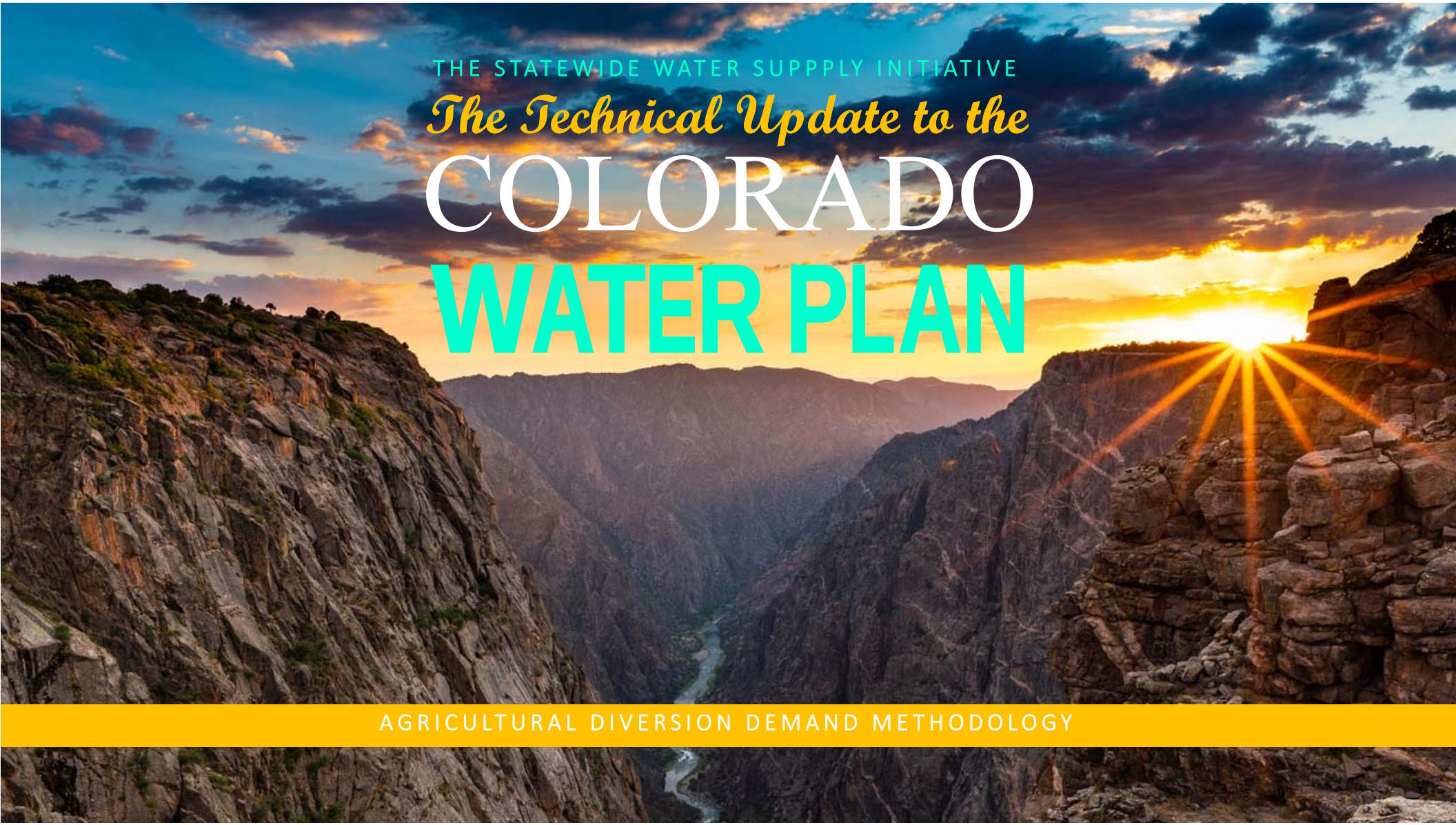

THE STATEWIDE WATER SUPPPLY INITIATIVE
The Technical Update to the
COLORADO
WATER PLAN
AGRICULTURAL DIVERSION DEMAND METHODOLOGY

PRESENTATION

AGENDA

- Background / Process/ Methodology
- Agricultural Diversion Demands/ Analysis

TECHNICAL WEBINARS

- **February 19** SWSI Methodologies Overview and Population Data
- **March 19** Municipal and Industrial Data & Methodologies
- **April 23** Agricultural Data & Methodologies
- **May 21** Environmental Data & Methodologies
- **June 25** SWSI Tools & Next Steps

SIGN-UP FOR WEBINARS

WEBINARS

ENHANCED STAKHOLDER

ENGAGEMENT

- 2017
  - Technical Advisory Groups
- 2018
  - Roundtable Presentations
- 2019
  - Implementation Working Group
  - Technical Webinars (Recorded and Posted)
  - Iterative Process with Basin Implementation Plans

UPDATING THE WATER PLAN

A ANALYSIS + TECHNICAL UPDATE PHASE

B BASIN PLAN UPDATE PHASE

C COMPREHENSIVE UPDATE PHASE

TABLE 11-1 CYCLICAL PLANNING PROCESS PROPOSED BY THE CWCB

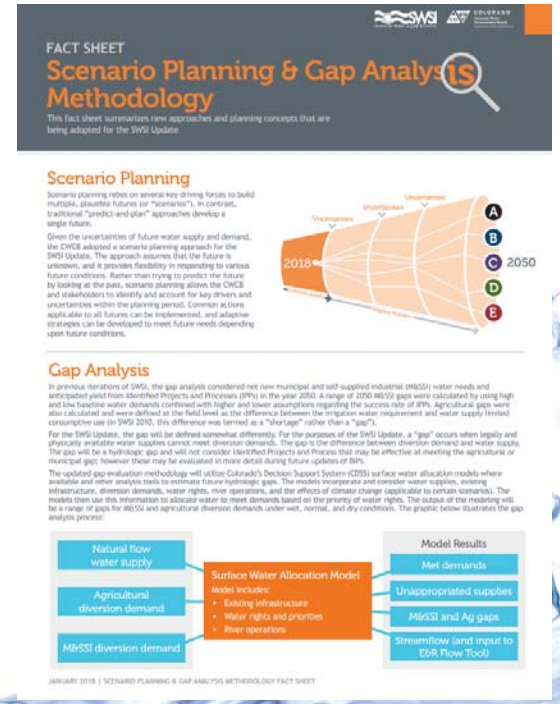
Product	Year Initiated
Basin Implementation Plans	2013
Colorado's Water Plan	2013
Statewide Water Supply Initiative	2016
Basin Implementation Plans	2018
Colorado's Water Plan	2020
Statewide Water Supply Initiative	2022

ACTIONS

1. The CWCB will work with other state agencies, the basin roundtables, and the people of Colorado to update Colorado's Water Plan, beginning no later than 2020.
2. The CWCB will develop guidelines for Basin Roundtable WSRA grants to help facilitate the implementation of the BIPs.

TECHNICAL UPDATE
METHODOLOGY

- New Water Plan-based approach
- First update since the Water Plan
- First update to incorporate climate
- First update to use the hydrologic modeling


FACT SHEET

Scenario Planning & Gap Analysis Methodology

This fact sheet summarizes new approaches and planning concepts that are being adopted for the SWSI Update

Scenario Planning

Scenario planning relies on several key driving forces to build multiple, plausible futures (or "scenarios"). In contrast, traditional "predict-and-plan" approaches develop a single future.

