river rock (cobbles) in the channel bottom, constructing a couple of rock drop structures, armoring banks around bends, and establishing some wetland areas just upstream of the improvements.

Greenway improvements between Goose Creek and Glenwood were completed in 2010. The project included separation of the creek from the Boulder and White Rock Ditch, channel improvements, a grade-separated crossing of Valmont Road, water quality improvements and extension of the multi-use path.

The Elmer's Twomile Creek Letter of Map Revision reflecting the project improvements was accepted by the Federal Emergency Management Agency (FEMA) and went into effect on September 7, 2011. The new mapping updates and replaces both the FEMA Flood Insurance Rate Map (FIRM) and the City of Boulder floodplain map.

Twomile Canyon Creek

The city has contracted with ICON Engineering to develop updated floodplain maps for Upper Goose Creek and Twomile Canyon Creek. Hydraulic modeling of the project area is in progress. Draft revised floodplain mapping is anticipated to be available in summer 2012. Submittal to FEMA for review and approval is expected in early 2013. It is anticipated that a mitigation planning study will be completed following the remapping study.

Wonderland Creek

Flood mitigation improvements along Wonderland Creek since 1989 include:

- A box culvert with trail underpass at Broadway and drainageway improvements from 47th Street to Valmont
- A box culvert capable of passing the 100-year flood under Valmont Road was completed in 1992
- Construction of a 100-year capacity channel and multi-use path extension between Valmont Road and North Goose Creek

The city initiated a flood mapping study and flood mitigation master planning effort for both Wonderland Creek and Fourmile Canyon Creek in 2006. A letter of map revision for these two streams was approved by FEMA in November 2006, and the new floodplains became regulatory

in late March 2007. The studies identified a previously unrecognized spill from Fourmile Canyon Creek to Wonderland Creek during storms that exceed the 50-year event. The spill begins near North Broadway and effectively doubles the 100-year flow in the downstream reaches of Wonderland Creek. The public process resulted in revisions to the study recommendations for a number of the stream reaches. City Council accepted a recommended flood mitigation plan for Wonderland Creek in November 2009. City staff documented the accepted recommendations in a final plan in 2011. The recommended improvements accepted by City Council in 2009 would greatly reduce the flood risk to numerous existing structures located along Wonderland Creek.

A Community Environmental Assessment Process (CEAP) Report was completed in 2010 that evaluated proposed flood mitigation improvements along Wonderland Creek from Foothills Parkway to 30th Street. This segment of Wonderland Creek has an extensive floodplain that includes numerous structures. It is anticipated that final design of the CEAP recommendations will be completed in 2013 with construction beginning in 2014. The city will develop a CEAP for the next upstream reach from the Diagonal Highway to Winding Trail in late 2012. The city has received federal funding for both of these stream reaches. The city with financial assistance from UDFCD purchased and deconstructed a single family structure located in the High Hazard flood zone in 2010 (3115 Iris Avenue).

Fourmile Canyon Creek

Flood mitigation improvements along Fourmile Canyon Creek have included the following:

- Box culvert and separated grade crossing at Broadway (1995)
- Channel improvements and trail construction from Yellow Pine to Broadway (1998)
- Drainageway improvements associated with the Pleasant View Soccer Complex
- Acquired single-family residences at 1800 Violet and 2446 Sumac.

In 2006 the city initiated a flood mapping and mitigation study for Fourmile Canyon Creek and Wonderland Creek. A letter of map revision for these two streams was approved by FEMA in November 2006, and the new floodplains became regulatory in late March 2007. The studies identified a previously unrecognized spill from Fourmile Canyon Creek to Wonderland Creek during storms that exceed the 50-year event. The spill begins near North Broadway and effectively doubles the 100-year flow in the downstream reaches of Wonderland Creek. The public process resulted in revisions to the study recommendations for a number of the stream reaches. City staff documented the accepted recommendations in a final plan in 2011. During a 100-year storm event, flooding would prohibit safe vehicular access to Crest View Elementary School. In 2009, City Council stated the importance of mitigating flood conditions to allow safe vehicular access.

To accomplish this, channel improvements will be required at the crossings of Violet Avenue, Upland Avenue and 19th Streets along Fourmile Canyon Creek and at 19th Street along Wonderland Creek. Funding is shown in the Greenways and Flood Utilities 2013-2018 CIP for

flood mitigation, a multi-use path connection and environmental restoration. The initial proposed project is for flood mitigation at 19th Street and Fourmile Canyon Creek. The city has completed a Community and Environmental Assessment Process (CEAP) to evaluate the social and environmental impacts of potential pedestrian, bicycle and vehicular access improvements for the area bound by 19th Street on the west, Upland Avenue on the north, 22nd Street on the east and Riverside Avenue on the south. The recommended flood improvement alternative is to replace the existing bridge at Fourmile Canyon Creek and 19th Street with box culverts sized to convey 100-year event flows. One of the box culverts would be used as a pedestrian and bicycle underpass. Final design is anticipated in 2013 with construction in 2014.

In fall of 2010 approximately 6,200 acres of land located west of the city burned. Approximately 20 percent of this area, known as the Fourmile Fire, is tributary to Fourmile Canyon Creek. Risk of flash flooding from the burn area will be elevated for the next 2-5 years. As a result, the UDFCD cleared debris and vegetation along Fourmile Canyon Creek upstream of Broadway in 2012. A new automated stream and rainfall gage was also installed in the tributary burn area in 2012.

Other improvements along Fourmile Canyon Creek include a private development located just east of Broadway. The project included channel improvements from Broadway to Violet Avenue and was completed in 2012 with partial city funding.

Viele Channel

Additional flood mitigation measures are proposed in conjunction with the South Boulder Creek Flood Mitigation Plan recommended alternative.

Stream, Wetland and Waterbody Protection Program

In February 1992, City Council adopted the following goal: “protect all wetlands in the Boulder Valley.” This goal aims to ensure no net loss of wetland acreage or function. Since the city does not have the ability to protect all wetlands outside the city limits, at a minimum, significant wetlands outside the city and inside the Boulder Valley should be protected. The City of Boulder will be held to the standard of no net loss on city lands and for city projects both inside and outside the city limits. A wetland protection ordinance that requires a permit for certain activities in and around wetlands went into effect in 1993. This ordinance was revised in 2009. The implementation techniques listed below all contribute to the no net loss goal of the wetlands protection program:

- A local wetland permitting program
- Negotiated agreements with other governmental entities to protect wetlands
- Acquisition of significant wetlands
- Public education and technical assistance to encourage property owners to preserve, enhance, and restore wetlands through voluntary compliance

- Preservation, restoration, and enhancement of wetlands in conjunction with the development and maintenance of capital facilities
- Preservation, restoration, and enhancement of wetlands on city-owned or city-managed land.

4.4.5 Wildfire Mitigation Capabilities

Fire–Rescue Master Plan

The Fire–Rescue Master Plan, recently revised and adopted in June, 2012, was developed to enhance the overall Fire–Rescue Program. The master plan was created through the cooperative efforts of Fire–Rescue Department members, staff from other city departments, and officials from emergency response agencies with which the department works. The Master Plan Committee identified several issues concerning service delivery, developed program goals and objectives, and identified recommendations to enhance the program.

Fire Training Center Relocation and Improvements

The Fire Department utilizes the Boulder Regional Fire Training Center, located on approximately ten acres of land east of the Boulder Reservoir, for much of its training activities. Opened in July, 2010, under a cooperative agreement between the city and Boulder County, the center is operated today under an intergovernmental agreement between the city and the county. The site includes a 15,800-square-foot classroom/administration building, a training tower and a burn building. Specific features are designated for extrication training, propane fire scenarios, attic and garage fire simulations, rappelling practice, and a burn building that allows firefighters to experience actual fires that burn more cleanly and with less pollution than in older facilities. The center will give crews throughout Boulder County hands-on, realistic opportunities to train for emergencies close to the communities they serve. The facility is available to over 20 fire departments in Boulder County, enhancing their ability to respond effectively and safely.

A new wildland fire facility is being developed at the Fire Training Center site with 2011 capital investment bond funds. It is anticipated that the new wildland facility will be completed by 2015.

City of Boulder Wildland Urban Interface Community Wildfire Protection Plan

The 2008 City of Boulder Community Wildfire Protection Plan (CWPP) is the result of a communitywide fire protection planning effort that included extensive field data gathering, compilation of existing fire suppression documents, a scientific analysis of the fire behavior potential of the study area, and collaboration with a variety of participants: homeowners, city officials, and the Colorado State Forest Service. A risk assessment estimated the risks and hazards associated with wildland fire in proximity to communities. In conjunction with values at risk, the assessment results were used to define areas of concern to assist with the prioritization of mitigation efforts. The plan offers solutions and mitigation recommendations to aid homeowners, land managers, and other interested parties in developing short- and long-term

fuels and fire management plans. This project meets the requirements of the federal Healthy Forests Restoration Act (HFRA) of 2003 for community fire planning.

Boulder County Wildfire Mitigation Group

In the aftermath of the Black Tiger fire in 1989, which burned 44 homes and blackened over 2,000 acres of forested land in the western part of the County, just five miles from the City of Boulder, the Boulder County Wildfire Mitigation Group evolved. This group is headed by the Wildfire Mitigation Coordinator and consists of members from the County Land Use and Sheriff departments, the County's fire protection districts, the Colorado State Forest Service, the City of Boulder Fire–Rescue Department, the U.S. Forest Service, National Park Service, American Red Cross, representatives from the insurance, real estate and forest industry and private citizens. The group's mission is to discuss and coordinate actions that could help minimize loss of life and property from future wildfires. As part of their efforts, the GIS-based Wildfire Hazard Identification and Mitigation System (WHIMS) was developed to assess wildfire hazard using a hazard-rating model based upon wildfire behavior models and the expertise of wildfire behavior specialists.

City of Boulder Structure Protection Plan 2012

In 2012 the City of Boulder adopted the Structure Protection Plan. This document assists in the development of objectives, strategies, and tactics in protecting structures in—and immediately adjacent to—the municipal boundary of Boulder and provides guidance on ordering and placement of structure protection resources. It provides information graphically in order to provide information as quickly and methodically as possible with as little reading as possible. One of its key features is its modular design which facilitates the use of portions of the plan based on the fire location.

The plan divides the City of Boulder's wildland/urban interface into four zones: South, South Central, North Central, and North. These zones are based on topographic features and major road locations. The central dividing line is Boulder Canyon with two zones to the north and two to the south. Each zone contains three to four units. Within each unit, one to three tactical areas are defined with task assignments and resources required to accomplish those tasks.

The document is organized into sections based on four levels of resolution:

- **City-wide**: City-wide maps provide a broad overview of wildland/urban interface areas.
- **Zones:** Zone maps show the relationship of planning units to one another.
- **Units:** Planning unit maps provide depictions of structures, defensible features, and supervision.
- **Tactical:** Tactical maps provide detailed views of structures, defensible features, water sources, work assignments, suggested resources, and placement.

4.4.6 Multi-Hazard Mitigation Capabilities

Emergency Operations Plan Boulder County–City of Boulder

The Boulder Emergency Operations Plan (Boulder EOP) describes the structure and guidelines for managing a major emergency or disaster affecting Boulder. This plan is part of a larger system of inter-related plans at the local, state and federal levels. They are founded upon the National Response Framework (NRF) and the principles of the National Incident Management System (NIMS). The inter-related nature of the plans and incident management are designed to allow maximum coordination and cooperation between responders from all levels of government.

The EOP is designed in segments. The core document or Basic Plan (sometimes also referred to as the Basic Emergency Operations Plan - BEOP) describes the overall structure, assignment of responsibilities and general guidance for the overall emergency management program. The program includes activities related to mitigating the threat(s), preparing for the inevitable incident, response and recovery from an incident. The ESF Annexes contain the primary details of the Emergency Operations Plan. These annexes are function-specific guidelines for the coordination and the delivery of specific services. These annexes are developed by the affected organizations, and are to include agreements on policies and procedures for responding to specific requests. Each ESF Annex may also include a number of attachments, such as reference documents, resource lists, checklists and contact information for personnel. The EOC Support Annexes are specific guidelines for operating the EOC and the primary management positions within the EOC structure. These annexes include the EOC Operations Manual, the Policy Group Manual, the Planning Section Manual and the Logistics Section Manual.

Large Scale Incident Plan and Hazard-Specific Operational Support Annexes

The intent of the Large-Scale Incident Plan is to provide a common operational framework for initial response to an incident where multiple agencies and/or disciplines are involved. The Hazard-specific operational annexes provide field reference and resource material, and provide a scalable response framework appropriate to specific hazards. These annexes are currently being updated, and include the following hazards: Avalanche, Civil Unrest, Dam Failure, Explosion, Flood, Hazardous Materials Incident, Landslide, Pandemic Flu, Passenger Airliner Crash, Severe Winter Weather, Tornado, Train Incident, West Nile Virus, Wildland Fire, Windstorm, Subsidence, Drought, Earthquake, Extreme Temperatures, Severe Weather (lightning/hailstorm).

Boulder County Incident Management Team

This is an All Hazards Type 3 Incident Management Team (IMT) comprised of city employees, county employees, volunteer firefighters, and other private citizens. IMTs are "typed" according to the complexity of incidents they are capable of managing and are part of an incident command system. An IMT will provide the command and control infrastructure that is required to manage the logistical, fiscal, planning, operational, safety and community issues related to the

incident/emergency. There are 5 types of IMTs, with Types 3-5 designated for standing teams at the local level. They manage incidents that extend into multiple operational periods and require a written Incident Action Plan (IAP). These incidents can include weather-related disasters such as a tornado, earthquake, or flood; a joint law enforcement operation; public health emergency; or a planned exercise or event. A Type 3 IMT may initially manage more complex incidents that later transition to a National Level IMT (Type 2 or Type 1). Its mission is to provide a qualified Type-3 Incident Management Team (IMT) as a mutual aid resource to fire departments and other entities in Boulder County for wildfires, emergency incidents and planned events of significance.

Boulder County Warning Systems

The city and County of Boulder have numerous types of warning systems in place to alert residents of potential and imminent danger from natural and manmade hazards. These systems are discussed below.

Emergency Outdoor Warning Sirens

The siren system is an all-hazard warning system used to alert citizens who are outdoors to potential danger. More than thirty outdoor warning sirens are in place across Boulder County. The sirens are located in Boulder, Longmont, Lafayette, Lyons, Eldorado Springs, Jamestown, Superior, Erie and the University of Colorado at Boulder. The sirens will broadcast a voice message immediately following the siren signal to inform the public of the situation and what actions should be taken.

The outdoor warning sirens are sounded only in the event of an emergency or during pre-announced tests. The sirens are activated through the Boulder County Sheriff's Communications and Boulder Police and Fire Communications centers. During an actual emergency, the sirens will sound for five minutes. During a test, they will sound for two minutes. The same signal is used whether the emergency is a flood, tornado or other disaster. While the sirens have "voice over" capabilities, citizens are encouraged to tune to a local TV or radio station for further information when the sirens are sounded.

CU Lightning Detection and Warning System

The University of Colorado Boulder (CU) campus has a lightning warning system that detects the presence of electromagnetic fields that trigger lightning. The system does not need storms or strikes in the area to predict lightning and can predict first and "out of the blue" strikes. If lightning is predicted, the system will sound an alarm for about 30 seconds and activate a strobe light that will remain active until danger has passed. Once the siren blast stops, the light will continue to flash to indicate that unsafe conditions still exist. Once conditions improve, the all clear signal sounds. This consists of 3 shorter blasts of the siren and then the light will stop flashing (this cycle will repeat if conditions change again). Signage regarding the operation of the device is posted at each station. The six stations include Student Recreation Center, Williams Village Fields, Business Field, Kittredge Fields, Farrand Field and Franklin Field

(operated as a strobe-only device; the light will begin to flash to indicate dangerous conditions exist and the light will cease to flash when conditions improve).

Emergency Warning and Evacuation System

The existing 911 database of telephone numbers and addresses is used in combination with detailed maps to help determine the geographic boundaries of an impacted area. The system is capable of making up to 1,200 calls per minute. It is designed to deliver recorded information to endangered people in advance of a disaster. Messages can be delivered in various languages. They can also be sent to pagers, cell phones and the Emergency Alert System.

Emergency Alert System

In January of 1997, the Federal Communications Commission (FCC) replaced the Emergency Broadcast System (EBS) with the Emergency Alert System (EAS). This digital system works with both new and established communications technologies, including satellite, broadcast, and cable systems. The EAS helps to make the disaster warning system more effective by emphasizing speed, reliability, and efficiency. It is designed to reduce property damage, injuries, and deaths resulting from natural and manmade disasters. There are eight Boulder County EAS stations according to the Denver Metro–Local Area 3 plan. The EAS can be activated locally by the emergency management director, Boulder County sheriff, and the manager of the Boulder Police and Fire Communications Center and Boulder County Sheriff's Communications Center.

NOAA Weather Radio All Hazards

NOAA Weather Radio All Hazards is a service of the National Oceanic and Atmospheric Administration (NOAA). It provides continuous broadcasts of the weather information directly from National Weather Service offices. Weather messages are repeated every four to six minutes and are routinely revised every two to three hours, or more frequently if needed. The broadcasts are tailored to weather information needs of people within the receiving area. During severe weather, National Weather Service forecasters can interrupt the routine weather broadcasts and substitute special advisory, watch and warning messages. Special weather radio receivers are available for purchase at local electronics stores. Although NOAA classifies coverage in Boulder as reliable, the signal may not be received in all canyon areas. The National Weather Service also emails messages to Boulder officials during severe events.

Metropolitan Emergency Telephone System

The Metropolitan Emergency Telephone System (METS) is a specially designed telephone system for alerting law enforcement, other response agencies, and Denver media of emergency situations. METS is available in the Boulder Police and Fire Communications Center, and is sometimes used to receive information about emergency events around the Denver metro area. The Boulder Police and Fire Communications Center has the ability to instantly notify all Denver

media of any life-threatening situations in Boulder County that can be immediately broadcast on all Denver radio and television stations, but this system is used infrequently.

National Warning System

The National Warning System consists of private line voice circuits. The detection systems of the North American Air Defense Command (NORAD), and other sources, provide the information from which NORAD commanders determine the probability or imminence of attack. At the present time, it is used mostly by the National Weather Service in Denver to disseminate weather-related warnings to warning points in Colorado.

Preparedness Checklists

The City of Boulder OEM website provides an emergency preparedness guide available for download, which has information for the public on planning and preparing for unexpected disasters and emergencies along with helpful checklists.

Drought Management

Source Water Master Plan

The city obtains its water from the Boulder Creek basin and from the western slope though the Colorado-Big Thompson and Windy Gap projects. Flows in the watershed basins supplying each source are highly variable from year to year. Because of this, the amount of water derived from each of Boulder's water sources and delivered into the municipal system also varies. These water rights are described in more detailed below.

- **Boulder Creek Basin Water Rights**—The city's water rights in the Boulder Creek basin include direct use and storage rights on Boulder Creek, Middle Boulder Creek and North Boulder Creek. Exchange rights allow the city to release water into Boulder Creek near 75th Street from Boulder and Baseline Reservoirs in exchange for increased diversion at the city's direct use and storage points on Middle and North Boulder Creeks. Most of the city's water rights are absolute. The city also has several conditional rights that are being developed for future use.
- **The Colorado-Big Thompson (CBT) Project**—Boulder receives western slope water at Boulder Reservoir from the CBT Project facilities. The city utilities own 21,015 CBT units out of a total of 310,000 units in the project. At present, CBT deliveries to Boulder can only be made from April through October of each year due to winter operating limitations on canals. Boulder uses CBT water for direct treatment at the Boulder Reservoir Water Treatment Plant, either diverted directly from the Boulder Feeder Canal or pumped out of Boulder Reservoir, and as a source of exchange water to increase water deliveries to the Betasso Water Treatment Plant and to meet some of its contractual delivery obligations to the Silver Lake Ditch.

- **The Windy Gap Project**—The Windy Gap Project delivers western slope water to municipal and industrial water users on the eastern slope through CBT facilities. The city has an allotment contract for 37 units out of a total of 480 units in the project. These units, when used in conjunction with storage space in Boulder and Barker Reservoirs and "borrowing" of CBT water, can deliver up to 3,700 acre-feet per year. Unlike much of the rest of Boulder's water, the Windy Gap water is fully consumable, meaning that the return flows (wastewater effluent and lawn watering return flow) from this source can be reused either for exchange back into Boulder's water system, for augmentation and replacement purposes, or for leasing to other downstream users.

Boulder's water supply system also includes many storage, conveyance, hydroelectric, and treatment facilities. The city owns approximately 7,200 acre-feet of reservoir storage in the North Boulder Creek watershed and 11,686 acre-feet of storage in Barker Reservoir on Middle Boulder Creek. Boulder also controls 8,500 acre-feet of storage in Boulder Reservoir. Boulder's two water treatment facilities are the Betasso plant, with approximately 45 million gallons per day of treatment capacity and the Boulder Reservoir plant at 16 million gallons per day. The city operates eight hydroelectric plants within the municipal water supply system. Four of these plants are located on raw water pipelines, and four are on treated water transmission pipelines. Electricity generated at these plants is sold to Xcel Energy.

Water provided by the city serves a variety of purposes ranging from those uses that require an assured supply, such as drinking water and firefighting, to those uses that can tolerate occasional restrictions, such as lawn irrigation and car washing. It is recognized that no municipal water supply can ever be 100 percent reliable against all risk factors and that the economic and environmental opportunity costs of reducing the risks of occasional water shortages are significant. The reliability standards for the city's municipal water supply that were adopted by City Council in 1989 are:

- For those water uses deemed essential to the maintenance of basic public health, safety, and welfare, such as indoor domestic, commercial, industrial uses, and firefighting uses, the city will make every effort to ensure reliability of supply against droughts with occurrence intervals of up to 1,000 years.
- For the increment of water use needed to provide continued viability of outdoor lawns and gardens, the city will make every effort to ensure reliability of supply against droughts with occurrence intervals of up to 100 years.
- For the increment of water needed to fully satisfy all municipal water needs, the city will make every effort to ensure reliability of supply against droughts with occurrence intervals of up to 20 years.

The Source Water Master Plan anticipates that the city will maintain a diversity of water supply sources (both eastern and western slope sources) to hedge against droughts and increase water supply reliability. In addition, the master plan identifies multiple-purpose uses for the city's municipal raw water supplies. In addition to municipal uses, the city's raw water supply has been

used for maintaining streamflow and enhancing stream habitat in Boulder Creek and its tributaries and for leasing to downstream agricultural and recreational users.

Based on extensive modeling of the city's municipal water system and its water supply basins, it is believed that, assuming a continuation of historical hydrologic conditions and absent curtailment of Boulder's Colorado-Big Thompson (CBT) and Windy Gap project yields due to a Colorado River Compact Call, the city has sufficient raw water supply holdings to meet its reliability criteria while serving the projected water needs associated with expected development levels within the city's water service boundaries based on the current BVCP planning area. Future water needs were evaluated in the Raw Water Master Plan in 1989. The city's water demand forecasts have been updated several times since then based on more recent demographic and land use forecasts provided by the city's Planning and Development Services and changes in water use factors due to water conservation practices.

The reliability of Boulder's water supply system was most recently assessed as part of a study of the potential consequences of climate change on Boulder's water supply system, which combined paleohydrology with climate change projections to provide a robust statistical evaluation of the city's water supply system. Modeling in that study showed that the city's existing water supply system (including its present water rights portfolio) would be able to provide sufficient water to meet the city's reliability criteria at full buildout of the city's water supply service area in 12 of the 18 alternative climate change scenarios evaluated in that study. In the most severe scenario examined (which combined the greatest projected level of greenhouse gas emissions with a "dry" global climate model at 2070 conditions), voluntary use reductions or moderate use restrictions would be necessary in 8% to 16% of the years due to reduced supplies during drought. Severe use restrictions would be required in only two years out of 439 years when drought conditions would reduce water yields significantly. In only one year out of 439 years did water yields drop below the level of meeting essential indoor needs. A major caveat for this study was that the modeling assumed that there would be no curtailment of Boulder's CBT and Windy Gap project yields due to a Colorado River Compact Call

The recently completed Source Water Master Plan has recommended an array of capital improvements and additional management studies of the of the city's water supply system.

With respect to the water distribution system, loss prevention capabilities include:

- Redundant pipelines, treatment facilities, storage tanks and pumping equipment to assure delivery of water based on a number of vulnerability scenarios.
- Facilities have been designed and constructed to resist the affects of ground movement, wildfire and in some cases floods.
- Redundant telecommunications facilities are available for system control purposes.

Wastewater Utility Master Plan

The Wastewater Utility Master Plan (WWUMP) is the overarching planning document that is intended to present key issues, programs, projects and associated budgets for the collection system, wastewater treatment plant and water quality programs. The WWUMP is supported by three primary planning documents for the Wastewater Utility: the Wastewater Collection System Master Plan (WWCSMP), the Wastewater Treatment Plant Master Plan (WWTPMP), and the Water Quality Strategic Plan (WQSP). Boulder's wastewater collection system and the 75th Street WWTP serve residences and businesses within the 26 square-mile Wastewater Utility Service Area (WUSA). Boulder's collection system currently serves a population of approximately 110,000 people and 101,000 employees associated with commercial and industrial business.

Loss prevention elements include:

- Wastewater treatment facility (WWTF) is protected by a flood levee designed with 3 feet of freeboard above the 100-year water surface elevation.
- Interceptor sewers have been encased in concrete at major drainageway crossings.
- The WWTF has two power feeds in case one is interrupted by a natural hazard such as lightning or wildfire.

Information Technology Master Plan and Continuity of Operations Plan

Information Technology based communications and applications are critical to disaster response and recovery efforts. The city Department of Information Technology has a Master Plan and Continuity of Operations (COOP) Plan. The COOP plan has been integrated into the WebEOC program so it can be readily accessed and updated when needed. The city has also housed redundant servers at the OEM outside of the 100-year floodplain.

Boulder County Climate Change Adaptation Plan

In 2011 the City of Boulder jointly developed a climate change adaptation plan with Boulder County. The planning project systematically considered the effects of projected climate changes and identified opportunities for adaptive planning efforts to address the challenges and opportunities posed by changing climate conditions in Boulder County. The plan identifies the potential impacts of climate change and explored the implications of these changes on four key sectors: water resources, emergency management, public health, and agriculture and natural resources. The planning process was designed such that the Plan itself can work in concert with the City of Boulder’s and Boulder County’s existing plans, processes, programs, and policies that currently, or could potentially, address climate-related issues. For example, current capabilities include those of the Office of Emergency Management, stormwater and floodplain management programs, Community Rating System (CRS) participation, hazard mitigation and emergency operations plans, and programs to improve forest health. The Plan emphasizes the need for additional disaster management planning, including long-term recovery plans and debris

management plans. The plan also emphasizes the importance of the hazard mitigation plan and recommended incorporating climate change considerations into the hazard mitigation plan updates. By developing this plan through a collaborative process, the city has a better understanding of the impacts of climate change and how climate change may stress capabilities currently in place to manage flood and wildfire risk and other potential emergencies. The Plan is being finalized in the 2nd quarter of 2012 and will serve as a resource for County and municipal planners as they integrate climate change as an aspect of ongoing planning efforts with the intent to help the city and Boulder County be more resilient to impacts of climate change.

West Nile Virus Mosquito Management Plan

The City of Boulder adopted the West Nile Virus Mosquito Management Plan in 2006 (formerly the West Nile Virus Vector Control Plan) in response to the public health threat of the virus. Species of mosquitoes from the genus *Culex* are able to carry and potentially transmit the West Nile Virus to humans.

Beginning in June of each year and continuing through September a baseline monitoring plan is implemented and lands owned or managed by the city are surveyed to evaluate the presence of these species. Areas that will be routinely surveyed include all known potential mosquito habitat areas found on city-owned lands within the city limits and on city-owned lands outside of the city limits.

These breeding sites are regularly monitored throughout the mosquito season and if the species of mosquito larvae that can transmit West Nile virus are found, the site is immediately treated with a larvicide. Adult mosquitoes are also monitored with a grid of traps throughout the city and samples from sentinel traps are tested for the presence of West Nile Virus. Control efforts during the larval stage are the most cost-effective and efficient means to eliminate mosquitoes at their source and, therefore, to most effectively reduce the risk of human infection. Measures to control mosquito larvae consist of treatment of breeding habitats with a bacterium that attacks the larvae. Control of the larvae limits the possible future need for nonbiological control of adult target mosquitoes, such as pesticide fogging or spraying.

5 MITIGATION STRATEGY

Requirement §201.6(c)(3):

[The plan shall include] a mitigation strategy that provides the jurisdiction's blueprint for reducing the potential losses identified in the risk assessment, based on existing authorities, policies, programs and resources, and its ability to expand on and improve these existing tools.

This section describes the mitigation strategy process and mitigation action plan for the City of Boulder's Multi-Hazard Mitigation Plan. This section describes how the city accomplished Phase 3 of FEMA's 4-phase guidance-Develop the Mitigation Plan-and includes the following from the 10-step planning process:

- Planning Step 6: Set Goals
- Planning Step 7: Review Possible Activities
- Planning Step 8: Draft an Action Plan

5.1 Mitigation Strategy: Overview

The results of the planning process, the risk assessment, the goal setting, the identification of mitigation actions, and the hard work of the HMPC are captured in this mitigation strategy and mitigation action plan. As part of the 2012 plan update process, a comprehensive review and update of the mitigation strategy portion of the plan was conducted by the HMPC. Some of the initial goals and objectives from the 2008 plan were revisited, reaffirmed, and refined. The end result was an updated mitigation strategy that reflects the updated risk assessment, the completion of 2008 actions, and the new priorities of this plan update. To support the updated goals, the mitigation actions from 2008 were reviewed and assessed for their value in reducing risk and vulnerability to the planning area from identified hazards and evaluated for their inclusion in this plan update (See Section 5.4.1). Section 5.2 below identifies the current goals and objectives of this plan update and Section 5.4.2 details the updated mitigation action plan.

Taking all of the above into consideration, the HMPC developed the following umbrella mitigation strategy:

- **Communicate** the hazard information collected and analyzed through this planning process as well as HMPC success stories so that the community better understands what can happen where and what they themselves can do to be better prepared.
- **Implement** the action plan recommendations of this plan.
- **Use** existing rules, regulations, policies, and procedures already in existence.
- **Monitor** multi-objective management opportunities so that funding opportunities may be shared and packaged and broader constituent support may be garnered.

5.2 Goals and Objectives

Requirement §201.6(c)(3)(i):

[The hazard mitigation strategy shall include a] description of mitigation goals to reduce or avoid long-term vulnerabilities to the identified hazards.

Up to this point in the planning process, the Hazard Mitigation Planning Committee (HMPC) has organized resources, assessed natural hazards and risks, and documented mitigation capabilities. A profile of the City of Boulder's vulnerability to natural hazards resulted from this effort, which is documented in the preceding chapter. The resulting goals, objectives, and mitigation actions were developed based on this profile. The HMPC facilitated this aspect of the plan with a series of meetings and exercises designed to achieve a collaborative mitigation planning effort as described further in this section.

During HMPC meetings during the initial plan and 2012 update AMEC reviewed the results of the hazard identification, vulnerability assessment, and capability assessment. This analysis of the risk assessment identified areas where improvements could be made and provides the framework for the HMPC to formulate planning goals and objectives and the ultimate mitigation strategy for the City of Boulder.

Goals were defined for the purpose of this mitigation plan as broad-based public policy statements that:

- Represent basic desires of the community;
- Encompass all aspects of community, public and private;
- Are nonspecific, in that they refer to the quality (not the quantity) of the outcome;
- Are future-oriented, in that they are achievable in the future; and
- Are time-independent, in that they are not scheduled events.

Goals are stated without regard for implementation, that is, implementation cost, schedule, and means are not considered. Goals are defined before considering how to accomplish them so that the goals are not dependent on the means of achievement. Goal statements form the basis for objectives and actions that will be used as means to achieve the goals. Objectives define strategies to attain the goals and are more specific and measurable.

Team members were given the list of goals from the 2008 plan to consider. The HMPC was instructed that they could use, combine, or revise the statements they were provided or develop new ones on their own, keeping the risk assessment in mind. It was decided by the HMPC that the three previous goals were still legitimate, but some of the objectives needed revision. Planning goals remained the same, but the objectives were modified to better suit the 2012 plan update.

Based upon the risk assessment review and goal setting process, the HMPC developed the following goals with several objectives and associated mitigation measures. These goals and objectives provide the direction for reducing future hazard-related losses within the City of Boulder.

Goal 1: Increase Community Awareness of Boulder's Vulnerability to Natural Hazards

- Objective 1.1: Inform and educate the community about the types of hazards the City of Boulder is exposed to, where they occur, and recommended responses

Goal 2: Reduce Vulnerability of People, Property, and the Environment to Natural Hazards

- Objective 2.1: Provide mechanisms to enhance life safety
- Objective 2.2: Reduce impacts to critical facilities and services
- Objective 2.3: Reduce impacts to existing buildings and infrastructure to the extent possible
- Objective 2.4: Reduce impacts to future development and infrastructure to the extent possible
- Objective 2.5: Reduce impacts to the city's natural and historic resources
- Objective 2.6: Reduce impacts to public health

Goal 3: Increase Interagency Capabilities and Coordination to Reduce the Impacts of Natural Hazards

- Objective 3.1: Continue to collaborate and coordinate with other agencies on planning, projects, hazard response, and funding opportunities.

