COLORADO DROUGHT MITIGATION AND RESPONSE PLAN

August 2018

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

Prepared by
Colorado Water Conservation Board
Department of Natural Resources

In Cooperation with
The Department of Public Safety
Division of Homeland Security & Emergency Management
and the Drought Mitigation and Response Planning Committee

The Colorado Drought Mitigation and Response Plan

Drought Annex to the State Hazard Mitigation Plan
ANNEX VII to the State Emergency Operations Plan

Colorado Department of Natural Resources
Colorado Water Conservation Board

Updated in 2018 and 2013 by the CWCB and Wood Environment & Infrastructure Solutions, Inc. in coordination with the Drought Mitigation and Response Planning Committee
and the National Drought Mitigation Center

Drought Mitigation and Response Plan Comprehensive Revision by the CWCB and AMEC Environment and Infrastructure in 2010

Mitigation Plan Elements Revised by the CWCB and Leonard Rice Engineers in 2007

Revised by J. Brislawn, M. Gally, L. Boulas, J. Truby, T. Grier, P. White, and M. Koleis in 2001.
Revised by J. Truby, L. Boulas, and R. Kistner in 1986 and 1990.

Original document developed by J. Truby, L. Boulas 1981
Colorado Department of Local Affairs
Division of Local Government
Office of Emergency Management

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Executive Summary

The Colorado Drought Mitigation and Response Plan (Plan) was developed to provide an effective and systematic means for the State of Colorado to reduce the impacts of water shortages over the short and long term. The Plan outlines a mechanism for coordinated drought monitoring, impact assessment, response to emergency drought problems, and mitigation of long term drought impacts. There are three major components of the plan: mitigation, response and vulnerability assessment. The mitigation component of the Plan conforms to the standard and enhanced state hazard mitigation planning requirements of the Disaster Mitigation Act of 2000 and serves as the Base Plan. Included is a description of the process used to prepare the Plan and a profile of the drought hazard in Colorado, including the nature of impacts and probability of occurrence. A detailed vulnerability assessment discusses the past and potential impacts to Colorado's economy, environment, state assets, and water providers. The vulnerability assessment is covered in detail in Annex B, and summarized in Sections 3.4 and 3.5 of the Plan. 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 during drought and non-drought times. A capability assessment describes the State's plans, policies, and procedures in place that already help manage and reduce drought impacts. 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.

The response component of the Plan is detailed in Annex A and includes monitoring, assessment, and response. This Annex guides State and partner agency response actions during times of drought. Monitoring is ongoing and accomplished by regular meetings of the Water Availability Task Force (WATF). This task force is comprised of Colorado's water supply specialists from state, local, and federal governments, as well as experts in climatology and weather forecasting. This task force monitors snowpack, precipitation, reservoir storage, and streamflow and provides a forum for synthesizing and interpreting water availability information. When the WATF determines that drought conditions are reaching significant levels the Governor is notified and activation of the Plan is recommended.

When Annex A is activated, assessment begins with activation of the relevant Impact Task Forces (ITFs). These task forces convene on an as needed basis to determine existing or potential impacts within specific sectors. Impact Task Forces include Municipal Water, Agricultural Industry, Wildlife, and Energy. Assessment coordination is handled by the Drought Task Force. This task force is comprised of directors from the Departments of Natural Resources, Agriculture, Public Safety, and Local Affairs, and chairpersons of the WATF and the Impact Task Forces. They review reports from the WATF and ITFs, aggregate impact assessments and projections, evaluate overall conditions, develop recommendations for drought response, and make timely reports to leadership, the media, the response agencies, and others. The response process consists of coordinated drought response activities amongst the lead state agencies under leadership of the Governor and recommendations of the ITFs.

1 PREREQUISITE

1.1 Adoption by the State

1.1.1 Formal Adoption by the State

Adoption by the Office of the Governor empowers the Colorado Water Conservation Board (CWCB) and the Colorado Division of Homeland Security and Emergency Management's Office of Emergency Management (DHSEM) to execute their responsibilities with respect to disaster preparedness, response, recovery, and mitigation. The Drought Mitigation and Response Plan (hereinafter referred to as the Plan or Drought Plan; the mitigation component only is referred to as the Base Plan) was reviewed and formally approved by the board of the CWCB in September 2018. As an annex to the State of Colorado Hazard Mitigation Plan (SHMP), this Plan is on a five-year update cycle and will be re-adopted by the Governor each cycle.

1.1.2 Assurance 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 Disaster Mitigation Act emphasized the need for mitigation plans and more coordinated mitigation planning and implementation efforts, the regulations established the requirements that local hazard mitigation plans must meet in order for a 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. While not a federal requirement, the Drought Mitigation Plan complies with and adheres to the Emergency Management Accreditation Program, or 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 national standards for emergency management programs. The Drought Response Plan Annex (Annex A) has been designed to comply with the National Response Framework (NRF) and National Incident Management System (NIMS) protocols.

According to Federal Emergency Management Agency (FEMA) state hazard mitigation planning guidance which became effective in 2016, climate change consideration must be integrated into

state hazard mitigation plan updates. What this means for Colorado plans, including this Drought Mitigation and Response 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 Drought Plan has addressed climate change since the 2010 update, and continues to in the 2018 update. 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 the 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 (DMA) planning and update requirements and FEMA's associated guidance for state hazard mitigation plans. The Drought Mitigation and Response Planning Committee (DMRPC), convened by CWCB, followed FEMA's recommended four phase 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 Colorado statewide 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 DHSEM took the lead on the 2018 update of the State of Colorado Hazard Mitigation Plan umbrella document. The original umbrella document was created in 2001, was updated in 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.

The DHSEM coordinated with other agencies on concurrent state planning and risk management efforts, including the Drought Plan and Flood Hazard Mitigation Plan as stand-alone hazard specific annexes to the SHMP. CWCB's Office of Water Conservation and Drought Planning took the lead on the 2007, 2010, 2013 and 2018 updates to the Drought Plan. The 2010 update cycle was a comprehensive revision and will be referred to as such in the remainder of the Plan. A consulting firm, Wood Environment and Infrastructure Solutions, Inc (Wood)) was selected to coordinate and facilitate the 2018 update process to the Plan.

Evolution of the Colorado Drought Mitigation and Response Plan

Drought planning has been evolving in Colorado since the late 1970s. During the 1976-1977 drought Colorado's government assumed a lead role in coordinating federal, state, and local government response and promoted statewide public conservation practices. Conclusions from that effort include:

- the diversity, complexity, and ambiguity of drought impacts blurred identification of alternative actions available to decision makers;
- a systematic definition of problem areas and potential solutions was essential to effective government response, so under and overreactions could be minimized;

- both physical and social impact data were needed;
- knowledge of the location, kind, and degree of water shortage provides better identification of impacts;
- timely and accurate data on impact development were crucial to effective response;
- impact identification provides the framework for governmental and public adjustments;
- integration of response by private, public, and governmental entities was needed;
- as the drought intensifies, the maintenance of established channels of responsibility, with emphasis on water conservation and planning, becomes increasingly important;
- as impact problems and local needs become more serious, better management and integration of effort also intensifies; and
- should drought intensify to the point where impacts exceed the State's response capabilities, an effective state program will help facilitate a request for federal assistance.

Governor Lamm took action in February 1981 to deal with potential drought situations. His memorandum of February 5 required the accomplishment of the following tasks:

1. Develop and activate a data collection and assessment system which will identify the potential impacts of a drought and track their occurrence and intensity. At some point, this assessment process may result in a recommendation that a drought emergency be proclaimed.
2. Develop a drought emergency response plan which would be activated by a drought emergency decision. This task includes cataloguing existing state and federal response and relief programs and authorities, and developing recommendations to meet additional needs.

The initial Colorado Drought Response Plan was completed in 1981, and revised in 1986, 1990, 2001, and 2002. In 1981, it was one of three state drought plans in the nation. Since that time, the Plan has been widely distributed and received interest both nationally and internationally and has served as a model for other states. Mitigation was first introduced into the Plan's 2001 update and since that time the Plan has been both a mitigation and response plan. Mitigation includes actions that could be taken pre-drought that would lessen impacts when a drought occurs. It also includes "incident" mitigation, which are short-term actions taken during a drought meant to reduce disasters losses or impacts. The mitigation component was further expanded in 2007 with the development of a companion document "Updated Information Provided in Support of the 2002 Colorado Drought Mitigation and Response Plan." This was developed to align the Plan's mitigation element with the standard state mitigation planning requirements of the DMA, thus making it consistent with the SHMP and placing it on the same update cycle as that plan (required every five years). The SHMP update of 2018 was done in accordance with FEMA standard and enhanced plan requirements.

The Colorado Drought Mitigation and Response Plan was developed to provide an effective and systematic means for the State of Colorado to reduce the impacts of water shortages over the short or long term. The Plan outlines a mechanism for coordinated drought monitoring, impact assessment, response to emergency drought problems, and mitigation of long-term drought impacts. The Plan does not create a new government entity to deal with drought, but provides a

means for coordinating the efforts of public and private entities that would be called upon to deal with drought impacts.

There are four components of the Plan: monitoring, assessment, response, and mitigation. monitoring is ongoing and accomplished by regular meetings of the Water Availability Task Force (WATF). This task force is comprised of Colorado's water supply specialists from state, local, and federal governments, as well as experts in climatology and weather forecasting. This task force monitors snowpack, precipitation, reservoir storage, and streamflow and provides a forum for synthesizing and interpreting water availability information. When the WATF determines that drought conditions are reaching significant levels the Governor is notified and activation of the Plan is recommended. When the Plan is activated, the first step is impact assessment. Assessment begins with activation of the relevant Impact Task Forces (ITFs). These task forces convene to determine impacts within specific sectors which effect the environment and economy. The original Impact Task Forces included Municipal Water, Wildfire Protection, Agricultural Industry, Tourism, Wildlife, Economic Impacts, Energy Loss, and Health. These task forces have been activated as needed during times of drought, notably in 1989-1990, 1994, 1996, 2002, 2011 and 2018. The number and nature of the ITFs have changed over the years; the 2018 ITFs are listed and described in Annex A.

2010 Revision Planning Process

In 2010 the Plan underwent a significant revision and overhaul as part of the five-year State Plan update cycle. The major objectives that revision included:

- Updating the Plan to meet DMA 2000 and EMAP planning standards
- Merging the 2002 Response and Mitigation Plan with the 2007 companion document
- Developing a comprehensive drought hazard vulnerability assessment
- Revising and modernizing the response elements of the Plan
- Developing additional tools and resources to support local drought planning efforts
- Modernizing and evaluating the indices used for drought monitoring in the State

A significant change in the 2010 document was that the response elements can be accessed in one location, Annex A Drought Response Plan. This was done so that these elements could be referenced individually when a drought occurs. The Plan outline mirrors that of the FEMA standard mitigation plan update review crosswalk for consistency with DMA 2000 planning requirements.

2013 Update Planning Process

In 2013 the Plan was updated as part of the three-year State Plan update cycle required at that time. The objectives of the update included:

- Reconvening and updating the DMRPC to provide input to the 2013 planning process
- Meeting DMA 2000 standard state plan update requirements and EMAP planning standards
- Review, revisit, and update all sections of the Plan, highlighting changes since 2010, notably progress in mitigation actions in Chapter 4.
- Update the Vulnerability Assessment in Annex B with recently available information
- Update the hazard profile to capture the 2013 assessment of Colorado's unique climatology, including a discussion of the 2011-2013 drought
- Update the Response Plan in Annex A to reflect current procedures and lessons learned from response to the 2011-2013 drought.
- Update changes in coordination and plan maintenance procedures.

2018 Update Planning Process

In 2018 the Plan was updated as part of the five-year state plan update cycle, as required by FEMA. The objectives of the update included:

- Reconvening and updating the DMRPC to provide input to the 2018 planning process
- Meeting DMA 2000 standard and enhanced state plan update requirements and EMAP planning standards
- Review, revisit, and update all sections of the Plan, highlighting changes since 2013, notably progress in mitigation actions in Chapter 4.
- Update the Vulnerability Assessment in Annex B with recently available information
- Update changes in coordination and plan maintenance procedures.

Similar to the 2010 and 2013 revision process, the committee followed FEMA's four phase planning process and participated in three major planning meetings between November and April 2018, which are summarized in Table 1.

Table 1 Key Planning Meetings of the 2018 Update Process

Meeting	Date	Purpose
1. Kickoff	11/28/2018	Review Disaster Mitigation Act planning requirements, scope of work, and schedule Review role of DMRPC Introduce methodology to record progress of mitigation actions from 2013 Discuss data collection needs Discuss stakeholder involvement Discuss coordination with other State Plan update efforts
2. Risk Assessment & Capability Assessment	02/22/2018	Present and discuss updated risk and vulnerability assessment Discuss improvements to response Plan elements Introduce methodology for updating goals and objectives
3. Mitigation Strategy	04/05/2018	Revisit and revise goals Review and approve state mitigation criteria for evaluation and prioritization Revisit status and priority of existing mitigation actions and develop new mitigation actions

Sign in sheets and summaries of these meetings are included in a Planning Process Reference Notebook on file with the CWCB.

Several other meetings took place to foster coordination and raise awareness of the planning effort. Significant events are noted here:

- Discussion on Plan update progress at monthly WATF meetings January-August 2018.
- Several members of the DMRPC also participated in the 2018 Colorado Hazard Mitigation Plan Update meetings (February 13, April 10 and May 22).

2.1.2 Involvement in Planning Process

Drought Mitigation and Response Planning Committee

The development, implementation, and maintenance of the Drought Plan are the responsibility of the DMRPC under the leadership of the CWCB. The DMRPC is made up of representatives of the principal state agencies and organizations with authorities, responsibilities, or expertise related to drought and hazard mitigation. The committee was formed during the 2010 revision process based on membership of the existing WATF and ITFs. Specific membership is discussed in Appendix A Drought Mitigation and Response Planning Committee.

During the 2018 update process, several individuals participated on the DMRPC and provided information and assistance to promote the development of the document. Appendix A identifies those that were involved or contacted for input in the update of this Plan.

The DMRPC consists of the following agencies/entities:

State

- Colorado State University – Colorado Climate Center
- Colorado State University – Water Resources Institute
- Colorado State University – Colorado State Forest Service
- Colorado School of Mines – Colorado Geological Survey
- Department of Agriculture
- Department of Corrections
- Department of Local Affairs – Division of Local Government
- Department of Public Safety –
  - Division of Homeland Security & Emergency Management - Office of Emergency Management
  - Division of Fire Prevention and Control
- Department of Local Affairs – Division of Local Government
- Department of Military and Veterans Affairs
- Department of Natural Resources – Colorado Water Conservation Board **(lead agency)**
- Department of Natural Resources – Colorado Parks and Wildlife
- Department of Natural Resources – Division of Water Resources
- Department of Natural Resources – State Land Board
- Department of Natural Resources – State Engineer's Office
- Department of Public Health and Environment
- Department of Regulatory Affairs – Public Utilities Commission
- Colorado Energy Office
- Governor's Office of State Planning and Budgeting
- Governor's Office of Economic Development and International Trade – Tourism Office
- University of Colorado at Boulder

Federal

- U.S. Bureau of Reclamation
- U.S. Department of Agriculture - Natural Resources Conservation Service
- National Oceanic and Atmospheric Administration – National Integrated Drought Information System (NIDIS)
- U.S. Geological Survey

Local

- City of Aurora
- City of Thornton
- Northern Colorado Water Conservancy District
- Denver Water
- Colorado Springs Utilities

Other

- National Drought Mitigation Center – University of Nebraska
- National Center for Atmospheric Research
- The Nature Conservancy
- University Corporation for Atmospheric Research
- Western Water Assessment

The DMRPC members were involved in the planning process through:

- Attending and participating in DMRPC meetings
- Providing available data requested
- Reviewing and commenting on Plan drafts and obtain agency buy-in for relevant sections
- Assist with public input/stakeholder process

2.1.3 Agency Involvement in Plan Preparation Process

During the update to the Drought 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. Documentation of their involvement in the 2018 update process is included in Appendix A and in the Planning Process Reference Notebook on file with the CWCB. Agencies were provided a data collection worksheet designed to capture information to update the Plan. The worksheet was designed 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. DMRPC members filled out these questionnaires and worksheets, and the information directly contributed to the preparation of this Plan. During 2018 specific agencies and organizations with relevant data were contacted through email and phone to provide updated information.

Federal agencies play a key partnership role in drought monitoring and mitigation in Colorado. The NRCS modernized the Surface Water Supply Index (SWSI) for Colorado as part of the 2013 planning effort and developed a summary of this effort that is included in the 2013 Annex D Drought Monitoring Indices. Parallel to this effort the Colorado Climate Center analyzed the validity of the Colorado Modified Palmer Drought Index as a drought indicator and prepared input for Annex D as part of the 2010 revision.

2.1.4 Description of Plan Review and Analysis

During the 2018 update, the DMRPC 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 DMRPC analyzed each section using FEMA's state plan update guidance to ensure that the Plan met requirements. Table 2 briefly summarizes how each section of the Plan was reviewed and analyzed to capture changes that occurred since the previous plan was approved. More detailed

documentation on revision methodology and process is provided at the beginning of each Plan section.

Additionally, the DMRPC reviewed and provided comment on the draft revised Plan. The document was shared electronically through a web-based collaboration site. Comments were solicited during a two-week period in June.

2.1.5 Indication of Section Revisions

As part of the 2018 update, every section was updated with new or revised information. Table 2 shows which sections of the Drought Mitigation Plan were revised with highlights of what is new.

Table 2 Highlights of Changes in the 2018 Update

Plan Element	Highlights of Update
Prerequisite Adoption by the State	• Language revised for 2018 • 2018 approval by CWCB Board
Planning Process Documentation of the Planning Process Coordination Among Agencies Program Integration	• Extensive planning effort documented • Multi-agency outreach and coordination and changes in coordination captured • Coordination with the 2018 update of the Colorado State Hazard Mitigation Plan
Risk Assessment Identifying Drought Hazards Profiling Drought Hazards Assessing Vulnerability by Jurisdiction Assessing Vulnerability of State Facilities Estimating Potential Losses by Jurisdiction	• Incorporated 2011-2013 drought info. • Revised with latest climate science and incorporation of paleo hydrology analysis • Detailed Vulnerability Assessment report in Annex B updated where available data permitted to assess drought vulnerability by various impact sectors; combined vulnerability table and map. • Includes EMAP consequence analysis updated to latest standards • Refer to Annex B summary of changes
Mitigation Strategy Hazard Mitigation Goals State Capability Assessment Local Capability Assessment Mitigation Actions Funding Sources	• Goals reassessed and revised to reflect 2018 priorities • Mitigation Action table updated with status and progress • Actions revised and prioritized • New actions developed • Comprehensive capability assessment review • Funding sources revision
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 three years
Plan Maintenance Process Monitoring, Evaluating, and Updating the Plan Monitoring Progress of Mitigation Activities	• Process more clearly defined and revised to reflect 2018 process

Plan Element	Highlights of Update
Drought Response Plan Annex	• Minor edits to reflect updated agency names and Impact Task Force representatives • Minor updates to the declaration procedures

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 revision to this Plan and the umbrella SHMP. The agencies are identified in the previous sections with specific contacts identified in Appendix A. Both federal and state agencies were represented on the DMRPC and participated in meetings previously listed. As indicated, these meetings served as a means 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 DMRPC 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

During the 2018 planning update process other groups 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 email group, providing information to support the effort, or reviewing and commenting on the draft Plan. The following groups in the list that follows were identified as interested groups. Specific contacts were identified with each group to solicit input on the draft Plan. Those that provided feedback or comments are noted with an asterisk. Many of these agencies provided feedback that improved the accuracy and content of the final draft. Others may be considered for additional involvement or outreach in the future.

Other Federal Agencies

- U.S. Geological Survey (USGS)
- National Oceanic and Atmospheric Association (NOAA)
- National Renewable Energy Laboratory
- USDA – Farm Service Agency (FSA)
- USDA – Risk Management Agency (RMA)
- USDA – U.S. Forest Service (USFS)
- USDA – Natural Resource Conservation Service (NRCS)*
- FEMA

- US Army Corps of Engineers (USACE)
- US Department of the Interior (USDOI) – Bureau of Land Management (BLM)
- USDOI – National Park Service (NPS)
- USDOI – Fish and Wildlife Service (FWS)
- USDOI – Bureau of Indian Affairs (BIA)
- USDOI – Bureau of Reclamation (USBR)

Other Agricultural Organizations

- Co Farm Bureau Federation
- Co Cattlemen's Association*

Wildland Fire/Forest Health

- Colorado Fire Chiefs Association
- Front Range Fuels Treatment Partnership
- Colorado Bark Beetle Cooperative
- Northern Front Range Mountain Pine Beetle Working group
- Culebra Coalition (southern Front Range)

Other Local and State Government

- Colorado Geological Survey*
- Colorado Parks and Wildlife*
- Colorado Department of Corrections*
- Colorado Municipal League
- Colorado Counties Inc.
- Colorado Emergency Management Association
- Western Governors' Association*
- Dept. of Labor and Employment

Utility Providers

- Xcel Energy
- Tri-State Energy
- Northern Colorado Water Conservation District
- Colorado River Water Conservation District
- Colorado Watershed Assembly
- Colorado Springs Utilities
- Denver Water
- Aurora Water

Recreation/Tourism

- Chambers of Commerce
- Colorado Ski Country USA

Conservation Organizations

- Colorado Wildlife Federation
- Colorado Audubon Society
- Colorado Trout Unlimited
- Defenders of Wildlife*
- Ducks Unlimited
- Playa Lakes Joint Venture
- Pheasants Forever
- The Nature Conservancy
- Western Resource Advocates*

Other Organizations

- National Drought Mitigation Center (NDMC)*
- Water Commissioners
- Western Water Assessment*
- Colorado Renewable Energy Society
- Associated General Contractors of Colorado
- Colorado Watershed Assembly
- University of Colorado Boulder

Public Review

Before finalizing the 2018 update the draft Plan was made available to the public for review. The Public Review Draft of the Plan was posted on the CWCB website for a 30-day comment period between July 24 - August 24, 2018. A notice was distributed through a CWCB email group that included the Water Availability Task Force. Some minor final state agency feedback was received but no public comments.

2.2.3 Changes in Coordination

Changes in coordination have occurred over the evolution of the Drought Plan. This Plan was originally developed and maintained by the Office of Emergency Management (formerly the Division of Emergency Management). The Plan's lead agency became the DNR-CWCB in 2002 and has continued to be since then.

As a result of the comprehensive analysis done by CWCB through the Statewide Water Supply Initiative (SWSI) following the 2002-2003 drought, as well as work completed by the Interbasin

Compact Committee (IBCC) and the Basin Roundtables (BRTs) it became clear that the State's current water trajectory is neither desirable nor sustainable. In May 2013 Governor Hickenlooper issued Executive Order D 2013-5, which directed CWCB to prepare a water plan for Colorado. The Water Plan is a framework to guide future decision making and to address water challenges with a collaborative, balanced, and solutions-oriented approach. The goals of the plan are to meet the water supply gap, defending Colorado's compact entitlements, improving regulatory processes and exploring financial incentives – all while honoring Colorado's water value and ensuring the state's water resources are protected and available for generation to come. Colorado's Water Plan was completed in 2015. The efforts put forth in the Water Plan will help support many of the mitigation actions previously identified in the Drought Plan.

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 Drought 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.

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 water section of the Climate Plan builds on the policies and strategy recommendations that are put forth in the state Water Plan. Some of the strategies and policy recommendations as they relate to this Plan include the following, "promote and encourage water efficiency and/or conservation at the local and state agency level, support water sharing agreements where feasible and cost effective, and promote and encourage drought preparedness through comprehensive drought planning and mitigation implementation."

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 as the update for this Plan and 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 supporting document to the State Plan. Portions of information included in drought hazard profile in the SHMP are taken directly from this plan update, contributing to the profile of the drought hazard in Colorado and analysis of the nature of impacts and probability of drought occurrence. Other plans that this Plan revises,

complements, and integrates portions of include the CWCB's 2004 and 2007 Drought and Water Supply Assessments (DWSA). Annex A of this plan also complements and works in concert with the State Emergency Operations Plan.

The State of Colorado is committed to the multi-agency mitigation strategy outlined in this Plan. Two goals listed in this Plan in Section 4.1 are related to this:

- Coordinate and provide technical assistance for state, local and watershed planning efforts
- Continue to develop intergovernmental and interagency stakeholder coordination

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 4.2 State Capability Assessment.

The following statewide planning efforts have included collaboration through the incorporation of the findings and recommendations from one plan to another:

- Colorado River Water Availability Study (Phase I and II)
- Colorado Inter Basin Compact Committee planning efforts
- Basin Needs Decision Support System
- Statewide Water Supply Initiative (various reports)
- Colorado Energy Assurance Emergency Plan
- Colorado Forest Resource Assessment Plan
- Local multi-hazard mitigation plans
- Local drought management plans
- Local water conservation plans
- Colorado State Water Plan
- Colorado Climate Plan
- Colorado Hazard Mitigation Plan (2018 Update)

Specific action items related to future integration are noted in Section 4.4. This Plan is a related component of the Colorado River Water Availability Study phases and other water supply planning initiatives being spearheaded by the CWCB.

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. The mitigation component of the Plan conforms to the standard State Hazard Mitigation planning requirements of the Disaster Mitigation Act of 2000 based on the FEMA Bluebook Multi-Hazard Mitigation Planning Guidance (2004, revised in 2008) and 2015 FEMA State Mitigation Plan Review Guide. FEMA does not have specific programs aimed at mitigating drought disasters. DHSEM is the primary state coordinating agency

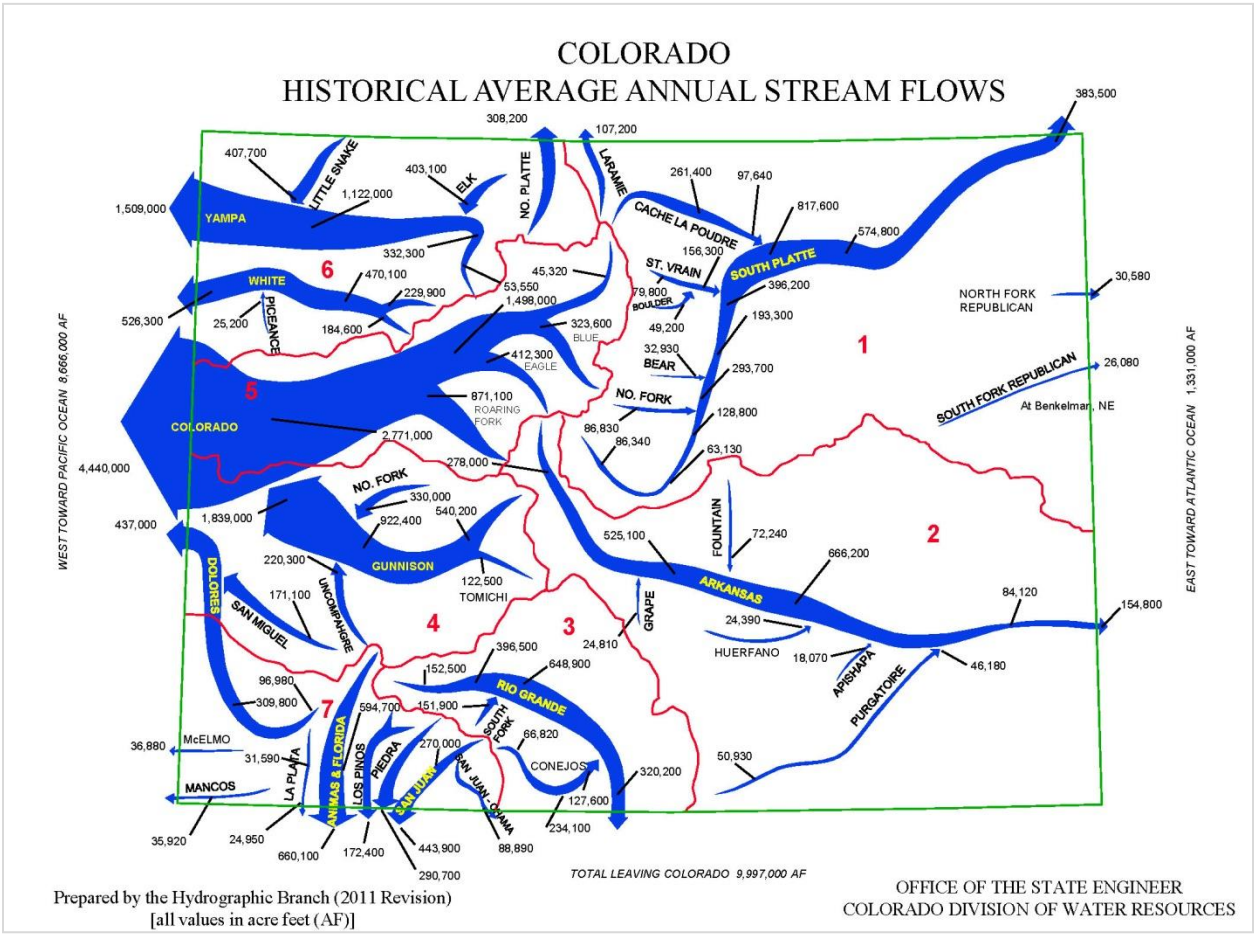
for all local emergency operation plans and hazard mitigation plans. The division has the primary responsibility of working with local governments in developing, reviewing, and updating local hazard mitigation plans. Refer to the 2018 Colorado SHMP for further description of the integration of FEMA mitigation programs and initiatives in Colorado.

3 RISK ASSESSMENT

3.1 Identifying the Drought Hazard

Colorado gets new water supplies from only one source: precipitation, in the form of rain, hail, or snow. Colorado gets all of its water from precipitation because there are no major rivers that flow into Colorado (McKee et al., 1999). There are several major river basins originating in the Colorado Rockies, which flow out of the State (see Figure 1), providing water to much of the southwestern United States, and contributing to the Missouri and Mississippi rivers as well. Thus, Colorado earns its title as "the Mother of Rivers." The water flowing out of the state fluctuates during wet and dry years, as depicted in Figure 2, which is excerpted from the Colorado Water Plan.

Figure 1 Colorado Historic Average Annual Streamflow (acre-feet)



Source: Office of the State Engineer – Colorado Division of Water Resources

Figure 2 Colorado Summary of Observed Wet and Dry Surface Water Hydrology

Source: Colorado Water Plan 2015

Although the source of Colorado's water supplies is precipitation, it is difficult to use directly in that form. Instead, water is often stored in one of five forms of usable water:

- snowpack (SN), used directly for recreation, although it also serves as a large storage of water supplies;
- streamflow (ST), used for recreation, habitat, irrigation and municipal water supplies, as well as meeting interstate compact obligations;
- reservoir water (RW), used similarly to streamflow;

- soil moisture (SM), used by natural vegetation and agriculture; and
- groundwater (GW) used for irrigation and municipal water supplies.

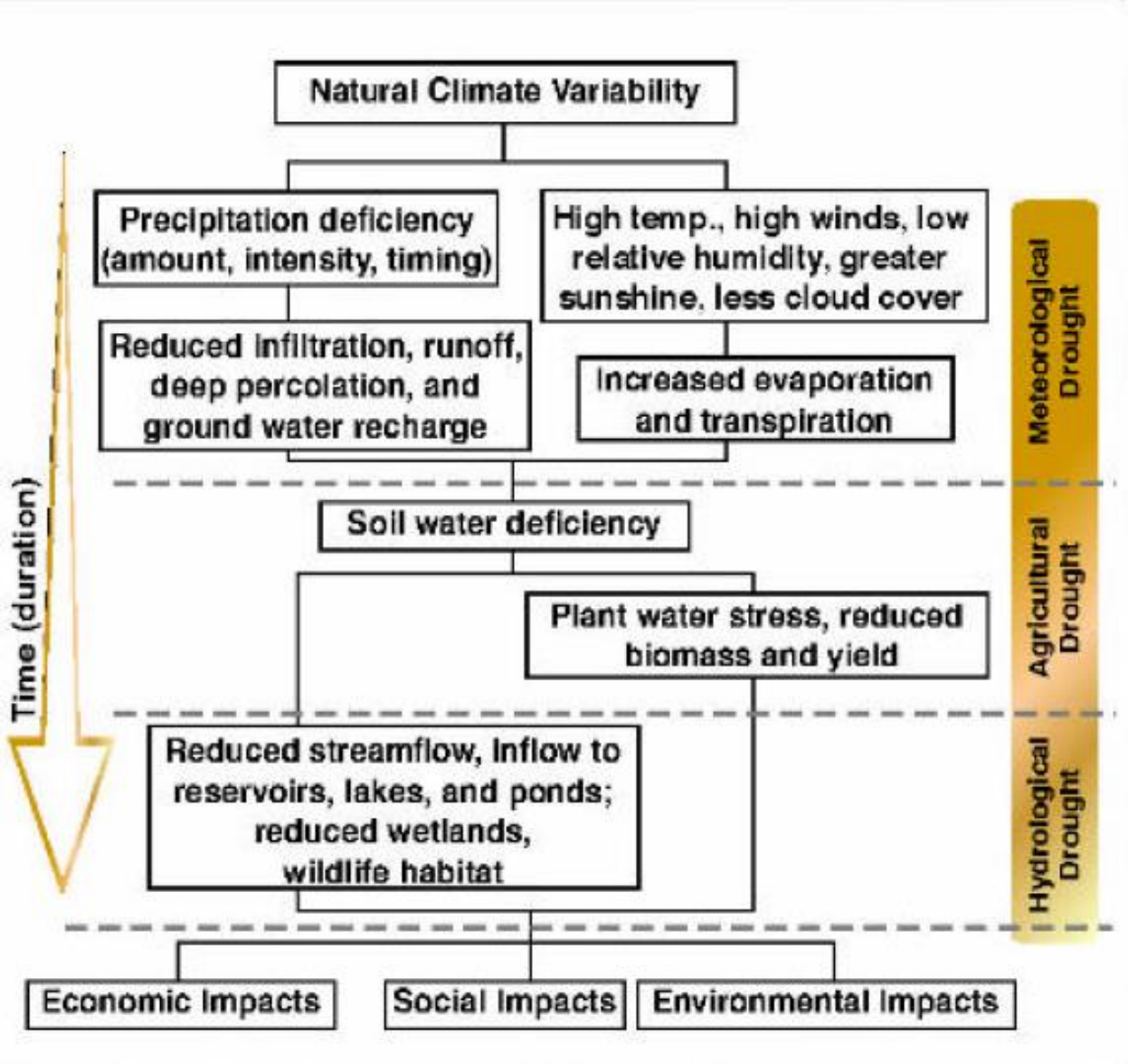
The amount of time it takes for precipitation to turn into a usable form of water can vary greatly. Precipitation can add to soil moisture or snowpack almost immediately. However, there can be delays of several days, weeks, or months before precipitation adds to the water levels in streams, reservoirs, or groundwater aquifers. During those periods, some precipitation is lost to evaporation as well as wind and dust-on-snow enhancing sublimation. Therefore, in warmer months with less precipitation such as summer, brief rains that fall will add little or no water to the usable water supply.

Drought is a complex and a gradual phenomenon in Colorado. Although droughts can be characterized as emergencies, they differ from other emergency events in that most natural disasters, such as floods or forest fires, occur relatively rapidly and afford little time for preparing for disaster response. Droughts typically occur slowly, over a multi-year period, and it is often not obvious or easy to quantify when a drought begins and ends. Drought can often be defined regionally based on its effects:

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

Figure 3 relates these definitions to drought duration and potential impacts.

Figure 3 Causes and Impacts of Drought



Source: National Drought Mitigation Center

3.2 Drought Hazard Profile

Drought is a natural part of the Colorado climate, due to the state's semiarid conditions. Because natural variations in climate and precipitation, it is rare for all of Colorado to be deficient in moisture at the same time. However, single season droughts over some portion of the State are quite common; these are sometimes referred to as flash droughts. According to NOAA flash drought refers to relatively short periods of warm surface temperature and anomalously low and rapid decreasing soil moisture that can usually be classified into two categories: heat wave and precipitation deficit flash droughts. Hydrologic conditions constituting a drought for water users in one location may not constitute a drought for water users elsewhere, or for water users that have

a different water supply. Individual water suppliers may use different criteria, such as rainfall/runoff, amount of water in storage, or expected supply from a water wholesaler, to define their water supply conditions. The drought issue is further compounded by water rights specific to a state or region. Water is a commodity possessed under a variety of legal doctrines. (See the Water Rights discussion in Section 3.2.5, and Chapter 4 of the Drought Vulnerability Assessment Technical Information document).

Drought impacts are wide-reaching and may come in different forms, such as economic, environmental, and/or societal. The most significant impacts associated with drought in Colorado are those related to water intensive activities such as agriculture, wildfire protection, municipal usage, commerce, tourism, recreation, and wildlife preservation. A reduction of electric power generation and water quality deterioration are also potential effects. Drought conditions can also cause soil to compact, decreasing its ability to absorb water, making an area more susceptible to flash flooding and erosion. A drought may also increase the speed at which dead and fallen trees dry out and become more potent fuel sources for wildfires. Drought can make trees more susceptible to insect infestations, causing more extensive damage to trees and increasing wildfire risk, at least temporarily. Trees in urban forests can also become susceptible to insects and mortality due to lack of water. An ongoing drought which severely inhibits natural plant growth cycles may impact critical wildlife habitats. Drought impacts increase with the length of a drought, as carry-over supplies in reservoirs are depleted and water levels in groundwater basins decline.

Impacts from drought can also be exacerbated due to the effects of dust settling on snow, which causes increased solar energy absorption. As a result, snowmelt takes place earlier in the season and runoff magnitudes increase. Research has shown that dust deposition has increased throughout the western United States since 1992, with the largest increases in western Colorado (Brahney et al., 2013). Rigorous sampling and analyses of dust by the Colorado Dust-on-Snow program (CODOS) and USGS show that most dust being deposited to the Colorado mountain snowpack is originating from source areas located outside of Colorado, scattered throughout the greater Colorado Plateau. Drought conditions in those dust source areas can increase the availability of dust for wind transport and, thereby, increase the dust-on-snow hazard in Colorado, even when the Colorado mountains are not experiencing drought conditions. In addition to earlier snowmelt due to dust-on-snow, runoff yields can be reduced, in some years, due to increased evapotranspiration by plants. This is caused by the plant community becoming active sooner than normal as a result of earlier snowmelt and loss of snow cover (Painter et al., 2010).

The impacts related to early runoff pose problems for many important sectors in Colorado including agriculture, recreation, tourism, and municipal water supplies. If runoff happens in a shorter timeframe, sometimes months early, it could mean a shorter season for the rafting industry and less water available for irrigation diversions in the summer. Reservoirs may also be filled to capacity during these constrained runoff periods, causing spills to be necessary. Ideally, to avoid releases of water downstream, water is captured over a longer timeframe with gradual melting of snowpack.

Alternatively, dust produced from the hardening and drying of bare soil can also be exposed as vegetative cover decreases due to extended periods of drought. The Eastern Plains of Colorado, where much of the agricultural economy exists, can suffer from dust storms originating from topsoil that is easily airborne. Entire crops can be damaged in one storm, affecting the livelihood of the farmers and ranchers.

3.2.1 Location of Drought Hazards in Colorado

No portion of the State of Colorado is immune from drought conditions. The effects of drought vary based on where in the state it occurs, when it happens, and how long the drought persists. For example, a drought in the plains of the state can greatly affect agricultural crops. A long-term drought is not needed to affect agricultural yields though. Droughts of just a few weeks during critical periods of plant development can have disastrous effects on agriculture production. Droughts that occur in the mountainous regions of the state during winter months may have great effects on the ski and tourism industry. However, drought in one area of the state may also impact other regions. Lack of winter snowfall in the mountains can eventually lead to agricultural impacts on the eastern plains due to decreased streamflows. Reduced reservoir storage from decreased runoff in the mountains leads to municipal and industrial water shortages on the Front Range. Droughts that occur in populated areas may not have direct affects to the residents, but may increase the threat of wildfire in the wildland/urban interface areas. In summary, drought is one of the few hazards with the potential to directly and indirectly impact the entire population of the State, be it from water restrictions, higher water and food prices, reduced air or water quality, or restricted access to recreational areas (McKee and Doesken, 1999).

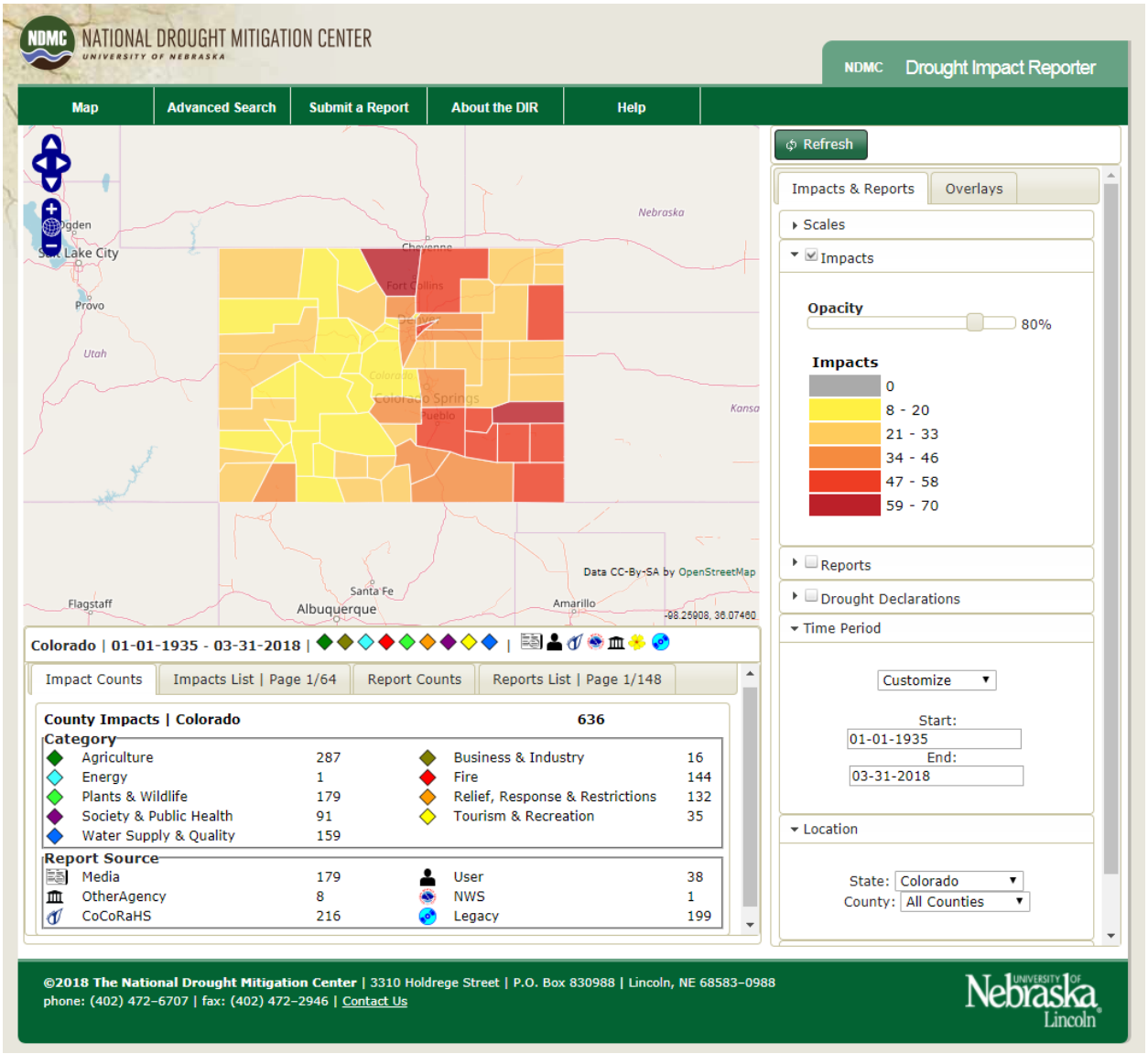
Tracking drought impacts can be difficult. The Drought Impact Reporter (Reporter) from the NDMC is a useful reference tool that compiles reported drought impacts nationwide. The Reporter, launched in 2005 and updated in 2011, is the first comprehensive database in the U.S. for drought impacts. Prior to the release of the Drought Impact Reporter, information on drought impacts were collected through rain gauges and media outreach. The Reporter helps to tell the whole story of drought by allowing individuals impacted by drought to add information, including pictures, to the database. The database also serves as an archive of drought impacts, helping planners and policy makers in prioritizing funding during future drought events. Figure 4 shows reported total drought impacts for all Colorado counties since the previous Plan update was approved in 2013 in the following impact categories:

- Agriculture
- Business & Industry
- Energy
- Fire
- Plants & Wildlife
- Relief, Response & Restrictions
- Society & Public Health
- Tourism & Recreation

- Water Supply & Quality

Figure 4 shows total drought impacts for all Colorado counties from January of 1935 to March of 2018, for the same impact categories. Based on reports to the NDMC, all counties recorded some impact from drought, and most counties recorded moderate to major amounts of impacts, illustrating that drought affects all regions of the state in all impact categories at one time or another. The data represented is skewed, with the majority of these impacts from records within the past 15 years. Since 1935, Colorado counties have reported 636 total drought impacts, with most of them being tied to the agricultural sector.