Given the uncertainties of future water supply and demand, the CWCB adopted a scenario planning approach for the SWSI Update. The approach assumes that the future is unknown, and it provides flexibility in responding to various future conditions. Rather than trying to predict the future by looking at the past, scenario planning allows the CWCB and stakeholders to identify and account for key drivers and uncertainties within the planning period. Common actions applicable to all futures can be implemented, and adaptive strategies can be developed to meet future needs depending upon future conditions.

Uncertainties
Uncertainties
Uncertainties
2018
A
B
C 2050
D
E

Gap Analysis

In previous iterations of SWSI, the gap analysis considered net new municipal and self-supplied industrial (M&SSI) water needs and anticipated yield from identified Projects and Processes (IPPs) in the year 2050. A range of 2050 M&SSI gaps were calculated by using high and low baseline water demands combined with higher and lower assumptions regarding the success rate of IPPs. Agricultural gaps were also calculated and were defined at the field level as the difference between the irrigation water requirement and water supply limited consumptive use (in SWSI 2010, this difference was termed as a "shortage" rather than a "gap").

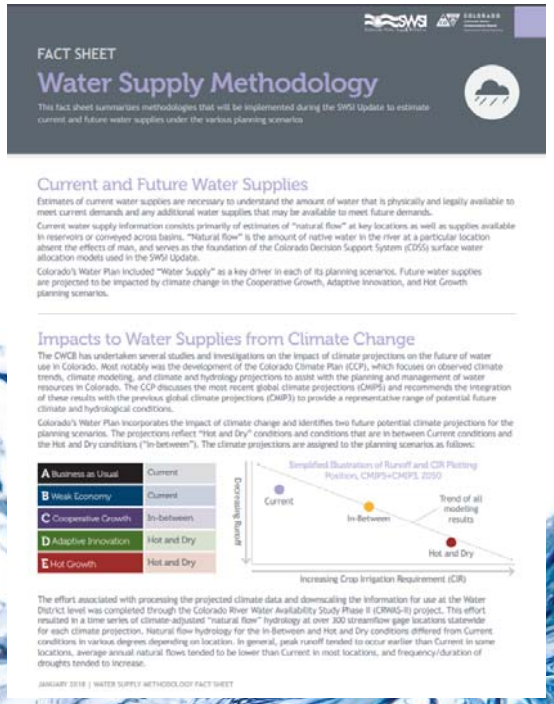
For the SWSI Update, the gap will be defined somewhat differently. For the purposes of the SWSI Update, a "gap" occurs when legally and physically available water supplies cannot meet diversion demands. The gap is the difference between diversion demand and water supply. The gap will be a hydrologic gap and will not consider Identified Projects and Process that may be effective at meeting the agricultural or municipal gap; however these may be evaluated in more detail during future updates of IWPs.

The updated gap evaluation methodology will utilize Colorado's Decision Support System (CDSS) surface water allocation models where available and other analysis tools to estimate future hydrologic gaps. The models incorporate and consider water supplies, existing infrastructure, diversion demands, water rights, river operations, and the effects of climate change (applicable to certain scenarios). The models then use this information to allocate water to meet demands based on the priority of water rights. The output of the modeling will be a range of gaps for M&SSI and agricultural diversion demands under wet, normal, and dry conditions. The graphic below illustrates the gap analysis process:

Natural flow water supply
Agricultural diversion demand
M&SSI diversion demand
Surface Water Allocation Model
Model includes:
- Existing infrastructure
- Water rights and priorities
- River operations

Model Results
Met demands
Unappropriated supplies
M&SSI and Ag gaps
Streamflow (and input to E&R Flow Tool)

JANUARY 2018 | SCENARIO PLANNING & GAP ANALYSIS METHODOLOGY FACT SHEET


FACT SHEET

Water Supply Methodology

This fact sheet summarizes methodologies that will be implemented during the SWSI Update to estimate current and future water supplies under the various planning scenarios

Current and Future Water Supplies

Estimates of current water supplies are necessary to understand the amount of water that is physically and legally available to meet current demands and any additional water supplies that may be available to meet future demands.

Current water supply information consists primarily of estimates of "natural flow" at key locations as well as supplies available in reservoirs or conveyed across basins. "Natural flow" is the amount of native water in the river at a particular location absent the effects of man, and serves as the foundation of the Colorado Decision Support System (CDSS) surface water allocation models used in the SWSI Update.

Colorado's Water Plan included "Water Supply" as a key driver in each of its planning scenarios. Future water supplies are projected to be impacted by climate change in the Cooperative Growth, Adaptive Innovation, and Hot Growth planning scenarios.

Impacts to Water Supplies from Climate Change

The CWCB has undertaken several studies and investigations on the impact of climate projections on the future of water use in Colorado. Most notably was the development of the Colorado Climate Plan (CCP), which focuses on observed climate trends, climate modeling, and climate and hydrology projections to assist with the planning and management of water resources in Colorado. The CCP discusses the most recent global climate projections (CMIP5) and recommends the integration of these results with the previous global climate projections (CMIP3) to provide a representative range of potential future climate and hydrological conditions.

Colorado's Water Plan incorporates the impact of climate change and identifies two future potential climate projections for the planning scenarios. The projections reflect "Hot and Dry" conditions and conditions that are in between Current conditions and the Hot and Dry conditions ("In-between"). The climate projections are assigned to the planning scenarios as follows:

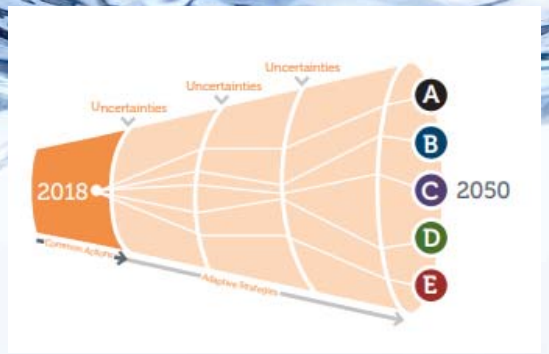
A Business as Usual	Current
B Weak Economy	Current
C Cooperative Growth	In-between
D Adaptive Innovation	Hot and Dry
E Hot Growth	Hot and Dry

Simplified Illustration of Runoff and CIR Planting Position, CMIP5+CMIP3, 2050

Decreasing Runoff
Current
In-Between
Trend of all modeling results
Hot and Dry
Increasing Crop Irrigation Requirement (CIR)

The effort associated with processing the projected climate data and downscaling the information for use at the Water Dist/rict level was completed through the Colorado River Water Availability Study Phase II (CRWAS-II) project. This effort resulted in a time series of climate-adjusted "natural flow" hydrology at over 300 streamflow gage locations statewide for each climate projection. Natural flow hydrology for the In-Between and Hot and Dry conditions differed from Current conditions in various degrees depending on location. In general, peak runoff tended to occur earlier than Current in some locations, average annual natural flows tended to be lower than Current in most locations, and frequency/duration of droughts tended to increase.

