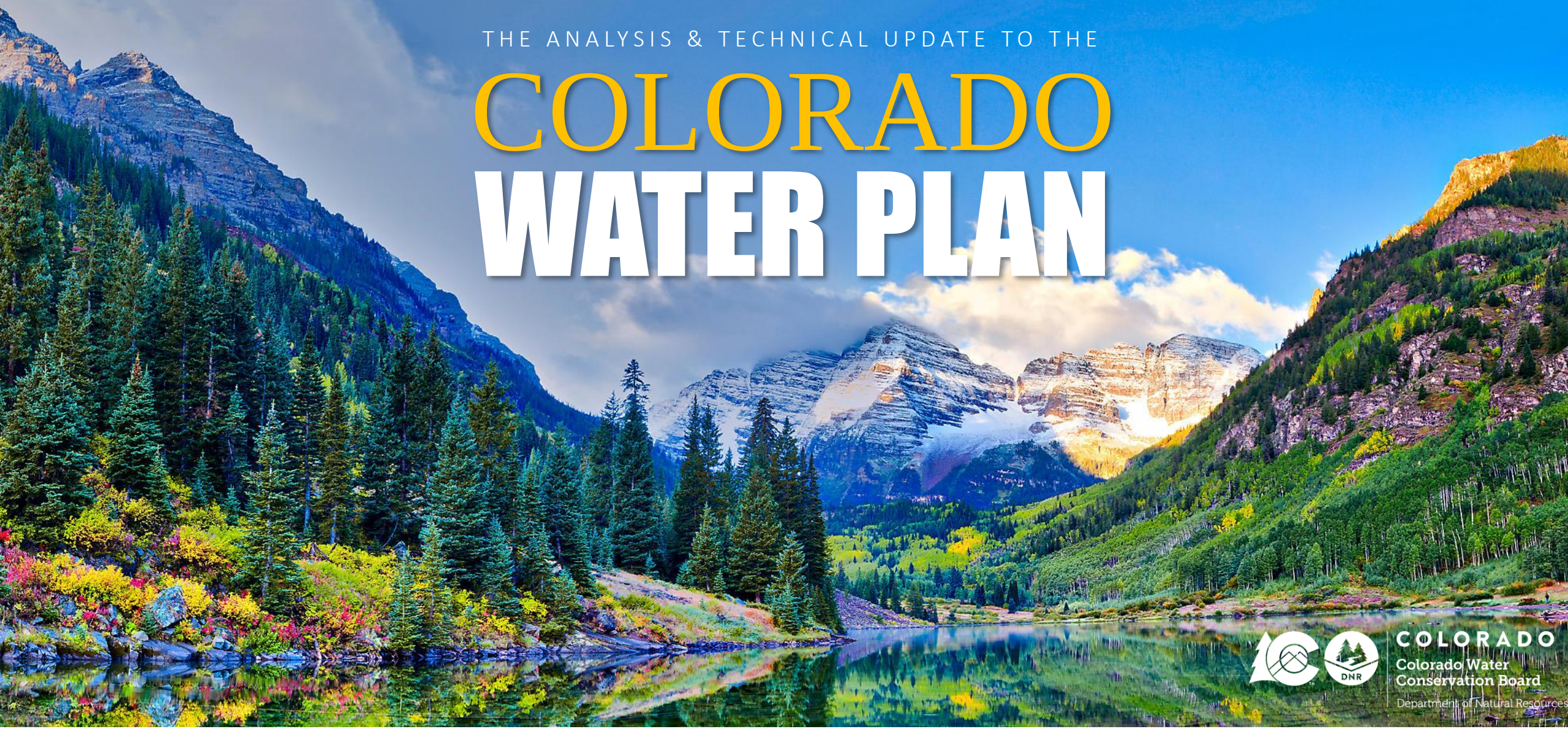


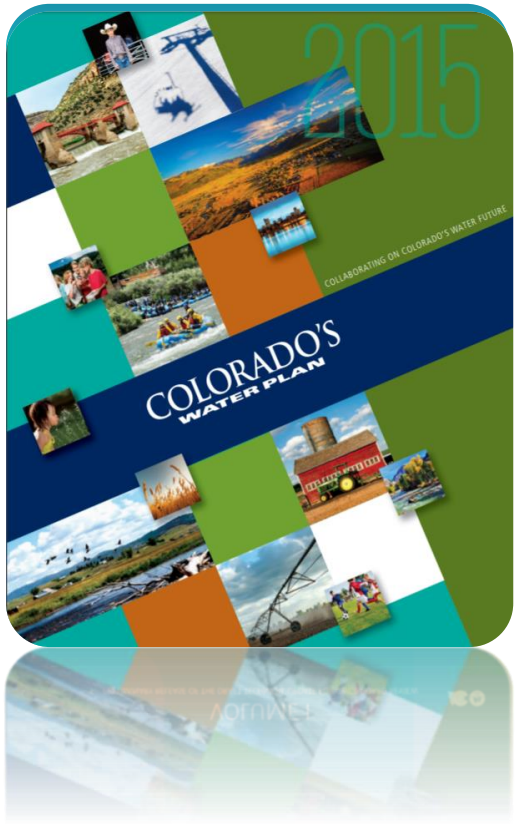
Middle Colorado Integrated