Figure 4 Total Drought Impacts for Colorado since 1935



Source: NDMC, http://droughtreporter.unl.edu/map/

3.2.2 Monitoring Drought in Colorado

Because drought can be defined differently, based on the cause (lack of supply) and the effect (adverse impacts to water users), several methods have evolved to measure and assess drought. Severity, the most commonly used term for measuring drought, is a combination of the magnitude and duration of the drought. In order to assess the severity of a drought event it is necessary to monitor "normal" or average conditions as well as conditions during drought events. Individual indicators of drought conditions can be used in addition to indices that combine multiple indicators to give a more comprehensive set of information. Both traditional maps and graphs of precipitation, snowpack, and streamflow patterns and compilations provide valuable information for drought monitoring. Instrumental data are used extensively for monitoring precipitation, snowpack, streamflow, and reservoir levels, some of which are summarized below:

- Precipitation is measured daily at several hundred locations across Colorado. National Weather Service (NWS) stations have collected data for 100 years or more, and are used extensively by the Colorado Climate Center (CCC) at Colorado State University (CSU) for drought research.
- Snowpack data, critical for predicting runoff and surface water supplies, are collected at higher elevations by the NRCS at Snow Telemetry Network (SNOTEL) sites. A few of these sites date back more than 65 years. Precipitation and snowpack data have been analyzed to determine the patterns of wet and dry periods and their hydroclimatic impacts in Colorado over the last 100 years. Monitoring this data is very important to predict near-future drought potential.
- Streamflow is the net result of precipitation, snowmelt, evapotranspiration, infiltration, and groundwater recharge, as well as man-made influences such as irrigation diversions and reservoir storage and releases. The combination of streamflow readings and reservoir levels provides the best direct indication of available surface water supplies in each of Colorado's river basins.
- Dust and its impacts are being monitored by the CODOS program of the Center for Snow and Avalanche Studies (CSAS), based in Silverton, Colorado. CSAS's Senator Beck Basin Study Area at Red Mountain Pass is the primary sentry site for dust-on-snow events in Colorado, where rigorous monitoring began in 2002/2003. Ten additional locations throughout the Colorado mountains are also being monitored each spring by CODOS (CODOS, http://www.codos.org/#codos).

These climate observation networks provide important data necessary to analyze recent and historic droughts and relate water availability to observed impacts. Years of experience, along with common sense, have shown that drought impacts are directly related to the following drought characteristics:

- Magnitude – how large the water deficits are in comparison with historic averages
- Duration – how long the drought lasts
- Areal Extent – what area is impacted by the drought

A variety of drought indices are used to track precipitation and water supply, as well as classify droughts that have occurred in the past. These indices help simplify and synthesize complex data to provide actionable information for planners and decision makers. Paleoclimatic techniques, such as measurement of tree rings, ice cores, pollens, and ancient lake levels, are also employed to study drought patterns and frequencies over the past several centuries. The following is a discussion of indices or index blends are most commonly used in Colorado and used to activate the Response Plan in Annex A.

The **Surface Water Supply Index** (SWSI) was originally developed in Colorado in 1981 by the Soil Conservation Service (now the NRCS) and the Colorado Division of Water Resources (DWR). The purpose of the index was to describe drought severity where water availability is driven by winter snow accumulation and subsequent melt, typical in the Western US. The SWSI is comprised of four inputs: snowpack, streamflow, precipitation, and reservoir storage. During the winter months (December to May) the index uses snowpack, water year precipitation and reservoir storage. In summer and fall, (June to November) the index switches to streamflow, previous month's precipitation and reservoir storage. The index is computed by determining each variable's non-exceedance probability (the probability that subsequent sums of that component will not be greater than the current sum), then multiplying by a subjective weighting factor. The Index currently uses the following inputs depending on the time of year:

- For January-June: SWSI = Streamflow Forecast + Reservoir Storage
- For July-September: SWSI = Reservoir Storage + Previous Month's Streamflow
- For October-December: SWSI = Reservoir Storage

The variables are summed and converted to an index of +4.16 (abundant supplies) to -4.16 (extreme drought). The +4.16 to -4.16 range was used to mimic the Palmer Drought Index. The SWSI is calculated independently for each basin due to differences in climate and reservoir capacities. One of the advantages to the SWSI is that it is simple to calculate and gives a representative measurement of surface water supplies across the state. It has been modified and applied in other western states as well.

The **Standardized Precipitation Index** (SPI), also developed in Colorado, is fairly simple to compute but is often a robust index for describing drought patterns. The SPI values are based on the probability, calculated from the long-term precipitation record for a given location, of recording a given amount of precipitation over the stated time period, and these probabilities are standardized so that a value of zero always indicates the median precipitation amount. The SPI can be computed for different time scales, can provide early warning of drought and help assess drought severity, and is less complex than the Colorado Modified Palmer Drought Index, or CMPDI (which was discontinued in 2016 in favor of other indices). The SPI identifies a beginning and end for each drought, as well as an intensity level for each month in which the drought occurs. Table 3 shows the values for the SPI index. The challenge of utilizing SPI objectively is understanding the appropriate time scale and vulnerability for various known and potential impacts.

Table 3 SPI Index

SPI Values	Description
2.0 +	extremely wet
1.5 to 1.99	very wet
1.0 to 1.49	moderately wet
-.99 to .99	near normal
-1.0 to -1.49	moderately dry
-1.5 to -1.99	severely dry
-2 and less	extremely dry

Source: NOAA National Climatic Data Center

The **Crop Moisture Index** was developed from the Palmer Index, and was designed to evaluate short-term moisture conditions across major crop producing regions. It uses the average temperature and total precipitation for each week and compares the calculated index with the previous week. This is a better index to measure rapidly changing conditions and for comparing different locations. However, the gross scale of the climate divisions (only five for Colorado) makes it a less useful index for Colorado statewide.

In addition to the indices noted above, the **U.S. Drought Portal**, which is a product of the National Integrated Drought Information System (NIDIS), is also used in Colorado.

The U.S. Drought Portal is part of an interactive system to:

- Provide early warning about emerging and anticipated droughts
- Assimilate and quality control data about droughts and models
- Provide information about risk and impact of droughts to different agencies and stakeholders
- Provide information about past droughts for comparison and to understand present conditions
- Explain how to plan for and manage the impacts of droughts
- Provide a forum for different stakeholders to discuss drought-related issues

A major component of this portal is the **U.S. Drought Monitor.** The Drought Monitor concept was developed jointly by the NOAA's Climate Prediction Center, the NDMC, and the USDA's Joint Agricultural Weather Facility in the late 1990s as a process that synthesizes multiple indices, outlooks and local impacts into an assessment that best represents current drought conditions. The final outcome of each Drought Monitor is a consensus of federal, state, and academic scientists who are intimately familiar with the conditions in their respective regions.

Upper Colorado River Basin NIDIS Project

A pilot effort to develop a drought monitor type of product specific to the Upper Colorado River Basin (UCRB) began in 2009. This effort included:

- Interviews with water providers and users to influence the design
- UCRB Community on the Drought Portal
- Web based snow model charting tool
- UCRB Weekly Climate, Water and Drought Assessment webinar series
- Monitoring gaps assessment
- Spatial analysis of water demand
- Reconciling estimates of 21st century flows
- Low flow impacts database
- Linkage of climate and river modeling
- Develop and test drought early warning activities

Results of this project (which started as a pilot study) and lessons learned were implemented into the development of the NIDIS Intermountain West Drought Early Warning System project, to be applied in other major river basins in Colorado. The specific pilot project has since morphed into the "Upper Colorado Drought Early Warning System," and two Drought Early Warning System (DEWS) regions now exist for Colorado. Current activities of the DEWS regions include weekly monitoring; drought assessment webinars; and weekly climate, water and drought assessments for the respective basins. After a local consensus is reached for each assessment, monitoring information is sent to the U.S. Drought Monitor along with recommendations.

Drought Monitoring Indicators 2018 Review

During the 2018 update of this Plan an effort was made to do a literature review of the current state of the art drought indicators or evolving technologies that could be used to supplement the tried and true indexes. The findings of this effort are included in Annex D Drought Monitoring Indices. While the USDM, SWSI, PDSI, and SPI indices represent the most widely applied drought tracking index tools, there are numerous other drought indices that have provided added benefit to the state's ongoing drought monitoring practices as well as several newer indices that may soon provide further enhancements to drought monitoring in Colorado. A literature review of recent publications provided the framework for a brief overview of the indices commonly applied within the state and regional drought monitoring community. Each index summary includes a breakdown of documented applications as well as some of the most relevant strengths and weaknesses of the indices in their current state. By providing this information in an organized and detailed manner, future updates to the Plan may continue to evaluate the list of indices and focus efforts on linking local drought impact response/mitigation to the most appropriate drought indices and index values.

The annex also presents a synopsis of the 2012-2013 drought conditions in southeastern Colorado through a series of timeline plots. This high-level case study evaluation is intended to help illustrate the drought progression and decision-making processes performed via the Plan. The analysis also provides a simplified proof of concept example of a post-event evaluation that can be generated for future Plan updates to further refine indices and threshold values for improved localized monitoring.

3.2.3 Drought Indicators Modernization

The SWSI has been used, along with the SPI and Drought Monitor, as the basis for making decisions for the activation and deactivation of the Drought Response Plan (Annex A). While the use of the word "triggers" has been used in the past, the index values have been more appropriately used as guidelines that need to be evaluated with the professional judgment of the Water Availability Task Force (WATF) before activation of the Response Plan (Annex A). It had long been recognized that the SWSI methods were in need of modernization. A significant effort has been made in recent years to modernize the SWSI and other indices for Colorado. One example of how analysis of drought index effectiveness has translated into action is the discontinuation of the CMPDI, as it was deemed not useful at a local level based on how it performed indicating the severity of past droughts. The findings of these and related index study efforts are included in Annex D Drought Monitoring Indices.

3.2.4 Drought History in Colorado

Since the late 1800s, Colorado has experienced widespread, severe drought many times. The most dramatic occurred in the 1930s and 1950s when many states, Colorado included, were affected for several years at a time. Table 4 shows seven multi-year droughts experienced in Colorado since 1893, based on McKee et al. 1999. The 2002 and 2011-2013 droughts occurred after the study was published, but the table has been modified and updated to reflect Colorado's most recent and intense droughts based on input from the Colorado Climate Center (CCC). During the writing of this 2018 Plan Update, parts of Colorado was experiencing extreme and exceptional drought. The impacts of the 2018 drought on the state included in the next plan update. Following this section is a history of drought declarations. Details on the more significant droughts, particularly the droughts of 2002 and 2011-2013, conclude the discussion of the State's drought history.

Table 4 Historical Dry and Wet Periods in Colorado

Date	Dry	Wet	Duration (years)
1893-1905	X		12
1905-1931		X	26
1931-1941	X		10
1941-1951		X	10
1951-1957	X		6
1957-1959		X	2
1963-1965	X		2
1965-1975		X	10
1975-1978	X		3
1979-1999*		X	20
2000-2006*	X		6
2007-2010*		X	3
2011-2013*	X		2

Source: McKee, et al. 1999
*modified for 2018 Plan Update based on input from the CCC

USDA Disaster Declarations for Colorado

Past USDA Secretarial Disaster Declarations needed to be requested by a governor's authorized representative or by an Indian Tribal Council leader. Damages and losses prompting disaster designation should have been due to a natural disaster and a minimum of 30 % production loss in at least one crop in the county must have occurred. The Secretarial Disaster Declaration is widely used and makes low-interest loans and other emergency assistance available for those affected, e.g., to farmers and ranchers in the case of agricultural disasters due to drought. Under a new streamlined process by the Farm Services Agency (FSA), a nearly automatic USDA Disaster Declaration can be made if any portion of a county has experienced eight consecutive weeks of severe drought (D2) according to the U.S. Drought Monitor (Congressional Research Service, 2013), provided it occurs during the growing season. Table 5 lists the disaster declarations related to drought for Colorado from 2003 through May 2018. The calendar year is listed, along with the type of hazard, the declaration number, and the primary affected counties. As can be seen in the table below, numerous drought declarations took place from 2011 through 2013. In early July of 2012, 62 of the State's 64 counties were included in a Secretarial disaster designation due to drought. Farmers were then eligible to apply for FSA emergency loans for the next eight months. As of May 2018, 43 of Colorado's 64 counties were included in a Fast Track Secretarial disaster designation due to drought.

Table 5 USDA Secretarial Disasters 2003-2017

Year	Type	Declaration Number and Affected Counties
2003	Drought	**S1797** Baca, Bent, Elbert, Kiowa, Lincoln, Prowers
2003	Drought, Insects	**S1843** Alamosa, Archuleta, Chaffee, Conejos, Costilla, Crowley, Custer, Dolores, Fremont, Garfield, Hinsdale, Huerfano, La Plata, Lake, Las Animas, Mesa, Mineral, Moffat, Montezuma, Otero, Pueblo, Rio Blanco, Rio Grande, Routt, Saguache
2003	Drought	**S1890** Cheyenne, Phillips
2004	Drought, Freeze, Hail	**S1947** Baca, Chaffee, Cheyenne, Custer, Eagle, Fremont, Garfield, Grand, Jackson, Kiowa, Kit Carson, Lake, Lincoln, Phillips, Pitkin, Prowers, Pueblo, Routt, Summit, Yuma
2004	Drought	**S2009** Moffat
2005	Drought	**S2031** Huerfano, Las Animas, Rio Blanco
2005	Drought, Freezing Temperatures	**S2160** Delta, Kit Carson
2005	Drought, Wind, Heavy Rain, Hail	**S2188** Crowley, El Paso, Lincoln, Otero, Park, Phillips, Pueblo, Teller, Washington, Yuma
2005	Drought, Crop Diseases, Insect Infestation	**S2217** Logan
2005-2006	Drought, Crop Diseases, Insect Infestation	**S2287** Huerfano, Kiowa, Las Animas, Sedgwick
2005-2006	Drought, Fire, High Winds, Heat	**S2327** Adams, Alamosa, Baca, Broomfield, Chaffee, Cheyenne, Conejos, Costilla, Custer, Denver, Dolores, Douglas, Elbert, Fremont, Hinsdale, Huerfano, Kit Carson, Lake, Las Animas, Mineral, Montezuma, Morgan, Prowers, Pueblo, Rio Grande, Saguache, San Miguel, Weld
2006	Heat, High Winds, Insect pests, Late Freeze, Drought	**S2329** Arapahoe, Archuleta, Bent, Boulder, Crowley, Delta, El Paso, Gunnison, Jefferson, Kiowa, La Plata, Montrose, Ouray, Park, Phillips, Teller, Washington
2006	Heat, High Winds, Drought	**S2351** Eagle, Garfield, Larimer, Logan, Otero, Pitkin, Rio Blanco, Yuma
2006	Drought	**S2382** Jackson, Lincoln, Mesa, Moffat
2006	Drought	**S2480** Sedgwick
2007	N/A	N/A
2008	Drought	**S2750** Adams, Arapahoe, Baca, Bent, Cheyenne, Crowley, Douglas, El Paso, Elbert, Huerfano, Kiowa, Kit Carson, Las Animas, Lincoln, Logan, Otero, Park, Prowers, Pueblo, Teller, Washington, Weld
2008	Drought	**S2802** Fremont
2009	Drought	**S2970** Dolores, Mesa, Montezuma, Montrose, San Miguel
2010	Drought, High Winds	**S2996** Costilla, Las Animas
2011	Drought	**S3080** Baca **S3125** Baca, Bent, Crowley, El Paso, Kiowa, Las Animas, Lincoln, Otero, Prowers, Pueblo **S3131** Archuleta, Baca, Conejos, Costilla, Las Animas **S3133** Alamosa, Baca, Bent, Chaffee, Cheyenne, Costilla, Crowley, Custer, El Paso, Fremont, Gunnison, Huerfano, Kiowa, Lake, Las Animas, Lincoln, Otero, Park, Pitkin, Prowers, Pueblo, Saguache, Teller **S3144** Alamosa, Archuleta, Chaffee, Conejos, Costilla, Custer, Fremont, Gunnison, Hinsdale, Huerfano, Las Animas, Mineral, Rio Grande, Saguache

Year	Type	Declaration Number and Affected Counties
		S3149 Montezuma **S3172** Arapahoe, Douglas, El Paso, Elbert, Jefferson, Lincoln, Park, Teller
	Drought, Wildfires, High Winds	**S3117** Baca, Cheyenne, Kiowa, Kit Carson, Prowers
	Drought, Fire/Wildfire, Heat/Excessive Heat, Rain, Flooding, Tornadoes, Lightning, High Winds, Hail, Blizzard, Freeze	**S3139** Baca
	Drought, Excessive Heat/Rain, Flooding	**S3157** Cheyenne, Kit Carson
2012	Drought	**S3229** Arapahoe, Cheyenne, Crowley, Elbert, El Paso, Kiowa, Kit Carson, Lincoln, Pueblo, Washington
	Drought, Wind/High Winds, Heat/Excessive Heat	**S3260** Adams, Alamosa, Arapahoe, Archuleta, Baca, Bent, Boulder, Broomfield, Chaffee, Cheyenne, Clear Creek, Conejos, Costilla, Crowley, Custer, Delta, Denver, Dolores, Douglas, Eagle, Elbert, El Paso, Fremont, Garfield, Gilpin, Grand, Gunnison, Hinsdale, Huerfano, Jackson, Jefferson, Kiowa, Kit Carson, Lake, La Plata, Larimer, Las Animas, Lincoln, Logan, Mesa, Mineral, Moffat, Montezuma, Montrose, Morgan, Otero, Ouray, Park, Phillips, Pitkin, Prowers, Pueblo, Rio Blanco, Rio Grande, Routt, Saguache, San Juan, San Miguel, Sedgwick, Summit, Teller, Washington, Weld, Yuma
	Drought, Wind/High Winds, Fire/Wildfire, Heat/Excessive Heat, Insects	**S3267** Montezuma **S3269** Delta, Gunnison, Mesa, Montrose **S3276** Baca, Cheyenne, Kiowa, Kit Carson, Prowers, Yuma **S3281** Yuma **S3282** Archuleta, Baca, Conejos, Costilla, La Plata, Las Animas, Montezuma **S3284** Baca **S3289** Dolores, Garfield, Mesa, Moffat, Montezuma, Montrose, Rio Blanco, San Miguel **S3290** Jackson, Larimer, Moffat, Routt, Weld **S3315** Logan, Phillips, Sedgwick, Weld, Yuma **S3319** Jackson, Larimer
2013	Drought, Wind/High Winds, Fire/Wildfire, Heat/Excessive Heat, Insects	**S3455** Montezuma **S3456** Adams, Arapahoe, Baca, Bent, Boulder, Broomfield, Chaffee, Cheyenne, Clear Creek, Costilla, Crowley, Custer, Denver, Douglas, Eagle, Elbert, El Paso, Fremont, Gunnison, Huerfano, Jefferson, Kiowa, Kit Carson, Lake, Larimer, Las Animas, Lincoln, Logan, Morgan, Otero, Park, Phillips, Pitkin, Prowers, Pueblo, Saguache, Sedgwick, Teller, Washington, Weld, Yuma **S3459** Baca, Cheyenne, Kiowa, Kit Carson, Prowers, Yuma **S3461** Archuleta, Baca, Conejos, Costilla, La Plata, Las Animas, Montezuma **S3463** Baca **S3466** Dolores, Garfield, Mesa, Moffat, Montezuma, Montrose, Rio Blanco, San Miguel **S3505** Phillips, Sedgwick, Weld, Yuma **S3508** Larimer, Moffat, Routt, Weld **S3518** Alamosa, Conejos, Costilla, Huerfano, Las Animas **S3539** Archuleta, Dolores, Gunnison, Hinsdale, La Plata, Mineral, Montezuma, Montrose, Ouray, Saguache, San Juan, San Miguel **S3545** Conejos, Hinsdale, La Plata, Mineral, Rio Grande, Saguache **S3548** Adams, Alamosa, Arapahoe, Archuleta, Boulder, Broomfield, Chafee, Clear Creek, Conejos, Costilla, Custer, Delta, Denver, Douglas, Eagle, Fremont, Garfield, Gilpin, Grand, Gunnison, Hinsdale, Huerfano, Jackson, Jefferson, Larimer, mesa, Mineral, Moffat, Montrose, Ouray, Park, Pitkin, Rio Blanco, Rio Grande, Routt, Saguache, San Miguel, Teller
	Drought, Heat/Excessive Heat, Insects	**S3550** Moffat **S3575** Eagle, Garfield, Grand, Lake, Pitkin, Routt, Summit

Year	Type	Declaration Number and Affected Counties
		S3583 Delta, Garfield, Gunnison, Mesa, Montrose, Ouray, Pitkin, San Miguel **S3641** Baca, Cheyenne, Kiowa, Kit Carson, Prowers, Yuma
2014	Drought, Wind/High Winds, Fire/Wildfire, Heat/Excessive Heat, Insects	**S3627** Arapahoe, Baca, Bent, Cheyenne, Costilla, Crowley, Custer, Douglas, Elbert, El Paso, Fremont, Huerfano, Kiowa, Kit Carson, Las Animas, Lincoln, Logan, Otero, Phillips, Prowers, Pueblo, Sedgwick, Teller, Washington, Yuma **S3629** Baca, Cheyenne, Kiowa, Kit Carson, Prowers, Yuma **S3630** Baca, Costilla, Las Animas **S3632** Baca **S3634** Dolores, Mesa, Montezuma, Montrose, San Miguel **S3645** Archuleta, Conejos, Costilla **S3651** Montezuma **S3653** Archuleta, La Plata, Montezuma **S3669** Phillips, Sedgwick, Yuma **S3698** Yuma **S3703** Sedgwick **S3714** Garfield, Moffat, Rio Blanco **S3715** Archuleta, Conejos, Dolores, Hinsdale, La Plata, Mineral, Montezuma, Rio Grande, San Juan, San Miguel
2015	Drought, Wind/High Winds, Fire/Wildfire, Insects	**S3783** Montezuma **S3785** Arapahoe, Baca, Bent, Cheyenne, Costilla, Crowley, Elbert, El Paso, Huerfano, Kiowa, Kit Carson, Las Animas, Lincoln, Otero, Prowers, Pueblo, Washington **S3787** Baca, Cheyenne, Kiowa, Kit Carson, Prowers, Yuma **S3788** Archuleta, Baca, Costilla, La Plata, Las Animas, Montezuma **S3790** Baca **S3792** Dolores, Mesa, Montezuma, Montrose, San Miguel **S3802** Archuleta, Conejos **S3826** Garfield, Moffat, Rio Blanco **S3925** Delta, Gunnison, Mesa, Montrose
2016	N/A	N/A
2017	Drought	**S4145** Adams, Boulder, Broomfield, Weld, Arapahoe, Baca, Bent, Cheyenne, Crowley, Douglas, Elbert, El Paso, Kiowa, Kit Carson, Larimer, Las Animas, Lincoln, Logan, Morgan, Prowers, Pueblo, Washington **S4148** Baca, Prowers **S4152** Baca
2018	Drought	**S4279** Montezuma **S4380** Baca, Bent, Las Animas, Prowers **S4285** Costilla, Las Animas **S4289** Baca, Bent, Costilla, Huerfano, Las Animas, Otero, Pueblo **S4290** Baca, Prowers **S4291** Baca, Las Animas **S4293** Alamosa, Baca, Bent, Costilla, Custer, Fremont, Huerfano, Kiowa, Las Animas, Otero, Prowers, Pueblo, Saguache **S4300** Archuleta, Conejos, Costilla, La Plata, Montezuma **S4304** Bent, Crowley, Delta, Garfield, Gunnison, Kiowa, Las Animas, Mesa, Montrose, Otero, Pitkin, Pueblo **S4308** Dolores, Mesa, Montezuma, Montrose, San Miguel **S4309** Delta, Gunnison, Mesa, Montrose, Ouray, San Miguel **S4313** Arapahoe, Bent, Cheyenne, Crowley, Custer, Elbert, El Paso, Fremont, Huerfano, Kiowa, Kit Carson, Las Animas, Lincoln, Otero, Prowers, Pueblo, Washington **S4315** Cheyenne, Kiowa, Kit Carson, Prowers **S4318** Garfield, Mesa, Montrose **S4320** Alamosa, Archuleta, Chaffee, Conejos, Costilla, Custer, Dolores, Fremont, Gunnison, Hinsdale, Huerfano, La Plata, Las Animas, Mineral,

Year	Type	Declaration Number and Affected Counties
		Montezuma, Montrose, Ouray, Rio Grande, Saguache, San Juan, San Miguel **S4326** Chaffee, Custer, El Paso, Fremont, Gunnison, Lake, Park, Pitkin, Pueblo, Saguache, Teller **S4329** Alamosa, Archuleta, Chaffee, Conejos, Costilla, Delta, Gunnison, Hinsdale, Huerfano, La Plata, Mesa, Mineral, Montrose, Ouray, Pitkin, Rio Grande, Saguache, San Juan **S4331** Crowley, Douglas, Elbert, El Paso, Fremont, Lincoln, Pueblo, Teller **S4334** Arapahoe, Douglas, Elbert, El Paso, Lincoln **S4336** Eagle, Garfield, Mesa, Pitkin, Rio Blanco, Routt **S4338** Garfield, Moffat, Rio Blanco **S4345** Garfield, Moffat, Rio Blanco

Source: USDA – Colorado Farm Services Agency

Governor's Drought Emergency Declarations for Colorado

In addition to USDA Drought Declarations, the following list shows a timeline for Governor Drought Emergency Declarations and Executive Orders, from 1951 to 2018. These differ from USDA declarations because they can provide emergency assistance beyond that targeted for agricultural purposes alone.

- 8/3/1951 – Governor Dan Thornton declared a drought emergency in La Plata, Dolores, Montezuma, Rio Grande, Archuleta, Conejos, Alamosa, Saguache, Costilla, and Mineral counties due to a shortage of feed for livestock.
- 8/22/1952 – Governor Dan Thornton declared a drought emergency for Elbert, Douglas, Kit Carson, El Paso, and Cheyenne counties due to a shortage of feed for livestock.
- 2/10/1977 – Governor Richard Lamm issued a "Conserve Water! Month" proclamation. The Proclamation stated the snowpack was 30% of normal, and that the eastern plains had not received adequate precipitation for the second straight year. The intention of the proclamation was to encourage water conservation in order to lessen the impact of drought.
- 3/31/1977 – Governor Richard Lamm issued a "Conserve Water Year" proclamation, essentially extending the above proclamation out for the entire year. .
- 7/20/1977 – Governor Richard Lamm issued a proclamation for the formation of the Drought Council.
- 2/16/1978 – Governor Richard Lamm issued a proclamation to retain the Drought Council until the end of the drought.
- 8/1/1994 - In response to extremely arid conditions, Governor Roy Romer activated several Impact Task Forces to assess impacts.
- 7/29/1996 - Governor Roy Romer issued an Executive Order (D000996) proclaiming a Drought Disaster Emergency Declaration. Fifteen counties were included in a request for USDA assistance. The Directive activated the Water Availability, Agriculture, Wildfire, Tourism, Municipal Water, and Review and Reporting Impact Task Forces.
- 2002 – Governor Bill Owens activated eight Impact Task Forces during the 2002 drought. (Colorado received a statewide Presidential Disaster Declaration for the wildfires)

- 2011 – Governor John Hickenlooper activated the Drought Mitigation and Response Plan and the Agricultural Impact Task Force due to drought conditions in southeast Colorado.
- 2012 - Governor John Hickenlooper requested and received a Presidential Disaster Declaration due to severe wildfires associated with ongoing drought conditions. The Governor also expanded activation of the Drought Mitigation and Response Plan from the southeast to statewide.
- 14/5/2013 - Governor John Hickenlooper activated the Municipal Water Impact Task Force in response to growing water availability concerns due to ongoing and expanded drought conditions since 2011.
- 7/19/2017 – Governor John Hickenlooper declared a disaster emergency due to the statewide fire risk arising from very hot and dry conditions which began in June.
- 5/2018 – Initiated by a Governor request, USDA fast tracked disaster designations for 43 of the 64 counties in Colorado as primary natural disaster areas due to losses and damages by the recent drought.

Major Droughts

The following is a summary of information on major droughts that have affected Colorado.

The 1930's Drought – The Dust Bowl drought severely affected much of the United States during the 1930s. Figure 5 illustrates the extent of the Dust Bowl as defined by the Natural Resources Conservation Service.

Figure 5 Extent of the Dust Bowl

Source: Public Broadcasting System American Experience "Surviving the Dust Bowl"
http://www.pbs.org/kenburns/dustbowl/interactive/homestead/

The drought came in three waves, 1934, 1936, and 1939-1940, but some regions of the High Plains experienced drought conditions for as many as eight consecutive years. The soil, depleted of moisture, was lifted by the wind into great clouds of dust and sand which were so thick they concealed the sun for several days at a time. They were referred to as "black blizzards." The period itself is known as the dust bowl. The "black blizzards" were caused by sustained drought conditions compounded by years of land management practices that left topsoil susceptible to the forces of the wind.

The agricultural and economic damage devastated residents of the Great Plains. The Dust Bowl drought worsened the already severe economic crisis that many Great Plains farmers faced. In the early 1930s, many farmers were trying to recover from economic losses suffered during the Great Depression. To compensate for these losses, they began to increase their crop yields. High production drove prices down, forcing farmers to keep increasing their production to pay for both their equipment and their land. When the drought hit, farmers could no longer produce enough crops to pay off loans or even pay for essential needs. Even with federal emergency aid, many Great Plains farmers could not withstand the economic impacts of the drought. Many farmers were forced off of their land. One in ten farms changed possession at the peak of the drought. The agricultural and economic damage devastated residents of the Great Plains.

Many factors contributed to the severe impact of this drought and in its aftermath a better understanding of the interactions between the natural elements (e.g., climate, plants, and soil) and human-related elements (e.g., agricultural practices, economics, and social conditions) of the Great Plains developed. As a result, farmers adopted new cultivation methods to help control soil erosion in dry land ecosystems; consequently, subsequent droughts in the region have not had the same impact.

The 1950s Drought – Fueled by post-war economic stability and technological advancement, the 1950s represented a time of growth and prosperity for some Americans. But while much of the country celebrated a resurgence of well-being, many residents of the Great Plains and southwestern United States were suffering. During the 1950s, the Great Plains and the southwestern U.S. withstood a five-year drought, and in three of these years, drought conditions stretched coast to coast. The 1950s drought was characterized by both decreased rainfall and excessively high temperatures. The first effects of the drought were felt in the southwestern U.S. in 1950 and by 1953 conditions had spread to Oklahoma, Kansas, and Nebraska. By 1954, the drought encompassed a ten-state area reaching from the mid-west to the Great Plains, and southward into New Mexico. The area from the Texas panhandle to central and eastern Colorado, western Kansas, and central Nebraska experienced severe drought conditions. The drought maintained a stronghold in the Great Plains, reaching a peak in 1956. The drought subsided in most areas with the spring rains of 1957. A disaster of this magnitude can create severe social and economic repercussions, as was the case in the southern Great Plains region. The drought devastated the region's agriculture, with crop yields in some areas decreased as much as 50%. Excessive temperatures and minimal rainfall scorched grasslands typically used for grazing. With grass scarce, hay prices rose, forcing some ranchers to feed their cattle a mixture of prickly pear cactus and molasses. By the time the

drought subsided in 1957, many counties across the region were declared federal drought disaster areas (NCDC, 2003).

The 1977 Drought – During 1976 and 1977, the state experienced record-low streamflows at two-thirds of the major stream gages, records that held until the 2002 drought. In addition, the Colorado ski industry estimated revenue losses at $78.6 million; agriculture producers had to incur higher crop production costs due to short water supplies; and numerous municipalities were forced to impose water use restrictions on their customers. The state's agriculture producers and municipalities received over $110 million in federal drought aid as a result of the 1976-1977 drought.

1980-1981 Drought – Although short lived, beginning in the fall of 1980 and lasting until the summer of 1981, this drought generated costly impacts to the ski industry and initiated a huge investment in snow making equipment; it motivated the writing of the "Colorado Drought Response Plan" and the formation of the "Water Availability Task Force" described in Section 2.1.1.

1994 Drought – On August 1, 1994, in response to extremely arid conditions, the Governor activated, by memorandum, several Task Forces to assess impacts: Agriculture (blowing soils), Wildlife, Wildfire, Commerce/Tourism, and Review and Reporting. Significant impacts reported included an increase in wildfires statewide, loss to the winter wheat crops, difficulties with livestock feeding, and impacts to the State's fisheries.

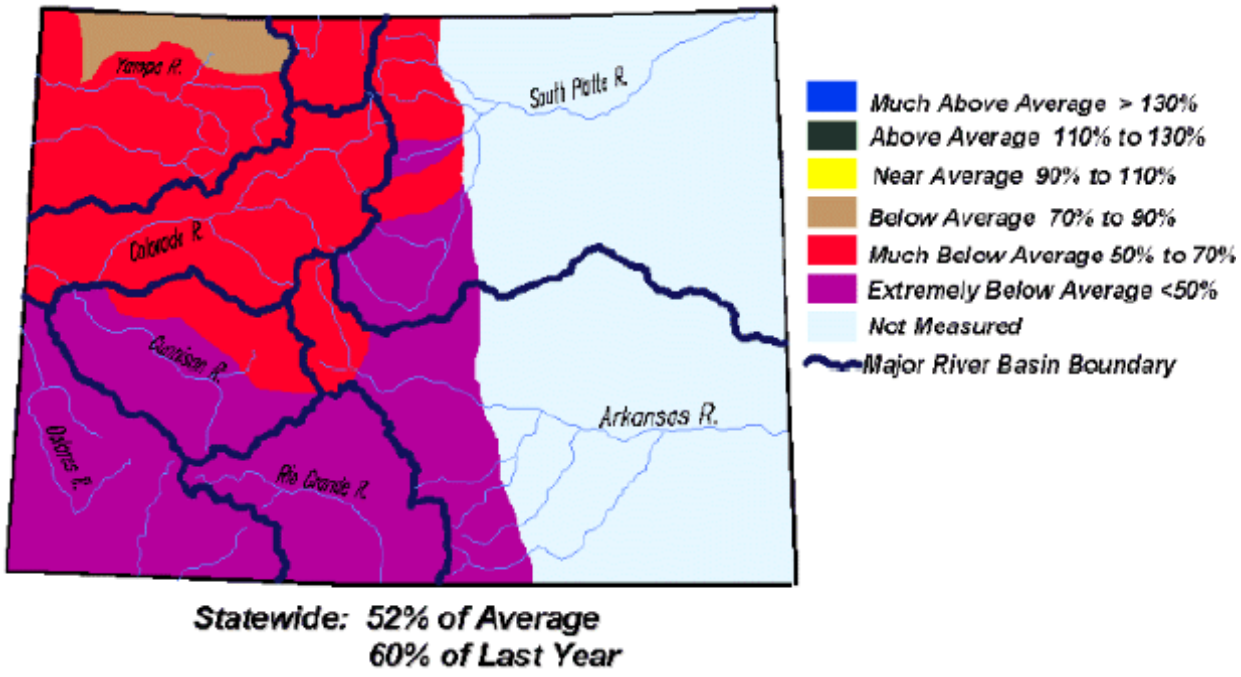
1996 Drought – On July 29, 1996, the Governor issued an Executive Order (D000996) proclaiming a Drought Disaster Emergency Declaration. Fifteen counties were included in a request for USDA assistance. The directive activated the Water Availability, Agriculture, Wildfire, Tourism, Municipal Water, and Review and Reporting Task Forces to monitor the situation, and evaluate impacts to potable water supplies in the southwest and northwest portions of the state. The State Drought Review and Reporting Task Force provided a Drought Status Report to the Governor's Office. The situation called for continued monitoring by the WATF until fall and winter precipitation alleviated further concerns.

2002 Drought – On a statewide basis, 2002 was the most intense single year of drought in Colorado's history (Pielke and Doesken, 2003). This was an extremely dry year embedded in a longer dry period (2000-2006), similar to 1934 being an extremely dry year within a period of longer drought (1931-1939). Holders of senior water rights dated 1865 and 1881 placed calls on the South Platte River—the most senior calls placed on the river in over a generation. In the southern part of the state, the Rio Grande nearly ceased to flow (Hall, 2002). The magnitude of this drought cannot be overstated. These conditions were rated "exceptional" by the U.S. Drought Monitor and were the most severe drought experienced in the region since the Dust Bowl (Tronstad and Feuz, 2002). Indeed, based on studies of tree rings and archaeological evidence from aboriginal cultures, the 2002 drought was arguably the most severe in the recorded history of the state (Pielke and Doesken, 2003).

The drought of 2002 had its roots in the autumn of 1999. After a very wet spring and a soggy August, precipitation patterns reversed and the fall of 1999 was very dry across most of Colorado. The winter of 1999-2000 followed with below average snowfall and above average temperatures, dryness continued into spring and early summer over northeast Colorado and the South Platte watershed and drought conditions quickly emerged. A persistently hot summer with evapotranspiration rates higher than average deteriorated conditions. The 2001 water year, although less extreme, continued to trend on the dry side.

October 2001 weather patterns appeared more favorable as a variety of storm systems crossed the region. However, the storms resulted in little moisture and when the month was over precipitation totaled again less than 50% of average over the majority of the state. November and December brought some snow accumulation but snow water content remained below average; and January's above average snowfall came down in the Front Range urban corridor and the southeastern plains, contributing very little to overall water supplies. February and March, despite cooler temperatures and numerous storm systems, did not see the copious wet snows that Colorado spring snowstorms typically produce. By the end of March 2002, the statewide snow water equivalent was a mere 52% of average and portions of Colorado's mountains were even further below average (see Figure 6).

Figure 6 April 1, 2002 snowpack for the State of Colorado



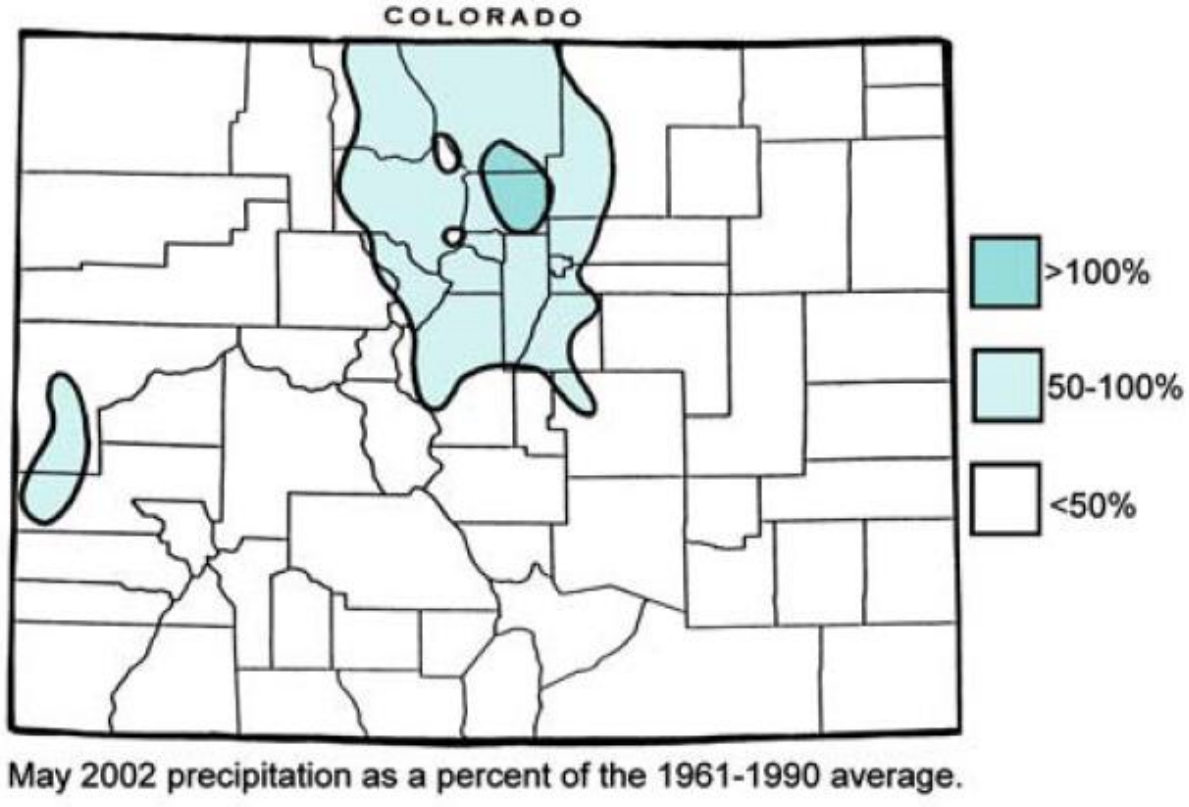
Source: National Resources Conservation Service

The spring storms that sometimes dump heavy and widespread precipitation were nonexistent in April and temperatures soared to record highs. In the mountains snow melted or evaporated at an alarming rate. Relative humidity on several afternoons fell to below 10%. Fire danger, which

typically stays low to moderate through early June, was already high by mid-April, and the first severe forest fire of the season ignited near Bailey on April 23 (Snaking Fire).

May was even drier (see Figure 7). At a time of year when Colorado's rivers and streams are normally churning with snowmelt runoff, there were only mere glimpses of snowmelt flows. Irrigation water demand was high, and it was soon obvious that supplies would not last through the growing season. Municipalities began to face the possibility that available water supplies might not be sufficient to meet typical summertime demand. Many areas implemented strict water conservation restrictions. Other forest fires erupted and each new blaze seemed to spread faster than the one before.

Figure 7 May 2002 Precipitation as a Percent of 1960-1991 Average

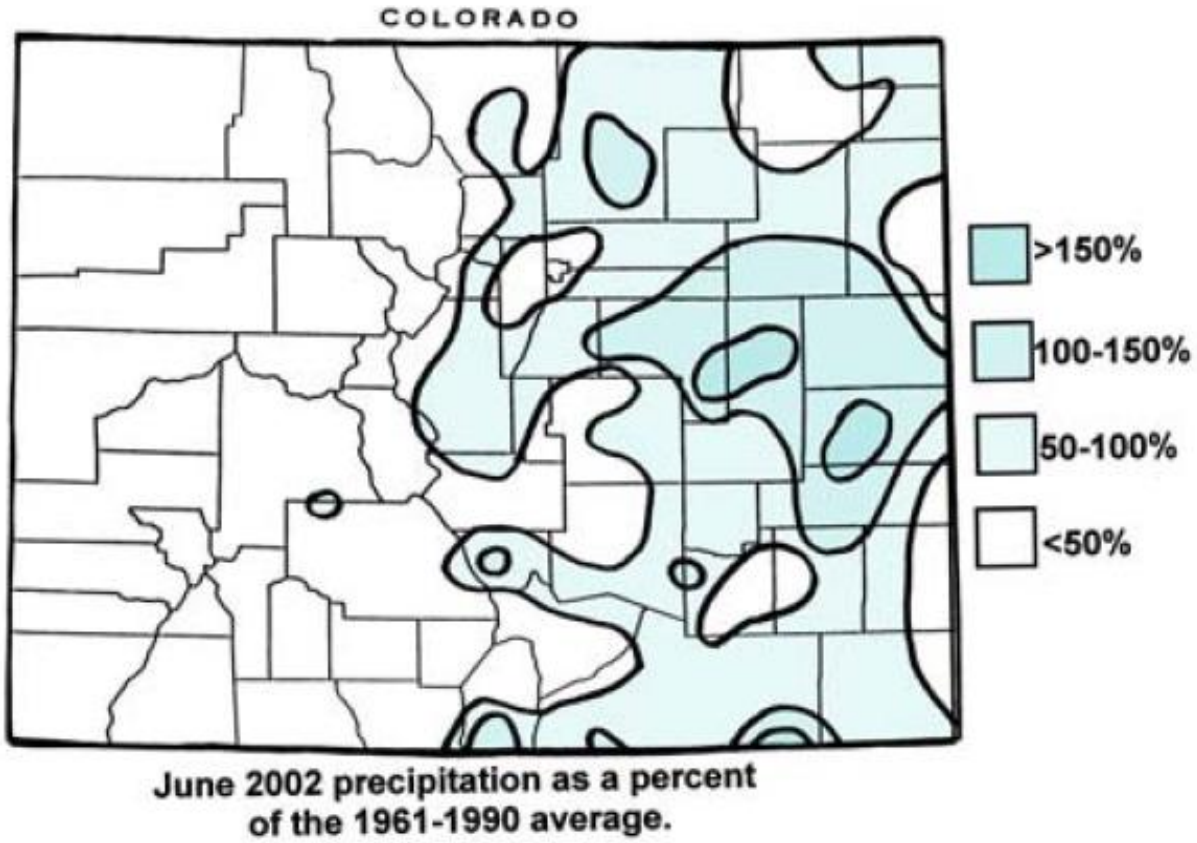


Source: *The Drought of 2002 in Colorado*. Nolan Doesken and Roger Pielke, Sr.