JANUARY 2018 | WATER SUPPLY METHODOLOGY FACT SHEET



Brown AND Caldwell

Presentation by
Matt Lindburg - Principal
www.brownandcaldwell.com

OVERARCHING

GOALS

Technical Update update goals:

- A consistent statewide framework for examining future water supply and demand scenarios.
- Tools and data for roundtables to update their basin plans (e.g. identify local solutions).
- Meet other Water Plan timing goals and actions (e.g. Chapter 6 Actions)
  - Monitor Drivers
  - Promote the use of scenario planning and adaptive strategies
  - Support the Colorado Decision Support System

STAKEHOLDER-DRIVEN

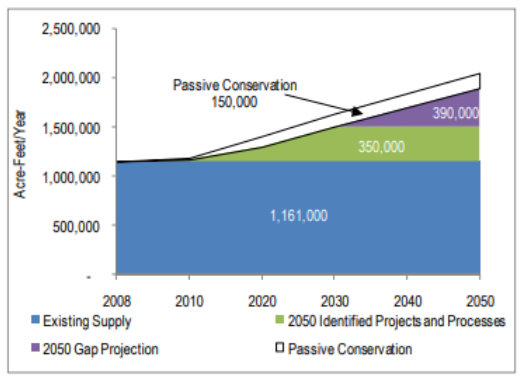
METHODOLOGIES

2050 Demand Projections

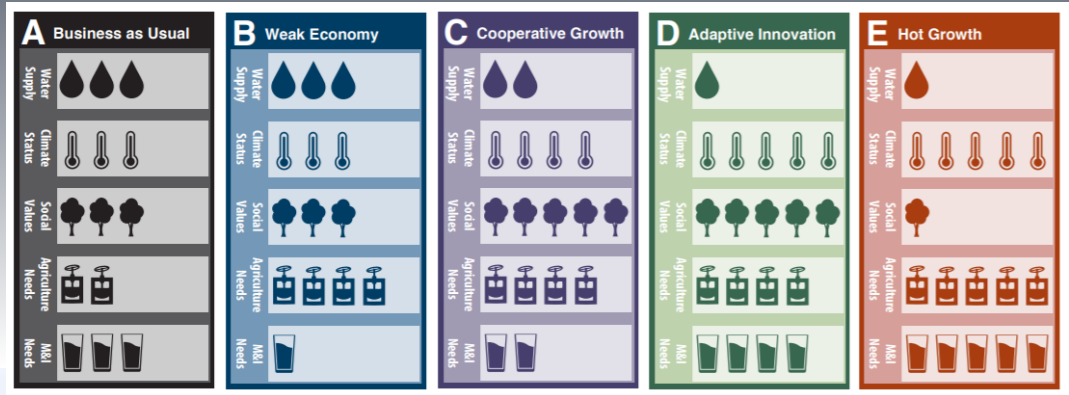
- IPPs

_____

= 2050 M&I Gap



- **Hydrologic Modeling**
- **Municipal Modeling**
- **Agricultural Modeling**
- **Environmental Modeling**
- **Scenario Planning Across Major Drivers**



AGRICULTURAL METHODOLOGY


FACT SHEET

Agricultural Diversion Demand Methodology

This fact sheet summarizes the methodologies used to estimate agricultural diversion demands in the SWSI Update

Previous Methodology

Water demands and shortages for irrigated crops at the field level were estimated in SWSI 2010. Irrigation water requirement, water supply limited consumptive use, and crop water shortages were estimated and aggregated at a basin level.

Updated Methodology:

In the SWSI Update, crop water demands will again be estimated. In addition, the river diversions or pumping necessary to meet crop water demands will also be estimated. Total agricultural water demands will account for consumptive needs at the field level plus the conveyance losses or pumping inefficiencies. As a result, agricultural demands (and gaps) will be higher than in SWSI 2010.

Why did we make this change?

- Allows the use of planning models to analyze planning scenarios from Colorado's Water Plan
- Provides information and tools for basin roundtables to use in analyzing "what if" scenarios and for evaluating the effectiveness of future projects
- Provides consistency with estimates of municipal and industrial demands

Calculation Process for Current Agricultural Water Demands

Climate data, acreage, and cropping patterns are used to calculate irrigation water requirements

Crop Types

Acreage

Climate Data

On-farm irrigation and ditch conveyance efficiencies are applied to estimate diversion demand

Irrigation Water Requirement

Agricultural demand is the diversion or pumping amount needed to meet full irrigation requirement

