FLOOD HAZARD MITIGATION PLAN
FOR
COLORADO

August 2018

Prepared Pursuant to
Disaster Mitigation Act 2000 & Section 409, PL 93-288

Prepared for
Colorado Water Conservation Board
Department of Natural Resources

In Cooperation with
The Department of Public Safety
Division of Homeland Security & Emergency Management
and the Flood Technical Assistance Partnership

Original Plan prepared by the CWCB in 1982
after the Lawn Lake dam failure flood

Updated and revised in 2004, 2007, 2010, 2013 and 2018

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EXECUTIVE SUMMARY

The Colorado Flood Hazard Mitigation Plan summarizes the State of Colorado's vulnerability to flooding and outlines strategies to manage and reduce the impact of flood hazards. The Plan conforms to the Standard State Hazard Mitigation planning requirements of the Disaster Mitigation Act of 2000. The main components of this Plan include a detailed vulnerability assessment and mitigation strategy. Included is a description of the process used to prepare the Plan and a profile of the flood hazards in Colorado, including the nature of impacts and probability of occurrence. The vulnerability assessment discusses the past and potential impacts to Colorado's citizenry, economy, environment, and state assets. The vulnerability assessment is covered in detail in Sections 3.3 - 3.5. The mitigation strategy outlines the goals of the Plan and specific action items intended to meet those goals. Many of these mitigation actions are ongoing and can occur in between or after flood events. A capability assessment describes the state's plans, policies and procedures in place that already help manage and reduce flood impacts. Information on agency responsibilities and existing flood mitigation programs, local flood mitigation plans and contacts for local government outreach and assistance are also included. The Plan describes funding sources that can be used to implement local mitigation projects and plans and a description of the process for implementation, monitoring, and evaluating the Plan.

1 PREREQUISITE

1.1 Formal Adoption by the State

With the submission of the 2018 State of Colorado Hazard Mitigation Plan (SHMP), the SHMP is hereby approved and adopted by the State of Colorado Department of Public Safety - Division of Homeland Security & Emergency Management, and the Office of the Governor. The Flood Hazard Mitigation Plan (Plan) is incorporated as an annex to the SHMP and is consequentially approved by the Office of the Governor. Adoption by the Office of the Governor empowers the Colorado Water Conservation Board (CWCB) and the Colorado Division of Homeland Security & Emergency Management (DHSEM) to execute their responsibilities with respect to disaster preparedness, response, recovery, and mitigation.

The 2018 State of Colorado Hazard Mitigation Plan was approved and adopted by the State of Colorado, Department of Public Safety, and Office of the Governor. A copy of this approval is contained in an appendix of the SHMP.

In addition, this Plan was reviewed and formally approved by CWCB in September 2018.

1.2 Assurances of Continued Compliance with Federal Requirements

This Plan was prepared pursuant to the requirements of the Disaster Mitigation Act of 2000 (DMA or DMA 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) and finalized on October 31, 2007. (Hereafter, these requirements and regulations will be referred to collectively as the Disaster Mitigation Act.) While the act emphasizes 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 state 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).

The State of Colorado assures it will comply with all applicable federal statutes and regulations in effect with respect to the periods for which it receives grant funding in compliance with 44 CFR Part 13.11(c). The state will amend the SHMP whenever necessary to reflect changes in state or federal laws and statutes, as required in 44 CFR Part 13.11(d). The adoption of this SHMP demonstrates the State of Colorado's commitment to fulfilling the mitigation objectives in the SHMP and authorizes the agencies identified in the SHMP to execute their responsibilities.

In addition, the Flood Hazard Mitigation Plan complies with and adheres to the Emergency Management Accreditation Program (EMAP) standard. The EMAP is a voluntary review process for state and local emergency management programs. Accreditation is a means of demonstrating,

through self-assessment, documentation, and peer review, that a program meets the national standards for emergency management programs.

According to state hazard mitigation planning guidance released by the Federal Emergency Management Agency (FEMA) in 2015 that became effective in 2016, climate change consideration must be integrated into state hazard mitigation plan updates. What this means for Colorado plans, including this Flood Mitigation Plan update, is that climate change effects must be discussed and addressed with regards to the hazard/s in question. Specifically, plans must incorporate "*a summary of the probability of future hazard events that includes projected changes in occurrences for each natural hazard in terms of location, extent, intensity, frequency, and/or duration; and considerations of changing future conditions, including the effects of long-term changes in weather patterns and climate on the identified hazards*" (FEMA, 2016). The SHMP addressed climate change considerations for multiple hazards in the 2018 update and the information relevant to flooding is included in this plan. Another change in federal requirements is the requirement for state hazard mitigation plans to be updated every three years. Since 2014 the requirement is every five years due to a FEMA policy change.

2 PLANNING PROCESS

2.1 Documentation of Planning Process

2.1.1 Description of Plan Preparation Process

The process established for this planning effort is based on the Disaster Mitigation Act of 2000 planning and update requirements and FEMA's associated guidance for state hazard mitigation plans. The Flood Technical Assistance Partnership (Flood TAP) followed FEMA's recommended four-step mitigation planning process:

- Identify and organize available resources
- Identify hazards and assess risk
- Develop a mitigation strategy and mitigation plan
- Implement the plan and monitor progress

The CWCB took the lead on the 2018 update to the Flood Hazard Mitigation Plan, under the direction of the Community Assistance Program (CAP) Coordinator. A consulting firm (Wood Environment & Infrastructure Solutions, Inc., [Wood] formerly Amec Foster Wheeler) was selected to coordinate and facilitate the 2010, 2013, and 2018 update to the Plan.

The Colorado statewide hazard mitigation planning program is designed to coordinate the efforts of many state agencies and organizations in mitigation planning and programming on an ongoing basis. It is also intended to actively promote and coordinate mitigation planning and programming by local jurisdictions. The original umbrella document was created in 2001, was updated in 2004, 2007, 2010, 2013 and 2018 and was designed as a way to tie together various hazard-specific documents that had been developed over the previous years. DHSEM led the 2018 update of the State of Colorado SHMP umbrella document. The 2018 update of the Flood Mitigation Plan was completed in parallel to and coordinated with the update of the SHMP. The Flood Hazard Mitigation Plan is considered a stand-alone hazard specific annex to the SHMP, as is the Colorado Drought Mitigation and Response Plan, which is also being led by the CWCB.

2.1.2 Evolution of the Colorado Flood Hazard Mitigation Plan

The original Colorado Flood Hazard Mitigation Plan was prepared by the CWCB following the Lawn Lake dam failure flood in 1982. The plan was updated in 2004, 2007, and 2010 as part of the SHMP update process, which was on a three-year update cycle at that time. In 2007 the plan update was developed to align the Plan's mitigation element with the standard state mitigation planning requirements of the DMA 2000, thus making it consistent with the SHMP and placing it on the same update cycle as that plan (formerly required every three years; currently every five years following 2014). The SHMP update of 2018 was done in accordance with FEMA enhanced state plan requirements and the enhanced elements are addressed within that plan. The 2007, 2010,

and 2013 versions of this plan contain the narrative of the planning process followed at those times, which mirrored that of the umbrella SHMP, and is not repeated herein. The following description of the planning process is focused on the 2018 plan update process.

2.1.3 2018 Update Planning Process

In 2018, the Plan underwent an update as part of the five-year state plan update cycle. The major objectives of this update included:

- Updating the Plan to meet current DMA 2000 and EMAP planning standards
- Update of the flood hazard vulnerability assessment with revised estimates of risks and potential losses, with a focus on state assets
- Updating the flood hazard mitigation strategy
- Updating information on historical flood events in Colorado, including the 2013 flood disaster declaration
- Capturing state initiatives and projects completed or initiated within the past five years that contribute to flood loss reduction

The results of this effort are reflected in this updated Plan. The Plan outline mirrors that of the FEMA mitigation plan update review crosswalk, as well as that of the Colorado Drought Mitigation and Response Plan and SHMP for consistency among plans and with DMA 2000 planning requirements. The remainder of this section details the planning process used to develop this Plan, with an emphasis on the 2018 update process.

Flood Technical Assistance Partnership

The development, implementation, and maintenance of the Flood Plan are the responsibility of the Flood TAP. The Flood TAP is made up of representatives of sixteen state, federal, and local agencies and organization with authorities, responsibilities, or expertise related to flood hazard mitigation and preparedness programs. The Flood TAP was born out of coordination meetings between DHSEM, CWCB and FEMA in 2010 related to joint efforts on all aspects of flood hazards including preparedness and mitigation. The partnership expanded further in 2012 in response to coordination on post-wildfire flooding issues. Leadership of the Flood TAP has been shared amongst agencies including DHSEM, CWCB, and the Colorado Department of Transportation (CDOT). As of 2018, the Flood TAP is led jointly by CDOT and CWCB in partnership with FEMA. The purpose statement of the Flood TAP is:

"Enhancement of collaboration between agencies responsible for comprehensive flood preparedness and floodplain management to improve customer service and help each other fulfill our common missions."

The Flood TAP is a standing committee that meets on a regular basis, typically every other month and a minimum quarterly. The Flood TAP was used as the advisory committee during the 2013 and 2018 Plan updates. Formation of the Flood TAP was based on state and federal agencies that

have a stake in flood hazard mitigation in Colorado and have a lead or supporting role on mitigation actions. Membership included many agencies also active in the State Hazard Mitigation Team (SHMT), the State Flood Task Force, and/or the Drought Mitigation and Response Planning Committee. Specific membership is listed in Section 2.1.4. The Flood TAP participated in two major planning meetings between April and May 2018 summarized in the following table.

Table 2-1 Key Planning Meetings of the 2018 Update Process

Meeting	Date	Purpose
1. Project Kickoff	April 2, 2018	• Review Disaster Mitigation Act planning requirements, scope of work, and schedule • Review role of Flood TAP • Discuss updated risk assessment • Discuss data collection needs
2. Mitigation Strategy Update	May 2, 2018	• Review and Update Plan Goals and Mitigation Actions

Sign in sheets and documentation of these meetings are included in a planning process reference notebook on file with the CWCB.

In addition to these meetings, of the Flood TAP members and CWCB staff provided input on the draft plan during July 2018 via email. Additionally, some members of the Flood TAP participated on the SHMT and other meetings related to the SHMP update. This includes meetings on April 10, 2018 and May 22, 2018. In addition to these meetings, the process included individual phone conversations and e-mail between Wood and CWCB staff with various entities and agencies on the Flood TAP. CWCB and other agencies conducted internal meetings relative to the existing and proposed mitigation actions and their prioritization. The draft plan was presented at a public CWCB meeting on July 19th, 2018. It was formally approved by CWCB at the September 2018 board meeting.

2.1.4 Involvement in Planning Process

In keeping with the tenet of whole community partnerships, Flood TAP representation encompasses local, state, and federal governments, special districts and non-governmental organizations. The following is a list of the sixteen partnering organizations and agencies that comprise the Flood TAP:

- Department of Natural Resources - Colorado Water Conservation Board (CWCB)
- Department of Natural Resources - Division of Water Resources (CDWR) – Dam Safety
- Department of Natural Resources – Colorado Parks and Wildlife (CPW)
- Department of Public Safety - Colorado Division of Homeland Security & Emergency Management (DHSEM)
- Department of Transportation (CDOT)

- Department of Public Health & Environment (CDPHE)
- Department of Local Affairs (DOLA)
- Department of Local Affairs – Colorado Resiliency Office (CRO)
- Colorado Association of Stormwater and Floodplain Managers (CASFM)
- City and County of Denver
- Colorado School of Mines – Colorado Geological Survey (CGS)
- Urban Drainage & Flood Control and District (UDFCD)
- Federal Emergency Management Agency (FEMA)
- National Oceanic and Atmospheric Administration (NOAA)
- United States Geological Survey (USGS)
- United States Army Corps of Engineers (USACE)

During the update to the Plan, several individuals representing these agencies participated on the Flood TAP and provided information and assistance to promote the development of the document. In addition to the core Flood TAP participation the following agencies/entities have been participants in this plan's development over the years, and were engaged in 2018 through the umbrella SHMP planning effort:

State

- Department of Agriculture – State Conservation Board
- Colorado State University – Colorado Climate Center
- Department of Local Affairs –Division of Local Government
- Colorado State Forest Service
- Department of Natural Resources – Parks and Wildlife

The Flood TAP members were involved in the planning process through:

- Attending and participating in Flood TAP meetings
- Providing available data requested
- Reviewing and commenting on Plan drafts and obtaining agency buy-in for relevant sections
- Assisting with the public input/stakeholder process

During the update to the Plan, several individuals participated on the Flood TAP and provided information and assistance to promote the development of the document. These people, listed in Table 2-2, have performed invaluable service to the document, either by providing input and data, writing sections, performing analyses, or editing for content.

Table 2-2 Participants and Acknowledgments

Name	Agency
David Powell	City and County of Denver, Office of Emergency Management
David Jula	City and County of Denver Public Works
Jeremy Hamer	City and County of Denver Public Works
Dave Bennetts	Colorado Association of Stormwater and Floodplain Managers
Bill McCormick	Colorado Division of Water Resources, Dam Safety
Kallie Bauer	Colorado Division of Water Resources, Dam Safety
John Hunyadi	Colorado Division of Water Resources, Dam Safety
Cindy Lair	Colorado Department of Agriculture, State Conservation Board
Barry Cress	Colorado Department of Local Affairs, Division of Local Government
Anne Miller	Colorado Department of Local Affairs, Division of Local Government
Brian Varrella	Colorado Department of Transportation
Darrell Lingk	Colorado Department of Transportation
Elbert Hunt	Colorado Department of Transportation
Justin Werdel	Colorado Department of Transportation
Matt Morgan	Colorado Geological Survey
Scot Fitzgerald	Colorado Geological Survey
Iain Hyde	Department of Local Affairs, Colorado Recovery Office
Rob Pressly	Department of Local Affairs, Colorado Recovery Office
Logan Sand	Department of Local Affairs, Division of Local Government
Marilyn Gally	Department of Local Affairs, Colorado Recovery Office
Patricia Gavelda	Division of Homeland Security & Emergency Management
Scott Baldwin	Division of Homeland Security & Emergency Management
Mark Thompson	Division of Homeland Security & Emergency Management
Matt Arsenault	Division of Homeland Security & Emergency Management
Chris Sturm	Colorado Water Conservation Board
Stephanie DiBetitto	Colorado Water Conservation Board
Joe Busto	Colorado Water Conservation Board
Kevin Houck	Colorado Water Conservation Board
Thuy Patton	Colorado Water Conservation Board
Greg Stasinos	Colorado Department of Public Health & Environment
Jamie Prochno	US Army Corps of Engineers/Silver Jackets
Stephen Scissons	US Army Corps of Engineers/Silver Jackets
Rachael Orellana	US Army Corps of Engineers/Silver Jackets
Nicole Aimone	FEMA Region VIII
David Sutley	FEMA Region VIII
Matthew Buddie	FEMA Region VIII
Mark English	FEMA Region VIII

Name	Agency
Tony Anderson	National Oceanic and Atmospheric Administration
Zeke Peters	Unaffiliated
Teresa Patterson	Urban Drainage & Flood Control District
Terri Fead	Urban Drainage & Flood Control District
Shea Thomas	Urban Drainage & Flood Control District
Deb Ohlinger	Colorado Association of Stormwater and Floodplain Managers
Jeff Brislawn	Wood (formerly Amec Foster Wheeler)
Chris Ide	Wood

2.1.5 Agency Involvement in Plan Preparation Process

During the revision to the Flood Hazard Mitigation Plan, several agencies provided input and technical expertise. Several of the agencies listed previously provided data and information to support the Plan's vulnerability assessment. Agencies were provided a worksheet designed to capture information needed to update the Plan. The worksheet was used to collect agency input on changes in capabilities and funding sources since 2013. This worksheet also solicited input on the status of existing mitigation actions outlined in the 2013 Plan to determine which items had been completed, deleted, deferred, or were ongoing. The worksheet was used to survey agencies on flood vulnerability from their perspective, and to solicit input on projects that have contributed towards reducing flood vulnerability over the past three years. Flood TAP members filled out these questionnaires and worksheets and the information directly contributed to the preparation of this Plan.

Federal agencies were also involved in the process by providing information to support the risk assessment and/or reviewing and commenting on the draft updated document. FEMA Region VIII participated in meetings and provided data on flood insurance policies and claims.

2.1.6 Description of Plan Review and Analysis

During the 2018 Plan update, the Flood TAP updated each of the sections of the previously approved plan to include new information and improve organization and formatting of the Plan's contents. The Flood TAP analyzed each section using FEMA's Hazard Mitigation Planning Guidance for Standard State Mitigation Plans to ensure that the Plan met these requirements. As part of the 2018 Plan update, every section was updated with new or revised information. Table 2-3 shows which sections of the Plan were revised with highlights of what was updated or altered. More detailed documentation on the revision methodology and process is provided at the beginning of each Plan section.

Additionally, the Flood TAP reviewed and provided comment on the draft revised Plan. The document was shared electronically through e-mail. Comments were solicited from the Flood TAP during a period in July 2018.

Table 2-3 Changes in the 2018 Plan Update

Plan Element	Highlights of Update/Revision
Prerequisite Adoption by the State	• Language updated for 2018 • Added approval by CWCB Board
Planning Process Documentation of the Planning Process Coordination Among Agencies Program Integration	• Planning effort updated and documented • Multi-agency outreach and coordination • Changes in coordination noted
Risk Assessment Identifying Hazards Profiling Flood Hazards Assessing Vulnerability by Jurisdiction Assessing Vulnerability of State Facilities Estimating Potential Losses by Jurisdiction Estimating Potential Losses of State Facilities	• Incorporated updated information from 2017-18 update of SHMP including updated Hazus modeling statewide • Added information on flood events in Colorado since 2013 • Includes updated rollup of information in local mitigation plans • Incorporation of climate change considerations
Mitigation Strategy Hazard Mitigation Goals State Capability Assessment Local Capability Assessment Mitigation Actions Funding Sources	• Goals reassessed to reflect current priorities. Goal 3 was removed due to being largely in the purview of the SHMP Mitigation Action table expanded and organized by revised goals • Actions revised and prioritized • New actions developed • Updated capability assessment review • Funding sources updated
Coordination of Local Mitigation Planning Local Funding and Technical Assistance Local Plan Integration Prioritizing Local Assistance	• Information revised with changes and assistance provided in past five years
Plan Maintenance Process Monitoring, Evaluating, and Updating the Plan Monitoring Progress of Mitigation Activities	• Process revisited, minor revisions to align with CO SHMP process

2.2 Coordination among Agencies

2.2.1 Involvement of Federal and State Agencies

Federal and state agencies were integrally involved in the development of the information provided in the update to the Plan. The agencies are identified in the previous sections. Both federal and state agencies were represented on the Flood TAP and participated in meetings previously listed. As indicated, these meetings served to identify federal and state requirements, assign roles and responsibilities to obtain pertinent information, provide for the exchange or transmission of the information, and specifically provide insight and data pertinent to the risk assessment and mitigation strategies. In addition, the Flood TAP provided a mechanism for federal and state agencies to review the draft Plan and provide comments that were incorporated into the final document.

2.2.2 Involvement of Interested Groups

Early in the planning process, local groups, agencies, and organizations were identified that may have an interest in the Plan or could participate as stakeholders in the process. Stakeholders could participate in various ways, either by contributing input at meetings, being aware of planning activities through an e-mail group, providing information to support the effort, or reviewing and commenting on the draft Plan.

The following groups were identified as interested groups. Specific contacts were identified within certain groups to solicit input on the draft Plan. Others may be considered for additional involvement or outreach in the future.

Other Federal Agencies

- National Weather Service (NWS)
- Federal Emergency Management Agency (FEMA)
- U.S. Army Corp of Engineers (USACE)
- U.S. Geological Survey (USGS)
- U.S. Department of Agriculture – Natural Resource Conservation Service (NRCS)

Other Local and State Government

- CWCB – Office of Water Conservation and Drought Planning
- Colorado Counties Inc.
- Colorado Emergency Management Association (CEMA)
- Colorado Governor's Flood Task Force
- Colorado Municipal League (CML)
- City of Fort Collins

Conservation Organizations

- Colorado River Water Conservation District

Other Organizations

- Colorado Association of Stormwater and Floodplain Managers (CASFM)
- Colorado Watershed Assembly
- Rocky Mountain Insurance Information Association (RMIAA)
- Urban Drainage & Flood Control District (UDFCD)

The Urban Drainage & Flood Control District (UDFCD) is an important partner and stakeholder in flood mitigation in Colorado and active participant on the Flood TAP. UDFCD serves a significant percentage of the state's population with a wide range of flood mitigation efforts. More information on UDFCD programs and their contributions to flood mitigation are noted in Section

4.3.

2.2.3 Changes in Coordination

The Flood TAP mentioned previously has helped formalize coordination on all things flood related at the state, federal and local level. The Flood TAP has assumed the role of what was previously referred to in the 2010 plan as the Flood Mitigation Advisory Committee (FMAC). Leadership of the Flood TAP has been shared amongst agencies including DHSEM and CWCB. As of 2018 the Flood TAP is led jointly by CDOT and CWCB. The former Flood Task Force has also been absorbed into the Flood TAP and the spring and summer meetings of the Water Availability Task Force. In 2012 the former Colorado Division of Emergency Management was moved from DOLA into the Department of Public Safety DHSEM. Additional coordination between the CWCB, DHSEM and the Department of Public Safety (DPS) occurred following wildfire events that contributed to higher flash flood risk in 2012 and 2013. Strong coordination between DHSEM, CWCB, and other agencies also occurred in response to flooding in 2013 and 2015 that resulted in presidential disaster declarations (See 3.2.2 Flood History in Colorado).

The Colorado Resiliency Office (CRO) was created in the Governor's Office following the 2013 flood and became part of the Department of Local Affairs in 2017. This office supports and helps empower Colorado communities in building stronger, safer, and more resilient in the face of natural disasters and other major challenges. The CRO coordinates overarching recovery and resiliency activities by collaborating with numerous multi-disciplinary local, state, federal, and private partners in setting priorities, leveraging resources, communicating transparently and delivering measurable results to shape an adaptable and vibrant future. In 2018, the Colorado legislature passed HB 18-1394, which codifies the CRO's cross-agency resilience mission in statute, including implementing resilience policies and procedures, institutionalizing resilience practices across departments and agencies, developing a plan to improve coordination among state agencies and local jurisdictions to support community and economic recovery efforts and to address risk and vulnerability reduction, and developing metrics and targets to measure the short- and long-term success of resilience efforts and actions. CRO staff participate on the Flood TAP and provided input to the 2018 update of the Colorado Flood Plan, as well as the SHMP.

Other interagency coordination occurred as part of multi-agency "Stream Teams" formed following the 2013 flood. The Stream Teams integrated state and federal agencies to assess stream channel migration, rehabilitation and other watershed needs as a result of the flooding in September. FEMA initiated the formation of the Team, but state and federal officials determined that it would be best led by the State. CWCB staff is currently leading the Team. Team members include staff from federal agencies (USACE, FEMA, NRCS, FHWA), state agencies (CWCB, DWR, CPW, Office of Emergency Management, CDOT, CDPHE -WQCD), and local governments (city and county). The Team met with local communities and held weekly conference calls following the floods.

Colorado also started a Silver Jackets chapter in 2013. The Silver Jackets program provides an

opportunity to consistently bring together multiple state, federal, and sometimes tribal and local agencies to learn from one another and apply their knowledge to reduce flood risk. The CWCB, DHSEM, USACE and FEMA, has been utilizing the Silver Jackets common forum to address the state's flood risk management priorities since their first kick-off meeting in May of 2013.

NOAA, through a direct partnership with the CWCB, worked to update the regional rainfall atlas in 2013 which replaced a document that had not been updated since 1973. The CWCB has also had increased coordination with FEMA and USGS on Light Detection and Ranging (LiDAR) acquisition, and with the Colorado Office of Information Technology (OIT) regarding GIS data.

CWCB flood and watershed protection staff also participate in the Water Quality and Quantity (or 'QQ') Committee. This committee includes membership from DNR, CWCB, DWR, CDPHE-WQCD, Denver Water, Department of Agriculture, and USGS. The CWCB has also had increased coordination with CDOT regarding implementation of flood standards in the past few years.

The granting agency for the Colorado Flood Mitigation Assistance (FMA) program was transferred from the CWCB to DHSEM in 2009. CWCB continues to provide technical assistance and related efforts to support DHSEM and the local applicants on future applications. Additionally, DHSEM transferred the full administrative responsibilities of the CAP to the CWCB in 2010 to allow FEMA to pass grant funds directly to the CWCB.

2.3 Program Integration

2.3.1 Integration of Mitigation Planning with other State Planning Efforts

This Plan has been an integral part of the Colorado Hazard Mitigation Plan since 2007. The State Hazard Mitigation Plan was updated simultaneously with the update to this Plan. This Plan is directly integrated in to the State Plan in several ways, including planning process, risk assessment, capabilities, and actions and is formally included as a stand-alone hazard specific annex to the State Plan. Portions of information included in the flood hazard profile in the SHMP are taken directly from this plan update, contributing to the profile of the flood hazard in Colorado and analysis of the nature of impacts and probability of drought occurrence. During future updates there is potential for inclusion of the Flood Mitigation Plan into the SHMP.

Colorado has been on the forefront of statewide resiliency planning since the 2013 flood disaster and has developed its own Resiliency Framework to achieve cross-sector resilience planning. The Framework outlines guiding principles and tools for community stakeholders and calls for a collective commitment to partnership and action. The Framework provides guiding principles around resiliency for the state. It defines the structure through which the state will support local agencies and community groups as they identify and implement their own resiliency actions. Risks and vulnerabilities are analyzed, and specific strategies are identified that will strengthen the state's capacity to adapt and support local communities on their path toward resiliency.

Information from the Framework was used to inform the 2018 Flood Mitigation Plan update. For example, the prioritization criteria developed for the Framework has been adopted and incorporated into the update of this plan as well as plan updates under the SHMP umbrella.

Section 4.4 Mitigation Actions provides additional detail on actions designed to improve coordination and integration efforts. Details on related planning programs and initiatives are also discussed in Section 4.3 Local Capability Assessment.

The following mitigation planning efforts have been closely integrated with the planning efforts related to the following programs and plans:

- Flood Mitigation Assistance (FMA) Program
- Pre-Disaster Mitigation (PDM) Program
- FEMA Risk MAP Program
- CWCB Colorado Hazard Mapping (CHAMP) Program
- Local Hazard Mitigation Plans
- Colorado State Hazard Mitigation Plan (2018 Update)
- State Water Plan (2015)
- State Climate Plan

In addition, the CWCB completed and approved the "State of Colorado Floodplain and Stormwater Criteria Manual" in 2006. This planning document provides guidance to local communities on issues related to flood and stormwater management within the state.

CWCB supports watershed planning and projects designed to restore and protect watersheds. This is more clearly defined in the CWCB Board's Policy Implementation Objectives, which include multi-objective planning, project development, and stream restoration. To achieve this objective, the Board and staff participate with partners to plan and undertake multi-objective projects designed to reduce flood hazards, stabilize and restore stream channels, provide habitat, reduce erosion, and increase the capacity to utilize water. This objective is discussed in greater detail in Section 4.2.3 State Policies Related to Development in Flood Prone Areas. Watershed health and specifically the impact that wildfires and post-wildfire flooding can have on drinking water resources and infrastructure is a consideration within the State Water Plan and related Basin Implementation Plans.

2.3.2 Integration of Mitigation Planning with FEMA Mitigation Programs and Initiatives

Mitigation planning associated with this document has strived to include the integration of other FEMA mitigation programs and initiatives. Specifically, the goals of the National Flood Insurance Program (NFIP) Repetitive Loss Program have been integrated into the evaluation of mitigation projects identified through this planning process. Repetitive loss properties will be included as a criterion during the evaluation process. Furthermore, a discussion of repetitive loss properties is

included in this document with specific information provided on the number of repetitive loss properties in Colorado on a county-by-county basis. Through the integration of this information into the planning activities, the capability of Colorado to be selected for the nationally competitive grant programs should be increased.

The CWCB is also working on efforts to increase local participation in the NFIP's Community Rating System (CRS). This effort is described further in Section 4.2.1.

The CWCB is a Cooperating Technical Partner (CTP) with FEMA. The CWCB works with local governments outside of the Denver Metro Area to develop new Flood Insurance Studies and Flood Insurance Rate Maps. Within the six county Denver Metro area the Urban Drainage & Flood Control District is the CTP. FEMA operates the Risk Mapping, Assessment and Planning Program (Risk MAP), which has been underway since 2010. Risk MAP combines flood hazard mapping, risk assessment tools and hazard mitigation planning into one seamless program. The budget for Risk MAP is determined on an annual basis. Colorado continues to provide cost-sharing leverage for Digital Flood Insurance Rate Map (DFIRM) and future Risk MAP projects. Colorado's Risk MAP program is discussed in more detail in Section 4.2.5.

Following the September 2013 flood disaster, Colorado has taken steps toward long-term planning and resiliency efforts for flooding. In early 2015, Colorado's Legislature passed a funding bill for the Colorado Hazard Mapping Program (CHAMP), which aims to provide a mitigation and land use framework in areas likely to be affected by future flooding, erosion, and debris flow events. CHAMP is preparing updated hazard information for the streams most affected by the September 2013 flooding. An additional phase of CHAMP is also focusing on counties and communities that are still utilizing paper FEMA floodplain maps. This scope includes digitizing existing FIRM panels in select communities and jurisdictions and wherever topographic data is available, updated flood risk information will be provided as best available information for local communities to utilize. Community leaders can use this updated hazard and newly digitized information to assess risk and identify mitigation opportunities in their community. The updated information is also intended to eventually be used to update FEMA FIRMs. The CWCB is the lead agency coordinating CHAMP.

An additional step the CWCB has taken following the September 2013 floods is identifying risks in Fluvial Hazard Zones (FHZ). Riverine erosion is a significant, but unstudied, flood risk for many Colorado communities. Relying only on Flood Insurance Rate Maps to manage floodplains and to reduce flood risk is insufficient to prevent future damages in Colorado. Structures located above the regulatory base flood elevation and structures located outside of the regulatory floodplain were destroyed by riverine erosion from river banks migrating laterally in September 2013. Despite these very real, extreme hazards, riverine erosion hazard zones are currently not shown on the Flood Insurance Rate Maps. Furthermore, despite NFIP directives that communities should be managing erosion hazard areas, clear guidance from FEMA is not available on how such fluvial risks are to be mapped or managed. The state's FHZ mapping efforts will provide technical standards, conduct studies for pilot communities, and provide voluntary regulatory guidance.

3 RISK ASSESSMENT

The foundation of the Colorado Flood Hazard Mitigation Plan is the statewide risk assessment. It sets the stage for identifying mitigation goals and activities to help the state become resilient against floods and keep Colorado residents safe. The major components of this risk assessment include a hazard identification/analysis and a vulnerability analysis that answer the following questions: What are the flood hazards that could affect Colorado? What can happen as a result of those hazards? How likely is each of the possible outcomes? When the possible outcomes occur, what are the likely consequences and losses, and how does this vary across the state? This section attempts to answer these questions based on the best available data.

FEMA defines risk assessment terminology as follows:

- **Hazard**—A hazard is an act or phenomenon that has the potential to produce harm or other undesirable consequences to a person or thing.
- **Vulnerability**—Vulnerability is susceptibility to physical injury, harm, damage, or economic loss. It depends on an asset's construction, contents, and economic value of its functions.
- **Exposure**—Exposure describes the people, property, systems, or functions that could be lost to a hazard. Generally, exposure includes what lies in the area the hazard could affect.
- **Risk**—Risk depends on hazards, vulnerability, and exposure. It is the estimated impact that a hazard would have on people, services, facilities, and structures in a community. It refers to the likelihood of a hazard event resulting in an adverse condition that causes injury or damage.
- **Risk Assessment**—Risk assessment is the process of measuring the potential loss of life, personal injury, economic injury, and property damage resulting from hazards.

3.1 Identifying Flood Hazards

This hazard analysis assesses various risks facing the state and its communities in order to evaluate and rank them. This process is then used to characterize flood hazards for emergency planning. It estimates the probability of occurrence and the severity of consequences for each hazard and provides a method of comparison. The evaluation involves many interrelated variables (e.g., demographics, topography, scope, etc.), and should be used by state and local officials in planning and prioritizing allocation of resources.

A careful examination of flood hazard event profiles relevant to Colorado serves to define historic hazard trends and provides a reference point for understanding the potential impacts from future predicted events. Reviewing historic data assists in evaluating hazard event profiles, which focus on answering the following questions: How often might a particular disaster occur? Where are we most likely to be affected? How bad can it get?

The flood hazards that threaten Colorado are profiled below.

3.1.1 Description of Flood Hazards Affecting the State

The natural, technological, and human-caused hazards affecting the state are described in detail in the 2018 SHMP. This document focuses on a summary of the flood hazards that affect the State of Colorado.

A flood is a general and temporary condition of partial or complete inundation of normally dry land areas from: (1) the overflow of stream banks, (2) the unusual and rapid accumulation of runoff of surface waters from any source, or (3) mudflows or the sudden collapse of shoreline land. Flooding results when the flow of water is greater than the normal carrying capacity of the stream channel. Rate of rise, magnitude (or peak discharge), duration, and frequency of floods are a function of specific physiographic characteristics. Generally, the rise in water surface elevation is quite rapid on small (and steep gradient) streams and slow in large (and flat sloped) streams.

Floods are often measured in terms of magnitude and the statistical probability that they will occur. The 1% annual chance flood event is the standard national measurement for flood mitigation actions and insurance. The 1% annual chance flood, also referred to as the 100-year flood, "has a 1 in 100 chance of being equaled or exceeded in any 1 year, and it has an average recurrence interval of 100 years…".[1] This recurrence interval is an *average*; it does not necessarily mean that a flood of such a magnitude will happen exactly every 100 years. Only a few years may pass between one 1% annual chance flood and another while two other 1% annual chance floods may be separated by 150 years. The 0.2% annual chance flood, or 500-year flood, event is another measurement which "has a 0.2% chance (or 1 in 500) chance of occurring in a given year".[2]

The causes of floods relate directly to the accumulation of water from precipitation, rapid snowmelt, or the failure of human-constructed structures, such as dams or levees. Floods caused by precipitation are further classified as coming from:

- Rain in a general storm system
- Rain in a localized intense thunderstorm
- Melting snow
- Rain on melting snow
- Ice jams

Floods may also be caused by structural or hydrologic failures of dams or levees. A hydrologic failure occurs when the volume of water behind the dam or levee exceeds the structure's capacity resulting in overtopping. Structural failure arises when the physical stability of the dam or levee is compromised due to age, poor construction and maintenance, seismic activity, rodent tunneling,

[1] http://pubs.usgs.gov/gip/106/

[2] (http://pubs.usgs.gov/gip/106/pdf/100-year-flood_041210web.pdf

or myriad other causes.

Each of these causes results in floods that have distinct characteristics relative to flow rate, rate of rise, volume, duration, and flood season.

General Rain Floods

General rain floods can result from moderate to heavy rainfall occurring over a wide geographic area lasting several days. They are characterized by a slow steady rise in stream stage and a peak flood of long duration. As various minor streams empty into larger and larger channels, the peak discharge on the mainstream channel may progress upstream or downstream (or remain stationary) over a considerable length of river. General rain floods can result in considerably large volumes of water. The general rain flood season is historically from the beginning of May through October. Because the rate of rise is slow and the time available for warning is great, few lives are usually lost, but millions of dollars in valuable public and private property are at risk.

Thunderstorm Floods

Damaging thunderstorm floods are caused by intense rain over basins of relatively small area. They are characterized by a sudden rise in stream level, short duration, and a relatively small volume of runoff. Because there is little or no warning time, the term “flash flood” is often used to describe thunderstorm floods. The average number of thunderstorm days per year in Colorado varies from less than 40 near the western boundary to over 70 in the mountains along the Front Range. The thunderstorm flood season in Colorado is from the middle of July through October.

Snowmelt Floods

Snowmelt floods result from melting of winter snowpack in the high mountain areas. Snowmelt floods typically begin as spring runoff appears, after the first spring warming trend. If the warming trend continues up to 8 to 10 consecutive days in a basin where the snowpack has a water content more than about 150% of average, serious flooding can develop. The total duration of snowmelt floods is usually over a period of weeks rather than days. They yield a larger total volume in comparison to other types of floods in Colorado. Peak flows, however, are generally not as high as flows for the other types. A single cold day or cold front can interrupt a melting cycle causing the rising water to decline and stabilize until the cycle can begin again. Once snowmelt floods have peaked, the daily decreases are moderate, but fairly constant. Snowmelt flooding usually occurs in May, June, and early July.

Rain on Snowmelt Floods

Rain on snow flooding occurs most often in Colorado during the month of May. It is at this time of year that large general rainstorms occur over western Colorado. These rainstorms are most often caused when warm moist air from the Gulf of Mexico begins pushing far enough north that it begins to affect western weather. In combination with this movement of air mass is the continued

possibility of cold fronts moving into Colorado from the Pacific Northwest. When these weather phenomena collide, long lasting general rainstorms can often occur. Rain on snowmelt exacerbates an already tenuous situation as snowmelt waters rush down heavily incised stream channels. Any abnormal increase in flow from other sources usually causes streams to leave their banks.

During the summer months of May and June when rivers are running high, there is a potential for flooding due to rain falling on melting snow. Usually such rain is over a small part of a basin, and the resulting flood is of short duration and may often go unnoticed in the lower reaches of a large drainage basin. To some extent, the cloud cover associated with the rain system can slow the melting cycle and offset the compound effect. In some cases, however, rainfall may be heavy and widespread enough to noticeably affect peak flows throughout the basin.

Ice Jam Floods

Ice jam floods can occur by two phenomena. In the mountain floodplains during extended cold periods of 20 to 40 degrees below zero, the streams ice over. The channels are frozen solid and overbank flow occurs, which results in ice inundation in the floodplains. Ice jam floods can occur when frozen water in the upper reaches of a stream abruptly begins to melt due to warm Chinook winds. Blocks of ice floating downstream can become lodged at constrictions and form a jam. The jam can force water to be diverted from the stream channel causing a flood. An ice jam can also break up, suddenly causing a surge of water as the "reservoir" that was formed behind it is suddenly released. Ice jamming occurs in slow moving streams where prolonged periods of cold weather are experienced. Sometimes the ice jams are dynamited, allowing a controlled release of the backed-up water to flow downstream.

Dam Failure Floods

Dam failure floods are primarily a result of hydraulic or structural deficiencies at an existing dam. The operation of a reservoir can also influence the safety of the structure. Dam failure by hydraulic deficiency is a result of inadequate spillway capacity, which can cause a dam to be overtopped during large flows into the reservoir. Overtopping is especially dangerous for an earth dam because the uncontrolled flow of water over the crest will erode the downstream face, headcut through the embankment to the reservoir breaching the dam and releasing all the stored water suddenly into the downstream floodplain. Dam failure by overtopping can occur from excessive runoff due to extreme precipitation in the basin, or by plugging of a spillway with debris and reducing the capacity. Seiche waves generated from landslides into a reservoir, or the sudden inflow from upstream dam failures, are other causes of dam failure by overtopping.

Examples of structural deficiencies include seepage-induced piping of the embankment, piping along internal conduits, erosion, cracking, sliding, overturning, rodent tunneling, or other weakness in the structure. Lack of adequate maintenance is often at the root of structural deficiencies. Seismic activity in Colorado has recently been recognized as a potential source of structural problems due to liquefaction of sand layers in the foundation of a dam.

The mechanics of a dam failure depends on the type of dam and the mode of failure. They can occur at any time, but earthen dams are most susceptible to failure during the spring runoff and summer monsoon season, when inflows result in peak loading conditions.

Levee Failure Floods

A levee is an earthen embankment constructed along the banks of rivers, canals and coastlines to protect adjacent lands from flooding by reinforcing the banks. By confining the flow, levees can also increase the speed of the water. Levees can be natural or human-constructed. A natural levee is formed when sediment settles on the river bank, raising the level of the land around the river. To construct a human-constructed 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.

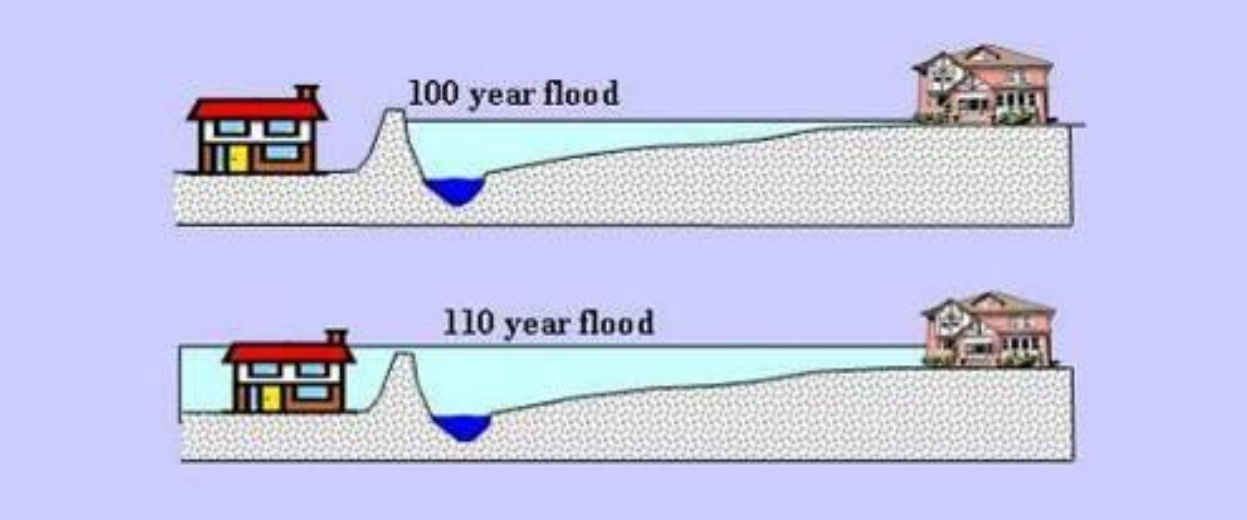
Many communities receive additional flood damage protection from "non-levee embankments," or NLEs. No formal definition or technical criteria exist for NLEs. However, one of the best informal definitions to date is "any structure that provides protection from the 1% annual chance flood." Highways, railroads, canals, culverts, bridges, landscaping features, and other similar structures could be considered NLEs. Such embankments, while not designed to prevent flooding behind them, do have a mitigating effect on flooding. Although NLEs have this effect, they are not recognized as accredited flood mitigation structures by FEMA.