5.3 Identification and Analysis of Mitigation Actions

Requirement §201.6(c)(3)(ii): [The mitigation strategy shall include a] section that identifies and analyzes a comprehensive range of specific mitigation actions and projects being considered to reduce the effects of each hazard, with particular emphasis on new and existing buildings and infrastructure.

In order to identify and select mitigation measures to support the mitigation goals, each hazard identified in Section 4.1: Identifying Hazards was evaluated. Once it was determined which hazards warranted the development of specific mitigation measures, the HMPC analyzed a set of viable mitigation alternatives that would support identified goals and objectives. Each HMPC member was provided with the following list of categories of mitigation measures, which originate from the Community Rating System:

- Prevention
- Property Protection
- Structural Projects
- Natural Resource Protection
- Emergency Services
- Public Information

The HMPC members were also provided with several lists of alternative multi-hazard mitigation actions for each of the above categories (See Appendix C). A facilitated discussion then took place to examine and analyze the alternatives. With an understanding of the alternatives, a brainstorming session was conducted to generate a list of preferred mitigation actions.

5.3.1 Prioritization Process

Once the mitigation actions were identified, the HMPC was provided with several decision-making tools, including FEMA's recommended prioritization criteria, STAPLEE sustainable disaster recovery criteria; Smart Growth principles; and others, to assist in deciding why one recommended action might be more important, more effective, or more likely to be implemented than another. STAPLEE stands for the following:

- Social: Does the measure treat people fairly? (e.g., different groups, different generations)
- 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?

In accordance with the DMA requirements, an emphasis was placed on the importance of a benefit-cost analysis in determining action priority. Other criteria used to assist in evaluating the benefit-cost of a mitigation action 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)?
- What will the action cost?
- What is the timing of available funding?

The mitigation categories, multi-hazard actions, and criteria are included in Appendix C: Mitigation Categories, Alternatives, and Selection Criteria.

With these criteria in mind, team members were given a set of four red colored dots. The team was asked to use the dots to prioritize projects with the above criteria in mind. This process provided both consensus and priority for the recommendations.

The process of identification and analysis of mitigation alternatives allowed the HMPC to come to consensus and to prioritize recommended mitigation actions. During the voting process, emphasis was placed on the importance of a benefit-cost review in determining project priority; however, this was not a quantitative analysis. After completing the prioritization exercise, some team members expressed concern that prioritizing all the actions as a group is not very effective, since many of the actions are department-specific. However, the team agreed that prioritizing the actions collectively enabled the actions to be ranked in order of relative importance and helped steer the development of additional actions that meet the more important objectives while eliminating some of the actions which did not garner much support.

Benefit-cost was also considered in greater detail in the development of the Mitigation Action Plan detailed below in Section 5.4. Specifically, each action developed for this plan contains a description of the problem and proposed project, the entity with primary responsibility for implementation, any other alternatives considered, a cost estimate, expected project benefits, potential funding sources, and a schedule for implementation. Development of these project details for each action led to the determination of a High, Medium, or Low priority for each.

Recognizing the limitations in prioritizing actions from multiple jurisdictions and departments and the regulatory requirement to prioritize by benefit-cost to ensure cost-effectiveness, the HMPC decided to pursue: mitigation action strategy development and implementation according to the nature and extent of damages; the level of protection and benefits each action provides; political support; project cost; available funding; and individual jurisdiction and department priority.

This process drove the development of an updated, prioritized action plan for the City of Boulder. Cost-effectiveness will be considered in greater detail through performing benefit-cost project analyses when seeking FEMA mitigation grant funding for eligible actions associated with this plan.

5.4 Mitigation Action Plan

Requirement §201.6(c)(3)(iii): [The mitigation strategy section shall include] an action plan describing how the actions identified in section (c)(3)(ii) will be prioritized, implemented, and administered by the local jurisdiction. Prioritization shall include a special emphasis on the extent to which benefits are maximized according to a cost benefit review of the proposed projects and their associated costs.

This section outlines the development of the updated mitigation action plan. The action plan consists of the specific projects, or actions, designed to meet the plan's goals. Over time the implementation of these projects will be tracked as a measure of demonstrated progress on meeting the plan's goals.

5.4.1 Progress on Previous Mitigation Actions

During the 2012 update process the HMPC reviewed and evaluated the 2008 mitigation strategy to determine the status of the actions. The purpose of this was to measure progress by determining which actions were completed, and to revisit the remaining items to determine if they should be carried forward or removed from the plan. This effort built upon a previous progress review that occurred in the third quarter of 2010. The 2008 mitigation strategy contained 24 separate mitigation actions. Of these actions, five have been completed. Three of the actions were determined to be similar to, and merged with, other actions in the revised action plan. The actions that have been completed and those not carried forward in this plan are shown in Table 5.1. In general, the review shows that much progress has been made since the original plan was adopted in 2008. Implementation of the actions has resulted in greater community awareness of Boulder's vulnerability to natural hazards and reduced vulnerability for hazards such as flood. Several of these actions have increased the response capabilities of the city, and thus will help save lives in future incidents. These include the construction of a new Fire Training Center in 2010. Table 5.2 lists16 actions from the 2008 plan being carried forward, as well as 17 new mitigation actions. More detailed descriptions of those actions follow Table 5.2.

Other actions have seen much progress and are close to completion. One example is the "Develop a critical facilities floodplain ordinance" action. The ordinance has been drafted and following public process and council approval should be completed in 2013. The status of the actions being carried forward from the 2008 plan is included in the more detailed action descriptions that follow Table 5.2. Another example of progress on an ongoing action includes a high hazard zone property that was purchased and deconstructed in 2010 as part of the "Acquire Properties in the High Hazard Flood Zone" action item.

During the update and revision to the mitigation strategy the priority of the 2008 actions were revisited. Revised priorities are reflected in Table 5.2. An example of a change in priority level is the "Institute a Community Assisted Floodproofing Program" action. Originally ranked high, this action has been revised to low and revised to apply to critical facilities only.

Table 5.1. Completed or Revised Mitigation Actions from 2008 Plan

Hazard(s)	Action Description	Status	Comments/Progress
Flood	Designate a Safe Zone for Flood Evacuation for City of Boulder Parks and Recreation	Completed	Action Completed. Working with the Boulder OEM, the City of Boulder Parks and Recreation Department completed emergency action plans for each recreation facility and program in 2009. These plans were developed with the assistance and input from staff at each facility and program. In addition, program supervisory staff attended training on emergency preparedness and hazard awareness, and each facility and program created an emergency plan that can be used by staff to inform park users to shelter-in-place or evacuate (including signage and instructions). Each plan discusses the appropriate actions to take during a flood and identifies possible evacuation sites (high ground).
Flood	Implement Flood Forecasting and Warning Enhancements for Boulder Creek, South Boulder Creek, and Tributary Streams	Completed	The city developed a web-based Geographic Information System (GIS) flood preparedness tool in 2010. This tool can be accessed at any location, at any time via the web. Information includes GIS layer files required to evaluate flood situations along with real-time overlay of radar, stream gage and rain gage information. This tool, along with web accessible WEBEOC (Web-based emergency operations center) communications system, provides increased staff ability and responsiveness to provide information to decision makers during flood events.
Wildfire	Add a Permanent Wildland Fire Crew Supervisor Position	Completed	2 hired and working in 2012.
Wildfire	Construct New Fire Training Center	Completed	This action is complete and a new Boulder Fire Regional Training Center was opened on July 26, 2010. It was constructed on 10 acres of city-owned land located at 63rd Street and the Diagonal Highway. The site includes a 15,800-square-foot classroom/administration building, a training tower and a burn building. Specific features are designated for extrication training, propane fire scenarios, attic and garage fire simulations, rappelling practice, and a burn building that allows firefighters to experience actual fires that burn more cleanly and with less pollution than in older facilities. The center will give crews throughout Boulder County hands-on, realistic opportunities to train for emergencies close to the communities they serve. The facility is available to over 20 fire departments in Boulder County, enhancing their ability to respond effectively and safely.

Hazard(s)	Action Description	Status	Comments/Progress
Human Health Hazards	Conduct West Nile Virus/Mosquito Mitigation to Provide Safe Activities at Parks and Recreation Sites	Completed Also part of "Continue the City of Boulder West Nile Virus Mosquito Monitoring and Control Program" ongoing action	The city implemented a pilot nuisance mosquito control program beginning in 2007. The city's vector mosquito control program has been effective, and the risk of West Nile Virus has remained low in recent years. However, in the event of a public health emergency due to a West Nile Virus epidemic, the city has a contingency plan to apply pesticides to control adult mosquitoes. Large-scale spraying has never been necessary in Boulder's history. If spraying is deemed to be necessary (worst-case scenario) it will be done twice, three nights apart. Residents will be notified 48 hours in advance by 911 call back, ads in the newspapers, on the city's website and on Municipal Channel 8.
Flood	Construct a South Boulder Creek Regional Detention Plan	Revised – Combined with South Boulder Creek Action	Alternatives to mitigate flood risk in the West Valley are being considered in the South Boulder Creek Flood Mitigation study (Action 8) and include measures with and without regional detention. Regional detention being considered include a regional detention facility located on the University of Colorado South Campus area; a detention facility located just north of US 93 and a distributed regional detention system that includes a detention facility at US36, Arapahoe Road and Baseline Road. Final recommendations are anticipated in 2012.
Flood	Mitigate Flooding in Fourmile Canyon Creek	Revised – this and the next project have been combined into the "Implement Mitigation Plan for Fourmile Creek and Wonderland Creek" new action in 2012	Mitigation plan completed in 2011. Design in process for flood mitigation at 19th Street and Fourmile Canyon Creek.
Flood	Mitigate Flooding in Wonderland Creek	Revised– see previous	Mitigation plan completed in 2011. Design in process for flood mitigation along Wonderland Creek from Foothills to 30th Street, segment upstream past 28th Street in planning process.

5.4.2 Continued Compliance with NFIP

Given the flood hazard and risk in the planning area, and recognizing the importance of the NFIP in mitigating flood losses, an emphasis will be placed on continued compliance with the NFIP by the City of Boulder. As an NFIP and CRS participating community the city has and will continue to make every effort to remain in good standing with NFIP. This includes continuing to comply with the NFIP's standards for updating and adopting floodplain maps and maintaining and updating the floodplain zoning ordinance. There are several action items identified in Table 5.2 that address specifics related to NFIP continued compliance. Other details related to NFIP participation are discussed in the community capabilities in Section 4.4 of this plan and the flood vulnerability discussion in Section 4.3.

5.4.3 Updated Mitigation Action Plan

A summary of the action items is captured in Table 5.2, including a description of the action, priority, the year the action was first identified, the timeframe for implementation, what goals it the action is linked to, and the priority for the action. For each identified project a worksheet designed to capture additional details was filled out by the HMPC member or organization taking the lead on project implementation. These details include: project background, other alternatives considered, responsible entity, priority, cost, benefits (losses avoided), and potential funding. Actions that were identified in the 2008 plan and carried forward in this plan update also have a description of progress to date. As the city is largely built out, many of these mitigation actions are intended to reduce impacts to existing development. Actions that protect future development from hazards, as required per the DMA 2000 regulations, are addressed by the city's continued compliance with the NFIP and CRS as well as through implementation of the Boulder Revised Code, Boulder Valley Comprehensive Plan and building code enforcement. See the discussion in Section 4.4 related to these existing policies and regulations.

It is important to note that the City of Boulder has numerous existing, detailed project descriptions (including structural flood hazard mitigation projects) in other planning documents, such as the Comprehensive Flood and Stormwater Utility Master Plan, various basin flood mitigation (Phase A) master plans, and capital improvement budgets and reports. These projects are considered to be part of this plan, and the details, to avoid duplication, should be referenced in their original source document. Many of these studies include more detailed alternatives analysis and benefit-cost analyses. The city also realizes that new project needs and priorities may arise as a result of a disaster or other circumstances and reserves the right to support these projects, as necessary, as long as they conform to the overall goals of this plan.

Table 5.2. City of Boulder Mitigation Action Plan Summary

	City of Boulder Action**	Responsible Office	Schedule	Priority	Estimated Cost	Potential Funding	Link to Goals*
Multi-Hazard Actions							
1	Outreach efforts associated with BoCo911Alert.com	Boulder OEM	Next 1 – 2 years	High	TBD	TBD	1
2	Develop updated city continuity of operations and emergency evacuation plans	CMO / Department heads	By 2018	High	Staff time, $50k – 100k	Grants	1, 2, 3
3	Preplan prime evacuation points and shelter locations	Boulder OEM	By 2013	High	Staff time, $10,000	City and county funds	1, 2, 3
4	Prepare pre-disaster FEMA forms	Boulder OEM	2013	Low	Staff time	N/A	1, 2, 3
5	Develop Recovery Plan	Boulder OEM	2013	Low	Staff time	N/A	1, 2, 3
6	Become a 'StormReady' Community	Boulder OEM	By 2013	Low	Staff time	N/A	1, 2, 3
7	Increase web-based public outreach**	Boulder OEM / Public Works	Ongoing	High	Staff time	N/A	1, 2, 3
8	Enhance outdoor warning system**	Boulder OEM	Ongoing	Low	$25,000 per siren, $250,000 total	City funds	1, 2
9	Implement replacement planting program**	City Parks and Recreation	Pending funding	High	$60,000	City funds	2
10	Increase urban forestry canopy**	City Parks and Recreation	Ongoing	High	TBD	City funds	2
11	Implement automatic vehicle location system**	Boulder OEM	By 2018	High	$195,000	Grants, city funds	2, 3
12	Increase rotational pruning of street trees**	City Parks and Recreation	Pending funding	Low	$40,000	City funds	2
Flood Actions							
13	Enhance flood warning system on smaller tributaries	Public Works	By 2018	High	$25,000 per camera / rain gage	UDFC, grants, city funds	1, 2
14	Relocate fire station outside 100-year flood risk	FAM	Pending funding	Medium	$17 million	Grants, bonds, city funds	2
15	Prioritize flood hazards	Public Works	2015	High	$50k - $100k	UDFCD, city funds	2

	City of Boulder Action**	Responsible Office	Schedule	Priority	Estimated Cost	Potential Funding	Link to Goals*
16	Update the Comprehensive Flood and Stormwater Master Plan	Public Works	2015	High	$50k - $100k	UDFCD, city funds	2
17	Update flood preparedness web mapping site	Public Works	2013	High	Staff time, $10,000	City funds	1, 2
18	Develop flood mitigation plans following mapping updates	Public Works	ongoing	High	$100k - $150k	UDFCD, city funds	2
19	Implement mitigation plan for Fourmile Canyon Creek and Wonderland Creek	Public Works	Pending funding	High	$15.4 million total	UDFCD, city funds, grants	2
20	Update city's floodplain maps	Public Works	Keep 10 yrs current	Medium	$100k - $150 k per study	UDFCD, city funds	1, 2
21	Acquire High Hazard Zone properties**	Public Works	Opportunistic	Medium	Based on property value	UDFCD, city funds	2
22	Mitigate flooding in South Boulder Creek floodplain**	Public Works	Pending funding	High	$36 million	Grants, bonding, UDFCD, city funds	2
23	Develop a critical facilities floodplain ordinance**	Public Works	2013	High	Staff time	N/A	2
24	Implement a community assisted floodproofing program focusing on critical facilities**	Public Works	By 2018	Low	Staff time / $50k annually	City funds	1, 2
Human Health Actions							
25	Continue West Nile Virus monitoring and control program**	Environmental Affairs	Annually	High	$200k per year	City funds	2
Wildfire Actions							
26	Develop a structure protection plan	Boulder Fire	Complete, ongoing revisions	High	$2k - $70k annually	City funds	1,2
27	Construct new wildland fire training center	FAM	Mid 2014	High	$2.4 million	Grants, city funds	2
28	Implement Community Wildfire Protection Plan**	Boulder Fire, OSMP	Ongoing	High	TBD by project	Grants, city funds	2
29	Implement forest ecosystem management plan**	OSMP	Ongoing	High	$80k - $150 k annually	Grants, city funds	2

	City of Boulder Action**	Responsible Office	Schedule	Priority	Estimated Cost	Potential Funding	Link to Goals*
30	Increase wildland fire hazard mitigation crew funding**	Public Works	By 2018	High	$50k annually	Grants, city funds	2
31	Develop a wildland fire mitigation program for the Middle Boulder Creek watershed**	Public Works	Pending funding	High	$10 million	Grants	2, 3
Drought Actions							
32	Review city landscape codes for drought	Development Review	2013	Medium	Staff time	N/A	2
33	Implement priority projects in city's drought plan**	Public Works	Ongoing	High	$1.5 million+	Grants, city funds	1, 2, 3

*Goal 1: Increase Community Awareness of Boulder's Vulnerability to Natural Hazards
Goal 2: Reduce Vulnerability of People, Property, and the Environment to Natural Hazards
Goal 3: Increase Interagency Capabilities and Coordination to Reduce the Impacts of Natural Hazards.
**Action identified in 2008, all others identified in 2012.

Multi-Hazard Mitigation Actions

2012 Actions

1. Outreach Efforts Associated with BoCo911Alert.com

Project Description/Background: Now that many families had stopped using telephone land lines efforts need to be made to insure that emergency notifications can be sent to people potentially impacted by emergency situations. Public safety agencies throughout Boulder County are switching to a new emergency notification system which is accessible at BoCO911Alert.com. This system will allow residents of the county and all cities within the county to be notified of an emergency situation in a variety of ways, including on their cell phone, home and work phones and by text messaging and e-mail. This project would include outreach efforts to raise awareness about BoCO911Alert.com to increase the number of subscribers.

Other Alternatives: Emphasize radio or television communications instead.

Responsible Office: Boulder OEM

Priority (High, Medium, Low): High

Cost Estimate: Unknown

Benefits (Avoided Losses): Improved ability to notify the public of emergency situations. Potential for avoided deaths and injuries due to early warning notification.

Potential Funding:

Schedule: Next 1 to 2 years

2. Develop Updated City Continuity of Operations and Emergency Evacuation Plans

Project Description/Background: The city has outdated or incomplete plans for staff evacuation and continuity of operations following a disaster. These plans need to be updated / developed to ensure adequate safety and services.

Other Alternatives: Continue using the existing plans developed by individual departments for evacuations. Continuity of operations plans for the entire city have not been developed.

Responsible Office: City Manager's Office and Individual Department Heads.

Priority (High, Medium, Low): High

Cost Estimate: Dedicated staff time and $50,000 - $100,000 for consultant services support

Benefits (Avoided Losses): Potential city employee lives saved during an event; planning to continue basic services following a disaster and minimize disruptions.

Potential Funding: State Emergency Management Performance Grants, city funds

Schedule: Within the 5-year planning period

3. Preplan prime evacuation points/shelter locations for emergency situations (fire, flood, snow, etc.)

Project Description/Background: The city and county have developed systems to alert the public when there is an emergency or disaster. These mass notification systems are effective tools to use when evacuating the public out of harm's way. Currently there is not a plan or infrastructure to identify locations or facilities as pre-designated evacuation sites. There is a shelter plan and this is managed by ESF 8 Mass Care and Red Cross. Shelters take 2-3 hours to establish and evacuation sites or locations are to be the intermediary locations for the public to gather safely and obtain information with little assistance provided except for immediate life threatening and safety issues. This project would entail preplanning prime evacuation points/shelter locations for emergency situations (fire, flood, snow, etc.).

Other Alternatives: Staff time to complete assessment in August

Responsible Office: Boulder Office of Emergency Management

Priority (High, Medium, Low): High

Cost Estimate: Staff time, GIS, Printing of field tools- $3,500 dollars, signage- $6,500 dollars

Benefits (Avoided Losses): When evacuations are ordered there will be a plan to move the public to safe locations until the shelter plan for the incident can be implemented. Knowledge of safe locations and access to these locations may reduce the potential for loss of life and injury.

Potential Funding: City and County general funds,

Schedule: Completed by December 31, 2012

4. Prepare pre-disaster forms to facilitate public infrastructure mitigation through the FEMA public assistance program during post-disaster recovery

Project Description/Background: Following a disaster there is a 60 day filing time to complete project sheets to qualify for funding under the Public Assistance (PA) program within a Stafford Act (Presidential Disaster) Declaration. Having the critical infrastructure project sheets completed in advance and updated yearly ensures that the City of Boulder will qualify to the maximum benefit under a disaster declaration within reimbursement cost share guidelines. In addition, if mitigation projects are included in the assessment and written into the project sheets it will increase opportunities to apply mitigation projects into the recovery process. This project would entail assembling, in a pre-disaster environment, data for PA forms for infrastructure that would be expected to be impacted by; flood, fire, or technological hazards.

Other Alternatives: Wait until the disaster and hire consultants to complete the arduous process and hopefully complete the projects within the time frame allotted and to the detail required to maximize benefits.

Responsible Office: Boulder Office of Emergency Management

Priority (High, Medium, Low): Low

Cost Estimate: Staff time to create and maintain the project sheets and printing of project sheet plan.

Benefits (Avoided Losses): Having the critical infrastructure project sheets completed in advance and updated yearly ensures that the City of Boulder will qualify to the maximum benefit under a disaster declaration within reimbursement cost share guidelines.

Potential Funding: City staff time; FEMA PA funding following Presidential Disaster Declaration with 25% local cost share.

Schedule: 2013

5. Recovery Plan Development

Project Description/Background: Currently there is not a recovery plan for the City and County of Boulder. The process is currently under way and integrating the efforts of the (UASI) Wide Area Recovery Plan and the State of Colorado Recovery Plan. Recovery planning is important because mitigation projects and efforts post disaster are coordinated through the recovery coordination group.

Other Alternatives: No action

Responsible Office: Boulder Office of Emergency Management

Priority (High, Medium, Low): Low

Cost Estimate: Staff time and printing

Benefits (Avoided Losses): The benefit is to create a plan that orchestrates the recovery system and program for the City and County to ensure mitigation is integrated into all recovery efforts where possible.

Potential Funding: State Mitigation and Recovery Grants

Schedule: Complete 2013

6. Become a StormReady Designated Community

Project Description/Background: The National Weather Service provides a StormReady assessment for local communities that develop their severe weather monitoring capability, public warning systems, and rain / stream gauge monitoring systems. If a community obtains this rating they can receive credits under the Community Rating System which could potentially lower the cost of flood insurance for residents. Boulder OEM has been working with the NWS to prepare and submit this application in 2012.

Other Alternatives: No action.

Responsible Office: Boulder Office of Emergency Management

Priority (High, Medium, Low): Low

Cost Estimate: Staff time to complete assessment

Benefits (Avoided Losses): Reduced flood insurance rates for business and private property owners. Increased CRS points for the City of Boulder. Formal recognition of capabilities that Boulder has in place to prepare and respond to severe weather events.

Potential Funding: None required

Schedule: By 2013

2008 Actions

7. Increase Web-Based Public Information Outreach

Project Description/Background: Increased public awareness of hazards in the city and county is a goal of this plan and an ongoing activity of the city and County of Boulder Office of Emergency Management. This project would continue and supplement existing outreach efforts with additional web-based information on hazards and personal preparedness measures.

Progress to Date: This action is ongoing. The Boulder OEM launched a redesigned website in August 2010, which includes warning system information, hazard information, personal preparedness information and resources, and a downloadable emergency preparedness guide. In addition, Boulder OEM introduced a Facebook page, Twitter account and RSS feeds to increase outreach efforts and information flow to the public during an emergency. The City of Boulder Public Works Department provides flood hazard information and safety preparedness updates on the website: www.boulderfloodinfo.net.

Other Alternatives: No action

Responsible Office: Boulder Office of Emergency Management**;** City of Boulder Public Works Department

Priority (High, Medium, Low): High

Cost Estimate: Limited direct financial costs through use of existing staff time

Benefits (Avoided Losses): Benefits include reduced impacts to life and property as a result of a more hazard awareness and better prepared citizenry. A better prepared public will reduce the impacts on emergency services during hazard events.

Potential Funding: Grants (state), in-kind staff time

Schedule: On-going

8. Enhance Outdoor Emergency Warning System - add sirens to NW, East & SE areas of the City

Project Description/Background: There are 11 outdoor warning sirens operating in the City of Boulder currently (see Figure 1.1). The sirens should be evaluated for all risk placement to ensure coverage serves the identified hazard message capability of the system. For example the sirens in sector 5 may need to be moved further west to increase coverage capability. The movement may require additional sirens towards the core of the city in the Northern corridor. In addition, to cover the entire city in outdoor warning sirens it possibly could require 6 additional sirens.

Progress to Date: In 2009, one of the 10 proposed new sirens was added to the City of Boulder soccer fields.

Other Alternatives: Outdoor emergency warning systems typically involve audible mechanisms that may be heard over large areas. Fixed-location warning sirens are generally the most efficient systems for such coverage. Other alternatives for emergency warning could be human-intervention methods, such as loudspeaker systems affixed to moving vehicles and individual door-to-door contacts by emergency personnel. These human-intervention alternatives require time consuming dissemination and place people in harm's way during critical emergencies. Other alternatives include radio and telephone notifications that may not be effective for notifying larger area and outdoor recipients. No other alternative appears to offer an advantage for outdoor warning over an audible siren system.

Responsible Office: Boulder Office of Emergency Management, City of Boulder, Boulder Fire, Boulder Public Works

Priority (High, Medium, Low): Low

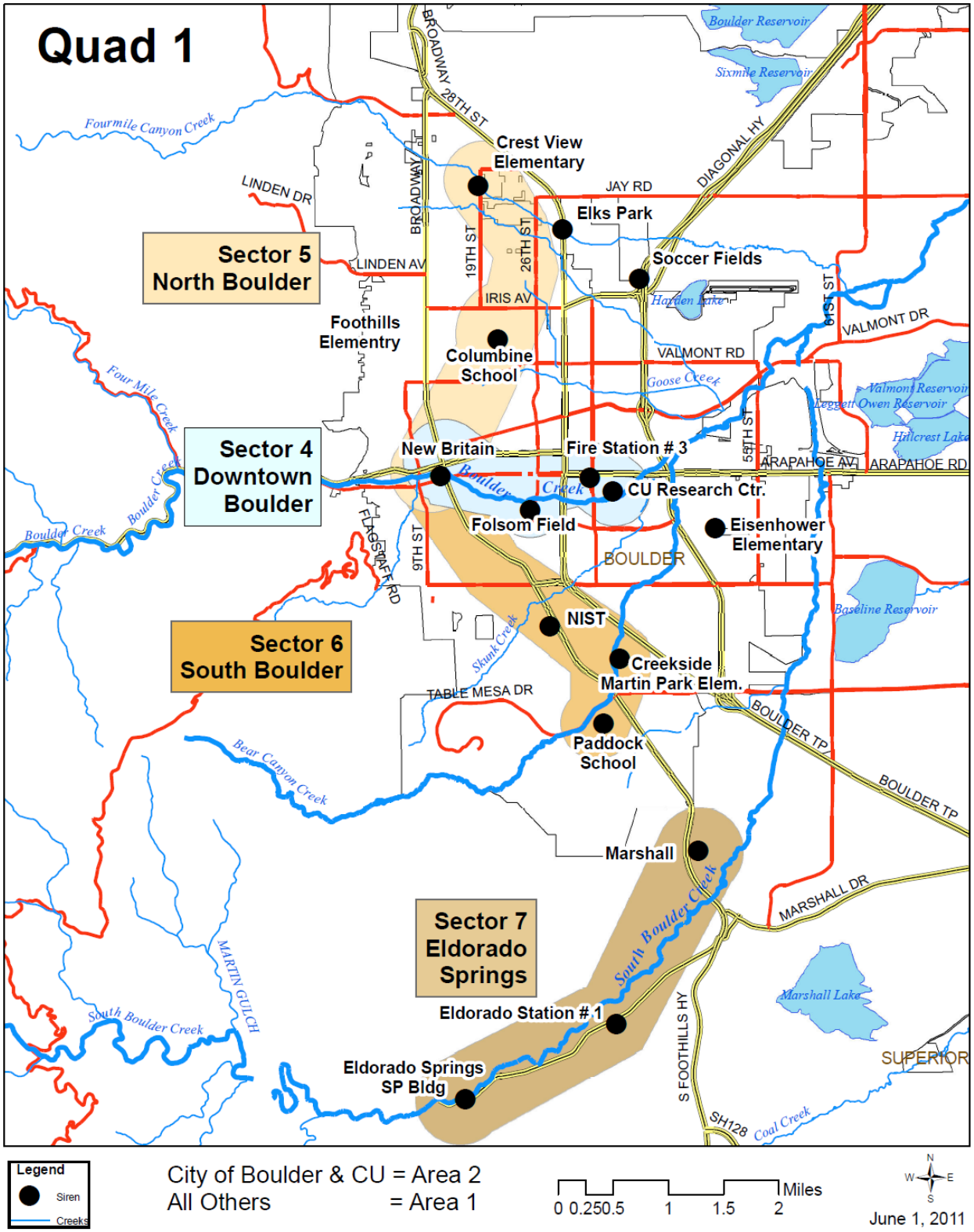
Cost Estimate: Estimated $25,000 per siren unit with a recommendation of at least 6 additional sirens citywide, total initial cost: $250,000

Benefits (Avoided Losses): Outdoor emergency warning sirens offer a notification system that can be implemented immediately by emergency operations in time of need. Warning sirens are recognized by the general population as a standard and accepted method of emergency notification. While multiple methods of emergency notification, including pagers, radio, television, reverse 911 calls, Internet, and cell phone listserv messaging, should be employed to reach all populations in the community, the outdoor emergency warning siren system offers the first line of defense in emergency preparedness. Having complete coverage ensures a standard of minimum alerting capability throughout the city.

Potential Funding: City of Boulder

Schedule: To be determined (policy decision by city)

Figure 1.1. City of Boulder Siren Locations



9. Implement Replacement Planting Program to Meet Tree Criteria

Target a 2:1 replacement ratio for the planting program and target species diversity such that no tree species comprises more than 10 percent of the current population (consistent with City of Boulder Environmental Management Audit 2001).

Project Description/Background: The Environmental Management Audit of 2001 points out that the current replacement program is not sufficient to maintain Boulder's urban forest. In addition, many existing trees are in a condition such that they will be the cause of a hazard or they will exacerbate impacts of snowstorms, windstorms, or drought. Replacement trees should meet the criteria of storm resistance, drought resistance, and appropriate height when located near utility lines.

According to the 2000 tree inventory figures, approximately 25 percent of trees in Boulder's urban forest are of species poorly suited to the harsh climate of the high plains. These include Siberian elm, silver maple, cottonwood, and boxelder. These trees sustain higher levels of storm damage. Accompanying costs result from property damage and potentially from injury to people. Six percent of Boulder's city-owned trees and 17.5 percent of its canopy cover are silver maples, many of which were planted at the turn of the century. Many of these are in a declining stage and are drought-intolerant, and all are subject to high rates of storm damage. (E.G. McPherson, et al. September 2005)

Trees growing near utility lines are often of taller species, which encroach on the lines, therefore requiring frequent pruning, which can make a tree less stable. Additionally, many of these trees are fragile species. This combination makes these trees subject to breakage and increases the chance of utility failure during a natural disaster.

Progress to Date: The current annual tree planting budget is $18,500. This budget allows approximately 125 trees to be planted per year. To achieve a 2:1 planting to removal ratio the budget would need to be approximately doubled. Planting to removal ratio for the past five years has ranged from 1:2 to 1.5:1. In 2010 thru 2012, the city Urban Forestry has achieved a 2:1 planting ratio using funding from the Tree Mitigation program. Urban Forestry receives reimbursement for trees removed or destroyed per B.R.C, 6-6-7. This funding source is variable from year to year however and therefore not stable.

Other Alternatives: No proactive program, maintain existing trees to the extent possible, replace trees at the current ratio, which is below the loss rate

Responsible Office: City of Boulder Parks and Recreation Urban Forestry Section

Priority (High, Medium, Low): High

Cost Estimate: $60,000

Benefits (Avoided Losses): Life safety, reduction in property loss, reduced impacts to utility lines, reduced road blockage, and reduced debris clearance costs following snow and windstorms

Potential Funding: Because planting trees is an annual process, a consistent year-to-year funding source is necessary.

Schedule: Implement as funding allows

10. Increase Urban Forest Canopy from 7 Percent to 9 Percent in Commercial Areas and from 31 Percent to 35 Percent in Residential Areas to Provide Maximum Flood Reduction Benefit

Project Description/Background: Extensive research conducted worldwide provides evidence that stream degradation occurs with as little as 10 percent impervious cover. During storms, accumulated pollutants are quickly washed off and rapidly delivered to aquatic systems as stormwater runoff. In a typical small-scale storm event (0.5 inch), highly concentrated and polluted stormwater would, without interference, flow directly into Boulder's waterways. These small storms are responsible for most pollutant washout, also known as the "first flush" effect. Urban stormwater runoff is the second most common source of water pollution for lakes and estuaries and the third most common source for rivers nationwide. (From Calculating the Value of Boulder's Urban Forest, October 2002, Chapter 1, page 2)

Trees in urban areas can protect water quality by substantially reducing the amount of runoff from the more frequent but less extreme storm events that are responsible for most annual pollutant runoff. Infiltrating and treating stormwater runoff on site can reduce runoff and pollutant loads by 20 to 60 percent. Trees' extensive fibrous root systems also hold soil in place, reducing further impacts on water quality due to erosion. (From Calculating the Value of Boulder's Urban Forest, October 2002, Chapter 1, page 4)

Progress to Date: The numbers stated in the action item were extrapolated from a series of plots studied within the city. The city is anticipating teaming up with the City of Denver to have a full canopy study completed in 2013 through The Mile High Million tree initiative. The city received additional funding for tree planting in commercial areas in 2009. The city planted 124 trees in the Business Improvements District area since spring 2008 (23 trees in 2008, 19 trees in 2009, 33 trees in 2010, 25 trees in 2011, and 24 trees in 2012). Due to budget demands, funding for this action in the future is uncertain. *Note*: This action aligns with the goals in the City of Boulder's Climate Action Plan as it pertains to urban forestry.