Water Management Planning

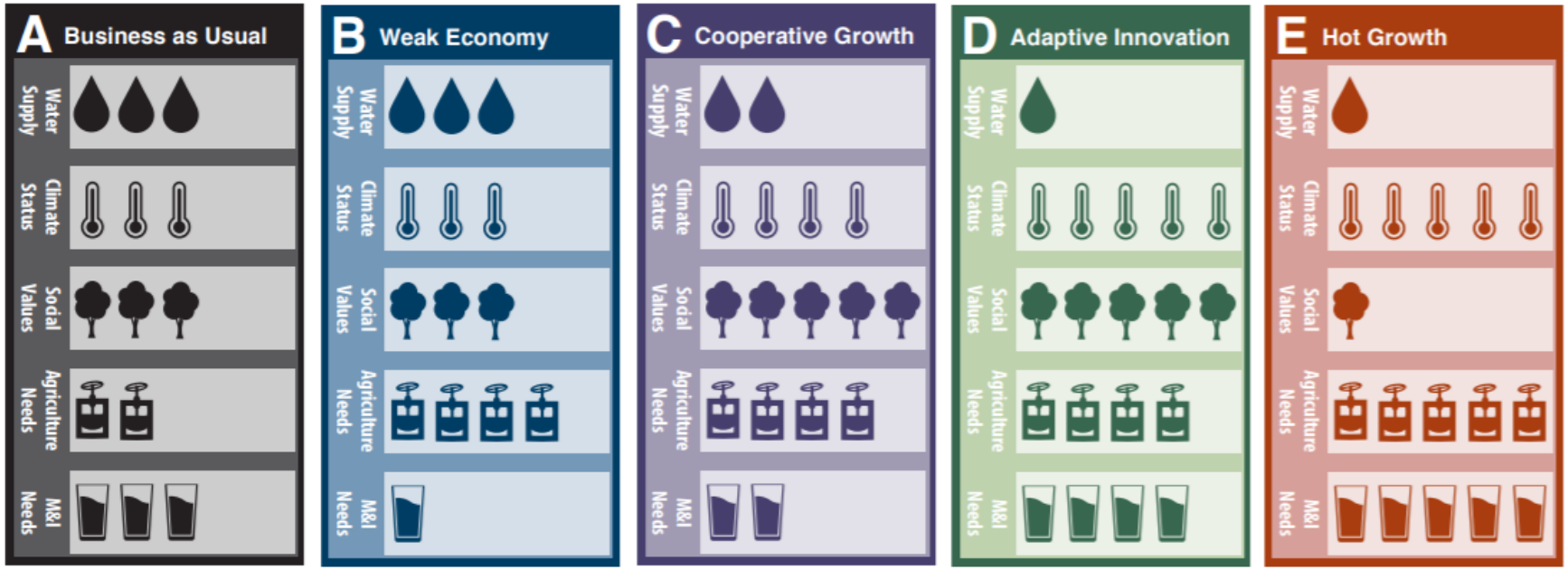
Greg Johnson & Kara Sobieski

WHAT'S NEW?