Levees provide strong flood protection, but they are not failsafe. Levees only reduce the risk to individuals and structures behind them; they do not eliminate risk. Levees are designed to protect against a specific flood level and could be overtopped during severe weather events. As seen in Figure 3-1, overtopping occurs when floodwaters exceed the height of a levee and flow over its crown. As the water passes over the top, it may erode the levee, worsening the flooding and potentially causing an opening, or breach, in the levee.

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

Earthen levees can be damaged in several ways. For instance, strong river currents and waves can erode the surface. Debris and ice carried by floodwaters—and even large objects such as boats or barges—can collide with and gouge the levee. Trees growing on a levee can blow over, leaving a hole where the root wad and soil used to be. Burrowing animals can create holes that enable water to pass through a levee. If severe enough, any of these situations can lead to a zone of weakness that could cause a levee breach. In seismically active areas, earthquakes and ground shaking can cause a loss of soil strength, weakening a levee and possibly resulting in failure. Seismic activity can also cause levees to slide or slump, both of which can lead to failure.

Figure 3-1 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

Unfortunately, in the rare occurrence when a levee system fails or is overtopped, severe flooding can occur due to increased elevation differences associated with levees and the increased water velocity that is created. It is also important to remember that no levee provides protection from events for which it was not designed, and proper operation and maintenance are necessary to reduce the probability of failure. In some cases, flooding may not be directly attributable to a river, stream, or lake overflowing its banks. Rather, it may simply be the combination of excessive rainfall or snowmelt, saturated ground, and inadequate drainage. With no place to go, the water will find the lowest elevations – areas that are often not in a floodplain. This type of flooding, often referred to as sheet flooding, is becoming increasingly prevalent as development outstrips the ability of the drainage infrastructure to properly carry and disburse the water flow. Flooding also occurs due to combined storm and sanitary sewers that cannot handle the tremendous flow of water that often accompanies storm events. Typically, the result is water backing into basements, which damages mechanical systems and can create serious public health and safety concerns.

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

Dam Operational Release Flooding

Recent flooding events in Colorado in 2013 and 2015, and nationwide in 2017, have highlighted how excessive reservoir inflows (the amount of water entering a reservoir) can impact dam spillway flows (flows designed to control the release of water to protect dam structures and prevent overtopping). In particular, excessive inflows can lead to dams exceeding normal spillway flow rates, which may require the controlled releases of water to lower reservoir levels. In some cases, emergency actions have been necessary to address hazardous conditions that developed in the channels and floodplains downstream of the dams.

Although all high-hazard dams in Colorado have dam failure inundation maps to outline flooding limits for dam failures, no mapping exists for the range of releases that might be anticipated to occur during flooding events. Providing emergency managers and floodplain managers with the tools to assess a range of scenarios from dam releases would enable them to begin addressing the risks certain areas face from such failures.

To address this need, a project team lead by Colorado Dam Safety developed the Colorado High-Hazard Dam Release - Downstream Floodplain Impacts Database and Ranking Tool. The tool can be used to support public awareness, planning, and emergency preparedness activities, as well as during emergency response situations involving high hazard dams throughout Colorado. Colorado Dam Safety is the first state dam safety program in the nation to systematically evaluate their portfolio of over 400 high-hazards dams related to operational and flood release capabilities.

Alluvial Fans, Debris Flows, and Erosion Hazards

Alluvial fans and debris flows can greatly exacerbate flood hazards. Alluvial fans can increase flooding due to the wide expanse of land and unpredictable flowpaths. Normally, the process of mapping flood hazards is relatively straightforward. Flood rates and the topography of the land around stream channels are usually known, making the process of flood mapping easier. In contrast, the convex shape of alluvial fans offers no directing channel for floodwaters. This causes the waters to spread over much greater distances, potentially endangering many more people. Additionally, flow rates in alluvial fans and debris flows are harder to quantify because of loose debris. Debris flows and mudslides can uproot trees and lift boulders, making the hazard even more dangerous. These types of hazards are not well mapped in the state. Although it is not required by FEMA, the CWCB supports mapping of alluvial fans and debris flows, and the CGS has taken significant steps through CHAMP to start to identify these risks statewide.

Avulsion and erosion hazards can result from floods and change the nature, location, and severity of future floods. Avulsion refers to the abandonment of an existing river channel and formation of a new river channel. This process can occur during floods powerful enough to exceed a river's stability threshold. The Town of Jamestown in particular was impacted by avulsions caused by the September 2013 flooding. In many places, the river scoured to bedrock dropping the base of the stream 6 feet or more. In other locations, major avulsions occurred resulting in the channel shifting a considerable distance. Alluvial channels, such as reaches of James and Little James

Creeks located in Jamestown, formed in response to both valley slope and flood regime. They require areas of relatively less slope and an infrequent flood regime that works to gradually decrease stream base level. Flood events like those observed in September 2013 create a dramatic drop in stream base level, and in response, the surrounding channels will now work to adjust to that change. In some cases, avulsion and erosion cause more damage than inundation when bridges, roads, and other structures are undermined from scour. The loss of infrastructure is extremely costly to repair or replace in long-term recovery efforts.

Post-Wildfire Floods

Wildfires greatly reduce natural flood mitigation by stripping the land of soil cohesiveness and vegetation ground cover. These "burn scars" can become hydrophobic, which means water does not absorb into the soil, increasing runoff and erosion. Vegetation helps stem the velocity of runoff down a slope, and also assists with water absorption into the soil. As a result, post-wildfire areas are highly susceptible to flash flooding. Moderate rainstorms can turn into walls of water several feet high. These floods can also capture loose soil and other debris and quickly turn into devastating debris flows or mudslides. These areas are not required to be mapped in relation to flood hazards, but the CWCB encourages local jurisdictions to do so following severe wildfires and to regularly update the maps.

3.2 Flood Hazard Profile

The relationship between flood hazards and population identifies patterns of risk. Such relationships are not new to Colorado. Flooding has occurred here long before people settled in high-risk areas. Risk grows from the increasing overlap between flooding as a natural phenomenon and a growing population.

People become vulnerable to hazards when they choose (knowingly or unknowingly) to live near the areas prone to flooding. Vulnerability is also related to preparedness. People who prepare for the occurrence of a flood event are less vulnerable to it than those who do not. The vulnerability of Colorado's population is rooted in a relationship between the occurrences of flood events, the proximity of people to these occurrences, and the degree to which these people are prepared to cope with these natural cycles.

3.2.1 Location of Flood Hazards in Colorado

The location of Colorado's rivers is closely related to the impact of flood hazards on growth and development within the state. Many rivers originate in Colorado, and flood prone areas have been identified in 270 cities and towns and in all of the 64 counties in the state. Between 20 and 30 large magnitude floods (in terms of peak discharge) occur somewhere in Colorado every year. In order to provide an understanding of potential flood hazards in Colorado, this section describes the major river basins and mapped flood hazard areas within the state. Figure 3-2 depicts the major river basins within the State of Colorado.

Figure 3-2 Colorado's Major River Basins

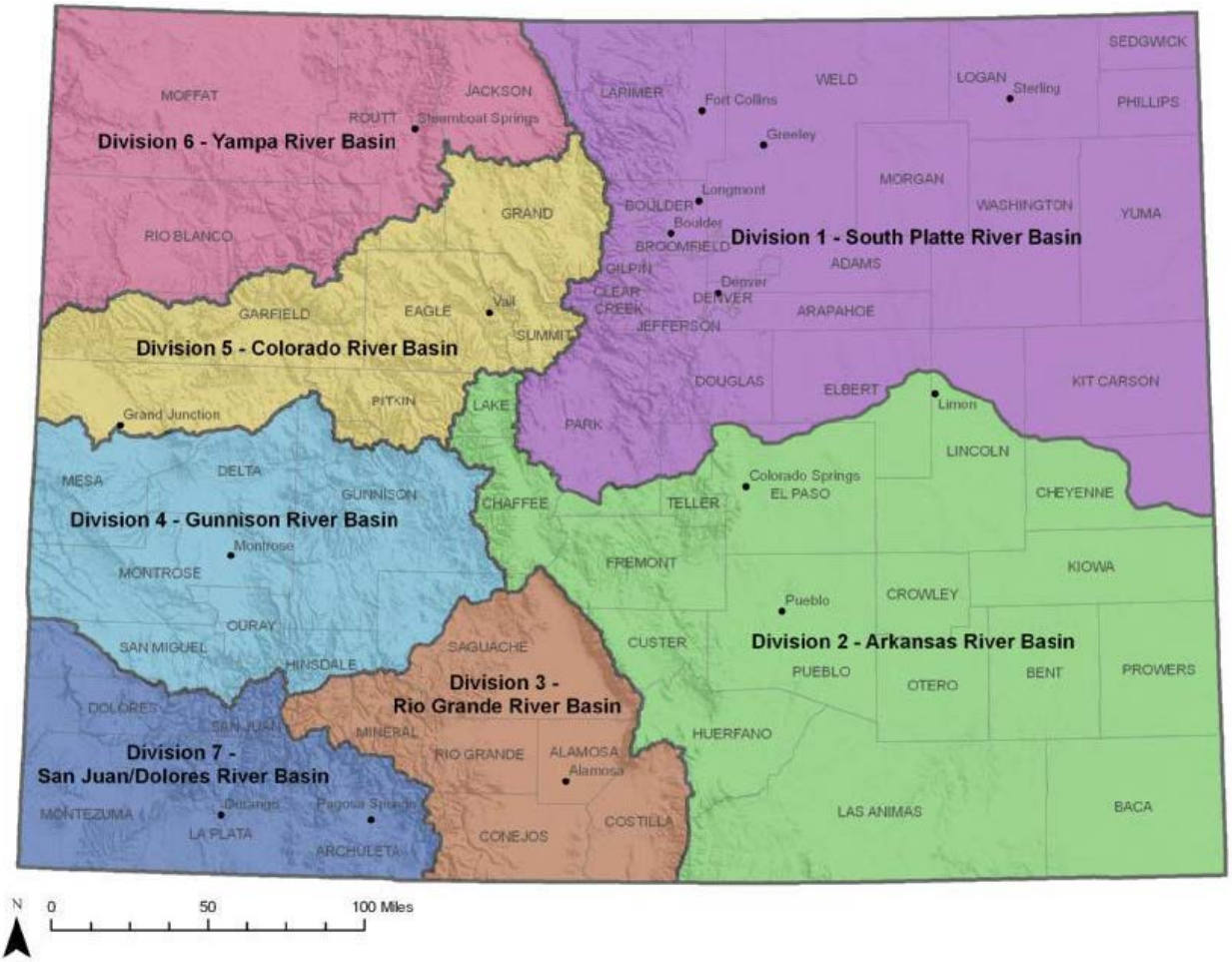


Figure 3-3 (below) presents river flows and how they compare during a typical dry year as compared to a wet year. This also helps to identify the major drainages and sources of riverine flooding across the state, and volumes of water discharged during wet years.

Figure 3-3 Colorado Summary of Observed Wet and Dry Surface Water Hydrology

Source: Colorado Water Plan 2015

South Platte River Basin

Including the Republican River Basin, the South Platte Basin encompasses all or part of 23 counties over 27,660 square miles. Elevation in the basin ranges from 14,000 feet at the Continental Divide to 3,400 feet at the Colorado-Nebraska state line. The largest population center in the basin is the Denver area, with a population of about 693,060 people in Denver proper and 3,116,501 in the Denver Metropolitan Area. The South Platte River is the major waterway in the

basin. The South Platte Basin is expected to continue to experience major strains on water use from population growth. Population growth could also potentially mean that more people will be at risk to flood. Some of the state's most devastating floods have occurred in the South Platte Basin. In a 2006 report by the CWCB, historic flood damages for the basin were estimated to be $3.4 billion at the time of the study.[3] Adding in damages from the 2013 and 2015 floods, both of which were primarily focused in the South Platte River Basin, would bring that total to over $6 billion.

Arkansas River Basin

Of all the river basins in Colorado, the Arkansas River Basin encompasses the greatest surface area of the state at 28,268 square miles. It extends over the entire southeastern corner of Colorado, and 18 counties lie within the area of the basin. Elevation in the basin varies from 14,000 feet at the headwaters near Leadville to 3,340 feet at the Colorado-Kansas border. The major population centers in the basin are Colorado Springs with roughly 464,474 people and Pueblo with a population of about 111,127 (U.S. Census Bureau, 2017). The population of several of the counties that lie within the basin (e.g. Chaffee, El Paso, Elbert, Park, Teller) is expected to grow by a significant amount (25% or more) from 2010 to 2030, placing major strains on water usage and potentially increasing the number of people exposed to flood hazards (Colorado's State Demography Office, 2016).

Rio Grande River Basin

The Rio Grande Basin stretches over 7,543 square miles in Colorado. Elevations range from under 6,000 feet to 14,000 feet, with an average elevation of 7,500 feet. The Rio Grande is the major waterway in the basin. Its headwaters are found in the Rio Grande National Forest in the south-central portion of the state. A portion of the basin is considered to be a "closed basin." Surface water in this portion does not contribute to the flow of the Rio Grande. The population within the basin is considered sparse to moderate. The largest population centers are Alamosa, with roughly 9,871 people, and Monte Vista, with 4,175 people (U.S. Census Bureau, 2017). Historic damages for the basin were estimated at $14.4 million.[4]

Gunnison River Basin

The Gunnison River Basin is roughly 7,800 square miles in size, extending all the way from the Continental Divide to Grand Junction where it empties into the Colorado River. Elevation in the basin ranges from 14,000 feet to 4,550 feet. The annual flow of the Gunnison River averages 547,000 acre-feet per year at the stream gage near the Town of Gunnison. Tributaries include Cochetopa Creek, Tomichi Creek, Uncompahgre River, East River, and Taylor River. The

[3] http://cwcbweblink.state.co.us/weblink/docview.aspx?id=113233&searchhandle=30039

[4] http://cwcbweblink.state.co.us/weblink/docview.aspx?id=113231&searchhandle=30039. Damages adjusted to 2016 dollars.

population in the river basin is relatively sparse. Eleven major reservoirs lie within the basin, including Blue Mesa, Morrow Point, Crystal, Taylor Park, Ridgway, Paonia, Crawford, Silverjack, Gould, Overland, and Fruitgrowers Reservoirs. Agriculture and hydroelectric power account for the primary uses of the waters, although there is some municipal and industrial usage as well.[4]

Colorado River (Grand River) Basin

The Colorado River Basin encompasses roughly 9,916 square miles of west-central Colorado. The Colorado River is the major stream in the basin. Its tributaries include the Fraser River, Williams Fork River, Muddy Creek, Blue River, Eagle River, Roaring Fork River, Rifle Creek, and Plateau Creek. The Colorado River originates in Rocky Mountain National Park at an elevation of about 12,800 feet and descends to 4,325 feet at the Colorado-Utah state line. The average annual streamflow is approximately 57,000 acre-feet near the headwaters and 4.9 million acre-feet by the time the river reaches Grand Junction. Population in the basin is moderate at less than 320,000 people (U.S. Census bureau, 2016). There are 20 reservoirs in the basin that help enable irrigation projects, power generation, municipal and industrial use, recreation, tourism, and transbasin diversions which bring water to many of the eastern parts of the state.[5]

Yampa/White River Basin

The Yampa River Basin encompasses the majority of Routt and Moffat Counties in the northwestern corner of Colorado. The basin extends over roughly 7,660 square miles of Colorado and ranges from 12,200 feet to 5,600 feet in elevation. The Yampa River is the major stream in the basin. Its tributaries include Bear River, Chimney Creek, Walton Creek, Fish Creek, Trout Creek, Elk River, Elkhead Creek, Fortification Creek, Williams Fork River, and the Little Snake River. Average annual streamflow is about 62,000 acre-feet near the headwaters and 1,623,000 acre-feet at the lower elevations. The area is sparsely populated, and major water usage includes industry, agriculture, hydroelectric power generation, municipal water supply, recreation and tourism. The nine major reservoirs along the Yampa River are Stillwater Reservoir No. 1, Allen Basin, Yamcolo, Lake Catamount, Pearl Lake, Steamboat Lake, Fish Creek, Stagecoach, and Elkhead Reservoirs.[6]

The White River Basin lies immediately south of the Yampa River Basin. The primary stream is the White River, which empties into the Green River after flowing into Utah. About 3,750 square miles of the river basin is within Colorado. It encompasses most of Rio Blanco County and smaller portions of Moffat and Garfield Counties. The headwaters of the White River begin at 11,000 feet elevation. The average annual streamflow is 596,000 acre-feet where the White River crosses

[4] ftp://dwrftp.state.co.us/cdss/swm/in/GunnisonInfo_200407.pdf

[5] http://cwcbweblink.state.co.us/weblink/0/doc/125202/Page1.aspx?searchid=613f0ec8-2c8d-4d1f-a8c7-45025da55104

[6] ftp://dwrftp.state.co.us/cdss/swm/in/YampBasinInfo_20091019.pdf

from Colorado into Utah. The White River's tributaries include Big Beaver Creek, Fawn Creek, Hahn Creek, Piceance Creek, Yellow Creek, Douglas Creek, and the North and South Forks of the White River. Much of the basin is publicly-held lands, primarily under the direction of the Bureau of Land Management. Very few people live within the basin. Meeker and Rangely, which both have populations of less than 3,000 people, are the primary population centers. The basins' water resources are primarily used for agriculture, recreation, and tourism. There are no federal storage projects in the basin, although Taylor Draw Reservoir, Lake Avery Reservoir and the Rio Blanco Reservoir provide sources of hydroelectric power and recreation.[7]

Dolores/San Juan River Basin

The Southwest Basin encompasses the Dolores and San Juan River Basins, whose headwaters originate in the San Juan Mountains. Navajo Reservoir lies along the San Juan River, which flows into New Mexico and Utah before emptying into the Colorado River. About 7,200 square miles of the San Juan River lies within Colorado. Elevations within the basin range from a high of nearly 13,700 feet near Bolam Pass in San Juan National Forest to 4,800 feet in the Four Corners area of Colorado. The San Juan's major tributaries include the Navajo River, Peidra River, Los Pinos River, Animas River, Florida River, La Plata River, Mancos River, and McElmo Creek.

The Dolores River originates near Bolam Pass, and supplies McPhee Reservoir before flowing into Utah where it joins the Colorado River. Roughly 4,350 square miles of the river runs through Colorado alone. Major tributaries to the Dolores River include the River's own West Fork, Lost Canyon Creek, Disappointment Creek, West Paradox Creek, and the San Miguel River. The principal water use in these basins is irrigation for agriculture, but the rivers are also a source of hydroelectricity and municipal water for the sparsely populated region. In addition to Navajo and McPhee Reservoirs, other major water resource development projects in the basin include Vallecito Reservoir, Jackson Gulch Reservoir, Lemon Reservoir, Ridges Basin Reservoir, and the San Juan Chama Project.[8]

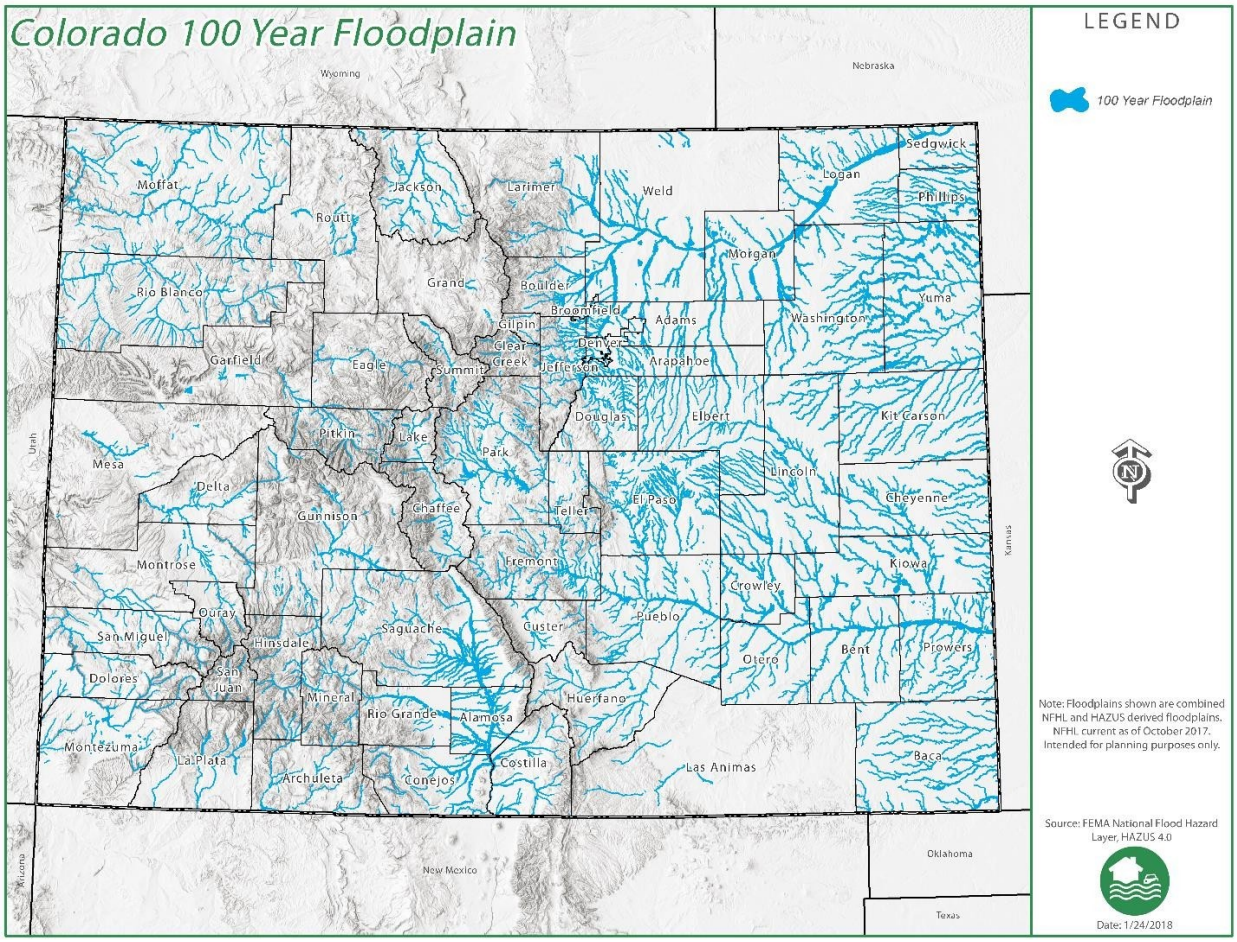
Floodplains

Figure 3-4 below shows Colorado's mapped floodplains that have a 1% chance of flooding annually or a 100-year recurrence interval, as discussed in Section 3.1.1 above. Data for this map came from a combination of FEMA National Flood Hazard Layer (NFHL) data, where available, and a 2018 Hazus-MH analysis completed as part of the SHMP update (see below); as such, not all of the floodplains shown in Figure 3-4 are included in FIRM/regulatory floodplain mapping.

[7] ftp://dwrftp.state.co.us/cdss/swm/in/WhiteBasinInfo_20091102.pdf

[8] ftp://dwrftp.state.co.us/cdss/swm/in/SanJuanInfo_20051101.pdf

Figure 3-4 100 Year (1% Annual Chance) Floodplains in Colorado



Source: Colorado SHMP 2018

Figure 3-5 represents DFIRM data from the National Flood Hazard Layer (NFHL) as of December 2017. The NFHL is a database that contains DFIRM data produced from FEMA's Map Modernization and Risk MAP programs. The data are based on effective and available DFIRMs and Letters of Map Revision (LOMR). Figure 3-6 illustrates the mapped flood zones in the state that were effective as of September 2013. The difference between the two maps shows the considerable progress made over the past four years in digital flood hazard mapping in Colorado.

In 2010, a FEMA Hazus-MH study was integrated into the Plan update which was revised and updated in 2018 based on an analysis completed as part of the SHMP update. Hazus-MH is a software program developed by FEMA to estimate potential losses from scenario events such as flooding. While not a flood mapping software, it does allow the generation of general flood hazard areas with associated depth grids and provides a proxy for flood areas not yet mapped by FEMA or the State of Colorado. The Hazus estimates supplemented the NFHL data and provided the Flood TAP with a greater understanding of the potential impacts of flooding in Colorado communities. The Hazus flood zones were combined with NFHL data in Figure 3-5. More discussion on the Hazus analysis is included in Section 3.4.2.

Figure 3-5 Mapped FEMA Flood Zones in Colorado 2018

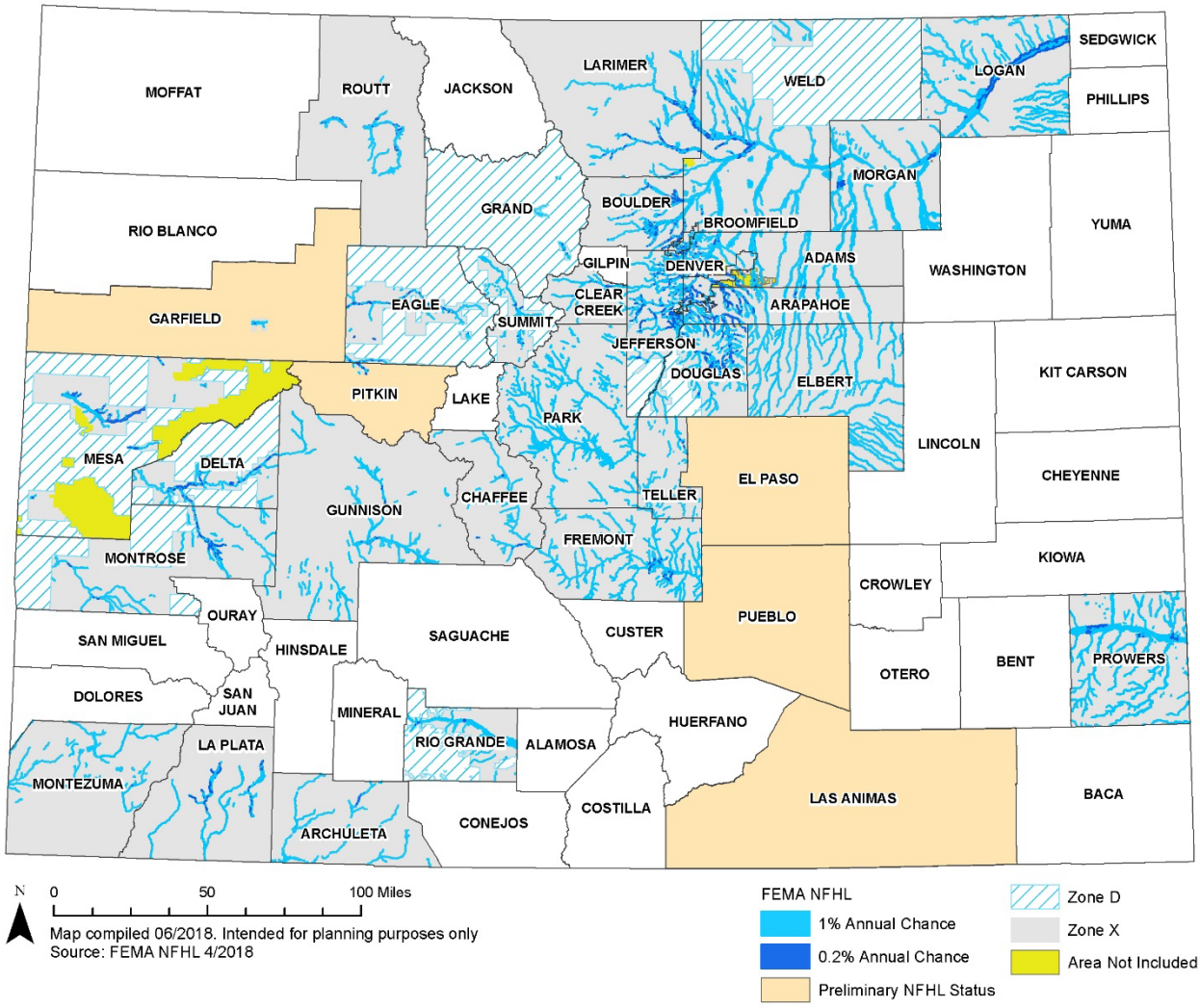
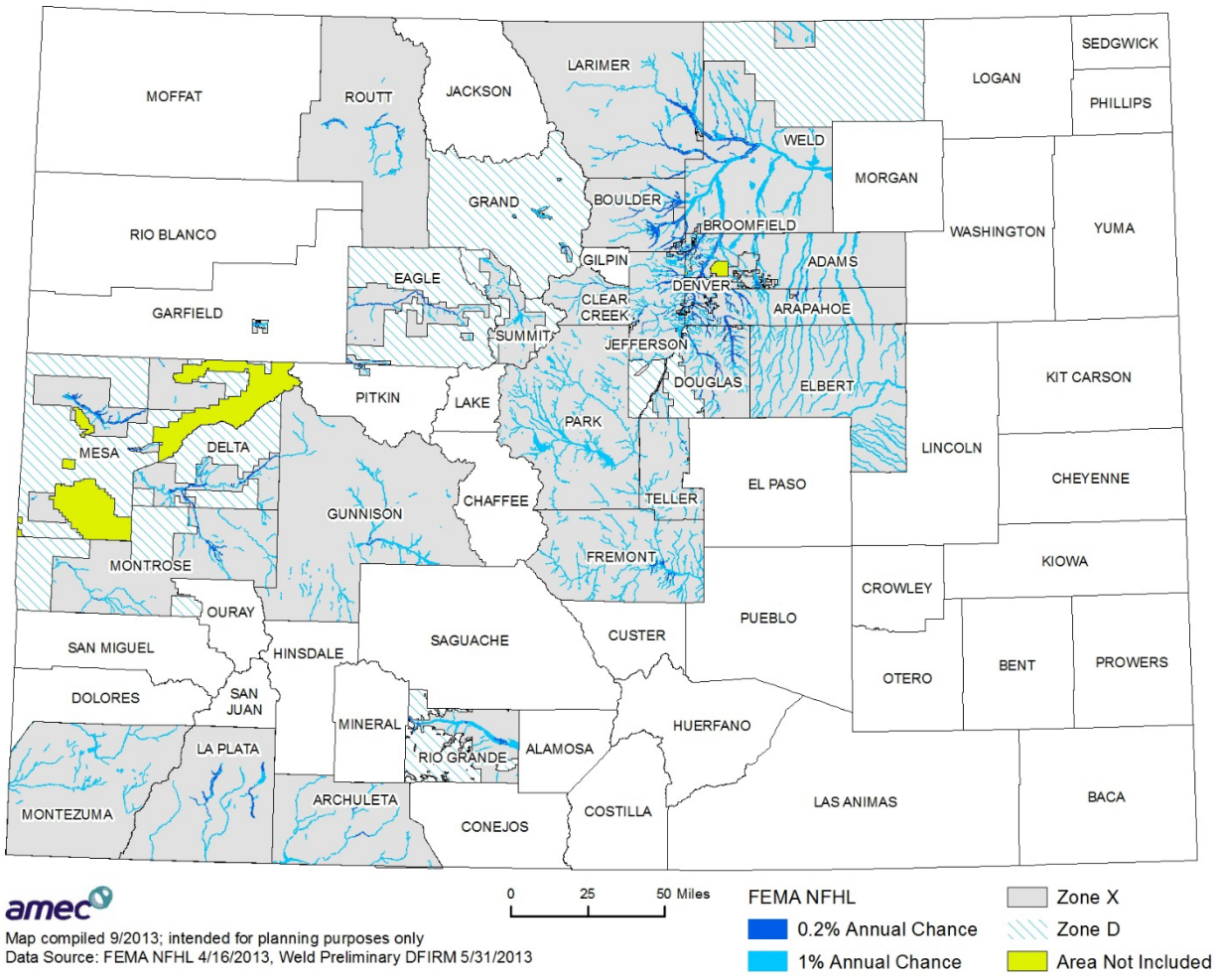
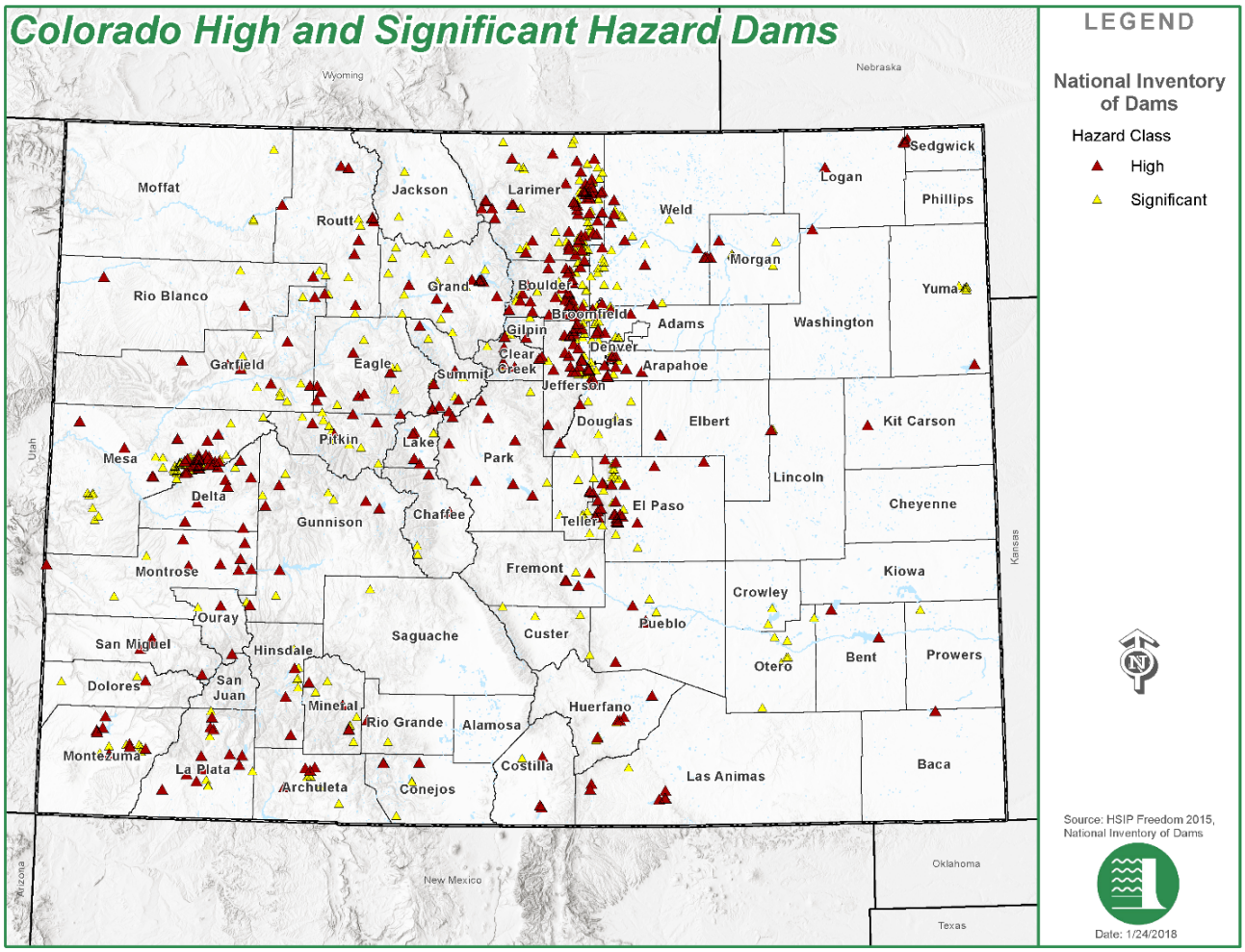


Figure 3-6 Mapped FEMA Flood Zones in Colorado 2013



As noted in Section 3.1.1, flooding can also result from the failure of human-constructed structures such as dams and levees, or from controlled and uncontrolled releases from dams. Figure 3-7 shows the location of all dams in Colorado that are ranked as High Hazard or Significant Hazard. For more details on dam failure, see that section of the Colorado SHMP.

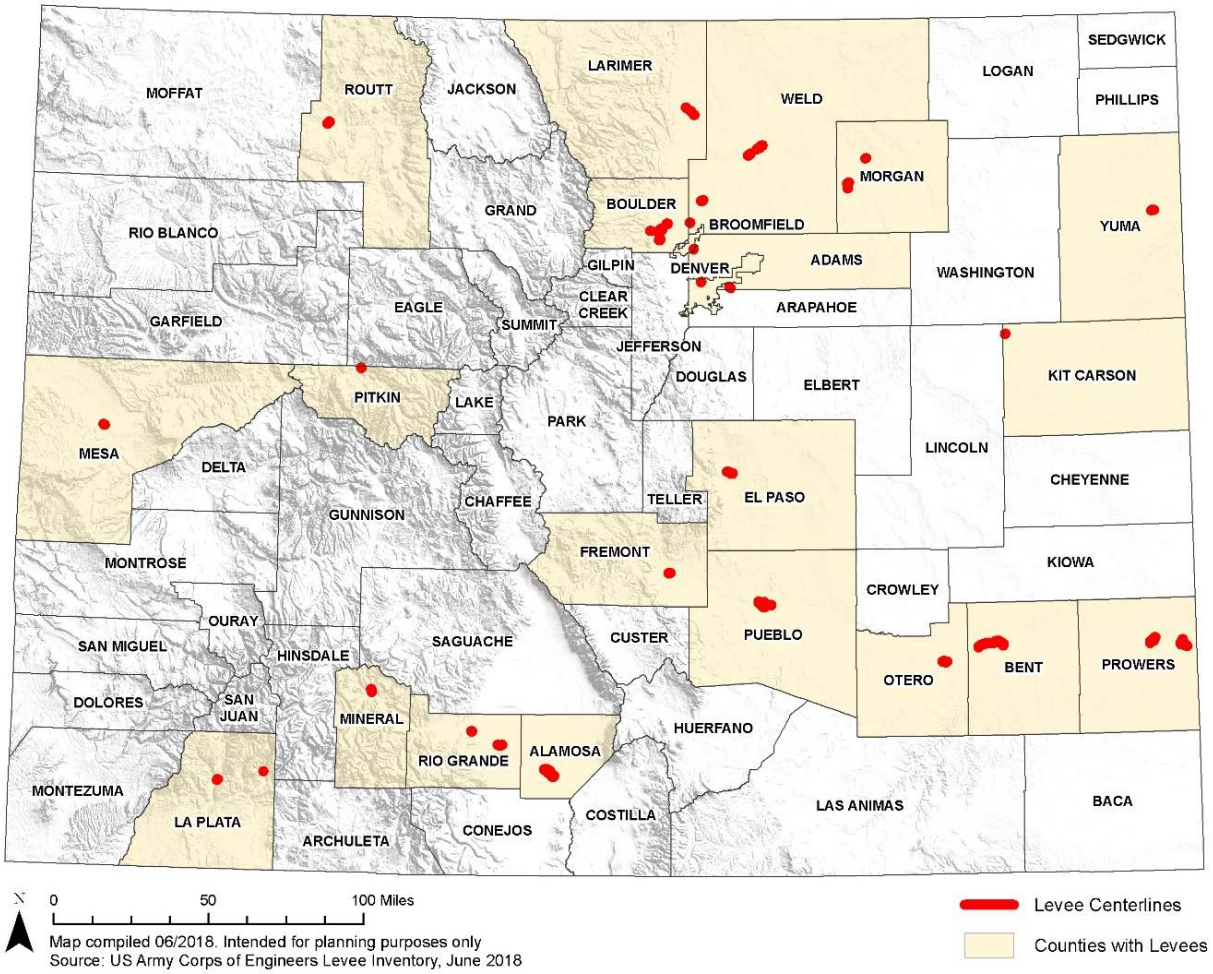
Figure 3-7 Colorado High and Significant Hazard Dams



Source: Colorado SHMP 2018

During the 2010 update of this Plan levee failure was identified as a component of the flood hazard within Colorado. Figure 3-8 shows the location of all Colorado levees identified in the U.S. Army Corp of Engineers National Levee Database (NLD) as of January 2018.