June arrived accompanied by relentless summer heat, temperatures routinely climbed above 90 degrees Fahrenheit at lower elevations east and west of the mountains. Vegetation that normally grows lush and tall with spring moisture barely greened up. Relative humidity often dropped to less than 10%, and bans on outside burning were enforced statewide. Little or no precipitation fell for the entire month over western Colorado (see Figure 8). Winter wheat crop conditions continued rapid deterioration, and ranchers quickly sold or relocated their herds in response to the poor range conditions and high cost of feed. The most severe fires of the season erupted in June, including the

Hayman fire southwest of Denver which quickly grew to be the largest documented forest fire in Colorado (217 mi^2) on record.

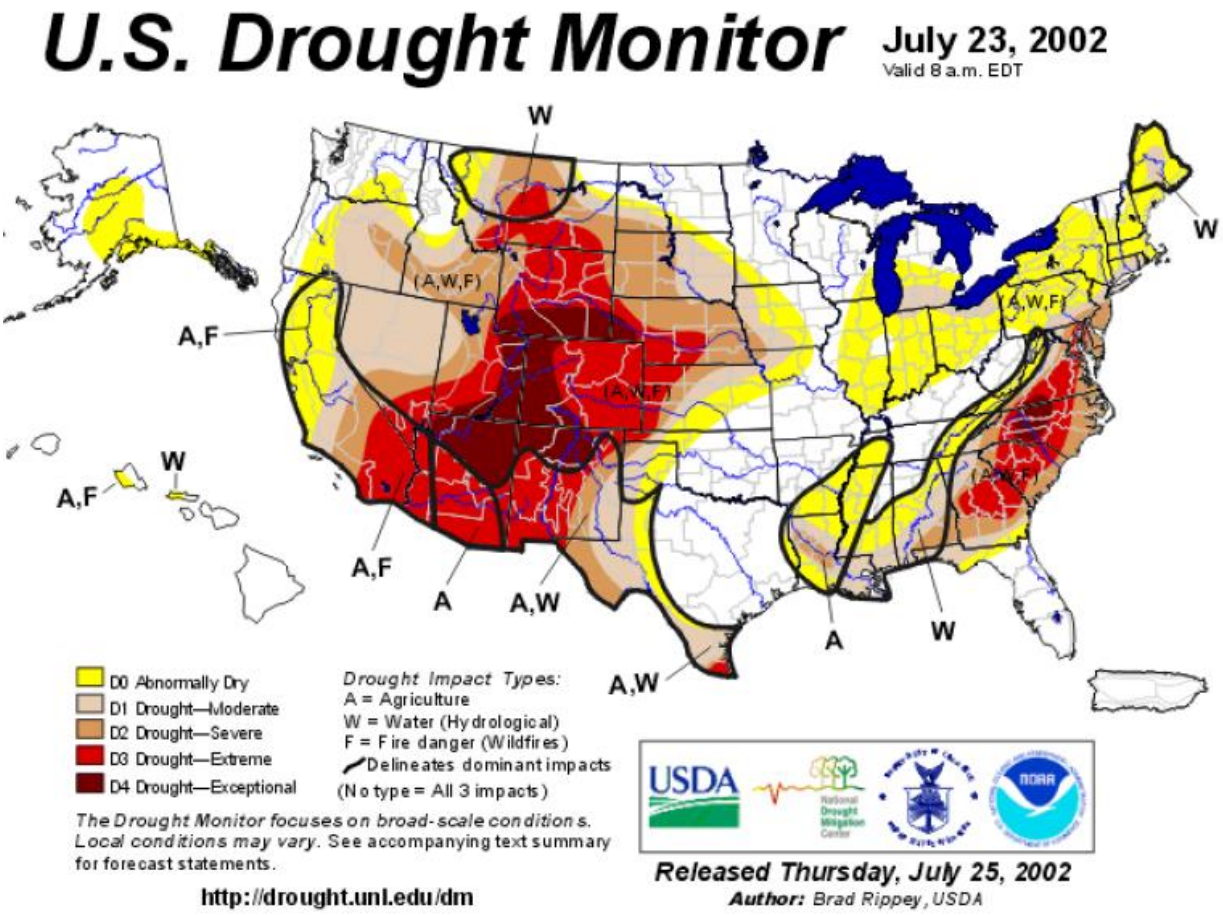
Figure 8 June 2002 Precipitation as a Percent of the 1961-1990 Average



Source: *The Drought of 2002 in Colorado*. Nolan Doesken and Roger Pielke, Sr.

July brought a few changes. Below average precipitation persisted statewide and temperatures were above average for the fourth consecutive month. By late July, the entire state of Colorado was in a serious drought. (See Figure 9)

Figure 9 2002 Drought – Drought Monitor from July 23, 2002



Source: National Drought Monitor

The first several days of August brought some hope for a respite but the monsoon moisture surge was brief. By mid-August, 100°F+ temperatures led media reports to liken conditions to the great Dust Bowl of the 1930s. As the month neared its end, a subtle change in weather patterns brought a round of spring-like thunderstorms loaded with hail and high winds to portions of eastern Colorado. Humid and stormy weather continued into September and for the first time since August 2001, the majority of Colorado received above average rainfall.

Fortunately for Colorado, drought conditions continued to slowly recede during the end of 2002 and into 2003. The March 18, 2003 blizzard that hammered the Colorado Front Range with as much as 87 inches of snow significantly relieved many of the lingering effects of the drought. Some areas of the state, however, continued to experience moderate to severe drought conditions, but these droughts did not affect the state as a whole. The 2007 Drought Update reported that during calendar year 2006, at least some portions of the state also experienced severe drought conditions (D2 drought intensity) between March and December, while additional parts of the state experienced extreme drought conditions (D3 drought intensity) between May and September.

In the 2007 DWSA, many (64% of respondents) felt the drought had passed, and that the state had "fully recovered" from the 2002 drought. Since 2003 both drought conditions the state water situation has improved, but it has taken nearly eight years to recover from the 2002 drought. Discussion in the April 2010 WATF meeting suggested that the state's water situation was the best it had been since the late 1990s, with near average snowpack and reservoir storage in most basins in the state.

Historical Perspective of the 2002 Drought

The year 2002 is considered the driest single year in recorded Colorado history. Statewide snowpack was at or near all-time lows. Water year 2002 precipitation was extremely low when compared to 1961-1990 normal precipitation levels. There have been individual years in Colorado that have been drier at individual points or portions of the State – 1894, 1934, 1939, 1954 and 1966 are some examples. However, what made 2002 so unusual was that the entire State was dry at the same time. By all accounts, soil moisture was nearly depleted in the upper one-meter of the soil profile over broad areas of Colorado by late August 2002. 2002 was clearly the driest year in over 100 years of record based on streamflow. Reservoirs dropped to extremely low levels. The excess of the late 1990s helped Colorado survive the drought of 2002, but very little useable water remained even with strict enforced water restrictions. For a more detailed historical impact of the 2002 drought, see *The Drought of 2002 in Colorado*, authored by Nolan Doesken and Roger Pielke, Sr. and referenced many times in this Plan.

2002 Drought and the Impact Task Forces

All eight impact task forces (ITFs) at the time were activated by the Governor during the 2002 drought. One outcome was the 2003 Drought Impact and Mitigation Report. It identified impacts from the drought, as well as actions or mitigation measures that already had been, or would be taken to address the impacts of an ongoing drought. The report also identified state and federal agencies and entities that are associated with actions and mitigation measures, as well as implementation statuses and related costs of those actions and mitigation measures. Each of the ITFs provided a summary table listing these actions and activities, also summarized in Appendix B.

2011-2013 Drought

Even though 2011 was very wet across northern Colorado, the extreme drought during this time in Texas, New Mexico and Oklahoma was also felt in the Rio Grande and Arkansas Basins in Colorado. This trend continued in those Basins as 2012 began, but also increased in breadth across the rest of Colorado. Based on the U.S. Drought Monitor, approximately 50% of Colorado was already under drought conditions at the beginning of 2012. Minimal snow accumulation further exacerbated the already dry conditions as below average snowfalls and above average temperatures occurred in February and March. The above average temperatures continued into April and May, causing early runoff as the thin snowpack quickly melted. The entire State was under drought conditions by the end of May 2012, causing concern as it included the regions where

80% of the State's water supply originates. Streamflows measured only slightly better compared to the extreme drought years of 1934, 1954, 1977 and 2002 (Ryan and Doesken, 2013).

Agriculture was highly impacted. Soil moisture was low on the plains during the spring planting season and temperatures were high, giving crops little chance to establish and survive the summer. This was compounded by less water availability for summer irrigation diversions due to low snowpack and runoff. June was very hot, consistently over 100°F, especially in the eastern plains of the state. These temperatures rivaled those observed during the historic drought years of 1934 and 1954, with many other areas setting high temperature records. A majority of pasture and rangeland areas were classified as "poor" or "very poor" by August of 2012. Hay was hard to come by due to production decreasing to 10% to 50% of average and limited supplies from neighboring states also impacted by drought. This caused prices to drastically increase, necessitating trucking hay in from northern Montana and Idaho, and even as far away as the Carolinas. Crop prices also increased in 2012. For example, corn prices increased 43% over two years as nearby corn-producing regions in other states also struggled with drought. High commodity prices helped some producers through the drought as they were able to sell fewer commodities and still bring in enough to cover their costs. Still other producers were not able to take advantage of the high prices because they lacked the product to sell.

The multi-year drought in 2011-2013 also deteriorated vegetative cover across the state's Eastern Plains. The exposed soil, combined with heavy winds, created dust storms similar to those of the devastating 1930's Dust Bowl. Some farmers lost entire crops with one storm, causing immense financial strain and emotional hardship. In early June 2013, many areas on the Eastern Plains normally inhabited by crops or cattle were barren. Many ranchers sold their herds because grasses had gone dormant (or had even died) and hay was expensive and in short supply. Even the smallest wind can create dust storms in Southeastern Colorado where the soil has become very thin after repeated dry years. Recovering from these conditions will take time, but many farms are implementing updated farming practices to help mitigate the effects of drought. These techniques include no-till farming and allowing crop residue to remain after harvest to help anchor the soil (Denver Post, 2013).

Dust can have other impacts that exacerbate drought conditions. The dust-on-snow phenomenon has been increasingly evident in recent years, particularly in the spring of 2013. The snowpack that the State relies on for water supplies, agriculture, recreation, habitat, and for many other economic sectors melts out even faster due to the presence of dust that settles on the snow. This dust is borne from wind and often from storms that originate in Arizona, New Mexico and Utah. The absorption of heat from the dust-laden sun hastens snowmelt, causing rapid loss of snowpack instead of the slow melt over a longer period of time that is desired for capture in storage reservoirs. Dust-covered snow can absorb 70% more solar energy compared to the 5 to 20% that is absorbed with clean snow (Durango Herald, 2013). Snowpack may already be thin from little snowfall in the preceding winter, further compounding the issue. Dust events that occurred repeatedly in April 2013 were followed by large snow events in the San Juan Mountains, Steamboat Springs, Summit County, Vail and Aspen, thus layering the dust throughout the snowpack. Runoff greatly increases

when the dust layers converge as melt occurs. Faster melting of snowpack decreases the likelihood that the water can effectively be captured in storage reservoirs for use in the summer when it is needed the most. This also affects late-season base flows in streams, a problem for irrigators who rely on this water for diversions (Denver Post, 2013b).

Drought conditions and a period of extremely hot temperatures in June 2012 also contributed to very dry forests, contributing to the conditions that led to the High Park fire in northern Colorado and the Waldo Canyon fire near Colorado Springs, two of Colorado's most destructive. These wildfires prompted a Presidential Disaster Declaration to be declared the end of June 2012 to provide federal disaster assistance to supplement state and local recovery efforts. Insurance claims totaled more than more than $453.7 million for the Waldo Canyon fire (Associated Press, 2013). This does not include the costs to fight the fire. Wildfires continued to burn throughout the State in 2012 until the last fire, the Fern Lake Fire in Rocky Mountain National Park finally extinguished in January 2013, a testament to how dry the forests were coupled with a low snowpack at the end of the year. Dry conditions on the Eastern Plains also contributed to an extended grass fire season. Typically, these fires occur in the spring, but in 2012 they were experienced well into the summer. Approximately 45,000 acres were scorched in a matter of days, destroying 23 structures, including 5 homes, as a result of the Last Chance Fire.

At the time, the Waldo Canyon Fire in Colorado Springs was the most destructive fire in Colorado history in terms of structures lost, burning approximately 346 total homes (The Gazette, 2012). However, the Black Forest Fire, also near Colorado Springs, surpassed it a year later when a record-setting 498 homes were destroyed and 28 damaged in June 2013 (El Paso County Sheriff's Office, 2013).

Other impacts seen during the 2011-2013 drought were decreased rafting numbers in 2012 due to low streamflows and wildfire conditions, making some river reaches inaccessible. Colorado's ski industry, another important economic driver for the state, experienced an 11.9% decrease in visits for the 2011-2012 season as compared to the five-year average. Many ski resorts closed early in 2012 because of minimal March snowfall and high temperatures. Both of these industries have developed marketing and operations strategies in recent years to mitigate economic impacts due to drought. In the agriculture sector, the Arkansas Basin lost approximately 1,300 jobs and $105 million in economic activity (Gunter et al., 2012).

Reservoir levels in many portions of the State helped abate some of the drought impacts seen in 2011-2013. Had they not been at levels sufficient for carryover storage into 2012 due to record breaking high snowpack in 2011 in many river basins, many of the impacts discussed above may have been worse. However, since May 2012, reservoir storage has dropped below average in most basins. Some relief was brought to northern Colorado from late spring storms that boosted snowpack in 2013, but reservoirs in the region remain below normal.

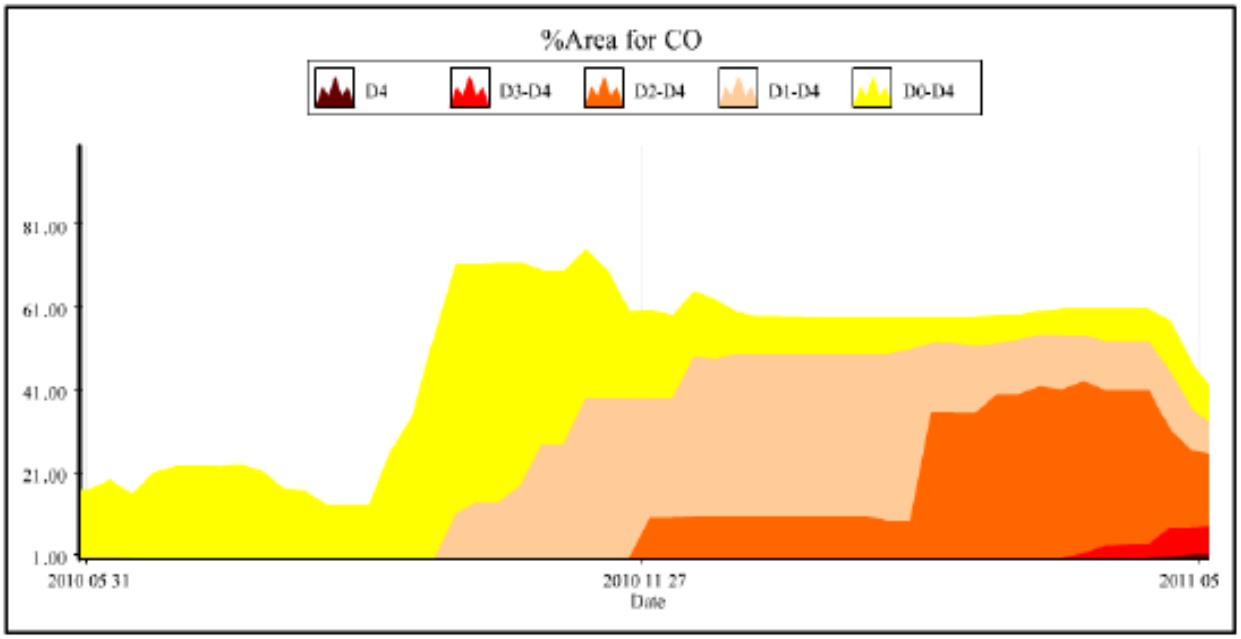
Figure 10 through 13 present time series graphs in year intervals beginning in May 2010 as a visual representation of the development of the 2011-2013 drought. Figure 10 highlights the drought

cycle from before the exceptional drought conditions began in late 2011, all the way to the ending period of the drought in 2015. These figures illustrate what percentage of the State was affected by drought according to the following intensities:

- D0: Abnormally Dry
- D1: Drought – Moderate
- D2: Drought – Severe
- D3: Drought – Extreme
- D4: Drought – Exceptional

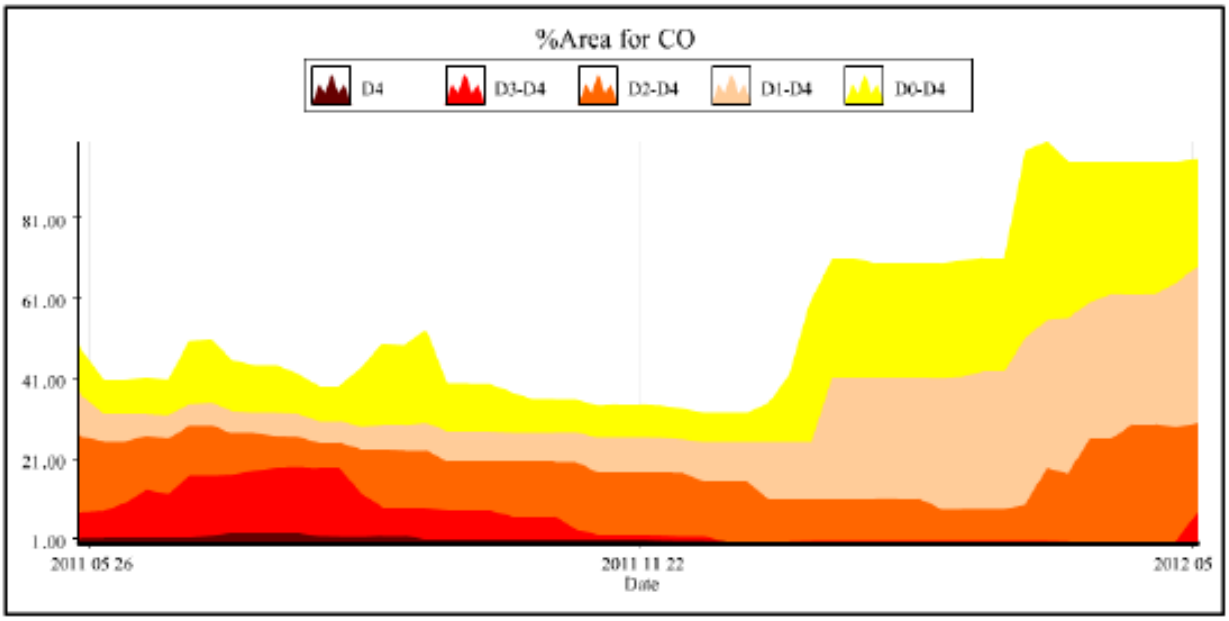
Beginning in May 2010, the majority of the state was not experiencing drought, though some regions were classified D0. By fall of 2010, some moderate drought conditions began, which elevated in intensity throughout the end of 2010 and into the beginning of 2011. However, the wet conditions during the spring and summer of 2011 suppressed the severity of drought conditions in northern Colorado. By early 2012 drought conditions began to expand and strengthen in intensity. The whole state was, at a minimum, under a severe drought by the summer of 2012. These conditions persisted until around October of 2013, when exceptional drought conditions ceased slightly throughout Colorado. The last remnant of drought (when the D0 category ceased to be prevalent from the entire State) was seen to last until summer of 2015, though the most severe drought conditions ended in late 2014.

Figure 10 Drought Time Series: May 2010-May 2011



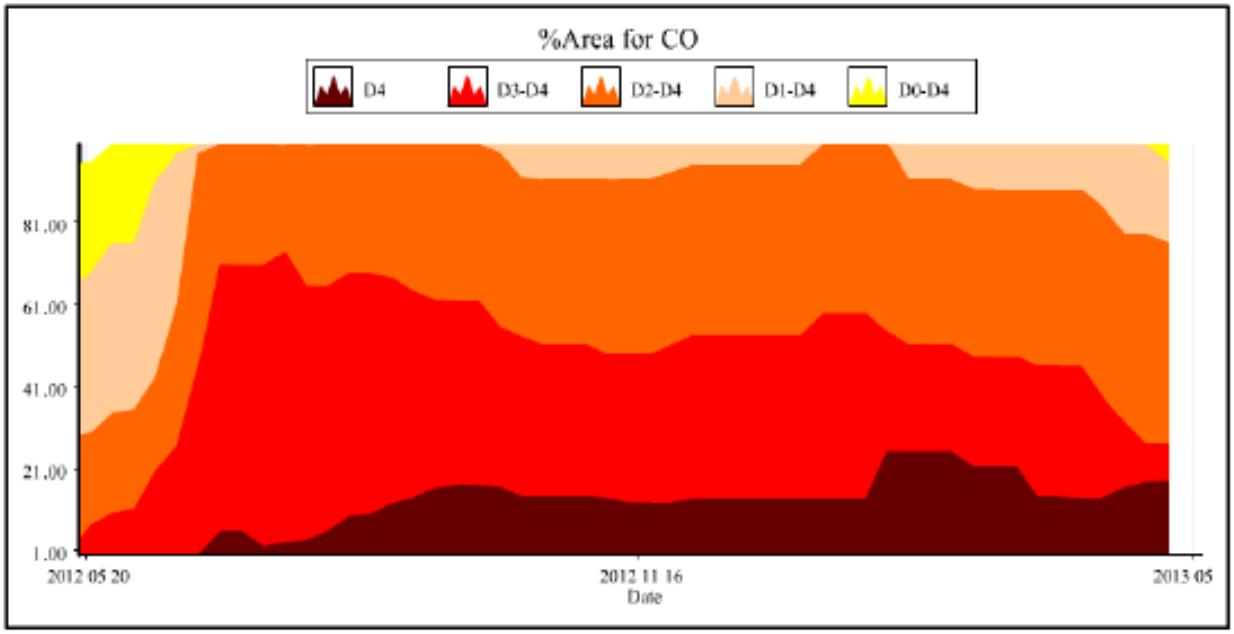
Source: NIDIS U.S. Drought Portal

Figure 11 Drought Time Series: May 2011-May 2012



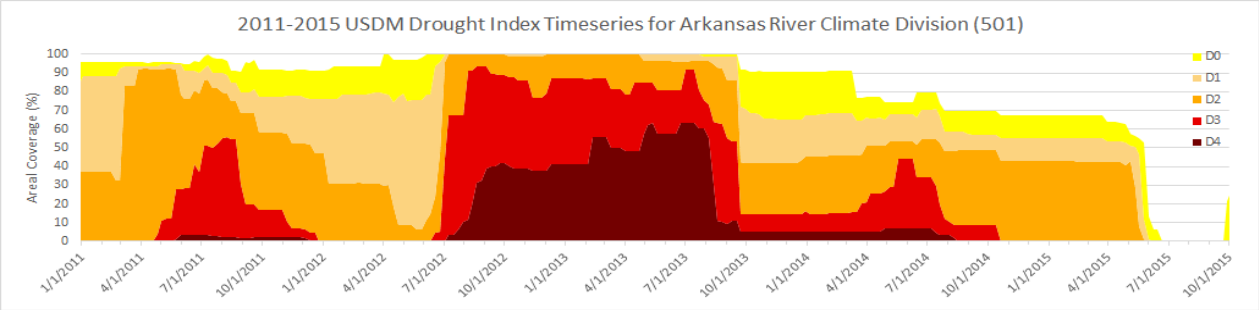
Source: NIDIS U.S. Drought Portal

Figure 12 Drought Time Series: May 2012-May 2013



Source: NIDIS U.S. Drought Portal

Figure 13 Drought Time Series with 'before' and 'after' drought conditions: January 2011-October 2015



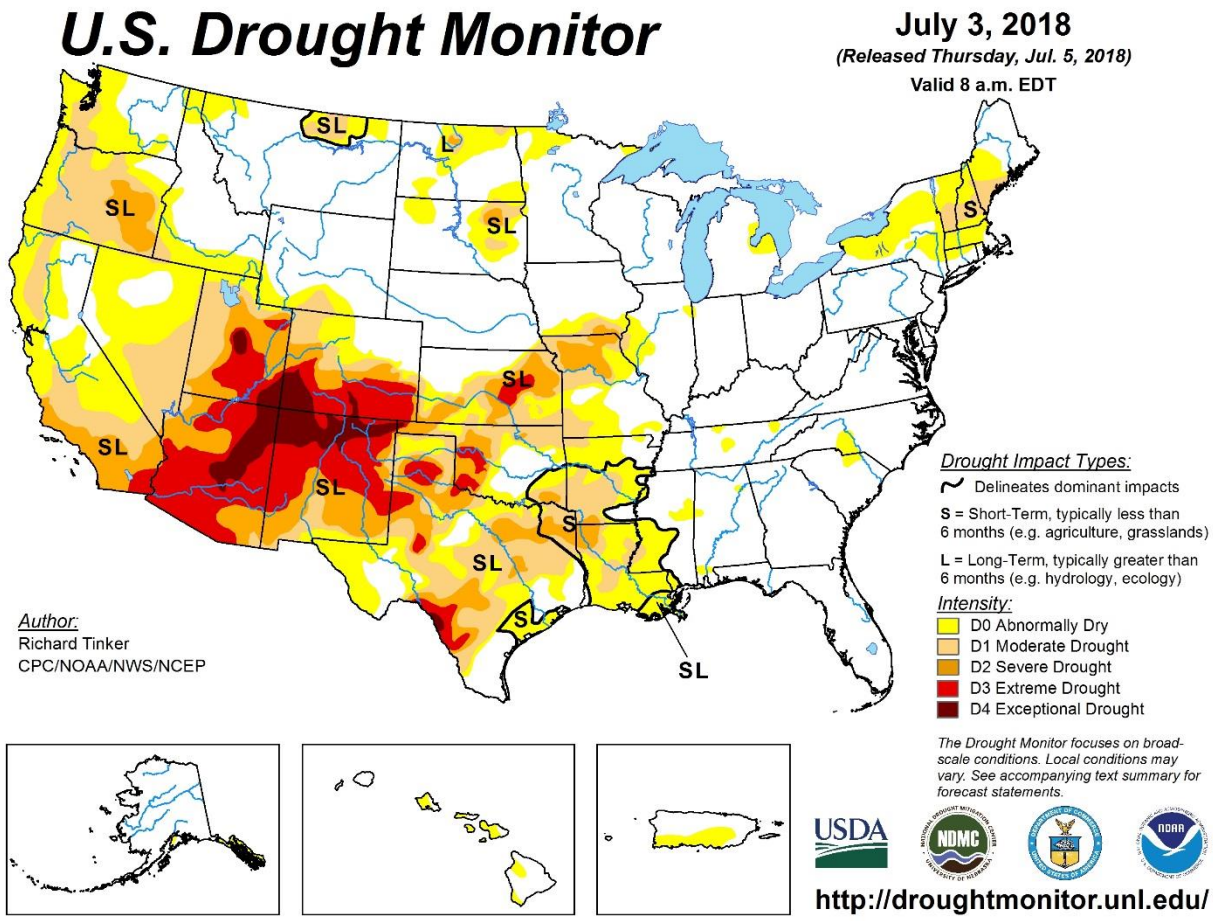
2011-2013 Drought and the Impact Task Forces - The Agricultural Impact Task Force met for much of 2011 and 2012 following activation by the Governor in 2011, bringing together Farm Service Agency personnel and state water managers to report failed and prevented planting acreages, updates on CRP (Conservation Reserve Program) grazing availability as well as emergency loan status and disaster declarations status by county.

Governor John Hickenlooper activated the Municipal Water Task Force (MWTF) in May 2013, as a response to growing water availability concerns. The MWTF assessed 2013 drought impacts on municipal water supply and public health impacts, and made recommendations for response actions.

2018 Drought

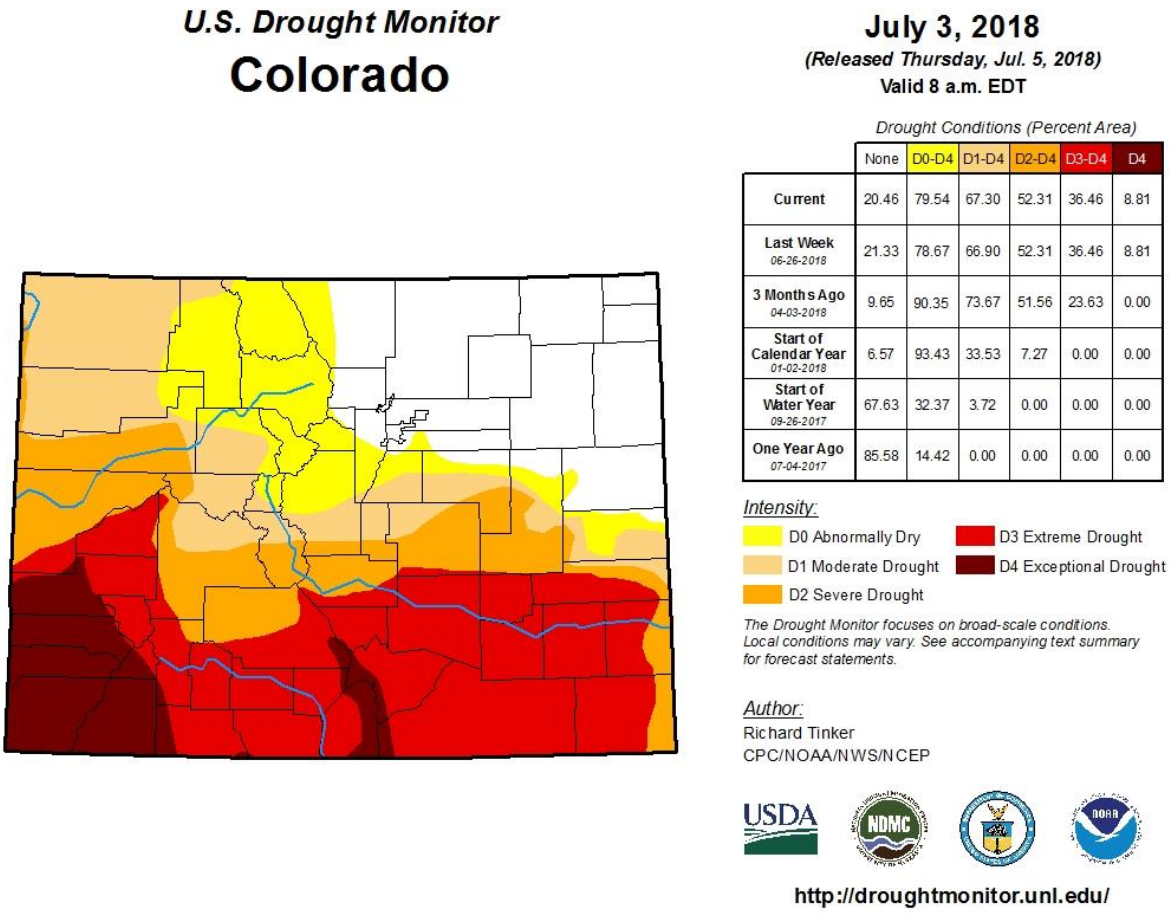
When this Plan was updated in late 2017-2018, drought emerged over the winter and persisted into the summer. A snapshot of the drought conditions as of July 2018 nationwide and specific to Colorado can be found in the following figures. The figures indicate the dry conditions that are evident throughout much of the south-central and western United States. As indicated below, the four corners region of the country (Arizona, New Mexico, Utah and Colorado) are experiencing extreme and exceptional drought In addition to moderate and severe drought impacting Kansas, northern Texas, and western Oklahoma . Some areas of the west coast of the U.S. and the northeast are also experiencing moderate and severe droughts, such as in Vermont, Washington, California and Oregon. The majority of drought conditions are classified as short-term, however, typically lasting less than 6 months.

Figure 14 July 2018 U.S. Drought Conditions



Source: United States Drought Monitor

Figure 15 July 2018 Colorado Drought Conditions

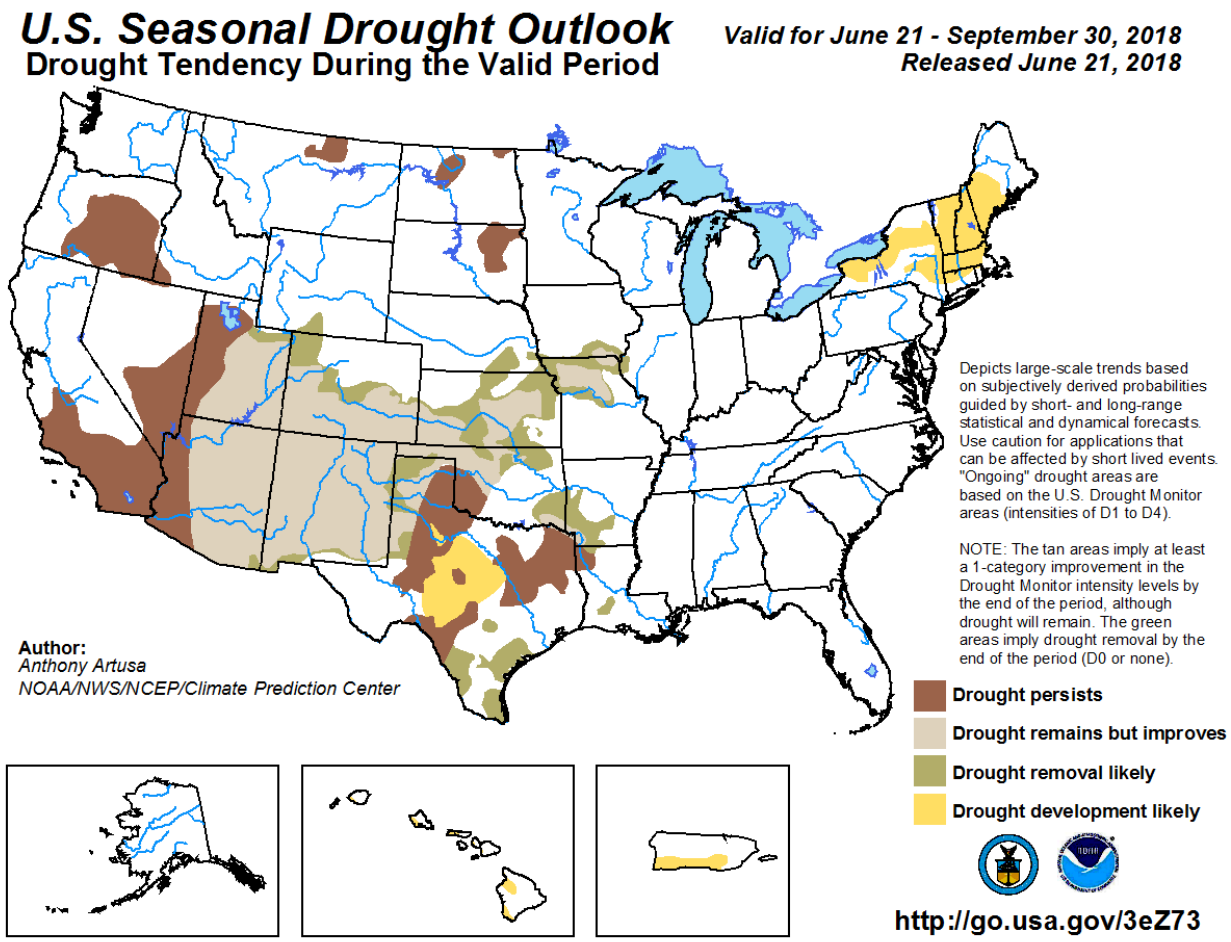


Source: United States Drought Monitor

Figure 15 displays the conditions in Colorado as of July 3, 2018. The southern region of the state is increasingly susceptible to drought, which is indicated by the yellow, beige, and orange shading, while most of the state exhibits signs of drought. The southern edge is particularly affected by extreme drought, with the southwestern corner being under exceptional drought conditions (dark umber shading). The central region is mostly under moderate and severe drought, with parts of the central-north, northwest, and central-east under abnormally dry conditions. Finally, the top central and northeastern parts are mostly unaffected, in stark contrast to the southern half of the state.

The U.S. Seasonal Drought Outlook developed by NOAA synthesizes long-term forecasts to generalize drought tendencies across the nation. A sample of this product is shown in the figure below, which shows that persistent drought is likely to continue in the northern high plains region while a portion of the central and southwestern U.S., including a very small area in southeastern Colorado near Kansas and Oklahoma, may show some improvement in drought conditions.

Figure 16 Seasonal Drought Outlook June 21 - September 30, 2018



Source: NOAA Climate Prediction Center

The USDA designated several counties in Colorado as primary natural disaster areas due to losses and damages from drought taking place in April and May of 2018. The counties include: Alamosa, Archuleta, Conejos, Gunnison, Hinsdale, Mineral, and Rio Grande. Farmers and ranchers in the following contiguous counties also qualified for natural disaster assistance: Chaffee, Costilla, Delta, Huerfano, La Plata, Mesa, Montrose, Ouray, Pitkin, Saguache, and San Juan. San Juan's declaration was initiated by a Governor's request due to being outside of the growing season for that county. The CWCB reported exceptional drought conditions in April, via their monthly drought update report, and the declaration was officially approved May 25th. The Colorado Drought Response Plan was once again activated in response to the drought conditions.

The four corners region suffered persistent precipitation deficits, which are expected to continue. While strong reservoir storage tempers conditions somewhat, the agricultural sector is seeing loss of winter wheat and early fires have already been reported. The Mesa Verde area in the southwest is seeing its lowest year-to-date water accumulation in its 95 year record.

Probability of Future Droughts

Historical analysis of precipitation shows that drought is a frequent occurrence in Colorado (McKee et al., 1999). Short duration drought, as defined by the three-month Standardized Precipitation Index (SPI), occurs somewhere in Colorado in nearly nine out of every ten years (McKee et al., 2000). However, severe and widespread multiyear droughts are much less common.

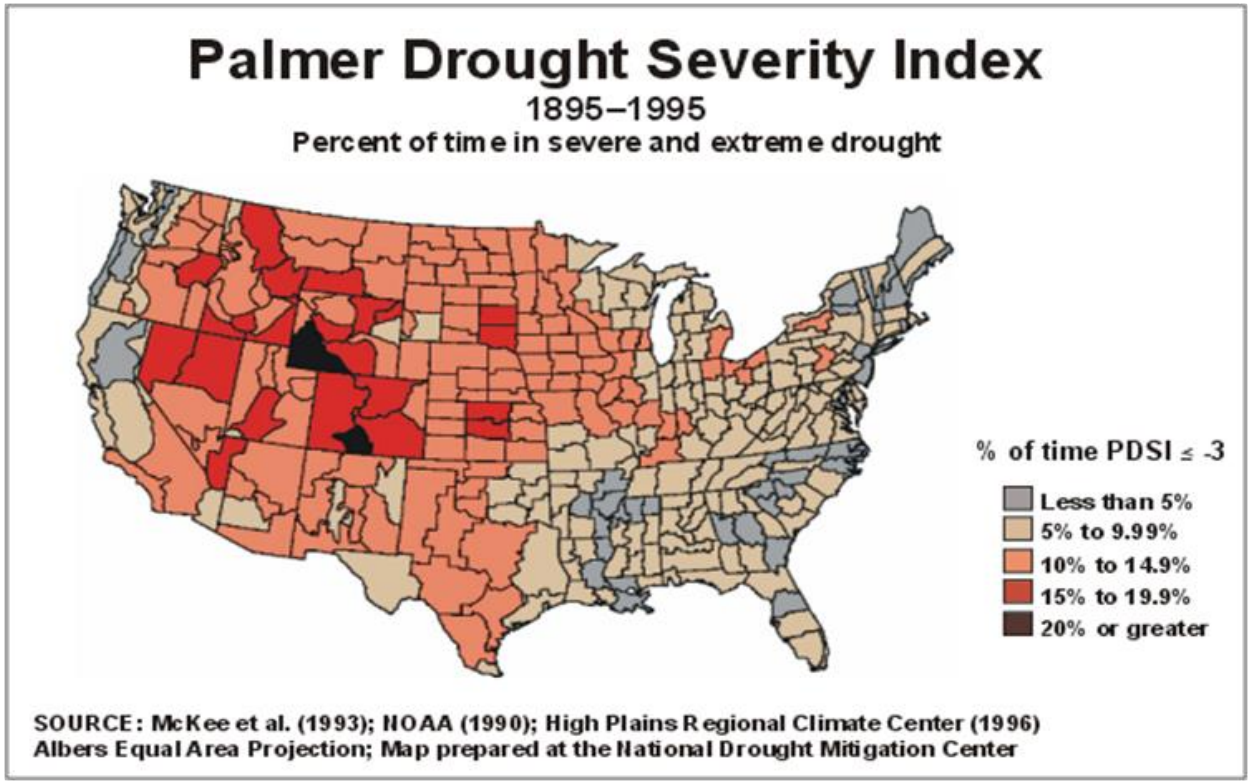
Up until the publishing of the *2004 Drought Water Supply Assessment* (DWSA), there had been six recorded drought incidents which impacted the State of Colorado since 1893, during a span of 111 years (from 1893 to 2004). As such, the SPI derived probability of a drought occurring in any given year is 32.4%. Table 6 under Section 3.2.4 summarizes the major multi-year drought and wet periods in Colorado history.

NOAA projects short term future probability of drought by releasing U.S. Seasonal Drought Outlook maps that forecast anticipated drought conditions three months out. The April 19 through July 2018 Outlook map was shown as Figure 7, under section 1.2.2. According to NOAA, in the short term, drought is expected to persist or intensify throughout most of Colorado's southwest. The southeast of the state is expected to see some drought remain but improving slightly, and small sections of the central-east might see actual drought removal conditions.

Figure 17, from the NDMC, illustrates that most of Colorado experienced severe or extreme drought between 15% and 19.9% of the time over a 100-year period (from 1895 to 1995).

Climate change could increase the frequency of drought in Colorado in the future. For a more thorough discussion on climate change as it relates to the probability of future droughts and its effects on the state economy, resources, and population, please review Annex C Climate Change Implications. However, a short section on this topic is included under Section 3.2.5 below.

Figure 17 United States: Percent of Time in Drought, 1895–1995



3.2.5 Other Drought Implications in Colorado

Climate Change

The hydrology and water resources, and hence the economy of Colorado, is extremely sensitive to climate. Climate change researchers around the world have recognized mountain systems as sensitive bellwethers of regional change. The interannual variability of the snow resource, the impacts of rapidly emerging factors such as dust-on-snow, and the possibility that climate change could cause substantial long-term reductions in Colorado's seasonal snow cover, highlight the vulnerability of the state's mountain snowpack and the economies that depend on the predictable storage and release of the water supply from snowmelt.

Multifaceted stress on water supply such as irrigation and municipal demands, mandated biological flows, coupled with climate variability and overall change, are increasing the importance of supply forecasting to both water managers and business markets. While the scientific understanding of climate change is ever evolving and entails many complexities when linking it with future trends in drought, in general, climate change is projected to increase the frequency of drought events in Colorado. As a result of increasing temperatures, water yields will generally decrease. Warmer temperatures will likely result in precipitation occurring as rain rather than snow, decreased high-elevation snowpack volume, an earlier spring melt of the decreased snowpack, more intense and

damaging precipitation events (e.g., flash floods), and increased evapotranspiration (WWA, 2011, CWCB 2008, CWCB 2010, Knowles et al., 2006, Mote 2006, Saunders 2005, Udall 2007). Consequently, runoff will start earlier and end earlier. Reservoirs will fill earlier, and what cannot be stored in the spring and early summer will be spilled when agricultural demands are not as great as they are later in the summer. Decreased runoff in the summer will result in additional reservoir drawdown, and many studies agree that higher temperatures and lower precipitation during summer months will further increase agricultural demands, thus causing even more stress on reservoir storage even when annual total precipitation is projected to increase (CWCB, 2008; CWCB, 2012).

The International Panel on Climate Change (IPCC) indicated that predicted changes in mean flow or flow variability could cause physical infrastructure to be inadequate for intended purposes, or increase the risk of failure of the water resource system under extremes of drought (IPCC, 2007 and 2014). While such risks may be somewhat buffered in large water systems by robustness and resilience in the design of the system, smaller systems may be extremely vulnerable under climate scenarios beyond those considered in their design. To illustrate the evolving understanding of climate change science, several documents by the Congressional Research Service such as the IPCC's Fourth and Fifth Assessment reports indicated that large uncertainties still exist in terms of trends about drought on a global scale. Nevertheless, these reports highlight why and how early mitigation actions targeted to climate change impacts can improve aspects of citizens' everyday lives, enhance well-being and livelihoods, improve environmental amenities, and much more (IPCC 2007; CRS, 2013). Colorado has been paying increased attention to climate change projections from the IPCC, particularly with the latest IPCC report released in 2014.