NEW APPROACHES AND RESULTS IN THE TECHNICAL UPDATE

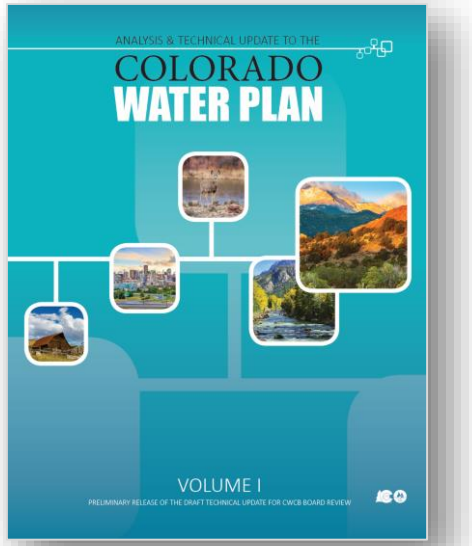
PLANNING SCENARIOS

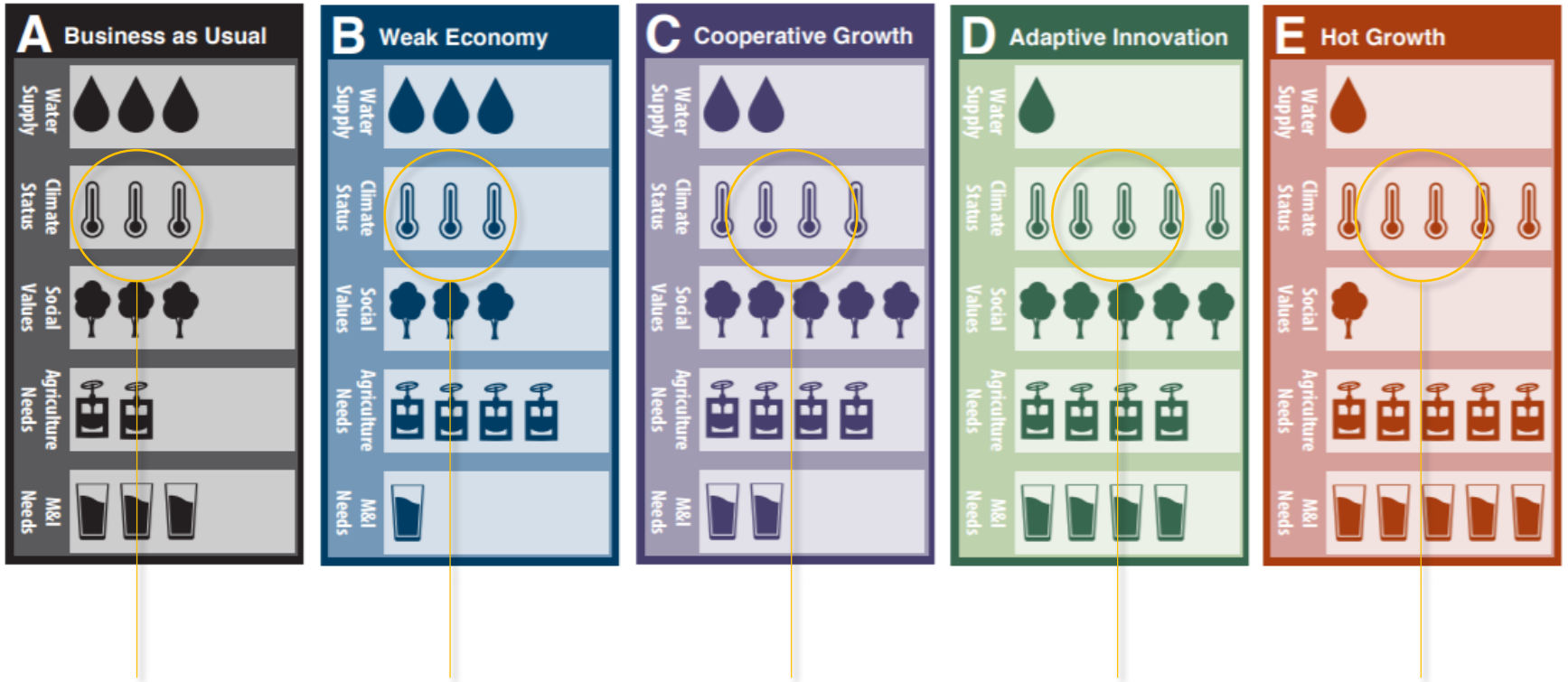




- Scenarios in the Water Plan were developed with the IBCC and BRTs
- These scenarios represent equally plausible futures
- Challenge to turn “narratives” into “numbers”