Figure 3-8 Colorado Counties with Identified Levees

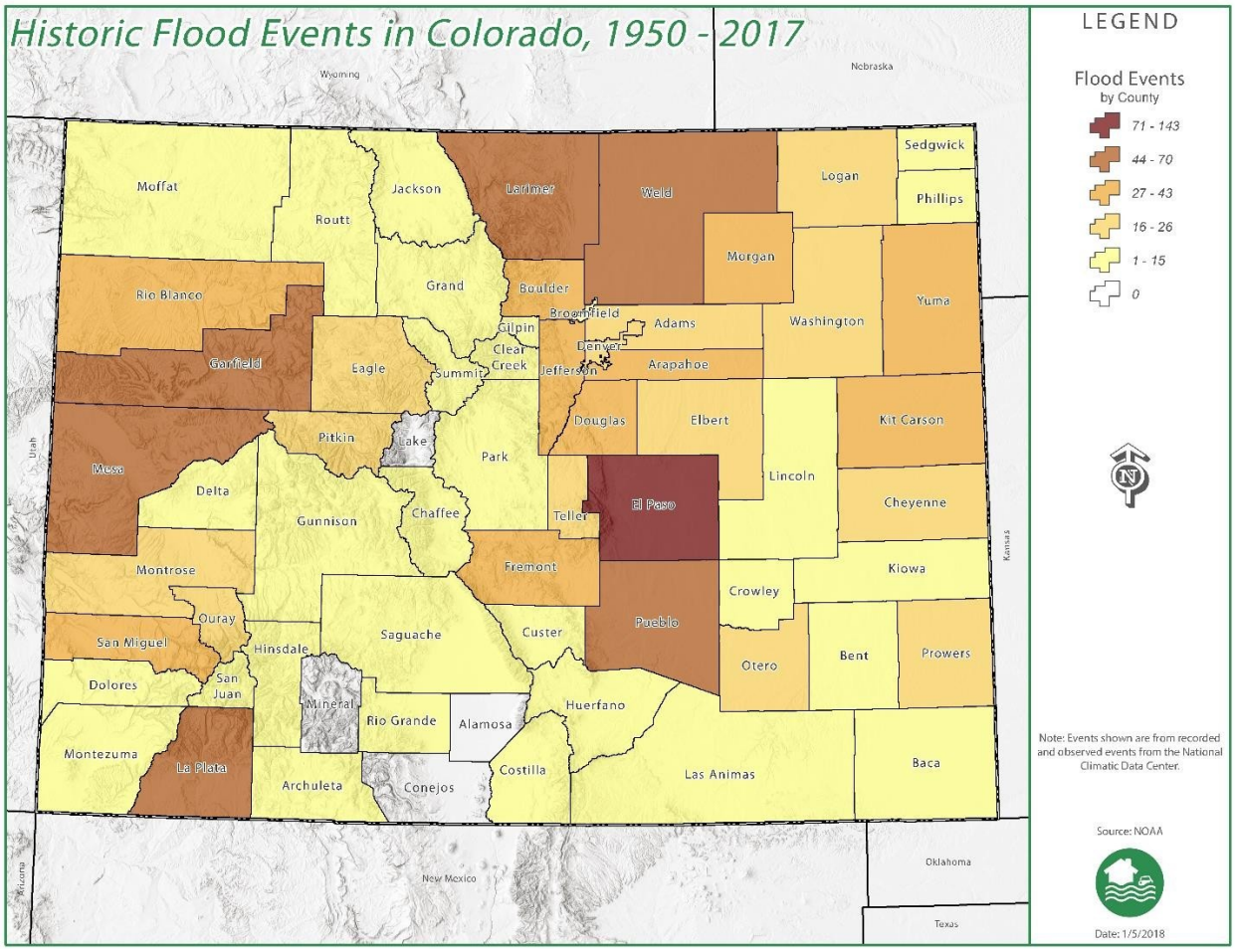


3.2.2 Flood History in Colorado

Colorado has a long history of tragic flood events. The earliest recorded floods in Colorado occurred in 1826 in the Arkansas River and Republican River basins. USGS records show that Colorado experienced "major" flooding in 52 of the 123 years between 1826 and 1948.[9] Figure 3-9 shows the number of flood events by county since 1950.

[9] Floods in Colorado, Follansbee, Robert and Sawyer, Leon R., US Geological Survey, 1948

Figure 3-9 Historic Flood Events in Colorado, 1950-2017



The most notable flood events in Colorado from 1864 to 2017 are presented in Table 3-1. As indicated in the table, the greatest loss of life occurred during the Big Thompson flood event of 1976. The most damaging flood in Colorado occurred in June 1965 on the South Platte River, which caused over $3 billion in damages (2017 dollars) to the Denver metro area.

Table 3-1 Notable Flood Events in Colorado: 1864-2017

Year	Location	Deaths	Damages (2017$)
1864	Cherry Creek (Denver)	0	$8,268,439
1896	Bear Creek (Morrison)	27	$9,449,645
1911	San Juan River (by Pagosa Springs and Durango)	2	$8,268,439
1912	Cherry Creek (Denver)	2	$184,268,088
1921	Arkansas River (Pueblo)	78	$1,167,031,222
1935	Monument Creek (Colorado Springs)	18	$80,321,986
1935	Kiowa Creek near Kiowa	9	$23,624,113
1942	South Platte River Basin	?	$12,757,022

Year	Location	Deaths	Damages (2017$)
1955	Purgatorie River (Trinidad)	2	$55,516,667
1956*	Denver, Jefferson, Arapahoe Counties		Unknown
1957	Western Colorado	0	$27,167,731
1965*	South Platte River (Denver)	8	$3,071,134,793
1965	Arkansas River Basin	16	$315,381,919
1969*	South Platte River Basin	0	$33,073,758
1970*	Southwest Colorado	0	$20,080,497
1973*	South Platte River (Denver)	10	$596,508,872
1976*	Big Thompson River (Larimer)	144	$129,932,625
1982*	Fall River (Estes Park)	3	$75,597,163
1983	North Central Counties	10	$40,160,993
1984*	West & Northwest Counties	2	$72,053,546
1993	Western Slope	0	$3,189,256
1995	Western Slope & South Platte	21	$80,321,986
1997*	Fort Collins & 13 East Counties	6	$479,439,793
1999*	Colorado Springs, 12 East Counties	0	$153,556,739
2000-6	Statewide Various Events	5	$131,113,831
2006	Beaver, Brush Hollow & Eightmile Creeks (Fremont Cnty)	0	$2,245,080
2006	Horse Creek, West Creek (Douglas)	0	$14,929,783
2006	Vallecito Creek (La Plata)	0	$1,122,540
2007	Chalk Creek Canyon (Chaffee)	0	$1,122,540
2007	Chalk Creek Canyon (mudflows)	0	$2,245,080
2009	Six Mile Creek	0	$360,335
2010	Statewide flooding (various events)	0	$884,562
2013*	Front Range and Northeast Counties	9	$2,000,000,000
2015*	Central to Eastern Colorado	0	$9,053,369
2017	South Central Colorado	0	TBD
Totals		**372**	**$8,810,182,412**

Sources: Colorado State Hazard Mitigation Plan 2018, NCDC, SHELDUS, NOAA-NWS
*Denotes federal disaster declaration event

The following section goes into more detail on selected historic flood events, broken down by the categories of flooding discussed in Section 3.1.1.

General Rain Floods

The October 5, 1911 floods in Pagosa Springs and Durango were a result of a general rain system over tributaries of the San Juan River Basin in southwestern Colorado. This flood event resulted in two deaths and damages of approximately $8.3 million (2017 dollars). The damaging floods of June 1965 in the Denver metro area and in the Arkansas River Basin were a result of heavy to torrential rainfall over large portions of the South Platte River Basin that lasted several days.

Parts of Buena Vista were flooded after two days of localized rainstorms on July 4 and 5, 2007. Saturated soils and inadequate detention basins resulted in flooding that impacted private residences and apartment complexes.

In July 2011 after 2 inches of rain fell in less than an hour in the Fourmile Fire burn area, a 4-foot surge of water rushed down Boulder Creek. At least one home was damaged, and debris was deposited on many roads.

El Paso and Larimer counties dealt with flash flooding from heavy rains during the summer of 2012 and 2013 as a result of rainfall on areas burned by the Waldo Canyon and High Park Fires, respectively.

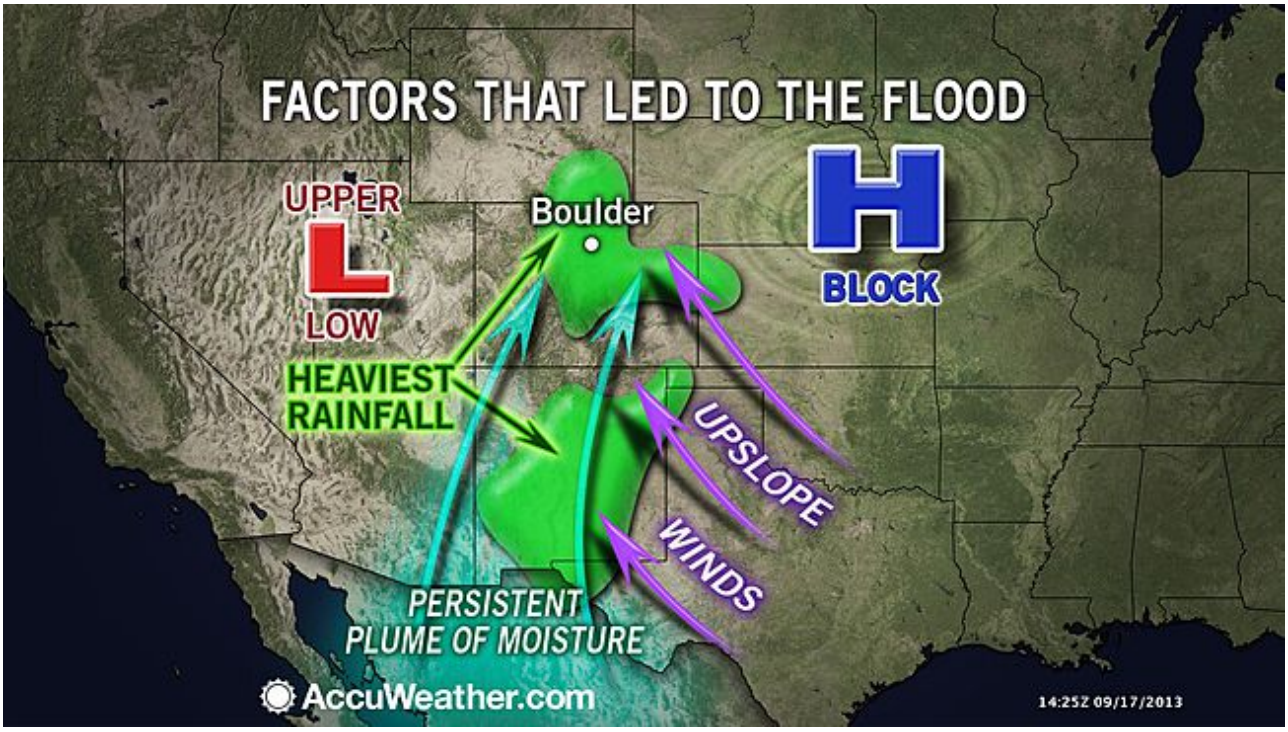
September 2013 Flood Event

One of the state's most costly and widespread floods affected the Colorado Front Range during September 2013 while the 2013 update of this Plan was in process. During the week beginning on September 9, 2013, a slow-moving cold front stalled over Colorado, clashing with warm humid monsoonal air from the south as depicted in Figure 3-10. A report from Accuweather summarized the weather events that led to the flooding as follows:

"The key weather players during the September 2013 flooding event were a large swath of tropical moisture over the Rockies (referred to as the Monsoon by locals), a large area of high pressure over the Midwest and a storm in the upper atmosphere over the Great Basin. The moisture over the Rockies was literally being squeezed from both sides by the high to the east and the dry air rotating in from the Great Basin around the upper-level storm. This squeezing resulted in a much more vertical profile of moisture than would have occurred without either system present. The high over the Midwest also drove additional air thousands of feet uphill from the Plains to the foothills and Rockies. This action released extra moisture and further enhanced the rainfall. The high over the Midwest acted like a giant roadblock and turned what would have been a several-hour event into a week-long ordeal. The result was a plume of heavy rain that re-fired on an almost daily basis from New Mexico to Colorado and southern Wyoming. While the Flood of 1976 was more intense over a small area and the Flood of 1965 was intense and lasted for days, the Flood of 2013 lasted nearly a week and covered hundreds of square miles in multiple states. Rainfall exceeded 12 inches at a number of locations."[10]

[10] http://www.accuweather.com/en/weather-news/colorado-flooding-why-so-bad/17861732

Figure 3-10 Weather Conditions that Led to September 2013 Flooding



Source: http://www.accuweather.com/en/weather-news/colorado-flooding-why-so-bad/17861732

Nine people were killed as a result of these floods. Thousands of homes and buildings were damaged or destroyed, forcing several thousand people and pets to evacuate. Boulder County was the most heavily impacted, with devastating damage in Lyons, Longmont, Jamestown, and several other communities, many of which were isolated for weeks after the storms due to road damages and closures. Damages totaled more than $2 billion across 24 counties; 486 miles of CDOT roadways were impacted, and 39 roadways and 120 bridges were temporarily closed. Highway damages alone were estimated at $535 million, and approximately 135 million cubic feet of debris was removed from the transportation network. Some sections of these highways and roads were closed for several weeks after the floods, displacing thousands of residents in the Front Range foothills. The floods also caused crop damage, particularly in agricultural communities in northeast Colorado. Eighteen counties were ultimately included in the disaster designation, with eleven counties receiving both Individual Assistance (IA) and Public Assistance (PA): Adams, Arapahoe, Boulder, Clear Creek, El Paso, Fremont, Jefferson, Larimer, Logan, Morgan, and Weld. An additional seven counties received only PA: Crowley, Denver, Gilpin, Lake, Lincoln, Sedgwick, and Washington.

Table 3-2 summarizes FEMA Region VIII flood impact data from the FEMA Modeling Impact Task Force (MOTF). The MOTF is a group of modeling and risk analyst experts from FEMA Regions VIII (Denver) and IV (Atlanta) that is activated in support of major disaster response operations. The table lists affected counties and their impact rank, estimated NFIP claims, and total

number of damaged households. The impact rank was estimated using a jurisdiction loss ratio which was derived from dividing the number of directly damaged households by the total number of households for each jurisdiction. The highest jurisdiction loss ratios were in Jamestown (~34%), Lyons (~27%), City of Boulder (~14%) and County of Boulder (~12%). Final damage and impact assessments will be captured in future updates to this plan after the damages and losses are fully accounted for.

Table 3-2 September 2013 Flooding Impact Rank by County

County	Impact Rank	# of Estimated NFIP Claims	$ Value of Estimated NFIP Claims	Total # of Damaged Households
Adams	High	7	$48,500	659
Arapahoe	High	35	$536,500	1,897
Boulder	Very High	1,350	$18,643,640	9,815
Broomfield	Low	1	$0	0
Clear Creek	Very High	5	$82,500	100
Crowley	Low	0	$0	0
Denver	Low	4	$94,000	0
El Paso	High	162	$2,109,500	724
Fremont	Moderate	4	$71,000	9
Gilpin	Low	0	$0	0
Jefferson	Moderate	48	$615,400	541
Lake	Low	0	$0	0
Larimer	Very High	267	$2,836,400	1,216
Lincoln	Low	0	$0	0
Logan	Very High	17	$133,000	104
Morgan	Moderate	8	$80,500	12
Pueblo	Low	2	$21,500	0
Sedgwick	Low	0	$0	0
Washington	Low	0	$0	0
Weld	Very High	90	$1,000,500	1,185
Total	High	**2,000**	**$26,272,940**	**16,262**

Source: FEMA Region VIII
*Very High: Greater than 1% of households damaged
High: Greater than 0.25% and less than or equal to 1% of households damaged
Moderate: Greater than 0% and less than or equal to 0.25% of households damaged
Low: 0% of households damaged

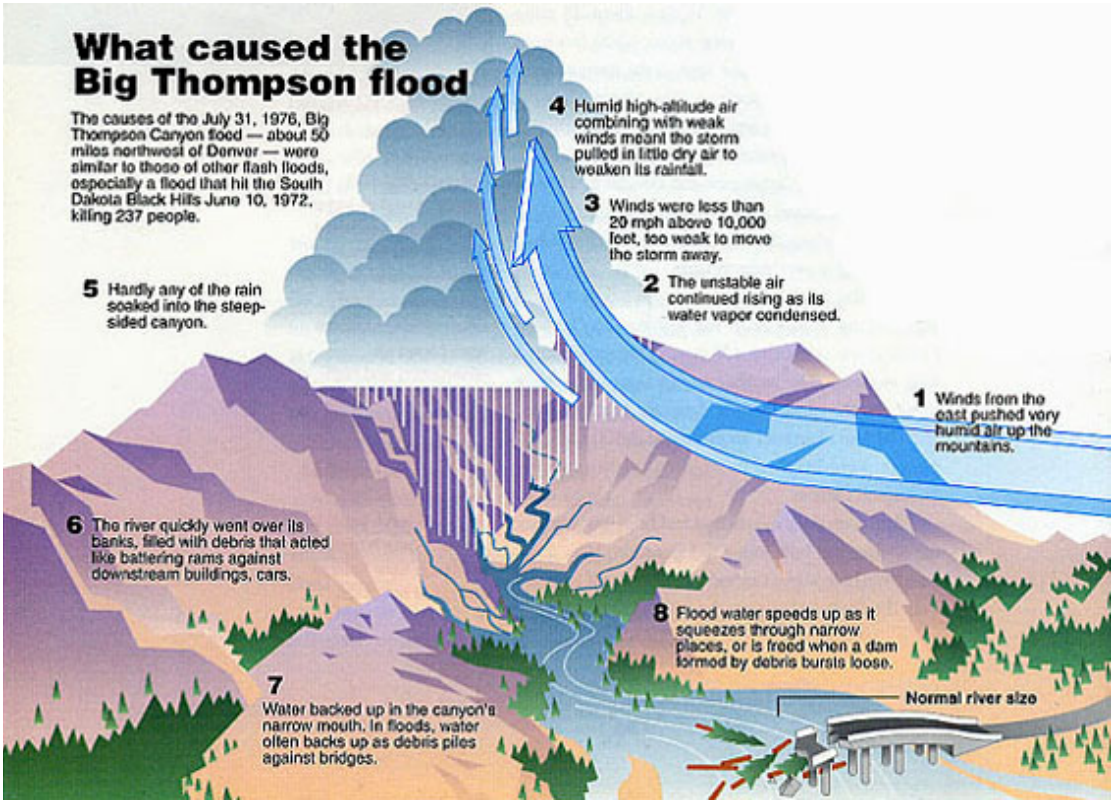
The September 2013 flooding caused significant impacts to the oil and gas industry in the state. Thousands of facilities were impacted by standing or flowing water. Fortunately, many wells were

shut down prior to the storm to help prevent environmental contamination.[11] The Colorado Oil & Gas Association (COGA) began assessing thousands of facilities once rescue operations and immediate emergency response were complete. The tests did not find any pollutants associated with oil and gas spills but did find high levels of E. coli, particularly in the Boulder Creek and Big Thompson River watersheds.[12]

Thunderstorm Floods

The widely publicized Big Thompson Canyon flood disaster of July 31, 1976 was a result of an intense thunderstorm cell that stalled over the Big Thompson River Basin and dropped up to 10 inches of rain in a few hours. "The total rainfall from this event [was] nearly equivalent to a year's average annual precipitation in this area." The massive amount of rain, combined with the canyon's thin soil, sparse vegetation and steep rock walls, transformed the normally two-foot-deep river into a wall of water 19 feet high (see Figure 3-11).

Figure 3-11 1976 Big Thompson River Flood Explanation



(http://www.assessment.ucar.edu/flood/flood_summaries/07_31_1976.html) Line of thunderstorms from Little Rock, Arkansas to Wyoming (these events usually result from large-scale meteorological forces)

[11] http://denver.cbslocal.com/2013/09/16/flood-waters-impact-oil-gas-wells-impact-unclear/

[12] http://www.coga.org/index.php/Events/ColoradoFloods#sthash.55I3rO2X.dpbs

The immense flash flood roared through the canyon where thousands of people were enjoying the scenery and celebrating Colorado's 100th year of statehood. Two law enforcement officers attempted to warn people of the impending danger, but the sheer volume and velocity of the flood waters were overwhelming. Many people lost their lives trying to outrun the deluge, not knowing that they should climb to higher ground for safety. "In two hours, the Big Thompson Canyon flood killed 144 people (including five who were never found), destroyed 418 houses and damaged another 138, destroyed 152 businesses and caused more than $40 million in damages."[13] The Big Thompson flood remains the deadliest natural disaster in Colorado to date.

On May 15 and 16, 1993, a thunderstorm-induced flood event occurred at Rifle on Rifle and Government Creeks. As is usually the case, the highest flows in the shortest period of time occurred when an estimated 125-year flood discharge impacted Rifle. Structures and vehicles in harm's way suffered damages in excess of $200,000.

On June 17, 1993, a flash flood occurred on Shooks Run in Colorado Springs. Damages were confined to a mobile home park on the creek's edge with losses estimated at $1 million.

In July 1993, the Town of Otis and the unincorporated area of Cope in Washington County and the City of Yuma in Yuma County experienced a weekend flood event as a result of three consecutive days of thunderstorms. Several homes suffered damages and roadways were inundated with losses in excess of $650,000. In Otis, a flood control and storm drainage project protected the northern half of town.

On August 10, 1993 flash floods occurred on several creeks in Delta County. Two roads were washed out and a flood fight was conducted with sandbags on Robideaux Creek near the Department of Corrections Detention Facility.

On August 26 to 29, 1993, general rainstorms caused flooding in Archuleta and La Plata counties. A subdivision in Archuleta County was threatened and roads damaged as the Rio Blanco overflowed its banks south of Pagosa Springs. In Durango, the Fire Department had their emergency operations plan in effect and came very close to evacuating residents of a mobile home park on the Animas River.

In the spring and early summer of 1995, the lower South Platte River, the lower Arkansas River and the Roaring Fork River were impacted by significant flooding. Most damages were experienced by agricultural landowners.

On July 24 to 28, 1997, the City of Fort Collins and most of eastern Colorado received soaking and/or drenching rains, adding to soil moisture in some locations. As the cold front arrived in the late afternoon of July 27, strong thunderstorms developed just north and west of Fort Collins. Later that night, steady rains developed along the eastern base of the foothills in Larimer County and

[13] http://www.noaanews.noaa.gov/stories/s688.htm

continued until about noon on July 28. Several inches of new rain were reported just west and northwest of Fort Collins totally saturating the ground, producing major flooding in Laporte, and setting the stage for the evening flood event. On the evening of July 28, 1997, intense rains began around 6:30 pm in the foothills west of Fort Collins. Winds from the east and southeast continued to pump moisture into the storm system throughout the evening. The core of the storm was very small but remained nearly stationary over the headwaters of Spring Creek, the Fairbrooke Channel, Clearview Channel, the CSU Drainage Basin, and the West Vine Drainage Basin. Rainfall intensity increased and reached a maximum between 8:30pm and 10:00pm before ending abruptly. A subsequent analysis of rainfall conducted by CSU showed a maximum of 10.2 inches of rainfall in less than five hours near the intersection of Drake Road and Overland Trail.

On July 29, 1997, slow-moving thunderstorms dumped large amounts of rainfall over the Pawnee Creek Basin in Weld and Logan counties and over the Schaefer Draw Basin in Morgan County north of Weldona. Floodwaters from Schaefer Draw entered the unincorporated Town of Weldona on the evening of July 29 while similar damaging floodwaters from Pawnee Creek entered the unincorporated Town of Atwood early on July 30 (west of Sterling and north of U.S. Hwy 6). Additionally, floodwaters flowing east from Atwood entered the City of Sterling.

During the Presidential Declaration incident period (July 28 to August 12, 1997) storm systems drenched other areas in northeastern Colorado, as well as several counties in southeastern Colorado. In addition, the Denver Metropolitan Area received flooding rains as did the Clear Creek County area to the west of Denver.

These rainfall totals are large, but not extreme in comparison to the largest storms experienced in Colorado. What made this storm so different was that most of the affected basins were receiving heavy rainfall throughout the basin. This is not the "norm" for Colorado. Also, rain on snow is generally not a great problem in Colorado, but sizeable areas of the Front Range foothills did receive heavy rain on top of several inches of saturated snowpack. The melt rate of this snowpack was low, but additional water was added to the runoff.

The flooding that occurred along Fountain Creek and the Arkansas River in 1997 was the worst flooding event Colorado had seen since 1965. In total, the storm affected Bent, Crowley, Custer, Elbert, El Paso, Fremont, Kiowa, Larimer, Las Animas, Otero, Pueblo, and Weld Counties. These counties sustained damage to roads, bridges, culverts, homes, and business from overtopping, dike breaches, erosion, mudslides, and rockslides.

The City and County of Denver was impacted by localized thunderstorm flooding on May 14, 2007. A woman and her two-year old son sought shelter from rain and hail in a culvert on Lakewood Gulch. Rescuers were able to save the mother, but the two-year old was tragically swept away from his mother during the flood and drowned. In July 2011, a thunderstorm dropped as much as 3 inches of rain in 90 minutes in parts of Denver. Dozens of people were rescued from cars stranded in the flooded streets.

On June 11, 2015, thunderstorms producing heavy rainfall caused flooding and flash flooding

across parts of the Front Range urban corridor and adjacent plains. Some places received as much as three inches of rain in less than an hour. The rains caused over $21M in damage, but while several people had to be rescued from trapped cars, no injuries or fatalities were reported. A Presidential Major Disaster Declaration was issued for 15 Colorado counties.

Snowmelt Floods

Floods in June 1983, along the Cache la Poudre River in Fort Collins and Greeley, along Clear Creek and its tributaries in Silver Plume and Georgetown, and along the Arkansas River in Fremont and Chaffee counties were principally due to melting snow. The 1984 floods on the Western Slope were primarily snowmelt flooding.

Grand, Gunnison, Routt, and Delta Counties experienced minor snowmelt flooding in May 2008 that resulted in isolated instances of structural damage. Several days of high temperatures melted the above-average levels of snowpack in these areas. Damages were relatively minor.

Flooding in northern Colorado along the Front Range in late May and early June 2010 was also mainly due to rapid snowmelt. Routt County dealt with snowmelt flooding once more in June 2010. A stream gage near Milner, Colorado recorded record peak discharge along the Elk River on June 8, 2010. However, no significant damages were recorded from the event. The Cache La Poudre River flooded from June 14 to 16 and washed out a number of roads in Weld County. Water levels on the Poudre River were exacerbated by rainfall in the days preceding the floods. The Eagle River flowed at twice its normal volume near Gypsum and reached its second highest water level in recorded history. Stream channels around Vail filled with debris and washed out bridges. Water recreation such as kayaking, rafting, and tubing became dangerous, and a few people lost their lives doing such activities.

Rivers in the South Platte, North Platte, Yampa/White, Colorado, and Gunnison watersheds experienced snowmelt runoff in 2011 that had not been seen in several years or even decades. High snowpack combined with runoff from a cool and wet May resulted in many smaller watersheds reading well above normal levels on June 1. Had it not been for the cool temperatures and gradual snowmelt the flood season could have been far worse. The Elk River near Steamboat Springs set a new record flow at 7,400 cubic feet per second on June 6, which is in excess of a 1% annual chance event. Other rivers that experienced very high flows included the Colorado River, the Yampa River, the Eagle River, the Gunnison River, Tenmile Creek, the Blue River, and the Fraser River. The Colorado River peaked at 48,000 cfs at the Utah state line, which was the highest recorded flow since 1984.[14]

Rain on Snowmelt Floods

Flooding along the Colorado River in Grand Junction in July 1884, along Clear Creek at

[14] http://cwcb.state.co.us/water-management/flood/Documents/Floodstage_Nov2011.pdf

Georgetown in June 1965, and along the Gunnison and Colorado Rivers at Grand Junction in June 1983, are examples of flooding from rain on melting snow. The effect of rain on melting snow in the Colorado River Basin in 1983 was felt as far downstream as Mexico. In 1984, rain or melting snow caused severe flooding conditions at Paonia.

On May 28, 1993, rain on snowmelt flooding occurred at Paonia on the North Fork of the Gunnison River. The rainfall occurred over a five-hour period during the evening. This caused the North Fork of the Gunnison River to reach its highest level since the 1984 flood season. Many miles of agricultural land experienced severe bank erosion in unincorporated Delta County.

Ice Jam Floods

In 1955, 1962, and 1983, flooding in Rangely resulted from ice jams. In addition, flooding in Meeker in 1973 and in Gunnison in 1980 and 2016 resulted from ice jams.

Levee Failure Floods

A three-day rainfall event occurred on April 29 to May 1, 1999. Heavy rain and saturated soil caused flooding in two major areas along the Front Range; specifically in northeastern Colorado along the South Platte River and some of its tributaries; and southeastern Colorado along the Arkansas River and some of its tributaries. Rainfall totals of up to 13 inches were recorded in the Cheyenne Mountain region of Colorado Springs. The La Junta region recorded approximately 8 inches over the same three-day period. The Arkansas River broke the levees near North La Junta, flooding approximately 200 residences and businesses. The stormwater runoff from the three-day general rain resulted in large flood inundation and erosion in the Arkansas River and Fountain Creek watersheds.

In 2006, La Plata County experienced prolonged and heavy rainfall over October 5 and 6. Vallecito Creek overflowed, resulting in flash flooding. Levees and dikes built in the 1970s along the Creek breached on the night of October 6.

The area north of Pueblo was inundated by heavy rainfall in early May 2007. On the morning of May 7, an earthen embankment along Fountain Creek failed and 15 structures were flooded. The flooding was not a result of overtopping, but rather structural failure. This embankment was not a certified levee and was not identified on the effective FIRM.

The Riverside Park levee failed in Evans during the September 2013 flooding. The floodwaters created a 70-foot gap in the levee. The flood put the sewage treatment plant out of operation, leaving residents unable to shower or flush their toilets for over a week.[15]

[15] Ashleigh Walters. "*Evans residents can now flush toilets.*" ABC 7 News Colorado. September 21, 2013. http://www.thedenverchannel.com/news/local-news/evans-residents-can-now-flush-toilets

On June 15, 2015, a levee breach, about 100 yards wide along the South Platte River, produced farmland flooding over northeast Morgan and northwest Washington Counties. Floodwaters, three to four feet deep, washed out the Union Pacific railroad tracks southwest of Messex. Up to ten inches of water covered several miles of track. Approximately 30 trains per day had to be diverted until the tracks could be repaired and inspected. Washington County Road 58.3 was also washed out.

Dam Failure Floods

Although few lives have been lost from dam failures, property damage has been high. There have been at least 130 known dam failures and incidents in Colorado since 1890. The failure of the Lower Latham Reservoir Dam in 1973 and subsequent flooding in the Town of Kersey, Weld County, Colorado, resulted in a Presidential Major Disaster Declaration.

The earliest recorded dam failure flood in the Estes Park region occurred on May 25, 1951, when Lilly Lake Dam failed, sending flood waters down Fish Creek and into Lake Estes.

In June 1965, a flood occurred on Clay Creek in Prowers County, which overtopped an earthen dam being constructed by the Colorado Game, Fish, and Parks Commission. Although the dam did not fail, it did divert floodwater into an adjacent drainage. The subsequent damage and death from this flood resulted in an important legal controversy known as the Barr Case. This case was finally decided in 1972 by the Colorado Supreme Court, which recognized the concept of probable maximum flood as a predictable and foreseeable standard for spillway design purposes.

The Lawn Lake Disaster of 1982 resulted from the failure of a privately-owned dam on Forest Service property, and $31 million of damage was sustained in Larimer County and Estes Park. A lawsuit awarded $480,000 to one of the four persons killed in the disaster.

The most unusual flood from the failure of a human-made structure in Colorado is probably the complete draining of Lake Emma, a natural lake located high in the San Juan Mountains above Silverton, Colorado. On June 4, 1979, floodwater flowed through a network of tunnels in an abandoned mine that extended under the lake.

The Carl Smith Reservoir failed on the evening of May 2, 1998. Carl Smith Dam is an 850 acre-foot, Class 1 off-channel reservoir in Leroux Creek Basin north of Hotchkiss, Colorado. The failure was a result of a large slide on the downstream slope that extended across the crest and into the upstream slope. The releasing water swiftly eroded down through the top half of the remaining embankment and quickly released about 500 acre-feet of storage. The peak discharge just below the dam was determined to be around 3,300 cfs. Several residences were evacuated. The only loss of life was livestock. The high water washed out numerous bridges, and diversion structures were quickly rebuilt to restore water to irrigators.

Nine low-risk dams were breached during the September 2013 flooding, and many small ponds

that are not inspected by the state overflowed. Five small dams in the Big Elk Meadows area of Larimer County failed. Several dams in Boulder County were overtopped, but fortunately none of these experienced structural failure.[16] The storm resulted in spillway flows from roughly 70 reservoirs in the state. None of the high or significant hazard dams failed. Following the flooding, the dam safety branch of CDWR headed the largest emergency dam inspection initiative in Colorado history.[17] Emergency measures were taken at 14 locations to clear out clogged outlet ditches to prevent more overflows or structural failures. Dams with structural deficiencies were restricted to little or no water storage.

Dam Operational Release Floods

Another consequence of dams is the potential for flooding as a result of discharge from dam outlet structures or spillways during excessive rain or snowmelt events. In 2017, Colorado DWR Dam Safety set out to systematically evaluate all high hazard dams related to operational and flood releases. The analysis produced the Colorado High Hazard Dam Release - Downstream Floodplain Impacts Database and Ranking Tool, containing information for both private and publicly owned high hazard dams across the state. The ranking of the dams identifies the dams with the highest threat of downstream flooding associated with releases of excess water during high runoff or heavy rain. DWR Dam Safety screened the state's dam database using information from USGS (StreamStats), FEMA Flood Insurance Studies (FIS), and the National Flood Hazard Layer (NFHL). The data was used to compare natural flows versus natural flows in combination with dam release flows. The resulting ranks were developed based on the severity of the conditions, estimated safe channel capacity of the downstream channel, and maximum controlled discharge. The report assesses 415 dams in the State of Colorado and provides a ranking for 366 dams where there is either a high, moderate, or low likelihood of dangerous conditions created by dam and reservoir release operations simultaneously with naturally occurring flood conditions. The high, moderate, or low designations were assigned by DWR by dividing the total number of ranked dams into thirds. The risk from this type of flooding is discussed further in the Dam Failure hazard profile in the 2018 SHMP.

Alluvial Fans, Debris Flows and Erosion

In addition to the deadly flash floods, the Big Thompson Flood of 1976 was also subject to destructive debris flows. Many structures that were not directly damaged by the floodwaters were destroyed by debris flows or streambank erosion. Massive sediment deposits literally buried some homes and other structures, seen in Figure 3-12.

[16] http://www.denverpost.com/environment/ci_24080336/dams-break-at-rocky-mountain-arsenal-and-larimer

[17] http://www.denverpost.com/news/ci_24153355/colorado-launching-massive-emergency-dam-inspection-progam

Figure 3-12 Big Thompson River Debris Flows

(Source: http://pubs.usgs.gov/fs/2006/3095/pdf/FS06-3095_508.pdf)

In 1977, Glenwood Springs suffered $2 million in damages from debris flows following an intense rainstorm. Fortunately, no one was severely injured or killed in the incident. Most of the damage could have been prevented, however, if developers had recognized the hazard presented by building on and around a known debris fan.[18]

Debris flows and erosion associated with channel migration in many areas caused more damage than the floodwaters during the September 2013 floods. Debris flows and mudslides killed a man in Jamestown on September 12, 2013. His home was crushed by 12 feet of rocks and mud. The 2013 floods also created problems with erosion and sedimentation. Erosion damaged or destroyed many state highways, roads, and bridges. Houses located along stream channels were also damaged or threatened by erosion. CDOT has gradually reopened roads after completing temporary repair projects, but full restoration will take years to complete. Erosion and sediment distribution can drastically change the course of rivers and streams or clog stream channels,

[18] http://geosurvey.state.co.us/Default.aspx?tabid=378)

altering the floodplain.

Post-Wildfire Floods

Flooding in Colorado has been exacerbated by wildfires in recent years. The Boulder area was afflicted by the Flagstaff fire in 2012 and the Fourmile Canyon fire in 2010. The Black Forest (2013), Waldo Canyon (2012), and High Park (2012) fires were devastating to watersheds in the Colorado Springs and Fort Collins areas. In July and August 2013 deadly flash floods and mudslides caused several million dollars in damages and claimed one life in Manitou Springs, located just south of the Waldo Canyon fire burn area. In all these cases scorched, hydrophobic soils and lack of vegetation made burn areas more susceptible to severe flash flooding and mudslides. There are several initiatives among local, state, and federal agencies to mitigate the potential impact of flash floods and mudslides in post-burn areas. For example, the U.S. Forest Service (USFS), CDOT, Colorado Springs Utilities, and local government have constructed or planned retaining walls, sediment ponds, catchment basins, and debris fences in the Colorado Springs area.

The year 2012 was the most devastating wildfire season in Colorado since 2002. Several separate fires occurred between June and August, including large magnitude fires that threatened or destroyed hundreds of homes. The Waldo Canyon and High Park fires were the most destructive. A combination of a dry winter and an atypically hot, dry summer created dangerous wildfire conditions. Wildfires kill vegetation that anchors soil and absorbs rain and snowmelt waters. Without these protections in place, post-wildfire areas are highly susceptible to flash floods and mudslides, especially along steep slopes. These conditions contributed to the severe magnitude of the September 2013 floods and other flood and mudslide events, such as the mudslides in Manitou Springs in July and August 2013.

Mudslides and flash flooding in Manitou Springs caused several million dollars in damages in July and August 2013 and one fatality in August 2013. Highway 24, which runs through Manitou Springs, was previously closed due to mudslides in July 2012. Mudslides also occurred in the Fourmile Canyon burn area in Boulder County in 2011, and along Highway 14 in Larimer County in the Poudre Canyon during July 2012 and July 2013. Rain events do not have to be unusually heavy or sustained to cause mudslides in post-burn areas. The mudslides can carry massive boulders and trees, causing more damage to structures and roads. The potential for mudslides and flash floods after wildfires can last for several years.

The Buffalo Creek, Elk Creek, and Hayman Fire burn areas faced increased susceptibility to flash flooding and debris flows for years after the fires occurred. The lack of vegetative and soil ground cover increased the rate of erosion in the area, and nothing was left to help absorb and stem the flow of rainwaters. In the case of Buffalo Creek, the fires burned with such intense heat that the soils were rendered hydrophobic. With the loss of natural mitigation measures, a thunderstorm on July 12, 1996 evolved into a deadly flash flood that claimed the lives of two Buffalo Creek residents. Roads were washed out, and the water and telephone utilities in the City of Buffalo

Creek were destroyed in addition to the North Fork Volunteer Fire Department Station #1 and a new ambulance and tanker truck. Sediment and debris piled up in the North Fork of the South Platte River and in Strontia Springs Reservoir. Problems from sediment deposition, lack of vegetation and hydrophobic soils continue to be an issue even 15 years later.[19]

3.2.3 Probability of Future Floods

Flooding will continue to occur in Colorado. As mentioned previously, between 20 and 30 large magnitude floods (in terms of peak discharge) occur somewhere in Colorado every year. Furthermore, between 1959 and 2018, Colorado experienced twelve major floods that resulted in presidentially declared disasters as indicated below:

- 1956 (DR-59): Front Range
- 1965 (DR-200): 33 Front Range communities
- 1969 (DR-261): 15 Front Range communities
- 1970 (DR-293): Southwestern Colorado
- 1973 (DR-396 and DR-385): 13 Front Range communities
- 1976 (DR-517): 2 Front Range communities
- 1982 (DR-665): Larimer County (dam failure)
- 1984 (DR-719): 15 Western Slope counties
- 1997 (DR-1186): 13 Eastern Colorado counties
- 1999 (DR-1276): 12 Southeastern Colorado counties
- 2013 (DR-4145): 18 Front Range and Northeastern Colorado counties
- 2015 (DR-4229): 15 Front Range and Eastern Colorado counties.

Based on this flood history, Colorado experiences a major flood disaster roughly once every five years. The state faces an approximately 19% chance that a major flood disaster will occur in any given year.

3.2.4 Climate Change

According to the best data available at the time of this plan update, the impacts of climate change are expected to influence future flood events. Table 3-3 presents a breakdown of these projected changes in terms of hazard: location, extent/intensity, frequency, and duration. However, ongoing efforts to reduce Colorado's greenhouse gas emissions and adapt to a changing climate, such as the Colorado Climate Plan and the Climate Change in Colorado Report, aim to reduce the impacts of climate change on floods.

[19] http://www.landandwater.com/features/vol41no1/vol41no1_1.html

Table 3-3 Climate Change Impacts

Impact	Projected Change
Location	The location of flooding is not projected to change.
Extent/Intensity	Flood extent is not projected to change. Flood intensity may increase due to transition from hail to rain on the Front Range of the Rocky Mountains resulting in higher flash-flood risk specifically in eastern Colorado. In the mountainous regions of Colorado, snowmelt-driven spring and summertime floods are expected to diminish.
Frequency	There are no clear trends in heavy precipitation events for Colorado, and like annual precipitation, there is considerable variability at annual and decadal time scales.
Duration	The duration of flood events is not likely to change. However, seasonal runoff shifting one to four weeks earlier may contribute to earlier flooding during the spring.