The State has also been involved regionally and nationally in policy-making decisions to reduce vulnerabilities due to climate impacts to the various sectors that drive Colorado's economy. The Colorado Climate Action Plan that was developed in 2007 and updated in 2015 identifies the need to investigate vulnerabilities of the State's water supplies to climate change and to plan for severe drought (as well as other risks) resulting from climate change. More recently, the Colorado Climate Plan, updated in 2018, introduces additional policies and strategies for the State, designed to mitigate and adapt to a changing climate. This Plan particularly provides recommendations about water issues, public health, greenhouse gas emissions, transportation, tourism, ecosystems, agriculture, and the partnerships and efforts behind supporting federal, regional, and local entities and agencies become more resilient and adaptable.

The State has also held conferences to bring water providers, planners, managers, and government officials together to assess drought risk, impacts, and preparedness in Colorado, and to consider the improvements that will be needed for management under different conditions such as climate change. The Governor's Conference on Managing Drought and Climate Risk was held in October 2008 and included attendees from state, federal and local agencies. The September 2012 CWCB Statewide Drought Conference program focused on building a drought resilient economy through innovation which included discussions on climate variability. In February of 2018, the Colorado Communities Symposium took place, where Governor John Hickenlooper and many elected

officials and community business leaders participated in visioning workshops and educational programs tied to climate preparedness and clean energy development. These forums are important to bring stakeholders together to discuss adaptive strategies, incorporate variability into decision making, and understand the complexities and challenges associated with the constantly evolving nature of climate science.

Annex C contains a more detailed analysis of possible implications of climate change for drought in Colorado. Assessments from the Colorado River Water Availability Study (CRWAS) phases were sponsored by the CWCB, to investigate water availability on the Colorado River under a range of climate change scenarios. CRWAS analyzed drought duration intensity and the likelihood for a range of possible future conditions. Refer to Annex C for the findings of this analysis, as the document was updated in 2018 with information from the CRWAS Phase II findings.

Water Rights

Under the Colorado system of prior appropriation, also known as "first in time, first in right," claims with earlier adjudication dates and earlier appropriation dates have senior rights while claims with more recent adjudication dates and appropriation dates have junior rights. During droughts, senior water rights take precedence over junior rights. Water use will be reduced or cut off for junior rights, protecting senior rights. Colorado's water supply fluctuates continually. During times of drought, when water is scarce, the prior appropriation doctrine has profound implications for water management. The topic of drought and Colorado Water Rights, including background details on the Colorado Water Trust and State Water Plan from 2015, is discussed in more detail in chapter 4 of the Annex B Drought Vulnerability Assessment Technical Information. Below is a general discussion on the system of prior appropriation, a summary of river administration during the 2002 drought, and recommendations for future studies. While some information is available on river administration based on the 2011-2013 drought, including aspects about leasing instream flow rights and utilizing reaches to protect assets, more time and collaborations would be necessary to acquire and process data that captures the extent of the impacts of the 2011-2013 drought on water rights. Future endeavors should address in more detail some of these water rights complexities, however, to highlight issues behind water appropriation and administration during and after times of water scarcity.

3.3 Assessing Vulnerability by Jurisdiction

The Plan's risk assessment includes 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 drought. 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 on how the Plan reflects changes in development in 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, the vulnerability of a county is approximated by looking at previous impacts due to drought and identifying existing conditions, or "metrics," that would cause a county to be more or less impacted during future droughts. These metrics are determined on a sector-by-sector basis. In an attempt to expand upon previous vulnerability assessments for the State of Colorado, the scope has been widened to include six private economic sectors and one public sector in total. The private sectors are as follows: Agriculture, Energy, Environment, Municipal and Industrial (M&I), Recreation and Tourism, and Socioeconomic. The public sector is State Assets. State assets that are considered at-risk from drought are as follows: state-owned or operated buildings, critical infrastructure, state lands, instream flows, 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. While Agriculture, Energy, Environment, Municipal and Industrial (M&I), Recreation and Tourism, and the Socioeconomic sectors are discussed in this section (3.3), facilities related and infrastructure related to the State Assets sector are described under section 3.4 instead, given their slightly different nature in affecting the economic sphere in Colorado.

In addition to the FEMA requirements, the Emergency Management Accreditation Program, or EMAP risk assessment standards, require a consequence-based analysis. Table 6 outlines the detrimental impacts that drought can have on various subject areas as designated by EMAP.

Table 6 EMAP Consequence/Impact Analysis: Drought

EMAP Risk Assessment Subject Area	Detrimental Impacts
Health and Safety of the Public	Water supply disruptions may adversely affect people. Reduced water quantity and quality could impact delivery of potable water, particularly in rural areas. Reduced air quality associated with blowing dust could have detrimental impacts. Mental health issues may be associated with loss of farm income and heavily impacted lifestyles in agricultural areas. See the Socioeconomic Sector analysis for a detailed impact discussion.
Health and Safety of Personnel Responding to the Incident	Nature of hazard expected to have minor impacts to properly equipped and trained personnel, though dust storms may require special equipment.
Continuity of Operations Including Delivery of Services	Slow onset and nature of drought makes it unlikely to have an impact on continuity of operations. Nature of hazard not expected to impact delivery of government services, except for moderate impact on water utilities. In extreme cases, municipal water delivery may be interrupted. Ability to deliver recreational services may be impacted at the local level. Food supply and delivery could be disrupted, with an associated increase in food prices.

EMAP Risk Assessment Subject Area	Detrimental Impacts
Property, Facilities, and Infrastructure	Buildings: Nature of hazard expected to have minimal impact. Landscaping can be damaged or lost in events of severe municipal water restrictions or water rights out of priority. Increased risk of wildfire can threaten catastrophic loss of buildings. Critical infrastructure (e.g., dams, transmountain ditches, irrigation ditches): Infrastructure can be damaged by excessively dry expansive soil as it contracts. Dams and ditches can experience structural damage due to decreased pore water pressure, damage caused by high sediment loads when pulling water from the bottom of reservoirs, and damage caused by debris flows and flooding following wildfires. State lands: Environmental quality of land can be impacted by overgrazing during drought conditions. See the State Assets Sector analysis for a detailed impact discussion.
The Environment	May cause disruptions in wildlife habitat, resulting in an increasing interface with people, and reduction in numbers of animals. Land quality can be negatively impacted by overgrazing during drought. Water quality can become degraded to the point of causing localized fish kills. See the Environment Sector analysis for a detailed impact discussion. Low streamflows will have negative impacts on riparian habitats and aquatic species.
Economic Condition	Local economy and finances dependent on abundant water supply or precipitation (e.g., snow at ski areas) adversely affected for duration of drought. Agricultural economies adversely affected if drought results in widespread loss of crops or yield reductions. Increased expenses possible among M&I providers. See sector analyses for Recreation and Tourism, Agriculture, State Assets, Energy, M&I, and Socioeconomic.
Regulatory and Contractual Obligations	Water trading between municipalities expected to occur on a voluntary rather than obligatory basis. Drought reservations or instream flows may be invoked to allow a reduction in bypass requirements and an interruption to agricultural leases (see the M&I Sector analysis). Interstate compact obligations could become stressed if long term or severe decreases in availability occurs. Recreational in-channel diversions and instream flow rights are subject to water rights priority system and may become out-of-priority in a drought (see Recreation and Tourism and State Assets analyses).
Public confidence in the jurisdiction's governance	Ability to respond and recover may be questioned and challenged if planning, response, and recovery efforts are not timely and effective. State must balance *over* and *under* responses to the drought hazard.

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, presented in the chapters of Annex B, are presented.

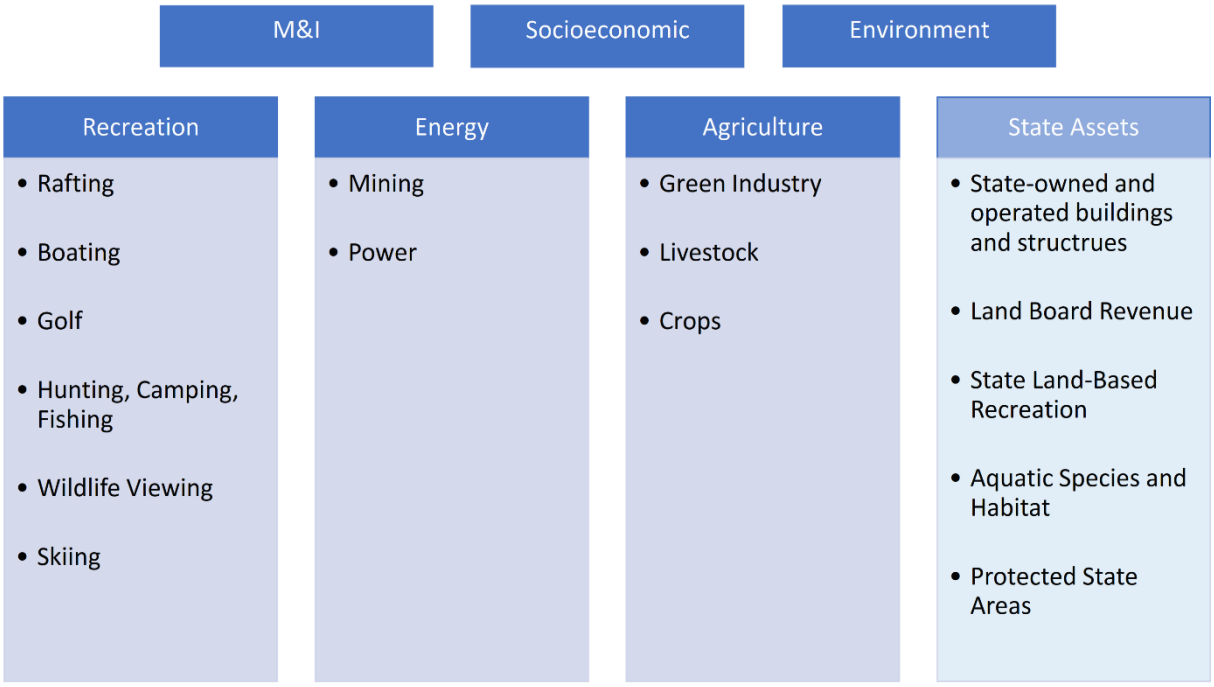
3.3.1 Vulnerability Based on Local and State Risk Assessment

State and local hazard mitigation plans were reviewed to assess vulnerability of the private economy sectors of Recreation and Tourism, M&I, Socioeconomic, Environment, Energy, and Agriculture sectors, on a jurisdictional level. Information was updated accordingly to reflect hazard mitigation plans that have been finalized since the previous update to this Plan was

completed in 2013. During that 2013 Plan update, an extensive literature review was conducted to collect previously-reported impacts to drought and adaptive capacities that had been developed by sectors and the State. Interviews were conducted with individuals knowledgeable about a particular sector or asset. The information was analyzed and incorporated into a spreadsheet to evaluate vulnerability in a quantitative as well as qualitative way. To the extent available, new reports and data available since the 2013 update were reviewed and incorporated into revised vulnerability analyses during this 2018 update.

The six private economy and one public economy sectors, listed in Figure 18, were divided into sub-sectors to facilitate analysis in cases when a sector is sufficiently diverse to warrant separate consideration (e.g., Recreation and Tourism).

Figure 18 Sectors and Sub-Sectors Analyzed in the Drought Vulnerability Assessment



As shown in Figure 19, the private sectors of Agriculture, Energy, and Recreation & Tourism were divided into sub-sectors while Environment, M&I, and Socioeconomic were not. The public sector of State Assets was also broken into sub-sectors, but its sub-sectors are described in more detail under Section 3.4.

From the literature review, previous drought impact reports (including local and state hazard mitigation plans), and interviews with agency directors, program employees, industry

representatives, and academics who are continually involved in drought-related issues[1], impacts of drought to the sub-sectors and departments were identified and listed for analysis. Similarly, adaptive capacities were identified as they can mitigate the impacts to the sub-sectors. The existence of adaptive capacities helps offset the impacts and reduce overall vulnerability and risk.

Using the list of impacts and adaptive capacities, data relating to the impacts that could be used to quantify the vulnerability of each sector were identified. An example of a vulnerability (impact) metric for Energy is the total water withdrawals used in the power generation sector. For Agriculture, an identified impact was crop loss due to drought; crop indemnity data is available by county specifically for drought, so these data were used as a metric for agriculture. The data for all the sectors were aggregated at a county level to satisfy the jurisdictional requirements of the FEMA regulation, while also introducing localized details and perspectives.

To determine the overall impact a sector or sub-sector has within a county, data were collected to assess the spatial density of the sub-sector in question (in one or more ways). This enabled a presentation of sub-sector relative densities throughout the State. For example, Colorado State Parks were mapped and correlated to one or more counties where they are located. In this way, only counties that contain state parks can be vulnerable to drought impacting state parks (in terms of visitation revenue, for instance), or for agriculture, only counties that have grazing cattle can be vulnerable to grazing losses during a drought.

For each sector and/or sub-sector, spatial inventory data were used to determine its proportionality within the county. For example, a county with a high number of high-value state buildings and state-owned dams, but a low acreage of land managed by the State Land Board, would have its vulnerability rated proportionally higher for state-owned buildings and dams. Refer to Annex B (Drought Vulnerability Assessment Technical Information) for further discussion of the vulnerability assessment methodology.

3.3.2 Jurisdictions Most Threatened and Most Vulnerable to Damage or Loss

While these other approaches are examples of tools addressing vulnerability, risks, and impacts of drought to the State of Colorado, the vulnerability assessment and methodology incorporated in this Plan differs by highlighting vulnerability and adaptive capacities, impact metrics, spatial

[1] Including individuals from the Colorado Department of Agriculture (CDA), Colorado State University (CSU), U.S. Department of Agriculture (USDA), National Oceanic and Atmospheric Administration (NOAA), water division engineers, National Resources Conservation Service (NRCS), GreenCO, water commissioners, The Nature Conservancy (TNC), NatureServe, Audubon Society, Department of Local Affairs (DOLA), Colorado Energy Office (CEO), National Renewable Energy Laboratory (NREL), Tri-State Energy, Xcel Energy, Colorado Geological Survey (CGS), Division of Reclamation and Mining Safety (DRMS), Western Resource Advocates (WRA), Golf Course Superintendents Association of America (GCSAA), U.S. Geological Survey (USGS), Colorado River Outfitters Association (CROA), National Ski Areas Association (NSAA), Office of Economic Development and International Trade (OEDIT), State Office of Risk Management, State Land Board, fish hatchery managers, Colorado Park and Wildlife (CPW), Colorado Department of Public Health and Environment (CDPHE), and others.

densities, and of course the localized perspectives of each sector based on interviews, professional interactions, and other such information and data. In addition, both private and public economic sectors are taken into account, more holistically approaching the issue of drought at local and statewide scales. In the section below, drought vulnerabilities are summarized based on the methodology described herein (in the Plan), by county and sector.

Drought Vulnerability by County Summary

By researching previous impacts to various sectors and by talking to people in the industries/agencies of concern, a methodology to "rank" vulnerability in a quantitative way was developed. This ranking process is described in discussions specific to each sector in Annex B, and results were updated in 2018. In many cases, vulnerability scores did not change from 2013 due to lack of available quantitative data consistent statewide. Where changes did occur in the county listings, notably in state-owned buildings and infrastructure and state-owned recreational activities, this was due to incorporation of improved data. The summaries of the rankings are provided in Table 7 below, excluding the M&I sector because that sector did not follow the standard methodology and instead calculated vulnerabilities and adaptive capacities based on the seven major river basins across the state (and not counties). Figure 19 displays the cumulative vulnerability assessment scores for all the sectors (except the M&I sector), in map form.

Table 7 Vulnerability Ranks by County and Sector (excluding M&I), 2018 Update

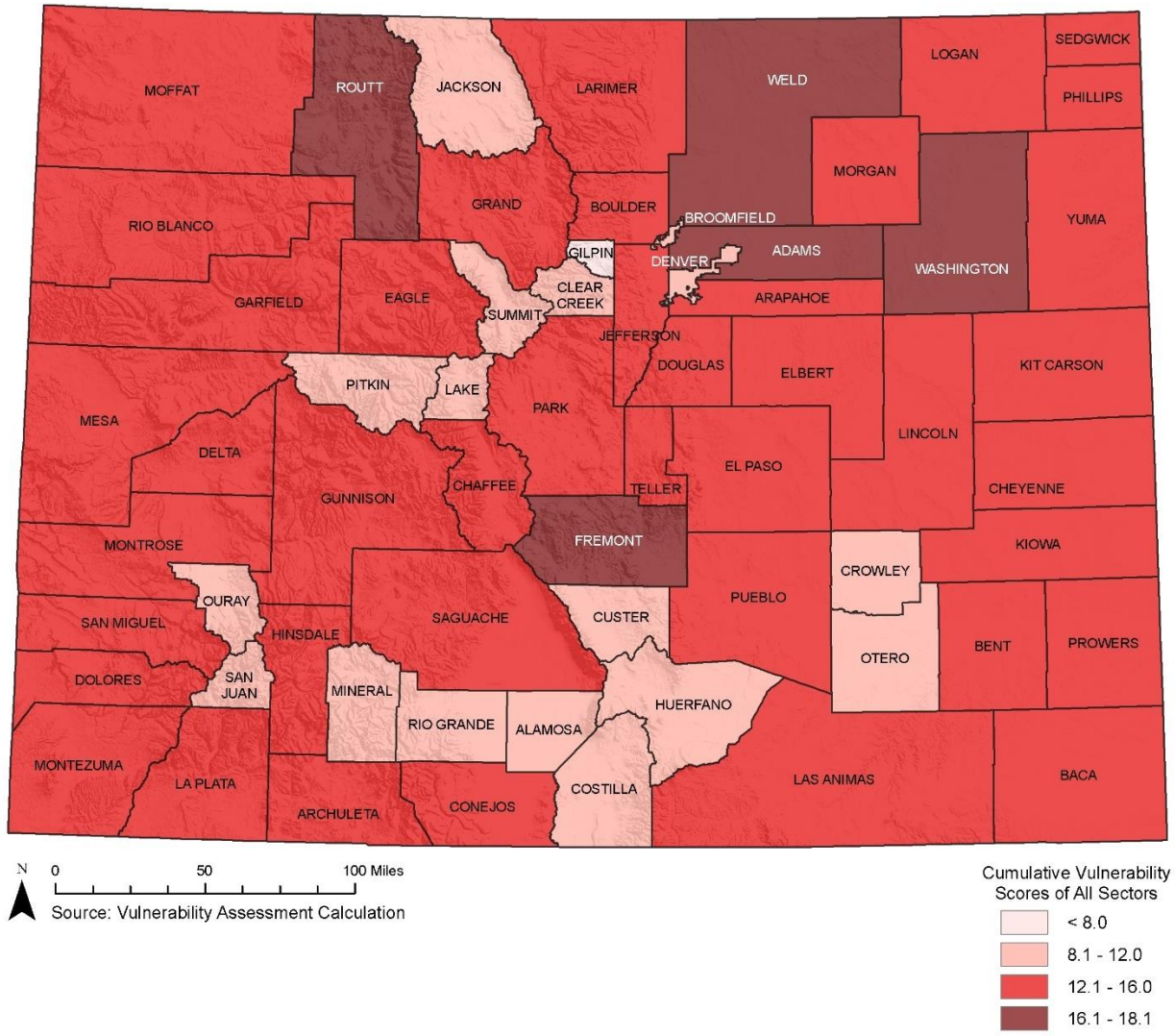
County	Recreation	Energy	Agriculture	State Assets	Socioeconomic	Environment	Average Overall Vulnerability (not including M&I Sector)	Cumulative Vulnerability Assessment Scores (not including M&I Sector)	Number of Sectors with Vulnerability Scores of 3.0 and above
Adams	2.29	3.00	3.54	2.92	2.80	2.50	2.84	17.05	2
Alamosa	1.17	0.55	1.85	1.98	2.80	1.27	1.60	9.62	0
Arapahoe	2.35	1.00	2.96	2.31	2.60	1.90	2.19	13.12	0
Archuleta	2.75	1.75	2.17	2.84	3.20	1.94	2.44	14.65	1
Baca	2.14	1.48	4.00	2.82	2.20	1.83	2.41	14.47	1
Bent	1.91	0.40	3.38	2.70	2.00	1.94	2.06	12.33	1
Boulder	2.15	3.00	2.05	1.50	1.80	2.08	2.10	12.58	1
Broomfield	1.94	0.00	2.06	1.35	2.40	1.67	1.57	9.42	0
Chaffee	2.55	1.75	1.92	2.14	2.80	2.03	2.20	13.19	0
Cheyenne	1.75	3.25	3.32	2.92	2.20	1.67	2.52	15.11	2
Clear Creek	2.12	1.00	1.00	1.98	2.80	1.36	1.71	10.26	0
Conejos	2.20	1.47	2.66	2.08	2.40	1.67	2.08	12.48	0
Costilla	1.50	1.00	2.19	1.67	2.80	0.97	1.69	10.13	0
Crowley	1.00	0.00	2.43	2.85	2.00	2.17	1.74	10.45	0
Custer	1.60	0.00	2.13	1.57	3.00	1.53	1.64	9.83	1
Delta	2.46	2.75	1.88	2.84	2.40	2.54	2.48	14.87	0
Denver	1.44	2.00	0.75	1.53	2.60	2.00	1.72	10.32	0

County	Recreation	Energy	Agriculture	State Assets	Socioeconomic	Environment	Average Overall Vulnerability (not including M&I Sector)	Cumulative Vulnerability Assessment Scores (not including M&I Sector)	Number of Sectors with Vulnerability Scores of 3.0 and above
Dolores	1.65	1.75	3.13	1.97	2.20	1.59	2.05	12.29	1
Douglas	2.46	1.00	2.17	1.97	2.40	2.03	2.00	12.03	0
Eagle	2.94	1.50	2.00	2.10	3.00	2.08	2.27	13.62	1
El Paso	2.44	0.94	2.40	2.14	2.60	2.54	2.18	13.06	0
Elbert	1.33	1.75	3.25	2.95	3.00	1.83	2.35	14.11	2
Fremont	3.48	3.75	2.17	2.43	1.80	2.54	2.69	16.17	2
Garfield	3.04	2.00	2.25	2.97	2.60	2.86	2.62	15.72	1
Gilpin	1.33	0.00	0.00	1.74	2.60	1.52	1.20	7.19	0
Grand	2.98	1.38	2.00	2.11	3.00	2.42	2.31	13.89	1
Gunnison	2.54	2.71	1.46	2.56	2.60	1.74	2.27	13.61	0
Hinsdale	1.96	1.00	2.25	2.19	3.20	1.52	2.02	12.12	1
Huerfano	2.09	0.75	2.25	3.00	1.60	2.12	1.97	11.81	1
Jackson	1.58	0.00	2.50	1.80	2.00	1.45	1.55	9.33	0
Jefferson	2.48	1.00	2.42	2.59	2.00	2.27	2.13	12.76	0
Kiowa	1.00	1.75	3.58	3.23	2.60	2.00	2.36	14.16	2
Kit Carson	2.00	1.10	3.78	3.67	2.40	1.83	2.46	14.78	2
La Plata	2.57	2.69	2.20	1.78	2.80	2.03	2.34	14.07	0
Lake	1.44	2.13	2.25	1.95	1.60	1.45	1.80	10.82	0
Larimer	3.08	1.54	2.74	2.43	2.60	3.33	2.62	15.72	2
Las Animas	2.57	1.99	3.42	2.80	1.40	2.78	2.49	14.96	1
Lincoln	1.43	0.82	4.00	3.23	2.40	2.00	2.31	13.88	2
Logan	2.36	1.62	3.41	2.93	2.20	2.67	2.53	15.19	1
Mesa	3.02	2.13	1.85	3.57	1.80	2.86	2.54	15.23	2
Mineral	2.03	0.00	1.00	1.38	2.80	1.25	1.41	8.46	0
Moffat	3.08	3.88	2.40	1.91	1.60	2.58	2.57	15.45	2
Montezuma	2.43	1.45	2.13	2.77	3.00	1.82	2.27	13.6	1
Montrose	2.64	2.20	1.28	3.53	2.80	2.22	2.45	14.67	1
Morgan	2.90	2.15	2.81	2.81	2.80	2.33	2.63	15.8	0
Otero	1.79	0.40	3.04	3.14	1.00	2.17	1.92	11.54	2
Ouray	2.13	1.00	1.75	2.75	2.20	1.59	1.90	11.42	0
Park	2.83	1.00	2.00	2.07	2.60	2.17	2.11	12.67	0
Phillips	1.60	1.75	2.71	3.60	1.80	1.33	2.13	12.79	1
Pitkin	2.26	1.00	1.63	1.43	3.60	1.11	1.84	11.03	1
Prowers	1.50	1.45	3.25	3.00	2.00	1.67	2.14	12.87	2
Pueblo	3.08	1.60	3.20	3.09	2.00	2.38	2.56	15.35	3
Rio Blanco	2.73	2.80	1.70	2.40	2.00	2.32	2.32	13.95	0
Rio Grande	2.62	0.00	2.04	2.67	2.20	1.88	1.90	11.41	0

County	Recreation	Energy	Agriculture	State Assets	Socioeconomic	Environment	Average Overall Vulnerability (not including M&I Sector)	Cumulative Vulnerability Assessment Scores (not including M&I Sector)	Number of Sectors with Vulnerability Scores of 3.0 and above
Routt	3.28	3.50	2.75	2.19	4.00	2.32	3.01	18.04	3
Saguache	2.57	0.85	2.13	2.30	2.80	2.12	2.13	12.77	0
San Juan	2.25	0.00	1.00	1.63	2.60	0.87	1.39	8.35	0
San Miguel	2.47	1.00	2.13	2.37	3.40	2.06	2.24	13.43	1
Sedgwick	1.00	0.70	2.83	3.68	2.60	1.50	2.05	12.31	1
Summit	2.16	1.00	2.13	1.30	3.40	1.67	1.94	11.66	1
Teller	1.92	2.50	2.50	2.59	2.80	1.59	2.32	13.9	0
Washington	2.13	3.25	3.13	3.43	2.40	2.50	2.81	16.84	3
Weld	2.96	2.32	2.81	2.50	3.00	3.50	2.85	17.09	2
Yuma	1.58	2.50	3.53	2.36	3.00	1.11	2.35	14.08	2

Source: Vulnerability assessment calculation

Figure 19 Vulnerability Assessment Cumulative Scores for all Sectors (except M&I)



The following conclusions were reached in terms of least adaptable and/or most vulnerable jurisdictions to damage associated with drought, for the State Assets sector:

- Vulnerability to state-owned buildings and critical infrastructure was found to be highest in these counties: Archuleta, Eagle, Mesa, Rio Blanco, Routt, Baca, Conejos, Kit Carson, Larimer, Park, Saguache, and San Miguel. This is because these counties contain state-owned buildings and/or dams (as determined from data provided by the Colorado Risk Management Office and the National Inventory of Dams). These counties either have proportionally more dams (since dams are more likely to be impacted by drought than buildings, this would make a county relatively more vulnerable), and/or there is a moderate to high wildfire threat as determined by the Colorado State Forest Service (CSFS) Wildfire Threat data, which poses a risk to state-owned buildings. These results are displayed in Figure 22.

- Vulnerability to State Land Board lands and revenues in Figure 23 was found to be high in quite a few counties. In general, counties on the eastern plains were found to have the highest vulnerability to drought as it impacts state lands because these counties received the highest agricultural lease discounts in the 2002 drought. Several counties in the west/southwest also have high vulnerability scores for the same reason. In 2002, the State Land Board issued across-the-board agriculture lease discounts, something they do not intend to do in future droughts as it did not have the desired effect of encouraging ranchers and farmers to adjust their grazing/farming practices to reflect the lower carrying capacity of the drought-stressed land. Because of this, in future droughts, State Land Board lease revenue will vary based on how many discounts are offered to individuals in each county (personal communication with State Land Board, 2010). While the spatial density metric (acres) was updated with the latest data as were total Land Board-owned surfaces in acres, this Lease Discounts vulnerability metric could not be updated for the 2011-2013 drought as the program was discontinued after the 2002 drought.
- Vulnerability to state-operated recreational activity and parks (CPW) in Figure 24 was found to be highest in Chaffee, Routt, Archuleta, Eagle, Mesa, Garfield, Huerfano, Las Animas, Montezuma, Weld, Park, Delta, Gunnison, Jefferson, Logan, Morgan, and Pueblo counties. This is because these counties contain state parks with relatively high annual visitation numbers, the state parks are water-based (which tend to attract more visitors and are more vulnerable to drought), and/or are in an area of moderate to high wildfire risk based on CSFS Wildfire Threat data.
- Vulnerability to aquatic habitat and species as shown in Figure 25 (consisting of instream flows and state-owned or operated fish hatcheries) was found to be highest in these counties: Mesa, Pueblo, Arapahoe, Ouray, Teller, El Paso, Montrose, Fremont, Alamosa, Garfield, Huerfano, Delta, Jefferson, Larimer, Gilpin, San Miguel, and Clear Creek. This is because these counties contain state-owned or operated hatcheries and/or many instream flows (as determined from data obtained from CPW and the CWCB), and they could have relatively junior instream flow rights.

Jurisdictional vulnerability to drought for the six private (i.e., not state-owned) sectors is discussed in detail in Annex B. General results by sector are as follows:

- Vulnerability to agriculture activities was higher in counties with significant proportions of dryland crops compared to total farmed acreage, and in counties with high numbers of grazing cattle and livestock feed program allocations. Aspects about the Green Industry were taken into account as well, to derive overall vulnerability ranks. These counties are found to be most vulnerable (obtaining scores of 3.5 and above, or most vulnerable/least adaptable): Adams, Baca, Kiowa, Kit Carson, Lincoln, and Yuma.

  Although the vulnerability analysis for the Energy Sector was performed on a county by county basis to be consistent with the drought vulnerability modeling methodology, it is important to note that energy production is regional, i.e., it is distributed over a grid which covers the entire

western United States. Generally, the energy sector is fairly resilient to drought impacts. This is due to the broad spectrum of drought preparedness utilities and power providers implement, which can range from diverse water rights portfolios to contract supplies from municipalities. In addition, due to a shift in energy production that is moving towards more sustainable and renewable sources, county vulnerabilities are changing from what was previously expected due to reliance on water for cooling processes in mining, for example. The county-level analysis showed that vulnerability was higher in counties with high mining water use (as estimated in a 2010 study from the USGS), and of that water use, counties using a higher percentage of surface water (as opposed to groundwater) are considered more vulnerable to drought. Counties with renewable energy development options (wind and/or solar power) were considered to have higher adaptive capacity, so that drought vulnerability is subsequently reduced. These counties scored highest in vulnerability: Washington, Cheyenne, Routt, Fremont, Boulder, Adams, and Moffat.

- Vulnerability in the Environmental Sector was higher in counties with relatively low protected area status (as determined by stewardship rankings in the 2000 Southwest Regional Gap Analysis Program), a relatively high number of Environmental Protection Agency (EPA) 303(d) Listed Impaired Waters, forests infected by bark beetle (as determined by the USFS aerial surveys), moderate to high ranking in the wildfire threat data, relatively junior instream flow rights, and a relatively high number of high-order streams (as determined by the USGS National Hydrography Dataset flowline attributes). The highest-ranking counties in terms of vulnerability/low adaptability are: El Paso, Delta, Fremont, Moffat, Logan, Las Animas, Garfield, Mesa, Larimer, and Weld counties.
- Vulnerability to the M&I Sector is generalized to water divisions rather than specific counties or water providers. In general, providers will be better insulated from drought impacts if they have senior water rights, if they actively plan and are prepared for drought, and if they have a diverse portfolio. Specific vulnerability rankings were not available for this Sector. Drought and water resources planning information from CWCB surveys focused on the M&I sector were conducted in 2004, 2007 and 2013 along with supplemental information from various resources that were used to characterize the sector's vulnerability.
- Vulnerability to drought specific to the Recreation and Tourism Sector was higher in counties with little recreational diversity, or a high concentration of water-dependent activities. For example, a county with a strong economic dependence on the skiing industry is more vulnerable to drought impacts than a county with recreational attractions ranging from hiking and camping to rafting and boating. The highest-ranking counties in terms of vulnerability or low adaptability are: Mesa, Garfield, Pueblo, Moffat, Larimer, Routt, and Fremont.
- Vulnerability to drought specific to the Socioeconomic Sector was higher in counties with little economic diversity. Counties that depend upon one main economic sector for the majority of their stability (for example, recreation or agriculture) are more vulnerable to drought conditions. This is because these counties lack other aspects of their economies that would not be impacted by drought to keep the overall economy functioning. In addition, counties with large highly vulnerable or at-risk populations such as the elderly are also more likely to prove

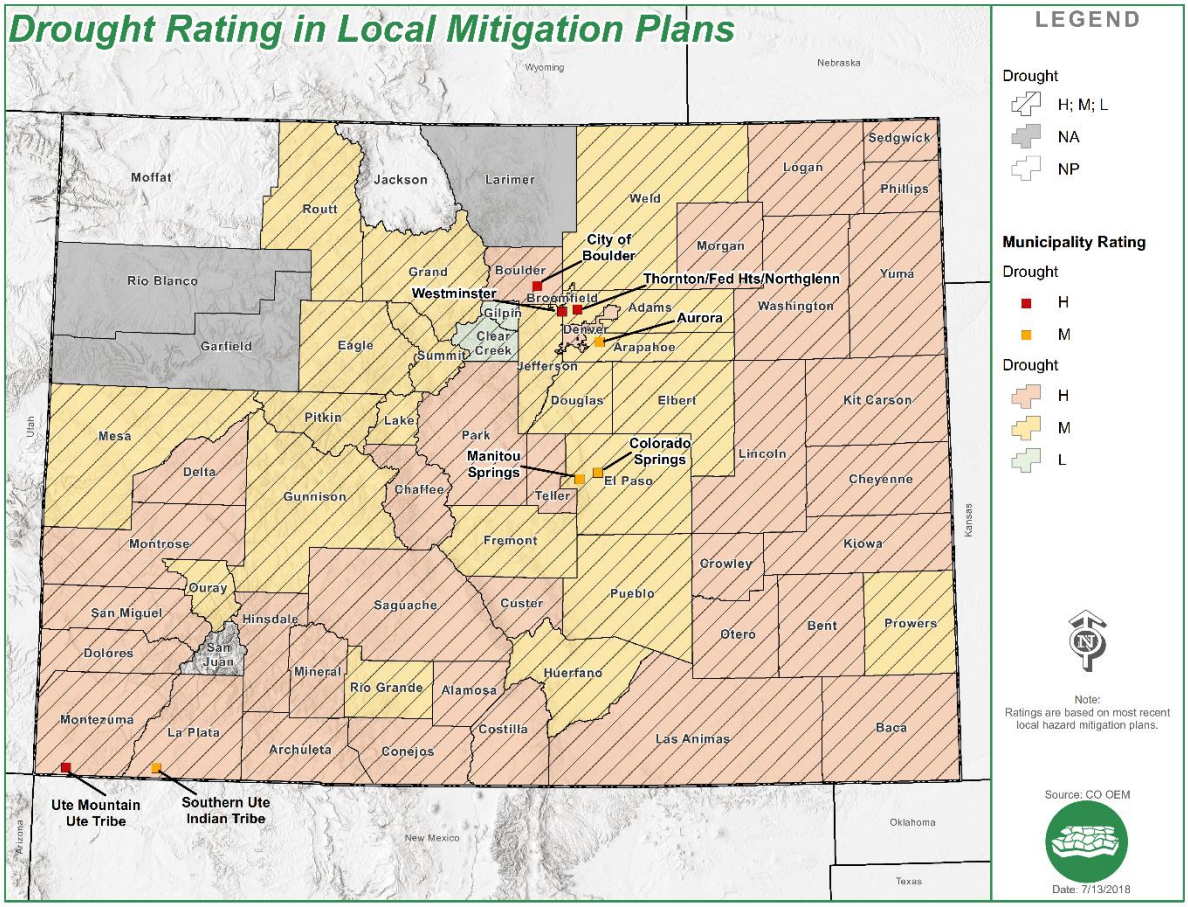
vulnerable in this sector. The highest-ranking counties are: Routt, Pitkin, San Miguel, Summit, Archuleta, Hinsdale, Grand, Weld, Eagle, Montezuma, Custer, Yuma, and Elbert.

In some cases, the counties determined by the vulnerability assessment to have high vulnerability to drought are not as intuitive as others. The limitations and recommendations sections of the Drought Vulnerability Assessment Technical Information report, located in Annex B, include discussion of these instances.

3.3.3 Process Used to Analyze Information from Local Mitigation Plans

As of June 2018, there were three counties (Moffat, Jackson, and San Juan) without Hazard Mitigation Plans, six counties with plans that expired, and 55 counties' plans were approved and active. Figure 20 below highlights how local hazard mitigation plans, including jurisdictional plans (for cities), rate drought in terms of hazard priority. To arrive at these conclusions, the state plans were reviewed to obtain insight as to how individual jurisdictions view their vulnerability to drought.

Figure 20 Ranking of Drought as a Hazard in Local Mitigation Plans in Colorado



The results in Table 10 suggest that counties consider drought a high priority hazard for planning purposes, given the fact they include it in their plans. Not all the 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 drought vulnerability methodology so county-level plans can be easily compared. The statewide methodology presented in this Plan (using risk and vulnerability metrics for the various sectors of the economy)could be adapted and improved upon at the local level for improvement of local hazard mitigation plans. More information on local plan assessment as related to losses is available in Section 3.5.2

3.3.4 Changes in Development Patterns

As part of the Plan revision process, changes in growth and development were examined in the context of drought vulnerability. Changes in growth and development naturally affect loss estimates and vulnerability, and when the population in a 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 agencies and assuming loss to communal property may exceed the resources of the declining population.

Growth and development are primarily noted in the Socioeconomic and M&I Sector analyses in Annex B, although population growth and decline will cause impacts from drought to manifest with more or less severity across the board. Population growth was factored into socioeconomic vulnerability by designating the fastest growing counties as most vulnerable to drought impacts. Drought can severely challenge a public water supplier through depletion of the raw water supply and greatly increased customer water demand; and any impacts to municipal providers can be exacerbated by increased water demands brought about by a growing population. If a county or city is growing rapidly, the entity may have difficulties securing new sources of water while maintaining a comfortable margin of storage in case of drought. In general, counties experiencing higher growth are also likely to experience increased competition over existing water supplies.

Table 8 summarizes county population and growth rates, and Figure 21 displays the data in map form, illustrated with gray circles to show growth percentages, while shading represents projected growth rates. Projections are from 2010 to 2030. Counties with already large populations and high projected growth include Broomfield and Weld Counties. Other counties with significant growth rates include Elbert and San Miguel. These counties are expected to have correspondingly higher vulnerability to drought as it impacts the M&I and Socioeconomic Sectors (see the M&I and Socioeconomic Sector analyses in Annex B for more discussion). Counties such as Moffat, Jackson, Las Animas, and Kit Carson (among others) are projected to decrease in population anywhere from 0.71% to 0.01%.

Table 8 Projected Growth in Colorado by County, 2010-2030

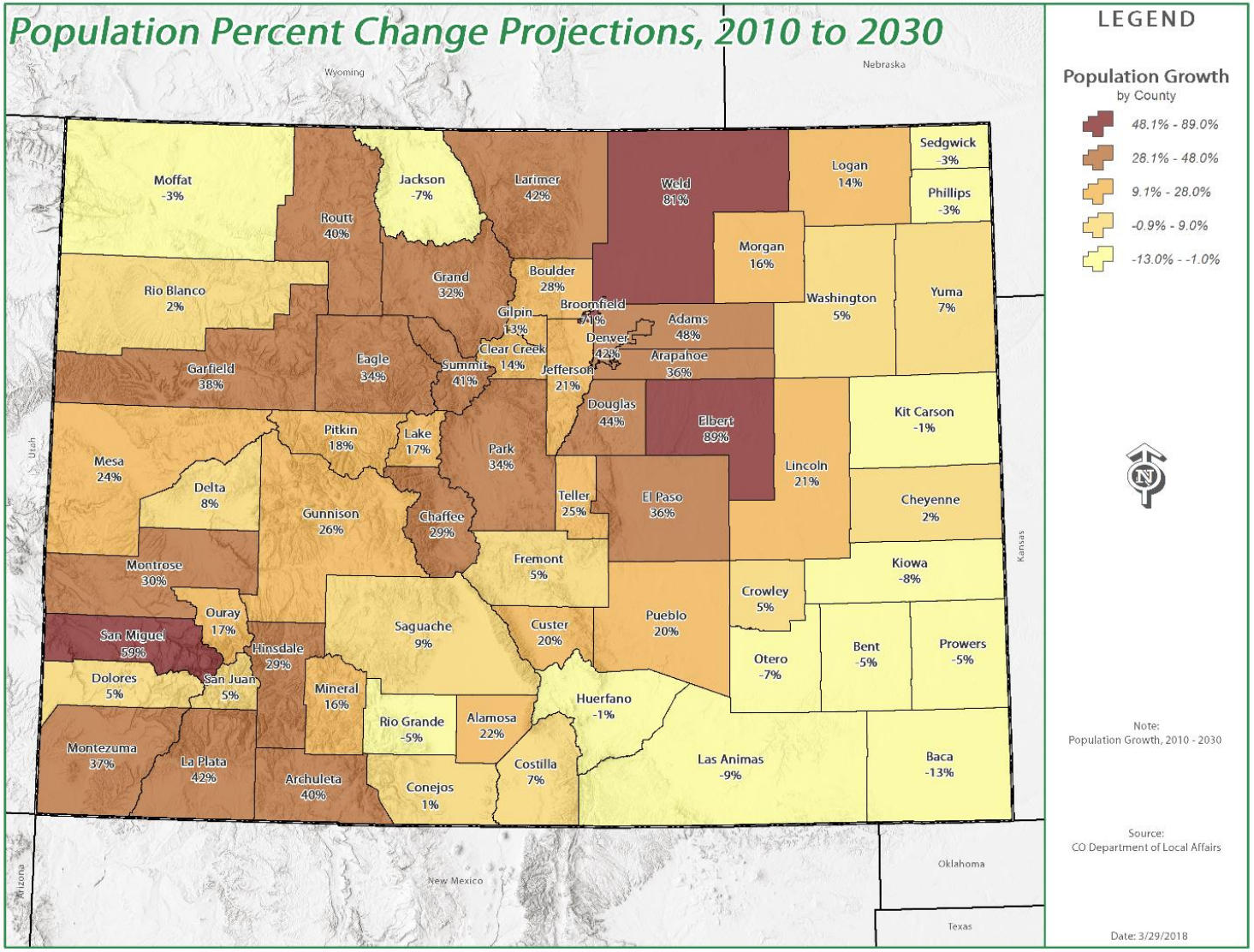
Counties	Census 2010 Population	Projected 2030 Population	Change Percent	Average Annual Percent Change	Growth Rate
COLORADO	5,049,935	6,892,192	20.26%	0.85%	0.01%
Adams	443,709	658,865	48.49%	2.00%	2.00%
Alamosa	15,454	18,894	22.26%	1.01%	1.01%
Arapahoe	574,808	779,283	35.57%	1.53%	1.53%
Archuleta	12,082	16,942	40.22%	1.70%	1.70%
Baca	3,765	3,262	-13.36%	-0.71%	-0.71%
Bent	6,523	6,206	-4.86%	-0.25%	-0.25%
Boulder	295,610	377,107	27.57%	1.22%	1.22%
Broomfield	56,098	96,097	71.30%	2.73%	2.73%
Chaffee	17,835	23,040	29.19%	1.29%	1.29%
Cheyenne	1,811	1,848	2.06%	0.10%	0.10%
Clear Creek	9,083	10,319	13.60%	0.64%	0.64%
Conejos	8,293	8,374	0.97%	0.05%	0.05%
Costilla	3,549	3,795	6.94%	0.34%	0.34%
Crowley	5,850	6,128	4.75%	0.23%	0.23%
Custer	4,248	5,079	19.57%	0.90%	0.90%
Delta	30,897	33,417	8.16%	0.39%	0.39%
Denver	604,875	861,706	42.46%	1.79%	1.79%
Dolores	2,084	2,191	5.15%	0.25%	0.25%
Douglas	287,119	413,162	43.90%	1.84%	1.84%
Eagle	52,064	69,748	33.97%	1.47%	1.47%
El Paso	627,238	855,170	36.34%	1.56%	1.56%
Elbert	23,140	43,695	88.83%	3.23%	3.23%
Fremont	46,856	49,354	5.33%	0.26%	0.26%

Counties	Census 2010 Population	Projected 2030 Population	Change Percent	Average Annual Percent Change	Growth Rate
Garfield	56,153	77,404	37.85%	1.62%	1.62%
Gilpin	5,461	6,178	13.13%	0.62%	0.62%
Grand	14,790	19,487	31.76%	1.39%	1.39%
Gunnison	15,314	19,282	25.91%	1.16%	1.16%
Hinsdale	825	1,067	29.32%	1.29%	1.29%
Huerfano	6,639	6,560	-1.19%	-0.06%	-0.06%
Jackson	1,417	1,316	-7.10%	-0.37%	-0.37%
Jefferson	535,648	647,959	20.97%	0.96%	0.96%
Kiowa	1,410	1,298	-7.98%	-0.41%	-0.41%
Kit Carson	8,259	8,169	-1.09%	-0.05%	-0.05%
La Plata	51,443	73,266	42.42%	1.78%	1.78%
Lake	7,288	8,536	17.12%	0.79%	0.79%
Larimer	300,545	426,293	41.84%	1.76%	1.76%
Las Animas	15,383	13,937	-9.40%	-0.49%	-0.49%
Lincoln	5,502	6,673	21.28%	0.97%	0.97%
Logan	22,291	25,438	14.12%	0.66%	0.66%
Mesa	146,587	181,209	23.62%	1.07%	1.07%
Mineral	728	846	16.22%	0.75%	0.75%
Moffat	13,812	13,389	-3.06%	-0.16%	-0.16%
Montezuma	25,515	35,043	37.34%	1.60%	1.60%
Montrose	41,179	53,355	29.57%	1.30%	1.30%
Morgan	28,213	32,631	15.66%	0.73%	0.73%
Otero	18,875	17,566	-6.94%	-0.36%	-0.36%
Ouray	4,471	5,210	16.54%	0.77%	0.77%
Park	16,277	21,834	34.14%	1.48%	1.48%
Phillips	4,467	4,336	-2.93%	-0.15%	-0.15%

Counties	Census 2010 Population	Projected 2030 Population	Change Percent	Average Annual Percent Change	Growth Rate
Pitkin	17,147	20,218	17.91%	0.83%	0.83%
Prowers	12,527	11,865	-5.28%	-0.27%	-0.27%
Pueblo	159,464	191,163	19.88%	0.91%	0.91%
Rio Blanco	6,634	6,763	1.95%	0.10%	0.10%
Rio Grande	12,018	11,440	-4.81%	-0.25%	-0.25%
Routt	23,451	32,916	40.36%	1.71%	1.71%
Saguache	6,101	6,672	9.35%	0.45%	0.45%
San Juan	713	746	4.62%	0.23%	0.23%
San Miguel	7,393	11,742	58.83%	2.34%	2.34%
Sedgwick	2,403	2,340	-2.64%	-0.13%	-0.13%
Summit	28,078	39,540	40.82%	1.73%	1.73%
Teller	23,402	29,228	24.90%	1.12%	1.12%
Washington	4,851	5,104	5.22%	0.25%	0.25%
Weld	254,240	459,772	80.84%	3.01%	3.01%
Yuma	10,030	10,721	6.89%	0.33%	0.33%

Source: Colorado Department of Local Affairs, March 2018; U.S. Census, 2010

Figure 21 Projected Population Growth by County, 2010-2030



Source: Colorado Hazard Mitigation Plan 2018

3.4 Assessing Vulnerability of State Facilities

Vulnerability to state facilities and other assets from drought varies depending on the asset. For state-owned or operated facilities (e.g., buildings, dams, ditches) the primary vulnerability is to catastrophic loss due to wildfires that can be made more severe by drought conditions. These facilities can be damaged due to prolonged droughts. For example, a building can be in an area with mandatory municipal watering restrictions, and as a consequence landscaping can be damaged or lost, incurring costs to the State. Dams and ditches, which are built to hold water, can become weakened if left dry for extended periods of time. The at-risk critical assets and their impacts are shown in Table 9, revised from the 2018 Updates to the Colorado Drought Mitigation and Response Plan.