Other Alternatives: No action, accept current water quality conditions

Responsible Office: City of Boulder Parks and Recreation Urban Forestry Section, possibly others (e.g., the city's Stormwater Quality Office's Keep it Clean Partnership)

Priority (High, Medium, Low): High

Cost Estimate: Not yet evaluated. The cost would be shared public/private since most trees are on private property. The cost would include an education and outreach mission to encourage citizens to plant appropriate trees. This outreach goal could be combined with other outreach, and the staff member housed in a central location, or the specialist could be housed with Urban Forestry.

Benefits (Avoided Losses): Using data from the Urban Drainage and Flood Control District regarding detention areas constructed in the Denver-Metro area, it was determined that the urban forest saves more than $350,000 annually. This estimated value addresses only water quantity, not water quality ("City Green," Chapter 1, page 7). Moving from 31 to 35 percent cover represents approximately a 12 percent improvement. A 10 percent improvement would have a value of $35,000 annually.

Potential Funding: Because planting trees is an annual process, a consistent year-to-year funding source is necessary.

Schedule: Annually, began in 2010

11. Implement a System of Automatic Vehicle Location for Police, Fire, Snow Removal Vehicles

Project Description/Background: City snow removal vehicles now have GPS vehicle locators; however, this information is not shared with police, fire, and other agencies. Police and fire vehicles, if equipped with automatic vehicle location (AVL), will enable better tracking and dispatching of resources. Tracking of resources during flood warnings will enable police, fire, and snow vehicles potentially at risk to flooding to be mobilized. During a major flood event on Boulder Creek, the city will be cut in two. The AVL system will help the tracking and dispatching of resources on the north and south sides of Boulder Creek. Sharing of snow removal vehicle movement during winter storms and blizzards will assist fire and police personnel with emergency response access and evacuation needs.

Progress to Date: This action item is in progress. It is anticipated that in 2012, police and fire vehicles will be tracked using a computer aided dispatch system. The Boulder Regional Emergency Telephone Service Authority (BRETSA) is financing the project and the licensing for police and fire vehicles for AVL/GPS. Public Works vehicles have their own AVL/GPS system and are dispatched and tracked independently. There has been no discussion to this point about adding any Public Works vehicles onto the system. Public Works vehicles have their own AVL/GPS system, and are dispatched and tracked independently.

Other Alternatives: Do nothing and have on snow removal vehicles only (existing), improved coordination/information sharing only, police only, fire only—phased in

Responsible Office: City and County of Boulder Office of Emergency Management; City of Boulder Police, Fire–Rescue, and Public Works (Utilities) Departments

Priority (High, Medium, Low): High

Cost Estimate: Cost of each vehicle unit assumed at $3,500 each, 35 police cars ($122,500), 15 fire engines ($52,500), 15 snow plows—already equipped, GPS base station ($20,000), total cost=$195,000

Benefits (Avoided Losses): Improved response time, enhanced life safety, improved coordination, improved resource allocation/tracking

Potential Funding: Vehicle replacement, U.S. Department of Homeland Security grant, Boulder Regional Emergency Telephone Service Authority

Schedule: Within the five year planning period.

12. Increase Rotational Pruning of Street Trees to Eight Years

Project Description/Background: The current pruning rotation of ten years places undue stress on the urban forest. Improving the pruning rotation from 10 years to 8 years will improve structure, reduce sight clearance problems, remove deadwood, mechanically remove insect/disease problems, and most importantly, reduce potential liability. An eight-year pruning rotation would make trees stronger and more resistant to storm, freeze, and snow damage, thus reducing post-storm cleanup costs and liability exposure.

Note that Boulder's urban forest, when maintained in a healthy condition, returns benefits of $56 per tree or $2 million annually. Furthermore, for every $1 spent on tree care, Boulder receives $3.64 in benefits (E.G. McPherson, et al. September 2005).

Progress to Date: The city is currently operating a 10-year pruning rotation for street trees and an eight-year rotation for park trees. Due to budget demands, funding for this action in the future is uncertain.

Other Alternatives: Continue current rotation schedule

Responsible Office: City of Boulder Parks and Recreation Urban Forestry Section

Priority (High, Medium, Low): High

Cost Estimate: $40,000

Potential Funding: Because pruning trees is an annual process, a consistent year-to-year funding source is necessary.

Schedule: Implement as funding allows

Flood Mitigation Actions

2012 Actions

13. Enhance Flood Warning System on Smaller Tributaries

Project Description/Background: There are 14 tributaries to Boulder Creek that flow through the City of Boulder. The city has an extensive network of rain and stream gages that provide real-time data for Boulder Creek and South Boulder Creek. The city also has cameras showing stream conditions on Boulder Creek and Fourmile Creek. The city is 'blind', however, on most of the smaller tributaries. Storm flows in these tributaries peak too quickly to make installation of stream gages effective. Installation of cameras, however, would greatly enhance the city's knowledge of flood conditions along the smaller tributaries. Installation of additional rain gages located within the city's smaller tributary watersheds would also provide reliable real-time information that could be accessed by the Urban Drainage and Flood Control's ALERT network.

Other Alternatives: Rely on volunteer gage information and spotters for the city's smaller tributaries.

Responsible Office: Public Works Utilities Division

Priority (High, Medium, Low): High

Cost Estimate: ~$25,000 per camera/ rain gage installation

Benefits (Avoided Losses): Ability to provide enhanced flood warning capabilities along the city's smaller tributaries.

Potential Funding: UDFCD, State Pre-flood mitigation grants, city funds

Schedule: Within the five year planning cycle

14. Relocate Fire Station out of 100-year Floodplain

Project Description/Background: As noted in the City of Boulder's 2011 Operations and Management Assessment, Fire Station #3 at Arapahoe and 30th Street is currently located in the 100-year floodplain. The city's 2012 Fire Master Plan also recommends that a new station include administrative staff space and records storage. This project would entail relocation of the station to a location outside of the 100 and 500 year floodplains.

Other Alternative Continue the practice of relocating fire station personnel and vehicles during high flood potential times.

Responsible Office: Facilities and Asset Management / Fire and Rescue

Priority (High, Medium, Low): Medium

Cost Estimate: $17,000,000 – including cost of land purchase

Benefits (Avoided Losses): Loss in fire and emergency services capability at the city's busiest fire station when needed most. Avoided damages to building and contents.

Potential Funding: Bonds / Public-private partnership; FEMA PDM, FEMA post disaster HMGP or PA mitigation funds.

Schedule: Pending funding

15. Flood Hazard Prioritization

Project Description/Background: The city prepares flood mitigation studies for creek systems. The flood master plans prioritize flood mitigation among each creek system. The city, however, has not conducted an evaluation to prioritize flood mitigation efforts city wide.

Other Alternatives: Continue to implement flood mitigation efforts as prioritized by creek system.

Responsible Office: Public Works Utilities Division

Priority (High, Medium, Low): High

Cost Estimate: $50,000 - $100,000

Benefits (Avoided Losses): Ability to implement the highest priority flood improvements based on a city-wide evaluation. The analysis will help justify public expenditures and secure grant funds.

Potential Funding: UDFCD, Public Works funding

Schedule: 2015

16. Update the Comprehensive Flood and Stormwater Master Plan (CFS)

Project Description/Background: The city prepared a Comprehensive Flood and Stormwater Master Plan (CFS) in 2004. The plan provides a framework for evaluating, developing, and implementing programs and activities related to the city's flood management, stormwater quality and stormwater drainage problems. The plan is nearly eight years old and requires updating.

Other Alternatives: Continue to rely on the 2004 master plan.

Responsible Office: Public Works Utilities Division

Priority (High, Medium, Low): Medium

Cost Estimate: $50,000 - $100,000

Benefits (Avoided Losses): An updated master plan would provide current guidance for the city's programs related to flood management, stormwater quality and stormwater drainage.

Potential Funding: UDFCD, city funds

Schedule: Within the five year planning cycle

17. Update Flood Preparedness Web Mapping Site

Project Description/Background: The Flood Preparedness website is a primary tool for city flood preparedness. The site brings together a large amount of city GIS data with real time USGS/UDFCD rain and stream gages along with NWS radar info. ESRI, the GIS software company, will sunset the WebADF API in future releases of software; meaning the Flood Preparedness site will not work in 10.1 (released July '12). The city is holding off upgrading to 10.1 until all issues have been explored. The plan is to upgrade to a Javascript or Silverlight application. Once the flood site has been upgraded, consider adding All-Hazards functionality depending on how useful it would be to other departments.

Other Alternatives: Use UDFCD gage sites, USGS gage sites, & city GIS information separately. The city has no input on UDFCD's site architecture. In an emergency, critical time could be lost navigating to multiple websites.

Responsible Office: Floodplain Management

Priority (High, Medium, Low): High

Cost Estimate: $10,000 (for consultant programming services)

Benefits (Avoided Losses): The Flood Preparedness provides improved situational awareness in severe weather/flood. This allows the city and OEM staff the ability to provide advanced warning time for citizens. Most importantly, the site links real-time UDFCD/USGS gage and NWS radar information with city floodplain data.

Potential Funding: PW/Utilities

Schedule: 2013

18. Develop Flood Mitigation Plans After Flood Mapping Updates.

Project Description/Background: Develop major drainageway Phase A flood mitigation plans following floodplain mapping updates.

Other Alternatives: Emphasize flood insurance and post flood mitigation efforts.

Responsible Office: Public works/Utilities

Priority (High, Medium, Low): High

Cost Estimate: $100,000 - $150,000 per study

Benefits (Avoided Losses): Constructed improvements provide direct relief from flooding with associated life safety enhancements and protection of the city's built infrastructure. The Phase A reports will result in an analysis of the preferred mitigation alternative.

Potential Funding: UDFCD, Public Works funds

Schedule: Following each flood mapping update

19. Implement Mitigation Plan for Fourmile Creek and Wonderland Creek

Project Description/Background: Fourmile Canyon Creek and Wonderland Creek exhibits a significant flood risk to a number of residential neighborhoods in Boulder. The existing system is undersized along most reaches of both creeks. Fourmile Canyon Creek spills to Wonderland Creek during storms greater than the 50-year event, increasing the flood risk along Wonderland Creek during major events. In addition, approximately 20 percent of the Fourmile Burn area that occurred in 2010 is tributary to Fourmile Canyon Creek. The burn area will increase the flood risk along Fourmile Canyon Creek for up to the next 10 years. The Fourmile Canyon and Wonderland Creek Flood Mitigation Final Plan presents background information and recommended flood mitigation measures.

Other Alternatives: A number of alternatives were identified in the above referenced study. Five alternatives were evaluated for each reach and are discussed in the planning document.

Responsible Office: City of Boulder Utilities Division

Priority (High, Medium, Low): High

Cost Estimate: Approximately $5.4 million to implement recommended improvements for Fourmile Canyon Creek and $10 million for Wonderland Creek.

Benefits (Avoided Losses): This project would provide flood relief to several neighborhoods along Fourmile Creek.

Potential Funding: City of Boulder Stormwater fund, FEMA's Pre-Disaster Mitigation program

Schedule: A flood mitigation master plan has been completed and mitigation projects will be implemented as funding becomes available.

20. Update City's Floodplain Mapping

Project Description/Background: The city recognizes that floodplain maps need to be periodically revised to incorporate changes in development, modeling techniques, and improved topographic data as well as LOMR information. The city is trying to keep mapping at least 10 years current. The city is currently updating Boulder Creek, Skunk Creek, Kings Gulch, Bluebell Canyon Creek, Boulder Slough, Upper Goose, and Two Mile Canyon Creek. The city goal is to keep all 14 tributaries to Boulder Creek current within a 10-year timeframe. Other basins that will need future updating include: Sunshine Canyon Creek.

Updates to floodplain mapping should include the development of depth grids which can be imported and used to refine loss estimation through programs such as HAZUS-MH.

Other Alternatives: No action

Responsible Office: City of Boulder Utilities Division

Priority (High, Medium, Low): Medium

Cost Estimate: $100,000 - $150,000 per study

Benefits (Avoided Losses): More accurate flood hazard delineations provide for improved floodplain management, ordinance enforcement, public awareness and flood insurance determinations. Can also be used to refine flood risk modeling and target mitigation strategies.ies.

Potential Funding: UDFCD, Public Works funds

Schedule: Currently updating Boulder Creek, Upper Goose, Skunk Creek, Boulder Slough, Kings Gulch , Bluebell Canyon Creek, and Two Mile Canyon Creek; trying to keep 10 years current.

2008 Actions

21. Acquire Properties in the High Hazard Flood Zone

Project Description/Background: Numerous structures are located in the City of Boulder's High Hazard Flood Zone where there exists the potential for risk to life and safety. In 1989, Boulder created a floodplain ordinance that prohibits new construction of structures intended for human occupancy in the high hazard zone. As part of this objective, community acquisition and removal of high hazard structures has been a key component of mitigating floodplain impacts in the city. The High Hazard Zone acquisition program has been in place for many years with funding by the flood management utility. Available funds are leveraged with matching funds from other organizations such as the Urban Drainage and Flood Control District, and purchases are made as high hazard properties become available on the market.

Progress to Date: (Reviewer/Responsible Office: City of Boulder Public Works Department) The city purchased easements in July 2010 from the Geological Society of America that owns a single-family residence located in the High Hazard flood zone of Wonderland Creek. The property is located at 3115 Iris Ave. The home was deconstructed in September 2010. The Urban Drainage and Flood Control District contributed one half of the purchase price of $650,000. The city is also under contract to purchase a single-family residence located in the High Hazard flood zone of Gregory Canyon Creek. The property is located at 810 Marine Street. Purchase of the property is anticipated in July of 2012 with demolition to follow in the second half of 2012.

Other Alternatives: Acquire properties post-flood.

Responsible Office: City of Boulder Utilities Division

Priority (High, Medium, Low): Medium

Cost Estimate: $500,000 annually is programmed into the Stormwater and Flood Management Utility Fund for pre-flood property acquisitions.

Benefits (Avoided Losses): Would eliminate the most severe flood risks to human safety. Would also reduce the potential for flood-related damage to structures in the high hazard zone, which are subject to greater damage potential given the higher velocities and depths of flooding.

Potential Funding: Increased utility budgeting, federal matching funds, bonding, etc. FEMA PDM, FEMA post disaster HMGP funds.

Schedule: List of highest priority High Hazard Zone structures has been developed and will be periodically updated with new mapping studies. Structures are purchased opportunistically.

22. Mitigate Flooding in the South Boulder Creek Floodplain

Project Description/Background: Updated floodplain mapping has identified several hundred residential structures to be subject to South Boulder Creek flooding that are located in the city and were previously not determined to be in the floodplain. These structures were developed without flood protection measures. The large residential area is primarily "built-out" and is referred to as the West Valley. West Valley flood is the result of flooding that spills the main creek along the east side of the valley and spreads to the west, exacerbated by the U.S. 36 highway that serves to redirect flows away from the main creek corridor. Floodplain mitigation would preserve the regulatory floodplain status that existed during the development stages of the West Valley and would prevent the flood potential to structures that are not designed to accommodate flood impacts.

Progress to Date: A risk assessment completed in 2009 estimates damages in excess of $230 million if a 100-year flood event were to occur in South Boulder Creek. The city began a flood mitigation study for South Boulder Creek in early 2010. The study will identify best alternative plans for flood mitigation and a recommendation to boards and council. The plan is being co-sponsored by the UDFCD. Completion of the plan is anticipated in early 2013.

Other Alternatives: Nonstructural floodplain mitigation in the form of updated floodplain mapping, implementation of floodplain regulation, and the requirement for mandatory purchase of flood insurance is occurring as part of the submittal of the new flood mapping study that identified the flood potential. In order to best represent the interest of the residential community, the city is strongly interested in exploring the potential to mitigate this flood impact.

Responsible Office: City of Boulder Stormwater and Flood Management Utility

Priority (High, Medium, Low): High

Cost Estimate: Master planning $300,000, mitigation improvements $36 million

Benefits (Avoided Losses): Losses to several hundred residential structures constructed without flood protection measures could be avoided, and maintaining emergency access along major transportation corridors.

Potential Funding: Utility budgeting, U.S. Army Corps of Engineers funding, multi-funding and bonding

Schedule: Anticipated completion of master plan in 2013. The recommendation has a three phased implementation approach.

23. Develop a Critical Facilities Floodplain Ordinance

Project Description/Background: The 500-year floodplain affects approximately 20 percent of the incorporated lands in the City of Boulder. As a result, many of the community's critical facilities are located in the year floodplain. There is a significant concern with the location of critical facilities given the need to ensure that these facilities are operational and accessible during a major flood event. Adoption of an ordinance that regulates new construction and improvements for critical facilities to the 500-year flood level will offer a higher level of protection for these facilities from flood losses and damage that could render them unusable during times of need. In addition to adopting flood protection standards, the critical facilities ordinance offers a mechanism to support funding opportunities to floodproof existing facilities that are subject to flood impacts. Given the vital nature of critical facilities, protection from flooding is of particular interest to the community.

Progress to Date: A Critical Facilities Floodplain Ordinance was drafted in 2010 and is currently undergoing a public process. The ordinance development includes a draft critical facilities definition and management strategies. The definition and strategies were presented to the Water Resources Advisory Board and Planning Board, and are slated to undergo a public approval process, with a goal of City Council consideration in 2013.

Other Alternatives: The City of Boulder could consider the development of floodplain regulations that would adopt the 500-year floodplain standard for all flood applications within the community. Adoption of a higher standard would recognize and address the increasing level of flood damage and losses that are occurring outside of the 100-year floodplain across the United States. Adopting the higher 500-year floodplain standard for all regulatory activities has not undergone evaluation to determine if the costs of added protection measures are justified with respect to the benefits derived.

Responsible Office: City of Boulder Stormwater and Flood Management Utility

Priority (High, Medium, Low): High

Cost Estimate: Staff administrative costs for ordinance implementation

Benefits (Avoided Losses): Protection of critical facilities to 500-year flood levels will ensure that these facilities are operational and accessible during a major flood event. Adoption of a critical facilities floodplain ordinance requiring that all new critical facilities and improvements to existing critical facilities be protected to the 500-year flood level will prevent or mitigate damage and losses.

Potential Funding: Utility budgeting and grant funding

Schedule: Ordinance development and adoption in 2013, floodproofing activities if funding is available.

24. Institute a Community Assisted Floodproofing Program Focusing on Critical Facilities

Project Description/Background: Evolving trends and philosophies in national and regional floodplain management have outlined alternative approaches and measures for addressing flood hazards in the future. These trends focus on the "wise use of the nation's floodplains" and "no adverse impacts." In an effort to allow possible development and flood mitigation flexibility that would avoid the need to implement publicly funded drainageway improvements to contain flood waters, the City of Boulder is interested in establishing opportunities to permit limited applications of floodproofing of critical facilities. City assistance under the program would involve development and adoption of local floodplain regulations to approve floodproofing applications for property owners to implement improvements to their facilities. The program would be consistent with nonstructural measures endorsed under the Comprehensive Flood and Stormwater Master Plan. This action would be focused on critical facilities in the floodplain.

Progress to Date: No action has been taken on this item and no schedule has been established as this action item is considered a low priority within the flood management program where residential floodproofing is concerned. Floodproofing of residential structures does not eliminate or reduce the need to purchase flood insurance if located within the 100-year floodplain. The city is instead focusing on flood mitigation measures along high risk stream reaches. In 2012, the action was modified to apply only to critical facilities in the floodplain.

Other Alternatives: Other alternatives to mitigating flood damage potential to residential structures in shallow flooding areas involve continued application of structural drainageway improvements and assistance programs to elevate residential structures to meet standard FEMA requirements. Costs for these alternatives are far more expensive to implement and may not be justified with respect to benefits derived.

Responsible Office: City of Boulder Stormwater and Flood Management Utility

Priority (High, Medium, Low): Low

Cost Estimate: Administrative costs for ordinance adoption, $50,000 annual assistance funding

Benefits (Avoided Losses): A derived benefit avoids altering flood conditions as a result of structural improvements satisfying the "no adverse impact" philosophy.

Potential Funding: Increased utility budgeting

Schedule: Pilot program implementation within the planning period.

Human Health Mitigation Actions

2008 Action

25. Continue the City of Boulder West Nile Virus Mosquito Monitoring and Control Program

Project Description/Background: West Nile Virus is a mosquito-vectored disease first detected in the United States in 1999 in New York City, which has since spread westward across the United States. While many people who contract the virus experience very mild symptoms, infection can result in severe and sometimes fatal illnesses. In 2003, Colorado led the country in West Nile cases and deaths. Colorado experienced a significant decrease in cases in 2004 and 2005. During the 2006 mosquito season, Colorado had a resurgence of cases and ranked second only to Idaho in the national case count. Boulder and Weld Counties reported the highest number of cases (74 and 68) in Colorado. As in years past, the City of Boulder and Boulder County continued to conduct a very intensive mosquito testing program. With the widespread and frequent testing throughout the county, 107 pools of mosquitoes tested positive for the virus, which was significantly more than most other Colorado counties.

The city's West Nile Virus Mosquito Management Plan was first adopted by City Council in 2004. Further refinements were adopted in 2006. The primary goal of the program is to reduce the risk of West Nile Virus infection while minimizing environmental impacts. The plan is directed at controlling the larval stages of vector mosquitoes and their sources. The objectives that have been used to accomplish this goal are categorizing the habitats that support mosquitoes that most effectively transmit WNV to humans; applying the larvicide (*Bacillus thuringiensis subspecies israelensis*, or *Bti*) to all sites where *Culex* species are found; using adult mosquito monitoring to provide an early warning system of the occurrence of West Nile Virus within and near city limits; developing trigger mechanisms to respond to early larval detection and/or heightened mosquito activity to appropriately increase management activity; utilizing thresholds for initiating adult mosquito control in emergency cases; and continuing the program to educate the public about West Nile Virus and increase awareness of the city's West Nile Virus Mosquito Management Plan.

Progress to Date: This program is currently ongoing and it is anticipated this program will continue as long as West Nile Virus or other mosquito-borne illnesses are a threat to residents of Boulder. The City of Boulder's intensive larval control program, combined with education and personal protection measures, is helping to keep to a minimum the mosquito populations, the virus activity levels, and the number of cases in the area.

Other Alternatives: Discontinue control program but continue education and outreach component.

Responsible Office: City of Boulder Office of Environmental Affairs (within City Manager's Office); Boulder Community Planning and Sustainability Department

Priority (High, Medium, Low): High

Cost Estimate: Approximately $200,000/year (+ $100,000 contingency for adult mosquito spraying if needed). Additional funds may be needed in future years for adult mosquito testing if state funding is reduced.

Benefits (Avoided Losses): Controlling larval stages of mosquitoes capable of transmitting West Nile Virus is a public health issue. With the resurgence in cases in 2006 and again in 2007, it has become obvious that the virus will be an annual threat to residents of Colorado. Even though there was a significant increase in activity in the region in 2006, it is likely that the City of Boulder's intensive larval control program, combined with education and personal protection measures, helped keep to a minimum the mosquito populations, the virus activity levels, and the number of cases in the area.

Potential Funding: The program is currently budgeted through the City Manager's Office.

Schedule: The West Nile Virus Mosquito Management Plan was first adopted by City Council in 2004. Further refinements were adopted in 2006. It is anticipated this program will continue as long as West Nile Virus or other mosquito-borne illnesses are a threat to residents of Boulder.

Wildfire Mitigation Actions

2012 Actions

26. Structure Protection Plan

Project Description/Background: The City of Boulder communities are at risk to wildfire. A Structure Protection Plan would provide a common operating picture of the needs of protecting the communities on the west side of the city from wildfires.

Other Alternatives: Do nothing

Responsible Office: City Of Boulder Fire Department Wildland Division

Priority (High, Medium, Low): High

Cost Estimate: $2,000-70,000 per year indefinite maintenance

Benefits (Avoided Losses): Protection of communities at highest risk for wildland fire.

Potential Funding: Boulder Fire Department

Schedule: Complete with ongoing revisions

27. Construct New Wildland Fire Facility

Project Description/Background: The city's current wildland cache is in a residential unit at 1888 Violet. Due to zoning restrictions, the facility cannot be remodeled for what's needed for a wildland fire facility. In the November 2011 ballot, voters approved $1.15 million to construct a new Wildland Fire Facility; however, the 2011 Fire Operations and Management Assessment identified a need that doubled the space requirements from today's wildland fire operations to include adding permanent staff due to year-round wildland fire hazards and new equipment. A shortfall of $1.3 million from the bond funding is anticipated.

Other Alternatives: House additional wildland fire staff and resources at another location.

Responsible Office: Facilities and Asset Management / Fire and Rescue

Priority (High, Medium, Low): High

Cost Estimate: $2,400,000

Benefits (Avoided Losses): By constructing a consolidated wildland fire facility, staff and resources at one location will eliminate delayed responses due to staff having to be in different locations to service equipment or be housed out of.

Potential Funding: Grants; Sale of 1888 Violet property; other city funds

Schedule: Design is expected to be completed in early/mid-2013 with construction to follow, completing mid-2014.

2008 Actions

28. Implement the City's Community Wildfire Protection Plan

Project Description/Background: The City of Boulder is listed in the National Fire Plan as a community at high risk from wildfire. In 2007, the city worked with consultants to develop a Community Wildfire Protection Plan (CWPP) to address the wildfire threats to the community. The plan meets the requirements of the federal Healthy Forests Restoration Act and outlines steps the city can take to reduce and mitigate the threats of wildfire. The CWPP could be considered a parallel document to the city's Forest Ecosystem Management Plan (FEMP) in that the CWPP addresses areas within the city boundary, and the FEMP is focused on adjacent wildlands. The CWPP outlines steps the city and private property owners can take to both mitigate the threat of wildfire and increase public safety in the event of a wildfire. The plan makes recommendations for fuels modification projects, safety zones, evacuation routes, addressing, and ingress/egress routes. Funding for the plan development came from a combination of city departments and a matching state grant.

Progress to Date: This activity is ongoing.

Other Alternatives: Another alternative would be to rely fully on wildland management and implementation to decrease wildfire threat. The major drawback to this alternative is that it would not address the hazards within city limits and on private property. In the event of a fire in the wildland-urban interface, property could be lost and there would be an unnecessary risk to firefighters and the public.

Responsible Office: City of Boulder Fire–Rescue, City of Boulder Open Space and Mountain Parks

Priority (High, Medium, Low): High

Cost Estimate: Costs will vary depending on nature and magnitude of each project.

Benefits (Avoided Losses): The benefits from the implementation of this plan include decreased potential for wildfire, more consistent policies related to how a wildfire event is managed, education of the public in regard to wildfire and their responsibilities as property owners, and an increase in public preparedness and safety.

Potential Funding: City of Boulder Fire–Rescue, federal and state grants

Schedule: Ongoing

29. Implement the City's Forest Ecosystem Management Plan

Project Description/Background: The City of Boulder Open Space and Mountain Parks Department (OSMP) manages approximately 10,000 acres of forested land. Due to the land's close proximity to homes, dense forest conditions, and risks of fire ignition, the forests of Boulder fall within the high hazard category of the wildland-urban interface. In June of 1999, the City Council approved the Forest Ecosystem Management Plan (FEMP). The plan established a framework, policy guidelines, and management direction for forest ecosystem management on city lands. One of the FEMP's primary goals is to "reduce the wildfire risk to forest and human communities." Part of this objective includes forest thinning and prescriptive burning as key components in mitigating the threat of large scale wildfire. Forest treatments are to be completed on a steady basis under the plan. Funding for projects completed to date has come from the annual OSMP budget.

Progress to Date: This action is ongoing, and most of the recommendations in the CWPP have been implemented. OSMP, with the help of the city Fire Department- Wildland Fire Division has thinned close to 800 acres of forested city property and prescriptively burned over 200 acres. All of the projects conducted on city land have been in high hazard areas of the wildland-urban interface with the focus of improving ecological function and decreasing the risk of wildfire to public and private resources. Ongoing city monitoring has demonstrated the direct benefits of forest management on ecosystem health and wildfire risk.

In 2004, OSMP began hiring a four-person seasonal forest management crew to implement the FEMP. Funding is part of the annual OSMP operating budget and the primary focus of this crew is the implementation of the FEMP. The addition of this crew has allowed the city to thin, on average, 100 to 150 acres of city forests each year. The city also developed a Community Wildfire Protection Plan in 2007 for the portions of OSMP directly adjacent to the city. This plan, in conjunction with the FEMP, allows the city to apply for federal and state grant funding.

Forest management will continue to be an ongoing city priority and a focus of OSMP work planning. The city plans to update the FEMP in coming years, in order to adaptively manage Boulder's forests and efficiently place treatments on the landscape.

Other Alternatives: There are few other alternatives to mitigate the threat of wildfire given current forest conditions and the extent of the wildland-urban interface. An option may be to secure funding for restoration following a large scale wildfire event. The downside to this approach is that it is not preventative and places property and potentially lives at greater risk.

Responsible Office: City of Boulder Open Space and Mountain Parks

Priority (High, Medium, Low): High

Cost Estimate: $80,000-$150,000 annually

Benefits (Avoided Losses): Fire mitigation and forest restoration work has a direct impact on fuels and can immediately decrease the potential for wildfire. The work will mitigate the threat to properties owned by the city as well as property adjacent to open space areas. There is also an immediate ecological benefit in increased habitat and forest health.

Potential Funding: Increased City of Boulder Open Space and Mountain Parks and City of Boulder Fire–Rescue budgets, federal and state matching grants

Schedule: Ongoing, will require indefinite maintenance

30. Increase Boulder Wildland Fire Hazard Mitigation Crew Funding

Project Description/Background: Since the 1990s, Boulder has maintained its own seasonal Wildland Fire Hazard Mitigation Crew through the City of Boulder Fire–Rescue Department Wildland Fire Division. Funding for the mitigation crew has historically come from Open Space and Mountain Parks and the Fire–Rescue Department. Constrained budgets are supplemented by crew assignment to fire incidents outside the local area for which the department is reimbursed by the federal, state, or local agency. While this reduces Boulder's cost to maintain the crew, it also reduces their availability to complete needed hazard mitigation on city-owned lands. The Utilities Division proposes to contribute to the Wildland Fire Hazard Mitigation Crew funding with the objective of increasing crew size and availability to:

- Identify and plan measures to protect infrastructure and access to Utilities Division properties,
- Complete hazard mitigation projects on lands owned and managed by the Utilities Division, and
- Participate in broader community hazard mitigation projects that would reduce risks to Utilities Division lands and facilities.

Progress to Date: Progress has not been made due to funding constraints.

Other Alternatives: No action, continue to fund individual mitigation projects as funding is available, or assign wildland fire mitigation responsibility to a Utilities Division work group

Responsible Office: City of Boulder Utilities Division

Priority (High, Medium, Low): High

Cost Estimate: $50,000 per year

Benefits (Avoided Losses):

- Helps Utilities Division meet its responsibility to manage and mitigate wildland fire hazards on its properties in a timely, on-going manner
- Reduces risk of wildland fire damage to city infrastructure and properties and associated repair/rehabilitation costs
- Increases likelihood of containing wildland fires prior to catastrophic damage by maintaining fire breaks created by Utilities Division infrastructure (access roads, pipeline corridors, etc.)
- Helps ensure continued viability and efficiency of this important city program

Potential Funding: City of Boulder Water Resources Fund, FEMA's Pre-Disaster Mitigation program, other grants available from federal and state governmental agencies

Schedule: Within the planning period

31. Develop a Wildland Fire Mitigation Program for the Middle Boulder Creek Watershed

Project Description/Background: The city's Barker Reservoir and Middle Boulder Creek supply approximately 35 percent of Boulder's annual water needs. When considered in terms of both wildland fire hazard rating and structural density, the approximately 25,000-acre Middle Boulder Creek watershed contains large areas of high, very high, and extreme danger for wildland fire. As has been experienced by other Colorado Front Range water providers, a major wildland fire can render a reservoir unusable for years when ash, sediment, and debris from upstream fire-ravaged areas are washed into streams and reservoirs following a fire. Reservoir clean-up and rehabilitation costs can be in the millions of dollars, not including loss of use of the water or lost hydroelectric power revenues.

The city proposes partnering with the Front Range Fuels Treatment Partnership (FRFTP), a coalition of federal, state, and local government agencies and private interests, to plan and implement a watershed-wide fire risk mitigation program targeted at the high and extreme risk areas within the Middle Boulder Creek basin. FRFTP exists to reduce wildland fire risks, protect communities from wildland fires, and restore fire-adapted ecosystems in the 10-county Front Range corridor. The city has successfully partnered with the FRFTP in the past in the 38,000-acre Winiger Ridge Ecosystem Restoration Project just south of the Middle Boulder Creek basin.

The city will explore recent guidelines developed by the Colorado State Forest Service for Community Wildfire Protection Planning specific to prioritizing watersheds for fuels treatment.

Progress to Date: Discussions with FRFTP and planning activities will begin as soon as funding is available.