Source: Colorado State Hazard Mitigation Plan 2018; FEMA 2017; Garfin et al. 2013; Lukas et al. 2014; and Childress et al. 2015

3.3 Assessing Vulnerability by Jurisdiction

The state risk assessment is to include an overview and analysis of the state's vulnerability based on estimates provided in both the local and state risk assessments. The plan must also identify those jurisdictions that are most threatened and most vulnerable to loss and damage due to flood. The following section follows the FEMA requirements and explains the process used to analyze information from the local risk assessments, as well as a requirement that the plan reflects changes in development within hazard prone areas.

According to FEMA's risk assessment guidance, vulnerability is defined as being open to damage or attack, and risk is defined as the possibility of loss or injury. For this assessment vulnerability is summarized at the county level. The vulnerability of a county is approximated by looking at a combination of several factors including previous flood events and impacts, population and area affected by flooding, potential total building loss, potential percent building loss, potential per capita loss, and exposure of state assets. State level analysis includes assets that are considered at-risk from flood such as: state-owned or operated buildings, critical infrastructure, state lands, and fish hatcheries. Only those facilities that are state-owned or operated are specifically addressed in the state assets section of the plan, but the impacts and vulnerabilities identified for these facilities would apply to similar privately-owned facilities and lands as well.

Beyond their human costs, natural disasters such as floods have significant economic and environmental impacts. Economic development research has long recognized the importance of quality transportation infrastructure. Much of the United States' economic growth history is driven by reductions in transportation costs, first through its canal systems, then its railways, then its interstate highways. The 2013 floods had a tremendous impact on many of the State's roads and bridges. Some communities were effectively isolated for weeks if not months. The destruction of transportation infrastructure affected state businesses in many ways. Some saw significant

increases in transportation costs and employee scheduling difficulties. Many agricultural producers had a harder time getting their products to market. Some manufacturing companies had to reroute their shipping. Other employers found that their workers' commute times increased, impacting the productivity and availability of their workforce. People lost their jobs because of the flooding. Businesses were damaged and destroyed, with some closing for good because of the event. Because Colorado's economy was still feeling the lingering effects of the Great Recession, some displaced workers found it challenging to find new opportunities that fully utilized their capabilities. Many people turned to the State's workforce system for help, needing assistance with job searches and resume writing. Business and property owners were hard hit by flooding. In the canyons, floodwaters washed away motels, cabins, bars, and restaurants. In other places retail and commercial establishments suffered extensive damage. Farther east, farmers lost their crops, and oil wells were damaged or shutdown. At the time of this Plan update, five years later, recovery efforts relating to the 2013 flood event continue.

Additional impacts of flood as determined from input by the SHMT in the 2010 and 2013 updates of this Plan are characterized in Table 3-4. The categories considered are taken from the Emergency Management Accreditation Program (EMAP).

Table 3-4 Flood EMAP Impact Summary

Consideration	Description
General Public	Impacts of people will change with characteristic of event (e.g., flash flood in a canyon, river flood on the plains, etc.) Localized impacts may be severe with moderate to light impacts for outward or other affected areas. The Big Thompson flood event which resulted from localized heavy rainfall and a subsequent flash flood took the lives of 144 people. Residents/property owners without flood insurance may be subject to greater impacts than those with coverage. Residents may be displaced or left homeless due to evacuation, damage, or inaccessibility to homes. A state-led Disaster Housing Taskforce is assessing the State's disaster housing capabilities and will make recommendations based on the assessments. Persons within flood areas have the potential for direct contact with hazardous materials.
First Responders	Need for evacuation support such as door-to-door notification and traffic management may increase responder risk as event escalates. Localized impact expected to limit damage to personnel in flood areas at the time of incident. Impacts to transportation corridors and communications lines may affect responder ability to effectively respond. There may be a higher risk to responders in flash flood events which are prevalent in the State.
Property	Private property losses with increased risk to those without flood insurance.

Consideration	Description
Facilities and Infrastructure	Localized impact to facilities and infrastructure in incident area. Some severe damage is possible. Evacuation routes can become flooded. Loss of electricity to government and business may affect public and first responders as well as water quality impacts on drinking and wastewater.
Economic	Local economy and finances adversely affected, possibly for an extended period of time depending on damage and length of investigation of flood event. Local disruption of roads, facilities, and/or utilities caused by flooding may postpone delivery of some services.
The Environment	Localized impact expected to be severe for incident areas and moderate to light for other areas affected by flood. Wetland impacts due to flooding can result in water quality impacts and wildlife habitat impacts. Orphan drums (containers that may contain hazardous materials). Commercial hazmat/hazardous waste. Household hazardous waste. Releases from transportation. Releases into streams, rivers, drinking water supply, ground water, and air.
Continuity of Government and Services	Damage to facilities/personnel in incident area may require temporary relocation of some operations.
Confidence in Government	Ability to respond and recover may be questioned and challenged if planning, response and recovery not timely and effective. State must balance over and under response not timely and effective. Regarding levees, localized impact expected to adversely affect confidence in local, state, and federal government, regardless of the levee owner.
Critical Assets	Critical facilities may be impacted by flooding such as those related to communications, hospitals, schools, nursing homes, utilities, wastewater treatment plants, and roadways.

In 2014, CDWR Dam Safety completed a social vulnerability assessment based on dam failure inundation. The intent of the project was to develop information to improve DWR's decision making support system by reassessing prioritization of dam safety and emergency management activities. The results of this study include a Social Vulnerability Index (SVI) and calculation of Populations at Risk (PAR) within dam failure inundation zones below high and significant hazard dams. This information is used with Colorado Dam Safety to prioritize activities, inspections, outreach, engineering analysis based on PAR in a Risk-Based approach. PAR indicates higher consequences of failure and therefore high risk; as a result, these dams receive additional attention to protect against failure, and prepare for emergency actions, if necessary. The SVI database has been made available to emergency managers to aid them in their mitigation and response planning activities.

In the sections that follow, the process used to analyze information from previous work is explained, the methodology for assessing vulnerability by county is discussed, and the results of the vulnerability assessment are presented.

3.3.1 Vulnerability Based on Local and State Risk Assessments

The 2013 update included a summary of vulnerability from both local and state level risk

assessments. The source of local risk assessment information was from available local hazard mitigation plans. State level risk assessment was based on available Hazus flood analyses and supplemented with an analysis of flood insurance claims data. Counties most at risk were determined following an evaluation of: displaced population, building loss, per capita loss, repetitive loss, NFIP claims, and claims monies paid out. The findings of these analyses are summarized in the following sections.

3.3.2 Jurisdictions Most Threatened and Most Vulnerable to Damage or Loss

Section 3.4.2 discusses the results of the flood hazard vulnerability assessment for the State of Colorado. This discussion is based on the loss estimates from state and local risk assessments and quantifies the loss by potential impacts to buildings and populations.

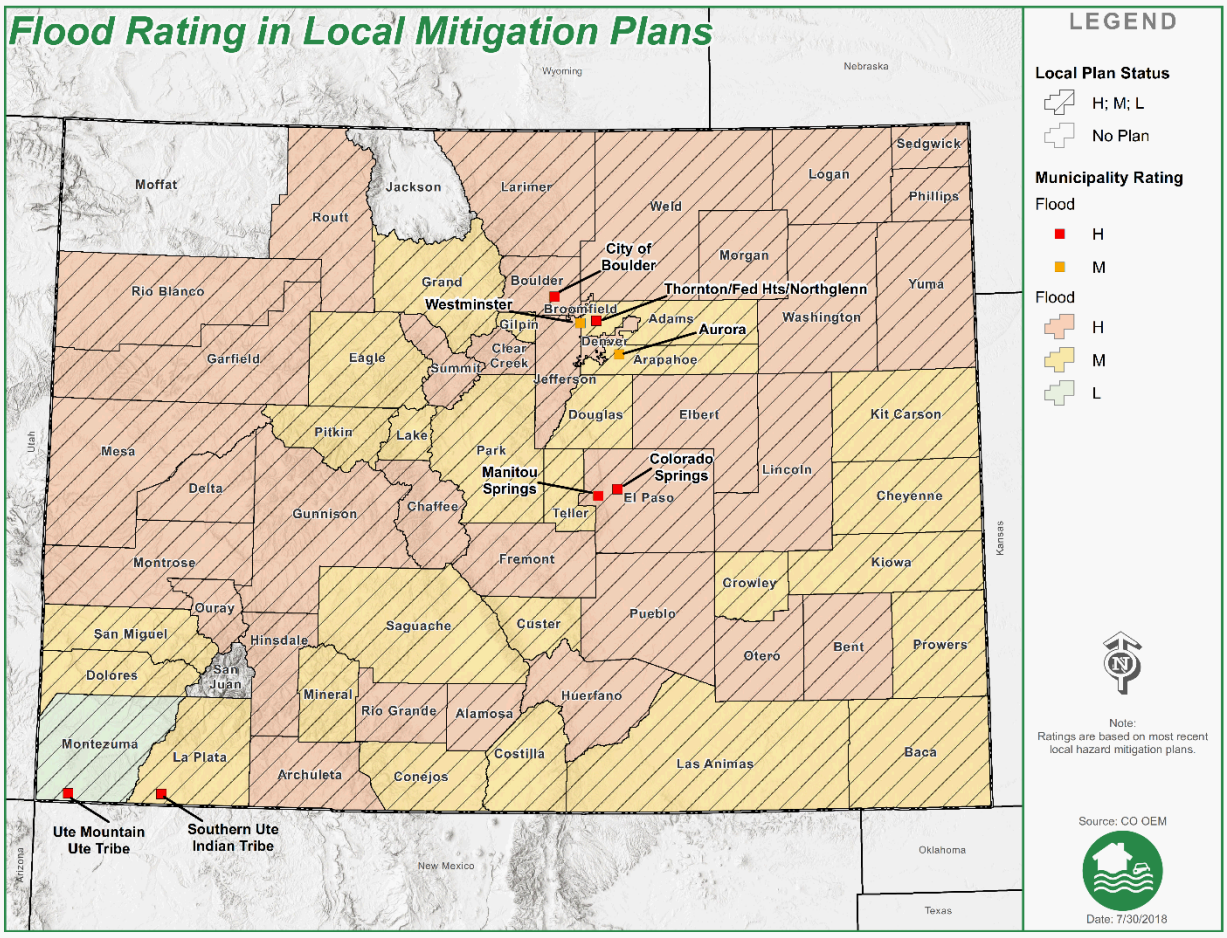
3.3.3 Process Used to Analyze Information from Local Risk Assessments

The State Hazard Mitigation Plan update process is closely integrated with local jurisdiction and tribal planning efforts. Like the process used to develop the 2013 SHMP, the 2018 plan update includes an analysis and data roll-up of risk assessment information. Based upon an updated (2017) review of local mitigation plans, nearly all counties and several major single jurisdictions profile floods in their local hazard mitigation plan. These rankings are shown in Figure 3-13.

The only three counties in the State that do not profile floods are Jackson, Moffat, and San Juan Counties, because those counties do not have local hazard mitigation plans as of 2017. Of these three counties, Moffat has experienced the most historic flood events, with 36 events recorded from 1950 to 2017. San Juan County has experienced six flood events during this time period, and Jackson County has only experienced one.

As of April 2018, 45 jurisdictions profile flood as one of their top four hazards: 37 county-level mitigation plans, five city-level plans, two tribal plans, and one University plan. Reviewing these 45 plans provides insight as to how individual jurisdictions view their vulnerability to flood. Table 3-5 summarizes the vulnerability and flood loss estimates included in these plans. The risk summarized in the table is typically associated with the 100 year flood. Keep in mind that different local jurisdictions may have used different criteria and methodologies, so comparing numbers between jurisdictions may not be a fair “apples-to-apples” comparison; see Table 3-6 for a more consistent comparison using statewide Hazus modeling performed in 2018 for the Colorado Hazard Mitigation Plan update. Also, blanks in the table indicate the information was not reported or listed. Those that used Hazus may only list the potential damages, as the loss tool often under-represents the actual structures in flood hazard areas.

Figure 3-13 Flood Profiles/Rating in Local Hazard Mitigation Plans



Source: Colorado SHMP 2018

Table 3-5 Summary of Flood Risk Identified in Local Hazard Mitigation Plans*

Jurisdiction	# of Structures/ Parcels in Hazard Area	# Critical Facilities in Hazard Area	Vulnerability Methodology	Loss Estimate	Loss Estimate Methodology
Adams County	4,461	6	Hazus	$315,824,000	Hazus
Alamosa County	1,259	4	Hazus	$57,441,000	Hazus
Arapahoe	294	66	Hazus	$41,000,000	Hazus
Archuleta County	326	2	DFIRM	$13,404,490	GIS with 25% damage
City of Aurora	7,392	0	Hazus	$10,512,223,000	Hazus
Baca		0	Hazus	$2,367,000	Hazus
Bent County		130	Hazus	$5,503,000	Hazus
Boulder County	3,040	51		$1,555,460,000	GIS with 25% damage

Jurisdiction	# of Structures/ Parcels in Hazard Area	# Critical Facilities in Hazard Area	Vulnerability Methodology	Loss Estimate	Loss Estimate Methodology
Boulder City	2,021	41	GIS loss estimates to be summarized by creek	$489,967,000	GIS with 20% damage
Broomfield, City & County	59	0			
Chaffee County	532	13	Hazus	$400,246,000	Hazus
Cheyenne County		10	Hazus	$6,151,000	Hazus
Clear Creek County	143	9	GIS Mapping	$14,369,000	Hazus
City of Colorado Springs	6,107	8	Hazus	$937,952,000	Hazus
University of Colorado		40		$87,370,100	Risk Management Report
Conejos		0		$4,440,000	Hazus
Costilla County		13		$120,835,308.00	GIS Mapping
Crowley County			Hazus	$15,848,000.00	Hazus
Custer	79	3	Hazus	$22,588,324.00	Hazus
Delta	124	23	GIS	$21,468.00	GIS with 20% damage
Denver, City & County	1,468	134	Hazus	$79,404,645	Hazus
Dolores	39	3	Hazus	$4,825,000	Hazus
Douglas County	452	101	GIS	$18,680,574	GIS with 25% damage
Eagle	886				
El Paso County (Unincorporated)	5,556	114	Hazus	$1,692,013,000	Hazus
Elbert County	545	0	Hazus	$23,690,000	Hazus
Fremont County	1,258	37	Hazus	$157,985,000	Hazus
Gilpin County	55	8	Hazus	$18,636,000	Hazus
Grand	199	2	Hazus	$16,812,176	Hazus
Gunnison County	591	3	GIS	$48,460,652	GIS with 25% damage
Hinsdale County		28		$2,000,000	
Huerfano County	372	89	Hazus	$20,405,619	Hazus
Jefferson County	4,843	224	Hazus	$705,804,417	GIS Mapping
Kiowa County			Hazus	$2,365,000	Hazus
Kit Carson County		0	Hazus	$3,060,000	Hazus
La Plata County	23,180	5	Hazus	$88,050,000	Hazus
Lake County	752	0	Hazus	$1,687,000	GIS Mapping
Larimer County	126,553	38	Hazus	$145,111,080	Hazus
Las Animas	271	5	Hazus	$36,916,000	Hazus

Jurisdiction	# of Structures/ Parcels in Hazard Area	# Critical Facilities in Hazard Area	Vulnerability Methodology	Loss Estimate	Loss Estimate Methodology
Lincoln County		43	Hazus	$8,920,000	Hazus
Logan County		8	Hazus	$52,966,000	Hazus
City of Manitou Springs	480	10	Hazus	$192,051,000	Hazus
Mesa County	324			$49,818,300	Full Value of Structures in Floodplain
Mineral				$6,050,000.00	Hazus
Montezuma	3366	28	Hazus	$62,266,000.00	Hazus
Montrose (Unincorporated)				$3,580,460.00	
Morgan County		10	Hazus	$97,477,000	Hazus
Otero County			Hazus	$40,756,000	Hazus
Ouray County	78	2	GIS	$7,180,748	GIS with 25% damage
Park	5,611	38	Hazus	$26,876,000	Hazus
Phillips County		13	Hazus	$27,783,000	Hazus
Pitkin County				$71,590,000	Hazus
Prowers		50	Hazus	$112,838,000	Hazus
Pueblo County	1,298			$1,205,174,000	
Rio Grande County	797	2	Hazus	$47,419,000	Hazus
Saguache County	335	1	Hazus	$12,494,000	Hazus
San Miguel	2098	9	FEMA Map with Buffer		
Sedgwick County		5	Hazus	$5,079,000	Hazus
Southern Ute Indian Tribe (La Plata)	138	99		$12,994,040	Hazus
Summit County	499	1	Hazus	$172,477,598	Hazus
Teller	182	25	Hazus	$3,973,500	Hazus
Thornton/Federal Heights/ Northglenn	1682	67	Hazus	$9,200,000	Hazus
Ute Mountain Ute Tribe (Montezuma)	71		Hazus	$176,000	Hazus
Washington County		1	Hazus	$6,798,000	Hazus
Weld County	2,096	55		$54,067,400	Hazus
City of Westminster		0			
Yuma County		10	Hazus	$29,543,000	Hazus

Jurisdiction	# of Structures/ Parcels in Hazard Area	# Critical Facilities in Hazard Area	Vulnerability Methodology	Loss Estimate	Loss Estimate Methodology
Total	**204,682**	**1,740**		**$13.655 B**	

Source: 2018 Colorado State Hazard Mitigation Plan based on approved plans as of May 2018; *Table only includes plans that ranked flooding within top four hazards.

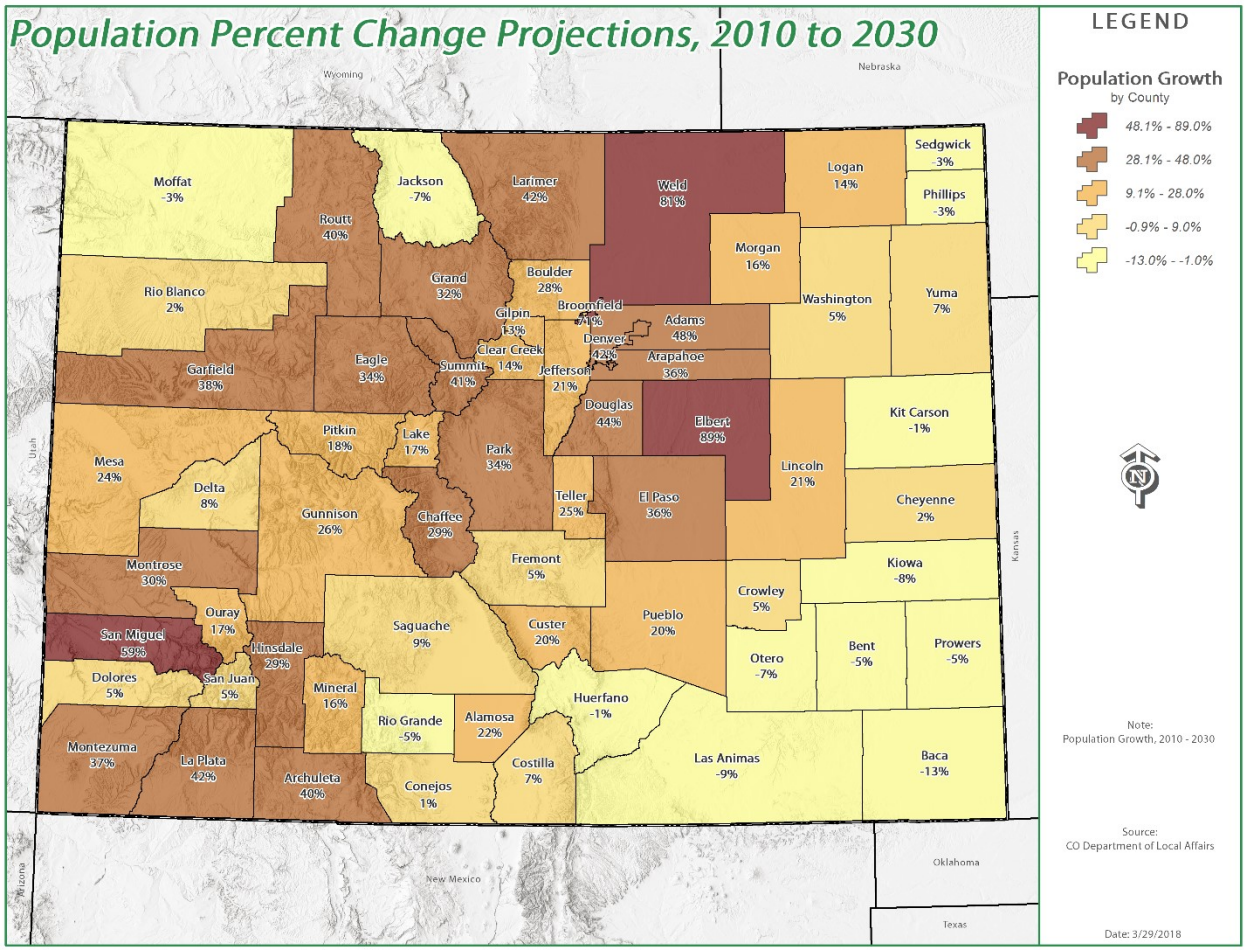
The results in Figure 3-13 indicate that most counties consider flooding a high or medium priority for planning purposes. However, not all plans included a priority ranking, and among those that did the ranking systems were not uniform. A recommendation for future local planning efforts is to standardize the priority ranking system and flood vulnerability methodology so county-level plans can be more easily compared. The statewide methodology presented in this Plan can be adapted and improved upon at the local level for improvement of local hazard mitigation plans.

The projected vulnerability associated with future development is also identified and reviewed as it pertains to future population, future number of structures, future number of critical facilities, and future potential loss (economic). This includes additional information regarding population shifts, changes in land use, effects of mitigation projects, etc. Most of the local hazard mitigation plans did not include forecasts of vulnerability.

3.3.4 Changes in Development Patterns

As part of the 2018 Plan update process, changes in growth and development were examined in the context of flood vulnerability. Changes in growth and development can affect loss estimates and vulnerability. When the population in a hazard area increases, so too does the vulnerability of the people and property unless mitigation measures are taken.

Figure 3-14 Projected Population Change by County



Source: Colorado SHMP 2018

Figure 3-14 shows the projected percent change in population for the State from 2010 through 2030. This information is presented at the county level. Statewide, Colorado is projected to have a 36 percent increase in population from 2010 to 2030. What the map indicates is that as Colorado's total population grows statewide to 2030, the growth is not shared equally by all counties. In particular, there is projected to be a continual population decline in the rural communities of the Eastern Plains and San Luis Valley (SLV). At the same time, population growth is anticipated to be prevalent in the central, north-central, west-central, and southwest areas of the State. Elbert County is projected to experience the largest percent change in population from 2010 to 2030, with a projected 89 percent increase. Weld County follows closely, with an 81 percent projected increase in population. Baca County is projected to have the lowest percent change in population from 2010 to 2030, with a projected -13 percent change.

3.4 Estimating Potential Losses by Jurisdiction

3.4.1 Overview and Analysis of Potential Losses

Estimates of potential vulnerability and losses associated with flood hazards reflect both the population and structures within the 1% annual chance floodplain. Methods utilized to develop the estimates were presented previously in this document and are summarized below.

3.4.2 Potential Losses Based on Estimates in Local and State Risk Assessments

Flood Analysis

The following section discusses the methodology used to perform the flood loss estimation associated with the 2018 update to the Colorado SHMP. Hazus-MH 4.0 was utilized to model the one percent annual chance floodplain (100-year) and perform associated building and population risk assessments. The Hazus flood model results included analysis for each of the 64 counties using two processing methods depending on floodplain data availability. These countywide assessments include analysis across all tribal lands within the state as well. Colorado has 35 counties where FEMA has developed countywide (or near-countywide) digital floodplain maps; for these counties a so-called Level 1+ analysis was performed. The remaining 29 counties that did not have countywide digital FEMA floodplain maps were analyzed utilizing traditional Standard (Level 1) analysis.

The Level 1+ counties had a custom depth grid developed for each county using the Colorado FEMA floodplain data (effective as of 10/26/17) as well as the 10-meter (1/3 arc second) Digital Elevation Models (DEMs) from the National Elevation Dataset (NED) as the terrain data source. The resulting depth grid was then loaded into Hazus and a hydraulic analysis was performed before running the overall flood damage analysis.

The standard Level 1 counties used the Hazus software to develop a stream network and hydrology for a 10-square mile drainage area. The 30-meter (one arc second) DEMs were used in this analysis as the terrain source. Hazus then ran hydraulics for and delineated the 100-year floodplain boundary. At this point Hazus developed a depth grid for the one percent annual chance floodplain. While not as accurate as an official FEMA floodplain, this one percent boundary is available for use in GIS and could be valuable to communities that have not been mapped by the National Flood Insurance Program. Hazus generated damage estimates are directly related to the depth of flooding and are based on FEMA's depth-damage functions built into Hazus. This data is available to communities upon request.

Hazus provides a variety of results from the flood analysis, including the estimated number of buildings both moderately and completely damaged, the debris generated, and social impacts such as displaced households and temporary shelter needs. The economic losses associated with the

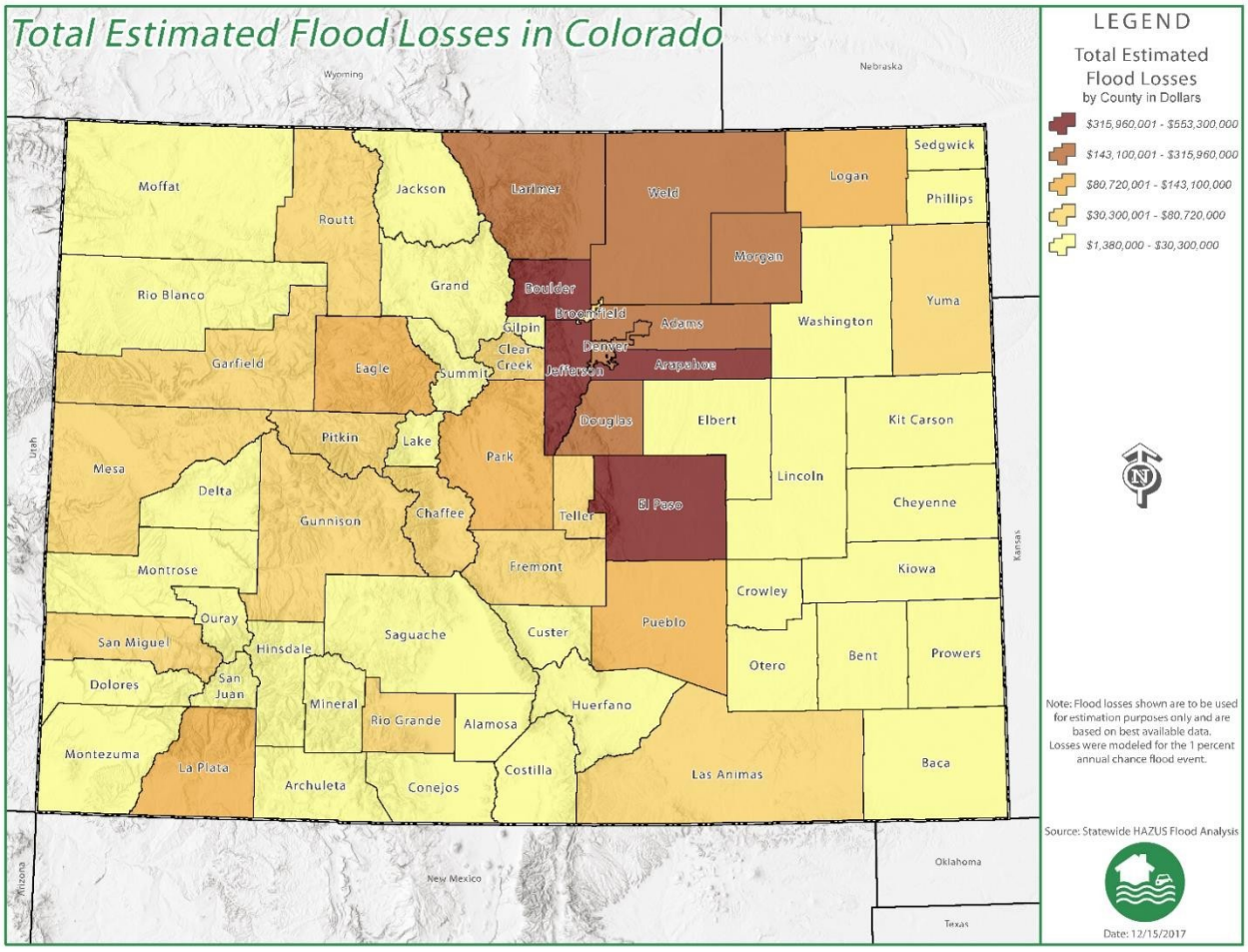
flood event are also provided, including building contents and inventory; business impacts such as relocation and wage losses are also reported.

All estimated losses from the Hazus analysis are derived from default national inventory databases and may contain inaccuracies, thus all loss and damage estimates should be used for planning applications only. The damaged building counts generated are susceptible to rounding errors because they are based off 2010 census block data. There is also potential for errors associated with hydrologic and hydraulic modeling within Hazus. In rural Colorado, census blocks are large and often sparsely populated or developed; this may create inaccurate loss estimates. Hazus assumes population and building inventory to be evenly distributed over a census block; flooding may occur in a small section of the census block where there are no actual buildings or people, but the model assumes that there is damage to that block. There could also be discrepancies in the extent and/or depth of the floodplains generated in certain counties. This is due in part to narrow mountain floodplains and ground surface terrain data resolution. One other important note is that losses were only calculated for counties where a created depth grid was present, however this does not mean other flood losses are not present elsewhere in the county. A Hazus Level 2 analyses based on local building inventory, higher resolution terrain data, and additional digital floodplain data could be used in the future to refine and improve the accuracy of the results. In addition, the CWCB has an inventory of local flood mapping efforts and flood studies that could supplement future analysis.

Hazus Reports and Maps

The results of this Hazus analysis are summarized in Figure 3-15, and presented in detail in Table 3-6. It should be again noted that these loss estimations are based off 2010 Census data and may under-represent expected losses in those Colorado counties that have experienced rapid growth since 2010. Table 3-6 presents the estimated expected building damages and total economic losses from the modeled flood event. As expected, those counties with larger populations and housing stocks oftentimes have the largest forecast building damages. Arapahoe, Boulder, El Paso, Jefferson, and Logan Counties are all estimated to have over 500 buildings moderately damaged. El Paso and Morgan Counties are modeled to have close to 200 and 300 buildings, respectively, completely destroyed. Related to expected total economic losses, a similar pattern is seen with Adams, Arapahoe, Boulder, Denver, El Paso, Jefferson, Larimer, Morgan, and Weld Counties each projecting at least $200 million in loss.

Figure 3-15 Total Estimated Flood Losses by County based on Hazus



Source: Colorado SHMP 2018

Table 3-6 Hazus Estimated Building Damages & Total Economic Losses

County	Buildings Moderately Damaged	Buildings Completely Destroyed	Total Economic Loss
Adams	330	67	$243,570,000
Alamosa*	1	0	$3,510,000
Arapahoe	606	99	$433,230,000
Archuleta	16	11	$22,740,000
Baca*	0	0	$1,420,000
Bent*	0	0	$2,010,000
Boulder	564	2	$507,910,000
Broomfield	99	10	$40,120,000
Chaffee	116	18	$39,680,000
Cheyenne*	13	0	$3,550,000
Clear Creek	79	35	$43,640,000
Conejos*	11	0	$7,640,000
Costilla*	7	6	$5,440,000
Crowley*	14	0	$6,040,000

County	Buildings Moderately Damaged	Buildings Completely Destroyed	Total Economic Loss
Custer*	135	60	$26,780,000
Delta	1	0	$8,310,000
Denver	426	23	$315,960,000
Dolores*	9	0	$3,670,000
Douglas	238	51	$182,600,000
Eagle	123	44	$103,380,000
El Paso	625	202	$442,930,000
Elbert	43	1	$20,190,000
Fremont	158	73	$80,720,000
Garfield	289	20	$56,500,000
Gilpin*	29	13	$15,850,000
Grand	0	0	$11,600,000
Gunnison	48	19	$55,730,000
Hinsdale*	26	0	$14,270,000
Huerfano*	19	2	$17,250,000
Jackson*	3	0	$2,570,000
Jefferson	1126	166	$553,300,000
Kiowa*	3	0	$1,380,000
Kit Carson*	0	0	$1,640,000
La Plata	222	73	$127,260,000
Lake*	2	0	$1,650,000
Larimer	315	37	$200,600,000
Las Animas	11	4	$42,820,000
Lincoln*	6	0	$7,250,000
Logan	542	13	$116,340,000
Mesa	151	30	$64,250,000
Mineral*	11	2	$10,570,000
Moffat*	78	0	$26,000,000
Montezuma	59	5	$20,630,000
Montrose	1	0	$7,350,000
Morgan	431	293	$216,850,000
Otero*	119	2	$29,200,000
Ouray*	36	6	$30,300,000
Park	255	128	$143,100,000
Phillips*	18	0	$8,280,000
Pitkin	33	13	$61,480,000
Prowers	12	2	$20,970,000
Pueblo	210	51	$111,860,000
Rio Blanco*	26	1	$26,940,000
Rio Grande	71	11	$36,024,000
Routt	82	21	$75,310,000
Saguache*	19	0	$7,270,000
San Juan*	6	0	$5,640,000
San Miguel*	49	5	$36,440,000
Sedgwick*	4	0	$1,850,000
Summit	11	0	$20,000,000
Teller	75	17	$47,100,000
Washington*	9	0	$6,390,000

County	Buildings Moderately Damaged	Buildings Completely Destroyed	Total Economic Loss
Weld	462	32	$197,220,000
Yuma*	124	0	$59,480,000

* Denotes Standard (Level 1) Hazus analysis, Source: CO SHMP

Table 3-7 below includes a summary of some other expected impacts as a result of the modeled flood events, per county. El Paso, Jefferson, and Morgan Counties should plan for the greatest amount of post-flood debris to be generated, each estimated to be over 20,000 tons. The most modeled displaced households would be in Boulder and Jefferson Counties. When reviewed as a percentage of a county's population however, Crowley and Logan Counties both stand out from the rest. Shelter needs are expected to be the largest in Boulder and Jefferson Counties, but Crowley and Logan Counties again stand out when shelter needs are considered as a percentage of the county population.

Table 3-7 Hazus Estimated Debris, Displacement, And Shelter Needs

County	Debris Generated (in tons)	Displaced Households	Displaced %	People in Need of Shelter	Shelter %
Adams	6,241	2,466	2%	4,911	1%
Alamosa*	55	185	3%	173	1%
Arapahoe	10,638	2,897	1%	6,308	1%
Archuleta	1,113	131	3%	140	1%
Baca*	236	9	0%	0	0%
Bent*	207	30	2%	1	0%
Boulder	9,750	6,005	5%	14,280	5%
Broomfield	99	489	2%	1,077	2%
Chaffee	1,824	251	3%	345	2%
Cheyenne*	433	55	6%	29	2%
Clear Creek	5,407	382	10%	241	3%
Conejos*	908	145	5%	109	1%
Costilla*	1,194	70	4%	43	1%
Crowley*	619	365	37%	622	11%
Custer*	5,140	87	4%	145	3%
Delta	900	106	1%	42	0%
Denver	11,221	2,652	1%	6,144	1%
Dolores*	352	11	1%	2	0%
Douglas	1,096	991	1%	1,770	1%
Eagle	3,884	795	4%	1,559	3%
El Paso	29,978	3,715	2%	6,610	1%
Elbert	991	178	2%	223	1%
Fremont	6,917	1,279	8%	2,132	5%
Garfield	3,185	507	3%	691	1%
Gilpin*	840	36	2%	31	1%
Grand	630	56	1%	35	0%
Gunnison	5,189	393	6%	523	3%
Hinsdale*	602	34	3%	18	2%
Huerfano*	1,105	106	4%	42	1%
Jackson*	263	22	2%	0	0%

County	Debris Generated (in tons)	Displaced Households	Displaced %	People in Need of Shelter	Shelter %
Jefferson	24,307	5,080	2%	10,336	2%
Kiowa*	154	25	3%	3	0%
Kit Carson*	180	12	0%	0	0%
La Plata	8,043	796	4%	1,488	3%
Lake*	274	30	1%	29	0%
Larimer	7,989	1,578	1%	2,997	1%
Las Animas	3,104	178	3%	212	1%
Lincoln*	571	128	6%	73	1%
Logan	8,682	2,038	25%	4,261	19%
Mesa	1,642	821	1%	1,725	1%
Mineral*	1,025	25	3%	10	1%
Moffat*	1,987	447	9%	653	5%
Montezuma	2,225	294	3%	342	1%
Montrose	731	57	0%	33	0%
Morgan	39,076	1,123	11%	1,624	6%
Otero*	2,063	227	3%	375	2%
Ouray*	1,845	99	5%	109	2%
Park	9,752	375	5%	628	4%
Phillips*	629	108	5%	92	2%
Pitkin	3,859	274	3%	421	2%
Prowers	992	165	3%	207	2%
Pueblo	6,348	770	1%	1,440	1%
Rio Blanco*	2,361	188	6%	146	2%
Rio Grande	2,920	255	5%	277	2%
Routt	2,106	476	5%	738	3%
Saguache*	1,295	136	5%	76	1%
San Juan*	221	69	7%	40	6%
San Miguel*	675	163	5%	241	3%
Sedgwick*	195	53	5%	13	1%
Summit	839	208	2%	178	1%
Teller	2,707	248	2%	316	1%
Washington*	794	106	5%	29	1%
Weld	7,346	2,405	3%	4,628	2%
Yuma*	2,611	581	15%	540	5%

* Denotes Standard (Level 1) Hazus analysis Source: CO SHMP

NFIP Claims Analysis

Vulnerability to flood hazards was also assessed using NFIP data on flood insurance policies and claims, repetitive losses, and population in flood hazard areas. Table 3-8 presents a summary of NFIP policies and claims in Colorado since the NFIP's inception in 1978 through 2017.

Table 3-8 FEMA NFIP Policy and Claims Report Colorado: 1978-2018*

County	Number of Policies	Total Coverage	Total Premiums	Total Claims	Total Paid
Adams	1,216	$306,425,600	$1,101,864	248	$788,935
Alamosa	47	$11,537,200	$27,049	18	$10,441
Arapahoe	641	$180,312,400	$461,810	96	$504,518
Archuleta	137	$35,351,200	$103,457	4	$1,863
Bent	6	$1,155,500	$4,594	2	$2,690
Boulder	5,822	$1,487,369,000	$4,765,863	1,734	$49,443,161
Broomfield	85	$27,189,200	$77,694	14	$21,601
Chaffee	132	$34,646,700	$108,491	6	$307,142
Clear Creek	130	$30,959,800	$161,287	27	$42,710
Conejos	7	$1,313,600	$9,747	3	$-
Costilla	9	$1,322,600	$6,806	1	$10,317
Crowley	0	$-	$-	1	$-
Delta	60	$14,793,400	$53,351	19	$92,296
Denver	1,278	$336,314,100	$1,226,512	202	$592,668
Dolores	5	$1,043,100	$1,528	1	$270
Douglas	412	$113,231,200	$206,436	48	$501,799
Eagle	451	$122,283,700	$301,770	32	$178,739
El Paso	2,775	$653,020,900	$2,237,750	753	$5,580,662
Elbert	30	$8,139,500	$22,937	2	$-
Fremont	300	$63,709,500	$278,676	67	$169,633
Garfield	194	$57,607,300	$169,443	24	$77,005
Gilpin	25	$11,510,800	$77,068	7	$9,794
Grand	152	$30,114,300	$113,451	2	$5,960
Gunnison	279	$72,235,000	$188,209	43	$152,531
Hinsdale	23	$6,447,500	$12,649	1	$-
Huerfano	72	$9,433,400	$79,451	5	$1,885
Jefferson	1,273	$335,732,800	$1,220,303	371	$2,228,399
La Plata	756	$214,017,400	$598,263	36	$486,383
Lake	5	$1,600,000	$5,071	1	$2,582
Larimer	1,551	$420,246,500	$1,274,453	538	$14,846,242
Las Animas	25	$3,286,500	$22,130	3	$10,992
Lincoln	10	$1,592,100	$14,807	5	$4,362
Logan	193	$33,361,200	$264,405	75	$853,931
Mesa	340	$81,427,500	$230,762	56	$281,065
Mineral	10	$1,925,400	$17,887	1	$268
Moffat	24	$5,819,600	$15,952	0	$-
Montezuma	114	$31,137,300	$131,408	5	$18,588

County	Number of Policies	Total Coverage	Total Premiums	Total Claims	Total Paid
Montrose	109	$23,063,200	$89,722	6	$56,693
Morgan	116	$16,996,200	$156,824	41	$449,479
Otero	82	$9,650,800	$102,345	136	$1,742,883
Ouray	58	$16,303,400	$42,712	6	$33,046
Park	33	$8,025,000	$26,066	2	$343
Phillips	6	$1,319,600	$9,686	2	$7,402
Pitkin	273	$76,037,900	$247,777	26	$219,978
Prowers	66	$14,201,200	$74,870	23	$27,035
Pueblo	171	$43,397,200	$114,214	89	$287,740
Rio	21	$4,552,000	$12,816	10	$31,031
Rio	142	$34,393,100	$136,356	6	$2,651
Routt	393	$98,788,800	$287,279	33	$414,728
Saguache	5	$420,000	$5,666	0	$-
San Juan	5	$1,520,000	$4,389	1	$1,144
San Miguel	525	$129,219,000	$331,818	17	$132,604
Sedgwick	2	$420,000	$632	0	$-
Summit	504	$114,021,500	$239,436	26	$43,798
Teller	72	$19,600,900	$71,802	10	$12,024
Washington	1	$60,000	$744	0	$-
Weld	517	$129,108,300	$539,112	161	$5,457,853
Yuma	15	$3,378,400	$22,318	3	$3,298
State Total	**21,705**	**$5,492,089,300**	**$18,109,918**	**5,049**	**$86,153,162**

Source: FEMA – NFIP *As of February 23, 2018

Figure 3-16 shows the number of claims made and the total amount paid by county. Figure 3-17 shows the current number of NFIP flood policies, and their total insurance coverage by county.