CLIMATE IMPACTS





NO CLIMATE CHANGE

MODERATE CLIMATE CHANGE

SIGNIFICANT CLIMATE CHANGE

NO CHANGE

+ 3.8 ºF

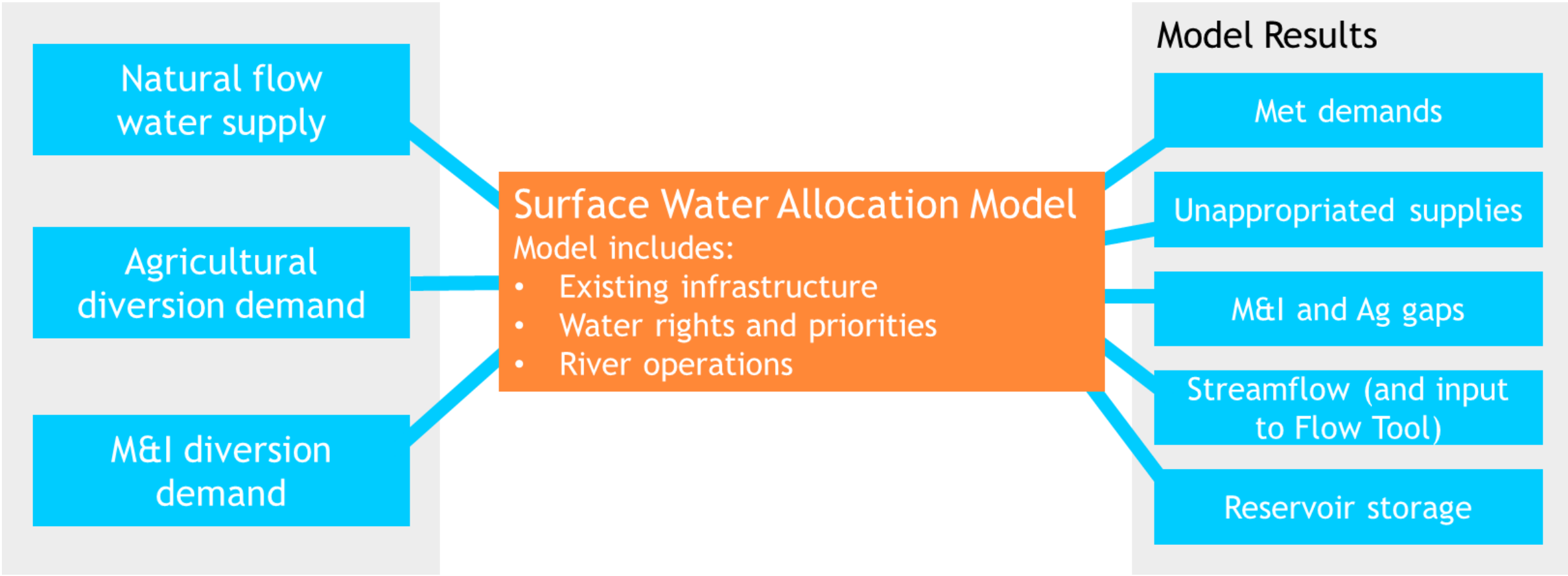
& 5% increase in precip.

+ 4.2 ºF

& 1% decrease in precip.