Other Alternatives: Rely on land managers/owners to individually mitigate fire hazards on their properties, implement post-fire mitigation of effects to water resources/facilities on an as-needed basis, or compensate for post-fire interruption of Middle Boulder Creek water supplies through reliance on other water sources, conservation, and water use restrictions.

Responsible Office: City of Boulder Utilities Division

Priority (High, Medium, Low): Medium to High

Cost Estimate: $10 million (over multiple years, partially offset by partnering agency funds)

Benefits (Avoided Losses):

- Reduced loss of life and property.
- Reduced interruption of critical city water supplies and infrastructure.
- Reduced post-fire water facility clean-up and rehabilitation costs.
- Reduced long-term impacts to natural resources and economic value of Boulder's mountain backdrop.

Potential Funding: City of Boulder Water Resources Fund, FEMA's Pre-Disaster Mitigation program; Healthy Forests Restoration Act; Colorado State Forest Service

Schedule: Pending funding.

Drought Mitigation Actions

2012 Action

32. Review City Landscape Codes for Drought

Project Description/Background: The Statewide Water Supply Initiative 2010 (http://cwcb.state.co.us/water-management/water-supply-planning/Documents/SWSI2010/SWSI2010.pdf) published by the Colorado Water Conservation Board in January 2011, recommended the following actions be taken by municipalities for landscape water use restrictions (residential and non-residential) including:

- Targeted audits for high demand landscape customers
- Landscape transformation of some high water requirement turf to low water requirement plantings
- Irrigation efficiency improvements

This project would review the current city codes related to landscaping and water conservation and recommend suggested improvements that may increase the resiliency of the city during times of drought.

Other Alternatives: Keep codes status quo.

Responsible Office: Water Conservation / Development Review

Priority (High, Medium, Low): Medium

Cost Estimate: Low, can be accomplished with staff resources

Benefits (Avoided Losses): Reduced losses to city landscaping during drought; water savings that can be used for other purposes during drought.

Potential Funding: Staff time

Schedule: 2013

2008 Action

33. Identify and Implement Priority Projects Identified in the City's Drought Plan

Project Description/Background: The City of Boulder is subject to drought due to its location in a semiarid climate. City Council adopted a Drought Plan in 2003 to mitigate the effects of drought on the municipal water supply. The plan applies principles of water conservation and reliability criteria for the city's raw water system. The reliability criteria specify acceptable levels of frequency and amount of reduction in water availability due to drought for the various classifications of use. Water provided by the city serves multiple purposes ranging from critical uses that require an assured supply, such as water for drinking or firefighting, to uses that can tolerate occasional restrictions, such as outdoor irrigation or car washing. The Drought Plan provides guidance for recognizing droughts that will affect water supply availability and responding to these droughts. Strategies for responding to drought include increasing the water supply (e.g., eliminate leasing programs to farmers, lease water, trade water) and decreasing water demand (e.g. voluntary restrictions, mandatory restrictions). Each option presents its own unique issues and must be considered individually and with respect to drought severity.

Progress to Date: Drought Plan actions will be implemented in the event of a drought as identified using the Drought Triggers in the plan and other relevant factors. Drought status is evaluated on May 1 of every year based on snowpack, projected runoff and reservoir storage. Volume 1 of the Drought Plan was updated in 2010 to include options available under the water budget rate structure that was fully implemented in 2008. Volume 2 of the Drought Plan is in the process of being updated in 2012.

Other Alternatives: Other alternatives to the actions included in the Drought Plan include imposing more severe water use restrictions than the adopted water reliability criteria and enhancing the water conservation program to reduce water use by more than the adopted 10 percent of 2000 levels by community build-out. Other options include acquiring additional senior water rights or Colorado-Big Thompson water shares and constructing additional reservoir storage for water rights the city has developed. A less attractive option would be to develop municipal wells requiring extensive and costly augmentation plans. However, wells may not significantly increase the yield of the city's water supply system.

Responsible Office: City of Boulder Utilities Division, Water Resources Program

Priority (High, Medium, Low): High

Cost Estimate: Administrative costs, $150,000 per acre-foot for senior water rights acquisition, $1.5 million for dam reconstruction

Benefits (Avoided Losses): Citizen response to most droughts will be voluntary water use restrictions. During more severe droughts, mandatory water use restrictions will be implemented

to assure that water is available for the most essential water needs (such as indoor use, fire protection, health care) for all of the city's water customers.

Potential Funding: Utility budget, increased utility budgeting, utility financial reserves, drought surcharges, and federal matching grants

Schedule: Ongoing

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5.4.2 Continued Compliance with NFIP 8

Given the flood hazard and risk in the planning area, and recognizing the importance of the NFIP in mitigating flood losses, an emphasis will be placed on continued compliance with the NFIP by the City of Boulder. As an NFIP and CRS participating community the city has and will continue to make every effort to remain in good standing with NFIP. This includes continuing to comply with the NFIP's standards for updating and adopting floodplain maps and maintaining and updating the floodplain zoning ordinance. There are several action items identified in Table 5.2 that address specifics related to NFIP continued compliance. Other details related to NFIP participation are discussed in the community capabilities in Section 4.4 of this plan and the flood vulnerability discussion in Section 4.3.8

5.4.3 Updated Mitigation Action Plan 9

6 PLAN ADOPTION

Requirement §201.6(c)(5): [The local hazard mitigation plan shall include] documentation that the plan has been formally approved by the governing body of the jurisdiction requesting approval of the plan (e.g., City Council, county commissioner, Tribal Council).

The purpose of formally adopting this plan is to secure buy-in from the City of Boulder, raise awareness of the plan, and formalize the plan's implementation. The adoption of this plan completes Planning Step 9 of the 10-step planning process: Adopt the Plan. The governing board for the City of Boulder, the Boulder City Council, has adopted this multi-hazard mitigation plan by passing a resolution. A copy of the generic resolution and the executed copy are included in Appendix A: Adoption Resolution. The plan was originally adopted on August 19, 2008. The plan was re-adopted by City Council in 2012 following the five year update.

7 PLAN IMPLEMENTATION AND MAINTENANCE

Requirement §201.6(c)(4):
[The plan maintenance process shall include a] section describing the method and schedule of monitoring, evaluating, and updating the mitigation plan within a five-year cycle.

Implementation and maintenance of the plan is critical to the overall success of hazard mitigation planning. This is Planning Step 10 of the 10-step planning process. This chapter provides an overview of the overall strategy for plan implementation and maintenance and outlines the method and schedule for monitoring, updating, and evaluating the plan. The chapter also discusses incorporating the plan into existing planning mechanisms and how to address continued public involvement.

7.1 Implementation

This plan is designed to be implemented over time so that the city's vulnerability to natural hazards can be reduced. The city is making progress towards this goal as discussed in Chapter 5. This plan contains many worthwhile mitigation actions, and while some are already completed or underway, the HMPC will need to decide which new actions to focus on. Two factors will help with making that decision: the priority assigned the actions in the planning process and funding availability. Low or no-cost projects can sometimes most easily demonstrate progress toward successful plan implementation. Implementation will also be accomplished through adherence to the schedules identified for each action in Chapter 5.

Another important implementation mechanism that is highly effective and low-cost is incorporation of the hazard mitigation plan recommendations and their underlying principles into other city and county plans and mechanisms, such as the Comprehensive Flood and Stormwater Utility Master Plan and the Boulder Valley Comprehensive Plan. The city has and continues to implement policies and programs to reduce losses to life and property from natural hazards. This plan builds upon the momentum developed through previous and related planning efforts and mitigation programs and recommends implementing projects, where possible, through these other program mechanisms.

Mitigation is most successful when it is incorporated into the day-to-day functions and priorities of government and development. This integration is accomplished by constant, pervasive, and energetic efforts to network, identify, and highlight the multi-objective, win-win benefits to each program, the Boulder community, and its stakeholders. This effort is achieved through the routine actions of monitoring agendas, attending meetings, and promoting a safe, sustainable community. Additional mitigation strategies could include consistent and ongoing enforcement

of existing policies and vigilant review of city and county programs for coordination and multi-objective opportunities.

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 any required local match requirements of state or federal grants can be met. When funding does become available, the HMPC will be in a position to capitalize on the opportunity. Funding opportunities to be monitored include special pre- and post-disaster funds, capital improvement budgeted funds, state or federal earmarked funds, and grant programs, including those that can serve or support multi-objective applications.

7.1.1 Role of Hazard Mitigation Planning Committee in Implementation and Maintenance

With re-adoption of this plan, the Hazard Mitigation Planning Committee (HMPC) will be tasked with plan implementation and maintenance. The HMPC, led by the City of Boulder Department of Public Works Utilities Division, agrees to:

- Act as a forum for hazard mitigation issues;
- Disseminate hazard mitigation ideas and activities to all participants;
- Pursue the implementation of high-priority, low/no-cost recommended actions;
- Keep the concept of mitigation in the forefront of community decision making by identifying plan recommendations when other community goals, plans, and activities overlap, influence, or directly affect increased community vulnerability to disasters;
- Maintain a vigilant monitoring of multi-objective cost-share opportunities to help the community implement the plan's recommended actions for which no current funding exists;
- Monitor and assist in implementation and update of this plan;
- Report on plan progress and recommended changes to the Boulder City Council; and
- Inform and solicit input from the public.

The HMPC will not have any powers over city staff; it will be purely an advisory body. Its primary duty is to see the plan successfully carried out and to report to the community governing board and the public on the status of plan implementation and mitigation opportunities for the city. Other duties include reviewing and promoting mitigation proposals, considering stakeholder concerns about hazard mitigation, passing concerns on to appropriate entities, and posting relevant information on the city website.

7.2 Maintenance

Plan maintenance implies an ongoing effort to monitor and evaluate plan implementation and to update the plan as progress, roadblocks, or changing circumstances are recognized.

7.2.1 Maintenance Schedule

In order to track progress and update the mitigation strategies identified in the action plan, the city will revisit this plan annually and after a significant hazard event or disaster declaration. The City of Boulder Utilities Division is responsible for initiating this review and will consult with members of the HMPC. The review may occur in concert with CRS review and recertification. The suggested time frame for the annual review is in the spring, prior to flood and wildfire season. This will also position the city for grant and CRS review cycles that occur in the fall. A five-year written update to be submitted to the state and FEMA Region VIII, unless disaster or other circumstances (e.g., changing regulations) require a change to this schedule.

This plan will be updated, re-approved by the state and FEMA, and re-adopted within a five-year cycle as per Requirement §201.6(c)(4)(i) of the Disaster Mitigation Act of 2000. Efforts to begin the update should begin no later than January 2017. The city will inquire with the Colorado Office of Emergency Management (CO OEM) and FEMA for funds to assist with the update. Funding sources may include the Emergency Management Performance Grants, Pre-Disaster Mitigation, Hazard Mitigation Grant Program (if a presidential disaster has been declared), and Flood Mitigation Assistance grant funds. Should a Pre-Disaster Mitigation planning grant be sought, the application should be submitted in 2014, as there is a three year performance period to expend the funds, plus there is no guarantee that the grant will be awarded the when initially submitted. This allows time to resubmit the grant in 2015 or 2016 if needed. The next plan update is anticipated to be completed and reapproved by COEM and FEMA Region VIII by November 2017.

7.2.2 Maintenance Evaluation Process

Evaluation of progress can be achieved by monitoring changes in vulnerabilities identified in the plan. Changes in vulnerability can be identified by noting:

- Decreased vulnerability as a result of implementing recommended actions,
- Increased vulnerability as a result of failed or ineffective mitigation actions, and/or
- Increased vulnerability as a result of new development (and/or annexation).

Updates to this plan will follow the most current FEMA, COEM, and CRS planning guidance and consider the following:

- Consider changes in vulnerability due to project implementation,
- Document success stories where mitigation efforts have proven effective,
- Document areas where mitigation actions were not effective,
- Document any new hazards that may arise or were previously overlooked,
- Incorporate new data or studies on hazards and risks,
- Incorporate new capabilities or changes in capabilities,
- Incorporate growth and development-related changes to city inventories, and

- Incorporate new project recommendations or changes in project prioritization.
- Document continued public involvement,
- Document changes to the planning process, which may include new or additional stakeholder involvement,
- Include a public involvement process to receive public comment on the updated plan prior to submitting the updated plan to COEM/FEMA, and
- Include readoption by all participating entities following OEM/FEMA approval.

In order to best evaluate any changes in vulnerability as a result of plan implementation, the HMPC will follow the following process:

- A representative from the responsible office identified in each mitigation measure will be responsible for tracking and reporting on an annual basis to the HMPC on project status and provide input on whether the project as implemented meets the defined objectives and is likely to be successful in reducing vulnerabilities.
- If the project does not meet identified objectives, the HMPC will determine what additional measures may be implemented and an assigned individual will be responsible for defining project scope, implementing the project, monitoring success of the project, and making any required modifications to the plan.

Changes will be made to the plan to accommodate for projects that have failed or are not considered feasible after a review for their consistency with established criteria, the time frame, city priorities, and/or funding resources. Priorities that were not ranked high but were identified as potential mitigation strategies will be reviewed as well during the monitoring and update of this plan to determine feasibility of future implementation. Updating of the plan will be by written changes and submissions, as the HMPC deems appropriate and necessary, and as approved by the Boulder City Council. In keeping with the process of adopting the plan, a public involvement process to receive public comment on plan maintenance and updating will be held during the annual review period, and the final product will be re-adopted by City Council.

7.2.3 Incorporation into Existing Planning Mechanisms

The mitigation strategy in Section 5.3 Mitigation Strategy of this plan recommends using existing plans and/or programs to implement hazard mitigation in the city, where possible. This point is also emphasized previously in this chapter. Based on this plan's capability assessment, the city has and continues to implement policies and programs to reduce losses to life and property from natural hazards. This plan builds upon the momentum developed through previous and related planning efforts and mitigation programs and recommends implementing projects, where possible, through the following mechanisms:

- Basin flood mitigation (Phase A) plans
- Boulder Climate Preparedness Plan
- Boulder Community Wildfire Protection Plan

- Boulder Recovery Plan (in development)
- Boulder Revised Code
- Boulder Valley Comprehensive Plan
- Capital improvement plans and budgets
- Comprehensive Flood and Stormwater Master Plan
- Facilities and Asset Management Master Plan
- Fire-Rescue Master Plan
- Forest Ecosystem Management plan
- Greenways Master Plan
- Source Water Master Plan
- Structure Protection Plan
- Transportation Master Plan
- Other plans, regulations, and practices with a hazard mitigation or loss prevention element

More information on these existing plans and planning mechanisms can be referenced in Section 4.4.

7.2.4 Continued Public Involvement

Continued public involvement is also imperative to the overall success of the plan's implementation. The update process provides an opportunity to publicize success stories from the plan implementation and seek additional public comment. At least one public meeting or workshop to receive public input will be held during the next update period. When the HMPC reconvenes for the update, they will coordinate with all stakeholders participating in the planning process-including those that joined the committee since the planning process began-to update and revise the plan. The plan maintenance and update process will include continued public and stakeholder involvement and input through attendance at designated committee meetings, web postings, and press releases to local media. Public awareness of the plan and individual flood mitigation strategies could be developed each spring prior to the beginning of runoff and flood season. This can also occur in coordination with CRS public notification activities. The Public Participation Plan added in the 2012 update to Appendix F and the Public Outreach Subcommittee of the HMPC (see Appendix B) will serve as a continuing resource for future public involvement.

Appendix A ADOPTION RESOLUTION

Note to Reviewers: When this plan has been reviewed and approved pending adoption by FEMA Region VIII, the adoption resolution will be signed by the city and added to this appendix. A model resolution is provided below:

Resolution # _____

Adopting the City of Boulder Hazard Mitigation Plan

Whereas, the City of Boulder recognizes the threat that natural hazards pose to people and property within our community; and

Whereas, undertaking hazard mitigation actions will reduce the potential for harm to people and property from future hazard occurrences; and

Whereas, the U.S. Congress passed the Disaster Mitigation Act of 2000 ("Disaster Mitigation Act") emphasizing the need for pre-disaster mitigation of potential hazards;

Whereas, the Disaster Mitigation Act made available hazard mitigation grants to state and local governments;

Whereas, an adopted Local Hazard Mitigation Plan is required as a condition of future funding for mitigation projects under multiple FEMA pre- and post-disaster mitigation grant programs; and

Whereas, the City of Boulder fully participated in the FEMA-prescribed mitigation planning process to prepare this local hazard mitigation plan; and

Whereas, the Colorado Office of Emergency Management and Federal Emergency Management Agency, Region VIII officials have reviewed the City of Boulder Multi-Hazard Mitigation Plan and approved it contingent upon this official adoption of the participating governing body;

Whereas, the City of Boulder desires to comply with the requirements of the Disaster Mitigation Act and to augment its emergency planning efforts by formally adopting the City of Boulder Multi Hazard Mitigation Plan;

Whereas, adoption by City of Boulder City Council demonstrates the jurisdiction's commitment to fulfilling the mitigation goals and objectives outlined in this Local Hazard Mitigation Plan.

Whereas, adoption of this legitimacies the plan and authorizes responsible agencies to carry out their responsibilities under the plan.

Now, therefore, be it resolved, that the City of Boulder City Council adopts the City of Boulder Multi-Local Hazard Mitigation Plan as an official plan; and

Be it further resolved, the City of Boulder will submit this adoption resolution to the Colorado Office of Emergency Management and FEMA Region VIII officials to enable the plan's final approval in accordance with the requirements of the Disaster Mitigation Act of 2000.

Passed:_____
(date)

_____
Certifying Official

Appendix B HMPC MEMBER LIST

City of Boulder Multi-Hazard Mitigation Plan Five-Year Update

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City of Boulder Multi-Hazard Mitigation Plan Update

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Appendix C MITIGATION CATEGORIES

C.1 Categories of Mitigation Measures Considered

The following categories are based on the Community Rating System.

- Prevention
- Emergency Services
- Property Protection
- Natural Resource Protection
- Structural Projects
- Public Information

C.2 Alternative Mitigation Measures per Category

Prevention

Preventive measures are designed to keep the problem from occurring or getting worse. Their objective is to ensure that future development is not exposed to damage and does not increase damage to other properties.

- Planning
- Zoning
- Open space preservation
- Land development regulations
- Subdivision regulations
- Floodplain development regulations
- Stormwater management
- Fuels management, fire breaks
- Building codes
  - Firewise construction
- (also see Property Protection)

Emergency Services

Emergency services protect people during and after a disaster. A good emergency services program addresses all hazards. Measures include:

- Warning (floods, tornadoes, ice storms, hail storms, dam failures)
  - NOAA weather radio all hazards
  - Sirens

  - Reverse 911
- Evacuation and sheltering
- Communications
- Emergency planning
  - Activating the emergency operations room (emergency management)
  - Closing streets or bridges (police or public works)
  - Shutting off power to threatened areas (utility company)
  - Holding children at school/releasing children from school (school district)
  - Passing out sand and sandbags (public works)
  - Ordering an evacuation (mayor)
  - Opening evacuation shelters (red cross)
  - Monitoring water levels (engineering)
  - Security and other protection measures (police)
- Monitoring of conditions (dams)
- Critical facilities protection (buildings or locations vital to the response and recovery effort, such as police/fire stations, hospitals, sewage treatment plants/lift stations, power substations)
  - Buildings or locations that, if damaged, would create secondary disasters, such as hazardous materials facilities and nursing homes
  - Lifeline utilities protection
  - Health and safety maintenance

Property Protection

Property protection measures are used to modify buildings subject to damage rather than to keep the hazard away. A community may find these to be inexpensive measures because often they are implemented by or cost-shared with property owners. Many of the measures do not affect the appearance or use of a building, which makes them particularly appropriate for historical sites and landmarks.

- Retrofitting/disaster proofing
  - Floods
    - Wet/dry floodproofing (barriers, shields, backflow valves)
    - Relocation
    - Acquisition
  - Tornadoes
    - Safe rooms
    - Securing roofs and foundations with fasteners and tie-downs
    - Strengthening garage doors and other large openings
  - Drought
    - Improve water supply (transport/storage/conservation)

    - Remove moisture competitive plants (tamarisk/salt cedar)
    - Water restrictions/water saver sprinklers/appliances
    - Grazing on CRP lands (no overgrazing-see noxious weeds)
    - Create incentives to consolidate/connect water services
    - Recycled wastewater on golf courses
  - Earthquakes
    - Removing masonry overhangs, bracing, and other parts
    - Tying down appliances, water heaters, bookcases, and fragile furniture so they will not fall over during a quake.
    - Installing flexible utility connections that will not break during shaking (pipelines, too)
  - Wildland fire
    - Replacing building components with fireproof materials (roofing, screening)
    - Creating "defensible space"
    - Installing spark arrestors
    - Fuels modification
  - Noxious weeds/insects
    - Mowing
    - Spraying
    - Replacement planting
    - Stop overgrazing
    - Introduce natural predators
- Insurance

Natural Resource Protection

Natural resource protection activities are generally aimed at preserving (or in some cases restoring) natural areas. In so doing, these activities enable the naturally beneficial functions of floodplains and watersheds to be better realized. These natural and beneficial floodplain functions include the following:

- Storage of floodwaters
- Absorption of flood energy
- Reduction in flood scour
- Infiltration that absorbs overland flood flow
- Groundwater recharge
- Removal/filtering of excess nutrients, pollutants, and sediments from floodwaters
- Habitat for flora and fauna
- Recreational and aesthetic opportunities

Methods of protecting natural resources include:

- Erosion and sediment control
- Wetlands protection
- Riparian area/habitat protection
- Threatened and endangered species protection
- Fuels management
- Set-back regulations/buffers
- Best management practices-Best management practices ("BMPs") are measures that reduce nonpoint source pollutants that enter the waterways. Nonpoint source pollutants come from non-specific locations. Examples of nonpoint source pollutants are lawn fertilizers, pesticides, and other farm chemicals, animal wastes, oils from street surfaces and industrial areas and sediment from agriculture, construction, mining and forestry. These pollutants are washed off the ground's surface by stormwater and flushed into receiving storm sewers, ditches and streams. BMPs can be implemented during construction and as part of a project's design to permanently address nonpoint source pollutants. There are three general categories of BMPs:
  - Avoidance-Setting construction projects back from the stream.
  - Reduction-Preventing runoff that conveys sediment and other water-borne pollutants, such as planting proper vegetation and conservation tillage.
  - Cleanse-Stopping pollutants after they are en route to a stream, such as using grass drainageways that filter the water and retention and detention basins that let pollutants settle to the bottom before they are drained
- Dumping regulations
- Water use restrictions
- Weather modification
- Landscape management

Structural Projects

Structural projects have traditionally been used by communities to control flows and water surface elevations. Structural projects keep flood waters away from an area. They are usually designed by engineers and managed or maintained by public works staff. These measures are popular with many because they "stop" flooding problems. However, structural projects have several important shortcomings that need to be kept in mind when considering them for flood hazard mitigation:

They are expensive, sometimes requiring capital bond issues and/or cost sharing with Federal agencies, such as the U.S. Army Corps of Engineers or the Natural Resources Conservation Service.

- They disturb the land and disrupt natural water flows, often destroying habitats.

- They are built to a certain flood protection level that can be exceeded by a larger flood, causing extensive damage.
- They can create a false sense of security when people protected by a structure believe that no flood can ever reach them.
- They require regular maintenance to ensure that they continue to provide their design protection level.

Structural measures include:

- Detention/retention structures
- Erosion and sediment control
- Basins/low-head weirs
- Channel modifications
- Culvert resizing/replacement/maintenance
- Levees and floodwalls
- Fencing (for snow, sand, wind)
- Drainage system maintenance
- Reservoirs (for flood control, water storage, recreation, agriculture)
- Diversions
- Storm sewers

Public Information

A successful hazard mitigation program involves both the public and private sectors. Public information activities advise property owners, renters, businesses, and local officials about hazards and ways to protect people and property from these hazards. These activities can motivate people to take protection

- Hazard maps and data
- Outreach projects (mailings, media, web, speaker's bureau)
- Library resources
- Real estate disclosure
- Environmental education
- Technical assistance

C.3 Mitigation Alternative Selection Criteria

The following criteria were used to select and prioritize proposed mitigation measures:

STAPLE/E

- Social-Does the measure treat people fairly? (different groups, different generations)
- Technical-Will it work? (Does it solve the problem? Is it feasible?)
- Administrative-Do you have the capacity to implement and manage project?
- Political-Who are the stakeholders? Did they get to participate? Is there public support? Is political leadership willing to support?
- Legal-Does your organization have the authority to implement? Is it legal? Are there liability implications?
- Economic-Is it cost-beneficial? Is there funding? Does it contribute to the local economy or economic development?
- Environmental-Does it comply with environmental regulations?

Other

- Does the proposed action protect lives?
- Does the proposed action address hazards or areas with the highest risk?
- Does the proposed action protect critical facilities, infrastructure, or community assets?
- Does the proposed action meet multiple objectives (multi-objective management)?

Table C.1. Example Mitigation Actions Items by Category and Hazard

Alternative Mitigation Actions	Human Health hazards (Pan flu, West Nile)	Dam Failure	Floods	Land slides/ Land Subsidence /Soil hazards	Weather Extremes (hail, lightning, wind, temps, fog, drought)	Tornadoes and Earthquake	Wildfires	Winter Weather
PREVENTION								
Building codes and enforcement			■	■	■	■	■	■
Comprehensive Watershed Tax			■					
Density controls		■	■	■			■	
Design review standards			■	■		■	■	
Easements			■	■			■	
Environmental review standards			■	■		■	■	
Floodplain development regulations		■	■					
Hazard mapping		■	■	■			■	
Floodplain zoning		■	■					
Forest fire fuel reduction							■	
Housing/landlord codes					■			
Slide-prone area/grading/hillside development regulations				■			■	
Manufactured home guidelines/regulations		■	■		■	■		
Multi-Jurisdiction Cooperation within watershed		■	■					
Open space preservation		■	■	■			■	
Performance standards		■	■	■	■	■	■	■
Special use permits		■	■	■			■	
Stormwater management regulations			■					
Subdivision and development regulations		■	■	■		■	■	
Surge protectors and lightning protection					■			
Tree Management					■		■	■
Transfer of development rights			■	■			■	
Utility location				■	■			■

Alternative Mitigation Actions	Human Health hazards (Pan flu, West Nile)	Dam Failure	Floods	Land slides/ Land Subsidence /Soil hazards	Weather Extremes (hail, lightning, wind, temps, fog, drought)	Tornadoes and Earthquake	Wildfires	Winter Weather
PROPERTY PROTECTION								
Acquisition of hazard prone structures		■	■	■			■	
Construction of barriers around structures		■	■					
Elevation of structures		■	■					
Relocation out of hazard areas		■	■	■			■	
Non structural improvements (safety film on windows, bookshelf anchoring, critical equipment bracing etc.)					■	■		
Structural retrofits (e.g., reinforcement, floodproofing, bracing, etc.)			■		■	■	■	■
PUBLIC EDUCATION AND AWARENESS								
Debris Control			■					
Flood Insurance		■	■					
Hazard information centers	■	■	■	■	■	■	■	■
Public education and outreach programs	■	■	■	■	■	■	■	■
Real estate disclosure		■	■	■	■	■	■	■
Crop Insurance					■	■		
NATURAL RESOURCE PROTECTION								
Best Management Practices (BMPs)	■		■	■	■		■	
Forest and vegetation management	■	■	■	■	■		■	■
Hydrological Monitoring	■	■	■	■	■			
Sediment and erosion control regulations		■	■	■				
Stream corridor restoration			■	■				
Stream dumping regulations			■					
Urban forestry and landscape management		■	■	■	■		■	■
Wetlands development regulations			■	■			■	

Alternative Mitigation Actions	Human Health hazards (Pan flu, West Nile)	Dam Failure	Floods	Land slides/ Land Subsidence /Soil hazards	Weather Extremes (hail, lightning, wind, temps, fog, drought)	Tornadoes and Earthquake	Wildfires	Winter Weather
EMERGENCY SERVICES								
Critical facilities protection		■	■	■	■	■	■	■
Emergency response services		■	■	■	■	■	■	■
Hazard threat recognition	■	■	■	■	■	■	■	■
Hazard warning systems (community sirens, NOAA weather radio)		■	■	■	■	■	■	■
Health and safety maintenance	■	■	■	■	■	■	■	■
Post-disaster mitigation	■	■	■	■	■	■	■	■
STRUCTURAL PROJECTS								
Channel maintenance			■					
Dams/reservoirs (including maintenance)		■	■					
Levees and floodwalls (including maintenance)			■					
Safe room/shelter					■	■		■
Snow fences								■
Water supply augmentation					■			

Appendix D REFERENCES

References and Resources

An Assessment of Volcanic Threat and Monitoring Capabilities in the United States. U.S. Geological Survey. 2005. http://pubs.usgs.gov/of/2005/1164/.

Boulder County Assessor's Office.

Boulder County Climate Change Preparedness Plan. 2012

Boulder Valley Comprehensive Plan. City of Boulder and Boulder County. 2010.

Boulder Wind Storms. University of Colorado at Boulder Department of Atmospheric and Oceanic Sciences Weather Lab.

Census 2010. U.S. Census Bureau. www.census.gov/.

Charlie, W., D. Doehring, and S. Oaks. Earthquake Hazard in Colorado: Design Earthquakes. Colorado Earthquake Hazard Reduction Program. Open File Report 93-01. 1993.

City of Boulder. www.bouldercolorado.gov/.

City of Boulder Climate Action Plan. City of Boulder Office of Environmental Affairs. 2011.

City of Boulder Comprehensive Flood and Stormwater Utility Master Plan. City of Boulder. 2004. www.bouldercolorado.gov/files/Utilities/Flood/CFSMasterPlan.pdf.

City of Boulder Drought Response Plan. City of Boulder Public Works Department. 2003.

City of Boulder Fire-Rescue Master Plan. City of Boulder Fire-Rescue Department. 2012 Draft Update.

City of Boulder Forest Ecosystem Management Plan. City of Boulder Open Space and Mountain Parks and Fire Departments. 1999.

City of Boulder Greenways Master Plan. City of Boulder. 2011.

City of Boulder Parks and Recreation Master Plan. City of Boulder Department of Parks and Recreation. 2006. City of Boulder Revised Code. City of Boulder.

City of Boulder Revised Code. City of Boulder. 2012.

City of Boulder Transportation Master Plan. City of Boulder. 2008.

City of Boulder Urban Open Lands Master Plan. City of Boulder.

City of Boulder Urban Wildlife Management Plan. City of Boulder. 2006.

City of Boulder Community Wildfire Protection Plan. City of Boulder. 2010.

City and County of Boulder Office of Emergency Management.

Colorado Avalanche Information Center.

Colorado Disaster History. Federal Emergency Management Agency.

Colorado Division of Wildlife.

Colorado Drought Mitigation and Response Plan. Colorado Water Conservation Board. 2010.

Colorado Earthquake Information Database. Colorado Geological Survey.

Colorado Geological Survey.

Colorado Landslide Hazard Mitigation Plan. 1988. Colorado Geological Survey. .

Colorado Late Cenozoic Fault and Fold Internet Map Server. Colorado Geological Survey.

Colorado Lightning Resource Page. National Weather Service, Pueblo.

Colorado Office of Emergency Management.

Colorado State Forest Service.

Colorado Water Conservation Board.

Community Rating System. Federal Emergency Management Agency National Flood Insurance Program.

Developing the Mitigation Plan: Identifying Mitigation Actions and Implementation Strategies. Federal Emergency Management Agency. FEMA 386-3. 2003.

Disease Maps 2007. U.S. Geological Survey.

Drought and Water Supply Assessment. Colorado Water Conservation Board. 2004.

Emergency Alert System. Federal Communications Commission.

Emergency Designation News Releases. U.S. Department of Agriculture Farm Service Agency.

Emergency Operations Plan Boulder County–City of Boulder. City and County of Boulder Office of Emergency Management

The Enhanced Fujita Scale. National Oceanic and Atmospheric Administration Storm Prediction Center. 2007.

Facts about Hail. Colorado Division of Emergency Management.

Flood Safety Education Project.

Fourmile Canyon & Wonderland Creek Flood Mitigation Planning. City of Boulder Utilities.

Framework for a National Volcano Early Warning System. U.S. Geological Survey. Open-File Report 2005-1164. 2005.

Getting Started: Building Support for Mitigation Planning. Federal Emergency Management Agency. FEMA 386-1. 2002.

Hazard Mitigation Planning and Hazard Mitigation Grant Program. Federal Register. Interim Final Rule. February 26, 2002.

HAZUS-MH. Federal Emergency Management Agency.

Heat Index. National Weather Service.

Influenza. World Health Organization Epidemic and Pandemic Alert and Response.

Introduction to Hazard Mitigation. Federal Emergency Management Agency. FEMA IS-393.A. 2006.

Jones, S. Boulder Daily Camera.

Levees in History: The Levee Challenge. Dr. Gerald E. Galloway, Jr., P.E., Ph.D., Water Policy Collaborative, University of Maryland, Visiting Scholar, USACE, IWR.

Lightning Safety. National Weather Service.

Modified Mercalli Intensity Scale. Math/Science Nucleus.Org.

NASA.

National and Regional Seismic Hazard Maps. U.S. Geological Survey Earthquake Hazards Program. .

National Atlas of the United States of America. U.S. Department of the Interior.

National Center for Atmospheric Research. .

National Flood Insurance Program. Federal Emergency Management Agency..

Natural Hazard Mitigation Saves: An Independent Study to Assess the Future Savings from Mitigation Activities. National Institute of Building Science Multi-Hazard Mitigation Council. 2005.