Figure 3-16 NFIP Claims and Amount Paid in Colorado Since 1978 by County

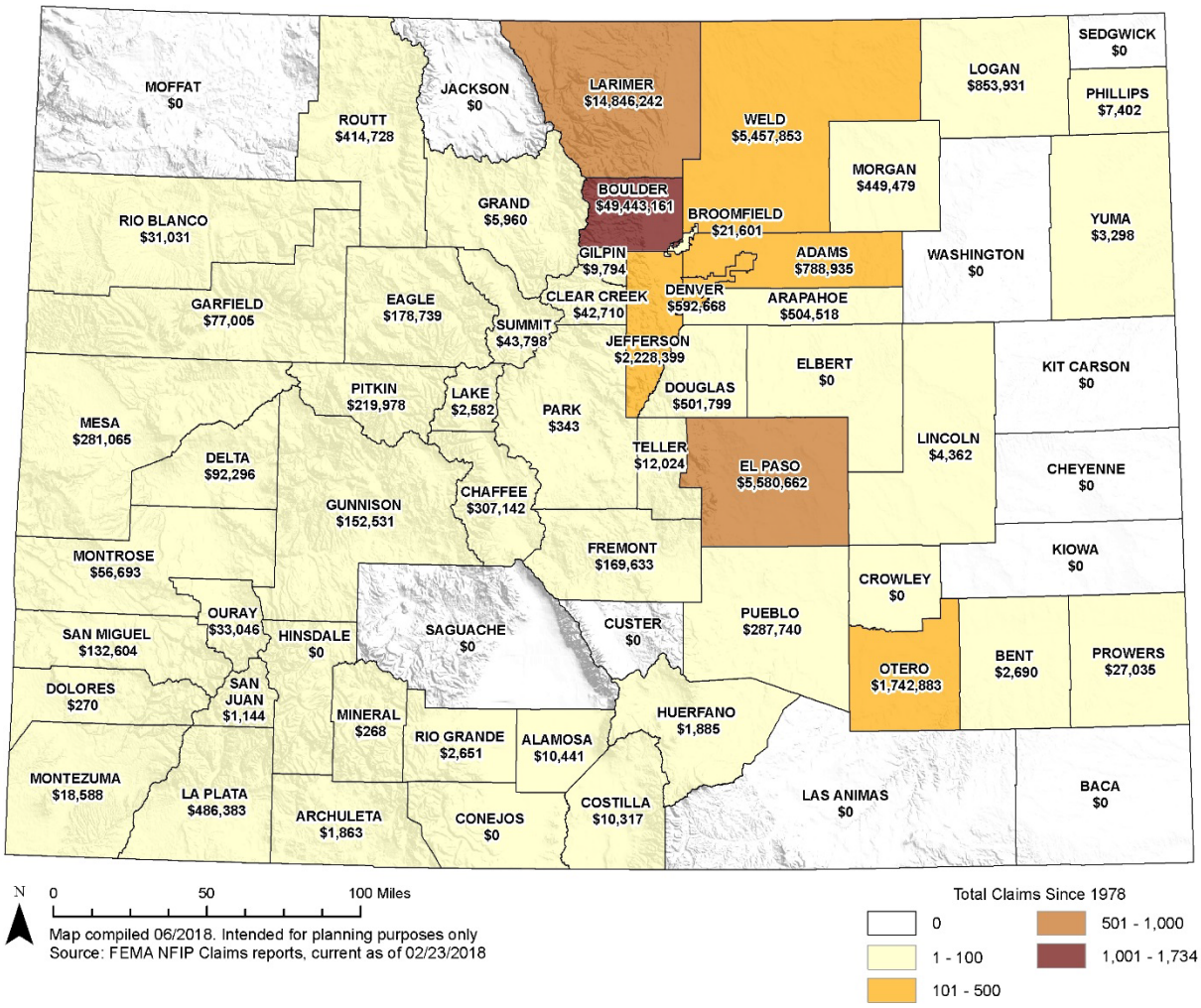
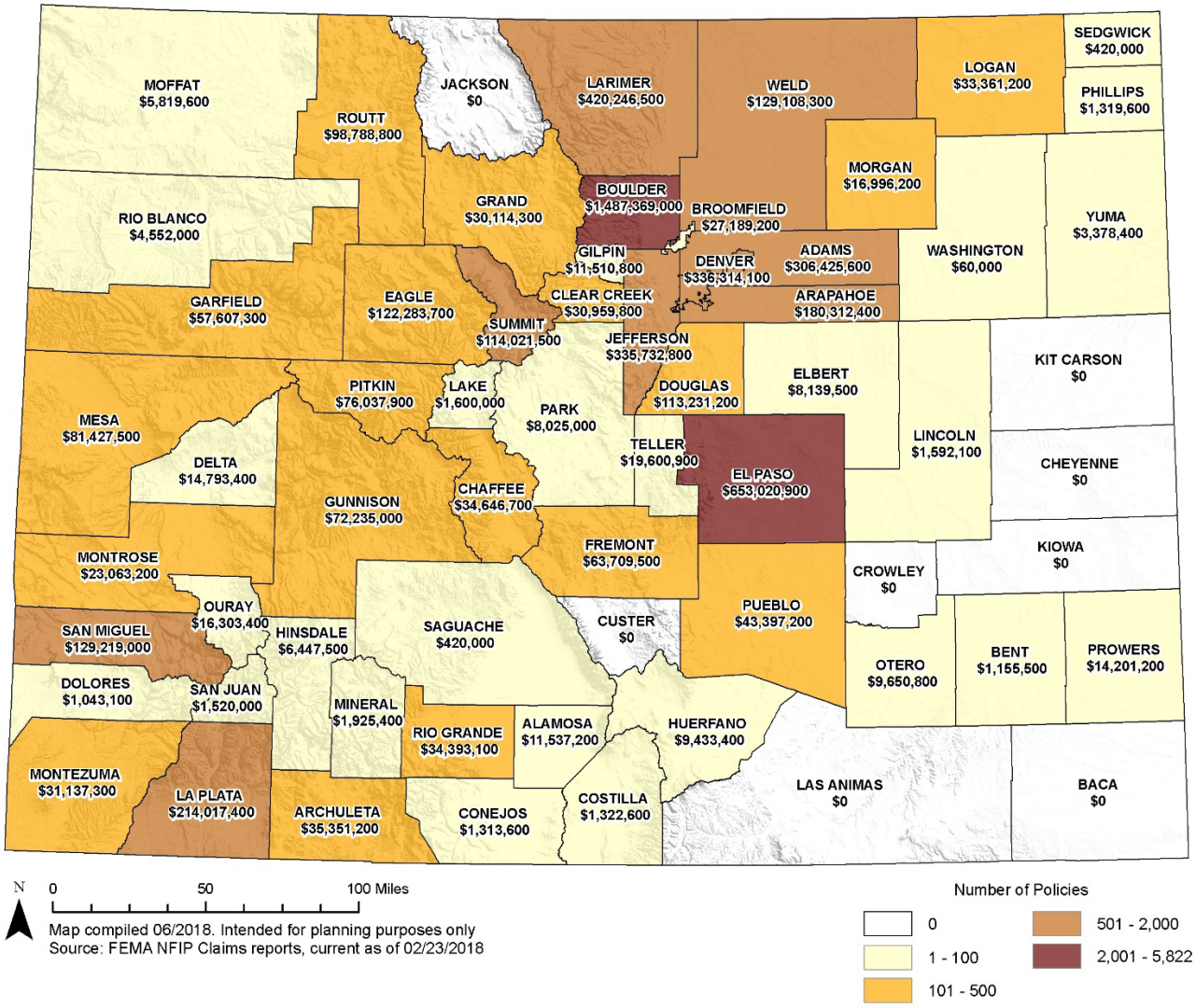


Figure 3-17 NFIP Colorado Policies and Total Coverage by County



Sorting the NFIP data shows which counties rank the highest in terms of the most number of claims filed, the largest amounts paid, the most current NFIP policies, and the largest policy coverage. The top 10 counties in each category are displayed in Table 3-9. As might be expected, the counties who have experienced the most flooding also have the most current insurance coverage.

Comparing Table 3-9 to the population growth projections in Figure 3-14 reveals that many of the counties with the most NFIP claims and policies are also expected to experience significant growth between now and 2030, to include Boulder (28%), Larimer (42%), El Paso (36%), Jefferson (21%) and Denver (42%).

Table 3-9 Top Ten Counties in Terms of NFIP Claims & Coverage

	Most # of Claims	Total Amount Paid	# of Policies	Total Insurance Coverage
#1	Boulder	Boulder	Boulder	Boulder
#2	El Paso	Larimer	El Paso	El Paso
#3	Larimer	El Paso	Larimer	Larimer
#4	Jefferson	Weld	Denver	Denver
#5	Adams	Jefferson	Jefferson	Jefferson
#6	Denver	Otero	Adams	Adams
#7	Weld	Logan	La Plata	La Plata
#8	Otero	Adams	Arapahoe	Arapahoe
#9	Arapahoe	Denver	San Miguel	San Miguel
#10	Pueblo	Arapahoe	Weld	Weld

Source: FEMA – NFIP

Information presented in Tables 3-10 and 3-11 provide a profile of the repetitive damages and losses in Colorado, by county and by type of structure. FEMA defines a Repetitive Loss property as any insurable building for which two or more claims of more than $1,000 were paid by the NFIP within any rolling ten-year period. Since 1978, 113 Colorado properties in 23 counties have suffered repetitive losses, submitting a total of 261 claims worth over $5 million. El Paso County has the highest number of Repetitive Loss properties and claims, followed by Jefferson and Boulder Counties. Of those 113 properties 27 have been successfully mitigated, leaving 86 repetitive loss properties in the State. FEMA further defines Severe Repetitive Loss properties as any single-family property for which the NFIP has paid four or more claims exceeding $5,000 and with the cumulative amount of such claims payments exceeding $20,000. As of May 31, 2018, Colorado has one Severe Repetitive Loss property, located in Greeley in Weld County, which since 2010 has been paid four claims totaling $188,192.

Table 3-10 NFIP Repetitive Loss Claims in Colorado: 1978-2018

County	Total # of Properties	# of Claims	Total Value of Claims
Adams County	8	21	$293,291
Arapahoe County	4	8	$102,596
Boulder County	15	33	$1,395,416
Clear Creek County	1	2	$9,260
Delta County	1	3	$16,161
Denver, City and County	6	15	$222,786
El Paso County	32	74	$1,716,867
Fremont County	2	4	$10,761
Gunnison County	1	2	$39,723
Jefferson County	15	38	$630,889

County	Total # of Properties	# of Claims	Total Value of Claims
La Plata County	1	2	$18,013
Larimer County	6	13	$136,538
Logan County	2	4	$12,435
Mesa County	1	2	$4,240
Morgan County	1	2	$89,271
Otero County	5	11	$189,031
Pitkin County	1	2	$7,499
Pueblo County	2	4	$33,498
Rio Blanco County	1	2	$11,384
Routt County	1	2	$3,061
San Miguel County	1	2	$16,280
Weld County	5	13	$384,084
Yuma County	1	2	$3,298
TOTALS	**113**	**261**	**$5,346,382**

Source: FEMA *As of May 31, 2018

Table 3-11 NFIP Repetitive Loss Properties and Claims in Colorado

Colorado Repetitive Loss Properties	
RL Buildings, Total	86
RL Buildings, Insured	36
RL Losses, Total	194
RL Losses, Insured	83
$ Losses, Total	$4,140,403.97
$ Losses, Insured	$2,548,892.86
Buildings with 4+ Losses, Total	5
Buildings with 4+ Losses, Insured	2
Buildings with 2-3 Losses,> Value Total	0
Buildings with 2-3 Losses,> Value Insured	0
Buildings, Post-Firm A/V Zone Total	3
Buildings, Post-Firm A/V Zone Insured	2

Source: FEMA *As of May 31, 2018

3.4.3 Impacts on Losses from Changes in Development

Changes in growth and development naturally affect loss estimates and vulnerability. When the population in a flood hazard area increases, so too does the vulnerability of the people and property unless mitigation measures are taken. When the population of a hazard area decreases, the burden of managing communal property may exceed the resources of the declining population.

Changes in development patterns can generally be related to changes in population. Population

growth and development contribute to increased exposure of people and property to flooding and its related impacts. Understanding changes in hazard exposure over time is an important element of comprehensive hazard mitigation planning. Among other things, increased population growth and development elevate exposure levels of property and people to the impacts of flooding.

Colorado continues to experience some of the largest population growth in the country and future projections seem to indicate a similar trend should be expected. As Colorado's population increases, infrastructure and businesses will follow these population centers. This further adds to the potential future exposure that counties face from flood. Those counties that have a large expected percent change in housing as well as a history of significant flood events can be viewed as being potentially the most at risk for future exposure. For all counties, future flood losses can be mitigated by ensuring that all future development avoids flood hazard areas. Unfortunately, not all floodplains have yet been mapped across the State and some existing mapping is in need of updates.

The following section provides county-scale flood exposure projections by comparing current flood risk with projected population data. As shown in Table 3-12, a flood risk value from zero to three was assigned to each county based on the total economic losses that were modeled in Hazus for the one percent annual chance flood event. The Jenks Natural Breaks algorithm was used to classify this estimated loss data set value.

Table 3-12 Flood Risk Values Based on Hazus Losses

Hazus Estimated Total Economic Losses	Flood Risk
$315.9 - $553.3 M	3
$80.7 M - $315.9 M	2
$1.3 M - $80.7 M	1
$0 - $1.3 M	0

Source: 2018 CO SHMP

Table 3-13 then compares that flood risk rating to county growth projections between 2010 and 2030 to determine the projected flood exposure for each county, from Negligible to Extreme.

Table 3-13 Future Flood Exposure Projections

		County Growth Projections (%), 2010 to 2030			
Flood Risk		-13% to 2%	3% to 17%	18% to 34%	35% to 89%
High	3	Moderate	High	Severe	Extreme
↑	2	Slight	Moderate	High	Severe
Moderate	1	Negligible	Slight	Moderate	High

Source: 2018 CO SHMP

The results of this analysis are presented in Table 3-14, and in map form in Figure 3-18. Two

counties – Arapahoe and El Paso – are projected to have Extreme increased flood exposure; eight counties are projected as Severe; 11 counties are projected as High; 13 as Moderate; 14 as Slight; and 16 as Negligible.

Table 3-14 Flood Exposure Projections by County

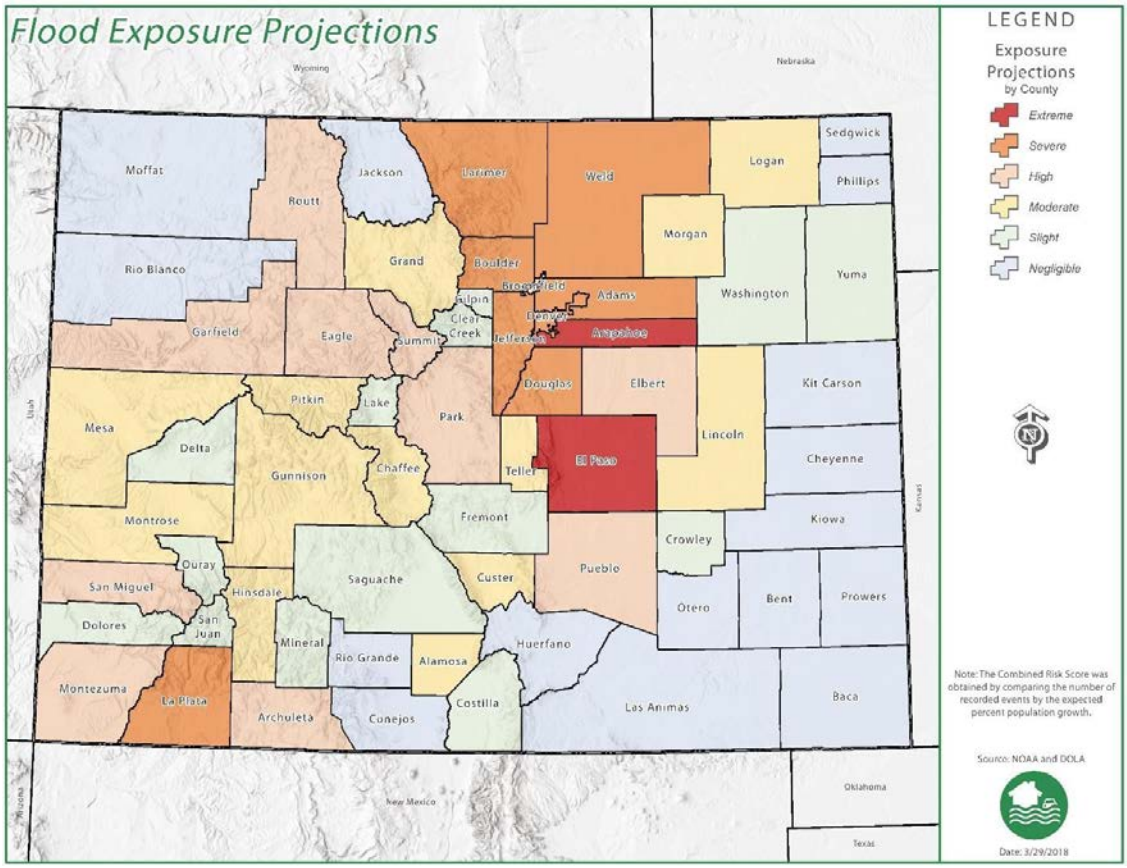
County	Risk	Population Change	Exposure Rating
Arapahoe	3	36%	Extreme
El Paso	3	36%	Extreme
Weld	2	81%	Severe
Adams	2	48%	Severe
Douglas	2	44%	Severe
Denver	2	42%	Severe
La Plata	2	42%	Severe
Larimer	2	42%	Severe
Boulder	3	28%	Severe
Jefferson	3	21%	Severe
Elbert	1	89%	High
Broomfield	1	71%	High
San Miguel	1	59%	High
Summit	1	41%	High
Routt	1	40%	High
Archuleta	1	40%	High
Garfield	1	38%	High
Montezuma	1	37%	High
Park	2	34%	High
Eagle	2	34%	High
Pueblo	2	20%	High
Grand	1	32%	Moderate
Montrose	1	30%	Moderate
Hinsdale	1	29%	Moderate
Chaffee	1	29%	Moderate
Gunnison	1	26%	Moderate
Teller	1	25%	Moderate
Mesa	1	24%	Moderate
Alamosa	1	22%	Moderate
Lincoln	1	21%	Moderate
Custer	1	20%	Moderate
Pitkin	1	18%	Moderate
Morgan	2	16%	Moderate
Logan	2	14%	Moderate
Lake	1	17%	Slight
Ouray	1	17%	Slight
Mineral	1	16%	Slight
Clear Creek	1	14%	Slight
Gilpin	1	13%	Slight
Saguache	1	9%	Slight
Delta	1	8%	Slight
Costilla	1	7%	Slight

County	Risk	Population Change	Exposure Rating
Yuma	1	7%	Slight
Fremont	1	5%	Slight
Washington	1	5%	Slight
Dolores	1	5%	Slight
Crowley	1	5%	Slight
San Juan	1	5%	Slight
Cheyenne	1	2%	Negligible
Rio Blanco	1	2%	Negligible
Conejos	1	1%	Negligible
Kit Carson	1	-1%	Negligible
Huerfano	1	-1%	Negligible
Sedgwick	1	-3%	Negligible
Phillips	1	-3%	Negligible
Moffat	1	-3%	Negligible
Rio Grande	1	-5%	Negligible
Bent	1	-5%	Negligible
Prowers	1	-5%	Negligible
Otero	1	-7%	Negligible
Jackson	1	-7%	Negligible
Kiowa	1	-8%	Negligible
Las Animas	1	-9%	Negligible
Baca	1	-13%	Negligible

Source: 2018 CO SHMP

Many of the counties with severe projected exposure to floods are counties along the Front Range. These counties have high populations, and their populations are projected to continue to grow, which could include pressures to develop within floodplains. While development is regulated in 1% annual chance areas new development often is not regulated in 0.2% annual chance areas, potentially exposing more buildings and people to risk from these less frequent floods.

Figure 3-18 Flood Exposure Projections by County



3.5 Assessing Vulnerability of State Facilities

Vulnerability to state facilities and other assets from flood is primarily due to direct damage of the structure and contents. The number and value of potentially flood prone state assets and approximate value are shown in Table 3-15, summarized by County. The following sections describe the types of facilities included in this assessment and present an overview of estimated monetary losses, where available.

3.5.1 Estimating Potential Losses of State Facilities

Table 3-15 and Figure 3-19 show counties in Colorado with state assets at risk to flooding. These assets were identified by intersecting the state asset GIS database with floodplain layers (which contained FEMA's NFHL effective and preliminary floodplain areas, as well as Hazus-MH-derived floodplains in the 100-year flood zones). Boulder, Denver, and Crowley Counties contain the highest values of state assets in floodplains. Boulder County has the highest, with 34 assets valued at $149,212,000. Denver County has the next highest, with 20 assets valued at $125,129,000. Crowley County has the third highest, with 15 state assets valued at $96,864,496. Larimer County contains the most state assets in floodplains, with 63 and a value of $21,396,900.

Overall, generally counties along the Front Range and northern Eastern Plains have the highest values of state assets in the floodplains. Statewide, 661 state assets are located in floodplains, and $465,353,021 at risk from state asset value. Table 3-15 summarizes the counts and value of state assets located in the floodplain layers in Colorado. A value of $1 indicates that a state asset in that county has been identified, but its value hasn't been determined.

Since 2008, there have been 146 property losses reported on state assets due to flooding, resulting in over $16 million in losses. Approximately $12 million of these losses, or 74 percent, were due to the September 2013 floods. It is important to note that state asset loss data is only available for state assets included in the 2017 Office of Risk Management (ORM) database. According to Colorado Parks and Wildlife 10 of their 17 hatchery facilities are near flood hazard areas and have an estimated replacement value of $20,000,000. These facilities have no flood hazard mitigation plans as of 2018.

Table 3-15 State Assets in All Floodplains, by County

County	State Asset Value	State Asset Count
Boulder	$149,212,000	34
Denver	$125,129,000	20
Crowley	$96,864,496	15
Larimer	$21,396,900	63
Logan	$14,997,400	43
La Plata	$8,205,760	14
Pueblo	$5,858,980	28
Archuleta	$4,812,380	28
Adams	$4,368,850	17
Morgan	$4,238,660	31
Park	$3,481,290	37
Jefferson	$3,189,300	25
Weld	$3,036,390	39
Fremont	$2,833,760	30
Clear Creek	$2,769,800	13
Delta	$2,532,890	13
Bent	$2,385,810	25
Jackson	$1,741,550	6
Prowers	$1,701,550	12
Rio Blanco	$727,745	6
Mesa	$697,831	10
Summit	$696,062	2
Yuma	$657,374	11
Arapahoe	$615,085	4
Conejos	$517,090	9
Chaffee	$449,357	16
Gunnison	$383,097	15
Teller	$258,770	5
Gilpin	$167,514	1
El Paso	$166,738	5
Routt	$155,988	5

County	State Asset Value	State Asset Count
Montezuma	$140,516	11
Phillips	$108,058	1
Moffat	$94,084	2
Broomfield	$74,387	1
Rio Grande	$66,596	9
Garfield	$56,327	4
Las Animas	$53,394	3
Lincoln	$53,012	2
Douglas	$52,644	4
Lake	$44,884	6
Custer	$35,761	2
Saguache	$35,577	3
Otero	$33,441	5
Cheyenne	$30,750	1
Montrose	$30,407	3
Alamosa	$30,236	2
Sedgwick	$27,510	4
Baca	$25,625	1
Huerfano	$24,271	3
Pitkin	$20,271	2
Costilla	$20,271	2
Mineral	$20,271	2
Ouray	$15,170	1
Eagle	$10,137	1
Hinsdale	$10,136	1
San Miguel	$1	1
Washington	$1	1
Grand	$1	1
San Juan	$0	0
Kit Carson	$0	0
Kiowa	$0	0
Elbert	$0	0
Dolores	$0	0
Total	**$465,353,021**	**661**

Source: 2018 CO SHMP

Figure 3-19 State Assets in Floodplains by County

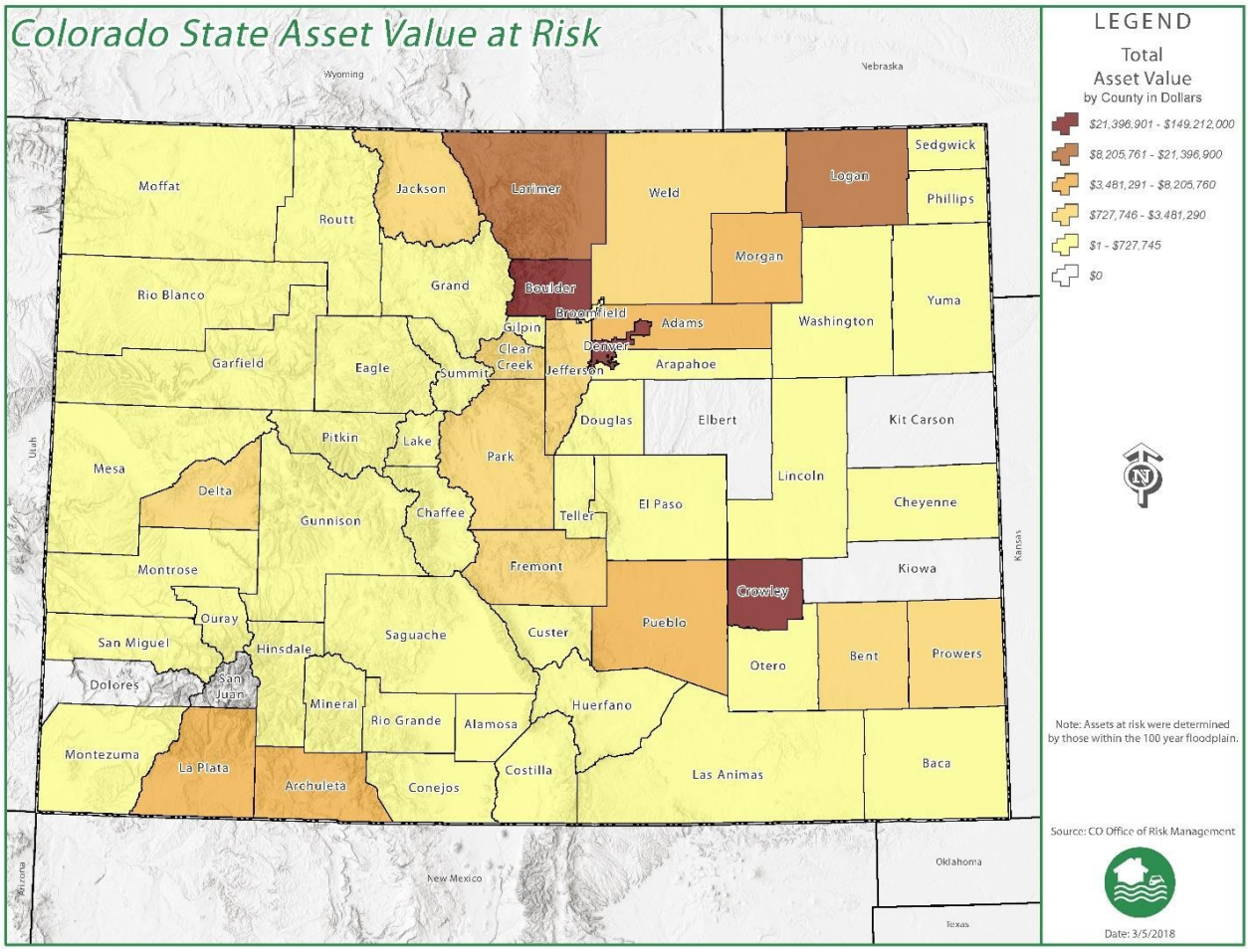


Table 3-16 State Assets Potentially at Risk to Flooding, by Facility Type

Occupancy	# of Assets	Total Value
Not Specified	30	$ 153,751,088
Bridge	3	$ 1,115,081
Electrical Box (Node)	2	$ 285,313
Employee Housing	1	$ 10,250
Garage Operations	5	$ 1,118,044
Hotel/Residency	19	$ 105,908,538
Maintenance/Repair	18	$ 13,805,965
Medical/Clinic	1	$ 2,436,102
Museum	4	$ 509,460
None	14	$ 1,205,421
Office	12	$ 43,896,593

Occupancy	# of Assets	Total Value
Office type contents	39	$ 21,612,094
Other	391	$ 82,249,995
Rest Area	31	$ 1,315,505
Sand Shed	12	$ 1,599,665
School	2	$ 10,202,460
Shop/Metalworking	12	$ 6,893,462
Storage	42	$ 5,628,740
Storage Shed	16	$ 379,552
Storage Tank	4	$ 174,828
Warehouse Operations	2	$ 10,848,433
Water Tank	1	$ 406,787
TOTAL	**661**	**$ 465,353,377**

Source: State Office of Risk Management, FEMA NFHL, Hazus-MH

In order to determine potential losses to state facilities, a GIS layer of state facilities was overlaid on digital flood hazard maps, where available. An exposure analysis was used for this endeavor. Exposure analyses are different from loss estimates in that they present facilities that may be exposed to flood hazards, but do not attempt to estimate the amount of damages that could potentially be incurred during a specific flood event. As such, these exposure endeavors are rather generalized.

A compilation of all floodplains available was used to determine state assets that could be potentially impacted by flooding. Floodplain polygon sources include the FEMA NFHL database (with both effective and preliminary DFIRM layers), and Hazus-MH modeled flood extents for 100-year flood zones.

The results shown in the previous table indicate that there are substantial numbers of state assets potentially exposed to flood damage in Colorado, including educational institutions. When grouped by state asset type (occupancy), the greatest exposure is to facilities of a type not specified, to hotel/residency structures, other facilities, offices and office contents, maintenance/repair facilities, warehouse operation facilities, and schools. This analysis does not take into account mitigation strategies that may be present at each facility, such as construction at or above the base flood elevation. This study simply indicates that there are over 600 facilities worthy of further investigation to determine true vulnerability. A more refined flood loss estimation could be determined based on estimated depth of flooding at a particular facility.

The State's road and bridge infrastructure is also prone to flood impacts and resulting disruptions, which can have considerable economic impacts. The potential losses associated with bridges that were determined to be at risk from scour during flooding events were estimated. Statewide, 358 bridges were determined to be scour critical (based on the National Bridge Inventory within Hazus) with a total replacement cost of $237 million. The 2013 flood provides a benchmark for road and

bridge infrastructure losses associated with a large-scale flood event, with over $353 million dollars' worth of damage to roads, bridges, and other infrastructure. This damage includes 200 miles of roads within multiple counties.[20] CDOT has been tracking and mitigating scour critical bridges, an action item that is discussed in the following section.

Table 3-17 lists the damage to state assets from the 2013 flooding, organized by total estimated damage. Larimer and Weld counties had the highest number of impacted assets with eight in each county. Damages to these assets, not including transportation infrastructure, was roughly $8.7 million.

Table 3-17 September 2013 Flood Damage to State Facilities

Facility	Location	County	Total Estimated Damage
Dept. of Natural Resources - North Forks SWA	Drake	Larimer	$898,600
Dept. of Transportation - Maintenance Yard	Drake	Larimer	$808,819
Dept. of Natural Resources - Big Thompson Pond SWA	Loveland	Larimer	$802,055
Dept. of Natural Resources - El Dorado Canyon State Park	Eldorado Springs	Boulder	$706,859
Dept. of Natural Resources - Simpsons Pond SWA	Loveland	Larimer	$687,470
Dept. of Natural Resources - St. Vrain St. Park	Firestone	Weld	$625,000
Dept. of Transportation - Maintenance Yard	Evans	Weld	$616,000
Dept. of Natural Resources - Bellvue Hatchery	Bellvue	Larimer	$610,629
Dept. of Natural Resources - Golden Gate Canyon State Park	Golden	Gilpin	$526,280
Dept. of Public Safety	Evans	Weld	$425,000
Dept. of Natural Resources - Centennial Valley SWA	Kersey	Weld	$382,585
Dept. of Natural Resources - Forks SWA	Loveland	Larimer	$332,310
Dept. of Transportation - Guardrails, signage, barriers. Only $250,000 covered by State Risk Management	Statewide		$250,000
Dept. of Natural Resources - Cherry Creek State Park	Aurora	Arapahoe	$245,800
Dept. of Transportation - Maintenance Building	Crook	Logan	$150,000
Dept. of Corrections International Management Training Facility	Canon City	Fremont	$115,000
Dept. of Natural Resources - Brower SWA	Evans	Weld	$97,834
Dept. of Natural Resources - State Wildlife Area	Henderson	Adams	$95,000
Dept. of Natural Resources - Cherokee SWA	Livermore	Larimer	$75,000
Dept. of Natural Resources - Mitani-Tokuyasu SWA	Greeley	Weld	$51,550
Dept. of Natural Resources - Webster SWA	La Salle	Weld	$46,450
Dept. of Natural Resources - Chatfield State Park	Littleton	Douglas	$41,820
Colorado School for the Deaf and Blind	Colorado Springs	El Paso	$35,000

[20] http://www.denverpost.com/news/ci_24127630/colorado-floods-millions-aid-will-barely-begin-fix

Facility	Location	County	Total Estimated Damage
Dept. of Natural Resources - Arkansas Headwater	Salida	Chafee	$30,000
Dept. of Natural Resources - Narrows SWA	Loveland	Larimer	$29,660
Dept. of Corrections - Colorado Correctional Center	Golden	Jefferson	$15,000
Dept. of Corrections - Denver Reception and Diagnostic Center	Denver	Denver	$10,000
Dept. of Corrections - Denver Women's Correctional Facility	Denver	Denver	$10,000
Pikes Peak Community College	Colorado Springs	El Paso	$5,000
Dept. of Natural Resources - Frank SWA	Windsor	Weld	$2,830
TOTAL			**$8,727,551**

Source: CDHSEM and Office of Risk Management as of October 10, 2013

4 MITIGATION STRATEGY

4.1 Hazard Mitigation Goals

This chapter focuses on the State's flood hazard mitigation strategy. It is divided into five parts:

- Hazard Mitigation Goals
- State Capability Assessment
- Local Capability Assessment
- Mitigation Actions
- Funding Sources

4.1.1 Description of State Flood Mitigation Goals

The purpose of this section is to describe the goals of Colorado's Flood Mitigation Plan. In order to be effective, these goals must be comprehensive and complement both state and local mitigation plans. The goals of the 2018 flood hazard mitigation plan, presented below, are intended to promote the reduction of future damages from flood hazards.

Flood Hazard Mitigation Plan Goals

1) Reduce flood impacts to Colorado's economy, people, state assets, and environment

2) Promote awareness and education of flood hazards and watershed protection

3) Coordinate and provide planning, technical assistance, and financial resources for state, local, and watershed planning efforts

4) Continue to update and develop floodplain maps for risk assessment, planning, and awareness applications

5) Promote and encourage the adoption of model codes and higher standards that emphasize hazard mitigation

4.1.2 Reassessment of Goals for Validity or Need for Revision

As indicated previously, the Flood TAP convened in April and May 2018 to provide information necessary to update the 2013 version of the Plan. The objectives of the Flood TAP meetings included reviewing goals and priorities, identifying strategies for protecting assets, and updating progress on mitigation projects already listed in the plan. Actions for each of the goals have been updated and can be referenced in Section 4.4.

The goals of this plan have been modified over the years to ensure they reflect current state priorities. The 2013 update process led to only minor language changes to Goal number four (the

words ‘planning’ and ‘and financial resources’ were inserted by request of the Flood TAP) were made. During the 2018 update process the Flood TAP determined goal number 3 ‘Promote the development of hazard mitigation plans with multiple objectives,’ should be removed as it is largely in the purview of the SHMP. Thus the number of goals went from six to five in 2018.

In 2018, the State Hazard Mitigation Team updated the SHMP and revisited and revised the goals of the State for hazard mitigation. These were shared with the Flood TAP for reference during the goals review process and are listed below:

2018 Colorado State Hazard Mitigation Plan Goals

1) Minimize the loss of life and personal injuries from all-hazard events
2) Reduce losses and damages to state, tribal, and local government, special district, and private assets and support similar local efforts
3) Reduce federal, state, local, and private costs of disaster response and recovery
4) Support mitigation initiatives and policies that promote disaster resiliency, nature-based solutions, cultural resources and historic preservation, and climate adaptation strategies
5) Minimize interruption of essential services and activities
6) Incorporate equity considerations into all mitigation strategies
7) Support improved coordination of risk mitigation between and among the public, private, and non-profit sectors
8) Create awareness and demand for mitigation as a standard of practice

4.2 State Capability Assessment

4.2.1 Pre-disaster Hazard Management Policies, Programs, Capabilities

State departments are responsible, within their statutory authorities, to provide assistance and support to local jurisdictions when they are unable to cope with a disaster emergency situation. Assistance and support is provided both prior to and following the disaster emergency. The State laws, regulations, authorities, and policies especially pertinent to flood hazards within the State of Colorado are listed below.

State Engineer’s Reports on High Hazard Dams, C.R.S. 37-87-123. The State Engineer develops and distributes reports on high hazard dams. Each report contains the State Engineer’s evaluation of the structural integrity and state of repair as of October 1983.

1977 – Executive Order 8504. Requirements and criteria for state participation in the National Flood Insurance Program.

1977 – Executive Order 8491. Evaluation of flood hazard in locating state buildings, roads, and other facilities, and in reviewing and approving sewage and water facilities, and subdivisions.

1977 – Senate Bill 126 – C.R.S. § 24.65.1-403(1), 1973, as amended. An Act authorizing CWCB to coordinate all activities relating to the designation of floodplains in the State in connection with land use planning.

1974 – House Bill 1041, Chapter 106, C.R.S. 1963, as amended. This Act involved comprehensive treatment of hazards and charged local governments with legal responsibility for designation and administration of hazardous areas of state interest.

Areas of State Interest – as determined by local governments. Natural hazard areas and mineral resource areas are two of the four areas of state interest.

Criteria for administration of areas of state interest. "Floodplains shall be administered so as to minimize significant hazards to public health and safety or to property." The CWCBwas to develop model hazard area control regulations.

Functions of other state agencies. (1) Pursuant to this article, it is the function of other state agencies to: (a) send recommendations to local governments and the Colorado Land Use Commission relating to designation of matters of state interest on the basis of current and developing information; and (b) provide technical assistance to local governments concerning designation of and guidelines for matters of state interest. (2) Primary responsibility for the recommendation and provision of technical assistance functions described in subsection (1) of this section is upon: (a) the Colorado Water Conservation Board, acting in cooperation with the Colorado Soil Conservation Board, with regard to floodplains."

1974 – House Bill 1034, C.R. S. 29-20-201, et seq., 1974, is the "Local Government Land Use Control Enabling Act. The act gives authority to local governments to plan and regulate the use of land within their jurisdictions, including regulating development and activities in hazardous areas.

1970 – Colorado Land Use Act – C.R.S. § 24-65-101, 25-65-105. Model resolutions – subdivisions – improvement notices. (2)(a) The commission shall, after consultation with its advisory committee, develop model resolutions to serve as guidelines for boards of county commissioners, city councils, town boards, and special districts and authorities in developing land uses and construction controls within designated floodways. (b) The commission shall, in its progress report, due February 1, 1972, designate critical areas in the state where a one hundred-year (storm return frequency) floodway should be identified and shall aid the state agencies and local governments having jurisdiction over such critical areas in adopting a program for such identification. The purpose of identifying a floodway is to ensure that life and property are protected, that the expenditure of public funds to clean up flood damage is kept to a minimum, that a high volume of water runoff can be accommodated, and that impediments to this flow are held to a minimum. The commission shall designate critical conservation and recreation areas and recommend state involvement in land use in such areas. (c) The commission shall include a report on land uses and construction within floodways in its interim and final land use planning programs.

1966 – House Bill 1007 – Flood Control – Planning and Zoning. State approval and designation of storm runoff channels and basins.

1963 – C.R.S. § 139-59-7. "The plan shall be made with the general purpose of guiding and accomplishing a coordinated, adjusted, and harmonious development of the municipality and its environs, which will, in accordance with present and future needs, best promote health, safety, …., and general welfare, as well as efficiency and economy in the process of development, including among other things, …, the promotion of safety from fire, and other dangers, …"

1937 – [C.R.S. § 37-60-102] The Colorado Water Conservation Board is created.

In the 2004 update to the SHMP, an evaluation of the effectiveness of the state's capabilities was submitted. Several of the programs identified in the evaluation matrix were adopted into the state's mitigation strategy. Information in Table 4-1 specifically addresses the state programs and capabilities related to flood hazards.