HOW THE GAP IS DEFINED

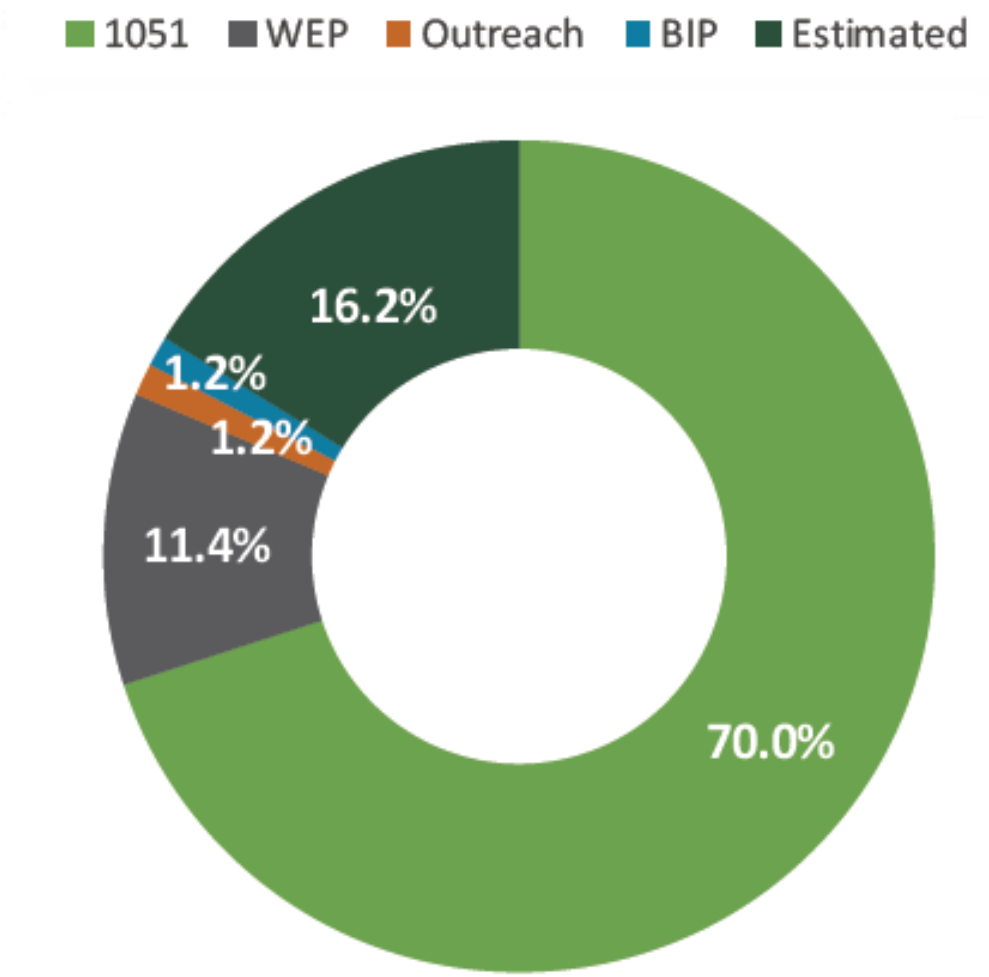
The amount of additional water supply that would need to be diverted or pumped to meet any demand