Agricultural Demands

JANUARY 2018 | AGRICULTURAL DIVERSION DEMAND METHODOLOGY FACT SHEET

wilsonwater group

we've got your basins covered

Presentation by

Kara Sobieski - Principal

www.wilsonwatergroup.com

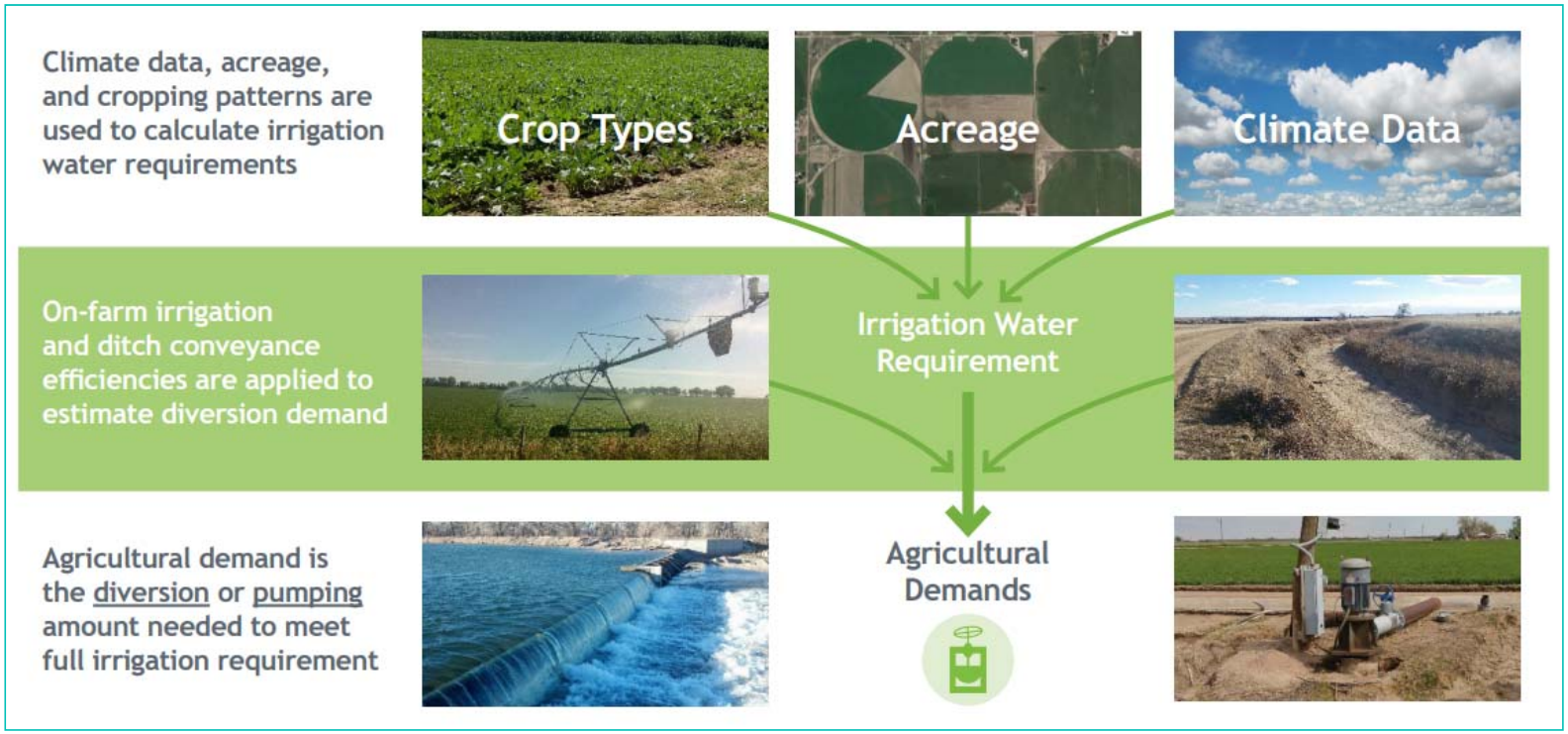
Webinar Agenda

- What is an Agricultural Diversion Demand?
- Current Results
- How is this different than SWSI 2010?
- Planning Scenario Adjustments
- Planning Scenario Results
- What is an Agricultural “Gap”?
- How is the Agricultural Gap estimated?

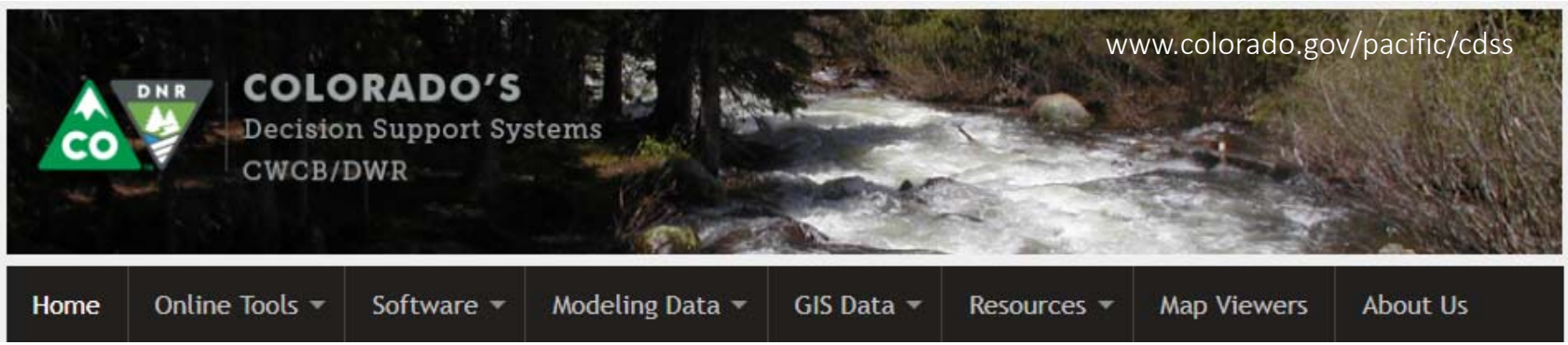
What is an Agricultural Diversion Demand ?

Agricultural Demand

- The amount of water supply that needs to be diverted or pumped to meet the full crop irrigation water requirement



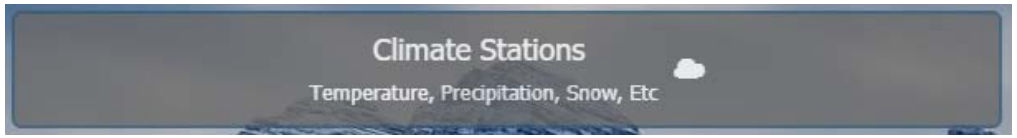
Where does the data come from?

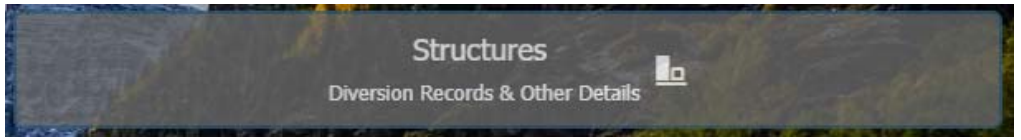


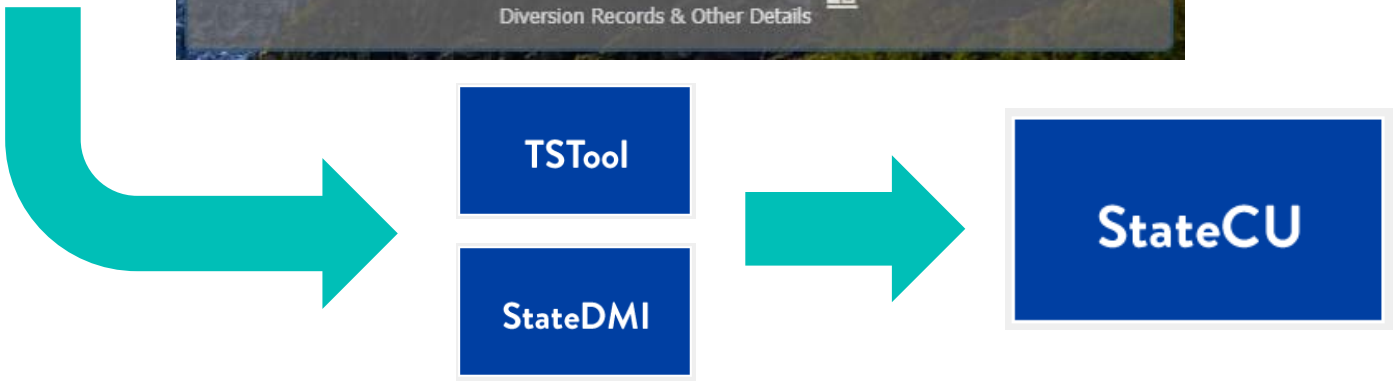
GIS Data

Data by Division or Category:

- Data by Category
- Division 1 - South Platte
- Division 2 - Arkansas
- Division 3 - Rio Grande
- Division 4 - Gunnison
- Division 5 - Colorado
- Division 6 - Yampa/White
- Division 7 - San Juan/Dolores







How is this different from SWSI 2010?

Previous Methodology

- Agricultural demands were estimated at the field (not at the headgate or well)

Why the change?