Rules and Regulations for Regulatory Floodplains in Colorado

According to the Rules and Regulations for Regulatory Floodplains in Colorado (or the "Rules"), the purpose of the document is "to provide uniform standards for regulatory floodplains (or floodplains) in Colorado, to provide standards for activities that may impact regulatory floodplains in Colorado, and to stipulate the process by which floodplains will be designated and approved by the CWCB. The Rules for Regulatory Floodplains are of statewide concern to the State of Colorado and the CWCB in order to prevent flooding and the negative impacts of floods, as well as to assure public health, safety, welfare and property by limiting development in floodplains" (pg. 3). The Rules apply to the entire state and with the intent to assist Colorado communities with sound floodplain management practices. The Rules also apply to floodplain management activities conducted by state and federal agencies and financed in part or full by state funds. In November 2010 the CWCB updated the Rules with stricter standards. The new standards became effective on January 14, 2011, and communities in Colorado had until January 14, 2014 to update their local ordinances to comply with the new standards. See the discussion under Section 4.2.5 for details on the new standards.

Following the 2013 Colorado Floods, the state participated in a FEMA case study: Reducing Losses through Higher Regulatory Standards 2013 Colorado Floods Case Study FEMA-DR-4145-CO. This study used loss avoidance methodology to determine how much damage would have been reduced if certain regulatory and policy actions had been in place, using both a 1% annual chance (100-year) flood event, and the 2013 flood event as models. Among the findings was evidence that higher regulatory standards did help reduce losses, and more could have been reduced if more stringent standards had been in place. Adopting freeboard requirements earlier would have resulted in a 38% decrease in estimated losses for Boulder and an over 18% decrease in losses for Larimer and Weld counties.

National Flood Insurance Program (NFIP)

The Federal Disaster Protection Act of 1973 requires state and local governments to participate in the NFIP as a condition to the receipt of any federal loan or grant for construction projects in flood prone areas. Participation in the NFIP requires communities to adopt floodplain regulations that meet NFIP objectives. The first objective is that new buildings must be protected at a minimum to the 1% annual chance (or 100-year) flood level. The second objective is that new development must not cause an increase in flood damage to other property. In 2012, the Biggert-Waters Reform Act was signed and contains many reforms that will impact the NFIP moving forward. These changes include the phasing out of subsidies for properties in high risk areas, new insurance policies to be issued at full-risk rates, and grandfathered rates being phased out over five years. The Biggert-Waters Reform Act was modified in 2014 through the Homeowner Flood Insurance Affordability (HFIA) Act. Further discussion on the HFIA Act can be found in Section 4.5.3.

The CWCB is responsible for providing technical assistance with NFIP participating communities in Colorado.[21] As of May 2018, 252 Colorado communities participate in the NFIP, with 244 in the regular program and eight in the emergency program. Sixteen NFIP participating communities have no special flood hazard areas and 34 communities have only minimal flood hazard areas in their community. As of May 2018, there were 18 sanctioned communities that have identified flood hazards but do not participate in the program. Over $86 million dollars in flood insurance claims have been paid within Colorado over the period of 1978-February 2018.

Colorado now requires higher regulatory standards above the minimum NFIP requirements. As of January 2014, the Rules required an additional one foot of freeboard above the base flood elevation as the standard in local flood ordinances. This improvement provides additional protection for structures during floods greater than the 1% annual chance flood and is an important and effective flood mitigation strategy across the State for future development (see Section 4.2.5).

Community Rating System (CRS)

The Community Rating System is a voluntary incentive program within the NFIP. Through participation in this program, communities can receive discounts on flood insurance premiums by conducting flood mitigation activities that reduce their long term risk and exceed NFIP minimum requirements. Technical assistance for this program is provided by the CWCB. Additional program information for Colorado can be found at http://coloradohazardmapping.com/crs and at https://crsresources.org.

[21] http://cwcb.state.co.us/water-management/flood/Pages/FloodplainManagement.aspx

4.2.2 Post-disaster Hazard Management Policies, Programs, Capabilities

The previous section includes pertinent information primarily on pre-disaster hazard management policies, programs, and capabilities. The following table summarizes additional state pre- and post-disaster programs by department and evaluates their effect on loss reduction. The majority of these are pre-disaster programs with the exception of the Community Development Block Grants (CDBG) and Hazard Mitigation Grant Program (HMGP).

Table 4-1 State Programs and Capabilities Related to Flood Hazards

DEPARTMENT	PROGRAM/POLICY REGULATION/PRACTICE	EFFECT ON LOSS REDUCTION*	PROVIDES FUNDS OR ASSISTANCE
Local Affairs	**Community Development Block Grants (CDBG)**	**Support**	**Yes**
Local Government Services in Local Affairs coordinates the overall administration of the federally funded "Small Cities" CDBG program. Funds are provided to the department through the U.S. Department of Housing and Urban Development (HUD) and are primarily intended to benefit low-to-moderate income persons through community development efforts. Eligible recipients are all municipalities and counties, except those larger jurisdictions that receive CDBG funding on an "entitlement" basis directly from HUD. These funds have been used for mitigation purposes. Example: After the floods in the Summer of 1999, $1 million was directed to buyouts of damaged properties in Otero County. HMGP and Unmet Needs funds were also used for buyouts.			
Natural Resources	**Dam Safety Program**	**Facilitate**	**Yes**
Funds for the update of local dam emergency preparedness plans come from FEMA's Dam Safety Program. All Class I dams have preparedness plans. Copies are at the State Engineer's Office and DHSEM.			
Colorado Water Conservation Board / Urban Drainage & Flood Control District	**Risk Mapping, Assessment, and Planning (Risk MAP)**	**Facilitate**	**Yes**
CWCB and UDFCD work with FEMA as Cooperating Technical Partners (CTPs) that administer the Risk MAP program. UDFCD manages Risk MAP within the Denver metro area, while CWCB manages the program for the rest of the State. Funding sources are from DHS, the state, and local funds. Further information about the floodplain programs for each CTP and their implementation can be found at http://www.coloradohazardmapping.com and http://udfcd.org/services/floodplain-mapping/.			
Public Safety	**Hazard Mitigation Assistance (HMA) Grants**	**Facilitate**	**Yes**
This program is administered by the Colorado Division of Homeland Security & Emergency Management. These grants provide funding for mitigation projects following a Presidentially-declared disaster. The HMA program includes the Hazard Mitigation Grant Program (HMGP), Pre-Disaster Mitigation (PDM) program, and Public Assistance (PA) mitigation funding (Section 406), as well as the FMA program, which is described in greater detail below.			
Public Safety	**Flood Mitigation Assistance (FMA) Program**	**Facilitate**	**Yes**
This program is administered by the Colorado Division of Homeland Security & Emergency Management. Two grants are available from FEMA for reducing flood risk to NFIP-insured properties in local communities. The FMA program offers grants for developing a local flood hazard mitigation plan and for completing flood mitigation projects to reduce flood risk in communities.			
Natural Resources	**National Flood Insurance Program (NFIP)**	**Facilitate**	**TA**

DEPARTMENT	PROGRAM/POLICY REGULATION/PRACTICE	EFFECT ON LOSS REDUCTION*	PROVIDES FUNDS OR ASSISTANCE
Assistance on floodplain issues is provided through the CAP, administered by the Colorado Water Conservation Board. Funding for the state to provide technical assistance is provided through FEMA with match funds from the state.			
Local Affairs	**Resources and Technical Assistance**	**Support**	**TA**
The Division of Local Government Field Managers and the Community Development Office provide planning resources and technical assistance to local governments, including long-term recovery planning.			

*Support: Programs, plans, policies, regulations, funding, or practices that help implement mitigation measures
Facilitate: Programs, plans, policies, regulations, funding, or practices that make implementing mitigation measures easier
Hinder: Programs, plans, policies, regulations, funding, or practices that pose obstacles to implementing mitigation measures

4.2.3 State Policies Related to Development in Flood Prone Areas

Policies and programs related to development in flood prone areas were presented and discussed previously in Section 4.2.1 of this document. In general, these policies and programs reflect regulatory requirements for construction in floodplains. In addition to zoning ordinances, regulations on construction in the floodplains are usually found in one or more of three locations: subdivision ordinance, building code, and/or a separate "stand alone" floodplain ordinance.

If the zoning for a site allows a structure to be built, then the applicable subdivision and building regulations will impose construction standards to protect buildings from flood damage and prevent the development from aggravating the flood risk.

Subdivision regulations govern how land will be subdivided into individual lots, often requiring that every lot have a buildable area above flood level. These regulations set construction and location standards for the infrastructure provided by the developer, including roads, sidewalks, utility lines, storm sewers, and drainage-ways.

The building code should establish flood protection standards for all construction. These should include criteria to ensure that the foundation will withstand flood forces and that all portions of the building subject to damage are above, or otherwise protected from, flooding.

Some Colorado communities have adopted the Building Officials and Code Administrators' (BOCA) National Building Code. The 1997 edition sets standards for protecting foundations against flood damage, including requirements for soil testing and prepared fill. It should be noted that one of the goals for flood hazard mitigation is the promotion and adoption of model codes and standards (such as the UBC and IBC).

Comprehensive plans and land use regulations funded by the Energy/Mineral Impact Assistance Fund Grant (EIAF) program are required to address risks and vulnerabilities of natural or human-caused hazards. As part of DOLA's mission to strengthen Colorado communities – the Division of Local Government provides technical assistance and planning expertise to help guide communities in addressing their risk and vulnerabilities.

Most communities subject to flood hazards in Colorado participate in the NFIP. The NFIP sets minimum requirements for participating communities' subdivision regulations and building codes. Communities are encouraged to adopt local ordinances that are more stringent than the state or federal criteria. This is especially important in areas with older maps that may not reflect the current hazard. These could include prohibiting damage-prone uses (such as garages, sheds, parking lots, and roadways) from the floodway or requiring structures to be elevated one or more feet above the base flood elevation.

As with any regulatory program, property owners may not be aware of the need for permits, or may resist getting permits, especially after a flood. Because many existing floodplain maps are out of date, caution should be exercised when utilizing them for regulations. Conservative safety factors are highly recommended. Some of the requirements, such as floodway construction criteria or substantial improvement rules, can be technically complicated. However, assistance is available from FEMA, CWCB, and DHSEM.

CWCB supports watershed planning and projects designed to restore and protect watersheds. This is more clearly defined in the Board's Policy Implementation Objectives, which include multi-objective planning, project development, and stream restoration. In order to achieve this objective, the Board participates with partners to plan and undertake multi-objective projects designed to reduce flood hazards, stabilize and restore stream channels, protect or restore habitat, reduce erosion, and increase the capacity to utilize water. Inter- and Intra-agency coordination, communication, and prioritization are essential components of this objective. Board Staff along with the Watershed and Flood Protection Section achieve these goals through administration of the Colorado Watershed Restoration Program, the Colorado Healthy Rivers Fund, and the Fish and Wildlife Resources Fund. The Board administers the Colorado Healthy Rivers Fund in cooperation with CDPHE's Water Quality Control Division.

4.2.4 State Funding Capabilities for Flood Hazard Mitigation Projects

The state funding sources and capabilities for flood hazard mitigation projects were presented in previous sections of this document, and are summarized below for reference. Several of the programs are federally-funded but flow through state agencies. Most of these are ongoing programs and are pre-disaster related; those programs that are post-disaster related are indicated with an asterisk (*) and may not be continuously funded:

Department of Local Affairs (DOLA):

- Community Development Block Grants (CDBG)
- CDBG Disaster Recovery (DR) Resilience Planning Program*
- CDBG-DR Watershed Resilience Pilot Program*
- Energy/Mineral Impact Assistance Fund Grants

Colorado Division of Homeland Security & Emergency Management:

- State Disaster Emergency Fund
- Hazard Mitigation Assistance (HMA) grants
- Emergency Management Performance Grant (EMPG)

Colorado Water Conservation Board:

- Risk MAP
- Emergency Watershed Protection (EWP) Program
- Watershed Restoration Program
- CWCB Flood Response Fund
- Community Assistance Program (CAP) (Technical Assistance)

Department of Natural Resources:

- Dam Safety Program (local dam Emergency Action Plans)

4.2.5 Changes in Hazard Management Capabilities of the State

The state funding sources and capabilities for flood hazard mitigation projects were presented in previous sections of this document. Hazard management capabilities have been increased by the activities associated with the items listed below.

- Development and approval of a state-wide criteria manual for floodplain and stormwater management.
- Advancement with the FEMA Risk MAP Program, providing cost sharing and progressing ongoing studies as a Cooperating Technical Partner with FEMA.
- Funding and implementation of CHAMP to update out-of- date studies and move all state flood maps to a digital format.
- Development of a platform for mapping fluvial hazards across the state, and providing technical standards and regulatory guidance.
- Training workshops and seminars developed and presented by the CWCB CAP Coordinator regarding floodplain management within the state.
- Training workshops to local emergency managers developed and presented by DHSEM.
- Training provided to state and local emergency managers and local insurance agents to promote their certification as Certified Floodplain Managers (CFM).
- The development of the CDOT Region 4 Standard Operating Procedure with input from CWCB and FEMA Region VIII, for acquiring pre-construction permit approval in transportation floodplain development actions.
- Disaster recovery capacity increased with short-term federal and state recovery funding related to the 2013 floods. The capacity will significantly decrease when grant funding expires in Summer 2019.

In November 2010, CWCB updated the Rules and Regulations for Regulatory Floodplains in Colorado with higher flood protection standards above the minimum required by the NFIP. The primary floodplain management provisions include:

- One-foot of freeboard for all new and substantially changed structures in 1% annual chance floodplains, with the exception of critical facilities. Non-residential structures can be elevated or floodproofed to at least one-foot above the base flood elevation.
- Two feet of freeboard shall be provided to all new and substantially changed critical facilities (as defined in the Rules) in 1% annual chance floodplains.
- In areas with base flood elevations defined, floodway surcharge criteria shall be reduced to 0.5 feet (from 1.0 feet) for all new studies begun after January 14, 2011. Exceptions to this requirement exist and are discussed in the Rules. The process for determining floodways and regulations associated with the floodways remain unchanged.
- Communities shall regulate construction in areas removed from FEMA's regulatory floodplain through a LOMR Based on Fill by requiring new and substantially improved structures built on these lands to maintain a lowest floor one foot above the base flood elevation that existed prior to the placement of fill, consistent with development in other regulatory floodplains.

CWCB provided technical assistance for local communities between 2013-2018, including conducting workshops on the new Rules and assistance with updating their ordinances based on the new standards. As of May 2018, 247 out of 252 communities (98%) participating in the NFIP have adopted the new Rules, with more adoptions pending.

NFIP policy and claims data were also analyzed as an aspect of the vulnerability assessment update in the Plan and are presented here in terms of capability improvements. In 1994, there were 9,893 flood insurance policies. In September 2003, there were 15,261 flood insurance policies statewide with an insured value of $2,477,325,600. As of September 2007, Colorado had 17,788 flood insurance policies statewide with an insured value of $3,626,858,400. In 2010, the state had 19,117 policies with $4,197,483,200 in total coverage. In 2013 there were 21,977 policies and $5,012,621,100 in total coverage in Colorado. As of February 23, 2018, there were 21,705 policies and $5,492,089,300 in total coverage in Colorado. The trend shows that overall NFIP policies and coverage have steadily increased. The slight decrease in policies between 2013 and 2018 may be a result of insurance reforms that have affected affordability, and reflects a nationwide trend during that time period.

DHSEM and the Division of Housing collaborated with other state, federal, and private nonprofit agencies to establish a state-led Disaster Housing Task Force. This Task Force works to assess the state's post-disaster housing capabilities and to develop recommendations for preparedness and response actions. This includes identifying housing options outside of hazard areas including floodplains.

Since the 2013 Plan update, DHSEM added one new position to its Mitigation Team to enhance

their capability to provide technical assistance to local and tribal governments, as well as state agency partners on mitigation planning. This will also enable DHSEM to offer greater assistance for developing and implementing mitigation projects throughout the state.

The CWCB funded and was a part of seven mobile radar projects from 2009-2018. The 2010 NOAA mobile radar campaign in Durango was funded by the Division of Emergency Management. Mobile radars were rented and deployed in Gunnison, Durango, on Bristolhead mountain near Rio Grande Reservoir, on Wolf Creek Pass twice, and at the Alamosa airport twice. The goal of these projects was to provide radar data in areas deficient in radar coverage. Two of the projects were for winter precipitation for water supply modeling, and five projects were to either collect and analyze data or for summer flash flood warning assistance to the NWS. The West Fork Complex fires near Rio Grande Reservoir are in a radar beam blocked area, therefore having real time mobile radar data in Pueblo was helpful in providing timely and accurate flash flood warnings to the NWS. These accurate warnings were used in emergency operations by emergency managers in Rio Grande and Hinsdale counties.

The CWCB worked with local emergency managers, water districts, NOAA National Severe Storms Lab, and the Oklahoma University Advanced Radar Research Corporation for these seven mobile radar projects. The radar rentals for a full winter at the Alamosa airport provided quality winter precipitation data in wilderness and remote areas that was useful in the national water model to provide accurate April through October water supply forecast volumes for the Rio Grande and Conejos Rivers when compared to official water supply forecasts. Those two winter projects built a valuable business case in the water community to support permanent radar in the San Luis Valley. The Governor's Executive Order (EO) for Fire Recovery in the Rio Grande also supports temporary or permanent radar solutions. The EO led to the creation of the Rio Grande Watershed Emergency Action and Coordination Team (RWEACT).

In 2018, plans for a permanent radar at the Alamosa airport became a reality when a large local coalition of counties and water districts worked cooperatively with CDOT and CWCB to fund-raise for a commercial grade C-Band dual polarized permanent mounted weather radar at the Alamosa airport. Funding from CDOT, the Colorado State Legislature's Capitol Development Committee, the CWCB Water Forecasting Partnerships Authorization, and RWEACT have been combined to fund permanent radar in the San Luis Valley. A permanent 50-foot tower at the Alamosa airport and selection of a radar vendor will happen in late 2018 and the permanent weather radar should be operating by late 2018 or early 2019. In the U.S. Congress HR. 1561 - Weather Research and Forecasting Innovation Act of 2016 addresses radar data gaps, observations, and modeling and through this enabling language can be supportive of this project and future Colorado permanent weather radar projects.

Colorado’s Resiliency Framework developed after the 2013 floods, aims to achieve cross-sector resilience planning. The Framework provides guiding principles around resiliency for the state, and defines the structure through which the state will support local agencies and community groups as they identify and implement their own resiliency actions.

The Colorado Climate Plan, which was initially completed in 2015 and updated in 2018, provides statewide policy recommendations and actions to mitigate greenhouse gas emissions and to increase Colorado's level of preparedness. The 2018 update of the Climate Plan includes the objectives contained in Governor Hickenlooper's July 11, 2017 Executive Order D 2017-015 Supporting Colorado's Clean Energy Transition, which committed the State to additional climate action. The Plan focuses on eight areas including water, public health, greenhouse gas emissions, energy, transportation, agriculture, tourism, and recreation and ecosystems. Opportunities for partnerships between the state, local governments, and businesses are also highlighted in the plan.

Floodplain Mapping

The FEMA Risk MAP program vision is to deliver quality data that increases public awareness of flood risk leading to actions that reduce the risk to life and property. Risk MAP emphasizes a comprehensive and integrated approach that includes floodplain mapping, risk assessment, and mitigation planning unified by risk communication. For the past 16 years the CWCB has received over $18 million dollars from FEMA for Map Modernization and Risk MAP projects.

Flood hazard risks have been identified and prioritized in all 64 counties in Colorado; however, not all counties have had floodplain maps completed. The mid-2018 status of flood hazard maps produced through Risk MAP (and formerly Map Modernization) in Colorado is depicted in Table 4-2; this is also shown on the map in Figure 3-5.

The CWCB launched the CHAMP website to provide an overview of all hazard mapping projects the CWCB is managing within Colorado. This website contains downloadable data from field surveys, meetings, and resources communities may use for outreach purposes.[22]

Table 4-2 Flood Hazard Mapping Status as of June 2018

County	Status	County	Status
Adams	Effective	Kit Carson	No study
Alamosa	Scoped	La Plata	Effective
Arapahoe	Effective	Lake	No study
Archuleta	Effective	Larimer	Effective
Baca	No study	Las Animas	Preliminary
Bent	Scoped	Lincoln	No study
Boulder	Effective	Logan	Effective
Broomfield	Effective	Mesa	Effective
Chaffee	Effective	Mineral	No study
Cheyenne	No study	Moffat	No study
Clear Creek	Effective	Montezuma	Effective

[22] http://www.coloradohazardmapping.com

County	Status	County	Status
Conejos	No study	Montrose	Effective
Costilla	No study	Morgan	Effective
Crowley	No study	Otero	Scoped
Custer	No study	Ouray	No study
Delta	Effective	Park	Effective
Denver	Effective	Phillips	No study
Dolores	No study	Pitkin	Preliminary
Douglas	Effective	Prowers	Effective
Eagle	Effective	Pueblo	Preliminary
El Paso	Preliminary	Rio Blanco	In Progress
Elbert	Effective	Rio Grande	Effective
Fremont	Effective	Routt	Effective
Garfield	Preliminary	Saguache	No study
Gilpin	No study	San Juan	No study
Grand	Effective	San Miguel	No study
Gunnison	Effective	Sedgwick	No study
Hinsdale	In Progress	Summit	Effective
Huerfano	No study	Teller	Effective
Jackson	No study	Washington	No study
Jefferson	Effective	Weld	Effective
Kiowa	No study	Yuma	No study

Source: Colorado Water Conservation Board 2018

Currently the outreach efforts for Risk MAP are supported through meetings, letters, emails, conference calls, presentations, and information provided on CWCB websites. The CWCB sends out letters and/or emails to community officials and representatives to initiate contact and inform them of upcoming meetings. Coordination and communication continues throughout the project timeline as needed until after the preliminary map products are sent out for review and the final meeting has taken place. Once comments are received from the communities on the preliminary map products, comments are reviewed and a comment resolution is sent out to address all community comments. The CWCB may also coordinate post preliminary efforts if needed or requested by a community should any mapping issues arise during the appeal or compliance period.

Between 2010 and 2013 FEMA provided $2,930,823, the State provided $613,135, and local communities provided $237,925 to fund Risk MAP projects in Colorado. Risk MAP projects are conducted on a watershed basis. According to the Colorado Risk MAP Business Plan Update 2013 with the initiative of Risk MAP and new program measures that need to be met for FEMA Region VIII, the top three unmet mapping needs for Colorado are the Upper Gunnison, Upper White, and the Middle South Platte-Cherry Creek watersheds.

4.3 Local Capability Assessment

Local governments in Colorado have long had policies, programs, and capabilities in place related to flood mitigation. A summary of local governments' flood mitigation capabilities is presented in this section.

4.3.1 Local Mitigation Policies, Programs, and Capabilities

Data in this section was gathered by reviewing 59 local hazard mitigation plans encompassing two multi-county regions, 49 counties, six cities, and two tribes. The majority of the reviewed plans ranked flood as one of their top three hazards. The local plans were reviewed for information on existing mitigation capabilities including regulations, codes, emergency warning systems, evacuation plans, public information programs, GIS/mapping, master plans, flood insurance programs, and potential projects. Table 4-3 summarizes which activities were identified in local hazard mitigation plans in 2018. Local capabilities to handle floods may have changed since the writing of a portion of these plans. Additionally, some of these plans have expired or are in the process of being updated. Currently, 61 counties of the 64 in Colorado have developed and adopted a FEMA-approved hazard mitigation plan.

Efforts to analyze flood mitigation capabilities from local plans in 2018 are shown below as an indication of the policies and projects used at the local level in Colorado.

Table 4-3 Typical Flood Mitigation Capabilities from Local Hazard Mitigation Plans

Flood Mitigation Capability	# of Counties
Building codes, land development regulations, etc.	48
Early warning systems	52
Early warning systems: Flood	7
Participation in NFIP	53
Outreach and education	26
Stormwater Program, Plan, or Ordinance	26
GIS capability	52
Erosion and sediment control	23
Elevation Certificates	18
Designated StormReady	24
CRS Participation	11
Property acquisition/relocation	11

Based on 2018 local hazard mitigation plan analysis

International Code Council (ICC) construction regulations are also used as a form of flood hazard mitigation. In Colorado, these codes are adopted at the local level.

Information related to flood mitigation projects, evacuation plans, emergency warning systems, etc., can also be found in local hazard mitigation plans. Local communities were originally encouraged by DHSEM to start their flood hazard mitigation plans and have them completed for the original November 1, 2003 deadline associated with the umbrella SHMP document. DHSEM and CWCB are encouraging communities across the state to start or update plans. As part of DOLA's mission to strengthen Colorado communities, the Division of Local Government provides technical assistance and planning expertise through workshops and the online *Planning for* Hazards in Colorado guide to help communities in addressing their risk and vulnerabilities.

The Denver Water Board has mobilized significant resources for sediment control programs to mitigate flooding and reduce reservoir siltation. The Denver Water Board has been removing excess sediment from the upper reaches of the South Platte River, which was heavily impacted by the Hayman Fire. Between 2010 and 2012, Denver Water removed at least 625,000 cubic yards of sediment from the Strontia Springs Reservoir.23

Much of the sediment in the Reservoir built up in the aftermath of the Buffalo Creek and Hayman wildfires. Sedimentation can increase the cost of water treatment, degrade water quality, and create operational problems. By removing the sediment Denver Water hoped to reduce these impacts.

UDFCD assists with funding and managing several flood mitigation initiatives in Colorado including drainageway and watershed master plans; converting and updating DFIRMs; assisting local governments with floodplain regulations; reviewing and commenting on proposed development in or near floodplains; and public education on flood hazards in local areas. Over 170 watershed master plans have been completed. The District's Information Services and Flood Warning Program includes assisting local governments to develop flood warning plans and installing flood detection networks. Daily forecasts and data from the detection networks are posted on the UDFCD website. The District's GIS system designs and tracks flood mitigation projects and supports regional mapping initiatives. The Design, Control, and Maintenance Program works with local governments and agencies on implementing drainage improvements and maintaining drainage facilities. The Floodplain Management Program at UDFCD promotes floodplain preservation to local governments and developers with the idea that the benefits of a preserved floodplain (recreation, wildlife habitat, etc.) can be marketed by developers as amenities to their projects, but they also become long term assets to the communities.

The local hazard mitigation plan analysis completed for the 2018 plan update identified 52 of the 64 counties have a floodplain management plan or ordinance. The latest NFIP Community Status

[23] http://www.thedenverchannel.com/news/waterton-canyon-reopens-after-19-month-closure

Book Report24 indicates that 53 of the 64 counties participate in the NFIP. Of the 11 counties that are not participants in the program, nine do not have completed FIRM maps. The other two, Custer and Grand Counties, do not participate in the NFIP; Custer County was sanctioned in June 1978 and Grand County was sanctioned in January 2009.

In addition to the capabilities listed above, many local Colorado jurisdictions are served by Certified Floodplain Managers (CFMs). The CFM program offers a standardized floodplain education and management system that can give many people the expertise to help reduce the damages caused by flooding. As of June 2018, Colorado has 509 active CFMs (up from 391 in 2013 and one of the highest numbers of any state in the nation), and a substantial number of individuals join the program each year. The knowledge and expertise afforded by the CFM program can help enable better decision-making regarding flood hazard mitigation.

4.3.2 Effectiveness of Local Mitigation Policies, Programs, and Capabilities

The effectiveness of the local mitigation policies, programs, and capabilities can be reflected by the continued progress of the local communities in the development and administration of local floodplain regulations, reduction of population and structures in the floodplain, and the implementation of both planning and flood control projects. In 2018, Washington, Sedgwick, Kit Carson, Kiowa, Cheyenne, Custer, and Baca Counties, and the Southern Ute Indian and Ute Mountain Ute Tribes were identified as not having local floodplain regulations. In order to participate in the NFIP, communities must have local floodplain regulations in place. The CWCB continues to encourage NFIP participation at the local level and assists with the development of the necessary documentation to apply for the NFIP.

The CRS program is helping with flood insurance affordability at the local level. As of May 2018, there were 47 Colorado communities (36 cities and 11 counties) participating in the CRS. Several changes were also made to the 2013 CRS Coordinator's Manual that impacted CRS activities in Colorado. The Manual was last updated in 2017. Some communities will receive increased credit for their existing CRS activities, while others could see a decrease. For instance, some mapping activity credits were being reduced, but credits for mitigation efforts are being increased.

The lack of DFIRM mapping, and accurate flood hazard mapping, remains an issue in some communities. Cuts in federal funding for mapping have not helped this situation. Communities need maps to effectively implement floodplain regulations. The implementation of the Biggert-Waters Act of 2012 and fears of exorbitant flood insurance premiums has resulted in resistance to more accurate floodplain mapping at the local level in some cases. The 2012 Biggert-Waters Reform Act did have an effect on homeowner's insurance premium rates, particularly on second homes, with affordability potentially becoming an issue in high-risk areas unless properties are

[24] http://www.fema.gov/cis/CO.pdf

mitigated. Following the 2012 Biggert-Waters Reform Act was the 2014 HFIAA, which repealed and modified certain provision of the 2012 Biggert-Waters Reform Act and made additional program changes to other aspects of the program that were not covered under the 2012 Act. A discussion on some of the changes under HFIAA can be found in Section 4.5.3.

4.4 Mitigation Actions

4.4.1 Identification of Actions under State Consideration

This plan emphasizes mitigation activities that will support local efforts and further statewide initiatives. The goals, recommendations, and actions for this plan were derived from several sources in the planning process. Goals and objectives from the 2018 update to the SHMP umbrella document were also reviewed. During the 2018 update the existing actions were reviewed for progress made, continued validity, and updates or changes. New actions were also developed through a process described in detail in Section 4.4.3. The following actions are captured in Table 4-4 and represent the collaborative efforts of the Flood TAP and other state agencies over the years. The mitigation action table was revised to be consistent with the 2018 SHMP action tables. Another effort to refine the mitigation strategy in 2018 was to separate out the actions identified as 'completed' from the ongoing action plan. In the 2018 State Flood Hazard Mitigation Plan Ongoing and New Actions Table there are a total of 29 active action items; 20 of the actions are continuing from the 2013 Plan; nine new actions were identified with this update.

Many of the recommendations can be implemented in the short term which is defined as the next five-year update cycle; others must be viewed as long-term measures, and some will be implemented during drought cycles. The actions are grouped by the goal they most help achieve, and are prioritized by **H**igh, **M**edium and **L**ow (see Section 4.4.4 for a discussion of the prioritization process). In general, the timeline of implementation is reflected in the prioritization: High- target implementation within three years; Medium- within three to six years; Low- within ten years or as needed.

Table 4-4 State Flood Hazard Mitigation Plan Ongoing and New Actions

Action ID	Action	Priority	Responsible Lead Agency or Work Group	Mitigation Type	Additional Comments on Status, Implementation, Funding, and Potential Benefits
1.1	Update State Stormwater and Drainage Criteria Manual.	M	CWCB	Planning & Regulations	As of 2018 this action has been deferred but is still needed. Action Development Date: 2013
1.2	Develop a statewide debris management plan that includes details on managing various types of hazardous waste, contaminated silt, etc.	M	CDPHE DHSEM	Planning & Regulations	Although not mature this action is mentioned in the 2016 Colorado Hazard and Incident Response and Recovery Plan (CHIRRP) and will be included in the new state EOP. Action Development Date: 2013
1.3	Continue to identify and mitigate bridges with "scour critical" ratings to reduce vulnerability of bridge infrastructure to flood events, and manage flood risks through the development of a new Standard Operating Procedure for certifying "no rise" base flood elevations.		CDOT	Structure & Infrastructure Projects	The CDOT Plan Of Action (POA) Bridge Scour project finished the first phase of work in which 243 scour critical bridges were identified. The bridges were categorized into low, moderate, and high priority scour. Three million dollars from the Responsible Acceleration of Maintenance and Partnerships (RAMP) Asset program have been dedicated for phase two of the POA and the consultant notice to proceed has been issued. Phase Two work includes final hydraulic and scour analysis and countermeasure design for the 27 high priority bridges. A design prioritization plan will be developed to maximize construction delivery efficiency. 2018 update: The design prioritization plan is being executed as proposed, and continues to evolve annually based on new information as it becomes available. The SOP for no rise certification was developed to guide acquisition of pre-construction floodplain permit approval for transportation floodplain development actions; developed in partnership with CWCB (Stephanie DiBetitto) and FEMA Region VIII (Matthew Buddie). Action Development Date: 2007
1.4	Improve emergency warning systems and encourage the installation of additional sensors and reporting devices to improve high flow measurement capabilities along flood prone streams in high risk areas.	H	DHSEM CWCB DWR UDFCD	Structure & Infrastructure Projects	CWCB and DHSEM provided funding for a CWCB project to study improvements in early warning capabilities by placing mobile radar trucks in Southwest Colorado and the Rio Grande Valley. This specific project was completed and demonstrated how more localized radar will improve storm prediction and early warning capabilities as compared to NWS facilities in Grand Junction. Data from the mobile radar is transmitted in real-time to the NWS Grand Junction office to improve their prediction capabilities. As a part of this project, NOAA and local communities are also funding the installation of a network of stream gages to further enhance prediction capabilities. Since 2012 for State declared disasters,

Action ID	Action	Priority	Responsible Lead Agency or Work Group	Mitigation Type	Additional Comments on Status, Implementation, Funding, and Potential Benefits
					DHSEM requests disaster recovery funding from the Disaster Emergency Fund that may be used by impacted jurisdictions to enhance stream emergency warning systems through additional sensors and reporting devices. UDFCD continues to maintain and improve the ALERT flood warning system and work with local emergency managers to utilize the tools during flood season. Action Development Date: 2007
2.1	Enhance the natural and beneficial functions of floodplains by promoting an increased awareness of stream ecosystem function and its benefits to flood hazard mitigation.	H	CWCB DWR CPW CASFM UDFCD FEMA Region VIII	Natural Systems Protection	This is part of the ongoing mission of the CWCB Watershed Restoration Program. The CWCB has provided funding and technical assistance for projects that promote natural and beneficial functions of stream ecosystems. This includes wetlands and habitat resources along with other biomes. Implementation should include ongoing Colorado Watershed Restoration Program initiatives, along with those that took place following the 2013 flood. UDFCD is actively promoting High Functioning Low Maintenance System channels and roadway crossing designs that are based on natural stream processes. Maintenance eligible projects by the development community must be informed by geomorphology. UDFCD, CASFM, and CRA are offering the Stream Academy to provide educational opportunities for engineers and local government staff. Action Development Date: 2007
2.2	Promote public education on post- wildfire flood hazard potential in burned watersheds	H	CWCB CO Forest Service CPW FEMA Region VIII	Education, Awareness, & Outreach	This will be implemented regularly particularly following large burn events. CWCB has conducted workshops and participated in public outreach meetings in areas impacted by wildfires, particularly since the 2012 Waldo Canyon and High Park Fires and 2010 Fourmile fire. Action Development Date: 2010
2.3	Provide newsletter articles, other relevant information on flood hazard mitigation, and other forms of information exchange to professional organizations and local governments.	H	DHSEM CWCB UDFCD CASFM CDOT FEMA Region VIII CRO	Education, Awareness, & Outreach	DHSEM provides local agencies with examples of mitigation “best practices” to assist in local planning and mitigation project activities, including information on flood reduction strategies. CWCB has a regular column in CASFM’s newsletter. In addition, CWCB publishes the Floodstage newsletter. CDOT is in partnership with CWCB for sharing Post-2013 Flood hydrology updates.

Action ID	Action	Priority	Responsible Lead Agency or Work Group	Mitigation Type	Additional Comments on Status, Implementation, Funding, and Potential Benefits
					CRO published an article with the U.S. Green Building Council on the need to build resilience into state investments and operations to avoid future losses in events similar to the 2013 floods. Action Development Date: 2007
2.4	Promote flood insurance outside of regulatory floodplains.	M	CWCB UDFCD	Education, Awareness, & Outreach	Inform public of risks outside of floodplains, including channel migration/erosion hazards; This is an ongoing effort and promotion of flood insurance in general is an increasing national priority, Action Development Date: 2013
2.5	Continue to provide access to information, education, and tools on flood mitigation through Resiliency Resource Center and Planning for Hazards websites.	H	DOLA – DLG & CRO	Education, Awareness, & Outreach	Action Development Date: New in 2018
2.6	State floodplain management website.	M	CWCB	Education, Awareness, & Outreach	Structure specific website showing estimated losses via crowd sourcing site and State floodplain management website (all state resources). Action Development Date: New in 2018
2.7	Continued support for Watershed Coalitions.	M	CWCB DOLA - DLG CDOT	Technical Assistance	Provide support for existing and new watershed coalitions. Coalitions build support, capacity, and community understanding about the importance of healthy watersheds; multiple benefits inclusive of flood mitigation. Action Development Date: New in 2018
3.1	Develop guidance and criteria for mapping and regulating mudflow/debris-flow areas.	M	CGS CWCB	Planning & Regulations	This has been partially addressed with a section in the Stormwater and Drainage Criteria Manual, but this manual needs updating (see related action regarding update of the Manual). More funding is needed for this effort, possibly through the CO Watershed Restoration Program. The CWCB is working to finalize guidance and criteria for mapping and regulating fluvial (erosion) river hazards. CGS is spearheading the mudflow/debris-flow mapping. Action Development Date: 2007
3.2	Optimize potential state and federal funding sources to support mitigation initiatives	H	DHSEM CWCB Flood TAP	Technical Assistance	See the section 4.5 of this plan for the list of current and potential federal, state, and local funding sources for hazard mitigation. DHSEM administers FEMA's PDM, FMA, and EMPG programs,

Action ID	Action	Priority	Responsible Lead Agency or Work Group	Mitigation Type	Additional Comments on Status, Implementation, Funding, and Potential Benefits
	which are part of the Colorado Flood Hazard Mitigation Plan to include additional coordination with Silver Jackets on State projects.				and has helped multiple communities in Colorado leverage these funds. DHSEM has also provided state agencies and local governments with EMPG funding for drainage studies and education programs related to flood hazards. Action Development Date: 2007 and updated in 2018 to include Silver Jackets reference
3.3	Develop a process to identify areas of Colorado where the combination of NFIP policy holders and flood risk indicate the potential for strong FMA projects.	M	DHSEM CWCB Flood TAP UDFCD	Data & Studies	This is due to a shift in federal funding away from the multi-hazard PDM program, and availability of FMA funding through increasing federal efforts to reduce claims to the NFIP. This effort is also being initiated to strengthen local participation in a traditionally under-applied program in Colorado. This effort is estimated to cost $100,000 in FMA state management costs for annual technical assistance. Progress still needs to be made on this action. Action Development Date: 2013
3.4	Colorado Hazard Mapping Program (CHAMP)	H	CWCB CGS	Data & Studies	In 2015 the Colorado Legislature passed a funding bill for the Colorado Hazard Mapping Program (CHAMP) with the goal of providing mitigation and land use framework in areas likely to be affected by future flooding, erosion, and debris flood events. Updated hazard information is provided for the streams most affected by the September 2013 flooding. Phase I and II of the project includes field reconnaissance and survey, creating terrain models from updated topographic datasets, evaluating hydrology, and modeling to produce flood hazard area limits reflecting the changed conditions. The updated information is intended to be used by community leaders to update hazard information to assess risk and identify mitigation opportunities in their community as well as used to update FEMA Flood Insurance Rate Maps. The website provides an overview of all hazard mapping projects the CWCB is managing within the state. This website contains downloadable data from field surveys, meetings and resources communities may use for outreach purposes. http://coloradohazardmapping.com Action Development Date: New in 2018
3.5	Continued LiDAR acquisition and management of data for flood and other hazard mapping.	H	CWCB OIT CGS	Data & Studies	The CWCB has been actively leading efforts to obtain LiDAR-based terrain data for the entire State of Colorado since the September 2013 flood. The other state agencies collaborating in this effort include OIT and CGS. The CWCB has received over

Action ID	Action	Priority	Responsible Lead Agency or Work Group	Mitigation Type	Additional Comments on Status, Implementation, Funding, and Potential Benefits
					$6.4 million from other federal, state, and local partners since 2013 specifically for LiDAR acquisitions. Action Development Date: New in 2018
4.1	Digitize existing 100-year floodplain maps.	H	CWCB	Data & Studies	See the discussion on DFIRM/Risk MAP mapping progress in this plan. As of 2018 Digital Conversions of some counties remain to be done and are in progress with assistance from the CWCB's mapping consultants. Action Development Date: 2013
4.2	Continue development of countywide Base Level Engineering Mapping.	L	CWCB	Data & Studies	Provide best available flood hazard data across a county using 2-D hydrologic and hydraulic modeling. Action Development Date: New in 2018
4.3	Create a Dam Safety Inundation Map Database.	H	DNR-DWR	Data & Studies	DWR has assembled a geodatabase of shapefiles that has been shared with the floodplain and emergency manager communities across the State. Data is not 100% complete as far as content, but it is updated as they add shapefiles to it. Action Development Date: 2013
4.4	Develop post-fire debris flow hazard maps.	M	CGS CWCB	Data & Studies	CWCB assisted in financing post-fire hydrology, inundation mapping, and debris flow assessment for the Waldo Canyon Fire burn scar. This included the use of quality base mapping, development of post-fire hydrology & hydraulic models, and an understanding of potential debris flow. Action Development Date: 2013
4.5	Provide technical assistance to local communities in the development of future conditions mapping for CRS credit.	M	CWCB UDFCD	Technical Assistance	CWCB assisted in financing engineering services to address near-term impacts posed by flooding and debris flows within Manitou Springs. Flood Hazard Area Delineation studies within UDFCD. Action Development Date: 2013
4.6	Continued Fluvial Hazard Zone mapping statewide (post pilot phase).	L	CWCB CGS DOLA – DLG	Data & Studies	This action would continue the mapping that began as a pilot into a statewide mapping effort. As of 2018 the CWCB is currently mapping eight pilot communities. Project website: http://coloradohazardmapping.com/hazardMapping/fluvialMapping. Action Development Date: 2013
5.1	Promote land use solutions to reduce risk to flood hazards	H	DHSEM CWCB	Technical Assistance	As a part of its technical assistance services, DHSEM provides background information and a comprehensive list of possible

Action ID	Action	Priority	Responsible Lead Agency or Work Group	Mitigation Type	Additional Comments on Status, Implementation, Funding, and Potential Benefits
	through information, education, and technical assistance.		DOLA – DLG UDFCD		mitigation actions. This list includes suggestions for enhancing codes and land use regulations and integrating hazard mitigation plans into local land use and comprehensive planning efforts. DLG has developed various tools to support local communities' hazard reduction through land use regulations and the *Planning for Hazards: Land Use Solutions for Colorado* guide, website, and workshops. UDFCD promotes floodplain preservation to local governments and developers within the District with the idea that the benefits of a preserved floodplain (recreation, wildlife habitat, etc.) can be marketed by developers as amenities to their projects, but also they become long term assets to the communities. DHSEM plays a supporting role to DOLA/DLG on this action. Action Development Date: 2007
5.2	Promote development of master drainage plans for State properties.	L	CWCB DHSEM	Planning & Regulations	CWCB provides funds for watershed master plans. Watershed master plans promote connectivity, healthy riparian vegetations, etc. which ultimately mitigate flood damage and promote resiliency. Action Development Date: 2007
5.3	Incorporate new State floodplain standards into local standards.	H	CWCB	Technical Assistance	The State Flood Rule became effective January 2014. This action is nearly complete as of mid-2018. As of May 2018, 247 out of 252 communities (98%) participating in the NFIP have adopted the new Rules. Action Development Date: 2013
5.4.	Promote use of CWCB best available data policy for local governments to manage floodplain redevelopment following a flood.	L	CWCB UDFCD	Technical Assistance	Action Development Date: New in 2018
5.5	Develop a policy that all State agencies providing grant funding will recognize compliance with State floodplain rules and regulations for Colorado in funding decisions.	M	CWCB Other State Agencies funding local projects	Planning & Regulations	Action Development Date: New in 2018

Action ID	Action	Priority	Responsible Lead Agency or Work Group	Mitigation Type	Additional Comments on Status, Implementation, Funding, and Potential Benefits
5.6	Promote a One Water approach and integrated water management into local water and land use planning.	H	CWCB DOLA	Planning & Regulations	CWCB and DOLA/DLG are partnering with organizations and local governments to help implement the Colorado Water Plan goal to increase water conservation in land use planning through training, technical assistance, guidance materials, and other resources. Action Development Date: New in 2018

Completed Actions

Consistent with the FEMA and EMAP requirements, those actions that have been completed are identified in Table 4-5. The completed actions show progress made toward the Plan's goals as the plan has matured over the years. Each project has an action identification number that connects the action to the primary goal they were designed to help achieve, as an indication of how each action contributes to the overall mitigation strategy. Each mitigation action also identifies the mitigation type of the proposed action (natural system protection; planning & regulations; education, awareness, & outreach; structure & infrastructure projects; funding; data & studies; and technical assistance) and the potential funding sources and the potential benefits of implementing the action. A summary discussion of progress made toward implementing the action is included in the table under the "Additional Comments on Status, Implementation, Funding, and Potential Benefits" column, and discussed in the Section 4.4.2.