MUNICIPAL WATER USE

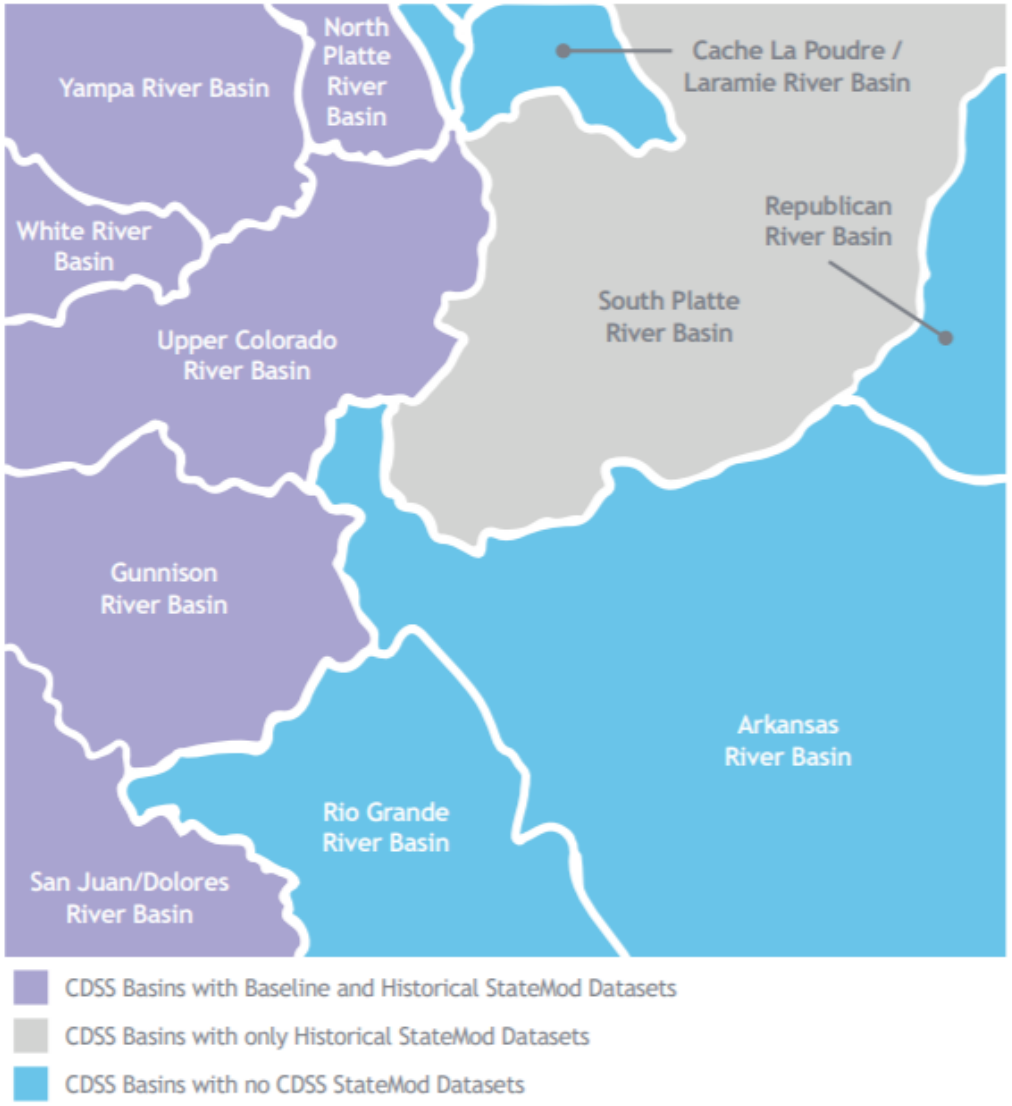
- House Bill 2010-1051 (“1051”)
  - Recent water usage information
  - Collected and reported by water providers