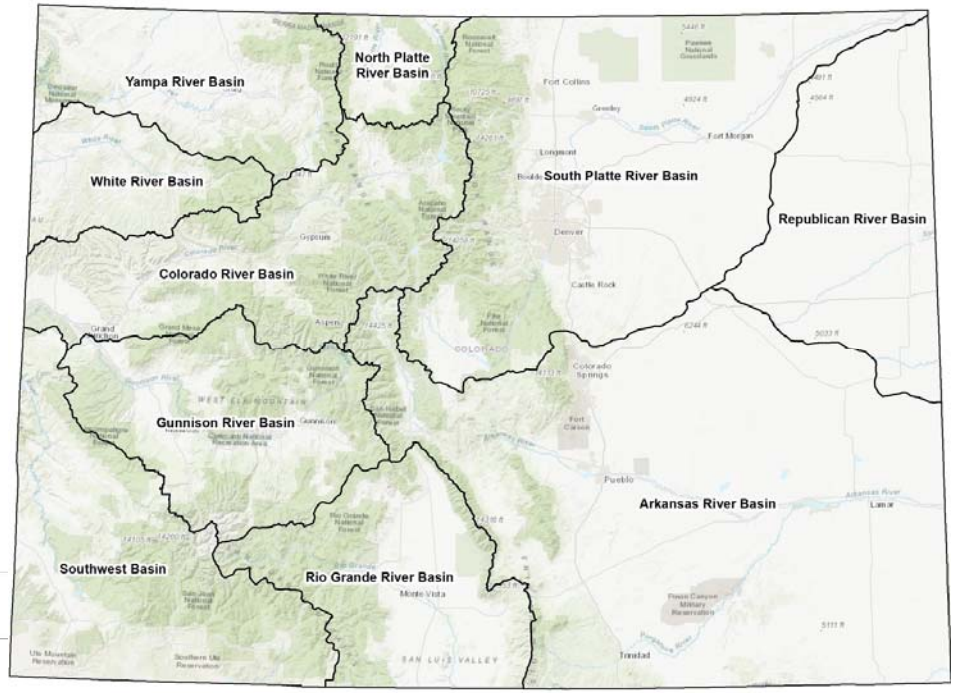
- Reflects true amount of water needed to meet agricultural demands
- Planning Models and “What-if” scenarios
- Consistency with M&SSI

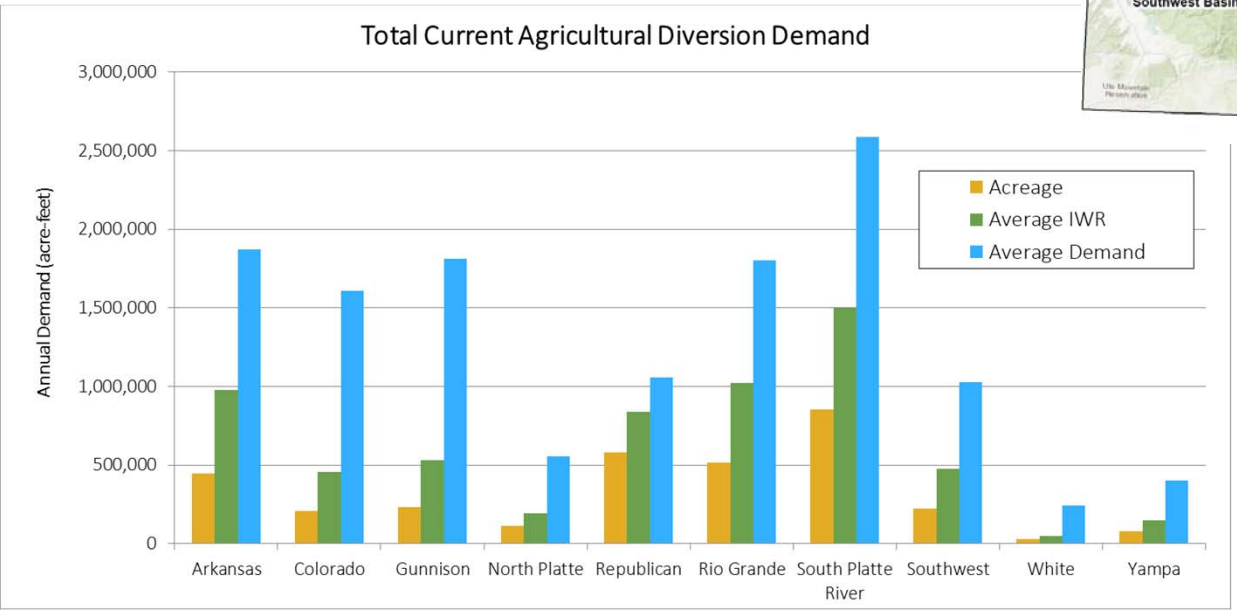
CURRENT AGRICULTURAL DIVERSION

DEMAND RESULTS

Currently:

- Nearly 13 million af of diversions + pumping
- Is needed to meet 6.2 million AF of IWR
- On 3.3 million acres of irrigated land





PLANNING SCENARIO

ADJUSTMENTS

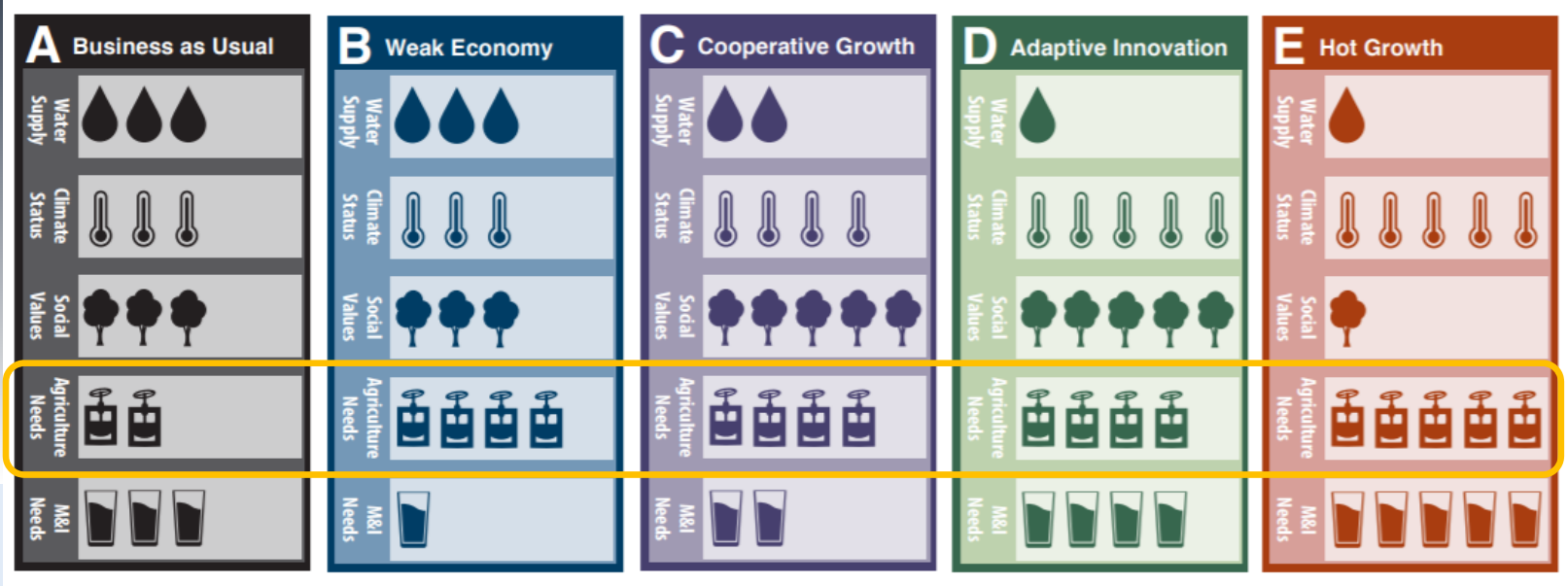
Urbanization

Planned Agricultural Projects

Ground Water Acreage Sustainability

Climate

Emerging Technologies



What is Urbanization?