Table 9 Critical Assets at Risk to Drought

State Assets at Risk	Key Impacts
State owned or operated buildings	Increased exposure to wildfires, increased wear and tear on building exterior and HVAC systems due to degraded air quality, and water shortages due to out-of-priority rights or restrictions imposed by municipality, landscaping loss.
Critical infrastructure	Decreased water levels in dams can cause structural damage, dry ditches can be damaged by animal holes and general exposure, and increased vegetative growth and high sediment loading resulting from low reservoir levels or wildfire debris can damage structures. Drought causes extensive damages to state rights of way through accumulation of dust and dirt on right of way fences and stormwater diversion utilities.
State Land Board	Decreased forage and crop yields on leased lands, negative impacts to lands if lessees do not appropriately adjust grazing allowances, and decreased mining activity if water is not available for production.
State Parks and CPW	Low reservoir and stream levels can deter visitors and prevent water-based recreation, park closures and campfire restrictions can result from severe wildfires, negative media portrayal is possible, and visitation decline results in lower operating budget. Revenue from licenses, water activities, tourism, park visitation, biological loss – State Forest and park land trees – dead trees, beetle activity, wildfires, impacts to tourism and recreation sectors.
Aquatic habitat	Impacts to flow levels, water quality, habitats, and fish populations, including increased management requirements and protection programs.
Instream flow rights	Junior rights associated with instream flows mean that adequate water flow may not be secured in the expected way, leading to possible economic and biological losses.

These at-risk state assets were reviewed and incorporated into the state assets assessment (the results of which are summarized in Section 3.3.2).

The following sections describe the types of facilities included in this assessment and present an overview of estimated monetary losses, where available.

3.4.1 Types of State Owned/Operated Facilities

For the vulnerability assessment of state assets, the sector was divided into the following sub-sectors: state infrastructure (buildings and dams), Land Board revenue (including state-owned lands), state-based recreation, aquatic species and habitat, and protected areas. Drought vulnerable critical infrastructure includes dams, transmountain ditches, and irrigation ditches. Instream flow rights are non-consumptive "in-channel" or "in-lake" water rights that can only be held by the Colorado Water Conservation Board, and were used as metrics to calculate vulnerable aquatic species and habitat as well as protected state-owned and operated areas. These instream flow rights designate minimum flows between specific points on a stream, or water levels for natural lakes.

The primary agencies responsible for drought-vulnerable state assets are the State Land Board, CWCB, and the CPW. Table 10 lists some key impacts to sub-sectors (based on their associated metrics and features) that were identified during the literature review and interview portion of the vulnerability assessment, in addition to those listed in Table 10.

Table 10 State Assets Key Impacts

State Assets Sub-sector	Key Impacts
State-owned or operated buildings	Increased exposure to wildfires, increased wear and tear on building exterior and HVAC systems due to degraded air quality, and water shortages due to out-of-priority rights or restrictions imposed by municipality, landscaping loss.
Critical infrastructure	Decreased water levels in dams can cause structural damage, dry ditches can be damaged by animal holes and increased vegetative growth and high sediment loading resulting from low reservoir levels. Wildfire debris can damage structures as well. Drought causes extensive damages to state rights of way through accumulation of dust and dirt on right of way fences and stormwater diversion utilities.
State Land Board	Decreased forage and crop yields on leased lands, negative impacts to lands if lessees do not appropriately adjust grazing allowances, and decreased mining activity if water is not available for production or cooling processes.
State Parks	Low reservoir and stream levels can deter visitors and prevent water-based recreation, park closures and campfire restrictions can result from severe wildfires, negative media portrayal is possible, and visitation decline results in lower operating budget. Increased costs of wildlife population management may occur as well, given degradation of habitats and environmental resources.
Aquatic habitat	Impacts to flow levels, water quality, and fish populations which are tied to increased management requirements.
Instream flow rights	Junior rights associated with instream flows mean that adequate water flow may not be maintained, resulting in environmental damages.

3.5 Estimating Potential Losses by Jurisdiction

Many state assets are conservation areas or protected wildlife that cannot be adequately evaluated based on the revenue they generate. Colorado is renowned for its wilderness areas and outdoor recreation activities, and the value of these areas goes far beyond any revenue stream. Still, economic consideration is important because the revenues generated by state assets help to maintain protected areas. The following sections offer discussion on infrastructure values, land values, and revenue streams for the state agencies such as those listed above.

3.5.1 Overview and Analysis of Potential Losses

A list of state-owned buildings and structures was provided by the Colorado Risk Management Office in 2017. This list is fairly comprehensive but may not be a complete inventory of state buildings (e.g., university campuses are not reflected in the list and there are individual counties that maintain their own lists of local assets, which may be more comprehensive than the statewide dataset). Critical infrastructure data (limited to dams for the quantitative analysis) were originally obtained from the Homeland Security Infrastructure Program (HSIP) Freedom database, which in turn used information from the National Inventory of Dams from 2015. Storage and volume data was not available for the 2018 Plan update, and as such was pulled from the previous version of the vulnerability assessment published in 2013. Table 11 summarizes building values and dam storage volumes by county, along with the vulnerability ranking (1 through 4, where 1 is the lowest vulnerability and 4 is the highest vulnerability) for the overall "structures" category. The vulnerability ranking is a weighted average of spatial inventory and vulnerability metrics – the spatial inventory establishes the relative presence of the drought-vulnerable item or sub-sector (in the case of structures, the items are buildings and dams), and the vulnerability metrics establish relative impacts to drought (for structures, the metrics are relative importance of dams over buildings as well as ratings on the wildfire susceptibility index). The result of combining these into a weighted average based on spatial density is the overall vulnerability ranking. See Annex B for a thorough explanation of the vulnerability ranking methodology.

In Table 11, counties that are ranked highly have a considerable amount of storage in state-owned or operated dams, and their buildings may be within a moderate or high wildfire threat area. In addition, building and structure values may quite high, indicating a large number of state-owned and managed structures that may be difficult to manage and maintain given drought conditions. The next step to improving this loss estimate would be to expand the database to include not just dams, but other state-owned water conveyances like ditches and channels. Instead of storage volume, the cost to repair or replace these assets would be another source of information that could be used to estimate potential costs due to drought impacts, as it would more fittingly describe actual impacts to those structures.

Table 11 Building Values, Dam Storage, and Vulnerability to Structures, by County

County	State-owned or Operated Building/Structure Value	State-owned Dam Storage Volume (Acre Feet)	Structures (buildings and dams) Vulnerability Ranking
Adams	$ 2,161,277,205	0	2
Alamosa	$ 361,142,477	0	1.7
Arapahoe	$ 539,093,243	85	2
Archuleta	$ 12,576,016	2,149	3.3
Baca	$ 1,559,394	75,241	3
Bent	$ 116,882,346	0	2
Boulder	$ 3,184,873,780	0	2
Broomfield	$ 7,925,505	0	1.7
Chaffee	$ 135,641,024	0	2
Cheyenne	$ 712,471	0	2.6
Clear Creek	$ 117,846,309	0	1.7
Conejos	$ 6,598,804	14,965	3
Costilla	$ 4,179,436	0	2
Crowley	$ 99,475,999	0	1.7
Custer	$ 1,130,093	0	2
Delta	$ 39,890,611	1,333	2.3
Denver	$ 2,631,589,251	0	1.7
Dolores	$ 4,252,292	0	2.3
Douglas	$ 41,437,868	0	2.3
Eagle	$ 22,080,216	576	3.3
El Paso	$ 664,445,003	0	2
Elbert	$ 6,135,198	0	1.7
Fremont	$ 762,885,781	0	2.3
Garfield	$ 935,656,625	4,826	2.6
Gilpin	$ 10,009,237	0	1.7
Grand	$ 12,702,273	220	2
Gunnison	$ 297,472,631	2,137	2.3
Hinsdale	$ 1,605,114	12,829	2.4
Huerfano	$ 35,640,305	2,760	2.6
Jackson	$ 13,799,847	8,822	2.4
Jefferson	$ 1,220,747,271	0	2.3
Kiowa	$ 1,308,651	0	1.7
Kit Carson	$ 4,146,764	1,360	3
La Plata	$ 459,565,270	526	2.3

County	State-owned or Operated Building/Structure Value	State-owned Dam Storage Volume (Acre Feet)	Structures (buildings and dams) Vulnerability Ranking
Lake	$ 2,881,105	0	1.7
Larimer	$ 2,520,380,928	3,039	3
Las Animas	$ 152,450,903	0	2.6
Lincoln	$ 115,435,436	345	2
Logan	$ 321,168,915	950	2.3
Mesa	$ 571,483,874	3,580	3.3
Mineral	$ 30,302,497	3,199	1.7
Moffat	$ 15,349,887	115	2.6
Montezuma	$ 26,250,958	0	2.6
Montrose	$ 19,168,190	0	2.6
Morgan	$ 67,190,695	0	2.3
Otero	$ 79,711,659	0	2
Ouray	$ 8,684,297	0	2
Park	$ 17,071,984	1,963	3
Phillips	$ 196,989	106	2.4
Pitkin	$ 712,334	0	2
Prowers	$ 73,450,933	0	2
Pueblo	$ 1,100,717,918	77	2.3
Rio Blanco	$ 63,910,055	9,038	3.3
Rio Grande	$ 134,839,207	5,158	2.3
Routt	$ 19,636,863	29,249	3.3
Saguache	$ 5,188,187	880	3
San Juan	$ 4,603,609	131	1.7
San Miguel	$ 6,959,485	7,081	3
Sedgwick	$ 1,827,494	63	2.4
Summit	$ 210,520,143	0	1.7
Teller	$ 9,932,427	2,066	2.7
Washington	$ 4,317,255	0	2.3
Weld	$ 723,621,026	192	2.6
Yuma	$ 14,101,084	143	2

Source: Risk Management Office, 2017. Dam Storage Volumes from 2013 Plan

The State Assets sub-sector analysis includes a thorough discussion of the ranking process, but in general the factors of vulnerability for structures were "relative importance of storage" and "wildfire threat ranking." Structure rankings ranged from 1.7 to 3.3, which is a relatively small range. A higher ranking resulted from a high relative importance of water storage and location within the wildfire urban interface.

The State Land Board is another other sub-sector within state assets where a dollar-value for the revenue stream was available. The State Land Board generates revenue by leasing land for agricultural and industrial activities. They also lease mineral and mining rights, and a significant portion of their income is produced by mineral royalties. Table 12 shows the leasing revenue by source for fiscal years 2014-2017. Although agricultural leases account for most of the land leases, they do not generate as much revenue as the mineral, oil, gas, and coal royalties.

Table 12 State Land Board Gross Revenue, FY 2014-2017

Revenue Source	FY 2014	FY 2015	FY 2016	FY 2017
Minerals including oil and gas, coal, copper, gravel, uranium, and other minerals	$ 155,207,000	$ 167,152,000	$ 108,382,000	$ 95,158,000
Surface including rental payments for grazing, cropland, rights-of-way, recreation, surface use agreements, timber sales, and ecosystem services	$ 13,367,000	$ 15,759,000	$ 18,158,000	$ 17,243,000
Commercial including rental payments from office buildings, ground leases, communication towers, and renewable energy	$ 4,815,000	$ 3,797,000	$ 4,462,000	$ 5,303,000
Revenue from Land Sales not reinvested in new properties	$ 0	$ 3,751,000	$ 5,303,000	$ 1,355,000
Interest income	$ 215,000	$ 896,000	$ 972,000	$ 343,000
TOTAL	**$ 173,604,000**	**$ 191,355,000**	**$ 137,277,000**	**$ 119,402,000**

Source: Office of the State Auditor analysis of the State Land Board's Fiscal Year 2016 Income and Inventory Report, and Fiscal Year 2017 data provided by the State Land Board.

Drought impacts to this revenue stream are mainly incurred through agricultural leases. Based on past conversations with State Land Board representatives, the mineral asset revenue is relatively drought tolerant; while it is likely that mineral producers would incur extra operating costs in a drought, it has not been the experience of the State Land Board that producing companies actually stop operations or postpone expansions. However, most mining activities do require water, and it is possible that, in a severe drought, mining operations would be unable to purchase the water they need for production. For a greater discussion and more information, refer to the Energy Sector analysis which discussing mining and power generation. Given the importance of mining revenue to the State Land Board, this possibility should be taken seriously in any future planning efforts.

While the mineral leases bring in the most revenue every year, the most vulnerable State Land Board revenue stream is actually the agricultural lease revenue. Under drought conditions, rangeland carrying capacity can be significantly reduced, leading to overgrazing concerns and financial hardship for the agricultural lessees. Similarly, crop yields on agricultural leases may be reduced and/or crop failure may occur. Agricultural leases through the State Land Board are issued on a 10-year basis, which makes it difficult for farmers and ranchers to change the amount of leased area in response to drought. However, the State Land Board has a vested interest in the responsible stewardship of the land, and in the past, they have been willing to offer lease discounts during drought in exchange for a reduction in grazing or other detrimental activity. In the 2002 drought, the State Land Board issued blanket lease discounts (between 10% and 40%) in an attempt to reduce grazing activity. The total cost of these discounts was estimated by State Land Board staff to be $1.9 million. These discounts did not have the intended mitigating impact because many lessees continued to manage the land as usual, however. As of the 2010 Plan Update, the State Land Board was planning on only offering lease discounts during future drought when applied for on a case-by-case basis (personal communication with State Land Board, 2010). However, the lease discount program was discontinued in 2012 (personal communication with State Land Board, 2013), and remains that way as of the 2018 Plan update.

Other potential losses to state departments include reductions in visitation to state parks and fewer hunting and fishing license sales. Both visitation and license sales are important revenue streams for CPW. Data are available showing a decrease in visitation to Colorado state parks during the 2002 and 2011-2013 drought events, but no revenue loss figures are available. Similarly, losses are expected to occur to CPW during future drought, but no exact figures outside of visitation totals were obtainable for this assessment. To give a sense of the relative importance of licensing revenue to CPW, in fiscal year 2002-2003, licensing accounted for $60.6 million out of the $87 million revenue stream, and in fiscal year 2003-2004 it accounted for $67.4 million out of the $100.3 million revenue stream. As of the 2018 Plan update, CPW attributed $114 million out of $212.4 million in revenue to licenses, passes, fees, and permits for the 2015-2016 fiscal year, (CPW Fact Sheet, 2017).

One way to estimate potential losses due to drought is to look at previously-reported losses and existing economic exposure of state assets. Table 13, taken from the 2007 Drought Update Report and updated with current sources, summarizes losses from recent droughts, and tabulates economic exposure of at-risk state assets.

Table 13 Potential Drought Losses Based on Historic Economic Impacts

Potential Economic Impacts to State Facilities	Where Potential Losses and Effects Could be Exhibited	State Economic Exposure and/or Past Drought Impacts
Costs and losses to agricultural and livestock producers	State lands leased for crops to crop producers for farming and livestock producers for grazing Grazing, recreation, and forestry uses of Colorado State Forests	Accounting for the last eight years, the State Land Board has generated $12-19 million annually in revenues from leases and royalties in land leased for ranching/grazing, farming, and recreation alone (not counting mineral leases or commercial building leases). However, for past drought years, these revenues have been shown to decrease when compared with non-drought years (e.g., Fiscal Year 2011-2012 vs. FY 2013-2014) (Colorado State Land Board Commissioners, 2014). While it is difficult to attribute all revenue differences directly to drought, it is expected that it may be a part of the reason revenues are reduced during dry years.
Loss from fishery production	State-owned fish propagation and restoration facilities Fishing license sales Fish in streams throughout state (since all wildlife is "owned" by the State) Angler visitation and spending	CPW estimates that fishing activities and angler-based spending contributed 1.9 billion to the Colorado economy, both directly and indirectly, for the 2015-2016 fiscal year. CPW operates 15 fish propagation facilities, including the Roaring Judy Hatchery for the propagation of endangered Colorado River fish, which may be affected in times of drought due to reduced revenues and/or water resources. In 2002, fishing license sales declined by about 15% from 2001, and there was a 13.4% decline in fishing recreation days from 2001 to 2002. Salmon runs were impacted by the 2012 (latest) major drought in Colorado (The Journal, 2012). The drought prevented the annual run due to low water levels in the Dolores River, which created a shallow, delta-like area of sediment that blocked the salmon from migrating. Kokanee eggs placed on the Dolores River by CPW to bolster the adult fish stocks in the McPhee Reservoir were not able to reach upstream spawning waters.
Losses to wildlife	Hunting license sales Wildlife throughout the State Management costs	CPW estimates that hunting (big and small game) generated $292.6 million in direct visitor expenditures for the 2011-2012 fiscal year. This revenue helped support over 900 full time CPW employees. While CPW license sales have generally increased over time, reductions in total sales were apparent during the 2012 and 2013 years (CPW 2015). A possible/partial explanation of the decrease in sales could be drought conditions and negative public perception of the health of State Parks, natural resources, and wildlife. The number of full time CPW employees has reduced slightly since 2011-2012, down to 886, likely due to changes in spending and budgets.

Potential Economic Impacts to State Facilities	Where Potential Losses and Effects Could be Exhibited	State Economic Exposure and/or Past Drought Impacts
Costs and losses to state parks	Revenues Damage to parks themselves	For the 2015-2016 fiscal year, Colorado's state parks had over 13.6 million visitors. Visitors to Colorado state parks contribute over $6 billion annually to local economies, directly and indirectly. Back in 2002, state parks experienced a 3% decline in visitation.
Losses due to hydrological effects	State-owned instream flows	CWCB has appropriated instream flow water rights on over 1,800 stream segments covering 10,332 miles of streams (as of 2018). Instream flow impacts during the 2002 drought were mitigated somewhat by downstream senior water rights calls. While acquisition of instream flows can benefit state-owned environmental assets, extensive junior rights can prove limiting in times of water scarcity and drought.

Source: 2007 Drought Update Report, CPW 2018. Statistics modified in 2010, 2013, and 2018

Instream flow rights are considered assets, as they have a real value on the water rights market. This market is highly variable and not well-documented; therefore, tabulating the 2018 value of CWCB water rights would be impractical from a logistical as well as value-added perspective. In future droughts it might be beneficial to track the value of instream flow rights to assess whether they gain or lose, and to collect data on additional expenditures by the CWCB to maintain a minimum flow to protect aquatic habitat during droughts.

In 2002 CPW learned that instream flows were not as adversely affected as precipitation conditions would have initially indicated, since low water supplies during the extreme drought resulted in a shift in typical water right administration and water use patterns. In 2002, there were significantly fewer and less depletions from junior water rights and the calling senior water rights were farther downstream thus having the effect of pulling water downstream through the watershed; the junior intervening instream flow water right became the unintended beneficiary of this pattern of water right administration. As a result, a number of higher order streams (e.g., first, second, and third order streams) experienced water levels greater than or equal to what is typically experienced under normal water supply conditions. Further, the 2002 drought experience highlighted the need for CPW and CWCB to increase their cooperative efforts regarding management of the now CPW's (previously DOW) water right portfolio, in particular the use of reservoirs and storage water rights, to examine the feasibility of releasing water to protect instream flows, releasing water to water uses downstream (CPW uses and other downstream uses) with the intervening instream flow reach becoming the incidental beneficiary of such practices.

Another asset heavily impacted by drought is crop yield, and the overall agricultural sector. Table 14 below shows agricultural indemnities from 2007-2017 due to drought in Colorado, by county. The data were obtained from the USDA Risk Management Agency and filtered for losses incurred specifically by drought. 2012 and 2013 had significantly higher totals for reported crop indemnities, which reflects the drought conditions across the state. Crop indemnities are just one

dataset that can be used to estimate potential losses for drought. While not specific to state assets, agricultural losses have the potential to significantly impact a local economy, which in turn can reduce the tax base and cause decreased government revenue.

Based on the information in this table, the total crop indemnity amount for all counties between 2007 and 2017 was over $550 million. This equates to an average annual drought related crop indemnities amount of $55 million. The top five counties with the highest losses (in order) are: Baca, Kiowa, Kit Carson, Cheyenne, and Washington.

Table 14 USDA Risk Management Agency Crop Indemnities Specific to Drought, 2007-2017

County	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	County TOTAL
Adams	$503,968	$3,529,313	$723,133	$216,685	$2,822,833	$2,776,135	$4,950,549	-	$20,521	$96,626	$1,318,466	**$16,958,229**
Alamosa	-	-	-	-	-	-	-	-	$30,308	-	-	**$30,308**
Arapahoe	$54,239	$1,496,292	$181,481	$54,077	$2,298,024	$1,872,548	$2,422,782	-	-	$32,232	$725,539	**$9,137,214**
Archuleta	-	-	-	-	-	-	-	-	-	-	-	**-**
Baca	$1,602,454	$17,696,922	$1,946,464	$248,581	$17,460,089	$7,689,184	$21,931,245	$10,993,442	$4,928,643	$310,225	$1,618,215	**$86,402,143**
Bent	$18,441	$202,878	$163,296	$17,674	$493,466	$109,815	$751,393	$526,064	$5,632	-	$153,547	**$2,442,205**
Boulder	$13,071	$1,786			$16,471	$4,326	$7,153	-	-	-	$10,963	**$53,770**
Broomfield	$2,208	$18,372		$787	$24,892	$16,066	$76,064	-	-	-	$36,710	**$175,099**
Chaffee	-	-	-	-	-	-	-	-	-	-	-	**-**
Cheyenne	$945,174	$7,888,562	$391,249	$119,675	$2,395,809	$11,290,463	$28,919,862	$8,142,640	$274,611	$383,953	$562,893	**$61,314,891**
Clear Creek	-	-	-	-	-	-	-	-	-	-	-	**-**
Conejos	-	-	-	-	-	-	-	-	-	-	-	**-**
Costilla	-	-	-	-	-	-	-	-	-	-	-	**-**
Crowley	$118,973	$214,221	$67,932	$3,276	$204,969		$4,468	$36,943			-	**$531,809**
Custer	-	-	-	-	-	-	-	-	-	-	-	**-**
Delta	-	-	-	-	$3,142	-	-	-	-	-	-	**$3,142**
Denver	$27,306	$189,666	$41,523	$26,221		$59,569	$57,310			$9,798	$98,059	**$509,452**
Dolores	$67,400	$15,013	$67,790	$33,919	$5,922	$192,791	$82,047	$21,238			$17,876	**$503,996**
Douglas	-	-	-	-	-	-	-	-	-	-	-	**-**
Eagle	-	-	-	-	-	-	-	-	-	-	-	**-**
El Paso	-	-	-	-	-	$50,355		$9,864	-	-	$7,099	**$67,318**
Elbert	$113,246	$1,372,410	$115,260	$81,346	$2,326,928	$2,350,947	$2,072,778	$226,923	$12,337	$77,341	$710,145	**$9,459,660**
Fremont	-	-	-	-	-	-	-	-	-	-	-	-
Garfield	-	-	-	-	-	-	-	-	-	-	-	-
Gilpin	-	-	-	-	-	-	-	-	-	-	-	-
Grand	-	-	-	-	-	-	-	-	-	-	-	-

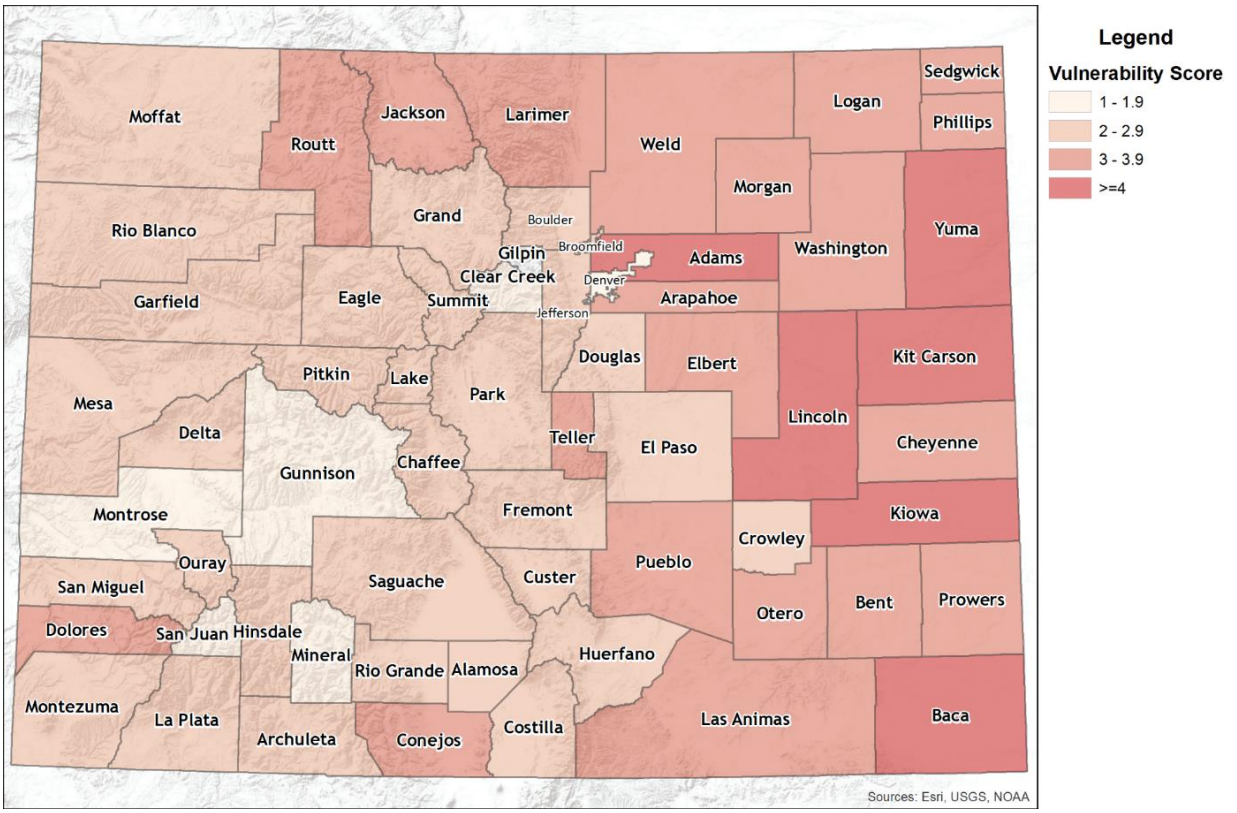
County	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	County TOTAL
Gunnison	-	-	-	-	-	-	-	-	-	-	-	-
Hinsdale	-	-	-	-	-	-	-	-	-	-	-	-
Huerfano	-	-	-	-	-	-	-	-	-	-	-	-
Jackson	-	-	-	-	-	-	-	-	-	-	-	-
Jefferson	-	-	-	-	-	-	-	-	-	-	-	-
Kiowa	$450,211	$8,735,942	$837,016	$126,083	$9,335,514	$16,631,494	$30,445,877	$12,296,815	$746,976	$2,029,718	$1,054,803	**$82,489,782**
Kit Carson	$1,406,962	$6,076,579	$69,240	$2,695	$1,866,837	$21,161,405	$32,921,685	$3,512,724	$250,178	$395,990	$1,235,393	**$68,891,579**
La Plata	$6,786	$9,818	$14,588	$18,022	$1,647	$22,805	$67,106	$15,593	$9,977	-	$8,421	**$174,763**
Lake	-	-	-	-	-	-	-	-	-	-	-	**-**
Larimer	$1,714	$11,427	$985	-	$28,009	$8,547	$29,609	-	-	-	$39,168	**$119,459**
Las Animas	-	$6,915	$1,735	-	$76,936	$26,720	$148,832	$109,033	-	-	-	**$370,171**
Lincoln	$691,723	$5,261,296	$546,405	$274,032	$8,500,933	$8,956,940	$11,121,007	$2,107,321	$350,073	$752,501	$2,184,995	**$40,747,226**
Logan	$672,616	$2,417,382	$142,449	$92,284	$229,547	$4,561,402	$3,728,355	$80,864	$66,477	$190,096	$400,923	**$12,582,394**
Mesa	-	-	-	-	-	-	-	-	-	-	-	**-**
Mineral	-	-	-	-	-	-	-	-	-	-	-	**-**
Moffat	$8,774	$22,357				$29,242	$128,960		-		-	**$180,559**
Montezuma	$8,951	$10,124	$15,359	$5,511	$5,752	$43,392	$107,168	$23,283	-	$975	$2,536	**$223,051**
Montrose	-	-	-	-	-	-	-	-	-	-	-	**-**
Morgan	$405,099	$1,434,712	$174,484	$95,986	$1,049,247	$1,548,373	$1,783,875	$8,776	$2,295	$3,278	$109,206	**$6,615,331**
Otero	-	-	-	-	-	$82,966	$253,712	-	-	-	-	**$336,678**
Ouray	-	-	-	-	-	-	-	-	-	-	-	**-**
Park	-	-	-	-	-	-	-	-	-	-	-	**-**
Phillips	$36,084	$979,974	$26,757	$40,301	$791,502	$11,306,964	$10,503,838	$108,453	$420,016	$9,515	$705,628	**$24,929,032**
Pitkin	-	-	-	-	-	-	-	-	-	-	-	**-**
Prowers	$199,326	$5,312,907	$713,272	$139,912	$4,986,312	$3,517,762	$13,950,541	$5,748,753	$1,517,310	$237,729	$1,041,479	**$37,365,303**
Pueblo	$199,391	$286,625	$113,814	$197,635	$171,389	$356,115	$347,435	$159,955		$111,737	-	**$1,744,705**
Rio Blanco	-	-	-	-	-	-	-	-	-	-	-	**-**

County	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	County TOTAL
Rio Grande	-	-	-	-	-	-	-	-	-	-	-	**-**
Routt	$842	$7,745	-	-	-	-	$98,049	-	-	-	$15,857	**$122,493**
Saguache	-	-	-	-	-	-	-	-	-	-	-	**-**
San Juan	-	-	-	-	-	-	-	-	-	-	-	**-**
San Miguel	-	$115	$4,525	-	-	$11,731	$4,179	$933	-	-	$795	**$22,278**
Sedgwick	$39,910	$62,239	$11,142	$4,016	$406,816	$4,840,233	$4,274,744	$207,761	$99,196	$77,522	$244,593	**$10,268,172**
Summit	-	-	-	-	-	-	-	-	-	-	-	**-**
Teller	-	-	-	-	-	-	-	-	-	-	-	**-**
Washington	$838,876	$4,800,648	$290,037	$369,834	$1,960,595	$15,668,509	$18,883,305	$164,320	$146,984	$233,258	$2,696,826	**$46,053,192**
Weld	$718,172	$1,598,584	$189,415	$130,387	$1,134,111	$1,202,956	$2,310,333	$37,348	$13,486	$42,085	$932,084	**$8,308,961**
Yuma	$92,118	$929,365	$51,824	$26,117	$436,494	$6,358,688	$10,640,207	$1,038,989	$836,638	$115,138	$585,177	**$21,110,755**
GRAND TOTAL	**$9,244,035**	**$70,590,189**	**$6,901,175**	**$2,325,056**	**$59,034,186**	**$122,748,443**	**$203,024,468**	**$45,578,035**	**$9,731,658**	**$5,109,717**	**$16,517,396**	**$550,245,120**

Source: USDA RMA Reports

Crop indemnities due to drought were one factor in the vulnerability assessment for the Agricultural Sector. Other factors taken into consideration were head of cattle, dryland crop acreage, and livestock indemnities. Figure 22 shows the results of the agriculture vulnerability assessment. See Annex B for a complete discussion of this assessment and the agriculture sector.

Figure 22 Agriculture Sector Overall Vulnerability Ranking



Source: Vulnerability Assessment Tool, 2018 Update

3.5.2 Potential Losses Based on Estimates in Local Risk Assessments

Most county and jurisdictional mitigation plans across Colorado have rated drought as a high significance hazard, as portrayed in Figure 20 of this document, with the rest of those who address the hazard rating it as medium. Only Garfield, Larimer, and Rio Blanco do not include drought in their local plans, while San Juan, Jackson, and Moffat have not rated the hazard due to a lack of a mitigation plan. The cities of Boulder, Thornton/Federal Heights/Northglenn and Westminster as well as the Ute Mountain Ute Tribe have all rated drought as a highly impactful hazard, while Aurora, Colorado Springs, Manitou Springs, and the Southern Ute Indian Tribe rate it as a medium hazard. Drought is considered the top hazard in fifteen communities in the state, then, with areas of El Paso County having the most potential quantified losses from this hazard, followed by the counties of Eagle, Grand, Fremont, La Plata, and areas of unincorporated land in Montrose.

While local hazard mitigation plans often contained information on losses due to drought (e.g., drought rankings, as described under Section 3.3.3), total loss estimations based on crop damages

for those plans that include drought in the top four highest risk hazards was not standard across the board and did not always include losses in a clearly defined way. What becomes clear from reviewing the drought sections of existing local hazard mitigation plans is that not many counties or jurisdictions have quantifiable data available on economic losses due to drought, or on potential losses based on various standard scenarios (e.g., reported damages from prolonged dry conditions); if losses from drought are indeed available, the information is not easy to review alongside other plans. A recommendation moving forward is to begin quantifying economic losses due to drought on a county level, and in a more comparable and standard manner across the state (such as how USDA's RMA losses are presented under Table 14 of this document). Standardizing losses can better highlight areas and/or economic sectors particularly hard-hit, and can help communities anticipate the magnitude of damages that could potential occur in future drought events.

3.5.3 Impacts on Losses from Changes in Development

Drought losses to State Assets, M&I, and the Socioeconomic Sectors in particular are expected to intensify with population growth and development, unless mitigation strategies are adopted. Figure 20 shows projected population growth rates by county and identifies the fastest-growing and potentially most-vulnerable counties. Counties with the highest estimated growth rates from 2010-2030 (according to state demographer estimates) include Weld, Elbert, and San Miguel Counties. The impacts listed in Table 14 above could become more severe in communities with a high rate of development and growth. A more in-depth discussion on growth rates and population change related vulnerabilities is included under Section 3.3.4 Changes in Development Patterns.

3.5.4 Estimating Potential Losses of State Facilities

It is difficult, if not impossible, to put a dollar value on potential losses to state-owned and operated facilities due to drought. The nature of this hazard is that it is slow-moving, long-lasting, and the exact start and end is not always clearly defined. Drought itself does not cause much damage to state facilities; rather, it is usually secondary hazards such as additional maintenance necessary, that arise because of drought and hence have the potential to cause catastrophic losses.

Because data were either not available or non-existent, dollar losses to state assets due to drought by county were not calculated. Instead, drought vulnerability of the state assets was quantified by identifying data that relates to previously-reported impacts. A full discussion of this approach is provided in Annex B, but general results as they relate to this Plan are provided below.

The figures that follow show the overall impact scores and spatial density metrics for the five State Assets sub-sectors. The shading on the maps represents the impact scores/vulnerability rankings, and the size of the gray circle indicates the size of the sub-sector (inventory metric) in a given county.

The state owns structures in every county. As shown in Figure 23, vulnerability for these structures tends to reflect the wildfire threat and dam related data. Highly rated counties are at the

intersection of areas of greatest wildfire threat and locations where the state owns the most dams (e.g., Rio Blanco, Routt, Mesa counties, among others).

Figure 23 State Assets – Structures Inventory and Impact Scores

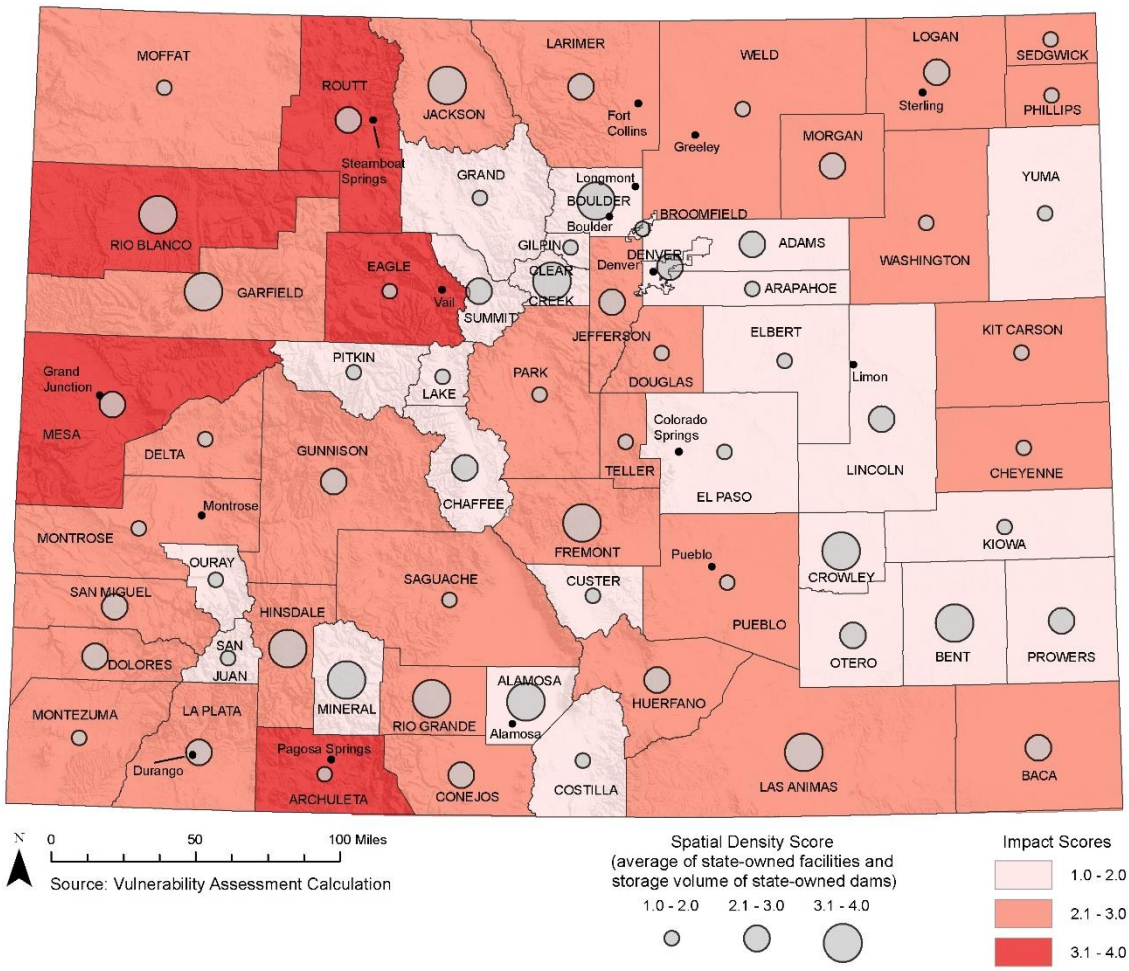


Figure updated in 2018

Vulnerability rankings for the State Land Board are partially dependent on the lease discounts issued in 2002, which although discontinued in present days, can provide context about the effects of drought on leases for agricultural purposes. Figure 24 shows that the eastern half of the state as a whole is more vulnerable than the west, based on again on the lease discounts program which took effect during the major drought of 2002. This is largely due to the significant agricultural presence on the eastern plains (refer to the Agricultural Sector analysis for more information) and because the eastern part of the state received the highest lease discounts of around 40%. Furthermore, many of the counties with high impact scores in eastern Colorado also fall in the largest category for surface ownership by the State Land Board. As discussed previously, the lease discount program was not continued for 2012, so this vulnerability metric could not be updated. Nevertheless, the spatial density metric indicating surface acres owned by the State Land Board, was updated for 2018.

Figure 24 State Assets – Land Board Inventory and Impact Scores

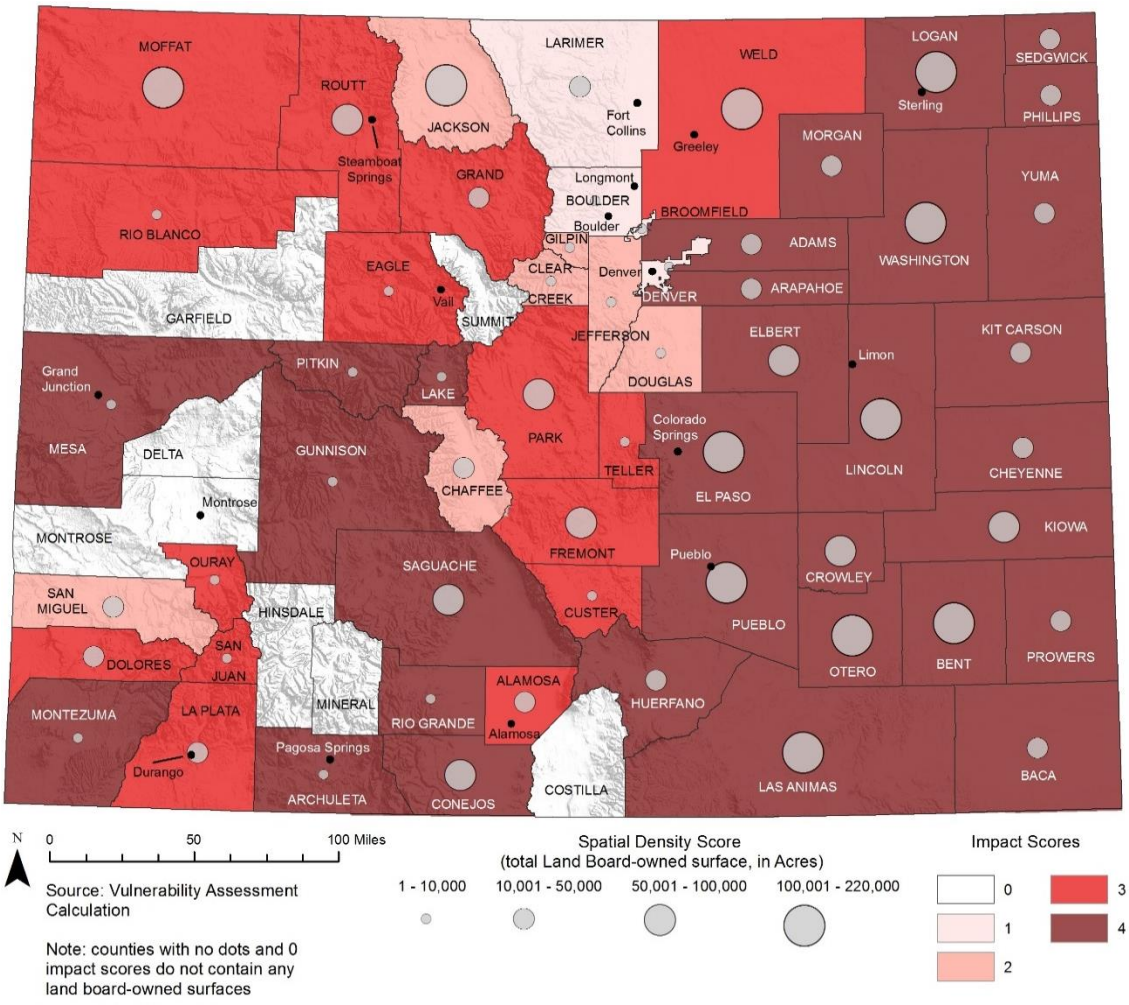


Figure updated in 2018

Figure 25 shows the vulnerability of recreation-based state revenue. Spatial vulnerability of State Parks revenue is highly dependent on the location of water-based state parks, since these tend to see the highest visitation numbers and thus generate the most revenue for the department. Counties located in eastern Colorado with high vulnerability ratings all have state parks with water-based activities, which would be at risk of suffering from revenue income were a drought event to occur.