Table 4-5 State Flood Hazard Mitigation Completed and Deleted Actions

Related Goal	Action	Priority	Responsible Lead Agency or Work Group	Mitigation Type	Comments on Status, Implementation
1	Seek ratification of State Executive Orders 8504, 8491, and legislation such as H.B. 1041 and incorporate into the Colorado Flood Hazard Mitigation Plan. In addition, promulgate rules and regulations to administer the legislation if necessary.	L	CWCB	Planning & Regulations	
1	Establish a section in state criteria manual to promote design and operation of flood control systems and other related infrastructure to convey floodwaters safely.	H	DWR CWCB	Planning & Regulations	This is addressed in the State's Stormwater and Drainage Criteria Manual; an update to this manual is needed (see action 1.4).
1	Look for opportunities in the recovery from 2013 floods to incorporate flood mitigation strategies into long-term recovery.	M	DHSEM	Structure & Infrastructure Projects	Opportunities that were capitalized on included use of Section 406 mitigation within the PA program during repair of flood damaged infrastructure. Acquisition of flood prone structures was a high priority for HMGP funding and included buy-outs of structures in Lyons, Jamestown, and Boulder County. CDOT leveraged resiliency into repair of damaged highway infrastructure by factoring in highway alignment setbacks from streams to reduce erosion potential in future events, where feasible.
1	Identify Long-Term Safe Affordable Housing Outside Hazard Areas Using Manufactured Housing Where Applicable and Volunteer Agency Construction.	L	DOLA DHSEM	Technical Assistance	The Division of Housing and DHSEM, along with other state, federal, and private non-profit partners have established a state-led Disaster Housing Task Force. The Task Force will work to assess state disaster housing capabilities and develop recommendations for preparedness and response actions. This will include identifying housing options outside of hazard areas such as floodplains, burn scars, and landslide paths. Disaster housing needs were significant following the September 2013 floods. Habitat for Humanity, local housing authorities, and other entities used multiple sources of funding, including CDBG-DR, to build new housing and to rehabilitate damaged housing for flood victims. DOLA was a key partner in this process. One lesson confirmed is that the local

Related Goal	Action	Priority	Responsible Lead Agency or Work Group	Mitigation Type	Comments on Status, Implementation
					government units and nonprofits are critical entities in these processes. Another lesson confirmed is that siting new and replacement low- and moderate-income housing, especially when previously utilized sites are now unavailable, is difficult for some communities. More funding for housing, particularly low- to moderate-income housing, is always needed. Action Development Date: 2010
1	Develop strategy through Flood TAP to identify or target potential HMGP or FMA projects following the 2013 floods.	M	DHSEM	Structure & Infrastructure Projects	Strategy developed and implemented. Acquisition of flood prone structures was a high priority for HMGP funding.
1	Work with State agencies to review and comment on State project proposals during the approval process to ensure that proposals for facilities and infrastructure take natural hazards into account.	H	CWCB CDOT	Structure & Infrastructure Projects	Adopted IBC. Revised in 2013 to reflect review process in place for efforts funded by federal housing grant programs. CDOT's Standard Operating Procedure for acquiring pre-construction permit approval in floodplain development was formulated and implemented in 2017 with input from CWCB and FEMA Region VIII.
1	Created educational outreach program to encourage communities to develop centralized sewer and water systems in areas that will not be impacted by flooding, and relocate or floodproof existing treatment plants and/or lagoons, where possible.	L	CDPHE	Education, Awareness, & Outreach	Outreach materials have been developed and distributed to locals. Funding assistance came from American Recovery and Reinvestment Act funding. Encouraged by WQCD programs.
1	Promote the sustainability and access of critical infrastructure during disaster events to the 100-year flood event.	H	CDOT DHSEM CWCB DWR CDPHE	Structure & Infrastructure Projects	DHSEM continues to refine the State Recovery Plan that includes an Infrastructure Systems Recovery Support Function. DHSEM also continues to work with CWCB by incorporating critical facility vulnerability and capability assessments into any local mitigation plan receiving CWCB funding support. The Office of Preparedness has completed the process of hiring an Infrastructure Planner that will provide additional multi-hazard implementation capabilities to critical facility-related initiatives. CWCB has promoted this concept with local communities for final implementation of the State Flood Rule that becomes effective January 2014. NOTE: Although not fully mature, this was included in the 2016

Related Goal	Action	Priority	Responsible Lead Agency or Work Group	Mitigation Type	Comments on Status, Implementation
			CASFM UDFCD Flood TAP Local govt's		CHIRRP and is being updated in the State EOP. CDOT is incorporating Risk & Resiliency analysis into Permanent Repair projects following Presidentially-declared floods of 2013 and 2015 and vetting those analyses with Federal Highway Administration (FHWA) partners. CDOT also completed a 2018 I-70 Risk & Resiliency Pilot Project, with assistance from AEM Corporation, to investigate the impacts of natural hazards on users (travelling public) and owners (CDOT) to understand fiscal implications of natural hazard damage potential on the I-70 corridor.
1	In floodplains that have already been urbanized, encourage and support a combination of structural and non-structural elements to reduce the risks from floods and other hazards.	H	CWCB DHSEM UDFCD FEMA Region VIII	Education, Awareness, & Outreach	Since 2010, 83% of HMA project awards facilitated by DHSEM were focused on flood hazard reduction. These projects include drainage retention/detention ponds, improved drainage infrastructure, and channel stabilization.
1	Provide post-flood information for better interim management of floodplain following events.	H	CWCB FEMA Region VIII UDFCD		Consider erosion zones for areas of potential stream movement. Gather and compile high water marks for the purposes of recovery mapping. In post-disaster emergency circumstances there may be a need to utilize preliminary FEMA map products or locally produced flood data as best available information for regulatory purposes. The Best Available Data policy seeks to adopt better available flood information in post- disaster situations where CWCB does not have an active role in carrying out the study or in situations where maps have been designated as preliminary by FEMA and are undergoing greater review before they become effective. CWCB designation does not enforce information at the local level; instead it gives the community the ability/protection to regulate to it legally. Communities are also adopting the CHAMP data before effective on regulatory maps. A post-2013 hydrology study was also conducted. UDFCD also provides post-flood documentation for local communities. Action Development Date: 2013

Related Goal	Action	Priority	Responsible Lead Agency or Work Group	Mitigation Type	Comments on Status, Implementation
2	Encourage use of watershed-based GIS maps and better topographic data sets in future land use planning and development review.	H	CWCB DWR	Education, Awareness, & Outreach	Risk MAP program evaluates flood hazards on a watershed basis. Post-September 2013 flooding activities included generating LiDAR datasets. A new action in 2018 further describes the acquisition and use of LiDAR to improve floodplain mapping.
2	Increase awareness of the designated 100-year floodplain in permitting new developments and structures by providing current information and technical data.	H	CWCB CASFM FEMA Region VIII UDFCD	Education, Awareness, & Outreach	Progress made during the September 2013 flooding. CWCB put together a document with information on obtaining post flood permits. UDFCD provides technical assistance and promotes flood risk management through review of development project referrals from communities within UDFCD. The Maintenance Eligibility Program provides an incentive for communities to require proposed projects comply with the Urban Storm Drainage Criteria Manual and are approved by UDFCD.
2.	Improve access to information regarding floodplain management, mapping, flood hazard mitigation. and flood insurance through approaches such as the use of hyper-links between State agency websites, bibliographies of available materials, etc.	H	CWCB DHSEM DWR UDFCD FEMA Region VIII CRO		Action replaced by updated State Floodplain Management Website action in 2018. Upon request, DHSEM works with CWCB to provide communities with information on the NFIP, including repetitive loss information to incorporate into local planning and hazard mitigation grant application efforts. The CWCB website provides access to floodplain management information. The CWCB prepares a "Floodstage Newsletter" each March in advance of spring runoff. The newsletter contains flood articles related to preparedness, response, flood mitigation, post-wildfire flooding, and other related items. The articles are posted on the CWCB web archive and notice distributed via Twitter. The CWCB also posts information related to digital flood map status on the Colorado Hazard Mapping webpage (http://www.coloradohazardmapping.com/) CRO's Resiliency Resource Center (coresiliency.com) provides users with detailed information from multiple State agencies for how to address risks and vulnerabilities to hazards through resiliency

Related Goal	Action	Priority	Responsible Lead Agency or Work Group	Mitigation Type	Comments on Status, Implementation
					frameworks and the integration of resiliency into existing planning efforts. The CRO's 2013 Flood Story Map (http://maps.co.gov/cofloodrecovery/) provides maps, data, and other resources related to the 2013 floods. UDFCD provides both FIRM and best available data on web mapping.
2	Promote the concept of people accepting responsibility for the consequences of living in flood prone areas by providing educational materials to local governments and the public.	H	DHSEM CWCB DNR DLG FEMA Region VIII UDFCD	Education, Awareness, & Outreach	DHSEM encourages participation in the NFIP and refers interested communities to the CWCB for further information. The Division of Local Government (DLG) advises local governments of the risks and funding program restrictions associated with development and infrastructure in floodplains. DHSEM, CWCB, FEMA, and other partners provided post-wildfire flood information (NFIP, enhance flood risk, early warning, property mitigation) through materials and presentations at local workshops, to local community leaders and emergency managers, and web postings. UDFCD performs annual Flood Hazard Information Brochure mailings to properties within flood prone areas. Provides information, handouts, relevant web links to other agencies on local flood hazards, flood safety, and flood insurance for property owners and renters.
2	Promote: 1) the development of contingency plans for household hazardous materials, 2) anchoring/locating containers of hazardous materials, and 3) safely transporting these materials during flood events.	M	CDPHE	Education, Awareness, & Outreach	CDPHE provides household hazardous waste guidance on their website (http://www.cdphe.state.co.us/hm/hhw/index.htm). CDPHE also provides leadership for Emergency Support Function #8 (Health, Medical, and Mortuary). Colorado State Patrol provides leadership for Emergency Support Function #10 (Oil and Hazardous Materials Response). Both agencies provide guidance on issues related to hazardous materials.
2	Publish comprehensive annual flood report combined with previous flood reports.	H	CWCB	Technical Assistance	The CWCB completes this report and discusses the annual summary of flood events at each CASFM conference. No additional reports have been created since 2012 and no plans to restart this program as of 2018.

Related Goal	Action	Priority	Responsible Lead Agency or Work Group	Mitigation Type	Comments on Status, Implementation
2	Develop floodproofing manual for Colorado communities to provide guidance to local officials and property owners on the various floodproofing methods and techniques used in Colorado and other parts of the country when implementing flood protection measures.	M	CWCB FEMA Region VIII UDFCD	Technical Assistance	A new *Floodproofing Existing Non-Residential Structures* manual was completed by FEMA in 2013. UDFCD coordinating with FEMA Region VIII to compile existing floodproofing information to be an available resource for use by property owners and local communities.
2	Develop a Youth Flood Education and Outreach program curriculum for K-12 students incorporating flood messages into school education and community outreach programs.	M	CWCB FEMA Region VIII UDFCD	Education, Awareness, & Outreach	A flood simulation model has been purchased and used in several schools. The FEMA Region VIII office also has flood simulation models that can be used to assist this effort. UDFCD also performs flood simulations at local schools to promote flood risk awareness.
2	Develop recommendations for better management of State floodplains based on compiled list of lessons learned from 2013 floods and apply to future mitigation and regulatory processes.	H	DHSEM CWCB CDOT CDPHE	Planning & Regulations	Following the 2013 Colorado Floods, the state participated in a FEMA case study: *Reducing Losses through Higher Regulatory Standards 2013 Colorado Floods Case Study* FEMA-DR-4145-CO. This study used loss avoidance methodology to determine how much damage would have been reduced if certain regulatory and policy actions had been in place, using both a 100-year (1% Annual) flood event, and the 2013 flood event as models.
2	Develop a hazard mitigation education program for public officials such as local water and wastewater management officials, local building officials, and road and bridge officials at annual conferences and workshops.	M	DHSEM DNR DOLA-DLG CWCB DWR UDFCD CASFM	Education, Awareness, & Outreach	G318 courses (Hazard Mitigation Planning) and CRS workshops have been held at various locations around the state. Outreach and related activities occur annually at the conferences noted. CWCB staff have participated in workshops and presentations at CML, CCI, CEMA, and other associations. DHSEM has continued to improve informational table displays and related materials, to include a notebook of best project practices, a brochure on team technical assistance, and related handouts. DHSEM mitigation staff assist local communities in facilitating hazard mitigation planning meetings, which include officials from various state and local departments and agencies. Additionally, DHSEM teaches local mitigation planning workshops that include flooding considerations.

Related Goal	Action	Priority	Responsible Lead Agency or Work Group	Mitigation Type	Comments on Status, Implementation
			FEMA Region VIII CRO		A workshop was held in fall 2010 on flood hazard mitigation planning and how to obtain CRS Flood Planning (Activity 510) credits from the process. Since 2010, DHSEM has held 5 mitigation courses for local emergency managers that provide information on flood mitigation. DHSEM, CWCB, and FEMA cooperatively developed informational articles about the benefits of close working relationships between Floodplain Managers and Emergency Managers. DHSEM developed a crosswalk tool for how to maximize CRS planning credit through the local hazard mitigation planning process. DHSEM staff spoke at the 2009 CASFM conference about mitigation planning and its relation to flood hazards. DHSEM has also asked project managers of flood reduction mitigation projects to speak at the annual Governor's Emergency Management Conference to discuss best practices and provide advice to other communities interested in pursuing mitigation projects. DHSEM provides Level 1 Hazus runs to counties upon request. DOLA and CDPS presented at the 2018 Colorado Emergency Management Conference on how collaboration between emergency managers and land use planners can lead to mitigation plans, policies, and actions that reduce risk to natural hazards. Mitigating Hazards Through Land Use Solutions Workshops (June 7th and Sept 6th, 2018) - DOLA, DHSEM, and FEMA will be hosting two separate one-day workshops on implementing land use solutions that reduce the impacts of hazards to Colorado's communities. The workshops are designed to guide participants through developing and adopting mitigation actions. There will be a focus on updating land use and development codes to reduce the impact of natural disasters, and creating incentive programs to promote development in safer areas. Utilizing the Planning for Hazards: Land Use Solutions for Colorado guide (www.planningforhazards.com) and supplemental materials, the workshop will draw on lessons from communities that have successfully implemented a variety of tools and strategies. Workshop Goal: Communities that participate will be able to implement their identified land use mitigation action(s) within one year of attending the workshop. These workshops have national applicability to implement hazard mitigation best practices, and may become an

Related Goal	Action	Priority	Responsible Lead Agency or Work Group	Mitigation Type	Comments on Status, Implementation
					offered training by FEMA in the future. These workshops build upon the G318: Local Mitigation Planning course. DOLA promotes integrated hazard mitigation and land use planning at workshops and conferences conducted by Colorado Municipal League (CML), Colorado Counties Inc. (CCI), CEMA, the American Planning Association (APA), and the American Planning Association Colorado Chapter. DOLA's CDO conducts periodic Planning for Hazards webinars on a variety of hazard mitigation and land use planning topics. This educational platform has statewide reach and is designed to offer education and guidance to all scales of local governments. Furthermore, the Planning for Hazards Implementation Pilot Project provides local governments and Colorado communities with a detailed process and supporting materials for developing a working group of planning staff, officials, and other resource experts and step-by-step advice for gathering information on hazards and achieving consensus on which land use tools should be developed and adopted. Resources developed include a Facilitator's Workbook and a Participant Workbook to provide communities necessary background information and the tools to initiate a planning process (including sample agendas, discussion questions, and suggestions for further reading) to prepare for and mitigate hazards by integrating resilience and hazard mitigation principles into local plans and regulations.
3	Promote regional intergovernmental cooperation concerning watershed-based planning and floodplain management using a strategic planning process with goals and recommendations.	H	CWCB DHSEM DWR Flood TAP UDFCD	Planning & Regulations	The CWCB provides technical assistance and promotes multi-objective, watershed based planning efforts. The Colorado Emergency Watershed Protection (EWP) Program for the 2013 Flood Recovery provided funding to implement emergency recovery measures to address hazards to life and property in watersheds impaired by the 2013 Colorado flood event. The program was implemented by the CWCB in cooperation with the NRCS. The program provided financial and technical assistance to local project sponsors to implement watershed recovery projects that reduce risk to life and property, enhance riparian ecosystems, and generate long-term stream system resilience through a collaborative, watershed-based approach that incorporates the needs of diverse stakeholders. Most of the projects were designed in 2016 and 2017 and constructed in 2017 and 2018.

Related Goal	Action	Priority	Responsible Lead Agency or Work Group	Mitigation Type	Comments on Status, Implementation
					The CWCB also implements watershed based mapping, assessment, and planning through the FEMA Risk MAP program. DHSEM has assisted communities in their efforts to develop multi-jurisdictional hazard mitigation plans with flood elements. One essential element to the mitigation planning process is bringing a diverse group of stakeholders from various government agencies, private non-profits, interested citizens, and all participating jurisdictions. As a Cooperating Technical Partner for FEMA, UDFCD coordinates with CWCB and FEMA Region VIII through the Risk MAP program.
3	Provide technical comments and recommendations on proposed state and federal legislation related to floodplains.	M	CWCB UDFCD		CWCB responded to FEMA's Levee Analysis and Mapping Procedures (LAMP) proposal for non-accredited levees. CWCB regularly contributes to the CRS committee. UDFCD provides technical comments and recommendations to FEMA on Guidance and Standard updates, and Letter of Map Revision MT-2 processes for the Risk MAP program.
3	Work with local emergency planners and floodplain administrators to identify critical infrastructure, housing, businesses and all other structures in the floodplains in their communities. Incorporate the information into local emergency response plans.	H	DHSEM CWCB	Planning & Regulations	Local hazard mitigation plans include the identification of critical facilities and other development in areas at risk to hazards. DHSEM and CWCB provide funding and technical assistance to complete these plans. DHSEM and CWCB have partnered to fund development or updates to approximately 20 local hazard mitigation plans, many of which represent multiple communities. Note: Goal # 3 was Deleted with 2018 update due to being largely the purview of SHMP
3	Promote the development of flood mitigation plans as part of multi-hazard mitigation plans through the FMAP, PDM, and Flood Response programs.	H	DHSEM CWCB UDFCD	Planning & Regulations	DHSEM and CWCB provide funding and technical assistance for local multi-hazard and flood mitigation plans. DHSEM has used a variety of funds for local multi-hazard mitigation plans (to include flood sections) with PDM, HMGP, FMA, EMPG and the State Mitigation Assistance Program (SMAP) with additional support from CWCB. UDFCD partners with local communities to develop watershed master plans for flood mitigation within UDFCD.

Related Goal	Action	Priority	Responsible Lead Agency or Work Group	Mitigation Type	Comments on Status, Implementation
3	Maintain database of communities with approved plans.	L	DHSEM CWCB	Planning & Regulations	Project completed. DHSEM posts approved mitigation plans on their website. CWCB has a laser fiche repository of mitigation plans on their website.
3	Update crosswalk between CRS planning and local mitigation planning tool.	M	DHSEM	Planning & Regulations	Action deleted. DHSEM will coordinate with CRS jurisdictions to incorporate their 10-step process within future SHMP updates, as requested by those communities. Replaced by related action in CO SHMP 2018.
3	Review the adequacy of existing stream gage networks and make recommendations for future maintenance and improvements.	H	CWCB DWR UDFCD	Data & Studies	Review completed. All existing gages have been repaired, and several new gages have been added. Action Development Date: 2013
4	Conduct statewide flood hazard reduction workshops, promote the use of a "hazard overlay" concept for GIS mapping using information developed by CGS for Garfield County as a model.	M	DHSEM CGS CWCB DOLA	Education, Awareness, & Outreach; Data & Studies	DHSEM mitigation staff provides technical assistance to local governments on hazard mitigation plans. The Flood Decision Support System also utilizes this concept and has been promoted at workshops at CASFM Conferences in 2010, 2011, and 2012. The *Planning for Hazards: Land Use Solutions for Colorado* guide and website includes an “Overlay Zoning” tool with detailed information and guidance for implementation and use. Overlay zoning is used by communities to apply area-specific standards and/or conditions that apply to many natural hazards, including geologic and soil hazards.
4	Promote compatibility of federal, state, and local GIS capabilities.	H	CWCB, OIT	Data & Studies	CWCB has been a partner with the Office of Information Technology’s efforts in this area.
4	Develop erosion hazard zone mapping as part of 2013 post flood recovery.	H	CWCB	Data & Studies	As of 2018 the CWCB is currently mapping eight pilot communities. A post-pilot phase mitigation action is included in the ongoing and new actions table. Project website: http://coloradohazardmapping.com/hazardMapping/fluvialMapping. Action Development Date: 2013

Related Goal	Action	Priority	Responsible Lead Agency or Work Group	Mitigation Type	Comments on Status, Implementation
4	Create user-friendly floodplain map system through website design.	H	CWCB UDFCD	Data & Studies	The CWCB posts information related to digital flood map status on the Colorado Hazard Mapping website: http://www.coloradohazardmapping.com/. UDFCD maintains a floodplain map system for flooding sources within UDFCD. Webmaps illustrating floodplain mapping changes for on-going Physical Map Revisions are made available in cooperation with FEMA Region VIII.
4	Develop multi-hazard database of state and local mitigation goals, objections, and actions by hazard.	H	DHSEM CWCB	Education, Awareness, & Outreach	This will serve as a tool to assist state-level prioritization of mitigation actions, identify statewide or regional action gaps compared to known hazard areas, and serve as a resource for organizations developing or updating mitigation plans. This database should be updated regularly as state and local mitigation plans are updated and approved. It should cost roughly $5,000 in EMPG or HMA funds for annual update and maintenance. Deleted due to lack of staff capacity and unclear value of action compared to programmatic requirements, local needs and willingness to implement, and updated mitigation prioritization guiding principles of 2018 SHMP Update.
5	Implement a statewide CRS strategy.	H	CWCB UDFCD	Education, Awareness, & Outreach, Technical Assistance	CRS subcommittee of CASFM formed; subcommittee provided input on revisions to CRS Coordinator's manual in 2012 and 2103. The subcommittee meets on a quarterly basis to discuss CRS activities. A CRS Website was completed in 2016 that acts as a one-stop-shop for communities and is updated with CRS coordinator manual updates. Created to achieve CWCB resiliency goals and increase CRS participation. Website: http://coloradohazardmapping.com/crs#/home UDFCD provides information and technical support to local CRS communities for qualifying CRS activities performed by or in coordination with UDFCD. Action Development Date: 2010

Related Goal	Action	Priority	Responsible Lead Agency or Work Group	Mitigation Type	Comments on Status, Implementation
6	Meet with local communities to incorporate the State's higher regulatory standards into local ordinances.	H	CWCB	Planning & Regulations	CWCB promulgated new rules of higher standards in 2010. CWCB is engaged with communities across Colorado to gather their input on the proposals. Communities were required to implement provisions of these rules by January 2014 or sanctions have been applied. Update State's Floodplain Rules and Regulations to include one-foot freeboard for all new and substantially changed structures, a ½ foot floodway for all stream reaches for which a ½ foot mapped floodway exists for new map updates, a two-foot freeboard for all new and substantially improved critical facilities, and a prohibition of basement construction for structures removed from the floodplain through a Letter of Map Revision based on Fill (LOMR-F).

Goal 1: Reduce flood impacts to Colorado's economy, people, state assets, and environment
Goal 2: Promote awareness and education of flood hazards and watershed protection
Goal 3: Promote the development of hazard mitigation plans with multiple objectives – Goal 3 was deleted with the 2018 update due to being largely the purview of the SHMP
*Goal 4: Coordinate and provide planning, technical assistance, and financial resources for state, local, and watershed planning efforts
Goal 5: Continue to update and develop floodplain maps for risk assessment, planning, and awareness applications
Goal 6: Promote and encourage the adoption of model codes and higher standards that emphasize hazard mitigation

4.4.2 Evaluation of Actions and Activities

The actions associated with the flood mitigation plan were presented in Table 4-4 in Section 4.4.1 organized by the major goal they help to achieve. This table was utilized as a tool to review the progress on achieving the goals and recommendations related to the flood hazard mitigation plan during the update process. As actions are reviewed during the update, the table is updated to reflect the progress on mitigation actions as a measure of achievement of the overarching goals.

The action table was evaluated and updated at Flood TAP meetings in 2018, and shared via email. The Completed and Deleted Action table shows 31 actions that have been completed, with at least one for each of the plan's original six goals. Two actions have been deleted or replaced by an updated action in the previous table. This table includes also actions that are now ongoing capabilities or regularly occurring education and outreach or workshops.

The total number of actions and the number of completed and/or ongoing ones indicates that the State of Colorado and its partner organizations are taking great strides towards meeting flood mitigation goals. Goals one, two, and three have the greatest number of related actions and most number indicated as completed.

4.4.3 Prioritization of Actions and Activities

Once the mitigation actions were identified, the Flood TAP members were provided with several sets of decision-making tools, including FEMA's example criteria, STAPLE/E (which considers social, technical, administrative, political, legal, economic, and environmental constraints and benefits) as well as Colorado's Resiliency Framework Prioritization Criteria.

STAPLE/E:

- Social: Does the measure treat people fairly?
- Technical: Will it work? (Does it solve the problem? Is it feasible?)
- Administrative: Is there capacity to implement and manage the project?
- Political: Who are the stakeholders? Did they get to participate? Is there public support? Is political leadership willing to support the project?
- 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? Does it reduce direct property losses or indirect economic losses?
- Environmental: Does it comply with environmental regulations or have adverse environmental impacts?

In accordance with the DMA requirements, an emphasis was placed on the importance of a benefit-cost analysis in determining project priority (the 'economic' factor of STAPLE/E). Other criteria used to recommend what actions might be more important, more effective, or more likely to be

implemented than another included:

- Does the action address hazards or areas with the highest risk (from Risk Assessment)?
- Does the action protect state assets or infrastructure?
- Does the action improve the state capability to manage and implement mitigation (from Capability Assessment)?

Colorado's Resiliency Framework, which is profiled in Section 4.2.5 of this Plan, sets forth resiliency prioritization criteria that local communities can use to evaluate and prioritize mitigation actions. Moving forward the Flood TAP concurred that the criteria could be used as guiding principles for prioritization of mitigation actions and projects. This is also consistent with the Colorado SHMP, which utilizes the criteria for allocation of mitigation funding. The prioritization criteria are listed below.

Resiliency Prioritization Criteria:

- Co-Benefits: Provide solutions that address problems across multiple sectors creating maximum benefit.
- High Risk and Vulnerability: Ensure that Strategies directly address the reduction of risk to human well-being, physical infrastructure, and natural systems.
- Economic Benefit-Cost: Make good financial investments that have the potential for economic benefit to the investor and the broader community both through direct and indirect returns.
- Social Equity: Provide solutions that are inclusive with consideration to populations that are often most fragile and vulnerable to sudden impacts due to their continual state of stress.
- Technical Soundness: Identify solutions that reflect best practices that have been tested and proven to work in similar regional context.
- Innovation: Advance new approaches and techniques that will encourage continual improvement and advancement of the best practices serving as models for others in Colorado and beyond.
- Adaptive Capacity: Include flexibility and adaptable measures that consider future unknowns of changing climate, economic, and social conditions
- Harmonize with Existing Activity: Expand, enhance, or leverage work being done to build on existing efforts
- Long-term and Lasting Impact: Create long-term gains to the community with solutions that are replicable and sustainable, creating benefit for present and future generations.

The action identification and prioritization process is the first step in laying out, in broad terms, what needs to be done to minimize the impact of the flood hazard in the State. Some of the actions can be accomplished with minimal cost or integrated into the work plans of the lead agency. While cost-effectiveness is required for FEMA funding of projects, many of the projects identified are non-structural. Thus, the cost-effectiveness is difficult to quantify. The detailed engineering studies, implementation costs, and benefit-cost analysis of specific projects will come at future

points in the process. Additional discussion on this topic is included in Chapter 6 Plan Maintenance Process. Results of the prioritization efforts are summarized in Table 4-6. The implementation of actions, activities and projects related to the Flood Hazard Mitigation Plan will be evaluated in accordance with the priorities established in the table below.

Other factors may be included to determine the priority associated with implementation of actions, activities, and projects related to the Flood Hazard Mitigation Plan. These factors include, but are not limited to, the following:

- Benefit-cost ratio
- Availability of matching funds
- Mitigation of repetitive loss structures

4.4.4 Contribution of Each Activity to Overall State Mitigation Strategy

The recommended state flood mitigation goals and activities were presented in Table 4-4 in the section entitled "Identification of Actions under State Consideration." Recommended activities are listed in accordance with the goals established for the flood mitigation strategy. For each recommended activity, actions have been identified to achieve the recommendation. These recommended activities and goals were also developed with the overall SHMP goals in mind.

4.4.5 Integration of Local Plans into Mitigation Strategy

FEMA recommends that the mitigation actions identified should be linked to local mitigation plans, where specific local actions and projects are identified; however, the absence of information on this piece will not cause FEMA to disapprove the plan. By connecting local actions with the State Hazard Mitigation Plan, the state can identify opportunities for targeted technical assistance and funding needs and assist with the implementation of these activities. DHSEM was tracking this information but discontinued the practice circa 2015 due to the labor-intensive nature of it. In the future the state may be able to track local mitigation actions through partnered efforts with FEMA to track progress on mitigation action implementation for the purposes of the Risk MAP program.

4.5 Funding Sources

4.5.1 Identification of Existing Federal, State, Local Funding Sources

Mitigation funding is available from FEMA to support a few mitigation projects each year in a non-disaster environment; post-disaster the amount will fluctuate depending on the magnitude of the presidentially declared disaster. The Hazard Mitigation Assistance (HMA) program is an umbrella program that includes pre- and post-disaster mitigation funding. Under HMA pre-disaster funding is available the Flood Mitigation Assistance (FMA) and Pre-Disaster Mitigation (PDM) grant programs. It is the role of the mitigation staff of DHSEM to help communities locate

potential sources of available federal and state funding. As grants from different sources are posted, DHSEM staff advertises to the communities and special districts. If a disaster occurs, the state will utilize HMGP and PA mitigation funds. PA mitigation funds under Section 406 will be used in accordance with program requirements and will be used for damaged facilities. HMGP funds may be used primarily in the affected area or may be used statewide at the Governor's and/or his/her representative's (GAR's) discretion. Local governments will continue to pursue grants from federal agencies to purchase equipment, training, and planning. Department of Homeland Security funds are part of the state strategy to fund interoperability and communications. FEMA and DWR provide funds to local dam owners to update and improve emergency preparedness plans. PDM and HMGP are the primary funding sources for local hazard mitigation plans. Additional information regarding the funding available from both federal and state agencies is summarized in Sections 4.5.2 and 4.5.3 below.

Large projects continue to be completed with federal and state funds and technical assistance from federal agencies other than FEMA. Examples include, but are not limited to, the U.S. Department of Transportation, Natural Resources Conservation Service (NRCS), the Bureau of Land Management, National Park Service, the USDA Forest Service, and the USACE. The USDA Natural Resource Conservation Service (NRCS) has programs for projects both exigent and not, including the Emergency Watershed Protection Program. The Small Business Administration (SBA) has provided funding related to several Presidential, USDA, and SBA administrative declarations in recent years. The USACE General Investigations and Continuing Authorities Programs provide opportunities for water resources projects, studies, design and engineering, and technical expertise. Funding through the USACE Silver Jackets funding can also be used for a variety of flood mitigation projects and related studies, a source that is identified in the 2018 mitigation action strategy (Action 3.2).

The Governor can move funds into the State Disaster Emergency Fund (DEF)to fund emergency types of activities. The local agencies have the required TABOR (Taxpayers Bill of Rights) reserves for use during emergencies. Local districts have used taxing mechanisms, such as mill levies, to support prevention activities. Local entities also actively pursue grant opportunities through federal and state agencies.

Education projects, outreach programs, repeater sites, early detection and warning/notification systems, and generators for backup power are very popular flood mitigation methods in Colorado. Local communities are constantly seeking sources of funding to maintain programs and install or upgrade systems. Unfortunately, funds for these types of projects are limited and the need strongly outweighs the availability. Even if communities receive initial funding, continuation of programs creates new financial impacts on already very tight budgets with competing demands. Despite this, Colorado communities have made great strides and progress in prevention and preparedness activities and continue to do more each year by taking advantage of limited opportunities. For example, several communities benefited years ago from a grant program through the USDA designed to fund repeater sites in remote locations, thereby serving communities with need but without means to provide warnings pertinent to their immediate area. DHSEM staff promoted the

grant opportunity and worked with communities on grant applications.

The state has loan and grant programs for which prevention activities are eligible. Funding sources traditionally used have been energy impact funds, gaming funds, general funds, and severance tax. Many agencies have grant programs, including, but not limited to, the Colorado State Forest Service, CWCB, CDWR, and DHSEM.

4.5.2 Sources of Funding Used to Implement Previous Mitigation Activities

Since approval of the 2013 update to the SHMP, Colorado flood mitigation activities have been funded by the FMA program, the PDM program, the HMGP, the Severance Tax Multi-Objective Watershed Protection program, the Colorado Watershed Restoration Program, the Colorado Healthy Rivers Fund, the Fish and Wildlife Resources Fund, and the Energy/Mineral Impact Assistance Fund. Table 4-6 illustrates how these funding sources have been used to facilitate flood hazard mitigation programs around Colorado. The grant amount for each project has been provided where available. Several of these projects used significant local funding to supplement state and federal funding. Furthermore, DHSEM provided state agencies and local governments with EMPG funding for drainage studies and education programs related to flood hazards.