As municipalities are expected to grow in the 2050 Planning Scenarios, anticipate that some municipal growth will occur onto currently irrigated agricultural lands (within or directly adjacent to current municipal boundaries)

Urbanization

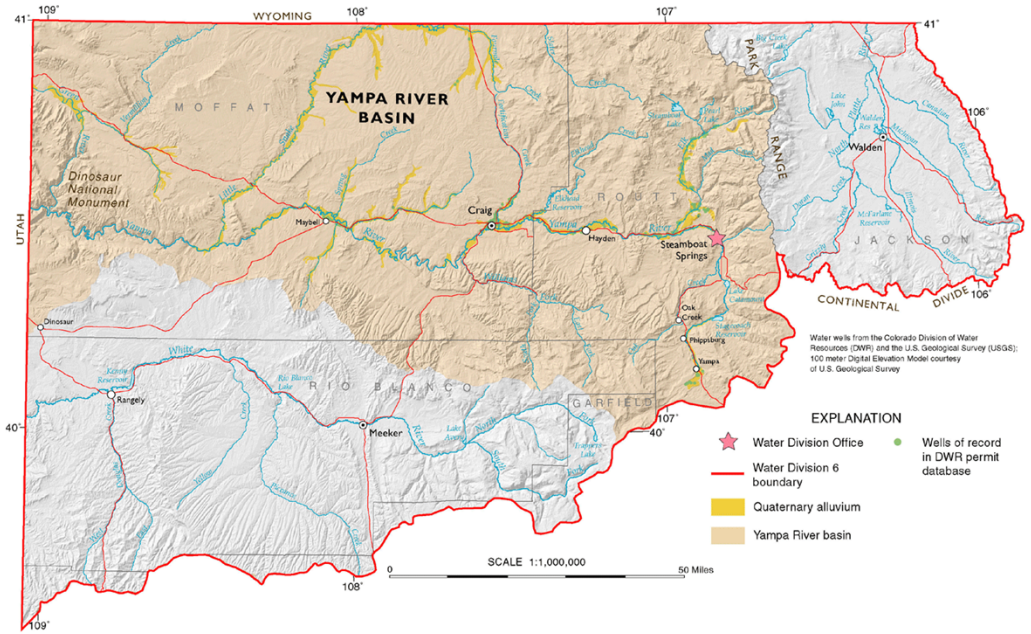
- Only irrigated acreage within or directly adjacent to current municipal boundaries
- Captures urbanization of irrigated acreage only
- No assumptions on direction/magnitude of municipal growth
- Additional dry-up: 42,500 - 63,700 acres in the South Platte River Basin & 12,600 acres in Arkansas River Basin
- Approx. 230,000 acres that could come out of production statewide by 2050

Basin	Maximum Urbanized Acreage
Arkansas	7,240
Colorado	13,590
Gunnison	14,600
North Platte	40
Republican	1,410
Rio Grande	4,010
South Platte/Metro	105,900
Southwest	3,800
White	360
Yampa	1,500
Total	**152,450**

Planned Agricultural Projects

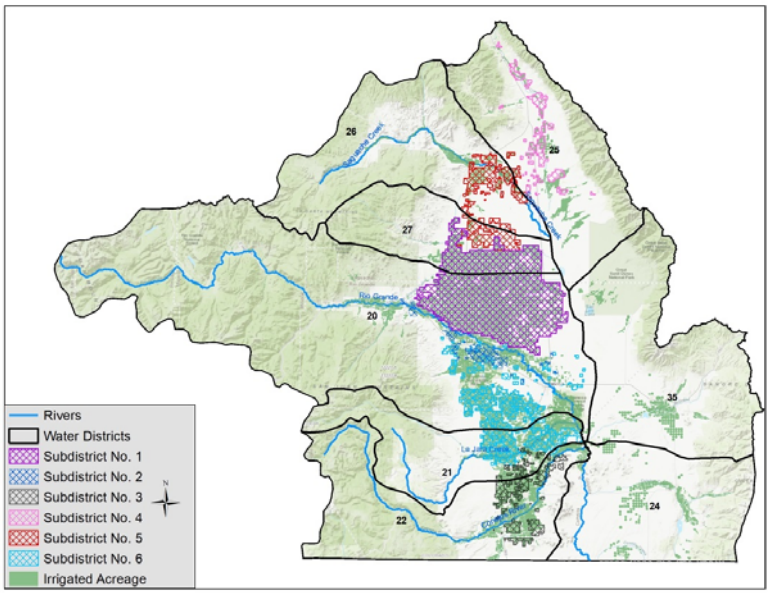
Planned agricultural development was identified by Basin Roundtables during Basin Implementation Planning efforts

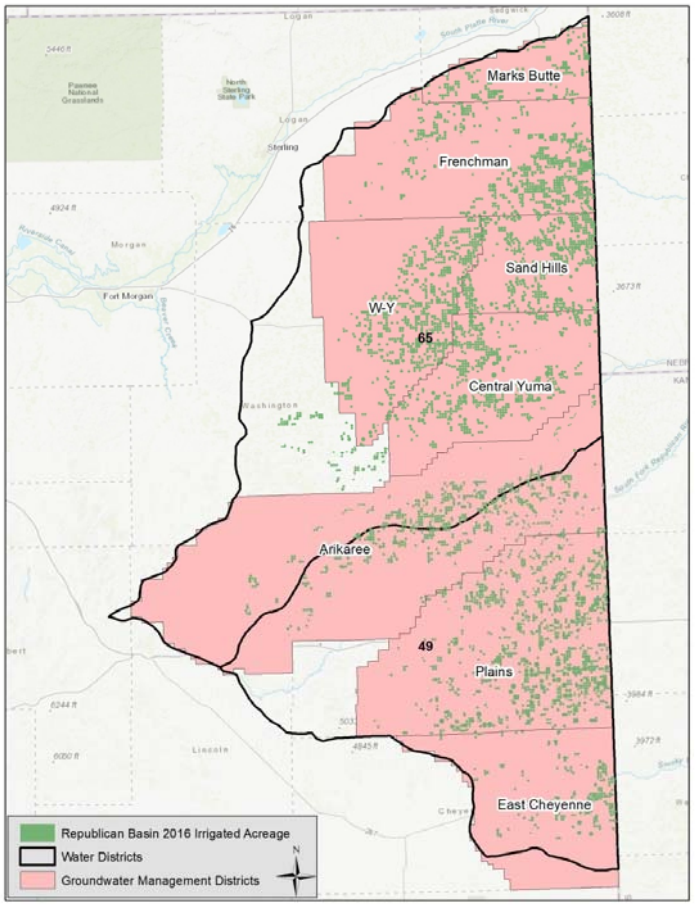
- Yampa River Basin = 14,800 acres
- North Platte River Basin = 10,500 acres
- Increased acreage by 2050