Figure 25 State Assets – State Parks Recreation Inventory and Impact Scores

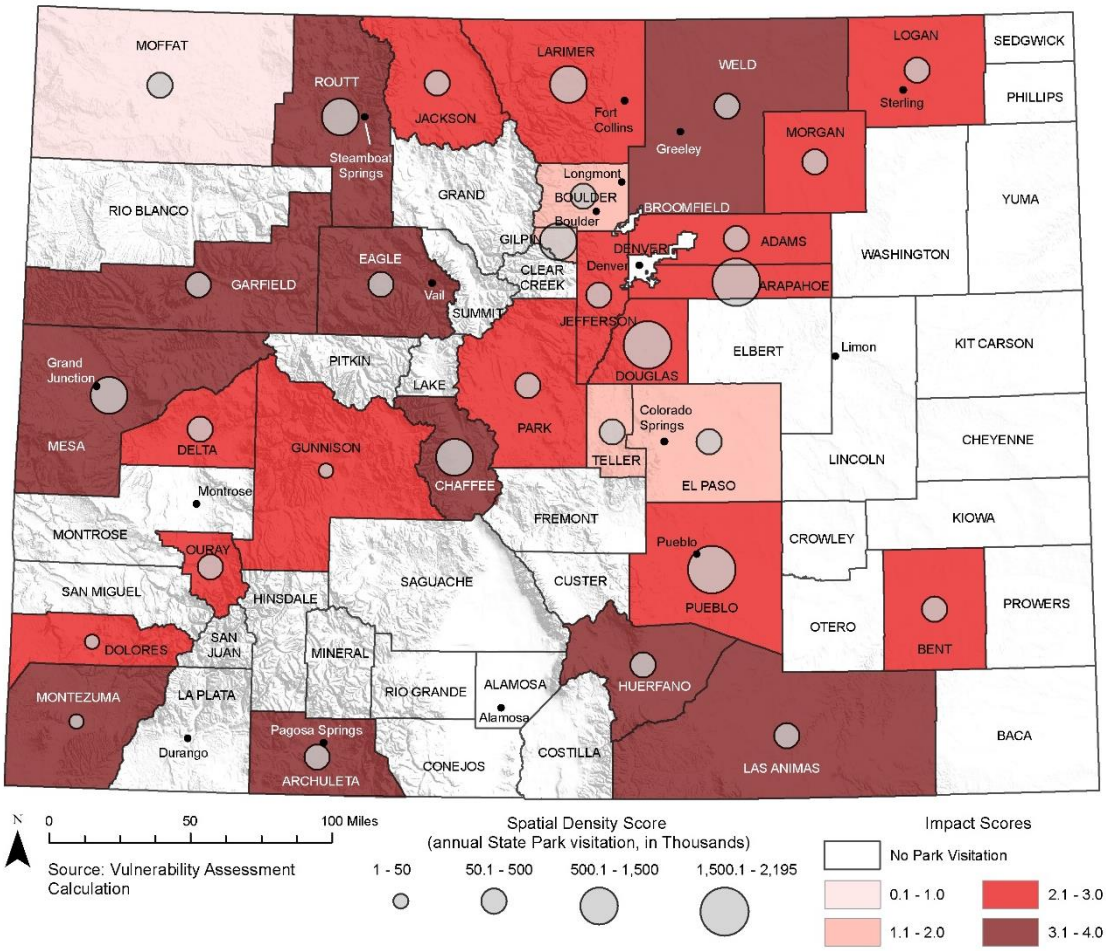


Figure updated in 2018

The final State Asset considered in terms of vulnerability to drought is state-owned aquatic habitat, as defined by instream flows and fish hatcheries. These assets are managed by the CWCB and CPW, respectively. Specific locations of instream flow reaches and fish hatcheries are depicted in Figure 26, as well as maps in Annex B, in the State Assets Sector analysis. Counties with the highest impact scores have the most junior priority dates for their instream flow rights. The spatial density category for the aquatic habitat sub-sector is a count of instream flow reaches and fish hatcheries. El Paso, Mesa, Alamosa, and Pueblo are among those counties with higher vulnerability scores (dark red/brown shading), while Larimer, Garfield, and San Miguel, for example, display higher spatial density rankings (based on the grey dot sizes).

Figure 26 State Assets – State Owned Aquatic Habitat Inventory and Impact Scores

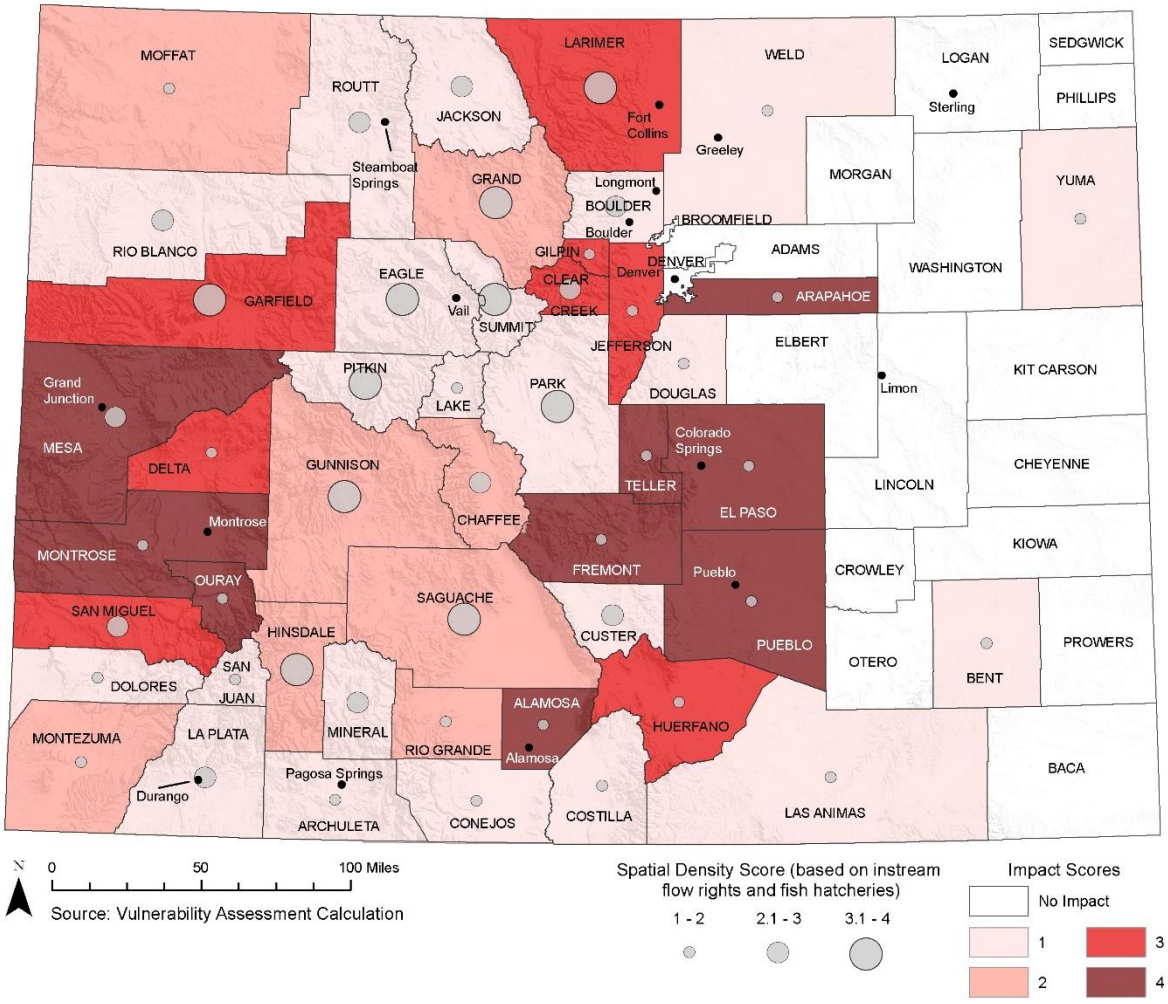


Figure updated in 2018

Taken as a whole, state assets overlap considerably with other sectors considered in this Plan. Work done by the State Parks and CPW helps preserve Colorado's natural environment and promotes public use of outdoor areas. Tourism in Colorado is strengthened by protected areas that are owned and managed by the State. Drought impacts to these assets directly translate to declines in recreation, tourism, and related industries. Furthermore, decreased revenues for state agencies resulting from drought can reduce management budgets, which can have a detrimental impact on lands and wildlife. In 2002, state and local governments received $550 million in tax revenue from the tourism industry alone (State of Colorado Water Availability Task Force, 2002). For 2015, that number jumps to over $1.13 billion in state and local tax revenue (The Denver Post, 2016). Clearly, the Environment and Recreation/Tourism Sectors are important to the State. A large portion of the protected areas in the State are government (largely federal) managed, owned or operated, and degradation of natural areas can have compounded effects on society.

Table 14 showed building values per county and indicated the presence of state-owned dams (critical infrastructure). In some counties, the worst-case scenario for building and infrastructure losses would occur in a severe and wide-reaching wildfire, which could arise as a result of hot and dry conditions during a drought. CPW has experienced direct impacts as a consequence of drought-related wildfires in the past. The Hayman fire of June 2002 resulted in increased runoff from the burn areas and a corresponding increase in sediment load and deposition into the South Platte River, via direct input and inflow from its tributary channels. Both Horse Creek and Wigwam Creek tributaries experienced direct loss of instream habitat. Similar degradation was produced in the Poudre River Drainage as a result of the 2012 High Park Fire. Increased sedimentation in the streambed negatively impacted macro-invertebrate (fish food) production and trout spawning habitat.

In addition to the vulnerability information summarized here, recommendations for "adaptive capacities" that could mitigate impacts to the various sectors have been developed. These suggested recommendations are captured in Annex B and organized by impact sector. This annex can serve the State as well as local governments, citizens, businesses and industry as a useful reference for mitigation strategies to be considered in the future. Mitigation action strategies that the State is currently involved with are discussed in the following section.

4 MITIGATION STRATEGY

4.1 Hazard Mitigation Goals

This chapter focuses on the State's 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 Mitigation Goals

This section describes the goals of the Drought Mitigation Plan and the process used to identify and update the goals over the history of the Plan. The State has revised the framework of its mitigation strategy to improve its ability to track progress in meeting Plan goals and to improve alignment with local mitigation strategies (e.g., goals and actions). The framework of the State's drought mitigation strategy has two parts: goals and actions, which are defined as follows:

- The goals are broad based and described the overall direction that the State will take to reduce drought impacts.
- The actions describe the activities or projects used to support the accomplishment of the goals.

The following eight goals of the Colorado Drought Mitigation and Response Plan are listed below, in no particular order or priority. Each goal is related to the mitigation actions in Table 19 below.

1. Improve Water Availability Monitoring and Drought Impact Assessment
2. Increase Public Awareness and Education
3. Work collaboratively with water rights holders to voluntarily augment water supply through mechanisms to transfer to areas of shortage during droughts.
4. Coordinate and Provide Technical Assistance for State, Local, and Watershed Planning Efforts
5. Reduce Water Demand/Encourage Conservation
6. Reduce Drought Impacts to Colorado's Economy, People, State Assets, and Environment
7. Continue to develop Intergovernmental and Interagency Stakeholder Coordination
8. Evaluate Potential Impacts from Climate Change

4.1.2 Reassessment of Goals for Validity or Need for Revision

For the 2018 revision to this Plan the DMRPC also re-evaluated the goals in a planning workshop. The group decided that the number and intent of the goals should remain the same, but that Goal 3 be re-worded. Goal 3 changed from "Enhance mechanisms to provide water supplies to areas of shortage during droughts" to "Work collaboratively with water rights holders to voluntarily

augment water supply through mechanisms to transfer to areas of shortage during droughts." The group felt that this change better reflected the nature of the action items related to that goal. The DMRPC also determined Goal 7 should be updated to be "Continue to development intergovernmental and Interagency Stakeholder Coordination."

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

2018 Colorado Hazard Mitigation Plan Goals

1. Minimize the loss of life and personal injuries from all-hazard events
2. Reduce losses and damages to federal, state, local government and private assets and support similar local efforts
3. Reduce 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
9. Incorporate equity considerations into all mitigation strategies
10. Support improved coordination of risk mitigation between and among the public, private, and non-profit sectors
11. Create awareness and demand for mitigation as a standard of practice

4.2 State Drought Mitigation Capability Assessment

4.2.1 Introduction

The state mitigation strategy must include a discussion of the State's pre- and post-disaster hazard management policies, programs, and capabilities to mitigate the hazards in the area, including an evaluation of state laws, regulations, policies, and programs related to drought mitigation as well as to development in drought-prone areas, and a discussion of state funding capabilities for hazard mitigation projects.

A mitigation capability assessment update was conducted as part of the 2018 Plan process. This entailed a review of the Colorado Revised Statutes, rules, regulations, and policy that contribute directly or indirectly to reducing drought losses. The process included incorporating Appendix A of the 2002 Drought Plan, which listed both state and federal drought assistance and related programs, and incorporating a summary of statutory programs related to drought from the 2007 Update report and the 2018 SHMP Update. During this process, the applicable Colorado Revised Statutes were compiled into a master excel spreadsheet and categorized by impact sector for a better synopsis of the strengths as well as any gaps or weaknesses of the State's existing drought mitigation capabilities across all impact sectors.

The spreadsheet identifies the name of the statute, the statute number and the date enacted, what state agency it affects, a definition of the statute, whether the statute was created for pre- or post-drought conditions, and whether it supports, facilitates, or needs improvement relative to reducing drought or water supply availability impacts. The spreadsheet has become a convenient reference document and has served as a tool to guide decisions through the Plan revision process; the results of this effort are captured in Appendix C Drought Mitigation Capability Summary. The 2018 update solicited input on changes or updates to these capabilities from multiple State and Federal agencies. The agencies had an opportunity to review the 2013 drought plan materials and provide updates on capabilities, mitigation and funding opportunities.

4.2.2 Pre-disaster Hazard Management Policies, Programs, Capabilities

State laws and regulations that provide authority to various agencies for pre-disaster programs are included in the existing State Hazard Mitigation Plan. Programs and the authorizing statutes that are specific to pre-drought disaster situations are identified in Appendix C Drought Mitigation Capability Summary (indicated by an 'x' in the pre- or post- disaster columns). In several cases the capabilities are both pre- and post-disaster. An example of this is the State's drought response capabilities, which can help mitigate losses through early warning and effective post disaster response. This capability has been further refined in 2010 and 2013 and captured in Annex A Drought Response Plan. The State's Water Availability Task Force, a major component of the response plan and the early warning mechanism, has been active for almost 40 years. Highlights of a few of these capabilities are summarized here:

CWCB

The Colorado Water Conservation Board's Office of Water Conservation and Drought Planning (OWCDP) promotes water use efficiency while providing public information and technical and financial assistance for water conservation planning. The OWCDP also promotes drought planning by encouraging and assisting communities to prepare and implement drought mitigation plans and by monitoring drought impacts and informing the public, media, and state officials. The office is a subset of the broader Water Supply Planning Section. The Office exists to perform the following:

- Maintain a clearinghouse of water conservation and drought information and disseminates information to the public
- Provide technical assistance and evaluate and approve water conservation and drought mitigation plans
- Provide financial assistance for water conservation planning, water efficiency, drought mitigation planning and implementation, and public education and outreach through one grant program
- Provide leadership through the Water Availability Task Force to monitor, forecast, mitigate, and prepare for drought
- Coordinate with multiple state and local agencies to provide public information

State Land Board

The State Land Board manages more than three million acres of land and four million acres of mineral rights that generate revenue for public education and other state institutions. The State Land Board maintains seven District Offices that follow drought and other disaster problems in their districts. The offices have the ability to handle any issues on State agricultural leases on a case-by-case basis at the request of State lessees, which has been found to be more effective than any broader action taken in anticipation of drought

DOLA

In March 2016, DOLA, DLG launched *Planning for Hazards: Land Use Solutions for Colorado* (www.planningforhazards.com), an online guide and interactive website resource that enables counties and municipalities to prepare for and mitigate multiple hazards through the integration of resilience and hazard mitigation principles into plans and codes related to land use and the built environment. This guide provides detailed, Colorado-specific information about how to assess a community's risk level to hazards and how to implement numerous land use planning tools and strategies for reducing a community's risk. The *Planning for Hazards* guide was developed with help from outside consultants and an Advisory Committee of local, state, federal governments and university representatives.

DOLA held workshops in 2002, 2003, 2004, and 2018 to raise awareness of drought impacts such as water quality impacts, state and federal resources, water rights administration, emergency management principles, the State's plan and response to drought, weather modification programs, funding options, and regulatory perspectives. These workshops will continue to be held again on an as-needed basis.

4.2.3 Post-disaster Hazard Management Policies, Programs, Capabilities

Programs and the authorizing statutes that are specific to post-drought disaster situations are identified in Appendix C Drought Mitigation Capability Summary (indicated by an 'x' in the pre- or post-disaster columns). The State's Division of Homeland Security & Emergency Management coordinates all of the post-disaster management activities and has led to Colorado becoming one of twenty-two states certified by the Emergency Management Accreditation Program in 2009. To maintain accreditation, the State needs to meet certain requirements in all mitigation and response planning efforts.

Highlights of these capabilities are summarized here:

State Land Board

The Board approved the 2013/2014 drought plan for state lands in March of 2013. It gives the authority to District Managers to make the decisions regarding drought management on state lands. The District Managers have the authority to make immediate cuts in carrying capacity,

rental adjustments and refunds in response to requests by lessees. They frequently make adjustments even without a request if they determine it is appropriate.

Such cuts can result in reductions in the carrying capacity for cattle, which in turn can reduce the land rent since rent is based on carrying capacity. Lessees have been advised to contact the District Office if they have already reduced their numbers of cattle or will be reducing their numbers. In areas of severe to exceptional drought the District Manager may make a mandatory reduction in carrying capacity. The Board has authorized a reduction to zero if necessary to protect the long-term productivity of the land.

Reductions also require the implementation of a monitoring plan which must be approved by the District Manager. This program is ongoing to ensure grazing will not be increased until the land is in an appropriate condition to sustain livestock. Lessees will be required to sign a rider to their lease outlining the provisions for managing the drought and the penalties for non-compliance. There will be some funding available to assist with establishing the monitoring plan, for weed and pest control and to improve watering facilities to help better utilize vegetation.

CPW

CPW personnel who are responsible for the day-to-day operation, management, and use of CPW-owned and/or managed water shall endeavor to see that no waste, misuse, or inappropriate use of those water rights is occurring. On May 1, 2007 the Director of CPW (Division of Wildlife at the time) signed Administrative Directive A-9 which is a department wide policy to inform CPW personnel and others of potential drought impacts on CPW's water resources and specific actions needed to manage these drought impacts. The Administrative Directive was updated and replaced by Administrative Directive P-3, which was approved on June 20th, 2018 by the CPW Director. During drought periods changes related to management of CPW water resources may be necessary to ensure compliance with relevant statutes as well as the Colorado's Drought Mitigation and Response Plan. Pursuant to Colorado Revised Statutes, Section 37-88-109 (2), C.R.S., 2017 (County Control of Reservoirs) CPW could be required to release water from CPW-owned and/or managed water resources stored in reservoirs for municipal and domestic purposes during drought. There may also be times and situations where CPW may be requested to bypass some of its senior irrigation rights to make water available for municipal and domestic uses. Any agreement to release or bypass CPW-owned or managed water for domestic or municipal purposes shall be submitted to and approved by the Colorado Parks and Wildlife Commission. In situations where "time is of the essence" the Director of the Colorado Parks and Wildlife department has the authority to act on behalf of the Colorado Parks and Wildlife Commission.

Also, since CPW receives federal fish and wildlife funds the eligibility rules regarding receipt of these federal funds place certain obligations on the management of CPW's properties, including water rights purchased with federal funds or wildlife cash. Prior to any release of CPW water from reservoirs or bypass of any direct flow water for domestic purposes, the State Attorney General's Office shall be contacted regarding federal aid obligations. Further, CPW has developed a detailed

list of criteria to be followed for addressing requests for use of CPW-owned and/or managed water resources under drought circumstances.

Impacts to wildlife, wildlife habitat and to CPW's water resources can be addressed as drought conditions arise. Impacts could include release of water from CPW-owned and/or managed reservoirs for domestic and municipal purposes, or for protection of aquatic and wildlife habitats. Priorities for use of CPW-owned and/or controlled water or water rights during drought conditions will be to protect and conserve, to the extent possible and on a statewide basis, have been identified.

CPW now has an invasive species coordinator. CPW anticipates that during future droughts, increased efforts will be needed to monitor for the presence and spread of aquatic nuisance weed species such as Eurasian aquatic milfoil.

CDPHE WQCC

In 2007, the Colorado Department of Public Health and Environment Water Quality Control Commission (CDPHE WQCC) adopted revised water-quality standards for temperature for protection of aquatic life. The standards include an acute standard (a two-hour daily maximum) for protection from lethal effects of elevated temperature and a chronic standard (i.e., a maximum weekly average temperature) for protection against sublethal effects on behavior, metabolism, growth, and reproduction. The standards also include seasonal adjustment for protection of spawning, and they include a narrative requiring that temperature maintain a normal pattern of daily and seasonal fluctuations and spatial diversity with no abrupt changes. These standards were implemented in the Upper and Lower Colorado basins in 2008 and in the South Platte Basin in 2009. The standards will be implemented in the San Juan, Dolores, and Gunnison Basins in 2012 and in the Rio Grande and Arkansas Basins in 2013.

Colorado's revised water-quality standards for temperature did not exist during the 2002 drought. Now a low-flow exclusion allows for temperature exceedances when the daily streamflow falls below an acute critical low flow or when the monthly average streamflow falls below a chronic critical low flow. This exclusion makes it unlikely that exceedances of the temperature standards during extreme drought would result in an impairment listing on the CDPHE WQCC 303(d) List. Regardless, the basis of Colorado's temperature standards in species-specific physiological tolerances to elevated temperature suggests that the standards will provide a useful benchmark against which to evaluate whether elevated temperatures resulting from drought conditions are likely to contribute to deleterious effects on fish communities. As real-time data capture becomes more economically viable as an option for temperature monitoring, it may become possible to explore real-time water-management alternatives to avoid lethal or chronic effects of elevated temperature during drought conditions. The implementation of the temperature standards has also prompted an increase in temperature monitoring, which will likely facilitate better evaluation of the influence of drought-associated flows and elevated temperature on fisheries during future drought conditions.

DOLA

As a result of the 2012-2013 federally-declared disasters in Colorado, funding through CDBG-Disaster Recovery grant programs (Resilience Planning, Watershed Resilience, and Housing) were made available and administered through DOLA. The funding through these grants have allowed the State to help local communities implement mitigation actions better preparing the State should another disaster of this magnitude occur in the future.

4.2.4 State Policies Related to Development in Drought Prone Areas

All communities in the State are at risk of drought. Although state policies exist related to development in hazard prone areas such as areas at risk of wildfire and flooding, policies related to development in drought-prone areas do not appear to be practical. Few Colorado statutes explicitly integrate land use planning with water planning. Several tools are in place to encourage and permit integration of planning but are voluntary. Legislation passed in 2008-09 requires developers to ensure sustainable water supplies with new development. Further, state statutes support and permit intergovernmental cooperative agreements on water, planning, and service issues; although coordination and sharing of information between local governments and water suppliers is largely voluntary. Several goals and objectives in the 2018 Colorado State Hazard Mitigation Plan relate to increasing the capacity to collaborate with different sectors and levels of government. For example, the Goal: "Support improved coordination of risk mitigation between and among the public, private and non-profit sectors" has several objectives listed under it related to increased collaborations including, "Strengthen continuity of operations at the federal, state, regional, tribal, and local levels of government to ensure the delivery of essential services" and "Strengthen cross-sector connections across the state government". Given the regional nature of water resources and the impact of local land development and uses on the resource, as water becomes scarcer in Colorado the necessity of collaboration becomes more apparent.

The 2010 document "Colorado Review: Water Management and Land Use Planning Integration" prepared by the Center for Systems Integration on behalf of the CWCB is a compendium of integrated land use planning and water supply planning. The document also reviews the legal context that allows for land use planning, including municipal and county powers, intergovernmental cooperation, and special districts. It also covers state agencies and legislatively created organizations that provide assistance and resources related to land and water planning issues to local and county governments. The document summarizes the key statutes related to land use planning and cross-jurisdictional authorities as well as statutes addressing water conservation, quality, supply, management, and water law that are relevant to integrating land use and water planning. DOLA's "Planning for Hazards: Land Use Solutions for Colorado" is a guide that provides detailed descriptions of range of land use planning mechanisms that counties and municipalities can implement to reduce risk to hazards. The guide profiles drought including how it relates to other hazards and provides available data sources and case studies and gives suggestions on applicable planning tools and strategies related to drought. This guide is

accompanied by workshops and webinars to continue to share information with local governments and collaborate between jurisdictions.

4.2.5 State Funding Capabilities for Drought Hazard Mitigation Projects

The types of state-funded projects available for drought mitigation are included in Appendix C Drought Mitigation Capability Summary and in Section 4.5. Various limited sources exist including disaster emergency funds, water conservation funding, wildlife cash funds, flood and drought response fund, wastewater treatment plant and drinking water treatment plant construction funds. There are also opportunities for existing funding to be appropriated for drought. For example, following the 2013 floods CDPHE created the Natural Disaster Grant to fund projects for the domestic wastewater treatment works or public drinking water systems that were impacted, damaged or destroyed in connection to the 2013 floods. Although this grant is not specific to drought, if funds were appropriated it would have the potential to also be used to fund drought mitigation projects. Funding options are discussed in the 2018 Colorado Hazard Mitigation Plan. This Plan includes information on state matching funds for federal programs the State Disaster Emergency Fund; grant programs of the CWCB, DWR, DHSEM, Natural Resources Conservation Service, and State Forest Service; and education and outreach program funds. The State Hazard Mitigation Plan also discusses the types of federal mitigation grant programs managed by the Mitigation Staff of the Colorado Division of Homeland Security and Emergency Management.

4.2.6 Changes in Hazard Management Capabilities of the State

Colorado became one of twenty-two states certified by the Emergency Management Accreditation Program (EMAP) in 2009. To maintain accreditation, the State needs to meet certain requirements in all mitigation and response planning efforts. This includes the EMAP accredited Natural Hazard Mitigation Plan which was updated in 2013 and 2018 by DHSEM. The response elements of the Colorado Drought Mitigation and Response Plan underwent significant changes to modernize the Plan in 2010. This included aligning the Plan with modern emergency management standards, revisiting the number and composition of the ITFs, updating the drought indicators and associated responses, and streamlining the communication framework of the Plan. The response element became a "stand alone" annex (Annex A) to this mitigation Plan so that the response procedures are condensed for use during drought emergencies.

The State has undergone the following activities to improve its drought management capabilities since 2013.

- In May 2013 Governor Hickenlooper issued Executive Order D 2013-5 directing CWCB to prepare a water plan for Colorado. Colorado's Water Plan, completed in 2015, is a framework to guide future decision making and to address water challenges with a collaborative, balanced, and solutions-oriented approach. The goals of the plan are to meet the water supply gap, defending Colorado's compact entitlements, improving regulatory processes and exploring financial incentives – all while honoring Colorado's water value and ensuring the state's water

resources are protected and available for generations to come. The Water Plan implementation grant funds can be used for long-term water supply efforts. The 2018 Projects Bill (SB18-218) included $7 million to continue the Water Plan Grant program, $1 million of which went to funding the implementation of long-term strategies for conservation, land use and drought planning.

- Colorado's Resiliency Framework developed after the 2013 floods was created 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 executive order from July 2017 that 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.
- DOLA, with help from consultants and an Advisory Committee made up of local, state, and federal government and university representative created the Planning for Hazards guide to help local governments reduce risks to hazards through land use planning strategies. Grant-funded recovery staff positions have built capacity through grants, resource development and training efforts.

Additional, information on the initiatives above and additional progress towards drought mitigation project implementation is presented in Sections 4.4.1 and 4.4.2.

4.3 Local Capability Assessment

Local governments in Colorado have a long history of implementing actions that relate to drought mitigation. A summary of policies, programs, and capabilities local governments have in place is presented in this section.

4.3.1 Local Mitigation Policies, Programs, and Capabilities

Information in this section was gathered by reviewing the existing Local Hazard Mitigation plans in Colorado. A total of 56 local hazard mitigation plans were reviewed (2 multi-county regions, 49 counties, 6 cities and 2 Tribes. A comprehensive review of existing local capabilities followed the collection of these plans. Relevant information was gathered to assess the capability of local governments to handle short- and long-term drought, and is displayed in Table 15. As of May 2018, 61 counties (all but three) and two tribes in Colorado have mitigation plans that are either FEMA approved or approvable pending adoption. These 61 jurisdictions covered by FEMA approved or approvable plans encompass nearly ninety-eight percent of the State's total

population. Local capabilities to handle drought may have changed since the writing of a portion of these plans.

Counties and cities in Colorado use a variety of tools to manage drought. Some of these tools can be found in both Table 15 and Table 16. For purposes of this plan, it is assumed that water efficiency is a component of drought mitigation. During the writing of the 2018 Plan Update there were two local drought plans that have been officially approved by the CWCB and 77 State approved water conservation plans, 45 of which are covered entities. The complete list of entities with state approved water conservation plans are listed in Table 15. This list also includes entities that have drought response and management plans that are officially recorded by the State.[2] Mitigation actions contained in local hazard mitigation plans are contained in Table 19 in Section 4.4.6.

Table 15 Local Mitigation Policies, Programs, and Capabilities

Plan	Policy, Program, or Capability
East Larimer County	Water Conservation Plan
City of Alamosa	Water Conservation Plan
City of Aurora	Drought Response Plan, Water Conservation Plan
City of Boulder	Drought Response Plan, Water Conservation Plan
City of Brighton	Water Conservation Plan
City of Cortez	Water Conservation Plan
City and County of Broomfield	Water Conservation Plan
City of Dacono	Water Conservation Plan
City of Durango	Water Conservation Plan
City of Evans	Water Conservation Plan
City of Fort Morgan	Water Conservation Plan
City of Fort Collins	Water Conservation Plan
City of Fort Lupton	Water Conservation Plan
City of Fountain	Water Conservation Plan
City of Glenwood Springs	Water Conservation Plan
City of Greeley	Water Conservation Plan
City of Lafayette	Water Conservation Plan
City of Lamar	Water Conservation Plan
City of Longmont	Water Conservation Plan
City of Monte Vista	Water Conservation Plan
City of Northglenn	Water Conservation Plan
City of Rifle	Water Conservation Plan

[2] Other M&I water providers have drought mitigation and/or response plans. However, such plans are currently not tracked by the State.

Plan	Policy, Program, or Capability
City of Salida	Water Conservation Plan
City of Sterling	Water Conservation Plan
City of Thornton	Water Conservation Plan
Town of Castle Rock	Water Conservation Plan, Drought Management Plan
Town of Eaton	Water Conservation Plan
Town of Erie	Water Conservation Plan, Drought Management Plan
Town of Firestone	Drought Management Plan, Water Conservation Plan
Town of Frederick	Water Conservation Plan
Town of Superior	Water Conservation Plan
Town of Windsor	Water Conservation Plan
Arapahoe County Water and Wastewater Authority	Water Conservation Plan
City of Arvada	Water Conservation Plan
Castle Pines Metropolitan District	Water Conservation Plan
Castle Pines North Metropolitan District	Water Conservation Plan
Centennial Water and Sanitation District	Water Conservation Plan
Cherokee Metropolitan District	Water Conservation Plan
Colorado Springs Utilities	Water Conservation Plan
Consolidated Mutual Water Company	Water Conservation Plan
Denver Water	Drought Response Plan, Water Conservation Plan
Donala Water and Sanitation District	Water Conservation Plan
Douglas County Regional Plan	Water Conservation Plan
Eagle River Water and Sanitation District	Water Conservation Plan
East Cherry Creek Valley WSD	Water Conservation Plan
East Larimer County Water District	Water Conservation Plan
Ft. Collins-Loveland Water District	Water Conservation Plan
Grand Valley Regional Plan	Water Conservation Plan
Left Hand Water District	Water Conservation Plan
Little Thompson Water District	Water Conservation Plan
Mount Werner Water District	Water Conservation Plan
North Table Mountain Water & Sanitation District	Water Conservation Plan
North Weld County Water District	Water Conservation Plan
Parker Water and Sanitation District	Water Conservation Plan
Pinery Water and Wastewater District	Water Conservation Plan
Platte Canyon Water and Sanitation District	Water Conservation Plan
Pueblo West Metropolitan District	Water Conservation Plan
Security Water and Sanitation District	Water Conservation Plan
St Charles Mesa Water District	Water Conservation Plan
Tri County Water Conservancy District	Water Conservation Plan
Widefield Water & Sanitation District	Water Conservation Plan

Plan	Policy, Program, or Capability
Willows Water District	Water Conservation Plan

Note: Information for this table was provided by the CWCB. Entities recorded in this table as having a state approved Water Conservation Plan have a plan that meets the requirements set forth in the Water Conservation Act of 2004.

4.3.2 Effectiveness of Local Mitigation Policies, Programs, and Capabilities

Chapter 7, "Tools for Managing Drought at a Local Level," of the 2004 DWSA presented the tools available to local communities to prepare for and manage the effects of drought. The chapter includes information on which tools are applicable to long-term mitigation or short-term drought response, and which can be effectively used to achieve different demand/supply outcomes. Table 16 summarizes this information for local scale drought management tools. As can be seen in the table, different tools are effective for different planning horizons and influence management goals. A variety of tools have been identified to facilitate development of effective local planning.

DOLA's "Planning for Hazards: Land Use Solutions for Colorado" is a guide that provides detailed descriptions of range of land use planning mechanisms that counties and municipalities can implement to reduce risk to hazards. The guide profiles drought including how it relates to other hazards and provides available data sources and case studies and gives suggestions on applicable planning tools and strategies related to drought. The suggested planning mechanisms to address drought include: addressing drought in a community's comprehensive plan, using 1041 regulations to protect sensitive areas, and implement subdivision and site design standards that specific to preventing the escalation of the effects of drought. This guide is accompanied by workshops and webinars, often put on in partnership with DHSEM and FEMA, to continue to share information with local governments and collaborate between jurisdictions.

Additionally, as part of a 2004 DWSA survey, respondents identified what they thought were the "best" tools for managing drought. For municipalities, lawn and garden water restrictions were favored (by 41%), followed by public education/involvement programs (34%), fines for excessive water usage (30%), and water conservation programs (13%). Among agricultural users, the most effective controls were water conservation programs (27%), cooperative agreements (13%), and public education programs (7%).

Table 16 Local Scale Drought Management Tools

Tool	Planning Horizon		Management Impact		
	Short-Term Response	Long-Term Mitigation	Reduce Demand	Increase Supply	Other
Public Policy and Assessment					
Prepare and regularly update comprehensive water management plan with drought component		✓			✓
Establish drought response principles, objectives, and priorities		✓	✓	✓	✓
Establish authority for declaring a drought emergency		✓	✓	✓	✓
Develop triggers for drought-related actions (establishing thresholds for mild, medium & severe droughts)		✓	✓	✓	✓
Prepare ordinances on drought measures		✓	✓	✓	✓
Evaluate impacts of drought on different groups, economic segments, and environmental receptors		✓			✓
Emergency Response					
Declare a drought emergency	✓		✓	✓	✓
Establish water hauling programs	✓			✓	✓
Extend boat ramps and docks	✓	✓			✓
Restrict/prohibit new taps	✓		✓		
Identify state and federal assistance	✓	✓			✓
Public Education and Relations					
Prepare position papers for the public, media and elected officials describing public drought policies		✓			✓
Establish a public advisory committee		✓			✓
Organize drought information meetings and workshops for public and media	✓	✓			✓
Create informational materials and establish a drought information center		✓			✓
Water Rights Management					
Review water rights for modifications/flexibility during drought		✓		✓	
Dry year leasing of water rights	✓			✓	
Water banks established for the sale, transfer, and exchange of water	✓			✓	
Interruptible water supply agreements	✓			✓	
Water Supply Augmentation					
Rehabilitate reservoirs to operate at design capacity		✓		✓	
Inventory and review reservoir operation plans		✓		✓	✓
Aquifer storage and recovery; conjunctive use		✓		✓	
Weather modification (cloud seeding)	✓	✓		✓	
New water storage facilities		✓		✓	
Monitoring and Evaluation					
Monitor water supply components (e.g. snow pack, stream flow, etc.)	✓	✓			✓
Monitor water quality	✓	✓			✓
Track public perception and effectiveness of drought measures	✓	✓			✓
Improve accuracy of runoff and water supply forecasts		✓			✓
Water Conservation					
Develop, implement and monitor ongoing water conservation program		✓	✓		✓
Implement, upgrade water metering		✓	✓		
Implement, upgrade water loss control systems		✓	✓		
Water-efficient fixtures and appliances		✓	✓		
Low water use landscapes and efficient irrigation		✓	✓		
Improve commercial and industrial efficiencies		✓	✓		
Educational programs	✓	✓	✓		
Rate structures to influence water use	✓	✓	✓		
Water reuse		✓	✓		
Soil management such as soil-moisture monitoring		✓	✓		
Improved tillage practices		✓	✓		
Use drought or salinity tolerant crops		✓	✓		

Source: 2004 DWSA

In addition to the drought tools in 0 above, the 2010 Municipal Drought Plan Guidance Document provides another comprehensive list of drought tools that Municipal & Industrial (M&I) water providers can use to select and implement to mitigate and respond to drought. The overall effectiveness of these tools will depend on the unique set of drought-related water supply challenges and set of circumstances faced by individual water users. For instance, the rehabilitation of reservoirs to operate at design capacity may be an effective drought tool for a water user that lost significant storage prior to the rehabilitation; while other users may only benefit moderately from reservoir rehabilitation. The nature of drought can also significantly impact the overall effectiveness of a particular management tool.

Water supply reliability planning can play a key role in the preparedness of M&I water providers. For instance, M&I providers with a junior portfolio of water rights that have not effectively incorporated drought planning into their long-term supply efforts will be more vulnerable to drought than those who have more senior water right and/or effective drought plans.

4.4 Mitigation Actions

The state mitigation strategy must identify, evaluate, and prioritize cost effective, environmentally sound, and technically feasible mitigation actions and activities the State is considering, and an explanation of how each activity contributes to the overall mitigation strategy. Local input should also be included when available. Additionally, with each update cycle the Plan must be reviewed and revised to reflect changes in development, progress in statewide mitigation efforts, and changes in priorities. The updated Plan must identify the completed, deleted, or deferred actions or activities from the previously approved Plan. It must also include any new actions identified since the previous Plan. The mitigation actions take into consideration the vulnerability and capability assessment, and are intended to address areas of high vulnerability or where capabilities should be strengthened.

The recommended actions for this Plan were derived from several sources in the planning process over the past 18 years. Mitigation was first incorporated into the Colorado Drought Response Plan with the 2000-2001 update process when the initial recommendations and actions were developed. These actions were reviewed and expanded during the 2007 update cycle, and incorporated some recommendations from the 2004 DWSA report. During the 2013 and 2018 updates the 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. In the 2013 Plan there were 78 action items total; eight new actions from the 2010 Plan. During the 2018 update the actions identified as ‘completed’ have been separated from the ongoing action plan. In the 2018 Plan, there are 53 active action items total; 48 of the actions are continuing from the 2013 Plan; five new actions were identified in 2018 and six were deleted or deferred.

4.4.1 Identification of Actions under State Consideration

Table 17 identifies the actions under consideration by the DMRPC for the State of Colorado in 2018. The following recommendations represent the collaborative efforts of the DMRPC over the years and in 2018. Consistent with the FEMA and EMAP requirements, those actions that have been completed are identified in Table 18. The completed actions show progress made toward the Plan's goals. Each project has an action identification number that connects the action to the primary goal they are 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 and regulations, education, awareness, and outreach, structure and infrastructure projects, funding, data and studies, and technical assistance), the resiliency section (community, economic, health and social, housing, infrastructure, watershed and natural resources), 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. Deleted and deferred actions are discussed in the section that follows the table.

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 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. As part of the 2018 update some of the ongoing or periodically completed actions (e.g. periodic workshops) were moved to low priority.