Table 4-6 Flood Mitigation Funding in Colorado: 2005-2017

Flood Management Assistance (FMA) Program		
2005:	Flood Mitigation Project, City of Sterling Flood Mitigation Planning Project, City of Pagosa Springs Flood Mitigation Planning Project, Costilla County State-wide Flood Mitigation Planning Projects	
2006:	Detention Pond Project, Town of Gilcrest Flood Mitigation Planning Project, Summit County	
2007:	Flood Hazard Mitigation Plan, City of Fort Collins Flood Mitigation Project (South Platte River), City of Denver Additional mitigation project activities that have been submitted (but not presently approved) to obtain funding from the FMA program include Flood Mitigation Projects for the Town of Erie and the City of Colorado Springs. Flood Hazard Mitigation Plan, Huerfano County	
2008:	San Luis Valley Hazard Mitigation Plan Flood Element Denver Regional Council of Governments (DRCOG) Regional Hazard Mitigation Plan Flood Element	
2009:	Southeast Colorado Regional Hazard Mitigation Plan Flood Element Archuleta County Hazard Mitigation Plan Flood Element Colorado Springs Hazard Mitigation Plan Flood Element	
2010:	Left Hand Creek Flood Project, City of Longmont Stone Creek Floodplain Improvements, Eagle County	$5,689,013 $240,000
2011:	Flood Mitigation Project at Montview Bridge, City of Aurora	$2,979,865
2012:	NA	
2013:	Pleasant Valley Flood Mitigation Project, City of Colorado Springs (application in process) Erosion Mitigation Project, City of Durango (application in process) Sanderson Gulch Reach 1 Improvements, City & County of Denver (application in process)	$5,538,671 $1,262,524 $6,851,732
2014:	NA	
2015:	NA	
2016:	NA	
2017:	NA	
Pre-Disaster Mitigation (PDM) Program		
2005:	Drainage Project, City of Grand Junction Drainage/Detention Pond Project, City & County of Denver	
2006:	Channel Stabilization, City of Colorado Springs	
2008:	Coal Creek Flood Hazard Mitigation Project Northeast Regional Hazard Mitigation Plan City of Arvada Property Acquisition Clark Reservoir Sedimentation Mitigation/Coal Creek Diversion Capacity Project, Larimer County	
2009:	Colorado Springs Hazard Mitigation Plan Update	
2010:	Fountain Creek Stabilization and Erosion Project	$4,362,391
2011:	Cottonwood Creek Stabilization at Vincent Drive Bridge, City of Colorado Springs John Law Ditch Flood Risk Reduction, Town of Windsor	$4,024,318 $2,224,778
2012:	Greencrest Channel Stabilization, City of Colorado Springs St. Vrain River Flood Project, City of Longmont	$3,870,790 $5,400,000
2013:	Platte Avenue Bridge Stabilization, City of Colorado Springs (application in process)	$4,065,061
2014:	Crestview Ditch Erosion/Flood Mitigation Project and City of Durango (as referenced above in 2013)	$640,387
2015:	NA	
2016:	NA	
2017:	NA	
Hazard Mitigation Grant Program (HMGP)		
2008:	Greeley Water Line Protection at Windsor Lake	

2009:	NA	
2010:	NA	
2011:	NA	
2012:	NA	
2013:	NA	
2015:	Superior Coal Creek Channel Improvements, City of Superior	$278,457
2015*	Boulder County Acquisition/Demolition, Boulder County Acquisition/Demolition in Colorado Springs, City of Colorado Springs Custer Avenue Acquisition/Demolition Project, City of Colorado Springs East Vine Drive Property Acquisition, City of Fort Collins Acquisition of 11 Structures, Town of Jamestown Acquisition/Demolition of 31 Properties, Town of Lyons Acquisition of Mobile Home Park, Town of Milliken Elevation of Residential Property, Boulder County Elevation of Two Residential Properties, Town of Jamestown Elevation of Two Properties, Town of Lyons Erosion Control – Manitou Incline, City of Colorado Springs Camp Creek – Garden of the Gods Retention Pond, City of Colorado Springs Platte Avenue Bridge Stabilization, City of Colorado Springs Sanderson Gulch Reach 1 Improvements, City & County of Denver Mulberry/Myrtle/Riverside Storm Sewer, City of Fort Collins Flood Reduction – Bridge, Town of Jamestown St. Vrain Creek WWTP Channel Project, City of Longmont Bosley Wash Reservoir A, Mesa County Flood Control Orchard Mesa Pond A, Mesa County Josephine Storm Sewer Improvement, Town of Milliken CU Boulder Campus Pedestrian Bridge, University of Colorado - Boulder Flood Reduction Projects, University of Colorado - Boulder	$7,273,875 $3,799,136 $259,831 $199,294 $1,541,857 $3,508,388 $424,934 $93,007 $245,249 $211,800 $766,262 $5,904,323 $3,909,694 $5,290,603 $1,124,706 $1,256,550 $1,401,671 $2,093,833 $899,549 $1,322,246 $175,479 $729,271
2016:	NA	
2017:	NA	
Severance Tax Multi-Objective Watershed Protection		
2008:	Lefthand Creek Off-Highway Vehicle (OHV) River Restoration Project, James Creek Watershed Initiative River Corridor Properties Survey, Town of Rico Ski Creek Restoration, Rocky Mountain Field Institute Midway Streambank Stabilization, North Fork River Improvement Association	$15,000 $25,000 $15,000 $15,000
2009:	Uncompahgre Watershed Plan, Friends of the River Uncompahgre Representative Reach Floodplain Study, Lower Blanco Property Owners Association Mancos Streambank Stabilization, Mancos Conservation District	$5,000 $5,000 $61,488
2010:	Rapid Riparian Assessment, Coal Creek Watershed Initiative Watershed Plan Update, North Fork River Improvement Association Diversion Dam Reconstruction Design, Gunnison River Festival Squirrel Creek Restoration Monitoring, Saguache County Sustainable Environment & Economic Development Council Lightner Creek Watershed Assessment I, San Juan Citizens Alliance	$22,250 $9,240 $4,955 $5,000 $5,000
2011:	Diversion Dam Reconstruction Design, Gunnison River Festival Relief Ditch Diversion Reconstruction Design, Gunnison Gorge Anglers – Trout Unlimited (TU) Watershed Plan Update, Eagle River Watershed Council Dolores Watershed Tamarisk Removal - Passive Revegetation, Southwest Conservation Corps North Fork South Platte River Watershed Assessment of River Stability and Sediment Supply (WARSSS) Phase 1 & 2, Colorado Open Lands Boulder Creek Riparian Revegetation, Wildlands Restoration Volunteers Rock Creek Riparian Revegetation, Wildlands Restoration Volunteers Sustaining Colorado Watersheds Sponsorship, Colorado Riparian Association	$25,000 $25,000 $25,000 $37,500 $7,000 $8,395 $18,000 $5,000
2012:	Trimble Survey Unit Flood Risk Map (MRP), Colorado Watershed	$4,175

	Assembly	$25,000
	Edwards Eagle River Restoration Project, Phase IIB, Eagle River Watershed Council	$11,940
	Boulder Creek Riparian Restoration/Invasive Species Removal, Wildlands Restoration Volunteers	$20,000
	Dolores River Watershed Tamarisk Removal, Southwest Conservation Corps	$19,990
	Diversion Reconstruction, Mancos Conservation District	$19,271
	Measurable Results Program, Colorado Watershed Assembly	
2013:	Upper Glen Cove Creek Erosion Control, Rocky Mountain Field Institute	$29,500
	Fourmile Fire Flood Mitigation, Boulder County	$24,500
	Uncompahgre River Riparian Revegetation, Uncompahgre Watershed Partnership	$6,000
	Lower Swan River Channel & Wetland Restoration, Swan's Nest HOA & Metropolitan District	$28,100
	Colorado River Watershed Inventory and Assessment, Eagle River Watershed Council	$25,000
	Chico Basin Riparian Revegetation, Wildlands Restoration Volunteers	$8,420
	Diversion Dam Reconstruction Design, Coal Creek Watershed Coalition	$4,300
2014:	NA	
2015:	NA	
2016:	NA	
2017:	NA	
Colorado Watershed Restoration Program		
2009:	Bank Stabilization & Riparian Revegetation, Colorado Open Lands	$28,520
	Riparian Maintenance & Monitoring, Eagle River Watershed Council	$50,000
	Channel Restoration – Trout Habitat Improvement, Boulder Flycasters	$30,000
	Floodplain/Channel Design Planning, Lake Fork Watershed Stakeholders	$95,000
	Diversion Structure Assessment & Project Prioritization, Mancos Conservation Dist.	$30,500
	Bank Stabilization & Riparian Revegetation, Coalition for the Upper South Platte	$50,000
	Greenway Master Plan, Westerly Creek Connection	$37,500
	Mine Mitigation, Bank Stabilization & Riparian Protection, Kerber Creek Restoration	$12,000
2010:	Bank Stabilization & Riparian Revegetation, Colorado Open Lands	$18,480
	Bank Stabilization & Riparian Revegetation, North Fork River Improvement Association	$38,000
	Bank Stabilization & Riparian Revegetation, Eagle River Watershed Council	$25,000
	Mine Remediation, Channel Stabilization & Riparian Revegetation, Coal Creek Watershed Coalition	$19,150
	River Restoration Design & Demonstration Projects, South Suburban Parks & Recreation District	$46,118
	Bank Stabilization & Riparian Revegetation, Wildlands Restoration Volunteers	$57,331
	Irrigation Diversion Reconstruction, Gunnison River Festival (Gunnison County)	$25,000
2011:	Bank Stabilization & Riparian Revegetation, Coalition for the Upper South Platte	$50,000
	Channel Restoration – Trout Habitat Improvement, Trout Unlimited – West Denver	$20,300
	Bank Stabilization & Riparian Revegetation, Chatfield Watershed Authority	$20,000
	Bank Stabilization & Riparian Revegetation, Rocky Mountain Field Institute	$7,115
	Riparian Revegetation, Wildlands Restoration Volunteers	$8,200
	Bank Stabilization & Riparian Revegetation, Colorado Mountain College	$30,000
	Ditch Diversion Reconstruction, Coal Creek Watershed Coalition	$13,705
	Bank Stabilization & Riparian Revegetation, Trout Unlimited	$37,000
	Bitch Diversion Reconstruction, Trout Unlimited – Gunnison Gorge Chapter	$25,000
	Channel Restoration Planning, Animas River Partnership	$13,220
	Channel Restoration Design, Blue River Watershed Group	$25,000
	Ditch Diversion Reconstruction, Colorado Water Trust	$39,325

2012:	Bank Stabilization & Riparian Revegetation, Wildlands Restoration Volunteers Channel – Floodplain Restoration/Beaver Habitat Creation, Colorado Open Lands Fen Restoration, Mountain Studies Institute Forest Road Restoration/Sediment Mitigation, Roaring Fork Conservancy Watershed Assessment, Land Trust of the Upper Arkansas Bank Stabilization & Riparian Revegetation, NFRIA-WSERC Conservation Center	$65,000 $40,000 $17,435 $39,579 $15,500 $62,100
2013:	River Restoration Assessment and Design, Crested Butte Land Trust Post-fire Watershed Restoration, Coalition for Poudre River Watershed Post-fire Watershed Restoration, Coalition for the Upper South Platte Watershed Wildfire Assessment and Treatment Identification, Huerfano County Water Conservancy District	$21,000 $100,000 $100,000 $45,000
2014:	Post-fire Watershed Restoration, Coalition for the Poudre River Watershed Watershed Assessment and Project Prioritization River Restoration Design, Lake Fork Valley Conservancy Bank Stabilization and Riparian Re-vegetation, Wildlands Restoration Volunteers	$16,480 $20,000 $21,300 $22,280
2015:	Riparian Re-vegetation, Wildlands Restoration Volunteers	$15,000
2016:	Fen Restoration Design, Mountain Studies Institute Diversion Reconstruction/Riparian Restoration Stream Management Plan Workshop, Colorado Water Trust Stream Management Plan, Trout Unlimited Stream Management Plan, Steamboat Springs Integrated Water Management Planning Framework, Colorado Basin Roundtable Stream Management Plan, North Fork River Improvement Association WARSSS, Fountain Creek Watershed, Flood Control and Greenway District Mine Restoration, Colorado Division of Reclamation, Mining and Safety Riparian Re-vegetation, Rocky Mountain Field Institute Riparian Protection, Animas Watershed Partnership	$14,530 $15,000 $17,500 $64,275 $51,875 $68,000 $27,500 $30,000 $75,000 $30,000 $32,500
2017:	Riparian Restoration, Grand Junction Riparian Restoration, Summit County Riparian Re-vegetation, Rocky Mountain Field Institute Post-fire Watershed Restoration, Coalition for the Poudre River Watershed Stream Management Plan Implementation, Roaring Fork Conservancy Stream Management Plan, Denver Trout Unlimited Stream Management Plan – Assessment, Upper Gunnison River Water Conservancy District	$99,703 $40,000 $25,000 $75,000 $31,000 $20,000 $175,000
Colorado Healthy Rivers Fund		
2007:	River Restoration, Coalition for the Upper South Platte Irrigation Diversion Reconstruction, North Fork River Improvement Association Watershed Plan, Mancos Conservation District	$25,000 $9,800 $15,000
2008:	Watershed Plan, Uncompahgre River Stewardship Alliance Watershed Plan, Roaring Fork Conservancy Watershed Plan, Friends of Bear Creek	$10,000 $10,000 $10,000
2009:	Open Space/Conservation Easement Acquisition, Rio Grande Headwaters Land Trust Channel Morphology Assessment, Park County & Colorado Open Lands River Restoration, Rocky Mountain Field Institute Irrigation Diversion Reconstruction, North Fork River Improvement Association River Restoration, Fountain Creek Restoration Committee Sedimentation Mitigation & River Restoration, Arkansas Headwaters Recreation Area	$15,000 $12,000 $25,000 $15,000 $50,000 $25,000
2010:	Riparian Restoration, Wildlands Restoration Volunteers Stormwater Management, Coal Creek Watershed Coalition Watershed Plan, Friends of the River Uncompahgre Watershed Plan Education and Outreach, Roaring Fork Conservancy	$19,220 $10,756 $15,000 $18,000

	Ecotype Specific Riparian Plant Development, Tamarisk Coalition Riparian Restoration, Eagle River Watershed Council River Restoration, Town of Vail	$10,000 $10,000 $6,000
2011:	Riparian Revegetation/Community Education, Groundwork Denver Riparian Revegetation, Rio Grande Headwaters Restoration Project	$15,000 $5,000
2012:	Sedimentation Mitigation, Coalition for the Upper South Platte Invasive Species Removal/Riparian Revegetation, Wildlands Restoration Volunteers Water Quality Monitoring, Chatfield Watershed Authority Macroinvertebrate Sampling, Colorado Watershed Assembly Riparian Vegetation Assessment, Tomichi Creek Stakeholders Group Sediment Analysis, Coal Creek Watershed Coalition	$25,000 $10,590 $15,000 $20,000 $6,000 $13,500
2013:	Water Quality Monitoring, Coal Creek Watershed Coalition Bank Stabilization and Riparian Re-vegetation, Crested Butte Land Trust Riparian Re-vegetation, Southwest Conservation Corps Community Outreach and Education, Uncompahgre Watershed Partnership Conservation Opportunities, Education and Outreach, Rio Grande Headwaters Land Trust Watershed Plan, Routt County Conservation District Macroinvertebrate Sampling, Colorado Watershed Assembly	$3,000 $15,000 $15,000 $14,000 $10,000 $15,000 $15,000
2014:	Water Quality Monitoring, Land Trust of the Upper Arkansas Watershed Flow Assessment, Roaring Fork Conservancy River Restoration Management Plan, National Forest Foundation River Restoration Assessment, Rio Grande Headwaters Restoration Project Riparian Re-vegetation, Wildlands Restoration Volunteers Macroinvertebrate Sampling, Colorado Watershed Assembly Low Flow Fish Habitat Improvement, Western Slope Conservation Center	$3,837 $15,000 $20,000 $10,000 $8,306 $10,000 $20,000
2015:	Water Quality Monitoring and Riparian Re-vegetation, Animas Watershed Partnership Riparian Re-vegetation, Bluff Lake Nature Center River Restoration Planning, Douglas County Conservation District River Restoration Plan, Rio Grande Headwaters Restoration Project Riparian Restoration Training, Tamarisk Coalition River Restoration, Trout Unlimited Agricultural Land Conservation, Colorado Cattlemen's Agricultural Land Trust Riparian Plan Propagation, Uncompahgre Watershed Partnership	$15,000 $12,665 $15,000 $10,000 $5,000 $10,000 $10,000 $5,000
2016:	Riparian Restoration, Crested Butte Land Trust	$25,000
2017:	NA	
Fish and Wildlife Resources Fund		
2008:	Rio Blanco River Restoration Phase III, Rio Blanco Property Owners Association	$30,000
2009:	Rio Blanco River Restoration Phase IV, Rio Blanco Property Owners Association Clear Springs Ranch Fish Passage, Colorado Springs Utilities	$132,000 $70,000
2010:	Hartland Diversion Dam Reconstruction, Painted Sky Resource Conservation and Development Council, Inc.	$560,000
2011:	Upper South Platte Diversion Reconstruction, Coalition for the Upper South Platte	$75,000
2012:	Stream Mitigation Banking Protocols, Colorado State University	$50,000
2014:	South Platte River Enhancement Project Phase II, South Suburban Park and Recreation District	$100,000
2015:	Stream Mitigation Protocol & Aquatic Habitat Mapping Development, Colorado State University	$50,000
2016:	NA	
2017:	South Platte Flood Hazard Mitigation, Urban Drainage & Flood Control District Plum Creek Restoration, Chatfield Reservoir Mitigation Company Abrams Creek Ditch Lining Project, Buckhorn Valley Metropolitan District	$450,000 $814,270 $550,000

Energy and Mineral Impact Assistance Program		
2007:	Fort Lupton Storm Drainage Improvement Sanford Drainage Study	$269,000 $14,000
2008:	Fruita Stormwater Drainage Improvements Windsor Drainage Basin Fort Morgan Downtown Infrastructure Design – Phase I	$500,000 $78,000 $175,000
2009:	Grand Lake Stormwater Filtration Olathe Stormwater Drainage Management Study Cokedale Drainage System Improvements	$155,370 $145,000 $150,000

*2015: 4145 Projects are still on-going, amounts noted here are obligated amounts but may change during the project
(Source: DHSEM, CWCB, DLG)

4.5.3 Identification of Potential Federal, State, Local Funding Sources

Other potential sources of funding have been identified and have been included in the information presented in the section above. HMGP funding will likely become a more important source of mitigation funding in the aftermath of the 2013 September flood disaster due to the amount of federal disaster assistance funding associated with the event. CDBG funding may also become a source for matching funds and applied in acquisition projects.

Colorado Flood and Drought Response Fund

Colorado's Flood and Drought Response Fund was created in 2012 and is managed by the CWCB. The Fund can be used for flood and drought mitigation and preparedness, and for response and recovery activities following flood or drought events and disasters. Up to $500,000 is available through this fund on an annual basis (increased from $300,000 in previous years).

Homeowners Flood Insurance Affordability Act

In 2014 the Homeowners Flood Insurance Affordability Act (HFIA) repealed and modified certain provisions of the Biggert-Waters Flood Insurance Reform Act of 2012.[25] The HFIA also made additional program changes to other aspects of the program that were not covered under the 2012 Act. A summary of the changes are listed below:

- Repeal rate increases on some polices including increases that have already gone into effect and provided refunds to those policy holders
- Prevent future rate increases
- Restored grandfathering of lower rates
- Delayed the increases in flood insurance premiums to obtain risk-based premiums under Biggert-Waters
- Spread the cost of the lower premiums over the reaming policy holders
- Permits FEMA to account for property specific flood mitigation that is not part of the insured structure in determining a full-risk rate

[25] https://www.fema.gov/media-library/resources-documents/collections/414

- Requires residential basement floodproofing be considered when developing full-risk rates after a map changes increased the BFE in an area where residential basement floodproofing is permitted
- Increases the maximum deductibles

5 COORDINATION OF LOCAL MITIGATION PLANNING

5.1 Local Funding and Technical Assistance

5.1.1 Description of State Process to Support Local Plan Development

Local plan development and a FEMA-approved Hazard Mitigation Plan (HMP) is required as a condition for receiving any federal disaster grant funding (under the HMGP) to evaluate the impact of natural hazards within designated disaster areas, and to identify actions that will reduce the effects of such hazards. The process utilized by the state to support the local plan development is described in the SHMP. In general, the mitigation staff of DHSEM is responsible to provide technical assistance and training to local governments to assist them in developing local mitigation plans and project applications. The mitigation staff is also responsible for reviewing and submitting all local reviews and submitting all local mitigation plans to FEMA.

5.1.2 Funding/Technical Assistance Provided in Past Five Years

Since approval of the previous versions of this Plan and the SHMP, funding and technical assistance has been provided to several local entities. Over the past five years, and in years prior, CWCB and DHSEM have frequently worked together to provide funding and technical assistance for mitigation planning efforts that include robust flood risk assessments and mitigation strategies. This partnership has resulted in strengthened and coordinated technical assistance and has helped to provide local communities with the means and motivation to assess flooding risks and identify potential projects. This work has culminated in the completion of several hazard plans and studies between 2004 and 2018. Workshops and seminars have been presented through the CAP to support communities with the development of flood mitigation planning documents. In addition, as indicated previously, funding available from the FMA Program has been accessed to develop flood mitigation planning documents. These funds have been utilized to address flood mitigation planning statewide. Table 5-1 illustrates many of the projects that were completed with funding and technical assistance from the CWCB since 2004.

Table 5-1 Funding/Technical Assistance Provided by the CWCB

Project	Comments
Costilla County	CWCB assisted in financing the creation of a countywide all-hazard mitigation plan. This plan was produced according to FEMA standards for the Flood Mitigation Assistance Program and PDM Program. The plan was subsequently adopted by the County and its municipalities and enabled these entities to be eligible for mitigation grants from these programs.
Pikes Peak Area Council of Governments	Financed a stream migration and sediment transport study performed by the USGS. This study analyzed the erosive and sedimentation properties of materials found in Fountain Creek. Results continue to be used in the ongoing development of watershed programs and projects to halt the massive sediment transport observed throughout the waterway.
Larimer County	CWCB assisted in financing the preliminary design for the Clark Reservoir, a critical component for solving many of the flooding problems known to exist in the Boxelder Creek watershed. Upon completion of this preliminary design, a PDM project application

Project	Comments
	was prepared and submitted to FEMA. The project was selected for a $3 million FEMA grant, and its construction began in 2011.
Town of Granada	CWCB provided technical and financial assistance in repairing the levee protecting the Town from Wolf Creek. The levee had received an unacceptable rating by the USACE and would have been dropped from their PL 84-99 program unless it was brought back into compliance. Through this project, the levee became compliant again through a subsequent inspection with a Minimally Acceptable rating.
SLV GIS/GPS Authority	CWCB assisted in financing the creation of a five-county all-hazard mitigation plan covering Alamosa, Saguache, Mineral, Conejos, and Rio Grande counties in the San Luis Valley. This plan was produced according to FEMA standards for the FMA and PDM programs and was completed in 2011. The plan was adopted by the Counties and their municipalities and enabled these entities to be eligible for mitigation grants from these programs.
Town of Severance	CWCB assisted the Town in a study to analyze possible solutions to floodplain problems created by the presence of an uncertifiable levee through the Town. The end goal was to pursue a FEMA mitigation grant to construct the chosen solution. Although a number of possible scenarios were considered, there were no cost-effective (as determined by FEMA's Benefit-Cost Analysis program) alternatives available.
Flood Season Flood Forecasting	An annual program in which a CWCB consultant provides a number of daily meteorological products for the public and local governments to use for better flood preparedness. The products include a daily rainfall reconstruction for the state for the previous day, a daily evaluation of flood threats facing the entire state, and a twice-weekly medium range outlook analyzing flood risks for the state for the coming two weeks. This program runs during the primary flood season – May through September.
NOAA Mobile Radar	An experimental program was run in the Gunnison area to identify radar gaps through this mountainous area, which is not well-covered by existing Doppler Radar. The program involved using a locally parked truck equipped with a full-scale radar instrument. The radar collected was merged with the radar products from the National Weather Service's Grand Junction office. Results were used to analyze shortcomings in flood and snowpack predictions and identify possible solutions to these deficiencies.
Floodplain Information Reports were prepared for Routt, Denver, Jefferson, and Elbert Counties - Michael Baker	Floodplain Information Reports were prepared for Routt, Denver, Jefferson, and Elbert Counties for use in further analyzing floodplain characteristics for approximate floodplains in these areas. Most importantly, hydrology quantifications were prepared for stream reaches that are shown as approximate floodplains on FEMA flood maps. This information assists in local floodplain management, further updates of floodplain maps, and allows the CWCB to meet statutory requirements for floodplain designations.
Denver Regional Council of Governments (DRCOG)	CWCB assisted in financing the creation of a multi-county all-hazard mitigation plan covering the counties incorporated within the Denver Regional Council of Governments – primarily the Denver metropolitan area. This plan was produced according to FEMA standards for the FMA and PDM programs and was completed in 2010. The plan was adopted by the Counties and their municipalities and enabled these entities to be eligible for mitigation grants from these programs.
Elbert County	CWCB assisted in funding a study to identify possible solutions to drainage and flood problems in the unincorporated town of Elbert. This project was completed in 2012. It is hoped that the study results will lead to identified solutions to these problems and a possible application to FEMA's Hazard Mitigation Assistance programs for construction funds.
Bent and Kiowa counties stormwater master planning	Funds were provided for the creation of a basin-wide stormwater master plan for the Adobe Creek Basin in Bent & Kiowa counties. This master plan identifies the flood hazard using existing information and develops a sequential plan to address these problems through capital improvements. Results from the existing conditions of this plan will be used for floodplain management and identified solutions will be used to develop a Capital Improvement Plan for the watershed.
Archuleta County	CWCB assisted in financing the creation of a countywide all-hazard mitigation plan covering Archuleta County and its municipalities. This plan was produced according to FEMA standards for the FMA and PDM programs and was completed in 2013. The plan was adopted by the county and its municipalities and enabled these entities to be eligible for mitigation grants from these programs.
Bent County	CWCB assisted in financing the creation of a six-county all-hazard mitigation plan

Project	Comments
	covering Bent, Prowers, Kiowa, Baca, Crowley, and Otero Counties in the southeastern plains. This plan was produced according to FEMA standards for the FMA and PDM programs and was completed in 2014. The plan was adopted by the Counties and their municipalities and enabled these entities to be eligible for mitigation grants from these programs.
Bosley Wash – Mesa County and 5-2-1 Drainage Authority	Funds were provided for the final design of a stormwater detention pond located in Mesa County north of Interstate 70 that will intercept flood waters in the Bosley Wash watershed. This reservoir was previously developed in a basin master plan produced in the early 2000's. The project was funded with HMGP funding following the 2013 flood. The reservoir construction was completed in 2017 and will mitigate most of the problems in the Bosley Wash watershed by reducing the flows significantly in the lower basin.
Engineering Services Regarding Near-Term Flooding and Debris Flow Mitigation and Drainage Planning for Williams Canyon in Manitou Springs, CO	CWCB assisted in financing engineering services to address near-term impacts posed by flooding and debris flows within Manitou Springs (i.e., impacts anticipated to occur in the remainder of 2013, in 2014, and during the subsequent two to three years when runoff rates from the burned watershed are anticipated to pose the greatest threat to the City). Longer term drainage planning concerns and issues for the City will be taken into consideration during the implementation of this scope of work for near-term measures.
Post-Fire Hydrology, Inundation Mapping and Debris Flow Assessment, Waldo Canyon Fire, El Paso County	CWCB assisted in financing this project to support emergency management of post-fire *Areas of Concern* for potential flood inundation in the Waldo Canyon burn scar. To develop this mapping for flood warning and potential evacuation will require use of quality base mapping, development of post-fire hydrology & hydraulic models, and an understanding of potential debris flows. This project affords a great opportunity for public outreach to make the potential hazard understood in the watershed community and encourage partnerships to mitigate those hazards.
Fourmile HEC-HMS Routed Flow Modeling	CWCB assisted with funding for this project to route modeled peak flows from the Fourmile Fire burn area to Boulder Creek and Fourmile Canyon Creek. Major tasks for the project include expanding the HEC-HMS Fourmile Fire model to include all subcatchments within the burn area tributary to Fourmile Creek and Fourmile Canyon Creek; using the expanded model to develop routed flows at the confluence of Fourmile Creek and Boulder Creek and at the upstream end of Fourmile Canyon Creek; and documenting the modeling efforts and results of the previous two tasks in a brief memorandum including necessary graphs and tables.
Cache La Poudre River Watershed Risk MAP Project, High Park Fire Area Flood Hazard Mapping and Mitigation Support	The scope of work for this project includes assistance from CWCB staff to identify post-wildfire needs in the High Park Fire Area and develop a scope of work to determine post-wildfire flood hazards and evaluate flood mitigation alternatives for protecting public infrastructure and homes from loss or damage.

Source: CWCB records

The State's commitment to providing technical assistance to local entities also includes verifying compliance with federal regulations. The NFIP verifies compliance with the CAP by conducting Community Assistance Visits (CAVs). These visits assess "the community's floodplain management program; assist the community and its staff in understanding the NFIP and its requirements; and assist the community in implementing effective flood loss reduction measures when program deficiencies or violations are discovered." Communities that participate in the NFIP are generally visited every three to five years. Each state has a designated agency which coordinates with the NFIP/FEMA and conducts the majority of CAVs. The CWCB has this responsibility in Colorado. As of June 8, 2018, 24 CAVs were conducted, four of which were conducted by FEMA. Table 5-2 illustrates the CAV visits conducted in Colorado since 2013. The CWCB has continued to provide assistance to local governments in modification to local floodplain ordinances to conform to the Rules update that went into effect in January 2014.

Table 5-2 Community Assistance Visits 2013 - June 2018

Year	State	FEMA
2013	9	2
2014	6	0
2015	2	2
2016	0*	0
2017	3	0
Total	**20**	**4**

Source: CWCB * Data incomplete

5.2 Local Plan Integration

5.2.1 Process and Timeframe to Review Local Plans

Local hazard mitigation plans are reviewed initially by DHSEM and approved by FEMA and are updated every five years. More specifics can be referenced on this topic in the 2018 Colorado SHMP.

5.2.2 Process and Timeframe to Coordinate and Link Local Plans to the State Hazard Mitigation Plan (SHMP)

Local hazard mitigation plans are reviewed initially by DHSEM and approved by FEMA and are updated every five years. With each SHMP update cycle, any new or updated local Hazard Mitigation Plans (HMPs) will need to be reviewed for assimilation and incorporation of information relevant to the State Hazard Mitigation Plan, including flood related vulnerability and loss estimates, capabilities, and mitigation strategies.

5.3 Prioritizing Local Assistance

5.3.1 Description of Criteria for Prioritizing Planning and Project Grants

During the update of the 2018 SHMP a process for prioritization of mitigation grant funding was developed to conform with the Colorado Resiliency Framework criteria. This criteria is described in Section 4.4.3 of this Plan and Section 8.2 of the SHMP. Moving forward from 2018 this criteria for prioritizing planning and project grants will be followed.

In a post-disaster environment, the criteria and process used to prioritize funding assistance requests are described in the DHSEM HMGP Administrative Plan. When a Notice of Interest (NOI) for receipt of financial assistance is submitted to the State, it must meet certain minimum criteria. These include whether the project: complies with the State's hazard mitigation strategies; meets funding eligibility requirements; is an independent solution to the problem; does not duplicate other funding sources; has a beneficial impact on the declared area; and is cost-effective

and environmentally sound. When projects are competing for limited funding, projects are scored and ranked. Under the direction of the State Hazard Mitigation Officer (SHMO) and the Governor's Authorized Representative (GAR), a subcommittee of the State Hazard Mitigation Team (SHMT) convenes to score and rank the projects. The ranking is to be based on criteria derived from 44 CFR §206.434(b) and may or may not be specific to the disaster.

Other considerations that will be weighed by the application review committee in awarding grants include, but are not limited to:

- Relative need (risk) compared to other local entities requesting projects
- Repetitive losses mitigated by project(s)
- Benefit-cost analyses (may include benefit/cost ratios greater than one for construction projects)
- Future development patterns and development pressure
- Availability/amount of grant funds along with commitment for matching funds

6 PLAN MAINTENANCE PROCESS

6.1 Monitoring, Evaluating, and Updating the Plan

Implementation and maintenance of the Plan is critical to the overall success of hazard mitigation planning. This section describes the state's system for monitoring implementation of mitigation actions and reviewing progress toward meeting Plan goals, and any changes in the system since the previously approved plan.

6.1.1 Method and Schedule for Monitoring Plan

The CWCB is charged with the overall responsibility for Plan monitoring and evaluation, with assistance from the Flood TAP and DHSEM. CWCB's responsibilities for monitoring and evaluating the Plan include the following:

- Communicating the schedule and activities for Plan updating and maintenance to the Flood TAP
- Assisting other agencies with the implementation of mitigation actions
- Coordinating with agencies between Flood TAP meetings
- Coordinating and conducting outreach to other stakeholders or interested parties and the public
- Obtaining local mitigation plan data from DHSEM to be used in Plan update cycles
- Conducting all Plan evaluation and monitoring activities that are not otherwise assigned to another agency
- Monitoring, capturing, and communicating mitigation success stories
- Documenting and incorporating the findings of the evaluation and monitoring analyses into the next edition of the Flood Hazard Mitigation Plan
- Updating the Flood TAP on grant funds available or disbursed for actions
- Engaging and maintaining the interest of the agencies participating on the Flood TAP

The CWCB CAP Coordinator and the DHSEM State Hazard Mitigation Officer or designee will conduct coordination activities that will result in the implementation and monitoring of this plan.

Role of Colorado Water Conservation Board (CWCB) in Flood Hazard Mitigation:

In addition to the above-mentioned activities, there are several duties and responsibilities of the CWCB which include:

- Continue to support CASFM
- Work with other agencies in approving mitigation activities
- Assist in exploring a state funding pool exclusively for flood hazard mitigation
- Serve as communication liaison with regional FEMA personnel

- Assist in the implementation and monitoring of cost-effective and environmentally-acceptable flood mitigation
- Provide technical assistance to county Emergency Management Coordinators
- Visit each of the 64 counties on a five-year cycle
- Monitor local project progress and annual maintenance activities
- Develop training materials about mitigation
- Identify mapping needed for flood and wildfire recovery operations

6.1.2 Method and Schedule for Evaluating Plan

Colorado SHMP evaluation requirements will necessitate annual coordination with the SHMT, including annual review of progress of mitigation actions, as the Flood Plan contains the state's flood mitigation strategy. As detailed in the SHMP, the SHMT has agreed upon following a bi-annual meeting schedule to ensure that the State's mitigation program continues to succeed and remains comprehensive across all agencies. Assuming FEMA approval of the 2018 Plan in December, the SHMT plans to convene each May and November. The spring meeting will be an opportunity for the SHMT to review and assess mitigation actions and the State's overall mitigation strategy, while the fall meeting will focus on the Hazard Identification & Risk Assessment (HIRA) and Standard and/or Enhanced Plan compliance. See Section 7 of the Colorado Hazard Mitigation Plan for additional details.

In addition, the Flood Plan should be evaluated after a major flood event for opportunities to implement actions and leverage post-disaster funding.

6.1.3 Method and Schedule for Updating Plan

Updates to state hazard mitigation plans are required by the DMA every five years. As an annex to the Colorado SHMP, the Flood Mitigation Plan will need to remain aligned with the update schedule of that plan. Updates to the Flood Plan must conform to the latest DMA 2000 and EMAP planning requirements. The Flood Mitigation Plan and Colorado SHMP were updated in parallel processes in 2018. It may be advantageous to incorporate the Flood Mitigation Plan into the next update of the SHMP. The next update of the Colorado SHMP will need to be reapproved by FEMA by December 2023. If the Flood Plan is updated as a stand-alone document again the CWCB and Flood TAP will aim to complete the Flood Plan by early September of the year the update is due to allow enough time for DHSEM to integrate it with the SHMP and submit to FEMA to review the Plan and for the State to readopt it. The Flood Plan will need to be approved by the CWCB by September of the update year. The Flood Plan will be readopted by the Governor as part of the overall SHMP.

DHSEM will coordinate with the CWCB on the schedule and specific needs for the SHMP update. Funding needs for the next update cycle should be identified and pursued so that the necessary resources are in place in advance of the update year. At the fall Flood TAP meeting prior to the update year the CWCB will issue a schedule for the Flood Plan update. This schedule will establish

a timeline for the following (and other activities as needed):

- Coordination with DHSEM on the update of the SHMP and determination if update will be stand-alone or integrated into the SHMP
- Plan update meetings
- Determining involvement and activities of newly participating state agencies (as well as changes in existing ones), including assessment of vulnerabilities, analysis of programs and policies, and identification of new mitigation actions
- Updating the status of mitigation actions identified in the 2018 plan
- Contracting consultant assistance, as necessary

6.1.4 Evaluation of Methods, Schedule, Elements, and Processes Identified in Previous Plan

The overall process defined for monitoring, evaluating, and updating the Plan is revisited with each plan update. This section was simplified to reflect current practices and align with Colorado SHMP procedures.

6.2 Monitoring Progress of Mitigation Activities

6.2.1 Monitoring Mitigation Measures and Project Closeouts

This sub-section pertains to FEMA funded mitigation grant programs. The method used to monitor mitigation project completions and closeouts for HMGP projects is described in the DHSEM HMGP Administrative Plan. This method will be utilized for monitoring all mitigation projects. Projects must be completed and reconciled within three years for those projects completed following a disaster declaration. For project completions, sub-grantees shall submit a letter with all final project documentation and a final inspection report to DHSEM requesting closeout. The SHMO, mitigation staff, and financial officer are responsible for review of all paperwork for completion and to determine that all eligible work was completed within the performance period. Site visits and inspections are conducted when deemed necessary. Procedures that will be utilized regarding the transmittal of closeout documents to FEMA are also described in the HMGP Administrative Plan.

FMA and PDM-funded mitigation activities will be monitored according to the latest programmatic guidance, in conformance with Region VIII and enhanced plan HMA compliance criteria, as appropriate.

6.2.2 Reviewing Progress on Achieving Goals in Mitigation Strategy

The goals associated with the flood mitigation plan are presented in Section 4.4.1. Mitigation actions were also identified in this table along with the actions taken to achieve the actions. This table will be utilized as a tool to review the progress on achieving the goals and actions related to

the Flood Hazard Mitigation Plan. As actions are finalized, the actions completed table will be updated to reflect the mitigation action and achievement of the activity.

The mitigation actions listed in the plan should be reviewed annually (see Section 6.1.2) for progress and updated every five years for consistency with the mitigation programs. The CWCB CAP Coordinator will be responsible for collecting the information necessary to update the progress of the goals and recommendations identified in the table. Much of this information will be provided by representatives of state agencies identified in the table. **Colorado State Hazard Mitigation Plan implementation requirements will necessitate annual coordination with the State Hazard Mitigation Team, including annual review of progress of mitigation actions.** See Section 7 of the Colorado State Hazard Mitigation Plan for additional details.

6.2.3 Changes in System for Tracking Mitigation Activities

For FEMA-funded projects, quarterly progress reports are required from sub-grantees, which are to reflect project and cost status. These reports are reviewed by mitigation staff and the State Hazard Mitigation Officer and submitted to FEMA.

As previously discussed, flood mitigation activities (both planning and project activities) will be tracked, from submittal through approval and completion, by the CWCB CAP coordinator on a spreadsheet that provides the following information:

- Local jurisdiction
- Project type (planning, mitigation project, or technical assistance)
- Total project cost
- Non-federal share of the total project cost
- Federal share of total project cost (itemized by planning, mitigation project, or technical assistance)
- Date of funding/award
- Performance period/completion date

Mitigation effectiveness

Moving forward, if Colorado becomes an enhanced plan state, then tracking mitigation effectiveness will become increasingly important. This includes preserving information on benefits of projects, such as Benefit Cost Analyses, or documenting losses avoided when a project is tested by a hazard event. This process is outlined in Chapter 8 of the SHMP.

6.2.4 System for Reviewing Progress on Implementing Activities and Projects in Mitigation Strategy

The procedures utilized for reviewing the progress associated with implementing activities and projects related to the mitigation strategy were discussed in the two previous sections. In summary,

the system will include the utilization of Table 4-4 presented in Section 4.4.1 along with the tracking spreadsheet utilized by the CWCB CAP coordinator. It is further recommended that the CWCB/Flood TAP prepare an annual report on progress towards mitigation projects and incorporate this information into other agencies' periodic reports where applicable (e.g., CWCB, DOLA, etc.), including those associated with annual SHMP standard and/or enhanced plan compliance.

During the five year update the Flood TAP, or alternately the SHMT, will be convened to identify which mitigation actions are still relevant and should be carried forward, which ones have been completed, and the actions that should be deleted in the next update.

6.2.5 Implementation of Previously Planned Mitigation Actions

Several actions in the Flood Mitigation Plan have been implemented over the years as noted in Table 4-4 in Section 4.4.1 and Section 4.4.2. Public outreach and training included workshops and seminars through the CAP to assist communities with the development of flood mitigation planning documents, improvements in flood and erosion hazard mapping, and more. Please refer to Table 4-6 in Section 4.5.2 for a more comprehensive list of flood hazard mitigation projects in Colorado.

APPENDIX A ACRONYMS

APA	American Planning Association
BOCA	Building Officials and Code Administrators
CAP	Community Assistance Program
CASFM	Colorado Association of Stormwater and Floodplain Managers
CCI	Colorado Counties, Inc.
CDBG	Community Development Block Grant program
CDBG-DR	Community Development Block Grant – Disaster Recovery
CDO	Community Development Office (DOLA-DLG)
CDOT	Colorado Department of Transportation
CDPHE	Colorado Department of Public Health & Environment
CDWR	Colorado Division of Water Resources
CEMA	Colorado Emergency Management Association
CFM	Certified Floodplain Managers
CFR	Code of Federal Regulations
CFS	Cubic Feet per Second
CGS	Colorado Geological Survey (Colorado School of Mines)
CHAMP	Colorado Hazard Mapping Program
CHIRRP	Colorado Hazard and Incident Response and Recovery Plan
CML	Colorado Municipal League
COGA	Colorado Oil & Gas Association
CPW	Colorado Parks and Wildlife
CRO	Colorado Resiliency Office (DOLA-DLG)
CRS	Community Rating System

C.R.S.	Colorado Revised Statute
CTP	Cooperating Technical Partner
CWCB	Colorado Water Conservation Board (DNR)
DEM	Digital Elevation Model
DFIRM	Digital Flood Insurance Rate Map
DHSEM	Colorado Division of Homeland Security & Emergency Management (DPS)
DLG	Division of Local Government (DOLA)
DMA	Disaster Mitigation Act of 2000
DNR	Department of Natural Resources
DPS	Colorado Department of Public Safety
EIAF	Energy/Mineral Impact Assistance Fund Grant
EMAP	Emergency Management Accreditation Program
EMPG	Emergency Management Performance Grant
EWP	Emergency Watershed Protection Program (CWCB)
FEMA	Federal Emergency Management Agency
FHWA	Federal Highway Administration
FHZ	Fluvial Hazard Zones
FIS	Flood Insurance Studies
FMA	Flood Mitigation Assistance program (FEMA)
FMAC	Flood Mitigation Advisory Committee
GAR	Governor's Authorized Representative
GIS	Geographic Information System
HFIA	Homeowner Flood Insurance Affordability Act
HMA	Hazard Mitigation Assistance Grants (FEMA)

HMGP	Hazard Mitigation Grant Program (FEMA)
HUD	U.S. Department of Housing and Urban Development
IBC	International Building Code
LiDAR	Light Detection And Ranging
LOMR	Letters of Map Revision
LOMR-F	Letter of Map Revision based on Fill
MOTF	Modeling Impact Task Force (FEMA)
MRP	Flood Risk Map
NED	National Elevation Dataset
NFHL	National Flood Hazard Layer
NFIP	National Flood Insurance Program (FEMA)
NLD	National Levee Database (USACE)
NLE	Non-Levee Embankments
NOAA	National Oceanic and Atmospheric Administration
NRCS	Natural Resource Conservation Service (USDA)
NWS	National Weather Service (NOAA)
OIT	Colorado Office of Information Technology
ORM	Colorado Office of Risk Management
PA	Public Assistance program (FEMA)
PAR	Populations At Risk
PDM	Pre-Disaster Mitigation program (FEMA)
POA	Plan Of Action
RAMP	Responsible Acceleration of Maintenance and Partnerships
Risk MAP	Risk Mapping, Assessment and Planning Program

RWEACT	Rio Grande Watershed Emergency Action and Coordination Team
SBA	U.S. Small Business Administration
SHMO	State Hazard Mitigation Officer
SHMP	Colorado State Hazard Mitigation Plan
SHMT	State Hazard Mitigation Team
SLV	San Luis Valley
SMAP	State Mitigation Assistance Program
STAPLE/E	Social, Technical, Administrative, Political, Legal, Economic, & Environmental
SVI	Social Vulnerability Index
SWA	State Wildlife Area
TABOR	Taxpayers Bill of Rights
TAP	Technical Assistance Partnership
UBC	Uniform Building Code
UDFCD	Urban Drainage & Flood Control District
USACE	U.S. Army Corps of Engineers
USDA	U.S. Department of Agriculture
USFS	U.S. Forest Service
USGS	U.S. Geological Survey
WQCD	Water Quality Control Division (CDPHE)