Ground Water Acreage Sustainability

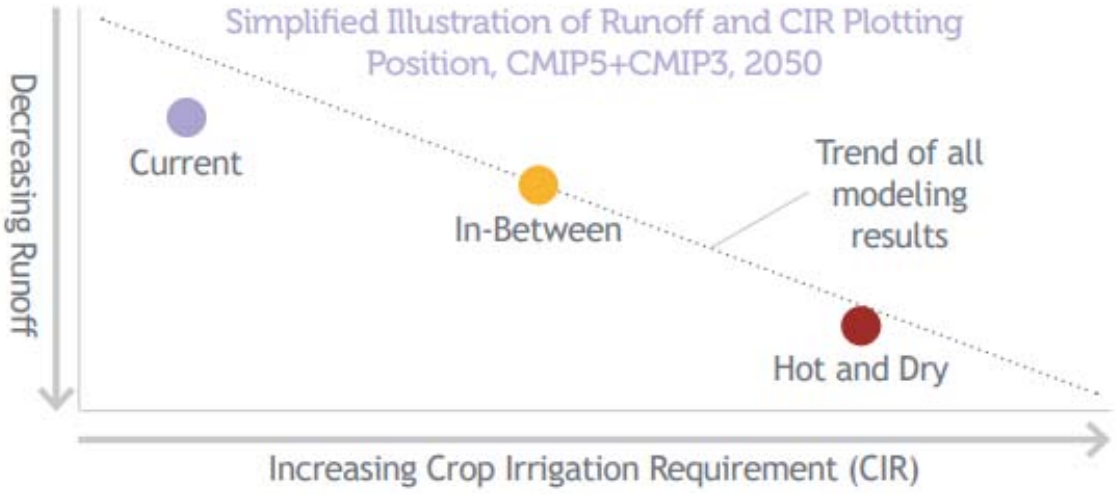
Irrigated acreage currently served by ground water supplies may not be sustainable by 2050, primarily due to falling aquifer levels and availability of augmentation supplies





Climate

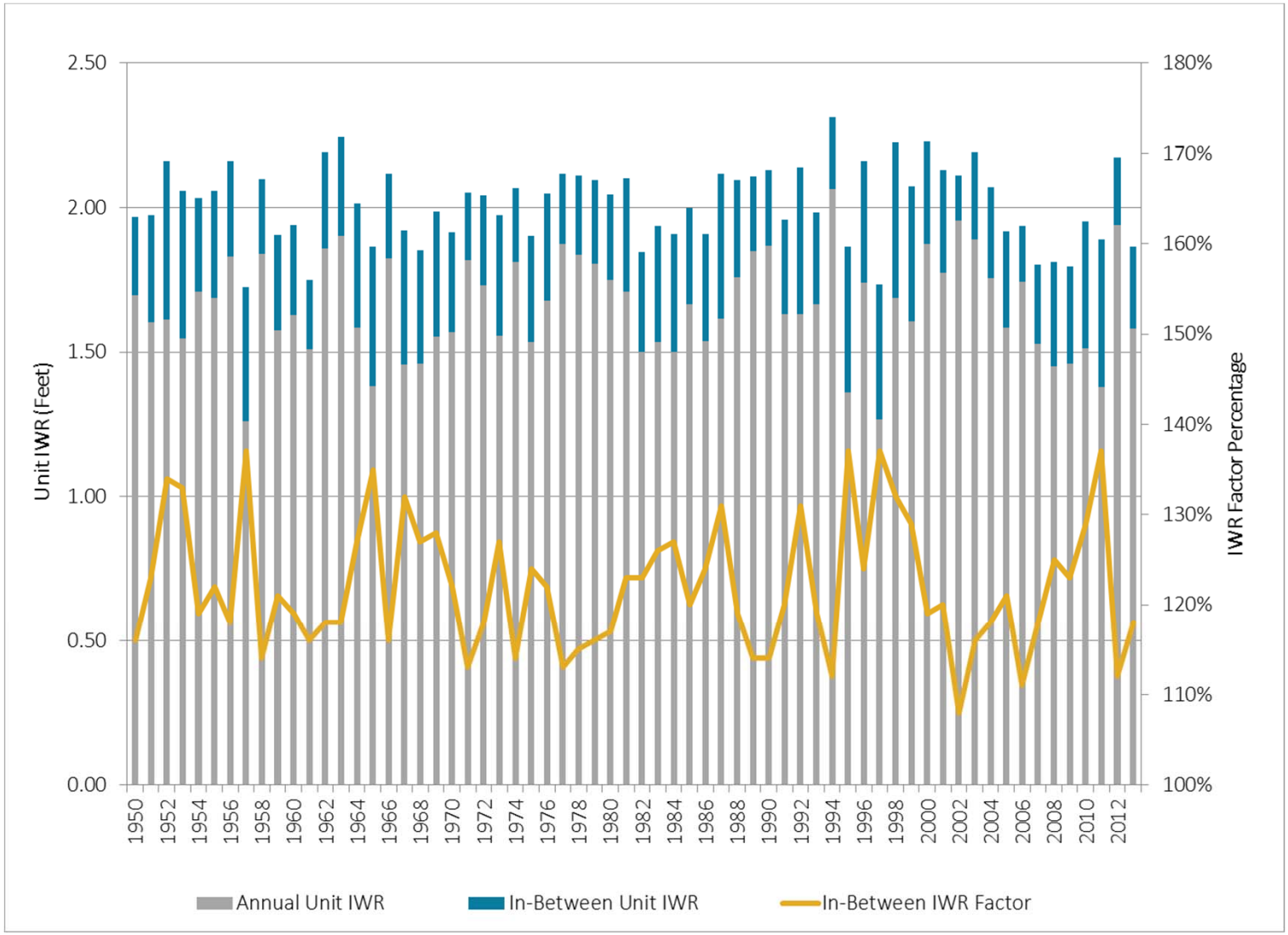
In keeping with direction from the IBCC, certain Planning Scenarios show that climate will change by 2050 and impact agricultural demands.



Basin	"In-Between" Average IWR Increase	"Hot & Dry" Average IWR Increase
Arkansas	18%	26%
Colorado	20%	31%
Gunnison	22%	30%
North Platte	25%	39%
Republican	4%	11%
Rio Grande	15%	18%
South Platte/Metro	15%	24%
Southwest	26%	34%
White	22%	37%
Yampa	19%	34%

Business as Usual	Weak Economy	Cooperative Growth	Adaptive Innovation	Hot Growth
Current	Current	In-Between	Hot and Dry	Hot and Dry