National Drought Mitigation Center.

National Lightning Safety Institute.

National Oceanic and Atmospheric Administration Climate Diagnostics Center. .

National Oceanic and Atmospheric Administration Storm Prediction Center.

National Weather Service.

NOAA National Severe Weather Laboratory

NOAA Weather Radio All Hazards. National Weather Service.

PandemicFlu.gov. U.S. Department of Health & Human Services. .

PERI Presidential Disaster Declaration Site.

Robert T. Stafford Disaster Relief and Emergency Act. Public Law 93-288, as amended, 42 U.S.C. 5121-5207. June 2007.

Rocky Mountain Area Predictive Services.

Rocky Mountain Insurance Information Association, 2010.

Spatial Hazard Events and Losses Database for the United States. University of South Carolina Hazards Research Lab.

State of Colorado Natural Hazards Mitigation Plan. Colorado Division of Emergency Management. 2010.

Storm Events Database. National Climatic Data Center.

Tornado Fujita Damage Scale. National Oceanic and Atmospheric Administration Storm Prediction Center. 1971.

Understanding Your Risks: Identifying Hazards and Estimating Losses. Federal Emergency Management Agency. FEMA 386-2. 2001.

University Corporation for Atmospheric Research.

University of Colorado at Boulder ATOC Weather Lab.

Urban Drainage and Flood Control District.

U.S. Department of Agriculture Farm Service Agency.

U.S. Drought Monitor. University of Nebraska–Lincoln National Drought Mitigation Center.

U.S. Earthquake Information by State: Colorado. U.S. Geological Survey. Earthquake Hazards Program. Colorado. 2007.

U.S. Forest Service Wildland Fire Assessment System.

Volcanic Hazards Ash Dispersion Map. U.S. Geological Survey.

West Nile Virus Mosquito Management Plan. City of Boulder Office of Environmental Affairs. 2006.

Western Regional Climate Center.

Wind Chill Chart. National Weather Service. 2001.

Zoonotic Diseases. Colorado Department of Public Health and Environment. Disease Control and Environmental Epidemiology Division. 2007.

-----Original MS Outlook Appointment inviting HMPC and non-City stakeholders to kickoff meeting-----

From: Bauer, Kurt

Sent: Friday, January 20, 2012 3:40 PM

To: Abernathy, Rella; Alexander, Kathleen; Bauer, Kurt; Brislawn, Jeff P; Castro, Joe; 'Chuck Merritt'; Claussen, Matt; Coleman, Christie; Crean, Joanna; Damico, Don; David Webster (dwebster@bouldercounty.org); DeSouza, Sarah; 'Doug Miller'; Ellenberg, Stewart; Geissler, Abra; Harberg, Robert; Hewat, James; Hutton, Kim; Jacobson, Jody; 'Jamie Prochno'; Johnson, Beverly; Johnson, Darcy; 'Julie Baxter'; Ken Brink (kenneth.brink@state.co.us); Kevin Houck (kevin.houck@state.co.us); Knapp, Katie; kstewart@udfcd.org; 'Lacey Croco'; 'Lisa Potter'; Lowrey, David; 'Mark Mullane'; Martin, Lisa; External-Chard-Mike; mleach@bouldercounty.org; Noble, Annie; Olander, Teri; Oliver, Brian; Rosato, Curry; Rosato, Peter; Shea Thomas; 'Steve Hoban'; Sullivan, Douglas; Sweeney, Michael; Taddeucci, Joe; Trice, Chris; Weinheimer, Carey; White, Kip; Zader, David

Cc: Sager, Carey; Foster, Jeanine; Morrison, Chris; Baxter, Julie; Zuzack, Marie

Subject: Multi-Hazard Mitigation Plan Kick Off Meeting

When: Thursday, February 09, 2012 10:00 AM-12:00 PM (UTC-07:00) Mountain Time (US & Canada).

Where: City Council Chambers 1777 Broadway

Note: The GMT offset above does not reflect daylight saving time adjustments.

Dear All:

We are requesting your participation on a Planning Committee to help us prepare a five-year update to the city's Multi-Hazard Mitigation Plan. The City of Boulder's Multi-Hazard Mitigation Plan (the Plan) was prepared pursuant to the requirements of the federal Disaster Mitigation Act of 2000 so that the city would be eligible for the Federal Emergency Management Agency (FEMA) Pre-Disaster Mitigation and Hazard Mitigation Grant Program and receive FEMA Community Rating System credits. The Plan was adopted by City Council on Aug. 19, 2008 and requires annual reviews and a full update every five years.

You are receiving this notice because you or your department was part of the original Planning Committee or are believed to be a current stakeholder. Attached is the proposed Planning Committee. Please confirm that contact information is correct and notify me of any needed changes.

- Your participation is requested for the following tasks:
- Attending and participating in the three meetings over an eight month period;
- Providing data required to update the Plan;
- Reviewing and providing comments on the Plan drafts;
- Advertising, coordinating, and participating in the public input process.

The Department of Public Works Utilities Division is taking the lead on coordinating the plan update. The city has hired AMEC, a consulting firm that developed the original plan, to facilitate the process and update the document. Our project kickoff meeting will be held from 10 a.m. - noon on Thurs. Feb. 9 in City Council Chambers located on the second floor of the Municipal Building (1777 Broadway). This meeting will be used to explain the process, your role in it, and to get us started. We will also discuss public input, the planning schedule and coordination with other organizations and plans at this meeting. I will forward a meeting agenda one week prior to the meeting.

The existing Multi-Hazard Mitigation Plan can be found on the city's website:

www.bouldercolorado.gov <http://www.bouldercolorado.gov/> > city A-Z > M > Multi-Hazard Mitigation Plan

or

http://www.bouldercolorado.gov/index.php?option=com_content&task=view&id=7898&Itemid=1189

Sincerely,

Kurt Bauer, P.E. C.F.M.
Engineering Project Manager
City of Boulder
Public Works Department - Utilities Division
P.O. Box 791
Boulder, CO 80306
303-441-4232
BauerK@bouldercolorado.gov

2012 UPDATE

KICKOFF MEETING

Thursday, February 9th, 2012
10:00 a.m. to 12:00 p.m.
City Council Chambers
1777 Broadway
Boulder, CO

- **Introductions**
- **Mitigation, Mitigation Planning, and the Disaster Mitigation Act Requirements**
- **The Role of the Hazard Mitigation Planning Committee**
- **Overview of the 2008 City of Boulder Multi- Hazard Mitigation Plan**
- **Objectives and Schedule for the Plan Update**
- **Review of Identified Hazards**
- **Implementation Success Stories**
- **Coordinating with Other Agencies, Related Planning Efforts, and Recent Studies**
- **Planning for Public Involvement**
- **Information Needs**
- **Questions and Answers/Adjourn**

SIGN-IN SHEET
CITY OF BOULDER
LOCAL HAZARD MITIGATION PLAN UPDATE PROJECT
HMPC Meeting #1 Kickoff and Hazard Identification Review
February 9, 2012
City Council Chambers, 1777 Broadway, Boulder, CO

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Christie Coleman	colemanc@bouldercolorado.gov	1739 Broadway Boulder, CO	303-441-4077	Public Works Flood Utility

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CITY OF BOULDER
LOCAL HAZARD MITIGATION PLAN UPDATE PROJECT
HMPC Meeting #1 Kickoff and Hazard Identification Review
February 9, 2012
City Council Chambers, 1777 Broadway, Boulder, CO

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SIGN-IN SHEET
CITY OF BOULDER
LOCAL HAZARD MITIGATION PLAN UPDATE PROJECT
HMPC Meeting #1 Kickoff and Hazard Identification Review
February 9, 2012
City Council Chambers, 1777 Broadway, Boulder, CO

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Jeff Briskman	Jeff.briskman@amec.com	1002 Walnut St Boulder, CO 80302	303-820-4654	AMEC

Summary of the City of Boulder Multi-Hazard Mitigation Plan Update Kick-Off Meeting

10:00 am to 12:00 pm
February 9, 2012
City Council Chambers
1777 Broadway, Boulder, CO

Introductions and Opening Remarks

Welcoming remarks and an introduction to hazard mitigation were presented by Kurt Bauer, from the City of Boulder Public Utilities Department. Kurt introduced Jeff Brislawn from AMEC Earth and Environmental, the consultant group hired to facilitate the planning process and to develop the updated City of Boulder Multi-Hazard Mitigation Plan (MHMP). Supporting documents also were provided as handouts.

Jeff asked everyone around the room to introduce themselves. 42 persons representing a mix of City agencies and special districts were present and documented on sign-in sheets. Other stakeholders present included representatives from the Colorado Water Conservation Board, Colorado Department of Emergency Management, American Red Cross, Colorado Department of Transportation, Urban Drainage and Flood Control District, University of Colorado-Boulder, and Boulder County.

Mitigation, Disaster Mitigation Act (DMA) Requirements, and the Planning Process

A PowerPoint presentation was presented by Jeff Brislawn, the project manager from AMEC Earth and Environmental. The presentation described the objectives and goals for the Multi-Hazard Mitigation Plan Update and the ten step planning process that will be followed. The plan is intended to identify hazards, assets at risk, and ways to reduce impacts through long-term, sustainable mitigation projects. The plan will also maintain eligibility for FEMA mitigation grant funding.

The Role of the Hazard Mitigation Planning Committee (HMPC)

This meeting is the first meeting of the City of Boulder Hazard Mitigation Planning Committee (HMPC) during the update process. A definition of participation in the planning process was provided that includes:

- Attending and participating in the HMPC meetings,
- Establishing or reconvening a local steering committee,
- Providing available data requested by the HMPC coordinator or AMEC's project manager,
- Providing or updating hazard profiles and vulnerability details specific to the City,

- Developing or updating the local mitigation strategies (action items and progress to date, such as the relocation of the EOC),
- Advertising and assisting with the public input process,
- Reviewing and commenting on plan drafts, and
- Coordinating the formal adoption actions.

It was discussed how each community needs to commit to the above elements to receive credit for participation in the plan update process Credit leads to eligibility for certain FEMA pre- and post-disaster grant funding for hazard mitigation projects. In addition, all communities must be in good standing with the National Flood Insurance Program (NFIP) to be eligible for FEMA grants.

Overview of the 2008 City of Boulder Multi Hazard Mitigation Plan

Jeff Brislawn talked about the existing plan originally developed in 2006 and 2007 and approved in 2008. The plan is being updated in accordance with the five year update requirement. Mr. Brislawn pointed out some of the hazards data in the plan and referred to the mitigation action strategies identified in the 2008 plan. The progress on implementation of these strategies will be assessed and documented during the update process.

Discussion of Objectives and Schedule for the Plan Update

Goals of the process were discussed that included:

- Update the City's Multi-Hazard Mitigation Plan (2006)
- Update the City's mitigation strategies
- Increase participation
- Expand the participation of non-governmental stakeholders in the planning process, including public input

The plan update will be developed over the next nine months, with one more meeting of the HMPC. AMEC will be drafting the updated risk assessment in the next couple of months, with input from the HMPC. The first draft for HMPC review is targeted for July 2012, and a public review draft in September 2012. A final draft for State and FEMA review is targeted to be completed by late September 2012. The final approved plan should be ready for adoption by December 2012. The next meeting of the HMPC is targeted for late April 2012, with exact dates to be determined (TBD).

Review of Identified Hazards

Based on hazards from the 2008 plan, the list of potential natural hazards was reviewed.. The focus is on natural hazards, since manmade hazards are not required by DMA 2000 regulations and often are dealt with through separate planning mechanisms. However, some health and

related hazards were included in the 2008 plan. For the City of Boulder the hazards currently in the plan include:

- Avalanche
- Dam Failure
- Drought
- Earthquakes
- Floods
- Human Health Hazards
  - Pandemic Flu
  - West Nile Virus
- Landslides and Rockfalls
- Severe Weather
  - Extreme Temperatures
  - Fog
  - Hailstorm
  - Heavy Rains
  - Lightning
  - Tornadoes
  - Windstorms
  - Winter Storms
- Soil Hazards
  - Expansive Soils
  - Land Subsidence
- Volcanoes
- Wildfire

These hazards were compared to the hazards list in the 2010 State of Colorado Hazard Mitigation Plan. In general, the HMPC felt that the list was comprehensive and should be maintained as such in the updated plan. Additional man-made hazards were identified that may need to be explored further, but the current scope of work is limited to natural hazards per the DMA 2000 requirements. The man-made hazards included hazardous material spills and problems at the local psychiatric facility.

Jeff Brislawn asked HMPC members to review specific hazard chapters and comment on how they could be enhanced or updated with:

- Historic incidents
- Public perception
- Scientific studies
- Other plans and reports (e.g., flood and drainage studies, CWPPs, Internet databases)
- Recent disasters

A discussion of recent studies of hazards in other documents and reports performed by or for the City followed. Recent studies included:

- Two studies for the Barker dam
  - A seismicity event
  - An overtopping event
- Urban Forestry Related Studies
- Newer/updated flood studies
- Updated CWPP plan
- Updated wetlands regulation
- A Structural Protection Plan (fire) for the west side of the City
- Update Critical Facilities Ordinance
- A study of Four Mile flooding and Urban Drainage
- A St. Vrain Wildfire Risk Assessment

Planning for Continued Public and Stakeholder Involvement

Public meetings will be part of the planning process. The original plan involved 2 such meetings. The update process will include 2 in locations to be decided. The first will occur early in the process to gain input on the updated risk assessment. The next will be held later in the process when the public review draft becomes available.

A discussion was held on how to coordinate this planning process with other agencies and departments in order to meet one of the DMA planning requirements. A list of stakeholders was gathered prior to the kickoff meeting. It was suggested that coordination with RTD, the Department of Commerce Laboratories, Boulder Valley School District, Naropa University, and Colorado State Parks, and others occur in the process.

The list below includes participants in the kickoff meeting:

- Local Government representatives
- County Agencies
- State Agencies
- Stakeholders
- Others

Some additional ideas for further consideration included using social media methods to disseminate and receive information; “piggy backing” plan update meetings on other public hearings, events, etc.; using school districts to help disseminate information; working with the Chamber of Commerce and Downtown Business Inc.; working with the Parks and Recreation Advisory Board; working with the Water Resource Advisory Board; and finding ways to close the gap between the public’s awareness and the existence of various emergency management related plans.

Coordination with other Plans

A discussion on coordination with other plans/policies and hazard information sources occurred, and the following were suggested by the HMPC:

- Community Wildfire Protection
- Boulder Valley Comprehensive Plan
- City of Boulder Drought Plan
- City of Boulder Urban Forestry Master Plan
- City of Boulder Recovery Plan
- City of Boulder Strategic Plan
- Boulder County Flood Mitigation Plan
- The State of Colorado's Hazard Mitigation Plan

Data Collection Needs and Next steps

A historic hazard event worksheet was distributed to members of HMPC that is designed to facilitate gathering updated information on detailed past hazard events. The HMPC was asked to return the updated information data to Jeff Brislawn by March 30, 2012. The HMPC was also asked to review the existing plan, and form a local steering committee to support the process.

Adjourn

The meeting adjourned at 12:00pm.

Summary prepared by Jeff Brislawn and Chris Morrison, AMEC Earth and Environmental

CITY OF BOULDER MULTI-HAZARD MITIGATION PLAN

2012 UPDATE

RISK ASSESSMENT and GOALS UPDATE MEETING

Thursday, May 31st, 2012
9:00 a.m. to 12:00 p.m.
City Council Chambers
1777 Broadway
Boulder, CO

- **Introductions**
- **Review of the Planning Process**
- **Review of Identified Hazards**
- **Vulnerability Assessment Update Results**
- **Capability Assessment Review**
- **Planning for Public Involvement**
- **Reviewing and Updating Plan Goals**
- **Information Needs and Next Steps**
- **Questions and Answers/Adjourn**

SIGN-IN SHEET
CITY OF BOULDER
LOCAL HAZARD MITIGATION PLAN UPDATE PROJECT
HMPC Meeting #2 Risk Assessment Review and #3 Goals Review
May 31, 2012 9:00am-12:00
City Council Chambers, 1777 Broadway, Boulder, CO

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SIGN-IN SHEET
CITY OF BOULDER
LOCAL HAZARD MITIGATION PLAN UPDATE PROJECT
HMPC Meeting #2 Risk Assessment Review and #3 Goals Review
May 31, 2012 9:00am-12:00
City Council Chambers, 1777 Broadway, Boulder, CO

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Shelby Hudson	shelby.hudson@ dhs.gov	Denver Federal center	303-519-3787	FEMA. Region VIII

Page 2

City of Boulder Hazard Mitigation Plan Update

Risk Assessment and Goals Update Meeting Summary
May 31, 2012 from 9:00 am to 12:00 pm
City of Boulder Municipal Building
City Council Chambers

Introductions and Opening Remarks

Welcome remarks were presented by Kurt Bauer, Engineering Project Manager from the City of Boulder Public Works Division, and Project Manager Jeff Brislawn from AMEC. Jeff asked everyone around the room to introduce themselves. 17 persons from the Hazard Mitigation Planning Committee (HMPC) were present. Specific organizations represented include: City of Boulder, City of Boulder/Boulder County Office of Emergency Management, Colorado Division of Emergency Management, University of Colorado, Urban Drainage and Flood Control District, Boulder County Hospital, Colorado Department of Transportation, and FEMA Region VIII.

Risk Assessment Presentation

Overview of the Planning Process

Jeff discussed the 10-Step Planning Process for the planning effort and highlighted the current steps under discussion in the meeting. He noted current progress on the plan, including the convening of the HMPC in February, the collection of necessary data, including GIS, recent hazard data, and related plans. Input from the HMPC and other stakeholders has been incorporated into the Risk Assessment and Capabilities Assessment draft documents.

Discussion of the Risk Assessment Methodology

Jeff presented an overview of the updated Risk Assessment in a Power Point presentation. He discussed the elements of the hazard identification process and the elements of the vulnerabilities assessment conducted for all medium- and high significance hazard profiles in the County. He then presented the preliminary ranking of the hazards based on a combination of probability, magnitude and extent. He emphasized that the rating of 'low', 'medium' and 'high' was a relative measurement used to prioritize hazards for planning purposes. Improvements in the risk assessment from the previous plan were presented, and the disaster declaration history for the City was reviewed.

Highlights of significant hazards affecting the City

Jeff then discussed hazards affecting the City, beginning with flood hazards and. He began the discussion by noting Boulder's flood history. Maps and tables of vulnerability were presented including an updated 100- and 500-year floodplain risk assessment aggregated by drainage basin. Jeff noted that data provided by the County Assessor had building construction date as one of the

GIS attributes. Using the date of the original FIRM (July 17, 1978), pre-FIRM buildings were identified in the 100-year floodplain as higher-risk structures; vs post firm construction which should be mitigated to withstand 100-year flood impacts. Kurt Bauer from the City of Boulder commented that some of the basins may need to be combined, particularly South Boulder Creek and a few of its tributaries. Kurt and Jeff decided to work together outside of the meeting to address this issue.

Jeff then noted that the City of Boulder's special flood hazard zones, known as the high hazard and conveyance zones, were analyzed as well. A table of critical facilities in the 100 and 500 year flood zones was presented. Christie Coleman from the City of Boulder Utilities noted differences between the critical facility table AMEC provided and the City of Boulder's table used for the draft critical facility protection ordinance. Kristie Coleman explained that the City only had three hazardous materials facilities in the City that met the definition of the draft ordinance. The remainder of the hazardous materials facilities are "notification facilities." Christie volunteered to work with AMEC to ensure continuity between the City lists and the list that AMEC will place in the plan.

Maps of where the critical facilities in the City are located was presented. Historic districts in the flood zones were shown as well. A member of the HMPC noted that the building value for the Boulder High School may not have been included in the Assessor's data, but that the Risk Management department would have these figures. Populations at risk in the flood zones were presented. AMEC noted that the figures were based on 2010 Census figures of 2.16 people per household. Chris Trice from the City of Boulder GIS department asked if AMEC had used the City of Boulder's vacancy rates of 5%. AMEC noted that the revision would be made.

A discussion of flood insurance policies in the City was presented. It was noted that there had been a 50% increase in the number of policies in the City since 2007. Records of flood insurance claims were presented, and it was noted that 6 were for post-FIRM structures. A discussion of why this occurred in the regulated floodplain followed. Kurt Bauer expressed interest in knowing where these properties are located. It was noted that there were no repetitive loss structures in the City.

Jeff then presented the dam failure hazard. A list and maps of the high and significant hazard dams was presented. GIS analysis was performed on the Barker dam failure inundation zone in the update, as it had been in 2007. New to the plan update was the GIS analysis of the Gross dam inundation risk. The HMPC noted the large number of structures in the City that would be at risk to a failure of either of these dams.

Jeff then presented the wildfire risk in the city. In particular, Jeff noted the recent occurrences in or near City limits in 2010. Jeff presented a map of the City's Community Wildfire Protection Plan communities and the analysis tables that AMEC had completed that summarize the buildings and populations within these subdivisions in the wildland urban interface.

Jeff then presented a brief discussion on drought. It was noted by the HMPC that a local expert in water supply planning could be consulted on the issue of drought. Jeff then presented the earthquake risk to the City, which would be a low probability but high consequence event. State plan earthquake analysis results were presented. AMEC performed a Hazus earthquake modeling scenario to refine the risk to Boulder. Results of this analysis was presented to the HMPC.

Jeff then presented the severe weather hazards of extreme temperatures, hail, and lightning. It was noted that extreme temperatures may increase with the affects of climate change. A question on whether hail would be worsened by affects of climate change was put forth. Jeff volunteered to look into the issue further. A discussion was also had regarding if the significance of extreme temperatures should be changed from low to medium due to projected temperature increases associated with climate change. The HMPC decided to keep it as is but note that it should be revisited with future plan updates.

Pandemic flu was then discussed. The question of downgrading the hazard significance from high to medium was suggested by AMEC. Chuck Merritt from the Boulder County Hospital noted that from the hospital's perspective, pandemic flu should remain as a high significance hazard. He noted that Boulder has a well traveled population, which increases the risk of pandemic flu being introduced to the City of Boulder. The HMPC decided to keep the pandemic flu significance as high.

Jeff presented the windstorm hazard. It was noted that many significant wind events have affected the City since 1955. It was also noted that one of the more recent wildfires was started when a power pole was blown over during a windstorm.

Finally, Jeff presented the severe winter storm hazard. Severe winter storm was separated from the other severe weather hazards for the plan update. During the creation of the risk assessment, the NCDC database was temporarily down. AMEC asked the HMPC for events since the 2007 plan. None were noted, but one of the HMPC members noted that in the 1978-1979 winter, a school in the City suffered a collapsed roof from a severe winter storm event. AMEC will insert this event into the past history.

Mitigation Capability Assessment

Susan Hayes of AMEC discussed the content, purpose and overview of the updated capabilities assessment, including a discussion on how the assessment was conducted. Highlights of the updated capabilities since the previous plan were presented, including CRS reclassification from Class 8 to Class 6, updated critical facilities ordinance, a recently completed climate change preparedness plan, long term recovery planning, and debris management plans.

Goals Update

The HMPC was provided a handout that listed the existing goals in the plan and asked to review for any needed changes. It was suggested that some of the bullets under the objectives were too specific and should be dropped. Some other modifications were suggested to the objectives, but the three goals were felt to be comprehensive and remained unchanged. AMEC will re-work the goals and objectives according to the discussion and redistribute for discussion and final consensus at the next HMPC meeting.

Next Steps

The next meetings will discuss the goals and action item developments and are scheduled for the morning of June 26th in the City Council Chambers. In addition, there are two public meetings required during the planning process that will be scheduled in the upcoming weeks.

AMEC has completed the draft risk assessment and distributed it for review. The HMPC is requested to read the draft documents, provide comments and feedback by June 8th, and begin to examine the risk assessment and mitigation strategy in terms of updating action items in the plan. The update of the mitigation strategy will be the focus of the June 26th meeting.

Adjourn

The presentation and discussions concluded at 12:00pm with additional individual discussions between HMPC members following.

Summary prepared by Chris Morrison and Jeff Brislawn, AMEC Environment and Infrastructure.

CITY OF BOULDER
MULTI-HAZARD MITIGATION PLAN
2012 UPDATE
Mitigation Strategy Development Meetings

Date: June 26th, 2012
Time: 9:00am-12:00pm
Location: City Council Chambers, 1777 Broadway, Boulder, CO

Agenda

1. Opening remarks and introductions
2. Review of the planning process and key issues from the risk assessment and capability assessment
3. Finalize goals and objectives
4. Meeting to review possible mitigation activities and alternatives
   - Discuss mitigation alternatives and options
   - Discuss criteria for mitigation action selection and prioritization
5. Meeting to update existing actions in the plan
   - Review of progress on existing actions in the plan and success stories
   - Brainstorming Session - Development of new mitigation actions (group process)
   - Prioritize mitigation actions (group process)
   - Discuss plan implementation and maintenance procedures
6. Discuss next steps

SIGN-IN SHEET
CITY OF BOULDER
LOCAL HAZARD MITIGATION PLAN UPDATE PROJECT
HMPC Mitigation Strategy Meetings
June 26, 2012
City Council Chambers, 1777 Broadway, Boulder, CO

Name	Email Address	Address	Phone	Department/Organization/ Affiliation
Chris Morrison	chris.morrison@amec.com	2000 S Colorado Blvd Suite 2-1000 Denver, CO 80222	303-740-5326	AMEC
Jeff Brislawn	jeff.brislawn@amec.com	1002 WALNUT ST Suite 200 Boulder, CO 80302	303-820-4654	AMEC
Doug Miller	damiller@frii.com	7634 Estate Cir Niwot CO 80503	303 818 9180	American Red Cross
Kurt Bauer	bauerk@bouldercolorado.gov		(3) 441-4232	COB
Chris Trice	TRICEC@BOULDERCOLORADO.GOV		3 441-3298	COB
Anne Noble	Noblea@bouldercolorado.gov		3 4413242	COB
Peter Rosato	RosatoP@bouldercolorado.gov	5050 Pearl 80301	3-413-7116	COB-PW
David Lowrey	lowreyd@bouldercolorado.gov		x4356	Fire
Marie Zuzack	zuzackm@boulder.col...		x1886	CP+S
Don D'Amico	DAMICOD@Boul...	66 S CHERRYVALE	x2055	OSMP
Joe Castro	castroj@boulder.colorado.gov		x3163	COB
Bob Harberg	harbergb@bouldercolorado.gov	P.O. Box 791 Boulder, CO 80306	5 x3124	COB
Abra Geissler	abra.geissler@dot.state.co.us	1420 2nd St Greeley, CO 80631	970-350-2269	CDOT
Susan Hayes	susan.hayes@amec.com		970-988-7154	AMEC.

SIGN-IN SHEET
CITY OF BOULDER
LOCAL HAZARD MITIGATION PLAN UPDATE PROJECT
HMPC Mitigation Strategy Meetings
June 26, 2012
City Council Chambers, 1777 Broadway, Boulder, CO

Name	Email Address	Address	Phone	Department/Organization/ Affiliation
SHEA THOMAS	sthomas@udfcd.org	2480 W. 26th Ave Denver, Co 80211	303-455-6277	UDFCD
Carey Weinheimer	Weinheimerc@boulder colorado.gov	1805 33rd St Boulder CO 80301	3-441-3337	Boulder Police
KEVIN KRAYNA	KRAYNAK@boulder colorado	1301 Arapahoe	3441-3061	RISK
Kim Hutton	hutton@boulder colorado.gov	1739 Broadway 2nd floor	303-441-3115	PW
Christie Coleman	colemanc@boulder colorado.gov	1739 Broadway 2nd Floor	303-441-4077	COB PW
MIKE CHANS	mchans@bouldercounty.org	3280 Airport Rd	303-441-3653	BOCM

CITY OF BOULDER MULTI-HAZARD MITIGATION PLAN

2012 UPDATE

Hazard Mitigation Planning Committee

Public Outreach Subcommittee Meeting

Wednesday, July 18th, 2012
4:00 to 5:30 p.m.
AMEC Environment and Infrastructure
1002 Walnut St, Suite 200
Boulder, CO

- **Welcome and Introductions**
- **Overview of Boulder's Hazard Mitigation Plan and 2012 update process**
- **Overview of the Public Participation Plan**
- **Public engagement ideas and activities**
- **Public workshop planning**

SIGN-IN SHEET
CITY OF BOULDER
LOCAL HAZARD MITIGATION PLAN UPDATE PROJECT
Public Outreach Subcommittee Meeting
July 18, 2012
AMEC Environment and Infrastructure, 1002 Walnut St, Suite 200, Boulder, CO

Name	Email Address	Address	Phone	Department/Organization/ Affiliation
Doug Grande	dgrande@taggartinsurance.com	1600 Canyon	3-442-1484	Taggart Insurance
Kurt BAUER	Bauerk@bouldercolorado.gov	COB	3 441-4232	COB
Merrie Leach	mleach@bouldercounty.org	Boulder OEM	3-441-3647	3280 Airport Rd. Boulder, CO 80301
Maela Moore	maela.moore@busd.org	Boulder Valley School District	720-561-5825	6500 E. Arapahoe Road Boulder, CO 80303
SHEA THOMAS	sthomas@udfcd.org	2480 W. 26th #156B DENVER, CO 80211	303-455-6277	UDFCD
Courtney Craig	Courtneycraig@fourstarrealty	2700 4th St Boulder	720 987 9675	Fourstar Realty
Brian Oliver	oliverb@bouldercolorado.gov	1805 33rd St Boulder CO 80301	303-877-5412	City of Boulder Fire Dept

CITY OF BOULDER

Department of Public Works/Utilities Division
PO Box 791
1739 Broadway, 2nd Fl
Boulder, Colorado 80306
(303) 441-3266
(303) 441-4271 FAX

Shea Thomas, P.E.
Urban Drainage and Flood Control District
2480 West 26th Avenue, Suite 156-B
Denver, Colorado 80211
303-455-6277
sthomas@udfcd.org

June 6, 2012

Dear Shea:

As you are aware, the City of Boulder is presently updating its Multi-Hazard Mitigation Plan (MHMP). As part of the update effort the city needs to engage in various public outreach activities to ensure that the public is aware of the process and has an opportunity to provide input to the updated plan. The plan is being developed under the guidance of the Hazard Mitigation Planning Committee (HMPC), of which you may already be a member.

We are creating a Public Outreach Subcommittee of the HMPC to focus on public engagement activities associated with the planning process. You are being requested to participate on this subcommittee because of your experience with other public information outreach activities. As a member of this subcommittee you will requested to participate in two meetings designed to solicit ways and methods to best engage the public in the city's update to the MHMP. We anticipate one meeting in late June and one in July 2012.

The ideas developed by the subcommittee will be captured and implemented through the Public Participation Plan (draft plan attached). This plan will be updated as the process unfolds and also serve as a tool to document outreach efforts.

Please let me know via email by Tues. June 19 if you are willing to participate on this subcommittee. Your time and input will be much appreciated.

Sincerely,

Kurt Bauer, P.E.
Engineering Project Manager
City of Boulder
Department of Public Works Utilities Division
bauerk@bouldercolorado.gov
303-441-4232

Doug Miller
American Red Cross
7634 Estate Circle
Longmont, Colorado 80503
303-818-9180
damiller@frii.com

June 6, 2012

Dear Doug:

The City of Boulder is presently updating its Multi-Hazard Mitigation Plan (MHMP). As part of the update effort the city needs to engage in various public outreach activities to ensure that the public is aware of the process and has an opportunity to provide input to the updated plan. The plan is being developed under the guidance of the Hazard Mitigation Planning Committee (HMPC).

We are creating a Public Outreach Subcommittee of the HMPC to focus on public engagement activities associated with the planning process. You are being requested to participate on this subcommittee because of your experience with the American Red Cross. As a member of this subcommittee you will requested to participate in two meetings designed to solicit ways and methods to best engage the public in the city's update to the MHMP. We anticipate one meeting in late June and one in July 2012.

The ideas developed by the subcommittee will be captured and implemented through the Public Participation Plan (draft plan attached). This plan will be updated as the process unfolds and also serve as a tool to document outreach efforts.

Please let me know via email by Tues. June 19 if you are willing to participate on this subcommittee. Your time and input will be much appreciated.

Sincerely,

Kurt Bauer, P.E.
Engineering Project Manager
City of Boulder
Department of Public Works Utilities Division
bauerk@bouldercolorado.gov
303-441-4232

Courtney Craig
2700 4th Street
Boulder, Colorado 80304
720-987-6951
courtneycraig@fourstarrealty.com

June 6, 2012

Dear Courtney:

The City of Boulder is presently updating its Multi-Hazard Mitigation Plan (MHMP). As part of the update effort the city needs to engage in various public outreach activities to ensure that the public is aware of the process and has an opportunity to provide input to the updated plan. The plan is being developed under the guidance of the Hazard Mitigation Planning Committee (HMPC).

We are creating a Public Outreach Subcommittee of the HMPC to focus on public engagement activities associated with the planning process. You are being requested to participate on this subcommittee because of your experience in the Real Estate industry. As a member of this subcommittee you will requested to participate in two meetings designed to solicit ways and methods to best engage the public in the city's update to the MHMP. We anticipate one meeting in late June and one in July 2012.

The ideas developed by the subcommittee will be captured and implemented through the Public Participation Plan (draft plan attached). This plan will be updated as the process unfolds and also serve as a tool to document outreach efforts.

Please let me know via email by Tues. June 19 if you are willing to participate on this subcommittee. Your time and input will be much appreciated.