Table 17 Ongoing State Drought Mitigation Actions

Goal and Action ID	Action	Priority	Responsible Lead Agency or Work Group	Mitigation Type	Additional comments on Status, Implementation, Funding, and Potential Benefits
1.1	Collect climatologic data at mid & lower elevations to fill existing gaps in the data collection network	H	WATF NRCS CCC CoCoRAHS CAIC	Data & Studies	The NRCS has installed one new SNOTEL site at 8920' since 2010, Black Mountain. Three new sites are planned for Colorado, two of which are at low and mid elevations. Additional sites may be installed at a later date if funding is made available. Ongoing based on funding. Action Development Date: 2010
1.2	Demonstrate Gap Filling Radars and Spatial Modeling for Water Supply Forecasts	M	CWCB NOAA NCAR USBR	Data & Studies	A compact compliance DSS tool was developed for the DWR. There was a NOAA mobile radar out winter 2014-15 and winter 2017-18 in Alamosa. There were NASA ASO flights winter 2014-15, 2015-16, and 2016-17. The NOAA radar and NASA ASO data was used to force the national water model to compare the experimental methods with the official water supply forecast methods. Five permanent gap filling snow data are being deployed in the Conejos, permanent weather radar in Alamosa, and continued use of national water model forecasts as value added to the official water supply forecasts from the NWS RFC and NRCS. Action Development Date: 2013
1.3	Funding: stream gage improvements	M	USGS CWCB	Data & Studies	Up to $250k continuously appropriated through the Construction Fund in collaboration with USGS and the State Engineer. Action Development Date: 2002
1.4	Improved Impact Assessment	M	CWCB ITFs	Data & Studies	Impact analysis has always been a weak link. Need multiple impact reporting and data mechanisms & an impact czar. Adapt the tools developed for the 2010 drought vulnerability assessment. DART study suggests a framework for impact collection for recreation and tourism. CSU Drought Agricultural Impact study completed in 2013 to assess impacts from 2011-2012 drought. Working closely with NDMC on their impact assessments. Western Water Assessment doing survey of agricultural impacts in 2018 Action Development Date: 2010
1.5	Improve soil moisture monitoring	M	NRCS CCC NIDIS	Data & Studies	CCC has expanded CoAgMet sites to 20 stations and will continue to expand the CoAgMet network. CCC is calibrating soil moisture sensor data with soil moisture data collected manually. In addition, CoCoRaHS soil moisture information is now on-line. NRCS's Snow Survey program has expanded and continues to expand its soil moisture program in Colorado. CCC has used NRCS SNOTEL data to create products that can be used for drought monitoring. Preliminary analysis by NRCS indicates

Goal and Action ID	Action	Priority	Responsible Lead Agency or Work Group	Mitigation Type	Additional comments on Status, Implementation, Funding, and Potential Benefits
					that soil moisture data will improve skill in stream flow forecasting; further analysis is needed to determine whether soil moisture sensor data will improve operational forecasts. A pilot study in Utah seeks to address this question. Quality control of the data is needed; the key constraint to progress on this effort is insufficient staff to quality control and edit historic and current data for the models. A constraint to increasing the network is funding for new sites, particularly mid- and lower-elevation sites, and staff for O&M of the sites. A Federal-State collaboration is needed to develop a long-term solution for funding O&M. Action Development Date: 2010
1.6	Vulnerability-weighted drought indexes	L	NCAR CWCB CCC NRCS	Data & Studies	This effort ties vulnerability issues (e.g., sectors, places, and times of year) with drought monitoring indexes to better gauge and weigh the significance of the drought. NCAR has been studying this and presented initial findings at CO Drought Conference in 2012 2018: Ongoing per input received from CCC and NCAR (revisiting 2012 work and publish findings as funding permits). Action Development Date: 2010
1.7	Test, ground-truth, and verify remote sensing tools for monitoring and analysis of drought	M	NIDIS CCC CWCB	Data & Studies	In 2018, CCC will focus on testing EDDI and the Evaporative Stress Index to assess performance and reliability. It is important to verify that remote sensing products provide relevant, valid, and useable information. A constraint to ground truthing remote sensing data is the need for staff and budget for O&M.
1.8	Extend spatial monitoring networks	M	NIDIS CCC	Data & Studies	CoAgMet stations that have been collecting data for a long time are now able to support more robust climate analyses. CCC will expand the CoAgMet observation network to improve spatial monitoring of drought. In addition, an important new extension of CCC's previous work in improving spatial monitoring is by utilizing CoAgMET data in value-added products and tools. CCC collaborates closely with the PRISM Climate Group and extensively uses PRISM products, which now include COCoRaHS and SNOTEL data, in drought monitoring. CCC is also focusing efforts on evaluating SPEI.
1.9	Continue to strengthen current and develop new remote sensing products and decision-support tools	M	CCC	Data & Studies	Progress has been made on improving the USDM's drought depictions over Colorado. It is essential that this effort continue to be supported and the CCC will continue to explore avenues to strengthen the USDM process. CCC will use validated remote sensing and model products in novel ways to strengthen the available suite of decision support tools

Goal and Action ID	Action	Priority	Responsible Lead Agency or Work Group	Mitigation Type	Additional comments on Status, Implementation, Funding, and Potential Benefits
1.10	Support dust-on-snow research regarding impacts on timing and magnitude of runoff	L	CSAS CWCB Denver Water City of Grand Junction USBR Water conservation /conservancy districts	Data & Studies	Continue support for this research. The Center for Snow and Avalanche Studies is home to "CODOS", the Colorado Dust-on-Snow program, an applied science effort funded directly by a collaboration of Colorado and regional water management agencies. CODOS provides its funders (various agencies listed on the left) and their agency partners with a series of "Update" analyses of how dust-on-snow is likely to influence snowmelt timing and rates during the snowmelt runoff season. That information assists reservoir operators, municipal and agricultural water providers, flood risk managers, and others at local, state, and federal agencies responsible for managing the spring runoff. Dust on snow updates sent out (when and where, how severe) within 5 days of dust event; summary done every year Action Development Date: 2013
1.11	Research to understand snowpack sublimation	L	CCC NRCS NOAA CWCB NIDIS CSAS	Data & Studies	Understanding snowpack sublimation is an important research question for water supply forecasting. The National Operational Hydrologic Remote Sensing Center produces fully-gridded estimates on snowpack sublimation; however, this work is not yet applicable for drought response planning. Significantly more research and modeling are needed to understand the impact of snowpack sublimation and how the data would be incorporated into operational forecasting. Action Development Date: 2010
1.12	Develop and implement low-flow streamflow forecasts	L	NRCS	Data & Studies	Forecast the date at which a stream reaches a certain low-flow threshold. Action Development Date: 2010
1.13	Continue to Support and Strengthen Intermountain West Drought Forecasting	H	NOAA NIDIS CCC CWCB	Data & Studies	CCC, with support from NIDIS, continues to lead operational drought monitoring, including weekly monitoring for the state of Colorado, and conditions monitoring through CoCoRaHS that serves as a valuable drought calibration tool. CCC has improved and will continue to improve visibility and communication of drought monitoring and assessments through webinars, social media, press releases, YouTube, etc. It is important to invest in research to improve S2S forecasting, with the goal of providing actionable S2S information and data for better drought decision-making. Action Development Date: 2010
1.14	Develop methods to assess rangeland condition of key game species and livestock	L	CPW NRCS BLM CCA	Data & Studies	Rangeland monitoring is needed to gauge drought stress on key game species and livestock, detection of noxious weed spread and other ecosystem health concerns. CPW has been actively researching large game herd size. NRCS monitors private lands.

Goal and Action ID	Action	Priority	Responsible Lead Agency or Work Group	Mitigation Type	Additional comments on Status, Implementation, Funding, and Potential Benefits
					See related action under Goal 7 regarding the Colorado Cattleman's Association Colorado Resource Monitoring Initiative (CRMI). Action Development Date: 2010
1.15	CoCoRAHS Condition Monitoring	M	CO Climate Center NOAA NIDIS CISA	Data & Studies	House Bill 15-1016 calls for the Board to update the Criteria and Guidelines to allow for the establishment of Regionally Applicable Factors that specify the amount of precipitation consumed through evapotranspiration of preexisting natural vegetative cover. If a sponsor submits an application in a region where a Regionally Applicable Factor has been adopted under these Criteria and Guidelines, the sponsor may propose the use of the Regionally Applicable Factor in SWSPs applied for pursuant to section 37-92-308(4) or (5), C.R.S. and associated with the sponsor's pilot project. The State Engineer shall give the sponsor's use of the Regionally Applicable Factor in said SWSP applications a presumptive effect, subject to rebuttal. Cost estimate: $50,000 - $100,000 Each sponsor shall submit a final report to the board and the state engineer by January 15, 2025. The board and the state engineer shall provide a final briefing to the water resources review committee by July 1, 2025. The potential benefit is that it allows for easier entry into pilot program and creates an incentive for more sponsors to implement precipitation harvesting. Action Development Date: New in 2018
2.1	Evaluate, improve, and coordinate the role and relationship of the CWCB public information and education efforts with those being conducted by local water authorities, utilities, users, and suppliers.	H	CWCB	Education, Awareness & Outreach	Initiated with 2010 revision of this Plan's mitigation and response elements. The CWCB hired a Public Engagement Specialist in 2013 to help develop Colorado's Water Plan and engage local stakeholders and partners in the process, and continue fostering public engagement after the plan's development. The position created and managed a website and social media for Colorado's Water Plan to share important public information. Colorado's Water Plan was finalized in 2015 after a multi-year, grassroots planning process that included hundreds of meetings with local water authorities, utilities, users, and suppliers, state agencies, the nine basin roundtables, the Interbasin Compact Committee (IBCC), and other stakeholders. It also engaged over 30,000 members of the public who submitted comments. The Public Engagement Specialist now manages the implementation of the goals and actions set forth in Chapter 9.5 Outreach, Education, and Public Engagement in Colorado's Water Plan. This requires extensive coordination between and collaboration with water stakeholders across the state.

Goal and Action ID	Action	Priority	Responsible Lead Agency or Work Group	Mitigation Type	Additional comments on Status, Implementation, Funding, and Potential Benefits
					The goals include 1) creating a new outreach, education, and public engagement grant fund, which has been completed, 2) creating a data-based water education plan, which will be tackled in a few phases and is in progress, and 3) improving the use of existing state resources, which is an ongoing endeavor, but the state is working on a few projects to improve this coordination into the future. In addition, the position manages the nine Public Education, Participation, and Outreach (PEPO) Workgroups comprised of local water interests. PEPO works on water education and information projects with each of the nine basin roundtables, the IBCC, and local and statewide stakeholders. The position also created an e-newsletter to share information and highlight different groups and projects. Action Development Date: 2003 (based on DWSA)
2.2	Resources to the Office of Water Conservation and Drought Planning for technical assistance, evaluating of drought plans, administering fund programs, and public education	M	CWCB	Technical Assistance	SB 10-025 The water efficiency grant program re-authorization bill; Request for severance tax funds for 2011 for implementing recommendations of drought mitigation plan. Flood and drought response fund added in 2012 and refunded annually. Action Development Date: 2007
2.3	Workshops: crop survival and livestock management. during drought	M	CSU Coop Ext. Dept. of Ag NRCS Conservation Districts	Education, Awareness & Outreach	Conducted on as needed basis, in coordination with Ag State Conservation Board and NRCS Conservation Districts. CSU is doing a series on 'how to survive the drought 101" through Extension. Two separate actions merged during 2018 plan update. Action Development Date: revised in 2018; formally two actions that have been merged
2.4	Examine the need for new or revised state water policy related to how CWCB provides public information and education, technical assistance, and infrastructure support from the Office of Water Conservation and other CWCB sections with regard to identified water user needs.	M	CWCB	Planning & Regulations	HB 10-1051 requiring data reporting on water conservation and water use annually. This will directly influence policy direction in the future. Use of the Water Conservation Technical Advisory Group to help determine appropriate projects and policy directions for water conservation. [Still exists but on hiatus, CWCB did use them to vet the SWSI water efficiency methodology] Integration of the OWCDP and the Water Supply Section within the CWCB [completed] Colorado's Water Plan was finalized in November of 2015. It is a comprehensive policy document that details Colorado's water resources and lays out measurable objectives, goals, and actions to achieve a balanced water future. It has a chapter dedicated to outreach, education, and public engagement to ensure the public is informed and able to engage in decision-making around water. Action Development Date: 2003 (based on DWSA) Portions of action completed in 2012

Goal and Action ID	Action	Priority	Responsible Lead Agency or Work Group	Mitigation Type	Additional comments on Status, Implementation, Funding, and Potential Benefits
2.5	Examine and improve role and relationship of public information and education efforts by the CWCB with the DNR, DWR-SEO, and the Governor's Office.	L	CWCB	Education, Awareness & Outreach	This was initiated with the 2010 revision of this Plan's mitigation and response elements and has led to improved coordination. Colorado's Water Plan laid out the goal to improve the use of existing state resources. This includes improving coordination between state agencies on outreach and education activities. The CWCB is currently leading a project to bring state agencies and groups together to develop coordinated data collection and evaluation efforts and a communication plan. The first phase will be complete in June 2018. In addition, the plan calls for involving Colorado's innovation and business communities, education and research institutions, and public and non-profit organizations in collaborative efforts with the water sector to address Colorado's water challenges with "outside-the- box" creativity. The CWCB, along with other partners, created a program called TAP-IN in 2017 to convene these diverse interests to bring fresh voices and new approaches to the conversation about water in Colorado. Action Development Date: 2003
2.6	Implement an improved process for educating municipal water users about conservation, xeriscaping, etc.	L	CO Water Wise	Education, Awareness & Outreach	Published the Guidebook of Best Practices for Municipal Water Conservation in Colorado in 2010; runs Xeriscape Colorado which promotes Xeriscape; working on Value of Water Campaign. The Grand Valley 'DRIP' program is a model example on the West Slope. CWCB with DOLA implementing water and land use integration trainings and guidance Action Development Date: 2010 Aspects of action completed in 2010
2.7	Website hosting all drought information for State	M	CWCB CCC	Education, Awareness & Outreach	The Colorado Drought Response website (www.coh2o.co) came online in 2013 and provides current information on water restrictions and drought response activities for municipalities. The website will be upgraded in 2018 with drought response information and establish links with the CCC website for additional drought data. Action Development Date: New in 2018
3.1	Fund water system improvements for drought mitigation and resiliency	H	DOLA CWCB WPA	Funding	Water and Power Authority (receive EPA funding) Water Project Loan Program DOLA Energy/Mineral Impact Assistance Fund Efforts to fund improvements receiving emphasis in 2013 Funding out of Water Plan and CWCB's loan program Action Development Date: 2002
3.2	Explore technologies for water supply banking, floodwater diversion storage, aquifer recharge, snow banking	M	CWCB CGS	Data & Studies	Arkansas Valley Pilot Water Bank Study completed in 2005 Colorado Water District is working on Water Banking compact. Other studies include the Statewide Aquifer Recharge Study, the Upper Black Squirrel Creek project, the Lost Creek project, the Gilcrest/ LaSalle

Goal and Action ID	Action	Priority	Responsible Lead Agency or Work Group	Mitigation Type	Additional comments on Status, Implementation, Funding, and Potential Benefits
					project, the Colorado River Basin Study, the Water Bank Working Group, the Aspinall Unit Roundtable Water Banking Project and others. Action Development Date: 2002
3.3	Evaluate the benefits of construction of water storage facilities on State Trust Land	M	State Land Board	Structure & Infrastructure Projects	This project would evaluate the potential benefits of water storage on State Trust Land for municipal and agricultural uses, supplementation of instream flows. Could help fund and would create a revenue stream. Coordination with CGS for possible underground storage. Action Development Date: 2010
3.4	Use of state water resources to address water shortages.	M	CPW SLB CWCB DWR-SEO AGO USBR COE WCDs	Technical Assistance	Use water, water rights or interests in water to assist water short municipalities, in-stream flow and recreational resources while paying attention to the primary purpose of the agency's water. Could be used to avoid loss of stream fisheries, loss of flat water recreation resources, as well as assisting water short municipalities. Funding could come from rate payers in water short entities Action Development Date: 2013
3.5	Encourage Local Water Providers to include drought in water supply shortage planning	L	CWCB Local Water Providers	Education, Awareness & Outreach	Natural systems adjust water consumption to adapt for drought and limited water supply. Most human systems are built for uniform and reliable water use regardless of water supply and drought. This is encouraged in the 2010 Drought Management Plan Guidance Document Action Development Date: 2010
3.6	Public/private partnerships to augment local water supplies	L	Local Water Providers	Technical Assistance	SB 02S-001 provides up to $1M for agricultural organizations for water augmentation in drought emergencies Colorado Water Trust instream flow program Action Development Date: 2002 Aspects of action completed in 2012
4.1	Make completion of local drought plans a priority; include vulnerability & risk assessments; incorporate info into next update	H	CWCB	Data & Studies	Local drought plan guidance document developed in 2010 to help facilitate local plan development. Sample drought plan completed in 2011. Approximately eight local drought plans have been completed 2010-2018. Action Development Date: 2007
4.2	Integrate results, tools and methods from the 2010 Statewide Drought Vulnerability Assessment to improve and standardize drought risk assessments in local hazard mitigation plans	H	DHSEM CWCB	Technical Assistance	Utilize in Plan update cycles or in new plans that are developed. Being incorporated by reference into new or updated plans since 2010), but no formal process. DHSEM to include template SOW for sub-applicants. DHSEM will engage early with in-house updates to encourage the incorporation of the Drought Plan.

Goal and Action ID	Action	Priority	Responsible Lead Agency or Work Group	Mitigation Type	Additional comments on Status, Implementation, Funding, and Potential Benefits
					Action Development Date: 2010
4.3	Develop approaches and technology to help farmers adapt to drought	H	Dept. of Ag State Conservation Board U.S.D. A	Technical Assistance	University research grants to address grazing management, forage and crop systems, and irrigation strategies. The federal agency hopes the grants will lead to improvements such as enhancing soil's ability to hold water and developing grazing systems that can tolerate drought and reduce the potential for dust storms. Increasing demonstrations and adoption of farming methods that improve soil health and water holding capacity so that lands will be more resistant/resilient to and during cyclic drought patterns. Action Development Date: 2004
4.4	Encourage cooperative sharing of water resources between municipalities and water districts within a watershed during a drought	M	CWCB Local Water Providers	Data & Studies	Cooperative projects continue to develop such as WISE and Southern Delivery System, which can improve drought resilience by diversifying water supplies for providers. Action Development Date: 2010
4.5	Encourage “drought resistant” communities	L	DOLA CWCB	Education, Awareness & Outreach	Communities are continued to be encouraged to incorporate drought in multi-hazard risk assessments and mitigation strategies, as appropriate. CWCB has worked with NDMC’s “Drought Ready Communities” initiative, which is similar to the NWS StormReady certification. The state recovery plan completed in 2013 has increased emphasis on economic/environmental recovery and community sustainability efforts as part of the operational elements of that plan. Follow CWCB drought planning guidance DOLA provides technical assistance and guidance through the Planning for Hazards guide for local community. DOLA also requires comprehensive plans funded out of the Energy and Mineral Impact Assistance Fund (EIAF) to identify hazard risks, vulnerabilities, and mitigation actions. Action Development Date: 2002 Aspects of action completed in 2002
4.6	Enhanced resource matrix of funding sources across the State and Federal agencies.	L	CWCB	Technical Assistance	The state is working to maintain and make publicly available an overview of current federal and state drought assistance programs. Some of this exists already on the CWCB drought toolbox but will be updated as part of the 2018 revision. Action Development Date: 2018
5.1	Continue development and the appropriate allocation of resources to the Office of Water Conservation and Drought Planning in providing technical assistance to covered entities, evaluating submitted water	H	CWCB	Funding	Funds allocated through construction fund and severance tax fund; Full time drought planner hired in 2008; full time water conservation technical specialist hired in 2009; $1.1million non-reimbursable for statewide municipal distribution system water loss training commencing Spring 2018 Action Development Date: 2003 (DWSA)

Goal and Action ID	Action	Priority	Responsible Lead Agency or Work Group	Mitigation Type	Additional comments on Status, Implementation, Funding, and Potential Benefits
	conservation and drought plans, administering fund programs, and disseminating information to the public.				
5.2	Provide technical assistance and information on more efficient agricultural irrigation systems	L	CSU ext. Dept. of Ag USDA CWCB	Technical Assistance	Program is related to irrigation efficiently and conservation through new technology and better management. CSU has installed drip and sprinkler irrigation works at their station in Ark Valley, San Luis Valley, West Slop and S. Platte CSU is in the process (as of June 2018) of standing up a new Irrigation Technology Center in Fort Collins that is working closely with the irrigation industry and has significant funding from the Foundation for Food and Agriculture Research, as well as industry support. The 3 regional extension water specialists are part of this network Action Development Date: 2010
5.3	Encourage and provide incentives for more efficient municipal irrigation systems, including State-owned properties	H	CWCB CRC Green CO Local Water Providers	Funding	Use water efficiency grant program; Center for Resource Conservation irrigation audits funded by CWCB; EPA Watersense specifications for outdoor irrigation technologies Green Industries of Colorado (GreenCO) Best Management Practices; Colorado Waterwise's Guidebook of Best Practices for Municipal Water Conservation in Colorado Use Colorado Water Plan grants to fund landscape retrofits and efficient irrigation implementation Action Development Date: 2010
5.4	Support economic incentives for individual investment in conservation including reduced lawn watering and irrigation maintenance	M	DNR	Funding	Water Efficiency Grant Program – CWCB Colorado Water Plan grants – CWCB Water Smart Home Initiative legislation (HB-10-1358 passed in 2010). Action Development Date: 2002
5.5	Provide technical assistance and information on growing crops appropriate to semi-arid climate, or promote growing drought resistant crops	L	CSU ext. Dept. of Ag USDA	Technical Assistance	CSU has been working on this topic since last update. NRCS can potentially utilize its programs be prepare producers for mitigation measures that may be necessary to get through the drought for both grazing and crop (irrigated and dry) lands. Action Development Date: 2010
5.6	Establish BMP's for landscaping uses	L	CO WWC CWCB	Planning & Regulations	BMPs developed through CO Water Wise Council in 2010; GreenCO developed green industry BMPs in 2008 Additional projects, funded by CWCB water efficiency grant funds, on landscaper certification, creation of landscape ordinances, etc. Action Development Date: 2010

Goal and Action ID	Action	Priority	Responsible Lead Agency or Work Group	Mitigation Type	Additional comments on Status, Implementation, Funding, and Potential Benefits
5.7	Reuse of water for cooling (full cycle) during power generation at coal and natural gas plants	L	Xcel Energy DORA-PUC	Structure & Infrastructure Projects	Coal and natural gas power generation plants use water for cooling. Coal fired plants use considerably more water than gas fired plants (94% vs. 6%) however in both cases, the water used is recycled. Given the "Clean Air Clean Jobs Act" passed by the legislature, coal fired plants are eventually being replaced with natural gas. Xcel Energy is utilizing water reuse as a strategy to reduce water demands. Action Development Date: 2013
5.8	Precipitation Harvesting Pilot Program	L	CWCB DWR	Structure & Infrastructure Projects	HB 09-1129 authorized up to ten pilot projects for new residential or mixed-use developments, providing an opportunity to further evaluate implementation of rainwater and snowmelt harvesting in Colorado (collectively referred to as "rainwater harvesting"). The goal of the pilot project program is to gain additional field-verified information about the feasibility of rainwater harvesting as a water conservation measure in Colorado, through pairing it directly with advanced outdoor water demand management – particularly efficient landscaping Each sponsor shall submit a final report to the board and the state engineer by January 15, 2025. The board and the state engineer shall provide a final briefing to the water resources review committee by July 1, 2025. and irrigation practices. Potential benefits of action: The Holistic Approach to Sustainable Water Management in Northwest Douglas County study concluded that lawn and garden irrigation demands could be significantly reduced by using rainwater and snowmelt harvesting, particularly when paired with active water management techniques (approximately 65% with "moderate conservation" and approximately 88% with "water wise conservation") while maintaining a landscape appearance acceptable to Coloradoans. Action Development Status: New in 2018
5.9	Rain Barrel Bill	L	DWR	Planning & Regulations	On or before March 1,2019 and on or before March 1, 2022, the State Engineer shall report to the committees of reference in each House of the General Assembly with jurisdiction over agriculture on whether the allowance of small-scale residential precipitation collection pursuant to this article has caused any discernible injury to downstream water rights. Potential benefits of action: While offsetting a small amount of potable water for irrigation purposes, the main benefit is educational in nature. The idea is that, during a drought, the lack of precipitation will result in empty rain barrels bringing attention to how little measurable precipitation has been collected over a period of time. Action Development Status: New in 2018

Goal and Action ID	Action	Priority	Responsible Lead Agency or Work Group	Mitigation Type	Additional comments on Status, Implementation, Funding, and Potential Benefits
5.10	Regional Factors for Precipitation Harvesting	L	DWR CWCB	Data & Studies	House Bill 15-1016 calls for the Board to update the Criteria and Guidelines to allow for the establishment of Regionally Applicable Factors that specify the amount of precipitation consumed through evapotranspiration of preexisting natural vegetative cover. If a sponsor submits an application in a region where a Regionally Applicable Factor has been adopted under these Criteria and Guidelines, the sponsor may propose the use of the Regionally Applicable Factor in SWSPs applied for pursuant to section 37-92-308(4) or (5), C.R.S. and associated with the sponsor's pilot project. The State Engineer shall give the sponsor's use of the Regionally Applicable Factor in said SWSP applications a presumptive effect, subject to rebuttal. Cost estimate: $50,000 - $100,000 Each sponsor shall submit a final report to the board and the state engineer by January 15, 2025. The board and the state engineer shall provide a final briefing to the water resources review committee by July 1, 2025. Potential benefits of action: Allows for easier entry into pilot program and creates an incentive for more sponsors to implement precipitation harvesting. Action Development Status: New in 2018
5.11	Encourage QWEL Certification	H	CWCB City of Aspen South Metro Water Authority	Education, Awareness & Outreach	The QWEL program provides landscape professionals with approximately 20 hours of education on principles of landscape water management including proper plant selection for the local climate, irrigation system design and maintenance, and irrigation system programming and operation. In order to obtain the QWEL certification, an individual must demonstrate their ability to perform an irrigation system audit as well as pass the QWEL exam. The QWEL program is recognized as a WaterSense labeled Professional Certification Program for Irrigation System Audits and upon certification, graduates receive the WaterSense Certified Professional designation, providing a nationally-recognized level of certification. The Sonoma-Marin Saving Water Partnership in California sponsors the QWEL program and certification. is currently offered in six states across the nation; this would be the first for Colorado CWCB has approved two water efficiency grants to South Metro Water Authority and the City of Aspen. These grants will focus mainly on the preparation and implementation of the training session for the Qualified Water Efficient Landscaper (QWEL) professional certification.

Goal and Action ID	Action	Priority	Responsible Lead Agency or Work Group	Mitigation Type	Additional comments on Status, Implementation, Funding, and Potential Benefits
					Potential benefit of action: Certifying landscapers in a proven certification program has resulted in an increase in water efficiency in urban landscapes as well as creation of more resilient urban landscapes. Certifications should be completed by end of 2018. Action Development Status: New in 2018
6.1	Continue to pursue implementation funding for recommendations in this plan	H	CWCB	Funding	Funding secured to implement some 2007 recommendations. $200k funding for implementation was set aside through construction funds in 2010. See Funding Sources of plan for updated details. Action Development Date: 2007
6.2	Create a sustainable funding source within State's Long Bill or CWCB budget to continue implementing all the recommendations in the Drought Plan – including monitoring and data collection	M	State Gov't CWCB	Funding	Flood and Drought Response Fund created in 2012 Action Development Date: 2010
6.3	Continue weather modification research	M	CWCB	Data & Studies	Efforts continue by CWCB and Water Users downstream in the Colorado River Basin to assist water users and develop their programs to industry standards through grants and technical assistance. There are seven wintertime ground based cloud seeding programs in Upper Colorado River, Grand Mesa, Gunnison, Telluride, Western San Juan Mountains, and Eastern San Juan Mountains. A 2012 Rules update require target control evaluations each year and suggest evaluations and refinement techniques. Action Development Date: 2002
6.4	Leverage the NIDIS Drought Portal (www.drought.gov) "Drought Impacts Reporter" to compile Colorado-specific drought impacts	L	WATF NOAA NDMC CWCB	Data & Studies	CWCB sends data to NDMC regularly on drought impacts. Drought Impacts Reporter data summarized in 2010 revision and 2013 update. NDMC working on web tool to allow overlay of drought impact reporter reports with drought monitor historic and present conditions Action Development Date: 2010
6.5	Support agricultural research of drought tolerant species	L	CSU	Data & Studies	CSU has ongoing research into crop improvement for drought tolerance both at the molecular and plant breeding levels. Funded by the Ag Experiment Station and various granting agencies. Action Development Date: 2010
6.6	Incorporate wetlands protection into watershed-scale planning efforts	L	CWCB DOLA CPW	Planning & Regulations	Effectively integrate wetland and aquatic resource protection into the planning process (e.g., plans, policies, codes, and standards). This can be achieved through regulatory and non-regulatory measures, including: watershed-scale/stream management plans, comprehensive plans, etc.

Goal and Action ID	Action	Priority	Responsible Lead Agency or Work Group	Mitigation Type	Additional comments on Status, Implementation, Funding, and Potential Benefits
					Continue supporting watershed groups carrying out planning and project execution in riparian and wetlands. CWCB has funding support for local efforts DOLA previously had capacity/project grants with CDBG-DR from DR 4145 flood disaster but those monies are fully allocated Potential benefits of action: Wetlands provide a range of ecosystem services including water storage and flood mitigation Action Development status: New in 2018
6.7	River restoration for streams that are most vulnerable to drought impacts	H	CPW CWCB	Watersheds & Natural Resources	In many streams in Colorado flows in normal water years are already below historical flows and thus the stream is more shallow, putting fish more at risk. High priority streams could be identified by CPW, CWCB and other agencies & NGOs. Funding could be made available for river restoration projects that would lower the risk of the stream running dry in the summer. Funding could be for projects implemented by: state agencies, local government, NGOs. Action Development status: New in 2018
7.1	Participate in new monitoring guidelines process for Ag lands being facilitated by Colorado Cattlemen's Association.	L	CCA Dept. of Ag CSU-WRI	Planning & Regulations	The Colorado Cattleman's Association leads a Colorado Resource Monitoring Initiative (CRMI), which is a database for ranchers to input rangeland condition information. 15 ranchers were utilizing the database as of June 2013, with more interest in the program being generated through CCA education and outreach. Has participation from federal and state land management agencies and Ag producers. Action Development Date: 2010

Goal and Action ID	Action	Priority	Responsible Lead Agency or Work Group	Mitigation Type	Additional comments on Status, Implementation, Funding, and Potential Benefits
8.1	Statewide Climate Change Initiatives	H	CWCB USBR	Planning & Regulations	The state has undertaken many statewide climate change initiatives since 2007. Over the course of the last decade the State's climate change efforts have become increasingly more coordinated. The items listed below are those that have a nexus with drought specifically and do not represent a comprehensive list of state climate actions. These include: 2007 Governor's Climate Action Plan developed Dealing with Drought 2008 Climate Change in Colorado synthesis report 2009 Adapting to Climate Change workshops 2010 Climate Change Impacts and Vulnerability Assessment 2011 Colorado Climate Preparedness Project 2012 CWCB Colorado River Water Availability Study 2012 Joint Front Range Climate Change Vulnerability Study 2012 Colorado Climate Action Plan 2012 Colorado River Basin Water Supply and Demand Study 2013 Colorado Drought Mitigation and Response Plan HB13-1293 Called for the development of a statewide climate plan and the appointment of a staff person to coordinate climate change efforts, this position is currently housed in CWCB. 2014 Climate Change in Colorado Report 2014 Colorado's Water Plan 2015 Colorado Climate Plan In July 2017, the Governor put forth Executive Order D 2017-015 committing the state to reduce statewide greenhouse gas emissions by more than 26 percent from 2005 levels by 2025. These goals have been incorporated into the 2018 Colorado Climate Plan. The EO also called for coordination with local governments and utilities, the development of an EV Plan and announced that the state would be joining the US Climate Alliance. Action Development Date: 2007 Action completed in 2007,2008,2009,2010,2011,2012,2013
8.2	Funding Climate Monitoring Stations	H	CWCB CCC	Funding	Through the Construction Fund CWCB and the State have provided $150K dollars annually to the Co9lorado Climate Center for the development of a Colorado Mesonet system for climate monitoring. More long-term funding will need to be developed in the future to sustain and support these efforts.

Goal and Action ID	Action	Priority	Responsible Lead Agency or Work Group	Mitigation Type	Additional comments on Status, Implementation, Funding, and Potential Benefits
					Action Development Date: 2007 Completed in 2012
8.3	Assess how the hydrograph will change due to climate change for each major river system/ basin in the State	L	CWCB CPW USBR	Data & Studies	2012 Colorado River Water Availability River Study 2012 Colorado River Basin Water Supply and Demand Study 2012 Joint Front Range Climate Change Vulnerability Study 2013 Climate Variability/Paleohydrology Analysis as part of Drought Plan update. 2015 & 2017 Colorado River Water Availability River Study phase 2. Results incorporated into Annex C Climate Change in 2018 Drought Plan update Action Development Date: 2010 Action completed in 2012, 2013, 2018
8.4	Continue to pursue improved climate data to inform the planning process	L	CCC CWCB	Data & Studies	CWCB continue to work with state, federal and academic partners to ensure that the best available science is being utilized in long term planning processes.

Deleted and Deferred Actions

In 2018 six actions were deleted from the summary table and two actions are being deferred. These actions were either no longer relevant, captured as aspects of other actions, or addressed in other State planning efforts. The actions include:

Deleted Actions:

- Coordinate input of groundwater monitoring into overall water availability picture
- Workshops: livestock management during drought*
- Evaluate, and where appropriate engage alternative funding sources and mechanisms to provide resources for programs water users identified as being needed on s statewide, regional and local basis
- Provide appropriate resources to continue to develop and administer opinion surveys of Colorado water users relative to important water issues, and to create a temporal database related to drought and water supply impacts, limitations, planning needs, and projects
- Develop data base to track key information in local drought plans
- Continue to assess potential climate change impacts on a variety of sectors

*Actions merged with similar ongoing action "Workshops: crop survival during drought"

Deferred Actions:

- Require drought planning by Colorado municipalities, water providers and large agricultural producers
- Evaluate the relationship/interaction between both drought (low flows) and water conservation on water quality of streams as well as health related consequences

4.4.2 Progress in Statewide Mitigation Efforts

As evidenced in the number of completed and/or ongoing projects in the actions summary table the State has been making active progress in the implementation of drought mitigation efforts. Of the 78 ongoing and new actions identified in 2013, 22 have been completed and 57 are ongoing, 6 of which are new actions developed as part of this planning effort. A concerted effort was made to streamline the action table in 2018 to separate out completed actions. The completed actions are noted in the following table. Additionally, several items associated with other State Planning efforts or other existing actions have been removed or deferred from the action table, as discussed in the previous section. This table can be modified to reflect progress made as the Plan matures.

Table 18 Completed/Deleted or Deferred State Drought Mitigation Actions

Related Goal	Action	Priority	Responsible Lead Agency or Work Group	Mitigation Type	Additional comments on Status, Implementation
1	Integrate state flood and drought monitoring	H	CWCB	Data & Studies	Improve efficiency through better integration. The WATF and Flood Task Force have been conducting joint meetings in the spring for several years. CWCB Flood and drought response fund created in 2012 for flood and drought preparedness activities. Refreshes to $500K each year based on how much is used the previous year (pre- and post-disaster though most is held for post-disaster.) Action Development Date: 2010
1	Additional Drought DSS support and development	H	CWCB DWR-SEO	Data & Studies	Basin Needs Decision Support System development. BNDSS was created to track projects (i.e. reservoirs) and processes (i.e. conservation programs) that are being implemented by providers statewide, to meet the water needs "gap" originally identified by the Statewide Water Supply Initiative (SWSI) study. This could provide a foundation to integrate drought information and local drought plans moving forward. Action Development Date: 2002
1	Additional SWSI Index modernization	H	NRCS DWR	Data & Studies	While this index was refined in 2010, additional work and automation was completed in 2015 and no further changes are planned per DWR. The TSTool pulls data directly from NRCS web services to run statistics. Action Development Date: 2013
1	Colorado Drought Status strategy	L	WATF	Multiple	Monthly drought status update developed for state leadership; www.coh2o.co website developed in 2013 for public access to drought conditions and municipal water restrictions. Expanded distribution of drought status report to media, leadership. More streamlined process for monitoring drought from a leadership standpoint.; periodic briefs from CWCB staff to governor's staff. Action Development Date: 2002 Completed in 2002 and 2013

Related Goal	Action	Priority	Responsible Lead Agency or Work Group	Mitigation Type	Additional comments on Status, Implementation
2	Drought Info Website	H	CWCB	Education, Awareness & Outreach	Drought information is hosted on the CWCB website including drought status, planning and response. Development of a Colorado Drought Response website in 2012 www.coh2o.co) that provides current information on water restrictions and drought response activities for municipalities. Website users are able to specify a certain local community and obtain information on water restrictions. Action Development Date: 2002 Completed in 2009
2	Develop technical drought planning toolbox	H	CWCB	Education, Awareness & Outreach	A drought web-based toolbox was developed as part of the 2010 revision of this Plan. The Toolbox is eventually going away in 2018 (replicates what already exists on drought.gov). Action Development Date: 2007 Completed in 2009
2	Workshops: water system management during drought	L	CSU Coop Ext. Dept. of Ag NRCS Conservation Districts DOLA CWCB CRWA USGS USBR CDPHE-WQCD CPW	Education, Awareness & Outreach	Four workshops were held around the State between 2002-2004 which raised awareness of drought impacts such as water quality impacts, state and federal resources, water rights administration, emergency management principles, the State's plan and response to drought, weather modification programs, funding options, and regulatory perspectives. Five municipal drought planning workshops were held in Spring of 2011 DOLA has developed updated training and technical assistance approach/program for this action. Completed in 2002, 2003, 2004, 2011
2	Drought workshop for urban and land use planners	L	CWCB DOLA	Education, Awareness & Outreach Technical Assistance	Focused training efforts for City and County planners Five municipal drought planning workshops were held in Spring of 2011 DOLA developed updated training plan for this action Action Development Date: 2010 Completed in 2011
2	2012 – Year of Water Education Initiative	L	CCC CFWE	Education, Awareness & Outreach	Education initiative for the State. Emphasis on youth education and community involvement. Completed in 2012. Colorado Water 2012 worked to: raise awareness about water; increase support for management and protection of Colorado's water; showcase exemplary models of cooperation, and collaboration; connect Coloradans to their water; and motivate them to participate in the future of their water resources.

Related Goal	Action	Priority	Responsible Lead Agency or Work Group	Mitigation Type	Additional comments on Status, Implementation
					Colorado Water 2012 touched more than 500,000 Coloradans with its message of water awareness. The relationships and partnerships that Colorado Water 2012 facilitated are one of the most powerful, if difficult to measure, successes of the initiative. The initiative also increased the amount of water education happening in Colorado, as well as the number of people participating in the discussion. Colorado Water 2012 was less successful at creating behavior change among the general public, which is generally a longer-term goal. Included the "Rain Gage in Every School" effort and CoCoRaHS outreach from CCC. Action Development Date: 2002 Completed in 2011-2012
2	"Drought Awareness Week"	L	CCC DHSEM CWCB	Education, Awareness & Outreach	This action is related to Drought Conferences action. Action Development Date: 2002 Completed in 2011
2	Drought Information Brochure	L	CWCB Local Water Providers	Education, Awareness & Outreach	CWCB Website has drought information that was expanded with drought toolbox development in 2010. Developed a brochure/flyer on the 2010 State Drought Plan update. Action Development Date: 2002 Completed in 2011
3	Resolve emerging water use conflicts	M	DWR-SEO	Planning & Regulations	DWR-SEO reviews and approves temporary water transfers through Substitute Water Supply Plans (for instream flow and other uses) and interruptible water supply agreements. Additional collaboration between involved parties may reveal creative solutions to water use conflicts. Substitute Water Supply Plans now actively used. Action Development Date:2010
3	Promote legislation that provides for policy to allow for greater flexibility during drought conditions to protect instream flows and/or wetlands critical to the survival of species of greatest conservation need	L	CWCB Colorado Water Trust Attorney General DWR-SEO CPW	Planning & Regulations	Action completed with enactment of 37-38-105 which enables entities in collaboration with CWCB to lease water for streams on short notice to protect the environment. This tool was the first used in 2012 to add water to streams during the drought and its use continued in 2013. Action Development Date: 2010 Completed in 2012
4	Risk-based water system assessments	H	CWCB	Data & Studies	Tools and methods developed as part of the local plan guidance document in 2010 Action Development Date: 2002

Related Goal	Action	Priority	Responsible Lead Agency or Work Group	Mitigation Type	Additional comments on Status, Implementation
4	Integrate and correlate the State Drought Mitigation Plan with other statewide planning efforts	H	CWCB CSFS CEO	Planning & Regulations	IBCC planning efforts, Forest Resource Assessment Planning; Drought plan integrated with Colorado Energy Assurance Emergency Plan developed in 2012. Integration of the OWCDP and Water Supply Planning Section. Update of the State Emergency Operations Plan in April 2013 The Drought Plan was linked with the 2015 State Water Plan and Colorado Climate Plan Colorado Resiliency Framework (adopted in 2015) State Hazard Mitigation Plan update (in 2017-2018) Action Development Date: 2010 Completed in 2011, 2012, 2015, and 2017-18
4	Workshops for local drought plans	L	CWCB DOLA	Education, Awareness & Outreach	Workshop held in 2010 during the development of local plan guidance document Dealing with Drought – Adapting to Climate Change workshops held in Held five workshops in the spring of 2011 on drought planning Fall of 2009 DOLA's Planning for Hazards webinar series including Climate Planning in November 2017. It was recommended that local plans look at efforts to integrate drought considerations into other planning efforts. planningforhazards.com/webinars Action Development Date: 2002 Completed in 2000-2001, 2009, 2010, 2011
4	Integrate the State Drought Mitigation Plan with Energy Assurance Emergency Plan	L	CEO DORA-PUC	Planning & Regulations	Action Development Date: 2002 Completed in 2012
5	Support development of local water conservation program	H	CWCB	Data & Studies	State Water Conservation planning requirement. To date, 83 water efficiency plans are currently approved. Rainwater Harvesting Pilot Project Program started in 2009 with one pilot project active; Water Conservation Technical Advisory Group meeting once per month but is currently on hiatus; HB 1051 data collection began in 2014 with web portal for collecting date online and currently holds four years of data; Water Efficiency Guidance document revised in 2012; development of several regional water efficiency plans for smaller providers who group resources. Action Development Date: 2002 Water Conservation Planning Guidance document completed in 2012

Related Goal	Action	Priority	Responsible Lead Agency or Work Group	Mitigation Type	Additional comments on Status, Implementation
5	Support economic incentives for individual investment in conservation including reduced lawn watering and irrigation maintenance	M	DNR	Funding	Recharge Colorado: CWCB partners with Colorado Energy Office (CEO) energy and water efficient appliance rebates; Action Development Date: 2002
5	Encourage minimizing building (particularly urban) water usage in cooling towers and explore other water-energy nexus connections	L	Local Water Providers CWCB	Education, Awareness, & Outreach	Recharge Colorado conducted a series of workshops funded by CWCB Action Development Date: 2010
7	Develop a drought exercise to test procedures and train constituents	H	CWCB	Education, Awareness & Outreach	Updated plan was tested during actual drought in 2011-2012 when Agricultural Impact Task Force activated. Municipal Water ITF activated in 2013. Drought response plan undergoing revisions in 2013 based on lessons learned. CWCB and NIDIS co-sponsored the first Colorado 'Drought Tournament' as a daylong event prior to the 2012 Governors Drought Conference. The tournament was designed to enhance multi-sector collaboration and creative response and mitigation in three simulated droughts. Tested during 2012-2013 drought Action Development Date: 2010 Completed in 2013
8	Host Statewide Drought Conference	M	CWCB	Education, Awareness & Outreach	Drought and Climate change conference held in October 2008, 'Dealing with Drought – Adapting to Climate Change' workshops held in Fall of 2009 (three around the State) Water and Land Use Planning for a Sustainable Future symposium Sept 2009 2012 Governors Drought Conference Action Development Date: 2007 Completed in 1999,2008,2009,2012

4.4.3 Evaluation and Selection of Actions and Activities

During the 2018 update process the DMRPC members were asked to generate new ideas for actions to be included in the plan. At a planning workshop DMRPC members were provided with several lists of alternative drought hazard mitigation actions. One of these was a compendium of tools typically used by states to mitigate drought, based on information from the National Drought Mitigation Center's website. In addition to these handouts, a presentation at the workshop on the vulnerability assessment update included recommendations for "adaptive capacities" that could mitigate impacts to the various sectors. These suggested recommendations are captured in Annex B Drought Vulnerability Assessment Technical Information and organized by impact sector. This Annex can serve the State as well as local governments, citizens, businesses and industry as a useful reference for mitigation strategies to be considered in the future.

The following general categories of state level approaches to drought mitigation were considered:

- Administrative
- Emergency Services
- Financial
- Monitoring and Prediction
- Natural Resource Protection
- Projects to Reduce Impacts to State Assets
- Public Education
- Regulatory
- Structural Projects
- Studies, Publications, Planning efforts
- Technical Assistance
- Training and Exercises

A facilitated discussion took place at the workshop to examine and analyze the alternatives. With an understanding of the alternatives and progress on existing actions, a brainstorming session was conducted to generate a list of preferred mitigation actions. DMRPC members wrote project ideas on sticky notes. These were posted on flip charts organized by goal. The result was a number of new or revised project ideas that help to meet the identified goals. New actions identified through this process are indicated in Table 19 with a 2018 development date. Existing actions were also evaluated and revised during this process and are also included in Table 19.

4.4.4 Prioritization of Actions and Activities

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

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

Colorado's Resiliency Framework, which is profiled in Section 4.2.6 of this Plan, sets forth resiliency prioritization criteria that local communities can use to evaluate and prioritize mitigation actions. Moving forward the DMRPC concurred that the criteria could be used as guiding principles for prioritization of mitigation actions. This is also consistent with the Colorado Hazard Mitigation Plan, which utilizes the criteria for allocation of mitigation funding. The prioritization criteria is 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 presenting and future generations.

With these criteria in mind, DMRPC members were given a set of eight sticky-dots and asked to place the dots on the identified actions as a means to prioritize projects. The projects with the most dots became the higher priority projects. This process provided both consensus and priority for the recommendations. The number of dots was converted into a relative low, medium, and high prioritization category using a score of 0-2 dots as low, 3-4 as medium, and 4-6 a high. The results of the project identification and prioritization exercise are summarized in Table 19 in the "priority" column.

The action identification and prioritization process is the first step in laying-out, in broad terms, what needs to be done to continue to minimize the impact of the drought 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 and thus difficult to quantify cost-effectiveness. 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.

Changes in Priorities

Actions developed prior to the 2018 update were prioritized by using the STAPLE/E criteria only. New actions developed for this update were prioritized using both the STAPLE/E and the Resiliency Framework criteria. The prioritization of actions was reviewed by the DMRPC during the planning process and the priorities were adjusted based on feedback from the DMRPC. The lead agencies were asked to review and rank these projects, based on the STAPLE/E and the Resiliency Framework criteria, for projects that they were responsible for implementing. 0 reflects the new priorities, which are grouped by relative priority under each goal. Some actions that have been partially implemented were revised to Low during the 2018 update.

4.4.5 Contribution of Each Activity to Overall State Drought Mitigation Strategy

Table 19 was reorganized in 2018 to be similar to the organization of mitigation actions in the State Hazard Mitigation Plan. The grouping indicates that a balanced number of activities are proposed or ongoing to meet the eight goals.

4.4.6 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. During the 2018 update the available local hazard mitigation plans were reviewed to identify drought-related mitigation projects. 0 contains mitigation actions that local or regional jurisdictions have identified in their plans intended to mitigate the effects of drought. This data originated from local multi-hazard mitigation plans in effect in counties, cities and other local entities in Colorado as of April 2018. By connecting these local actions with the State Drought Plan, opportunities for targeted technical assistance and funding needs can be identified so the State can assist with the implementation of these activities.