CLIMATE
EXAMPLE



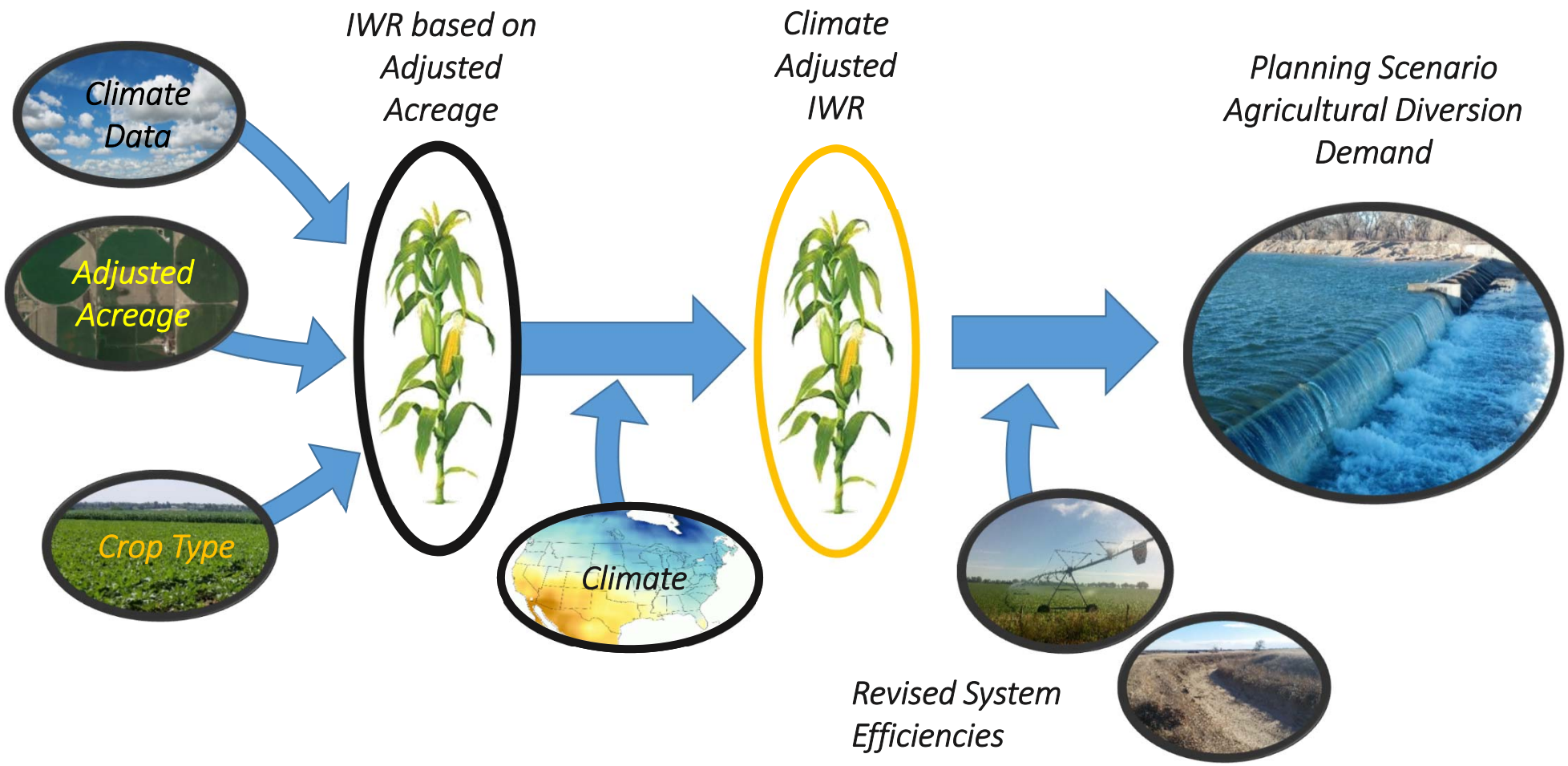
Emerging Technologies

Based on Planning Scenario narratives, capture the potential effect of emerging technologies on agricultural demands in the 2050 Planning Scenarios.

1. Sprinkler Development
   Increase the amount of acreage served by sprinklers in the South Platte and Arkansas River basins.

2. Adaptive Innovation Planning Scenario
   Reduce crop irrigation water requirement and improve system efficiencies.
   Improved System Efficiency by 10%; based on TAG input.

Planning Scenario Agricultural Diversion Demand Process

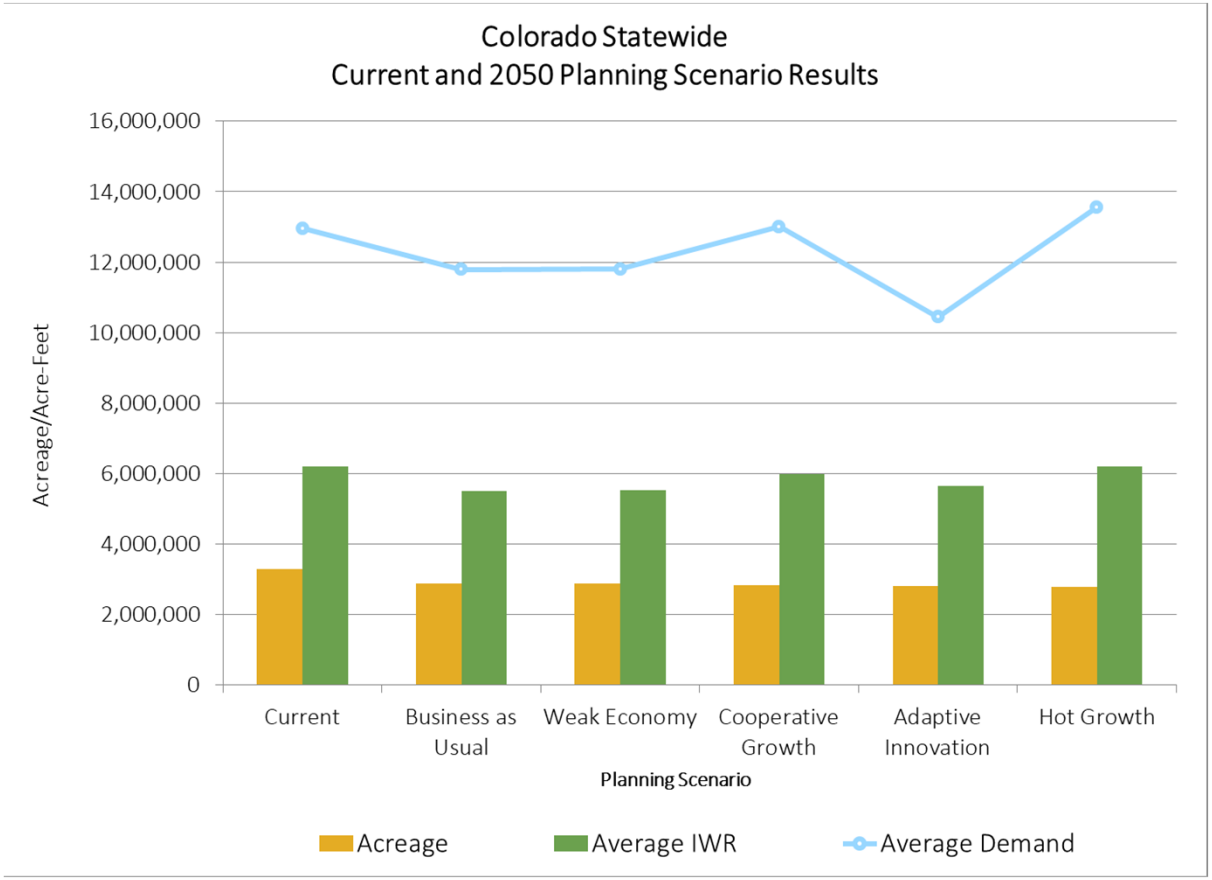


SCENARIO AGRICULTURAL DIVERSION

DEMAND RESULTS

By 2050:

- Nearly 10.4 to 13.6 million AF of diversions + pumping
- Will be needed to meet 5.5 to 6.2 million AF of irrigation water requirement
- On 2.8 to 2.9 million acres of irrigated land



What is an Agricultural Gap?

Agricultural Gap

- The amount of additional water supply that would need to be diverted or pumped to meet any crop shortages

Agricultural Gap Results

- Existing Gap under Current conditions
- Incremental increase in Gap between Current and Planning Scenarios
- Existing and incremental crop shortages

How is the Agricultural Gap estimated?

- CDSS StateMod Water Allocation Models (where available) to estimate gap
  - Allocates water based on physically and legally available flow (Prior Appropriation)

- Use current demands as maximum and adjust for Planning Scenario hydrology to estimate gaps where models are not available