Sincerely,

Kurt Bauer, P.E.
Engineering Project Manager
City of Boulder
Department of Public Works Utilities Division
bauerk@bouldercolorado.gov
303-441-4232

Katie Knapp
Civil Engineer II
City of Boulder
P.O. Box 791
Boulder, Colorado 80301
303-441-3273
knappk@bouldercolorado.gov

June 6, 2012

Dear Katie:

As you are aware, the City of Boulder is presently updating its Multi-Hazard Mitigation Plan (MHMP). As part of the update effort the city needs to engage in various public outreach activities to ensure that the public is aware of the process and has an opportunity to provide input to the updated plan. The plan is being developed under the guidance of the Hazard Mitigation Planning Committee (HMPC), of which you are a member.

We are creating a Public Outreach Subcommittee of the HMPC to focus on public engagement activities associated with the planning process. You are being requested to participate on this subcommittee because of your experience with public outreach. As a member of this subcommittee you will requested to participate in two meetings designed to solicit ways and methods to best engage the public in the city's update to the MHMP. We anticipate one meeting in late June and one in July 2012.

The ideas developed by the subcommittee will be captured and implemented through the Public Participation Plan (draft plan attached). This plan will be updated as the process unfolds and also serve as a tool to document outreach efforts.

Please let me know via email by Tues. June 19 if you are willing to participate on this subcommittee. Your time and input will be much appreciated.

Sincerely,

Kurt Bauer, P.E.
Engineering Project Manager
City of Boulder
Department of Public Works Utilities Division
bauerk@bouldercolorado.gov
303-441-4232

Curry Rosato
Watershed Outreach Coordinator
City of Boulder
P.O. Box 791
Boulder, Colorado 80301
303-413-7365
rosatoc@bouldercolorado.gov

June 6, 2012

Dear Curry:

As you are aware, the City of Boulder is presently updating its Multi-Hazard Mitigation Plan (MHMP). As part of the update effort the city needs to engage in various public outreach activities to ensure that the public is aware of the process and has an opportunity to provide input to the updated plan. The plan is being developed under the guidance of the Hazard Mitigation Planning Committee (HMPC).

We are creating a Public Outreach Subcommittee of the HMPC to focus on public engagement activities associated with the planning process. You are being requested to participate on this subcommittee because of your experience with public outreach. As a member of this subcommittee you will requested to participate in two meetings designed to solicit ways and methods to best engage the public in the city's update to the MHMP. We anticipate one meeting in late June and one in July 2012.

The ideas developed by the subcommittee will be captured and implemented through the Public Participation Plan (draft plan attached). This plan will be updated as the process unfolds and also serve as a tool to document outreach efforts.

Please let me know via email by Tues. June 19 if you are willing to participate on this subcommittee. Your time and input will be much appreciated.

Sincerely,

Kurt Bauer, P.E.
Engineering Project Manager
City of Boulder
Department of Public Works Utilities Division
bauerk@bouldercolorado.gov
303-441-4232

Merrie Leach
Boulder Office of Emergency Management
3280 Airport Road
Boulder, Colorado 80301
303-441-3647
Mleach@bouldercounty.org

June 6, 2012

Dear Merrie:

As you are aware, the City of Boulder is presently updating its Multi-Hazard Mitigation Plan (MHMP). As part of the update effort the city needs to engage in various public outreach activities to ensure that the public is aware of the process and has an opportunity to provide input to the updated plan. The plan is being developed under the guidance of the Hazard Mitigation Planning Committee (HMPC), of which you are a member.

We are creating a Public Outreach Subcommittee of the HMPC to focus on public engagement activities associated with the planning process. You are being requested to participate on this subcommittee because of your experience with public outreach. As a member of this subcommittee you will requested to participate in two meetings designed to solicit ways and methods to best engage the public in the city's update to the MHMP. We anticipate one meeting in late June and one in July 2012.

The ideas developed by the subcommittee will be captured and implemented through the Public Participation Plan (draft plan attached). This plan will be updated as the process unfolds and also serve as a tool to document outreach efforts.

Please let me know via email by Tues. June 19 if you are willing to participate on this subcommittee. Your time and input will be much appreciated.

Sincerely,

Kurt Bauer, P.E.
Engineering Project Manager
City of Boulder
Department of Public Works Utilities Division
bauerk@bouldercolorado.gov
303-441-4232

Eric Philips
Boulder County Wildfire Mitigation Coordinator
2025 14th Street
Boulder, Colorado 80302
720-564-2625
ephilips@bouldercounty.org

June 6, 2012

Dear Eric:

The City of Boulder is presently updating its Multi-Hazard Mitigation Plan (MHMP). As part of the update effort the city needs to engage in various public outreach activities to ensure that the public is aware of the process and has an opportunity to provide input to the updated plan. The plan is being developed under the guidance of the Hazard Mitigation Planning Committee (HMPC).

We are creating a Public Outreach Subcommittee of the HMPC to focus on public engagement activities associated with the planning process. You are being requested to participate on this subcommittee because of your experience with wildfire management. As a member of this subcommittee you will requested to participate in two meetings designed to solicit ways and methods to best engage the public in the city's update to the MHMP. We anticipate one meeting in late June and one in July 2012.

The ideas developed by the subcommittee will be captured and implemented through the Public Participation Plan (draft plan attached). This plan will be updated as the process unfolds and also serve as a tool to document outreach efforts.

Please let me know via email by Tues. June 19 if you are willing to participate on this subcommittee. Your time and input will be much appreciated.

Sincerely,

Kurt Bauer, P.E.
Engineering Project Manager
City of Boulder
Department of Public Works Utilities Division
bauerk@bouldercolorado.gov
303-441-4232

Bob Glancy
National Weather Service
2525 Broadway
Boulder, Colorado 80305
303-494-3210 ext. 726
Robert.Glancy@noaa.org

June 6, 2012

Dear Bob:

The City of Boulder is presently updating its Multi-Hazard Mitigation Plan (MHMP). As part of the update effort the city needs to engage in various public outreach activities to ensure that the public is aware of the process and has an opportunity to provide input to the updated plan. The plan is being developed under the guidance of the Hazard Mitigation Planning Committee (HMPC).

We are creating a Public Outreach Subcommittee of the HMPC to focus on public engagement activities associated with the planning process. You are being requested to participate on this subcommittee because of your experience with NOAA. As a member of this subcommittee you will requested to participate in two meetings designed to solicit ways and methods to best engage the public in the city's update to the MHMP. We anticipate one meeting in late June and one in July 2012.

The ideas developed by the subcommittee will be captured and implemented through the Public Participation Plan (draft plan attached). This plan will be updated as the process unfolds and also serve as a tool to document outreach efforts.

Please let me know via email by Tues. June 19 if you are willing to participate on this subcommittee. Your time and input will be much appreciated.

Sincerely,

Kurt Bauer, P.E.
Engineering Project Manager
City of Boulder
Department of Public Works Utilities Division
bauerk@bouldercolorado.gov
303-441-4232

Mike Echery
Bank of Commerce Mortgage
1637 Pearl Street
Boulder, Colorado 80302
303-544-0600
mechery@bankofcommercemortgage.com

June 6, 2012

Dear Mike:

The City of Boulder is presently updating its Multi-Hazard Mitigation Plan (MHMP). As part of the update effort the city needs to engage in various public outreach activities to ensure that the public is aware of the process and has an opportunity to provide input to the updated plan. The plan is being developed under the guidance of the Hazard Mitigation Planning Committee (HMPC).

We are creating a Public Outreach Subcommittee of the HMPC to focus on public engagement activities associated with the planning process. You are being requested to participate on this subcommittee (your name was provided by Merry Leach) because of your experience in the lending industry. As a member of this subcommittee you will requested to participate in two meetings designed to solicit ways and methods to best engage the public in the city's update to the MHMP. We anticipate one meeting in late June and one in July 2012.

The ideas developed by the subcommittee will be captured and implemented through the Public Participation Plan (draft plan attached). This plan will be updated as the process unfolds and also serve as a tool to document outreach efforts.

Please let me know via email by Tues. June 19 if you are willing to participate on this subcommittee. Your time and input will be much appreciated.

Sincerely,

Kurt Bauer, P.E.
Engineering Project Manager
City of Boulder
Department of Public Works Utilities Division
bauerk@bouldercolorado.gov
303-441-4232

MHMP Update Public Survey:

1. Please rank your perception of the city's hazards with 1 = low, 2 = moderate and 3 = high:

☐ Avalanche	☐ Dam Failure	☐ Drought	☐ Earthquakes
☐ Floods	☐ Health Hazards	☐ Landslides and Rock Falls	☐ Severe Weather
☐ Soil Hazards (expansion and subsidence)	☐ Volcanoes	☐ Wildfires	☐ Winter Storms

2. Please rank your preferred method of notification of a significant natural hazard event with 1 = least effective, 2 = somewhat effective and 3 = most effective:

Radio	☐	E mail	☐
Television	☐	Sirens	☐
Text Message	☐	Phone Message	☐

Other (describe): ☐

3. What would help you be more prepared for a significant natural hazard event?

Flood insurance information	☐
Flood proofing information	☐
Evacuation Planning information	☐
Emergency action planning information	☐
West Nile Virus / Pandemic Flu risk reduction information	☐

Other:

4. I am age:

18-25 ☐ 26-35 ☐ 36-45 ☐ 46-55 ☐ 56-older ☐

5. I live in zip code area: ☐

Summary of Public Input

Online Survey Results:

Please rank your perception of the following hazards (and their potential to effect you and your family) in the City of Boulder. Rank with: 1 = low risk, 2 = moderate risk, and 3 = high risk.

	1	2	3	Rating Average	Response Count
Avalanche	**89.4% (42)**	10.6% (5)	0.0% (0)	1.11	47
Floods	14.9% (7)	**51.1% (24)**	34.0% (16)	2.19	47
Soil Hazards (expansion and subsidence)	**50.0% (23)**	43.5% (20)	6.5% (3)	1.57	46
Dam Failure	**44.7% (21)**	38.3% (18)	17.0% (8)	1.72	47
Health Hazards	40.4% (19)	**42.6% (20)**	17.0% (8)	1.77	47
Volcanoes	**97.8% (45)**	0.0% (0)	2.2% (1)	1.04	46
Drought	19.1% (9)	27.7% (13)	**53.2% (25)**	2.34	47
Landslides and Rock Falls	**48.9% (23)**	38.3% (18)	12.8% (6)	1.64	47
Wildfires	6.4% (3)	29.8% (14)	**63.8% (30)**	2.57	47
Earthquakes	**85.1% (40)**	12.8% (6)	2.1% (1)	1.17	47
Severe Weather	12.8% (6)	**51.1% (24)**	36.2% (17)	2.23	47
Winter Storms	10.9% (5)	**45.7% (21)**	43.5% (20)	2.33	46
				answered question	**47**
				skipped question	**0**

Online Survey Results Continued:

In terms of preference, please rank the following hazard notification methods. Rank with: 1 = least effective, 2 = somewhat effective, and 3 = most effective.

	1	2	3	Rating Average	Response Count
Radio	31.9% (15)	**48.9% (23)**	19.1% (9)	1.87	47
E mail	17.0% (8)	**53.2% (25)**	29.8% (14)	2.13	47
Television	27.7% (13)	**48.9% (23)**	23.4% (11)	1.96	47
Sirens	8.5% (4)	42.6% (20)	**48.9% (23)**	2.40	47
Text Message	4.3% (2)	29.8% (14)	**66.0% (31)**	2.62	47
Phone Message	14.9% (7)	38.3% (18)	**46.8% (22)**	2.32	47
			Other (please describe)		6
			answered question		**47**
			skipped question		**0**

Q1. In terms of preference, please rank the following hazard notification methods.
Rank with:
1 = least effective,
2 = somewhat effective, and
3 = most effective.

1	.	Sep 13, 2012 3:30 PM
2	Twitter has consistently provided the most up-to-date information on disasters around here. People know it, use it, and it ought to be part of your mix.	Sep 13, 2012 2:22 PM
3	government and newspaper websites	Sep 13, 2012 2:18 PM
4	rradio and text are the most instant notification methods for me. Timelyness counts for notifications, I am not alway by a TV or email. I never know what a siern is signalling. I always think it is a test.	Sep 11, 2012 3:38 PM
5	Additional info on internet site - referenced in text message or sirens are good for tornadoes or flash floods	Sep 8, 2012 4:00 AM
6	Boulder's Channel 8 TV station has been underutilized during area wildfires. Info from Boulder OEM should be constantly posted and updates during crisis and near-crisis periods. Additionally, dissemination of emergency information via radio should be seriously considered by City management.	Sep 7, 2012 3:47 PM

Online Survey Results Continued:

What would help you be more prepared for a significant natural hazard event? Check all that apply.

	Response Percent	Response Count
Flood insurance information	14.9%	7
Flood proofing information	38.3%	18
Evacuation Planning information	**72.3%**	**34**
Emergency action planning information	70.2%	33
West Nile Virus / Pandemic Flu risk reduction information	31.9%	15
Other (please specify)		10
answered question		**47**
skipped question		**0**

Q1. What would help you be more prepared for a significant natural hazard event? Check all that apply.

1	Community networking - first response is generally local community helping themselves. I think efforts to create new or map and strengthen existing community networks would be extremely valuable.	Sep 18, 2012 3:52 PM
2	1. Practical flood proofing information -- are there supplies one should have on hand? (For the flood risk, not food/water/medicine...) 2. I am particularly concerned about wildfires and floods that occur during darkness, when the situation is very hard to evaluate.	Sep 13, 2012 2:22 PM
3	Not personally worried about large scale flooding	Sep 11, 2012 3:38 PM
4	BVSD flood/fire plan for individual schools (e.g., S.uthern Hills and Community Montessori in the event of a Bear Creek Flood or another foothills wildfire.	Sep 11, 2012 3:36 PM
5	I am chemically sensitive and have been deeply and negatively affected by the chemicals used to fight wildfires both here in Boulder as well as elsewhere in Colorado and the West. I would greatly appreciate more public info about the nature of chemicals used, how long they are airborne, how long they can be expected to continue to affect air, soil, and water quality, etc., and what, if anything, I can do to protect myself in the future.	Sep 10, 2012 4:43 PM
6	None of the above	Sep 9, 2012 9:41 PM
7	The city spending $ to mitigate the S.Bldr flood plain, to reduce number of houses that will be re-categorized as "inside the flood plain".	Sep 8, 2012 12:36 PM
8	Wildfire start susceptibility map	Sep 7, 2012 4:27 PM
9	wildfire insurance info? or is that a standard component of homeowners insurance?	Sep 7, 2012 3:47 PM
10	Siren could be more audible on the east side of town.	Sep 7, 2012 3:46 PM

Online Survey Results Continued:

I am age:

	Response Percent	Response Count
18-25	0.0%	0
26-35	6.4%	3
36-45	31.9%	15
46-55	**48.9%**	**23**
56 or older	12.8%	6
	answered question	**47**
	skipped question	**0**

I live in zip code area:

	Response Count
	47
answered question	**47**
skipped question	**0**

Q1. I live in zip code area:	
1	80303
2	80305
3	80304
4	80302
5	80304
6	80301
7	80304
8	80304
9	80305
10	80026
11	80304
12	80305
13	80302
14	80304
15	80302
16	80301
17	80305
18	80304
19	80304
20	80303
21	80304
22	80304
23	80303
24	80305
25	80304
26	80304
27	80301
28	80304
29	80304
30	80302
31	80305
32	80304
33	80304
34	80301
35	80027
36	80305
37	80302
38	80303
39	80304
40	80305
41	80303
42	80304
43	80027
44	80303
45	80304
46	80234
47	80301

Completed Open House Survey Results:

City of Boulder Multi-Hazard Mitigation Plan 2012 Update
Public Workshop Thursday, Sept. 13, 2012
Municipal Library Gallery Room

1. Please rank your perception of the city's hazards with 1 = low, 2 = moderate and 3 = high:

[ ] Avalanche	[ ] Dam Failure	[ ] Drought	[ ] Earthquakes
[X] Floods	[ ] Health Hazards	[ ] Volcanoes	[X] Wildfires
[ ] Soil Hazards (expansion and subsidence)	[ ] Landslides and Rock Falls	[ ] Severe Weather	[ ] Winter Storms

2. Please rank your preferred method of notification of a significant natural hazard event with 1 = least effective, 2 = somewhat effective and 3 = most effective:

Radio	[X]	E mail	[X]
Television	[X]	Sirens	[X]
Text Message	[X]	Phone Message	[X]

Other (describe): [ ]

3. What would help you be more prepared for a significant natural hazard event? (place a check mark in relevant boxes)

Flood insurance information	[X]
Flood proofing information	[X]
Evacuation Planning information	[X]
Emergency action planning information	[X]
West Nile Virus / Pandemic Flu risk reduction information	[ ]

Wildfire Risk info and Mitigation

Other:

OVER

4. Please provide comments related to the Draft Multi-Hazard Mitigation Plan 2012:

The draft plan and online survey is available at:
www.bouldercolorado.gov > City A-Z > M > Multi-hazard mitigation plan

5. I am age:

18-25 [ ] 26-35 [ ] 36-45 [ ] 46-55 [ ] 56-older [X]

6. I live in zip code area: 80305

City of Boulder Multi-Hazard Mitigation Plan 2012 Update
Public Workshop Thursday, Sept. 13, 2012
Municipal Library Gallery Room

1. Please rank your perception of the city's hazards with 1 = low, 2 = moderate and 3 = high:

1 Avalanche	1 Dam Failure	2 Drought	1 Earthquakes
2 Floods	3 Health Hazards	1 Volcanoes	3 Wildfires
2 Soil Hazards (expansion and subsidence)	3 Landslides and Rock Falls	3 Severe Weather	3 Winter Storms

2. Please rank your preferred method of notification of a significant natural hazard event with 1 = least effective, 2 = somewhat effective and 3 = most effective:

Radio	3	E mail	3
Television	3	Sirens	3
Text Message	1	Phone Message	1

Other (describe):

3. What would help you be more prepared for a significant natural hazard event? (place a check mark in relevant boxes)

Flood insurance information	
Flood proofing information	X
Evacuation Planning information	X
Emergency action planning information	
West Nile Virus / Pandemic Flu risk reduction information	

Other:

OVER

4. Please provide comments related to the Draft Multi-Hazard Mitigation Plan 2012:

The draft plan and online survey is available at:
www.bouldercolorado.gov > City A-Z > M > Multi-hazard mitigation plan

5. I am age:

18-25 [ ] 26-35 [ ] 36-45 [ ] 46-55 [ ] 56-older [✓]

6. I live in zip code area: 80302

City of Boulder Multi-Hazard Mitigation Plan 2012 Update
Public Workshop Thursday, Sept. 13, 2012
Municipal Library Gallery Room

1. Please rank your perception of the city's hazards with 1 = low, 2 = moderate and 3 = high:

[2] Avalanche	[3] Dam Failure	[3] Drought	[1] Earthquakes
[3] Floods	[2] Health Hazards	[1] Volcanoes	[3] Wildfires
[1] Soil Hazards (expansion and subsidence)	[2] Landslides and Rock Falls	[3] Severe Weather	[2] Winter Storms

2. Please rank your preferred method of notification of a significant natural hazard event with 1 = least effective, 2 = somewhat effective and 3 = most effective:

Radio	[3]	E mail	[1]
Television	[3]	Sirens	[3]
Text Message	[1]	Phone Message	[2]

Other (describe): [ ]

3. What would help you be more prepared for a significant natural hazard event? (place a check mark in relevant boxes)

Flood insurance information	[ ]
Flood proofing information	[✓]
Evacuation Planning information	[✓]
Emergency action planning information	[✓]
West Nile Virus / Pandemic Flu risk reduction information	[ ]

Other:

OVER ➡

4. Please provide comments related to the Draft Multi-Hazard Mitigation Plan 2012:

The draft plan and online survey is available at:
www.bouldercolorado.gov > City A-Z > M > Multi-hazard mitigation plan

The Boulder Creek area 9th – 17th will experience a severe flooding episode as Climate Chaos Occurs. Strong Rain in July made for high creek.

Walnut/Pearl – Arapahoe

Need way to divert the H_2O.

Perhaps an underground channel beginning up @ Eben Fine or 9th would be feasible & effective at keeping historical interest & beauty of Bol CK.

5. I am age:

18-25 [ ] 26-35 [ ] 36-45 [ ] 46-55 [X] 56-older [ ]

6. I live in zip code area: 80304

City of Boulder Multi-Hazard Mitigation Plan 2012 Update
Public Workshop Thursday, Sept. 13, 2012
Municipal Library Gallery Room

1. Please rank your perception of the city's hazards with 1 = low, 2 = moderate and 3 = high:

[3] Avalanche (local)	[2] Dam Failure (terrorists)	[2] Drought (water shortage from overuse) [1]	[3] Earthquakes
[1] Floods	[2] Health Hazards	[4] Volcanoes	[1] Wildfires
[3] Soil Hazards (expansion and subsidence)	[3] Landslides and Rock Falls (local)	[2] Severe Weather	[2] Winter Storms

2. Please rank your preferred method of notification of a significant natural hazard event with 1 = least effective, 2 = somewhat effective and 3 = most effective:

Radio	[ ]	E mail	[ ]
Television	[ ]	Sirens	[ ]
Text Message	[ ]	Phone Message	[✓] reverse 911

Other (describe): [ ]

3. What would help you be more prepared for a significant natural hazard event? (place a check mark in relevant boxes)

Flood insurance information	[ ]
Flood proofing information	[ ]
Evacuation Planning information	[✓]
Emergency action planning information	[✓]
West Nile Virus / Pandemic Flu risk reduction information	[ ]

Other:

OVER

4. Please provide comments related to the Draft Multi-Hazard Mitigation Plan 2012:

The draft plan and online survey is available at:
www.bouldercolorado.gov > City A-Z > M > Multi-hazard mitigation plan

Good to be thinking + planning
Any thoughts about biohazards?
intentional
or
otherwise

5. I am age:

18-25 [ ] 26-35 [ ] 36-45 [ ] 46-55 [✓] 56-older [ ]

6. I live in zip code area: 80305

City of Boulder Multi-Hazard Mitigation Plan 2012 Update
Public Workshop Thursday, Sept. 13, 2012
Municipal Library Gallery Room

1. Please rank your perception of the city's hazards with 1 = low, 2 = moderate and 3 = high:

1 Avalanche	3 Dam Failure	3 Drought	2 Earthquakes
3 Floods	2 Health Hazards	1 Volcanoes	3 Wildfires
1 Soil Hazards (expansion and subsidence)	2 Landslides and Rock Falls	3 Severe Weather	3 Winter Storms

2. Please rank your preferred method of notification of a significant natural hazard event with 1 = least effective, 2 = somewhat effective and 3 = most effective:

Radio	3	E mail	2
Television	2	Sirens	3
Text Message	3	Phone Message	2

Other (describe):

3. What would help you be more prepared for a significant natural hazard event? (place a check mark in relevant boxes)

Flood insurance information	✓
Flood proofing information	✓
Evacuation Planning information	✓
Emergency action planning information	✓
West Nile Virus / Pandemic Flu risk reduction information	✓

Other:

OVER

4. Please provide comments related to the Draft Multi-Hazard Mitigation Plan 2012:

The draft plan and online survey is available at:

www.bouldercolorado.gov > City A-Z > M > Multi-hazard mitigation plan

5. I am age:

18-25 [ ] 26-35 [✓] 36-45 [ ] 46-55 [ ] 56-older [ ]

6. I live in zip code area: 80305

City of Boulder Multi-Hazard Mitigation Plan 2012 Update
Public Workshop Thursday, Sept. 13, 2012
Municipal Library Gallery Room

1. Please rank your perception of the city's hazards with 1 = low, 2 = moderate and 3 = high:

[2] Avalanche	[2] Dam Failure	[2] Drought	[1] Earthquakes
[2] Floods	[1] Health Hazards	[1] Volcanoes	[3] Wildfires
[1] Soil Hazards (expansion and subsidence)	[2] Landslides and Rock Falls	[2] Severe Weather	[3] Winter Storms

2. Please rank your preferred method of notification of a significant natural hazard event with 1 = least effective, 2 = somewhat effective and 3 = most effective:

Radio	[2]	E mail	[1]
Television	[3]	Sirens	[3]
Text Message	[2]	Phone Message	[2]

Other (describe): [ ]

3. What would help you be more prepared for a significant natural hazard event? (place a check mark in relevant boxes)

Flood insurance information	[ ]
Flood proofing information	[ ]
Evacuation Planning information	[✓]
Emergency action planning information	[✓]
West Nile Virus / Pandemic Flu risk reduction information	[ ]

Other:

OVER ➡

4. Please provide comments related to the Draft Multi-Hazard Mitigation Plan 2012:

The draft plan and online survey is available at:
www.bouldercolorado.gov > City A-Z > M > Multi-hazard mitigation plan

5. I am age:

18-25 [ ] 26-35 [✓] 36-45 [ ] 46-55 [ ] 56-older [ ]

6. I live in zip code area: 80302

City of Boulder Multi-Hazard Mitigation Plan 2012 Update
Public Workshop Thursday, Sept. 13, 2012
Municipal Library Gallery Room

1. Please rank your perception of the city's hazards with 1 = low, 2 = moderate and 3 = high:

1 Avalanche	3 Dam Failure	2 Drought	1 Earthquakes
3 Floods	1 Health Hazards	1 Volcanoes	3 Wildfires
2 Soil Hazards (expansion and subsidence)	1 Landslides and Rock Falls	1 Severe Weather	2 Winter Storms

2. Please rank your preferred method of notification of a significant natural hazard event with 1 = least effective, 2 = somewhat effective and 3 = most effective:

Radio		E mail	
Television	1	Sirens	3
Text Message		Phone Message	2

Other (describe):

3. What would help you be more prepared for a significant natural hazard event? (place a check mark in relevant boxes)

Flood insurance information	
Flood proofing information	
Evacuation Planning information	✓
Emergency action planning information	✓
West Nile Virus / Pandemic Flu risk reduction information	

Other:

OVER ➡

4. Please provide comments related to the Draft Multi-Hazard Mitigation Plan 2012:

The draft plan and online survey is available at:
www.bouldercolorado.gov > City A-Z > M > Multi-hazard mitigation plan

5. I am age:

18-25 ☐ 26-35 ☐ 36-45 ☐ 46-55 ☐ 56-older ☐

6. I live in zip code area: ☐

City of Boulder Multi-Hazard Mitigation Plan 2012 Update
Public Workshop Thursday, Sept. 13, 2012
Municipal Library Gallery Room

1. Please rank your perception of the city's hazards with 1 = low, 2 = moderate and 3 = high:

1 Avalanche	2 Dam Failure	3 Drought	Earthquakes
2 Floods	3 Health Hazards	1 Volcanoes	3 Wildfires
2 Soil Hazards (expansion and subsidence)	3 Landslides and Rock Falls	2 Severe Weather	3 Winter Storms

2. Please rank your preferred method of notification of a significant natural hazard event with 1 = least effective, 2 = somewhat effective and 3 = most effective:

Radio	1	E mail	2
Television	1	Sirens	3
Text Message	2	Phone Message	1

Other (describe):

3. What would help you be more prepared for a significant natural hazard event? (place a check mark in relevant boxes)

Flood insurance information	
Flood proofing information	
Evacuation Planning information	✓
Emergency action planning information	✓
West Nile Virus / Pandemic Flu risk reduction information	

Other:

OVER

4. Please provide comments related to the Draft Multi-Hazard Mitigation Plan 2012:

The draft plan and online survey is available at:

www.bouldercolorado.gov > City A-Z > M > Multi-hazard mitigation plan

5. I am age:

18-25 [ ] 26-35 [ ] 36-45 [ ] 46-55 [ ] 56-older [✓]

6. I live in zip code area: 80233

Boulder to host open house on hazards mitigation plan

Camera staff
Posted: 09/12/2012 05:01:49 PM MDT
Updated: 09/12/2012 08:16:54 PM MDT

Boulder will hold an open house on its multi-hazard mitigation plan -- designed to protect the city from the impacts of wildfires, droughts and floods -- on Thursday afternoon.

The city is in the process of updating the plan and wants public input before it finalizes the update.

The open house is scheduled from 4 to 6 p.m. Thursday at the Boulder Public Library Gallery Room, 1001 Arapahoe Ave.

The city also has posted a survey about the plan at **www.surveymonkey.com/s/MHMPupdate.**

For more information about the plan, visit the **project website.**

Give
Give Back with a Single Click.

Sept. 10, 2012 - Open House on Boulder's Multi-Hazard Mitigation Plan update

Media Contacts:
Mike Banuelos, Public Works and Planning, 303-441-4073
Sarah Huntley, Media Relations, 303-441-3155
www.bouldercolorado.gov

Open House on Boulder's Multi-Hazard Mitigation Plan update

In the past few years, wildfires, drought and floods have caused devastating impacts in Colorado. The city maintains and updates a Multi-Hazard Mitigation Plan (MHMP) to help ensure that the city and its residents are less vulnerable to natural hazards.

The MHMP plan is being updated in 2012 and the city needs your input at a public open house from 4 to 6 p.m. on Thursday, Sept. 13, at the Boulder Public Library Gallery Room, 1001 Arapahoe Ave.

The meeting will be an opportunity to learn about the current MHMP, the 2012 update process and to provide feedback. In addition to the open house, a public feedback survey about the MHMP is available at http://www.surveymonkey.com/s/MHMPupdate.

For more information about the MHMP, visit the project website or contact Kurt Bauer at bauerk@bouldercolorado.gov.

Last Updated on Thursday, 13 September 2012 11:24

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-----Email sent from Boulder Valley School District to 14,990 different email addresses -----

From: **BVSD Communications** <communications@bvsd.org>
Date: Fri, Sep 7, 2012 at 3:28 PM
Subject: City of Boulder Open House re: Multi-Hazard Mitigation Efforts
To: maela.moore@bvsd.org

Dear Parents of Students who attend BVSD schools in the City of Boulder ~

BVSD is helping the City of Boulder to notify families about the Multi-Hazard Mitigation Plan (MHMP) for Boulder. That plan is currently being updated with plans targeted completion by early 2013. Public input and questions are welcomed.

A workshop/open house will be held next week at which community members may gather information and get their questions answered about natural hazards such as floods and fires:

City of Boulder Multi-Hazard Mitigation Workshop
Thursday, Sept. 13 * 4-6 p.m.
Boulder Public Library - Gallery Area
1001 Arapahoe Avenue, Boulder
(Drop in format / No formal presentation)

The city is also conducting a survey to learn what residents think about natural hazards in Boulder.

Information on the plan, open house and link to the survey are located as follows:

www.bouldercolorado.gov > City A-Z > M > Multi-Hazard Mitigation Plan

(Direct link:
http://www.bouldercolorado.gov/index.php?option=com_content&task=view&id=7898&Itemid=1189)

For more information about the Multi-Hazard Mitigation Plan, contact Kurt Bauer at bauerk@bouldercolorado.gov.

Boulder Valley School District would like to continue connecting with you via email. If you prefer to be removed from our list, please contact Boulder Valley School District directly. To stop receiving all email messages distributed through our SchoolMessenger service, follow this link and confirm: Unsubscribe

SchoolMessenger is a notification service used by the nation's leading school systems to connect with parents, students and staff through voice, SMS text, email, and social media.

City of Boulder Multi-Hazard Mitigation Plan 2012 Update
Public Workshop Thursday September 13, 2012
Municipal Library Gallery Room
4 P.M. – 6 P.M.

Name	Address	Phone	Email
Mani Mannion	1360 ALPINE AVE 80304	720 635 4383 txt	mani mannion@ gmail.com
Brian Highsmith	2244 Kalmia Ave.	3034433762	piecmie yahoo.com
Zach Kolp	1400 28th Street Suite 1 Boulder CO 80302	303 494 4700	Zach.kolp.uvb4@ statefarm.com
Gabriel Conners	651 Grapewood Ln Boulder, CO 80304	918 8093963	Gabriel.Conners@ GMail.com
Karen McCline	4770 Lee Circle Boulder, CO 80303	720-324-3952	Karen@i-s-s-t.org
Brian Oliver	5505 33rd St.	303-877-5412	oliverb@bouldercolorado.gov
Brittany Morris	1580 7th St Boulder CO Apt C 80302	615-692-9197	brittanyannmorris@ gmail.com

City of Boulder Multi-Hazard Mitigation Plan 2012 Update
Public Workshop Thursday September 13, 2012
Municipal Library Gallery Room
4 P.M. – 6 P.M.

Name	Address	Phone	Email
Suzan Heglin	4290 Darley Ave Boulder	303-499-5898	winds of 2 @ aol. com
Nicholas Story	745 S 44th St	970 485 1384	nist7089 @ colorado.edu
Pat Bohlin	4242 Quince Ct Boulder Co 80301	303 ~~447~~ 4467654	bohlinp @ bouldercolorado.gov

Appendix F PUBLIC PARTICIPATION PLAN

City of Boulder Multi-Hazard Mitigation Plan Update

Public Participation Plan

March 8, 2012

Prepared by
AMEC Earth and Environmental, Inc.

Purposes of the Public Participation Plan

The basic purpose for a public participation plan is to provide for a meaningful process through which the City of Boulder and its citizens, public officials, and stakeholder groups may effectively participate in the update of the City of Boulder Multi-Hazard Mitigation Plan. This plan will be developed based upon the understanding that citizens and groups are the source of tremendous creativity, and that their creativity and input will produce better planning decisions. The emphasis is to recognize every citizen's right to participate in the process of making local government decisions.