Table 19 Drought Mitigation Actions from Local and Regional Multi-Hazard Mitigation Plans

Plan Name/Jurisdiction	Mitigation Action
Archuleta County	1) Water conservation program 2) Drought management plan update
Boulder County	No drought specific mitigation actions, but incorporated into multi-hazard activities
Boulder County City of Longmont	1) Implement Water Supply and Drought Management Plan 2) Implement Water Conservation Draft Master Plan
Boulder County City of Louisville	Implement Drought Management Plan
City of Boulder	1) Identify and implement priority projects identified in the City's Drought Plan 2) Review city landscape codes for drought 3) Implement replacement planting program to meet tree criteria
City of Colorado Springs	Coordinate with Colorado Springs Utilities to review their current water conservation and drought programs
Costilla County	1) Contact Natural Resources Conservation Service regarding opportunities for technical assistance and financial assistance for drought preparedness and response. 2) Initiate appropriate drought preparation actions as specified in the Costilla County Drought Preparedness Action Guide.
Delta County	No drought specific mitigation actions, but incorporated into multi-hazard activities. Various drought-related activities also considered under alternative mitigation actions.
Denver Regional Council of Governments	1) Coordinate with local water providers to continually identify and promote water conservation measures 2) Monitor proceedings of the Colorado Water Availability Task Force. When necessary, support water providers in the implementation of conservation measures.
Dolores County	1) Obtain elevated, high volume/high flow water tanks (at least 6000 gallon) to be spaced throughout the county for an additional potable water source. 2) Update existing water delivery system. Perform leak detection and water loss control measures to minimize water loss during drought periods.
Eagle County	No drought specific mitigation actions identified
Elbert County Town of Elizabeth	Implement water delivery system improvements

Plan Name/Jurisdiction	Mitigation Action
Elbert County Town of Kiowa	1) Implement water delivery system improvements 2) Develop education and incentives program to encourage water saving measures by citizens.
El Paso County	1) Coordinate Conservation and Mitigation Actions with the Water Department 2) Adopt Water Mitigation Plan, Water Conservation Plan and Reusable/Renewable Water Plan
Grand County	1) Update drought management plan 2) Update Annual Operating Plan for Property Owners
Gunnison County	1) Monitor water issues in City of Gunnison area 2) Monitor city's wells for contamination or dropping water tables 3) Continue acquiring water rights in the area
Hinsdale County	No drought specific mitigation actions identified
Huerfano County	No drought specific mitigation actions identified
Jefferson County	1) Partial renovation and improvement to sections of the main pipeline 2) Conduct a leak detection survey 3) Expand storage capacity at upper Beaver Brook reservoir
Mesa County	No drought specific mitigation actions identified but incorporated into multi-hazard activities
Montrose County	No drought specific mitigation actions identified
Northeast Colorado Cheyenne County Kit Carson County Lincoln County Philips County Sedgwick County Washington County Weld County Yuma County	1) Improve water supply Improving water supply 2)-Seek grazing on Conservation Reserve Program land 3)Use of low-water crops 4) Encourage crop insurance awareness and education to offset the crop losses for the pervasive drought 5) Conduct a Public Education Campaign that addresses Water Conservation
Northeast Colorado Logan County	1) Construct a multi-purpose flood control dam at Pawnee Pass 2) Construct additional small retention ponds and new wellheads throughout the watershed
Northeast Colorado Morgan County	Development and implementation of a Source Water Protection Plan
Northern Colorado Region	1) Public information campaign expansion 2) On-line access to water history 3) Low income retrofit program 4) Irrigation technology rebates 5) Facility audit program expansion 6) Financial incentives for commercial water saving upgrades 7) Local water providers implement domestic water use restrictions during identified periods of drought. 8) Provide education to property owners about use of drought-resistant or native vegetation
Ouray County	1) Develop additional raw storage for the Town of Ridgway 2) Continued participation in water conservation and drought status outreach
Park County	1) Educate the public about ways to lessen the effects of drought and the need to be water wise.

Plan Name/Jurisdiction	Mitigation Action
	2) Identify those municipalities and unincorporated communities in Park County most at risk due to drought, develop Community Water Conservation Plans, and alternate water supply locations for those communities, and implement those plans. 3) Collect analyze drought-related data using GIS to help in pre-drought preparation 4) Identify alternative water supplies for time of drought. Consider the development of mutual aid agreements with alternative suppliers and look at obtaining additional water rights.
Pitkin County	No drought specific mitigation actions, but incorporated into multi-hazard activities
Prowers County	No drought specific mitigation actions, but incorporated into multi-hazard activities
Pueblo County	No drought specific mitigation actions, but incorporated into multi-hazard activities
Rio Blanco County	1) Drought preparedness planning 2) Wolf Creek Reservoir, drought, erosion/deposition
Routt County	1) Water use reduction projects 2)Water conservation education and outreach
San Luis Valley Multi-Hazard Mitigation Plan Alamosa County	Prepare a Drought Preparedness Action Guide
San Luis Valley Multi-Hazard Mitigation Plan Conejos County	Develop a drought action plan based on state guidelines
San Luis Valley Multi-Hazard Mitigation Plan Mineral County	No drought specific mitigation actions, but incorporated into multi-hazard activities
San Luis Valley Multi-Hazard Mitigation Plan Region-wide	Develop a regional drought action plan
San Luis Valley Multi-Hazard Mitigation Plan Rio Grande County	1) Develop an action/response plan for drought 2) Increase public awareness in regards to drought 3) Establish/maintain a water conservation process for protecting aquifer levels
San Luis Valley Multi-Hazard Mitigation Plan Rio Grande Water Conservation District	1)Prepare a Drought Preparedness Action Guide 2)Establish and maintain a ware conservation process for protecting aquifer levels
San Luis Valley Multi-Hazard Mitigation Plan Saguache County	1) Prepare a drought action plan 2) Work with Saguache Creek Water Users (and other similar organizations) to develop a plan and strategy for mitigating drought and flooding
San Miguel County	1) Public information campaigns during drought and non-drought periods 2) Work with water supply organizations to promote conservation and efficiency initiatives 3) Improve water supply systems to reduce the effects of drought 4) Identify and implement water restriction policies during drought times
San Miguel County Town of Sawpit	Develop and implement drought awareness for residents
San Miguel County	1) Improve drought awareness through public education campaign

Plan Name/Jurisdiction	Mitigation Action
Town of Norwood	2) Develop water usage restrictions to be used during drought periods
Summit County	No drought specific mitigation actions, but incorporated into multi-hazard activities
Teller County	Strategic snow stockpiling for Cripple Creek
University of Colorado, Boulder	No drought specific mitigation actions
Upper Arkansas Area	1) Acquire more senior water rights 2) Construction of more water storage facilities 3) Establish "Water Banks" or similar mechanism to protect both the agricultural and municipal centers in the region 4) Implement and Promote "Waterwise" programs 5) Implement water-use fee policies that promote conservation 6) Prepare public relations campaign to accurately portray drought impacts to recreational assets 7) Publicize findings of expert panel
Ute Mountain Ute Tribe	No drought specific mitigation actions, but incorporated into multi-hazard activities

4.5 Funding Sources

The state mitigation strategy includes an identification of existing and potential sources of federal, state, local or private funding to implement mitigation activities. Colorado uses a variety of sources to fund state and local drought mitigation activities that are described in the next section.

4.5.1 Identification of Existing Federal, State, Local Funding Sources

The state has loan and grant programs for which drought and other hazard mitigation 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 local and state agencies such as the State Forest Service, CWCB, DWR, and the DHSEM. Existing funding sources available for drought mitigation and recovery projects in Colorado from local and state agencies are presented in Table 20. Drought-related Federal response programs are shown in Table 21. New funding sources made available since the 2013 update are included in these tables as applicable.

Table 20 Local and State Drought Mitigation Funding Sources Available in Colorado

Program	Grant/Loan Funds Available	Uses/Requirements	Agency
CWCB Construction Fund & Severance Tax Trust Fund	-No limit -Loans typically range from $50,000 to $5,000,000 Loans can be made up to $10,000,000 without legislative authorization within the CWCB process	Raw water projects (e.g., dams, pipelines, ditches, wells, new projects or restorations) -Available to any organization (e.g., municipalities, agriculture, ditch companies, homeowners assn., special districts, etc.) -Must receive CWCB Board and Legislative approval if > $10M; CWCB Board approval if <$10M	CWCB
Water Pollution Control Revolving Fund (WPCRF)	-Fire-related nonpoint source projects can be given priority status -Direct loans up to $3,000.000 available with Board approval -$10K planning grants available for disadvantaged communities (fire-related O.K.)	Low-interest loans for public waste water treatment system needs and watershed nonpoint source control projects -Available to governmental agencies -Emergency projects can be identified at any time throughout the year with WQCC approval. -Loan funds require board review.	Colorado Water Quality Control Division, Division of Local Government, Water Resources and Power Development Authority
Drinking Water Revolving Fund (DWRF)	-Fire-related nonpoint source projects can be given priority status -Direct loans up to $3,000,000 available for projects that implement green components equal or greater to 20% of the total cost -$10K planning grants available for disadvantaged communities (including fire-related)	Low-interest loans for drinking water treatment system needs -Available to governmental agencies -Emergency projects can be identified at any time throughout the year -Loan funds require board review, study grants available immediately	CDPHE, Water Quality Control Division Colorado Water Resources and Power Development Authority Colorado Department of Local Affairs, Division of Local Government
Non point Source Pollution Grants	Typical awards range from $30K to $150K	-Applicants can include governmental and non-governmental organizations -Applicants generally evaluated through a stakeholder process, but this can be waived -40% non-federal match required	Colorado Water Quality Control Division
Agricultural Emergency Drought Response Fund	Up to $1 million annually, in the form of loans or grants	-For emergency drought-related water augmentation purposes -Limited to agricultural organizations	CWCB
Community Development Block Grant (CDBG)	$500,000 (guideline)	Public facilities including water and wastewater	DOLA field staff

Program	Grant/Loan Funds Available	Uses/Requirements	Agency
CWCB Drought Management Planning Grant Program	No limit, as long as funding is available	Water Conservation Planning; Drought Mitigation and Response Planning	CWCB, awarded through the Water Efficiency Grant Fund Program
Natural Disaster Grant	Grants can be awarded to counties in which the governor has declared a disaster emergency by executive order or proclamation order Section 24-33.5-704 C.R. S	Limited to local governments defined as governmental agencies. Repair water and wastewater infrastructure impacted by natural disaster. For planning, design, construction, improvement, renovations and/or reconstruction	CWCB
CWCB Water Efficiency Grant Program	No limit, as long as funding is available	To aid in achieving goals in Water Conservation Plans To promote the benefits of water resource conservation for education and outreach aimed at demonstrating the benefits of water efficiency	CWCB
Flood and Drought Response Fund	Up to $500,000	Flood and drought preparedness and for response and recovery activities following flood or drought events and disasters	CWCB
Watershed Restoration Grants	$500,000 (fiscal year beginning July 1, 2012)	Watershed/stream restoration and flood mitigation projects. These grants were utilized in response to the 2012 High Park and Waldo Canyon Fires	CWCB
Energy & Mineral Impact Assistance Fund	Tier I grants of up to $200,000; Tier II grants, of up to $1,000,000.	Public facilities including water and wastewater	DOLA Field Staff
Colorado Water Resources and Power Development Authority Revenue Bonds Program	$100,000,000 ($300,000 minimum)	Water and wastewater	CWR&PDA
CWCB Water Project Loan Program	Limited to fund availability. Loans typically range from $100,000 to $10,000,000	Raw water projects (e.g., dams, pipelines, ditches, wells, new projects or rehabilitation).	CWCB

Source: 2007 Drought Plan Update, modified in 2010, 2013 and 2018

Table 21 Federal Drought Mitigation Funding Sources Available in Colorado

Program	Grant/Loan Funds Available	Uses/Requirements	Agency
Water2025 Challenge Grant Program for Western States	Up to $250,000	Projects that can be completed within 24 months and that reduce conflicts through water conservation, efficiency, and markets	USBR

Program	Grant/Loan Funds Available	Uses/Requirements	Agency
WaterSMART Water and Energy Efficiency Grants	Funding Group I: up to $300,000. Funding Group II: Up to $1,000,000.	Projects conserve and use water more efficiently; increase the production of hydropower; mitigate conflict risk in areas at a high risk of future water conflict; and accomplish other benefits that contribute to water supply reliability in the western United States. Projects must be completed within 2 or 3 years. 50/50 cost share funding between USBR and another agency/source	USBR
Water Conservation Field Services Program	Up to $25,000	Funds projects that improve water use efficiency and improve water management practices	USBR
U.S. Economic Development Administration Grant (EDA)	No limit (subject to federal appropriation)	Water and wastewater	EDA
General Matching Grants Program	Varies	Funds projects that promote fish and wildlife conservation as well as conservation of their habitats	FWS
Hydrologic Research Grants	Up to $125,000	To conduct joint research and development on pressing surface water hydrology issues common to national, regional, local operational offices. Eligible applicants are federally recognized agencies of state or local governments, quasi-public institutions such as water supply or power companies, hydrologic consultants and companies involved in using and developing hydrologic forecasts.	NOAA
Natural Resources Conservation Service – Emergency Watershed Protection Program	-Funding available through the Simplified Acquisition Procedures (SAP) ranges from $25K to $100K -Funded through contracts between project sponsors and the NRCS. There are no grants. The NRCS pays 75% of the costs.	Installing/repairing conservation measures to control flooding and prevent soil erosion. Generally, more than one individual should benefit from the project. Public or private landowners or others who have a legal interest or responsibility for the values threatened by the watershed emergency	NRCS –Initial contacts should be made with NRCS county offices when an emergency exists.
Rural Development (U.S. Department Of Agriculture)	Subject to federal appropriation	Water, wastewater & stormwater projects	USDA

Program	Grant/Loan Funds Available	Uses/Requirements	Agency
Watershed Processes and Water Resources	$100,000	Sponsors research that address two areas: (1) understanding fundamental watershed processes; and (2) developing appropriate technology and management practices for improving the effective use of water (consumptive and non-consumptive) and protecting or improving water quality for agriculture and forestry production	USDA
National Research Initiative Standard Research (Part T): Watershed Processes and Water Resources	$500,000	Innovative research in understanding fundamental processes that affect the quality and quantity of water resources at diverse spatial and temporal scales, ways on improving water resource management in agriculture, forested, and rangeland watersheds, and developing appropriate technology to reach those goals.	USDA
Emergency Community Water Assistance Grants	$150,000 to $500,000	Available to rural communities with populations over 10,000 people with a median household income less than $65,900. Provides assistance to communities who have experienced a decline in quantity or quality of drinking water as a result of an emergency including drought.	USDA
USDA Rural Development 502 Direct Housing Loan Program	-Loans limited by individual county mortgage limits -Most counties have loan limit of $108,317	Available for wells and water connections – Applicants must be very low income, owner/occupant, unable to obtain conventional credit, and in rural communities and areas	8 USDA Rural Development offices in Colorado
Colorado Rural Water Association (CRWA) Revolving Loan Program	$100,000 or 75% of the total project (whichever is less)	Provides loans for pre-development costs associated with water and wastewater projects and for existing systems in need of small-scale capital improvements.	USDA Rural Utilities Service
Drought Contingency Planning	Up to $200,000 per plan, completed within 2 years	Designed for applicants to develop a drought contingency plan or to update an existing plan to meet the required elements described in the Drought Response Framework. 50% non-Federal cost-share	USBR
Drought Resiliency Projects	Funding Group I: up to $300,000 Funding Group II: up to $750,000	For drought resiliency projects that will help communities prepare for and respond to drought (i.e. implement mitigation actions). 50% non-Federal cost-share. Group I must be completed within 2 years; Group II must be completed within 3 years.	USBR

Program	Grant/Loan Funds Available	Uses/Requirements	Agency
Emergency Response Actions	Up to $300,000 in federal funds will be made available for each emergency response action.	Eligible emergency response actions are limited to temporary construction activities and other actions authorized under Title I that do not involve construction of permanent facilities, including water purchases and use of Reclamation facilities to convey and store water. Actions must be completed within 6 months of a contract.	USBR

The State, through DHSEM, has instituted an effective and comprehensive all-hazard mitigation program. Through a variety of programs, and the wise use of available federal and state funds, the State has been successful in mitigating areas against the devastating effects of drought and other hazards. As of the writing of this Plan, FEMA's hazard mitigation assistance programs are the primary sources of funding for Colorado's mitigation activities. These programs are the Pre-Disaster Mitigation Program and Emergency Management Performance Grant. Each of these programs, as they pertain to drought, is discussed further below. Additional information on existing funding sources available for mitigation projects can be found in the 2018 State Hazard Mitigation Plan.

Local

Local governments 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 governments also actively pursue grant opportunities through federal and state agencies and use general funds or in-kind services to meet the local match requirement.

Local communities are constantly seeking sources of funding to maintain programs and install or upgrade water systems. Unfortunately, funds for these types of projects are limited and the need strongly outweighs the availability. Even if communities get startup funds, continuation of programs creates new financial needs 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.

4.5.2 Identification of Potential Federal, State, Local Funding Sources

Federal

If a disaster occurs, the State may utilize Hazard Mitigation Grant Program (HMGP) and Public Assistance (PA) mitigation funds. PA mitigation funds 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 representative's (GAR's) discretion.

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 (USDOT), BLM, NPS, the USFS, and the USACE. NRCS has programs for projects both exigent and not, including the Emergency Watershed Protection Program.

The Bureau of Reclamation's WaterSMART program provides funding to local governments and special districts for mitigation projects related to water. The Drought Act of 1991 empowered the Bureau of Reclamation to provide support to states and local jurisdictions after they had experienced a drought emergency. In 2015 the program was reformulated to be a more proactive approach through collaborations with federal and non-federal agencies. The WaterSMART program is an umbrella for the six (6) Bureau of Reclamation water programs. The Drought Response program is one program that provides financial assistance to develop or update drought contingency plans and drought resiliency projects. The Bureau will provide a maximum of $200,000 of funding with a cost-share requirement of 50% federal funding and 50% non-federal funding, which may include state funding. Drought plans are required to include specific elements which include developing an administrative framework, form a drought planning task force, develop a work plan, and a communication and outreach plan. The WaterSMART website has a data visualization tool and provides links to previously selected projects.

https://www.usbr.gov/watersmart/index.html; WaterSmart Data Visualization Tool

Small Business Administration (SBA) has come in on several Presidential, USDA, and SBA Administrative declarations in the past. USACE General Investigations and Continuing Authorities Programs provide opportunities for water resources projects, studies, design and engineering, and technical expertise.

State

The governor can move funds into the State Disaster Emergency Fund to fund emergency types of activities, such as fire suppression or drought response activities. 0 listed previously and Appendix C Drought Mitigation Capability Summary lists the existing funding sources that could be used in pre- or post-disaster situations. Funding for implementing some of the recommendations from the 2010 Plan were appropriated from CWCB Construction Funds, including $100,000 for fiscal year 2010/2011 and another $100,000 for fiscal year 2011/2012. Severance tax funding of $75,000 was set aside for FY2012 and there is $20,000 available for FY2014. The CWCB has upgraded the funding set-aside for the Flood and Drought Response Fund up to $500,000 annually.

USDA

The U.S. Department of Agriculture's Household Water Well System Grant Program provides grants to qualified private nonprofit organizations to establish lending programs for household

water wells. Homeowners or eligible individuals may borrow money from an approved organization to construct or upgrade their private well systems. The website for the program is at: https://www.rd.usda.gov/programs-services/household-water-well-system-grants . The Notice of Funding Availability is published each year. The funds have never all been used nationwide.

State Land Board

The State Land Board has funding that could potentially be applied to drought mitigation projects including:

- State Land Board - Land and Water Management Fund
- State Land Board - Enhancement Fund
- Potentially, State Land Board Investment and Development Fund
- State Trust Land Improvement Account - SLB funds administered by the Colorado State Forest Service.

CDPHE - Colorado Water Quality Control Division (WQCD)

The eligible projects that can be funded by the Drinking Water Revolving Fund have expanded with the new emphasis on encouraging Green Infrastructure. These projects are primarily water conservation oriented, which could be considered a component of drought mitigation. Funding has been provided to small community drinking water suppliers. Eligible costs associated with water efficiency projects may include:

- Planning and design activities for water efficiency that are reasonably expected to result in a capital project.
- Purchase of water efficient fixtures, fittings, equipment, or appliances.
- Purchase of leak detection devices and equipment.
- Purchase of water meters, meter reading equipment and systems, and pipe.
- Construction and installation activities that implement capital water efficiency projects.
- Costs associated with development of a water conservation plan if required as a condition of DWSRF assistance.

4.5.3 Sources of Funding Used to Implement Previous Mitigation Activities

The CWCB, Colorado Department of Agriculture (CDA), and the Department of Agricultural and Resource Economics at Colorado State University (DARE-CSU) initiated a project in 2011 to develop a better understanding of the 2011 drought impact on the Rio Grande and Arkansas basins. The project consisted of the following: (1) a preliminary assessment of agriculture activity in the Arkansas and Rio Grande River basins from 1998-2011, (2) a survey of producers in the impacted basins, and (3) an analysis of the impact of the drought on economic activity. This project was expanded to a statewide study in 2012 and will be conducted again in 2018. The 2018 study will be broader by expanding the study to the impacts of the 2018 drought on other sectors in addition to agriculture.

DHSEM

FEMA Pre-Disaster Mitigation (PDM) grants and Emergency Management Performance Grants (EMPG) have both been used to fund local plans that include drought components.

CWCB

A comprehensive follow up to the 2004 DWSA was conducted by the CWCB and focused on gathering data on the state of drought planning and preparedness by municipal and industrial water providers throughout the State; this study was completed in 2007 and funded by CWCB.

The following drought-related mitigation and response funds have been provided through the CWCB in the past three years.

- Agriculture Emergency Drought Response Fund
- Flood and Drought Response Fund
  CWCB Watershed Restoration Grants in response to the High Park and Waldo Canyon Fires

Construction Fund and Severance Tax

The following funding sources were used to implement statewide planning activities in the past three years.

Construction Fund $ (Annual funds rollover if not used)

- FY 08-09 CO Drought Mitigation & Response Plan Implementation ($300K was the initial allocation)
- FY 08-09 CO Drought Mitigation Planning Technical Assistance ($150K was the initial allocation)
- FY 08-09 Climate Change Effects on CO Water Resources ($500K)

Severance Tax

- FY08-09 Drought Toolbox Scoping Document ($24,000)
- FY09-10 Drought Mitigation & Response Plan – Plan Coordination ($25,000)
- FY09-10 Drought Mitigation & Response Plan – Vulnerability Assessment ($50,000)

- FY10-11 Drought Planning and Water Adaptation ($100,000)
- FY11-12 Drought Planning & Response Implementation ($60,000)
- FY12-13 Drought Planning and Response Update ($75,000)
- FY12-13 Conservation and Drought Planning Program Management ($25,000)
- FY 13-14 Drought Preparedness and Response ($20,000)
- FY17-18 Conservation & Land Use Water Plan Grants (funds are available to advance drought mitigation planning efforts)

CDPHE

The Nonpoint Source Program administered by the CDPHE's WQCD is charged with monitoring, protecting and restoring the quality of the State waters. Activities under Section 319 of the Clean Water Act fall under this program and typically involve development of watershed-based plans, implementation and construction of best management practices, and outreach/education. Depending upon funding available, water quality assessments may also be conducted.

For the 2013 funding cycle, the Nonpoint Source Program allocated $400,000 to address reclamation activities associated with the 2012 Waldo Canyon and High Park wildfires. These funds will be leveraged with the CWCB's Watershed Restoration Program's matching funds. In addition, the High Park fire area will likely receive further funds because it was chosen as a 2013 program under the NRCS's Environmental Quality Incentives Program (EQIP) fund. The CDPHE is working closely with local communities at both wildfire sites in developing plans for their reclamation efforts.

Colorado Water Resources and Power Development Authority

The Colorado Water Resources and Power Development Authority donated $300,000 to CWCB in August 2012 for wildfire restoration work. The CWCB has administered these funds to assist with restoration planning and prioritization of mitigation activities associated with the 2012 High Park Fire near the City of Fort Collins. As well as in 2017 with the administration of $250,000 in funding to Ark Basin/Lower Ark Water Conservancy District for fire recovery projects from the Beulah, Hayden and Junkins fires.

5 COORDINATION OF LOCAL MITIGATION PLANNING

5.1 Local Funding and Technical Assistance

This section includes a description of the State process to support, through funding and technical assistance, the development of local mitigation plans and drought management plans. This section also describes the funding and technical assistance the State has provided in previous years to assist local jurisdictions in completing approvable mitigation plans, and the process to prioritize planning and project grants.

As water demand and population continues to increase in many areas of the State and climate change is resulting in greater uncertainty regarding the availability of future water supplies, the importance of drought planning at a local level is increasing in necessity. However, many local entities have not yet developed drought mitigation plans. This State Drought Mitigation and Response Plan continues to encourage and emphasize the importance of local drought planning.

5.1.1 Description of State Process to Support Local Plan Development

The overall state process to encourage and support the development of local plans is discussed in the Colorado Hazard Mitigation Plan. As of the writing of this Plan, there is not a requirement for local entities to adopt a drought mitigation plan. However, CWCB strongly supports the development of local drought mitigation plans. State staff continuously meets with local utilities and water suppliers, to provide drought management information, technical assistance, and drought planning at a grassroots level. CWCB is also exploring opportunities to fund future projects through increased coordination with the Bureau of Reclamations' Drought Response Program. Coordination between the state and the Bureau may lead to less of a cost-share from local communities due to the Program's requirement of matching state and federal funds for proposed projects.

In 2010, the CWCB developed a Municipal Drought Management Plan Guidance Document (Drought Guidance Document) as a means to assist municipal providers and local governments with their drought planning efforts. This Drought Guidance Document serves as a reference tool that municipal entities throughout the State can use in developing local drought management plans. The objectives of the Drought Guidance Document are as follows:

- Provide a comprehensive background on municipal drought management planning and recommend drought mitigation and response planning steps and components useful in developing local plans.
- Disclose the essential and recommended elements of an effective local drought management plan.
- Ensure that the Drought Guidance Document is applicable and useful to stakeholders statewide that vary by geographic location, size, water supply sources, financial resources, etc.

In 2011 the CWCB developed a Sample Drought Management Plan (Sample Plan) as another tool to assist in the development of local drought plans. The Sample Plan provides an example of what a plan developed with the Drought Guidance Document might contain and is based on a fictitious jurisdiction/watershed with attributes common to many Colorado communities. The Drought Guidance Document and Sample Plan are designed to be used in conjunction with CWCB's Drought Toolbox and other drought-related information presented on the CWCB website. The CWCB Drought Toolbox is available online and was also developed in 2010 to provide a point location for the state, local government, and the general public to access information on drought and drought planning. The toolbox specifically contains information on the following:

- Resources for local drought planning – links to the Drought Guidance Document, potential funding sources, other drought assistance related programs, examples of municipal drought management plans submitted to the CWCB for approval, information on drought impacts experienced by local entities statewide and other resources water providers and local governments can use for drought planning
- Frequently Asked Questions – geared toward the public to raise drought awareness and educate the public
- Funding sources/financial assistance – list of current and potential funding sources
- Technical resources – links to drought monitoring data and other monitoring resources
- Current drought status – information on the current drought status
- Contacts - regional and field contacts useful to the public and local governments for drought related information
- Internet resources – links to other drought-related websites and general planning sources
- Discussion on drought and climate change

As of mid 2018 the CWCB is considering phasing out the Drought Toolbox as many of the resources can be found through other web-portals such as www.drought.gov and the Colorado Drought Response Portal www.coh2o.co. The Colorado Drought Response Portal came online in 2013 and provides up to date information on statewide drought conditions as well as response activities for municipalities, including municipal watering restrictions. The website will be upgraded in 2018 with drought response information and establish links with the CCC website for additional drought data.

In addition to drought planning the CWCB promotes and provides assistance with local water conservation plan development. In 2012 the CWCB updated its water conservation guidance document with the development of the "Municipal Water Efficiency Plan Guidance Document." It serves as a reference tool for water providers and local governments throughout the State of Colorado for developing state approved local water efficiency plans. Similar to the Drought Guidance Document, the Municipal Water Efficiency Guidance Document is accompanied by a Sample Municipal Water Efficiency Plan to assist entities in developing their water efficiency plans.

The role of the Mitigation staff within the DHSEM is described in an appendix of the 2018 Colorado Hazard Mitigation Plan. Mitigation staff 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 also is responsible to review and submit all local mitigation plans.

Funding/Technical Assistance Provided in Past Five Years

In the past five years (July 2013 - June 2018) three communities have applied for drought planning grants and two are in the process of completing and submitting revised drought plans to CWCB for review and approval. As of the writing of this plan, one local drought management plan had been approved by CWCB. The CWCB continues to speak with communities regarding their desire to do drought planning and hopes to increase the number of approved plans in the coming years.

Financial assistance was initially made available in 2004 under the Drought Mitigation Planning Grant Program (authorized by §37-60-126.5 C.R.S.), available to local and state governmental entities to assist them in developing drought mitigation plans. In 2007, with the passage of SB07-008, the State's Water Efficiency Grant Program, (authorized by §37-60-126 C.R.S.) provided additional monies through 2012 to support water providers' efforts to plan and implement drought mitigation strategies. The program was extended again through legislation in 2010. Covered entities which are retail water providers that sell 2,000 acre-feet or more on an annual basis, are required to develop water conservation plans. They are also strongly encouraged to develop drought mitigation plans. This group of water providers accounts for the majority, by population, of the municipal water supply in Colorado. Since it was created in 2004, the Water Efficiency Grant Program Fund has given out $5.7 million for drought and water conservation planning and implementation projects. Currently the CWCB has under $1 million available for new grants.

In 2004, the Colorado General Assembly passed House Bill (HB) 04-1365, which was then signed by the Governor. HB 04-1365 expanded the mission and duties of the Office of Water Conservation and Drought Planning to reflect the State's involvement in drought mitigation planning and the need to provide more information relating to drought to water users and the public. The Office maintains a clearinghouse of drought information and disseminates information to the public; provides technical assistance and evaluates and approves drought mitigation plans; and provides financial assistance for drought mitigation plans through various grant programs. Further information on available technical and financial assistance, including the Water Efficiency Grant Program, can also be found on the CWCB website.

DOLA noted that eligible projects that can be funded by the Drinking Water Revolving Fund have expanded with the new emphasis on encouraging Green Infrastructure - Eligible costs associated with water efficiency projects may include:

- Planning and design activities for water efficiency that are reasonably expected to result in a capital project.

- Costs associated with development of a water conservation plan if required as a condition of DWSRF assistance.

In the past five years DHSEM has used FEMA PDM, HMGP and EMPG grants to fund local plans that include drought components. The multi-hazard plans funded are detailed in the State Hazard Mitigation Plan. The State will continue to apply for mitigation grants to support multi-hazard plan development. 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.

As of June 2018, 61 of the 64 counties in Colorado have Hazard Mitigation Plans that are approved, in development, or preparing to be updated. This means that ninety-five percent of the state's population is covered by one of these plans. For more information on local hazard mitigation capabilities refer to the 2018 State Hazard Mitigation Plan.

Since 2000, the Agriculture ITF has attempted to quantify the economic impact of drought on agricultural sectors; provided public education on the impact of drought on agriculture and served as media spokespeople; provided landowner education on drought response; developed a website of drought-related information for producers; offered decision tools to agricultural producers making economic choices; and responded to risk management agency needs for field verification letters.

The Colorado State Forest Service noted the following increases in capabilities since 2013:

- Hazard Fuels Mitigation projects in various locations around the State.
- Increase in local and county level Community Wildfire Protection Plans (CWPPs).
- Increased technical assistance and service.
- Legislative support for technical assistance and incentive programs for landowners.

5.2 Local Plan Integration

The following section includes a description of the State process and timeframe by which the local plans are reviewed, coordinated, and linked to the State Mitigation Plan and Drought Mitigation and Response Plan.

5.2.1 Process and Timeframe to Review Local Plans

In May 2005, the CWCB adopted guidelines that address the process and timeline for review of local drought management plans. These guidelines were revised and adopted again in July 2011 to be more in line with the Municipal Drought Management Plan Guidance Document. These "Guidelines for the Office to Review and Evaluate Drought Mitigation Plans Submitted by Covered Entities and Other State or Local Governmental Entities" are available on the CWCB website. Upon receipt of a completed local Drought Mitigation Plan, the Office must review and either approve or not approve the Plan within 90 days by providing written notice to the submitting

entity. Procedural guidelines for contesting Plan disapproval are also included. Plan content requirements include: 1)Municipal Drought Management Plan Guidance Document (use of this document is strongly encouraged to obtain CWCB approval); 2) Model Plan (preparing a Plan according to this outline will lead to a more valuable planning document); 3) information on Plan Adoption; 4) a discussion of how each of the eight Plan Elements were considered in the entity's program: Stakeholders and Plan Objectives and Principles; Historical Drought and Impact Assessment; Drought Vulnerability Assessment; Drought Mitigation and Response Strategies; Drought Stages, Trigger Points, and Response Targets; Staged Drought Response Program; Implementation and Monitoring; and Plan Review and Updates; and 4) Plan Public Review procedures.

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 Hazard Mitigation Plan.

5.2.2 Process and Timeframe to Coordinate and Link Local Plans to State Mitigation Plan

Linking local county hazard mitigation plans and water provider drought management plans to the State's Plan is integral to building a more effective mitigation program over time. Local drought plans will first be reviewed and approved by CWCB using the guidelines in Section 5.2.1. Local hazard mitigation plans are reviewed initially by DHSEM and approved by FEMA and are updated every five years. With each State Hazard Mitigation Plan update cycle any new or updated plans will need to be reviewed for assimilation and incorporation of information relevant to the State Plan, including drought 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

As noted above in Section 5.2.1, the CWCB (Board) adopted the most recent guidelines for reviewing and approving local drought mitigation plans submitted to the CWCB in July 2011. Section 9a of these guidelines called for the development of a set of additional guidelines associated with the prioritization and distribution of grant monies for assisting covered entities and other state or local governmental entities in their drought mitigation planning activities.

The "Intent of the Board" is defined as follows: It is the explicit intent of the Board to work with water users and local entities to increase drought planning in the State by: 1) increasing the number of covered entities and state or local governmental entities with CWCB approved drought mitigation plans; 2) improving the nature and breadth of drought mitigation practices at the local level; and 3) increasing the amount of technical assistance that the CWCB provides to local entities. With these objectives in mind, the Board intends to administer the Grant program for

purposes of providing assistance to the following: 1) covered entities or state or local entities that desire to improve, update, and/or create Drought Mitigation Plans; 2) entities, given expected growth trends, which either require or desire Drought Mitigation Plans; and 3) entities which sustained severe adverse impacts during the recent 2000-2003 drought.

Project Grants

The SWSI Phase 1 report prioritized projects for both structural and nonstructural projects to provide additional water supplies to help mitigate the effects of drought. Projects are recommended by basin, county, or subbasins; a table summarizing these projects can be found in the Executive Summary of the SWSI Report. Criteria used to prioritize these projects are described in detail in the SWSI Report.

The criteria and process used to prioritize post-disaster funding assistance requests are described in the State's Hazard Mitigation Plan and Grant Program (HMGP) Administration Plan. When a Notice of Interest (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, a subcommittee of the State Hazard Mitigation Team convenes to score and rank the projects. The ranking is to be based on criteria derived from 44 CFR 206.434(b) in tandem with the Colorado Resiliency Framework criteria, and may or may not be specific to the disaster. There has not been a presidential disaster declaration under the Stafford Act for drought in the lower 48 states since 1980 (as opposed to the more frequently used USDA drought declaration). However, related disasters, such as the 2002 and 2012 fires in Colorado were declared presidential disasters, and as a result HMGP funding was made available.

5.3.2 Cost-Benefit Review of Non-Planning Grants

For projects funded under HMGP or with PDM funds a requirement of eligibility of all projects is cost-effectiveness of the project. The exception would be the HMGP 5% set-aside funds, which could be used to funds projects that are difficult to quantify as cost-effective.

5.3.3 Criteria Regarding Areas of High Risk and Intense Development Pressures

As noted previously, as part of the criteria used to rank projects, points are given for the following: 1) entities that, given expected growth trends, either require or desire Drought Mitigation Plans (Rate of Expected Growth in Service Demand), and 2) entities which sustained severe adverse impacts during the 2000-2003 drought.

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 DMRPC. CWCB, in its capacity as support agency to the DMRPC, is responsible for coordination and leadership of the DMRPC. CWCB's responsibilities for monitoring and evaluating the Plan include the following:

- Communicating the schedule and activities for Plan updating and maintenance to the DMRPC
- Facilitating meetings of the DMRPC
- Assisting other agencies with the implementation of mitigation actions
- Coordinating with agencies between DMRPC meetings
- Coordinating and conducting outreach to other stakeholders or interested parties and the public
- Obtaining local mitigation Plan data 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 Drought Hazard Mitigation and Response Plan
- Updating the DMRPC on grant funds available or dispersed for actions
- Engaging and maintaining the interest of the agencies participating on the DMRPC
- Monitoring progress of local drought and water efficiency plan development and providing technical and financial assistance

As participants of the DMRPC state agencies have the following responsibilities for Plan monitoring and evaluation:

- Participating in meetings of the DMRPC
- Leading the implementation of their agency's respective mitigation action(s)
- Providing progress reports on their agency's respective mitigation action(s)
- Monitoring and documenting disasters of significance to state agencies and providing this information to DHSEM
- Suggesting Plan revisions to reflect changes in priorities, regulations, policies, or procedures

- Taking action as needed to effectively monitor and evaluate the agency's role in the planning process

DHSEM will keep the CWCB and DMRPC abreast of changes or opportunities with FEMA mitigation grants or policies

The DMRPC will convene at least once yearly, ideally in the spring. The meeting will include the WATF members and the Chairs of the Impact Task Forces. The meeting will focus on the progress made on mitigation actions, with status reports discussed by the respective agency and/or Task Force so that progress can be noted in the CWCB annual report that is developed in November. This meeting will also be used to discuss any lessons learned from response to drought conditions that may have been present during the year. WATF and Drought Task Force members also meet each as part of regular meetings of the WATF. The spring WATF/DTF meeting will discuss the drought outlook and any preparation needs and review the response procedures in the plan. These regular meetings also will help to ensure that staffs remain up to date on the activities related to the Mitigation plan and the response procedures.

6.1.2 Method and Schedule for Evaluating Plan

A thorough evaluation of the Drought Plan occurred within the 2007-2010 revision cycle, resulting in a concerted effort to modernize the plan. The CWCB recognized that the Plan needed to reflect advances in drought monitoring, integrate the latest climate change science, and re-evaluate the drought response structure. While the Plan will undergo evaluation during each update cycle, the level of effort used in the 2010 revision effort will occur less frequently.

The criteria utilized to evaluate the Plan will be obtained from the FEMA Plan Review Guide (2015), which includes a plan review crosswalk. FEMA uses the crosswalk to record information regarding required and recommended changes during its review of the SHMP and drought mitigation plan annex. The plan's outline mirrors that of the FEMA crosswalk in part to facilitate the review and evaluation process. FEMA will review the SHMP with the crosswalk, and may review sections or elements of the Drought Plan as well. Plan improvement recommendations from FEMA that may be noted in the crosswalk may be addressed, if applicable, in revisions associated with the next update to the plan.

In addition, any drought plan should be evaluated after droughts. Consistent with this commitment, the CWCB undertook the Drought and Water Supply Assessment after the drought of 2000-2003. The goals of this assessment were to determine how prepared Colorado has been for drought, and identify limitations and related measures to better prepare Colorado water users for future droughts. The DWSA was completed in 2004, and contained several findings and recommendations which have been integrated and discussed previously in this document. Following future drought, the actions taken by the State of Colorado to reduce drought impacts should be captured in Appendix B as appropriate.

The response elements of this Plan (Annex A Drought Response Plan) should be exercised periodically to evaluate the Plan and identify any shortcomings, as well as to train and educate Plan users. This should occur at least once every four years, particularly after a change in administration so that Governor's Office staff and departmental leadership are aware of the plan, its intentions, and the key role they have in implementing it. An exercise has not been needed in the 2010-2018 time period since the Response Plan was activated for drought in 2011-2013 and again in 2018.

6.1.3 Method and Schedule for Updating Plan

Updates to state hazard mitigation plans are required the DMA every five years. As an annex to the Colorado Hazard Mitigation Plan, the Drought Plan will need to remain aligned with the update schedule of that plan. Updates to the Plan must conform to the latest DMA 2000 and EMAP planning requirements. The Colorado Hazard Mitigation Plan was updated in 2018. The CWCB and DMRPC will aim to complete the Drought Plan update by early September of the year the update is due to allow enough time for DHSEM to link it with the Hazard Mitigation Plan and submit to FEMA to review the Plan. The Plan will need to be approved by the CWCB by September of the update year. The Plan will be readopted by the Governor as part of the overall State Hazard Mitigation Plan.

DHSEM will coordinate with the CWCB on the schedule and specific needs for the State Hazard Mitigation Plan 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 spring WATF/DMRPC meeting prior to the update year the CWCB will issue a schedule for the drought plan update. This schedule will establish a timeline for the following (and other activities as needed):

- 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

Each update cycle provides an opportunity to evaluate the methods, schedule, elements and process identified in the previous version of the Plan. In general, the overall process defined for monitoring, evaluating, and updating the Plan has been working since 2007. With the 2010 revision this section was made more specific in regards to agency responsibilities, DMRPC duties, and timelines. As a result of the 2018, 2013, 2010 and 2007 review of the existing drought hazard mitigation plan, CWCB staff has identified opportunities to incorporate several expanded elements

into future drought, water and climate change planning efforts. These include statewide water conservation efforts, formulation of a broad drought vision for the State, and a statewide climate change initiative tied to drought planning efforts and an examination of adaptation strategies to deal with potential water shortages.

6.2 Monitoring Progress of Mitigation Activities

6.2.1 Monitoring Mitigation Measures and Project Closeouts

This section pertains to FEMA funded mitigation grant programs. The process used to monitor mitigation project completions and closeouts funded by FEMA is described in the DHSEM HMGP Administration Plan. Projects must be completed and reconciled within three years of the disaster declaration. For project completions, subgrantees shall submit a letter with all final project documentation and a final inspection report to DHSEM requesting closeout. The State Hazard Mitigation Officer, mitigation staff, and financial officer are responsible to review all paperwork for completion and determine that all eligible work was completed within the performance period. Site visits and inspections are conducted when deemed necessary. Procedures regarding the transmittal of closeout documents to FEMA are also described in the HMGP Administration Plan. Similar procedures are used for projects funded through the Pre-Disaster Mitigation Program, also administered by DHSEM.

6.2.2 Reviewing Progress on Achieving Goals in Mitigation Strategy

Progress towards achieving this plan's goals will be checked in on annually through the annual meeting of the DMRPC mentioned previously. The progress will be evaluated and assessed in more detail in the final year of the five-year update cycle. All proposed actions listed in the 0 in Section 4 support one or more of these goals. As the progress on these recommended actions is tracked, progress on achieving the above eight goals will also be monitored and summarized in Section 4.4.2 Progress in Statewide Mitigation Efforts. If any of the goals are not receiving adequate attention, it will become apparent as the table is periodically updated.

6.2.3 Changes in System for Tracking Mitigation Activities

CWCB staff, with input from the DMRPC, will be responsible for reviewing and tracking progress made on all the activities identified on the Mitigation Actions Summary Table (0) in Section 4. This table should be updated at least annually, and new projects or initiatives added as they are developed. In 2018 improvements in the State Drought Mitigation Actions Summary table in Section 4 have been made which should facilitate easier tracking of mitigation activities and better coordination between state planning efforts. The only other change is that the process is more clearly defined in Sections 6.1 and 6.2. In 2018, a process for revisiting these action items at a fall DMRPC meeting was defined in Section 6.1.1. The annual DMRPC meetings were changed from the fall to the spring to align with the WATF/DTF meetings, recognizing that many members of this group also meet as part of the WATF/DTF during the spring each year, or more frequently

during times of drought. Regular meetings continue to be important to allow new DMRPC members to become familiar with the Plan as staff turnover or re-assignment occurs. Colorado Hazard Mitigation Plan enhanced 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 Hazard Mitigation Plan for additional details.

For FEMA-funded projects, quarterly progress reports are required from subgrantees, which are to reflect project and cost status. These reports are reviewed by DHSEM Mitigation staff and the State Hazard Mitigation Officer, and submitted to FEMA. This process is outlined in the DHSEM HMGP Administration Plan, which is periodically updated.

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

The procedures for reviewing the progress associated with implementing activities and projects related to the mitigation strategy were discussed in the previous two sections. It is further recommended that the CWCB/DMPRPC prepare an annual report on progress towards mitigation projects, and incorporate this information into other agencies' periodic reports where applicable (e.g., CWCB, DOLA, Agriculture, etc.), including those associated with annual Colorado Hazard Mitigation Plan enhanced plan compliance.

6.2.5 Implementation of Previously Planned Mitigation Actions

The Mitigation Actions Summary Table (Table 17) and Completed Mitigation Actions Table (Table 18) in Section 4 shows those actions that have been implemented to date, as well as those that are ongoing. Several mitigation actions have been implemented as planned and many more are ongoing. The discussion in the Completed Mitigation Actions Table under Section 4.4.2 Progress in Statewide Mitigation Efforts contains a summary discussion of action implementation. This discussion will be updated with each five-year update cycle so that successes and challenges with action implementation are documented.