A wide variety of public participation methods, representing distinct purposes, will be employed to provide for broad public participation. These purposes of public participation are as follows:

- **Public Awareness** – to share information and to promote awareness of planning process, including ways the public can participate
- **Public Education** – to educate citizens and help them make more informed choices
- **Public Input** – to provide citizens and groups with opportunities to inject ideas into the planning process
- **Public Interaction** – to exchange views and ideas as a means of reaching consensus
- **Public Partnership** – to involve citizens in the decision making process

Objectives of the Public Participation Plan

1. Recognizing that there are many levels of public participation, to provide for an effective mix of participation opportunities that include the above bulleted purposes.

2. Recognizing that not everyone participates in the same way or at the same time, to include a mix of participation strategies that provides for a broad and diverse set of participation opportunities that considers the diversity of the planning area.

3. Recognizing the City of Boulder's history of past public participation with planning projects, the Hazard Mitigation Planning Committee will continue to provide the public with opportunities to review, clarify, and update previously generated information, as well as generate new policies, goals, objectives, and information.

4. To build public support for, and ultimately ownership of, the City of Boulder Multi-Hazard Mitigation Plan.

Local Government Public Outreach/Involvement Responsibilities

The requirements related to public involvement in hazard mitigation plans according to the Disaster Mitigation Act of 2000 are listed below:

Requirement §201.6(b): *In order to develop a more comprehensive approach to reducing the effects of natural disasters, the planning process* ***shall*** *include:*

(1) An opportunity for the public to comment on the plan during the drafting stage and prior to plan approval;
(2) An opportunity for neighboring communities, local and regional agencies involved in hazard mitigation activities, and agencies that have the authority to regulate development, as well as businesses, academia and other private and non-profit interests to be involved in the planning process; and
(3) Review and incorporation, if appropriate, of existing plans, studies, reports, and technical information.

Requirement §201.6(c)(1): *[The plan* ***shall*** *document] the planning process used to develop the plan, including how it was prepared, who was involved in the process, and how the public was involved.*

Requirement §201.6(c)(4)(iii): *[The plan maintenance process* ***shall*** *include a] discussion on how the community will continue public participation in the plan maintenance process.*

To meet these requirements, and the goals of the Public Participation Plan, local governments are expected to assist with public outreach and feedback efforts, which can include:

- Assisting in distributing press releases and information to local media
- Sharing public input/comment with the HMPC
- Provide report on progress/activities related to public involvement, as requested by the City and/or AMEC
- Reviewing public input for incorporation in plan, as appropriate
- Assisting with holding public workshops as requested, including providing meeting space and advertising meeting.
- Announcing the planning effort at other public and civic meetings, or holding additional public meetings, if desired by the jurisdiction.
- Announce how the plan can be accessed during the public review period. This can include providing links from the City's website to the project website, or providing hardcopy of the plan in a public location such as a library or municipal building.
- Follow the recommendations for continued public involvement as designated in the implementation chapter of the plan.

The following public participation steps and specific activities are outlined in conjunction with the hazard mitigation steps to give a better picture of how they are linked in the process. This is a working document that will be updated throughout the process, and serve to document the efforts made to involve the public during the plan update.

City of Boulder Multi-Hazard Mitigation Plan Update

Public Participation Plan – 2012

Timeframe	Mitigation Planning Steps	Public Participation Steps/Ideas	Specific Activities/Actions
Feb – April 2012	1. Getting Organized 2. Plan for public involvement 3. Coordinate with other departments and agencies	• Build public awareness through media channels • Invite media to future public meetings • Outreach through other groups, Private, Non-Profit. Non-governmental organizations • Possible public groups include: Local media, Chambers of Commerce, Downtown Business, Inc., RTD, State Parks, Department of Commerce Labs, Boulder Valley School District, Naropa University, Red Cross, Human Service agencies (targeting vulnerable populations) • Possible private/business groups include: REI, RMIAA, Celestial Seasonings	• Hazard Mitigation Planning Committee formed • Invite to kickoff meeting extended to Red Cross, Boulder County, CDEM, CWCB, University of Colorado, Boulder Valley School District, Boulder Community Hospital and Urban Drainage and Flood Control District; several attended meeting on February 9th at the City of Boulder City Council Chambers. • Develop content for project website • Develop backgrounder fact sheet for public
April – July 2012	4. Identify the hazards 5. Assess the risks	• Hold a public workshop to review draft risk assessment findings • Provide maps and info materials at meetings • Share public input with HMPC • Cooperative review of public input • Announce workshops • Build contact list of interested citizens to inform of future activities	• Announcement of upcoming public workshop through various media channels • Public Workshop #1 in April, after HMPC meeting #2. Date TBD
August – September 2012	6. Set planning goals 7. Review mitigation alternatives 8. Draft an action plan 9. Adopt the plan 10. Implement the plan, evaluate its worth, and revise as needed	• Continue to build public awareness through various media channels, including social media • Host public workshop to allow comment on draft mitigation plan's goals, objectives, and actions. • Develop awareness by outreach through schools • Develop awareness by outreach through utility bills and Urban Drainage mailings • Outreach through local radio, local news • Outreach through volunteer organizations (United Way) • Outreach through cultural/bi-lingual organizations • Outreach through Parks and Recreation Advisory Board • Outreach through Water Resource Advisory Board • Place draft plan in local libraries • Encourage public review of final draft • Presentation at City Council meeting	• Announcement of upcoming public workshop through various media channels • Public workshop #2 , August 2012 • Utilize City Libraries to post announcements about the plan and hardcopies of the draft plan • Develop links from City website to project website, encourage review and comment on draft plan. • Final plan submission in late September 2012.

Table G.1. City of Boulder Critical Facilities Detail Table

Classification	Name	Address	1% Annual Chance Flood Prone	0.2% Annual Chance Flood Prone	Zone X Protected by Levee Flood Prone	Prone to Conveyance Flooding	Prone to High Hazard Flooding	Area of Fire Concerns
At Risk Populations								
After School Care	Cottage School (SACC)	805 30th Street	Yes	Yes				Moderate
After School Care	Friends School After care Program	5465 Pennsylvania	Yes	Yes				Moderate
After School Care	Lafayette Elementary BVSD SACC	New Vista 805 Gillaspie						Moderate
After School Care	YMCA of Boulder Valley (Creekside at Martin	3740 Martin Park Dr.		Yes				Moderate
After School Care	YMCA of Boulder Valley B/A (Mapleton)	840 Mapleton						High
After School Care	YMCA of Boulder Valley Bear Creek Elementary	2500 Table Mesa Dr.						High
After School Care	YMCA of Boulder Valley Columbine Elementary	3130 Repplier St	Yes	Yes				Moderate
After School Care	YMCA of Boulder Valley Crestview Elementary	1897 Sumac						Moderate
After School Care	YMCA of Boulder Valley Eisenhower Elementary	1220 Eisenhower Dr.						Moderate

Classification	Name	Address	1% Annual Chance Flood Prone	0.2% Annual Chance Flood Prone	Zone X Protected by Levee Flood Prone	Prone to Conveyance Flooding	Prone to High Hazard Flooding	Area of Fire Concerns
After School Care	YMCA of Boulder Valley Flatirons Elementary	1150 7th Ave.						High
After School Care	YMCA of Boulder Valley Foothill Elementary	1001 Hawthorne Ave.	Yes	Yes				High
After School Care	YMCA of Boulder Valley High/Peaks/BCSIS at	3995 Aurora Ave.						Moderate
After School Care	YMCA of Boulder Valley Mesa Elementary	1575 Lehigh						High
After School Care	YMCA of Boulder Valley University Hill	956 16th St.						High
After School Care	YMCA of Boulder Valley Whittier Elementary	2008 Pine St.						Moderate
Child Day Care	A Kid's World	1828 Del Rosa Ct						Moderate
Child Day Care	Acorn School for Early Childhood Development	2580 Iris Ave.						Moderate
Child Day Care	Alaya Preschool Kindergarten	3340 19th						Moderate
Child Day Care	Alpine Sunshine	343 Alpine						High
Child Day Care	Angel Babies	4285 Graham Court						Moderate
Child Day Care	Aurora 7 Preschool (BVSD)	3995 E. Aurora Ave.						Moderate
Child Day Care	BB's Haus	930 36th Street						Moderate
Child Day Care	Bixby School	4760 Table Mesa Dr.						Moderate

Classification	Name	Address	1% Annual Chance Flood Prone	0.2% Annual Chance Flood Prone	Zone X Protected by Levee Flood Prone	Prone to Conveyance Flooding	Prone to High Hazard Flooding	Area of Fire Concerns
Child Day Care	Blossom Preschool, L.L.C.	4700 Sioux Drive						Moderate
Child Day Care	Blue Sky (Preschool) Kindergarten	3046 11th Street						High
Child Day Care	Boulder Bilingual Childcare	2625 Freemont						Moderate
Child Day Care	Boulder Country Day	4820 Nautilus Ct. N.						Moderate
Child Day Care	Boulder County Head Start - Mapleton/Iris Site	2675 Mapleton		Yes				Moderate
Child Day Care	Boulder County Head Start (Martin Drive)	3650 Martin Drive		Yes				Moderate
Child Day Care	Boulder County Head Start (Martin Park)	3650 Martin Drive		Yes				Moderate
Child Day Care	Boulder County Head Start (Woodlands)	2675 Mapleton		Yes				Moderate
Child Day Care	Boulder Day Nursery	1518 Spruce St.						Moderate
Child Day Care	Boulder Journey School	1919 Yarmouth Ave.						Moderate
Child Day Care	Boulder Montessori School	3300 Redstone Road						Severe
Child Day Care	Boulder Valley School Dist - University Hill	956 16th St						High
Child Day Care	Boulder Valley School District Teen Parent	1515 Greenbriar Blvd.						Moderate

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Child Day Care	Boulder Waldorf Kindergarten	4072 N. 19th		Yes				Moderate
Child Day Care	BVSD Columbine Preschool	3130 Repplier Drive						Moderate
Child Day Care	BVSD Community Montessori School (SACC)	805 Gillaspie Drive						High
Child Day Care	BVSD Lafayette Elementary SACC	New Vista 805 Gillaspie Dr.						High
Child Day Care	Child Learning Center (C.U. - Language)	2501 Kittredge Loop						Moderate
Child Day Care	Children's Creative Learning Center-UCAR Child C*	3050 34th Street						Moderate
Child Day Care	Children's House Preschool	3370 Iris Walk Court						Moderate
Child Day Care	Commerce Children's Center	325 Broadway CCC-123, Building 26						Moderate
Child Day Care	Community Montessori of Boulder Valley	805 Gillaspie Drive						High
Child Day Care	Cottage School (SACC) (The)	805 30th Street	Yes	Yes		Yes		Moderate
Child Day Care	Cottage School (The)	805 30th St.	Yes	Yes				Moderate
Child Day Care	Cottage School North (The)	1301 North Street	Yes	Yes				Moderate
Child Day Care	Creekside Intensive Preschool BVSD	3740 Martin Drive						Moderate
Child Day Care	Creekside Preschool BVSD	3740 Martin Drive						Moderate

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Child Day Care	Dream Makers	1345 28th Street	Yes	Yes		Yes	Yes	Moderate
Child Day Care	Elm Tree (The)	1330 Alpine Ave.	Yes	Yes				Moderate
Child Day Care	family child care home	4500 E. Baseline Rd						Moderate
Child Day Care	family home provider	1694 Redwood Avenue						Moderate
Child Day Care	family home provider	710 35th Street						Moderate
Child Day Care	Family Learning Center	3164 34th St.						Moderate
Child Day Care	Friends School	5465 Pennsylvania	Yes	Yes				Moderate
Child Day Care	Friends School After care Program	5465 Pennsylvania	Yes	Yes				Moderate
Child Day Care	Harmony Preschool	3990 15th St.						Moderate
Child Day Care	Homestar Child Dev. Center	3280 Dartmouth		Yes				Moderate
Child Day Care	Jarrow Montessori School	3900 Orange Ct.						High
Child Day Care	Joanie's Daycare	198 Cherokee Way						Moderate
Child Day Care	Joy Care Infant/Toddler Center	950 28th St.						Moderate
Child Day Care	Jump for Joy	2530 4th Street						High
Child Day Care	Laura's Little Lambs	620 S. 42nd Street						Moderate
Child Day Care	Mapleton Montessori School	3121 29th Street						Moderate
Child Day Care	McGregor's Garden Preschool	3535 Eastman Avenue		Yes				Moderate

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Child Day Care	Meadowlark Preschool	2650 Table Mesa Dr.						High
Child Day Care	Miss Catherine's Creative Learning Center	6525 Gunpark Dr.						Moderate
Child Day Care	Miss Catherine's Infant Center	5280 Spine Rd						Moderate
Child Day Care	Mother Earth Play Group	745 39th St.						Moderate
Child Day Care	Mountain Morning Preschool	1286 Sumac Avenue		Yes				Moderate
Child Day Care	Mountain View Preschool	355 Ponca Place						Moderate
Child Day Care	Mt. Calvary Rainbow Child Care Center	3485 Stanford Ct.						Moderate
Child Day Care	Mt. Hope Lutheran Child Development	1345 South Broadway						Moderate
Child Day Care	Mt. Zion Lutheran Preschool	1680 Balsam Ave.						Moderate
Child Day Care	New Horizons Cooperative Preschool	1825 Upland		Yes				Moderate
Child Day Care	Patience Montessori	3600 Hazelwood Ct	Yes	Yes				Moderate
Child Day Care	Paula's Child Care	2411 Pine Street						Moderate
Child Day Care	Peter Pan Cooperative Preschool	355 Ponca Place						Moderate
Child Day Care	Planting Love	735 Mohawk Dr.						Moderate
Child Day Care	Presbyterian Coop Weekday Preschool	1820 15th St.						Moderate

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Child Day Care	Rainbow Bridge Life Ways Program	3640 Buckeye Ct.						Moderate
Child Day Care	Rally Sport Education	2727 29th St		Yes				Moderate
Child Day Care	Robin's Nest Playschool	909 Brooklawn Dr						Moderate
Child Day Care	Rose A Montessori School	3111 Westwood Court						Moderate
Child Day Care	Sacred Heart of Jesus (Early Learning Center)	1317 Mapleton Ave.						Moderate
Child Day Care	Shining Mountain Waldorf School (Center)	999 Violet Ave	Yes	Yes				High
Child Day Care	Shining Mountain Waldorf School (SACC)	999 Violet Ave	Yes	Yes				High
Child Day Care	Snow Lion Preschool	2575 Glenwood Dr						Moderate
Child Day Care	Strawberry Farm	1020 Portland Place						High
Child Day Care	Sunflower Preschool	3340 Dartmouth		Yes				Moderate
Child Day Care	Sunshine House Montessori, Inc.	745 College Ave.						High
Child Day Care	Surya Mountain Day School	740 Morgan Dr		Yes				Moderate
Child Day Care	Take a Break at Frasier Meadows	4950 Thunderbird Drive	Yes	Yes				Moderate
Child Day Care	The Learning House	760 33rd Street						Moderate
Child Day Care	Tiny Minders DayCare & Preschool North	3735 Iris Ave						Moderate

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Child Day Care	Tiny Minders Daycare Preschool	3685 Martin Drive		Yes				Moderate
Child Day Care	Univ CO Family Housing Children's Center	2202 Arapahoe	Yes	Yes				Moderate
Child Day Care	University Hill Preschool BVSD	889 17th St						High
Child Day Care	White Rose Preschool	529 Union Ave						High
Child Day Care	YMCA of Boulder Valley - Chief Niwot Jr's	3975 28th St						Moderate
Child Day Care	YMCA of Boulder Valley (Creekside at Martin Park)	3740 Martin Park Dr.						Moderate
Child Day Care	YMCA of Boulder Valley B/A (Mapleton)	840 Mapleton						High
Child Day Care	YMCA of Boulder Valley Bear Creek Elementary	2500 Table Mesa Dr.						High
Child Day Care	YMCA of Boulder Valley Columbine Elementary	3130 Repplier St						Moderate
Child Day Care	YMCA of Boulder Valley Crestview Elementary	1897 Sumac						Moderate
Child Day Care	YMCA of Boulder Valley Eisenhower Elementary	1220 Eisenhower Dr.						Moderate
Child Day Care	YMCA of Boulder Valley Flatirons Elementary	1150 7th Ave.						High

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Child Day Care	YMCA of Boulder Valley Foothill Elementary	1001 Hawthorne Ave.	Yes	Yes				High
Child Day Care	YMCA of Boulder Valley High/Peaks/BCSIS at Aurora7	3995 Aurora Ave.						Moderate
Child Day Care	YMCA of Boulder Valley Mesa Elementary	1575 Lehigh						High
Child Day Care	YMCA of Boulder Valley University Hill	956 16th St.						High
Child Day Care	YMCA of Boulder Valley Whittier Elementary	2008 Pine St.						Moderate
Child Day Care	YWCA of Boulder County Children's Alley	2222 14th St.						Moderate
Licensed Home Day Care		1140 Hartford Drive						High
Licensed Home Day Care		1286 Sumac Avenue		Yes				Moderate
Licensed Home Day Care		1694 Redwood Avenue						Moderate
Licensed Home Day Care		198 Cherokee Way	Yes	Yes				Moderate
Licensed Home Day Care		2411 Pine Street						Moderate
Licensed Home Day Care		2635 Mapleton Ave		Yes				Moderate
Licensed Home Day Care		2750 Carnegie Dr.						High

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Licensed Home Day Care		2990 Jefferson St.						Moderate
Licensed Home Day Care		3112 8th St						High
Licensed Home Day Care		3535 Eastman Avenue		Yes				Moderate
Licensed Home Day Care		4285 Graham Court						Moderate
Licensed Home Day Care		4616 Talbot Drive						Moderate
Licensed Home Day Care		4700 Sioux Drive						Moderate
Licensed Home Day Care		4745 Hancock Drive						Moderate
Licensed Home Day Care		580 Ithaca Drive						High
Licensed Home Day Care		590 Ithaca Drive						High
Licensed Home Day Care		60 Manhattan Drive						Moderate
Licensed Home Day Care		620 S 42nd Street						Moderate
Licensed Home Day Care		930 36th Street						Moderate
Schools	Bear Creek Elementary	2500 Table Mesa Dr						High
Schools	Bixby Pre/Elementary							Moderate
Schools	Boulder Country Day							Moderate
Schools	Boulder High School	1604 Arapahoe Ave	Yes	Yes				Moderate

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Schools	Boulder Preparatory	5075 Chaparral Ct						Moderate
Schools	Casey Middle	1301 High St						Moderate
Schools	Centennial Middle	2205 Norwood Ave						Moderate
Schools	Columbine Elementary	3130 Repplier St						Moderate
Schools	Community Montessori	805 Gillaspie Dr						High
Schools	Creekside At Martin Park	3740 Martin Dr						Moderate
Schools	Crest View Elementary	1897 Sumac Ave						Moderate
Schools	Eisenhower Elementary	1220 Eisenhower Dr						Moderate
Schools	Fairview High	1515 Greenbriar Blvd						High
Schools	Flatirons Elementary	1150 7th St						High
Schools	Foothill Elementary	1001 Hawthorn Ave	Yes	Yes				High
Schools	Friends' School		Yes	Yes				Moderate
Schools	Halcyon	3100 Bucknell Ct						Moderate
Schools	High Peaks/Bcsis	3995 E Aurora Ave						Moderate
Schools	Horizons K-8	4545 Sioux Dr						Moderate
Schools	Jarrow Montessori							High
Schools	Living School		Yes	Yes				Moderate
Schools	Manhattan Middle	290 Manhattan Dr						Moderate
Schools	Mesa Elementary	1575 Lehigh St						High

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Schools	Mt Zion Lutheran							Moderate
Schools	Naropa University		Yes	Yes				Moderate
Schools	New Vista High	700 20th St						High
Schools	Sacred Heart Of Jesus							Moderate
Schools	September School							Moderate
Schools	Shining Mountain Waldorf			Yes				High
Schools	Shining Mountain Waldorf		Yes	Yes				High
Schools	Southern Hills Middle	1500 Knox Dr						Moderate
Schools	Summit Middle Charter	4655 Hanover Ave						Moderate
Schools	Tara Performing Arts High							Moderate
Schools	University Hill Elementary	956 16th St						High
Schools	University Of Colorado	East Campus	Yes	Yes				Moderate
Schools	University Of Colorado	Main Campus						Moderate
Schools	University Of Colorado	Research Park						Moderate
Schools	University Of Colorado	Williams Village						Moderate
Schools	Watershed School							Severe
Schools	Whittier Elementary	2008 PINE ST						Moderate
Senior Center	South Boulder Recreation Center	1360 Gillespie						High

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Senior Center	West Senior Center	909 Arapahoe						Moderate
Senior Housing	Alterra Villas at the Atrium	3350 30th St.		Yes				Moderate
Senior Housing	Alterra Wyndwood at Ridge Point	3375 34th St.	Yes	Yes		Yes		Moderate
Senior Housing	Anam Chara	1795 Quince St.						Moderate
Senior Housing	Boulder Good Samaritan Center	2525 Taft Dr.	Yes	Yes				Moderate
Senior Housing	Boulder Good Samaritan Village	2525 Taft Dr.	Yes	Yes				Moderate
Senior Housing	Boulder Housing Partners	4800 N. Broadway						High
Senior Housing	Boulder Manor	4685 Baseline Rd.						Moderate
Senior Housing	Boulder Meridian	801 Gillaspie						High
Senior Housing	Dunn Memorial Housing	4805 Baseline Rd.						Moderate
Senior Housing	Frasier Meadows	350 Ponca Place						Moderate
Senior Housing	Golden West	1055 Adams Circle						Moderate
Senior Housing	Golden West Senior Residence	1055 Adams Circle						Moderate
Senior Housing	Hawthorne House	3275 23rd St.						Moderate
Senior Housing	Manor Care	2800 Palo Parkway						Moderate
Senior Housing	Mary Sandoe House	1244 Gillaspie						High
Senior Housing	Mesa Vista of Boulder	2121 Mesa Drive						Moderate
Senior Housing	Presbyterian Manor	1050 Arapahoe Ave.	Yes	Yes				Moderate

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Senior Housing	Shawnee Gardens	4755 Shawnee Place						Moderate
Senior Housing	Sunrise Assisted Living	3955 28th St.	Yes	Yes				Moderate
Senior Housing	Taft Towers - Good Samaritan Vllg.	2525 Taft Dr.	Yes	Yes				Moderate
Senior Housing	The Academy	970 Aurora Ave.						High
Essential Services								
Airport	Boulder Municipal Airport	3300 Airport Bv						Moderate
Communications	Cell Tower	1001 Lee Hill Dr						High
Communications	Cell Tower	1035 Pearl St						High
Communications	Cell Tower	1050 Arapahoe Av	Yes	Yes				Moderate
Communications	Cell Tower	1055 Adams Cr						Moderate
Communications	Cell Tower	1089 13th St						Moderate
Communications	Cell Tower	1100 Balsam Av	Yes	Yes				High
Communications	Cell Tower	1200 28th St						Moderate
Communications	Cell Tower	1200 Broadway						Moderate
Communications	Cell Tower	1343 Iris Av						Moderate
Communications	Cell Tower	1545 Walnut St						Moderate
Communications	Cell Tower	1657 28th St	Yes	Yes				Moderate
Communications	Cell Tower	1790 38th St		Yes				Moderate
Communications	Cell Tower	1850 Folsom St		Yes				Moderate
Communications	Cell Tower	1877 Broadway		Yes				High
Communications	Cell Tower	1919 14th St						Moderate
Communications	Cell Tower	2060 Broadway						High
Communications	Cell Tower	2525 Taft Dr	Yes	Yes				Moderate

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Communications	Cell Tower	255 Canyon Bl	Yes	Yes		Yes	Yes	Severe
Communications	Cell Tower	2660 Canyon Bl	Yes	Yes				Moderate
Communications	Cell Tower	2750 Broadway	Yes	Yes		Yes		Moderate
Communications	Cell Tower	2801 Iris Av						Moderate
Communications	Cell Tower	2829 Mapleton		Yes				Moderate
Communications	Cell Tower	2829 Mapleton Av		Yes				Moderate
Communications	Cell Tower	2935 Baseline Rd	Yes	Yes				Moderate
Communications	Cell Tower	2960 Diagonal Hy		Yes				Moderate
Communications	Cell Tower	3255 28th St						Moderate
Communications	Cell Tower	3267 28th St						Moderate
Communications	Cell Tower	3300 Airport Rd						Moderate
Communications	Cell Tower	3375 Mitchell Ln						Moderate
Communications	Cell Tower	3485 Stanford Ct						Moderate
Communications	Cell Tower	350 Ponca Pl	Yes	Yes				Moderate
Communications	Cell Tower	3600 Table Mesa Dr	Yes	Yes		Yes		Moderate
Communications	Cell Tower	3825 Iris Av						Moderate
Communications	Cell Tower	4041 Hanover Av						Moderate
Communications	Cell Tower	4041 Hanover Dr						Moderate
Communications	Cell Tower	4215 Grinnell Av						High
Communications	Cell Tower	4430 Arapahoe Av	Yes	Yes		Yes	Yes	Moderate
Communications	Cell Tower	4869 Broadway						High
Communications	Cell Tower	4920 Table Mesa Dr	Yes	Yes				Moderate
Communications	Cell Tower	505 27th St	Yes	Yes		Yes		Moderate
Communications	Cell Tower	6055 Longbow Dr						Moderate

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Communications	Cell Tower	6175 Longbow Dr						Moderate
Communications	Cell Tower	629 S Broadway						Moderate
Communications	Century Link	1860 S Flatiron Ct	Yes	Yes				Moderate
Emergency Medical Services	American Medical Response - Boulder County	3800 Pearl St		Yes				Moderate
Emergency Medical Services	Pridemark Paramedics - Boulder	3297 Walnut St		Yes				Moderate
Emergency Operation Centers	CU Police	1070 Regent Dr						Moderate
Emergency Operation Centers	Emergency Operations Center	3280 Airport Rd.						Moderate
Emergency Operation Centers	Yards	5050 Pearl St		Yes				Moderate
Emergency Warning Systems	Columbine School	3130 REPPLIER ST						Moderate
Emergency Warning Systems	County Jail	3200 Airport Rd						Moderate
Emergency Warning Systems	Creekside/Martin Park Elem.	3740 Martin Drive						Moderate
Emergency Warning Systems	Crest View Elementary	1897 Sumac	Yes	Yes		Yes	Yes	Moderate
Emergency Warning Systems	CU Research Ctr.	3300 Marine St.	Yes	Yes		Yes		Moderate
Emergency Warning Systems	Eisenhower Elementary	1220 Eisenhower Dr						Moderate
Emergency Warning Systems	Elks Park	3975 28th St	Yes	Yes				Moderate

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Emergency Warning Systems	Fire Station # 3	1580 30th Street	Yes	Yes			Yes	Moderate
Emergency Warning Systems	Fire Station 6	5145 63rd St.						Moderate
Emergency Warning Systems	Folsom Field	CU Stadium						Moderate
Emergency Warning Systems	Foothills Elementary	1001 Hawthorn Av	Yes	Yes				High
Emergency Warning Systems	Manhattan School	290 Manhattan Dr						Moderate
Emergency Warning Systems	New Britain Building	1101 Arapahoe Ave.	Yes	Yes		Yes	Yes	Moderate
Emergency Warning Systems	NIST	325 Broadway						Moderate
Emergency Warning Systems	Paddock School	805 Gillaspie Dr						High
Emergency Warning Systems	Vectra Bank Building	1101 Arapahoe Av						Moderate
Fire Station	Fire Station Five	4365 19th St.		Yes				Moderate
Fire Station	Fire Station Four	4100 Darley Ave.						Moderate
Fire Station	Fire Station One	2441 13th St.						Moderate
Fire Station	Fire Station Seven	1380 55th Ave.		Yes				Moderate
Fire Station	Fire Station Six	5145 63rd St.						Moderate
Fire Station	Fire Station Three	1585 30th St.	Yes	Yes			Yes	Moderate
Fire Station	Fire Station Two	2225 Baseline Rd.						Moderate
Government Buildings	Airport Terminal	3300 Airport Rd						Moderate
Government Buildings	Boulder County Jail	3200 Airport Rd.						Moderate

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Government Buildings	Cherryvale South	66 S Cherryvale Rd						Moderate
Government Buildings	Criminal Justice Center	1777 6th Street			Yes			High
Government Buildings	East Boulder Recreation Center	5660 Sioux Dr						Moderate
Government Buildings	East Boulder Senior Center	5660 Sioux Dr						Moderate
Government Buildings	Main Library New	1000 Canyon Blvd	Yes	Yes		Yes		Moderate
Government Buildings	Municipal Building	1777 Broadway	Yes	Yes		Yes		Moderate
Government Buildings	Municipal Service Center A	5050 Pearl Street		Yes				Moderate
Government Buildings	Municipal Service Center B	5050 Pearl Street		Yes				Moderate
Government Buildings	Municipal Service Center C	5050 Pearl Street		Yes				Moderate
Government Buildings	New Britain	1101 Arapahoe Ave	Yes	Yes		Yes	Yes	Moderate
Government Buildings	New Fire Training Center	Diagonal Hwy						Moderate
Government Buildings	North Boulder Recreation Center	3170 Broadway						Moderate
Government Buildings	OSMP Annex Admin	7315 Red Deer Drive						Moderate
Government Buildings	Park Central	1739 Broadway	Yes	Yes				Moderate
Government Buildings	Reynolds Branch Library	3595 Table Mesa						Moderate

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Hospitals	Boulder Community Foothills	4747 Arapahoe Av	Yes	Yes				Moderate
Hospitals	Boulder Community Hospital Main	1100 Balsam	Yes	Yes		Yes	Yes	High
Hospitals	Wardenberg Health Center	18th St & Broadway on CU Campus						Moderate
Police	Boulder County Sheriff	5600 Flatiron Pk	Yes	Yes				Moderate
Police	CU Police	1070 Regent Dr						Moderate
Police	Pearl St. Substation	1500 Pearl St						Moderate
Police	Public Safety Building	1805 33rd St.		Yes				Moderate
Police	University Hill Substation	1310 College Av						Moderate
Shelters	(cu) - Coors Event Center	Regent Drive						Moderate
Shelters	(cu) Student Recreation Center	Folsom St						Moderate
Shelters	(cu) University Memorial Center	1669 Euclid Ave.						High
Shelters	Boulder High School	1604 Arapahoe Ave.	Yes	Yes				Moderate
Shelters	Boulder Meeting Of Friends	1825 Upland Avenue		Yes				Moderate
Shelters	Casey Middle School	2410 13th St.						Moderate
Shelters	Centennial Middle School	2205 Norwood Ave.						Moderate
Shelters	East Boulder Rec Center	5660 Sioux Drive						Moderate

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Shelters	ELKS CLUB	3975 28TH STREET						Moderate
Shelters	Fairview High School	1515 Greenbriar Blvd.						High
Shelters	First Christian Church	1700 Stonehenge Drive						Moderate
Shelters	First Presbyterian Church	1603 Walnut Street						Moderate
Shelters	First United Methodist Church	1421 Spruce Street						Moderate
Shelters	Horizons International Student Center	777 Broadway						Moderate
Shelters	Manhattan Middle School - Bvsd Re-2	290 Manhattan Dr.						Moderate
Shelters	New Vista High	700 20th Street						High
Shelters	Sacred Heart of Jesus	1316 High Street						Moderate
Shelters	Southern Hills Middle School	1500 Knox Dr.						High
Shelters	YMCA Boulder Valley	2850 Mapleton Avenue		Yes				Moderate
Urgent Care Facility	Boulder Medical Center	2750 Broadway St #178	Yes	Yes				Moderate
Urgent Care Facility	Rocky Mountain Urgent Care	4800 Baseline Rd						Moderate
Utility - Power Plant	Boulder Hydro Plant	Boulder Canyon Dr						Severe
Utility - Power Plant	Silver Lake Hydroelectric Generator							High

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Utility - Power Plant	Sunshine Hydroelectric	Sunshine Dr & Green Rock Dr						High
Utility - Power Plant	Xcel Boulder Terminal	2500 28th St		Yes				Moderate
Utility - Power Plant	Xcel Energy	2451 63th St.						Moderate
Utility - Substation	Xcel Leggett Substation	1900 63rd St						Moderate
Utility - Substation	Xcel NCAR Substation	1245 Wildwood Rd						High
Utility - Substation	Xcel Substation	5001 75th St						Moderate
Utility - Substation	Xcel Sunshine Substation	151 Mapleton Av						High
Utility - Wastewater Facilities	75th Street Wastewater Treatment Plant							High
Utility - Wastewater Facilities	Diagonal aka IBM Lift Station	0 Diagonal Hwy						Moderate
Utility - Water Facilities	Barker Hydroelectric Generator							Severe
Utility - Water Facilities	Betasso Water Treatment Plant							High
Utility - Water Facilities	Booton Water Tank							High
Utility - Water Facilities	Boulder Reservoir aka 63rd Water Treatment Plant	0 N 63rd St						Moderate
Utility - Water Facilities	Chautauqua Water Tank	900 Baseline Rd						High
Utility - Water Facilities	Cherryvale Pump Station	6050 Baseline Rd						High

Classification	Name	Address	1% Annual Chance Flood Prone	0.2% Annual Chance Flood Prone	Zone X Protected by Levee Flood Prone	Prone to Conveyance Flooding	Prone to High Hazard Flooding	Area of Fire Concerns
Utility - Water Facilities	Devils Thumb Water Tank							High
Utility - Water Facilities	Iris Pump Station	3715 IRIS AV						Moderate
Utility - Water Facilities	Kohler Water Tank							High
Utility - Water Facilities	Kossler Reservoir							Moderate
Utility - Water Facilities	Maxwell Water Tank	3715 Wonderland Hill Dr						High
Utility - Water Facilities	Orodell Hydroelectric Generator	38000 Boulder Canyon Rd	Yes	Yes				Severe
Hazardous Materials								
Hazmat Facilities	28TH ST GARAGE INC	5472 Arapahoe Avenue, Suite A	Yes	Yes				Moderate
Hazmat Facilities	ABC Auto Body	3211 Pearl St						Moderate
Hazmat Facilities	Amgen Incorporated	4765 Walnut St		Yes				Moderate
Hazmat Facilities	Array Biopharma, Inc	3200 Walnut St		Yes				Moderate
Hazmat Facilities	Art Cleaners	1715 15th St	Yes	Yes				Moderate
Hazmat Facilities	Ball Aerospace	1600 Commerce St	Yes	Yes				Moderate
Hazmat Facilities	Ball Aerospace & Technologies Corp	1730 Conestoga St	Yes	Yes				Moderate
Hazmat Facilities	Ball Aerospace &Technologies Corp	1685 Conestoga St	Yes	Yes				Moderate
Hazmat Facilities	Batteries Plus	2700 28th St		Yes				Moderate
Hazmat Facilities	Boulder Bump Shop	2480 49th St		Yes				Moderate

Classification	Name	Address	1% Annual Chance Flood Prone	0.2% Annual Chance Flood Prone	Zone X Protected by Levee Flood Prone	Prone to Conveyance Flooding	Prone to High Hazard Flooding	Area of Fire Concerns
Hazmat Facilities	Boulder Chrysler Plymouth	2170 30th St		Yes				Moderate
Hazmat Facilities	Boulder Elec Motor Co	3865 Walnut St		Yes				Moderate
Hazmat Facilities	Boulder Gas	2700 Baseline Rd	Yes	Yes				Moderate
Hazmat Facilities	Boulder Gas	2995 28th St		Yes				Moderate
Hazmat Facilities	Boulder Nissan	2285 28th St		Yes				Moderate
Hazmat Facilities	Boulder Phillips 66 Gas Station	4501 N Broadway	Yes	Yes				High
Hazmat Facilities	Cache Cleaners	2690 28th St		Yes				Moderate
Hazmat Facilities	Circle K	2877 Baseline Rd	Yes	Yes				Moderate
Hazmat Facilities	Circular Technologies	3275 Prairie Ave		Yes				Moderate
Hazmat Facilities	City Of Boulder Serv Cntr & Fire Dept	5050 E Pearl St		Yes				Moderate
Hazmat Facilities	Colorado Powersports	1880 55th St						Moderate
Hazmat Facilities	Comcast	3250 Walnut St		Yes				Moderate
Hazmat Facilities	Conoco	1201 Arapahoe Ave	Yes	Yes				Moderate
Hazmat Facilities	Conoco	2360 Arapahoe Ave	Yes	Yes		Yes		Moderate
Hazmat Facilities	Conoco	3000 28th St		Yes				Moderate
Hazmat Facilities	Conoco	5500 Arapahoe Ave		Yes				Moderate
Hazmat Facilities	Corner Store	1884 Folsom Ave		Yes				Moderate
Hazmat Facilities	Crossroads Amoco	3005 Arapahoe Ave	Yes	Yes		Yes		Moderate

Classification	Name	Address	1% Annual Chance Flood Prone	0.2% Annual Chance Flood Prone	Zone X Protected by Levee Flood Prone	Prone to Conveyance Flooding	Prone to High Hazard Flooding	Area of Fire Concerns
Hazmat Facilities	CU Environmental Health	East Campus - 30th and Marine St	Yes	Yes				Moderate
Hazmat Facilities	D and K Printing	2930 Pearl St		Yes				Moderate
Hazmat Facilities	Dependable Dry Cleaners	2525 Arapahoe Ave #H5	Yes	Yes				Moderate
Hazmat Facilities	Diagonal AMOCO	2990 Diagonal Hy		Yes				Moderate
Hazmat Facilities	Diamond Shamrock	1704 Arapahoe Ave	Yes	Yes				Moderate
Hazmat Facilities	Eco-Cycle Inc	5030 Pearl St		Yes				Moderate
Hazmat Facilities	Eisenhower Elementary School	1220 Eisenhower Dr		Yes				Moderate
Hazmat Facilities	Enviro Cleaners	2859 28th St		Yes				Moderate
Hazmat Facilities	Estey Printing Co	2005 32nd St		Yes				Moderate
Hazmat Facilities	Express 1hr Cleaners	1659 28th St	Yes	Yes				Moderate
Hazmat Facilities	FedEx	2205 Central Ave						Moderate
Hazmat Facilities	Fuji Motors	1900 55th St		Yes				Moderate
Hazmat Facilities	Gebhardt Automotive	2470 49th St		Yes				Moderate
Hazmat Facilities	General Air Service and Supply	3750 Walnut St		Yes				Moderate
Hazmat Facilities	Global Collision	5751 Arapahoe Ave	Yes	Yes				Moderate
Hazmat Facilities	Golden Buff Cleaners	1715 28TH ST		Yes				Moderate
Hazmat Facilities	Goodbye Blue Monday Inc.	2865 Wilderness Pl		Yes				Moderate
Hazmat Facilities	Grizzly Gasoline and Store	3200 Arapahoe Ave	Yes	Yes		Yes		Moderate

Classification	Name	Address	1% Annual Chance Flood Prone	0.2% Annual Chance Flood Prone	Zone X Protected by Levee Flood Prone	Prone to Conveyance Flooding	Prone to High Hazard Flooding	Area of Fire Concerns
Hazmat Facilities	Haglin Automotive	5747 Arapahoe Ave	Yes	Yes				Moderate
Hazmat Facilities	Home Depot	1600 29TH ST		Yes				Moderate
Hazmat Facilities	Import Coachworks	2445 30th St		Yes				Moderate
Hazmat Facilities	Jiffy Lube	1788 30th St		Yes				Moderate
Hazmat Facilities	Kapp Tech LP.	2870 Wilderness Pl		Yes				Moderate
Hazmat Facilities	Larry H. Miller Toyota	2465 48th Ct		Yes				Moderate
Hazmat Facilities	MACYS WEST #17222	1900 28TH ST		Yes				Moderate
Hazmat Facilities	McCaddon Cadillac Buick	2460 48th Ct		Yes				Moderate
Hazmat Facilities	NCAR-RL6	3215 MARINE ST	Yes	Yes				Moderate
Hazmat Facilities	NOAA MARINE ST CENTER	3100 MARINE ST	Yes	Yes				Moderate
Hazmat Facilities	OSI Pharmaceuticals Incorporated	2860 WILDERNESS PL		Yes				Moderate
Hazmat Facilities	PDQ Gas Station	5200 Manhattan Cir						Moderate
Hazmat Facilities	Pearl Auto Body	4700 Pearl ST		Yes				Moderate
Hazmat Facilities	Plaza Cleaners	2610 N Broadway	Yes	Yes				Moderate
Hazmat Facilities	Pollard Jeep	2300 30th St		Yes				Moderate
Hazmat Facilities	Qwest	1860 S Flatiron CT	Yes	Yes				Moderate
Hazmat Facilities	Regional Transportation District	1707 Exposition DR		Yes				Moderate
Hazmat Facilities	Roche	2075 55th St	Yes	Yes				Moderate

Classification	Name	Address	1% Annual Chance Flood Prone	0.2% Annual Chance Flood Prone	Zone X Protected by Levee Flood Prone	Prone to Conveyance Flooding	Prone to High Hazard Flooding	Area of Fire Concerns
Hazmat Facilities	Rudi's Organic Bakery	3300 Walnut St, Unit C		Yes				Moderate
Hazmat Facilities	Scientech Incorporated	5649 Arapahoe	Yes	Yes		Yes	Yes	Moderate
Hazmat Facilities	Shell Gas Station	1480 Canyon Blvd						Moderate
Hazmat Facilities	Sinclair	2375 Canyon Blvd		Yes				Moderate
Hazmat Facilities	Somalogic Inc.	2945 Wilderness Pl		Yes				Moderate
Hazmat Facilities	Stammler Imports Inc	1799 Exposition Dr		Yes				Moderate
Hazmat Facilities	Sunbelt Rentals	5401 Pearl Pk		Yes				High
Hazmat Facilities	Symmetricom Inc	4775 Walnut St #1b	Yes	Yes				Moderate
Hazmat Facilities	Target Store T-64	2800 Pearl St		Yes				Moderate
Hazmat Facilities	The Sherwin Williams Co	3550 Arapahoe #3	Yes	Yes				Moderate
Hazmat Facilities	The Wireless Alliance Llc	5763 Arapahoe Rd Unit G	Yes	Yes				Moderate
Hazmat Facilities	Timberline Instruments, Inc	1880 S. Flatiron Ct,I	Yes	Yes				Moderate
Hazmat Facilities	Today's Choice Dental	2800 Valmont Rd		Yes				Moderate
Hazmat Facilities	U.S. West Communications (Qwest)	1545 Walnut St						Moderate
Hazmat Facilities	United Parcel Service Center	3795 Frontier Ave		Yes				Moderate
Hazmat Facilities	USPS Boulder Valmont	2935 55th St	Yes	Yes				Moderate

Classification	Name	Address	1% Annual Chance Flood Prone	0.2% Annual Chance Flood Prone	Zone X Protected by Levee Flood Prone	Prone to Conveyance Flooding	Prone to High Hazard Flooding	Area of Fire Concerns
Hazmat Facilities	Valley Chrysler Dodge	2100 30th St		Yes				Moderate
Hazmat Facilities	Walsh Environmental	4888 Pearl E Cir Ste 108		Yes				Moderate

Source: City of Boulder GIS

Appendix H CITY OF BOULDER HISTORIC LANDMARKS

Table H.1 City of Boulder Cultural Resources: Historic Landmark Listings

Landmark Address	Name of Landmark	Style	Date Approved	Date Recorded	Landmark Number or HIS Case #	Reception Number	Ordinance Number
1019 Spruce Street	Squires-Tourtellot House	Colonial Revival	04/13/76	07/08/76	75-1	183492	4087
1128 Pine Street	First Congregational Church	Gothic Revival	04/13/76	07/08/76	75-2	183492	4087
934 Pearl Street	Armory Building	Romanesque Revival	04/13/76	07/08/76	75-3	183492	4087
1142-1148 Pearl Street	Boettcher-Valentine Building	19th Century Commercial	04/13/76	07/08/76	75-3	183492	4087
2305 Broadway	Grill Mansion	Foursquare / Italian Renaissance Revival	04/13/76	07/08/76	75-6	183492	4087
885 Arapahoe Avenue	Highland School	Romanesque Revival	05/18/76	07/08/76	76-8	183493	4098
809 Pine Street	Morrison-McKenzie House	Gothic Revival	01/18/77	02/18/77	76-10	211381	4191
Chautauqua Park	Chautauqua Auditorium	Italianate	01/18/77	02/18/77	76-11	211383	4193
1507 Pine Street	Temple-Bowron House	Queen Anne	01/18/77	02/18/77	76-12	211380	4190
2429 Broadway	Greene-Earl House	Gothic Revival	01/18/77	02/18/77	76-13	211378	4188
1401 Pine Street	St. John's Episcopal Church	Gothic Revival	01/18/77	02/18/77	76-14	211379	4189
1125 Pine Street	Carnegie Library	Classical Revival	01/18/77	02/18/77	76-9	211382	4192
15 S. 35th Street	Martin Farmhouse	Vernacular wood frame (New England)	03/15/77	03/31/77	76-17	216675	4204
2115 13th Street	Boulderado Hotel	Mission	04/19/77	05/03/77	76-15	220963	4216
9th & Pleasant	Pioneer Cemetery	N/A	08/16/77	08/30/77	77-1	239856	4252
1305 Pine Street	Dwight-Nicholson House	Colonial Revival	08/16/77	08/30/77	77-2	239857	4253
1619 Pine Street	McAllister House	Queen Anne	12/13/77	01/17/78	77-3	260945	4294
1733 Canyon Blvd	Woodward-Baird (Culver-Bixby) House	Vernacular wood frame	08/01/78	10/04/78	78-3	302749	4379
1709 Pine Street	Whiteley-Hellems House	Queen Anne	08/01/78	08/25/78	78-4	295895	4378
741 Pearl Street	Arnett-Montgomery House	Queen Anne	06/05/79	06/29/79	79-1	345631	4424

Landmark Address	Name of Landmark	Style	Date Approved	Date Recorded	Landmark Number or HIS Case #	Reception Number	Ordinance Number
905 13th Street	Derham-Lindgren House	Shingle / Dutch Colonial Revival	06/05/79	06/29/79	79-2	345630	4425
2940 20th Street	Decker-Tyler House	Gothic Revival	06/05/79	06/29/79	79-3	345629	4426
30th & Pearl	Boulder Depot	Romanesque Revival	09/04/79	09/10/79	79-6	358647	4444
1206 Euclid Avenue	Harbeck-Bergheim House	Edwardian vernacular	01/01/80	01/22/80	79-7	380002	4454
1010 Aurora Avenue	Fire Station #2	Foursquare	01/01/80	01/22/80	79-8	380003	4455
2032 14th Street	Boulder Theater	Art Deco Style	03/04/80	03/25/80	79-5	388827	4483
427 Pine Street	Spencer House	Foursquare	09/07/82	09/23/82	82-1	512723	4703
1590 Broadway	Old Public Service Power Substation	Neo-Classical Style	06/07/83	05/31/83	83-1	552445	4753
1235-57 Elder Avenue	Wolff House	Italianate	06/07/83	05/31/83	83-2	552444	4752
1541-45 Pearl Street	Odd Fellows Hall	19th Century Commercial	06/21/83	06/21/83	83-3	557078	4751
3011 Broadway	Newland House	Combines Queen Anne/Richardsonian Romanesque/Neo-Colonial Georgian Revival Architecture	01/03/84	02/17/84	83-4	604671	4800
10th & Aurora	Mt. St. Gertrude Academy	Richardsonian Romanesque	04/03/84	04/27/84	84-1	617654	4823
745 Highland Avenue	Moorhead House	Colonial Revival	06/05/84	08/29/84	84-2	643313	4835
655 Arapahoe Avenue	Lennartz House	Foursquare	06/19/84	08/29/84	84-3	643314	4841
1034 Spruce Street	Terrace Apartments	Vernacular masonry	01/08/85	03/01/85	84-4	674674	4876
207 Pearl Street	Brierley Farmhouse	Vernacular stone	09/02/86	11/18/86	86-1	805927	4999
707 12th Street	Fischer House	Tudor Revival	03/01/88	03/30/88	87-1	910326	5104
541 Highland Avenue	Whitney-Holmes House	Shingle Style	04/05/88	05/11/88	88-1	918048	5116
1207 Aurora Avenue	Bushee House	Colonial Revival	10/18/88	11/22/88	88-2	954373	5144
933 Mapleton Avenue	Patton House	Colonial Revival / Foursquare	02/21/89	03/08/89	88-4	971021	5164

Landmark Address	Name of Landmark	Style	Date Approved	Date Recorded	Landmark Number or HIS Case #	Reception Number	Ordinance Number
1735 Mapleton Avenue	Greenman House	Vernacular wood frame	04/04/89	06/30/89	89-1	990362	5178
1302 Baseline Road	Repplier House	Tudor Revival	04/04/89	05/03/89	89-2	980879	5179
626 13th Street	Drewelowe-Van Ek House	Chateauesque	08/01/89	08/22/89	89-3	998945	5214
1540 Pine Street	Henry Fulton House	Edwardian vernacular	08/15/89	09/12/89	89-5	1002910	5226
1645 Pine Street	C.G. Buckingham House	Vernacular masonry	08/15/89	09/12/89	89-6	1002911	5227
355 West Arapahoe Lane	Queen Anne House	Queen Anne Cottage Architecture	09/19/89	10/19/89	89-4	1009296	5232
637 Pine Street	McClure House	Shingle / Dutch Colonial Revival	09/19/89	10/19/89	89-7	1009295	5231
2130 Arapahoe Avenue	Lincoln School	Italianate	10/03/89	10/19/89	89-8	1009297	5235
1015 15th Street	Alpha Omicron Pi	Jacobean / Elizabethan	10/03/89	10/19/89	89-9	1009298	5236
1403 Baseline Road	Henrietta Somers House	Colonial Revival	01/23/90	02/01/90	89-11	1026287	5265
2141 Bluff Street	Wickstrom House	Edwardian vernacular	02/06/90	05/14/90	89-12	1041863	5268
720-722 11th Street	David Hull Holmes House	Mediterranean	02/06/90	05/14/90	89-13	1041862	5269
888 13th Street	Alpha Phi House	French Eclectic	04/17/90	06/01/90	89-14	1045040	5286
1235 Pearl Street	White-Davis Mercantile Building	19th Century Commercial	06/05/90	07/30/90	90-1	1055104	5296
1000-1020 12th Street	Huntington Arms Building	Modernistic	07/24/90	08/09/90	90-3	1057148	5311
646 Pearl Street	Arnett-Fullen House	Gothic Revival	08/21/90	10/10/90	90-2	1068794	5318
308 Pearl Street	Brierley-Smith House	Vernacular masonry	08/21/90	10/10/90	90-4	1068795	5328
2224 13th Street	Patterson-Bittner House	Vernacular wood frame	10/16/90	11/13/90	90-5	1073903	5335
2455 Broadway	J.R. Brackett House	Queen Anne	12/18/90	12/24/90	90-6	1079936	5356
1813 Pine Street	Werley House	Colonial Revival	02/19/91	04/03/91	90-7	1095584	5371
2016 Walnut Street	Lytle House	Italianate	02/19/91	04/03/91	90-9	1095583	5370
907 12th Street	Norlin House	Romanesque Revival	03/19/91	04/03/91	91-1	1095586	5379

Landmark Address	Name of Landmark	Style	Date Approved	Date Recorded	Landmark Number or HIS Case #	Reception Number	Ordinance Number
2019 Goss Street	Ruth Cave Flowers House	Vernacular wood frame	05/19/92	06/05/92	91-2	1191041	5466
703 11th Street	Ekeley House	Tudor Revival	07/07/92	08/07/92	92-2	1209896	5474
2045 13th Street	B.P.O. Elks Lodge No. 566	Mission	07/07/92	08/07/92	92-3	1209895	5473
1750 13th Street	City Storage and Transfer Building	20th Century Factory/Warehouse	09/15/92	10/02/92	92-4	1225718	5488
942 Pine Street	Kohler House	Foursquare	12/15/92	12/30/92	92-6	1253021	5529
1841, 2108 & 2141 Walnut Street	Berkeley Farm	Vernacular frame; front gable	02/16/93	03/16/93	93-1	1274308	5542
1333 Pine Street	John Pughe House	Queen Anne	04/20/93	06/09/93	93-2	1301721	1831
2850 Links Drive	Boulder Country Club #1	Craftsman/Prairie	09/21/93	10/14/93	92-5	1348515	5589
1543 Pine Street	Austin House	Italianate	09/21/93	10/14/93	93-4	1348516	5590
907 7th Street	Scott Carpenter House	Foursquare	10/05/93	11/09/93	93-5	1359503	5595
511 Marine Street	Lotus House	Edwardian vernacular	01/18/94	03/16/94	93-6	1405927	5614
440 Arapahoe Avenue	Jones-Walton House	Vernacular masonry	01/18/94	03/16/94	93-7	1405928	5615
2242 16th Street	William & Jennie Montgomery House	Vernacular wood frame	02/15/94	03/16/94	93-8	1405926	5613
970 11th Street	Craftsman / Tudor Style House	Craftsman/Tudor Revival	04/12/94	05/17/94	93-10	1427993	5628
2331 Broadway	Lesser Family Home and Apartments	Foursquare	04/12/94	05/17/94	93-11	1427994	5629
811 Mapleton Avenue	Curtin House	Foursquare	06/07/94	07/27/94	94-1	1449627	5637
2303 Bluff Street	Perry White House	Gothic Revival	09/13/94	09/27/94	94-2	1466148	5658
1424-28 Pearl Street	Citizens National Bank Building	20th Century Commercial	09/20/94	10/28/94	94-3	1474174	5666
855 13th Street	Thornton House	Modernistic/Art Moderne	10/18/94	10/28/94	94-4	1547090	5673
2229 Broadway	Oliver-Bowman House	Queen Anne	12/20/94	02/07/95	94-5	1496843	5691
829 Mapleton Avenue	Burdick-Cole House	Edwardian vernacular	01/17/95	02/07/95	94-6	1496844	5694

Landmark Address	Name of Landmark	Style	Date Approved	Date Recorded	Landmark Number or HIS Case #	Reception Number	Ordinance Number
701 9th Street	Skiff-Armstrong House	Craftsman	05/23/95	06/09/95	95-1	1522966	5718
66 S. Cherryvale	Viele-Van Vleet Farmstead (15 bldgs)	Vernacular style farm buildings	06/20/95	09/13/95	95-2	1547090	5727
1928 Pearl Street	John & Matilda Borgstrand House	Queen Anne	06/20/95	09/13/95	95-3	1547094	5726
Central Park	Glen Huntington Bandshell	Art Deco Style	10/17/95	11/07/95	95-4	1561053	5751
1718 Canyon Blvd	McVey House	Vernacular wood frame	10/17/95	11/07/95	95-7	1561052	5763
1145 Grandview Ave	Tepley House	Queen Anne	12/19/95	01/09/96	95-8	1575387	5772
1410 Quince Avenue	Nomad Playhouse	Quonset Hut	01/16/96	02/20/96	95-5	1584883	5779
842 Grant Place	Malde House	Craftsman	08/20/96	09/19/96	96-1	1643741	5823
2043 Pearl Street	Goldberg House	Edwardian vernacular	08/20/96	09/19/96	96-2	1643740	5822
703 Pine Street	Cowie House	Foursquare	09/17/96	09/19/96	96-3	1643743	5827
453 Highland Avenue	Mayall-Pickett House	Foursquare	10/15/96	12/20/96	96-4	1665679	5837
505 Pine Street	Casaday-Winter House	Classic Cottage	11/12/96	12/20/96	96-5	1665681	5840
616 14th Street	Dyde-Rosall House	Jacobean/Elizabethan	12/03/96	12/20/96	96-7	1665682	5854
1317 7th Street	Allison House	Craftsman	06/17/97	09/11/97	97-3	1730037	5895
2008 Pine Street	Whittier School	Italianate	08/19/97	09/11/97	97-4	1730036	5918
1630-36 Spruce Street	Lamb House	Edwardian vernacular	09/16/97	09/25/97	97-5	1733699	5935
1035 Maxwell Avenue	Thurston House	Edwardian vernacular	10/21/97	10/28/97	97-6	1742630	5944
1607 6th Street	Webb House	Queen Anne	01/20/98	01/29/98	97-8	1767147	5964
2133 9th Street	Russell-Koerner House	Vernacular wood frame	05/05/98	05/13/98	98-1	1802316	5978
3rd & Canyon	Boyd Smelter Site	Archaeological site	08/04/98	08/12/98	98-2	1834413	6003
956 16th Street	University Hill Elementary School	Eclectic with Italian Renaissance influence	08/04/98	08/12/98	98-3	1834412	6002
1911-15 Pearl Street	Johnson-Betasso Terrace	Terrace	09/15/98	10/05/98	97-10	1855954	6022
2020 19th Street	John Day House	Vernacular masonry	09/15/98	10/05/98	97-11	1855956	6024
2010-14 19th Street	Wahlstrom Mission Terrace	Mission/Terrace	09/15/98	10/05/98	97-9	1855955	6023

Landmark Address	Name of Landmark	Style	Date Approved	Date Recorded	Landmark Number or HIS Case #	Reception Number	Ordinance Number
1949 Pearl Street	Campbell Corner Grocery	19th Century Commercial	09/15/98	10/05/98	98-6	1855953	6021
727 13th Street	Youmans House	Jacobean/ Elizabethan	10/20/98	11/18/98	98-5	1871780	6027
1117 Pine Street	Blystad-Laeser House	Bungalow	12/15/98	05/21/99	98-7	1941815	6042
436 Highland Avenue	Ardourel House	Edwardian vernacular	01/19/99	05/21/99	98-8	1941816	6047
2241 17th Street	Swedish Lutheran Church	Gothic Revival	06/15/99	06/18/99	99-1	1951361	6079
5172 Valmont Road	Roney Farmhouse	Vernacular wood frame	11/09/99	01/04/00	99-2	2012056	7017
3160 Airport Road	Platt Farmhouse	Vernacular wood frame	11/09/99	01/04/00	99-3	2012055	7016
815-817 Pearl Street	German House	Vernacular masonry; front gable	01/18/00	02/24/00	98-9	2023470	7029
2517 Broadway	Chapman House	Vernacular wood frame	05/05/00	06/14/00	99-6	2052948	7030
2008-2010 18th Street	Carey Hotel	Vernacular masonry with residential elements	10/17/00	12/14/00	00-1	2103182	7092
1123 Spruce Street	Soule-Coates House	Colonial Revival/ Italianate	01/02/01	01/08/01	00-2	2108652	7114
1740 Sunset Blvd	Reinert-Olson House	Ranch House	01/02/01	01/08/01	00-3	2108653	7113
1421 Spruce Street	First United Methodist Church of Boulder	Richardsonian Romanesque	02/20/01	03/01/02	00-4	2259936	7119
1610 Hillside Road	Linsley House	Shingle Style	03/20/01	03/01/02	00-5	2259938	7122
4789 28th Street	Holiday Drive-In Sign	Googie Sign style	05/21/02	08/02/02	02-1	2314405	7203
1135 13th Street	Fox-Rialto Theater	20th Century Commercial	05/21/02	07/23/02	02-2	2310260	7204
845 Walnut Street	Anderson-Martin House	Vernacular brick/ Bungalow	07/23/02	08/02/02	02-3	2314407	7220

Landmark Address	Name of Landmark	Style	Date Approved	Date Recorded	Landmark Number or HIS Case #	Reception Number	Ordinance Number
Diagonal Highway, Foothills Parkway, & Kalmia Avenue	Boulder Oil Field's McKenzie Well	N/A	11/12/02	01/22/03	02-4	2386484	7232
1290 Baseline Road	Pietenpol House	Italian Vernacular Revival	12/03/02	01/22/03	2002-00012	2386483	7245
602 Maxwell Avenue	Dasy Grocery	19th Century Commercial	01/21/03	03/14/03	2002-00004	2413038	7258
1625 Pine Street	Chauncey Stokes House	Second Empire	05/20/03	05/30/03	2003-00053	2448193	7280
1928 6th Street	Pool and Son Blacksmith Shop	False-front Commercial	07/15/03	07/23/03	2003-00081	2475642	7298
2045 Walnut Street	Gutfelder House and Mason Terrace	Foursquare and Terrace	08/19/03	08/27/03	2003-00125	2493913	7303
2430 20th Street	Raikes House	National Folk: Hall-and-Parlor	10/07/03	10/14/03	2003-00142	2515034	7309
1120 1/2 Pine Street	Soule Carriage House	Vernacular masonry with Italianate elements	12/16/03	12/28/03	2003-00212	2541975	7325
731 Pine Street	Herrick House	Edwardian vernacular	02/03/04	02/09/04	2003-00276	2556474	7337
820 Pine Street	William V. Casey House	Queen Anne vernacular	04/08/04	04/15/04	2003-00280	2576789	7352
2245 Mapleton Avenue	Johnston-House Residence	Italianate: Cube-and-Cupola	04/20/04	04/27/04	2004-00002	2580352	7355
743 9th Street	Crockett House	Edwardian vernacular	11/08/05		2005-00106		7435
1820 Pearl Street	Kohler-Sherman House	Queen Anne	02/21/06		06-01	2812595	7452
210 Arapahoe Avenue	Canon Cottages	Stone vernacular	6/6/2006		06-02	2783260	7471
700 16th Street	Totten House	Jacobean/Elizabethan Revival	1/16/2007		07-01	2831249	7508
1227 High Street	Pomeroy-Cheney House	Stone vernacular	3/20/2007		07-02	2845564	7510
700 Pearl Street	Racket Grocery	Commercial Block	4/9/2007		07-03	2849185	7513
1135 Jay Street	Roitz House	Late Modern	7/24/2007		07-04	2873478	7529

Landmark Address	Name of Landmark	Style	Date Approved	Date Recorded	Landmark Number or HIS Case #	Reception Number	Ordinance Number
1936 Mapleton	Frakes House	Vernacular masonry with Que	9/18/2007		07-05	2885302	7551
5653 Baseline Rd	Glenn Barn	Barn	4/1/2008		2008-01	2932797	7583
3231 11th Street	Chambers House	Vernacular Masonry	9/16/2008		2008-02	2968474	7611
4051 Broadway	Stephens Granary	Vernacular Agriculture	10/7/2008		2008-03	2959859	7612
819 6th Street	Labrot House	Expressionism/ Usionian	10/21/2008		2008-04	2968472	7618
2303 Mapleton	Herkert House		12/16/2008		2008-05	2969757	7633
2316 23rd Street	Herkert Cottage	Vernacular frame	12/16/2008		2008-06	2969756	7634
1777 Broadway	Municipal Building	International/ Formalism	2/3/2009		2009-01	2978843	7640
896 17th Street	Hampton-Barnes House	Usionian	2/17/2009		2009-02	2981023	7644
1918 1/2 Pearl Street	Lund Cottage	Vernacular Frame/Cottage	3/3/2009		2009-03	2985474	7647
800 Arapahoe	Barker House	Italianate	3/17/2009		2009-04	2987045	7648
1215 Cedar Avenue	Washington School	Italianate	7/7/2009		2009-05	3015750	7668
800 Pearl Street	Chamberlain & Co. Sampling	Vernacular Masonry	9/1/2009		2009-06	3029366	7683
1143 13th Street	Silver and Gold Cleaners/ Paynes Shoe Shop		10/27/2009		2009-07	3048812	7692
1155 13th Street	Kinsley & Co.	Tudor Revival	10/27/2009		2009-08	3048813	7693
1937 Spruce Street	Nelson-Whiteley House	Vernacular Frame	1/5/2010		2010-03	3052406	7708
1017 Maxwell	Inglis House	Edwardian Vernacular	1/19/2010		2010-01	305595	7709
900 28th Street	Greenshield Building	Modern	7/20/2010		2010-02		7227
550 College	Wilson-Haertling House	Modern	3/1/2010		2011-01		7784
1921 Pine Street	Bell-Bass House	Vernacular Masonry	6/14/2011		2011-01		

Source: City of Boulder Planning and Development Services

Table H.2 City of Boulder Cultural Resources State and National Registrar Listings

Resource Name	Address	Date Listed	Which List
Arnett-Fullen House	646 Pearl	1/2982009	National Register
Boulder County Poor Farm	Address Restricted	09/13/2001	National Register
Boulder Creek Bridge	Colo Hwy 119 N of Arapahoe Ave	03/11/2003	National Register
Carnegie Library	1125 Pine Street	02/16/1979	National Register
Chautauqua Auditorium	Chautauqua Park	01/21/1974	National Register
Colorado & Northwestern Railroad Locomotive No. 30	Central Park, south side of Canyon Blvd., between Broadway & 13th St.	09/09/1998	State Register
Colorado Chautauqua	Chautauqua Park	03/21/1978	National Register
Columbia Cemetery	Along 9th Street, bounded by Pleasant and College Avenues	08/01/1997	National Register
Denver & Rio Grande Western Railroad Caboose No. 04990	Central Park, south side of Canyon Blvd., between Broadway & 13th St.	09/09/1998	State Register
Denver & Rio Grande Western Railroad Coach No 280	Central Park, south side of Canyon Blvd., between Broadway & 13th St.	09/09/1998	State Register
Downtown Boulder Historic District	Roughly includes the south side of Spruce St. from 10th St. to 16th St., Pearl St. from 9th St. to 16th St., and the north side of Walnut St. from Broadway to 9th St. Also includes the Post Office at 14th and Walnut and the Hotel Boulderado at 13th and Spruce.	12/03/1980	National Register
First Baptist Church of Boulder	1237 Pine Street	04/14/2004	National Register
Fox Mine Office	1226 S. Cherryvale Road	02/23/1996	National Register
Fox Stone Barn	S. Cherryvale Road, .5 miles south of US 36	02/16/1996	National Register
Highland School	885 Arapahoe Avenue	12/18/1978	National Register
Hotel Boulderado	2115 13th Street	11/03/1994	National Register
McKenzie Well	Colo. Hwy. 119 near Independence Rd.	01/26/2005	National Register
Mount St. Gertrude Academy	970 Aurora Street	11/03/1994	National Register
Nelson House	1818 Baseline Road	12/16/2005	State Register
Norlin Quadrangle Historic District	University of Colorado campus	03/27/1980	National Register

Resource Name	Address	Date Listed	Which List
Northern Colorado Power Company Substation	1590 Broadway	05/22/1986	National Register
Squires-Tourtellot House	1019 Spruce Street	08/10/1978	National Register
US Post Office--Boulder Main	1905 Fifteenth Street	01/22/1986	National Register
Woodward-Baird House	1733 Canyon Blvd	02/15/1979	National Register

Source: City of Boulder Planning and Development Services, 2012