- Incorporated into the Current municipal demands



METHODOLOGY

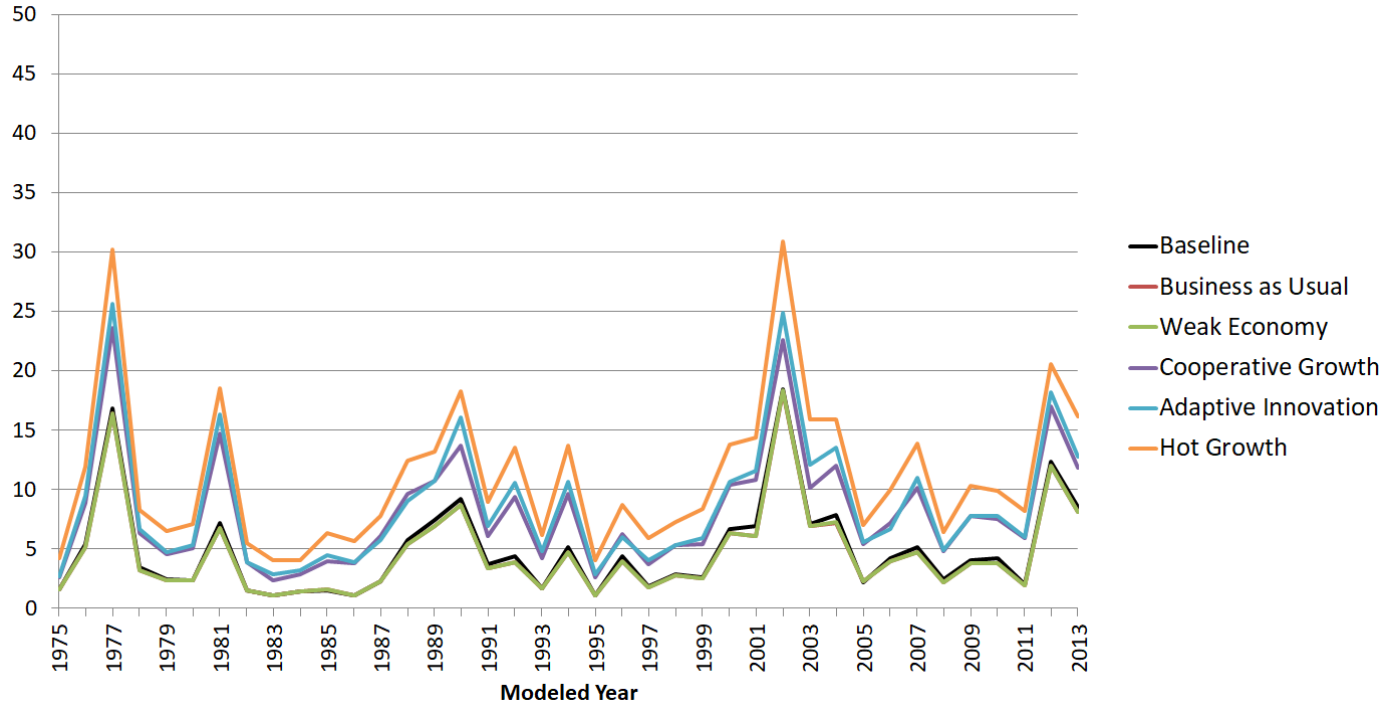
WATER SUPPLY & GAP

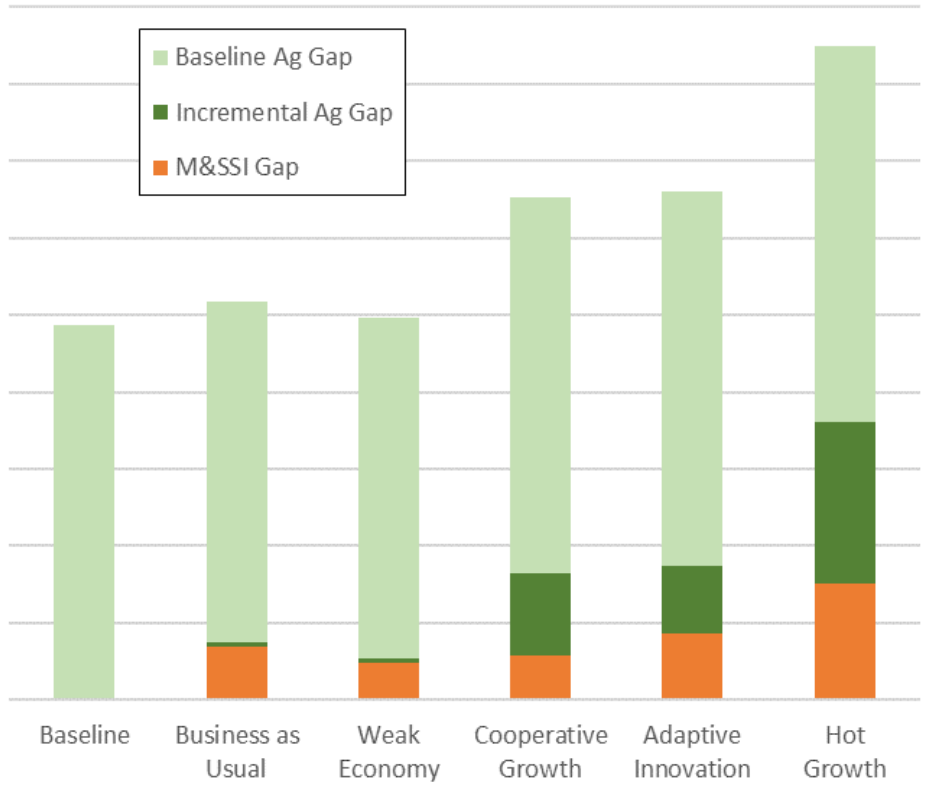


- Basin-wide Planning Models
  - Monthly time step, regional-level detail
  - Models capture typical operations

RESULTS

Time series of agricultural, M&I, reservoir, and streamflow results compared across the Planning Scenarios





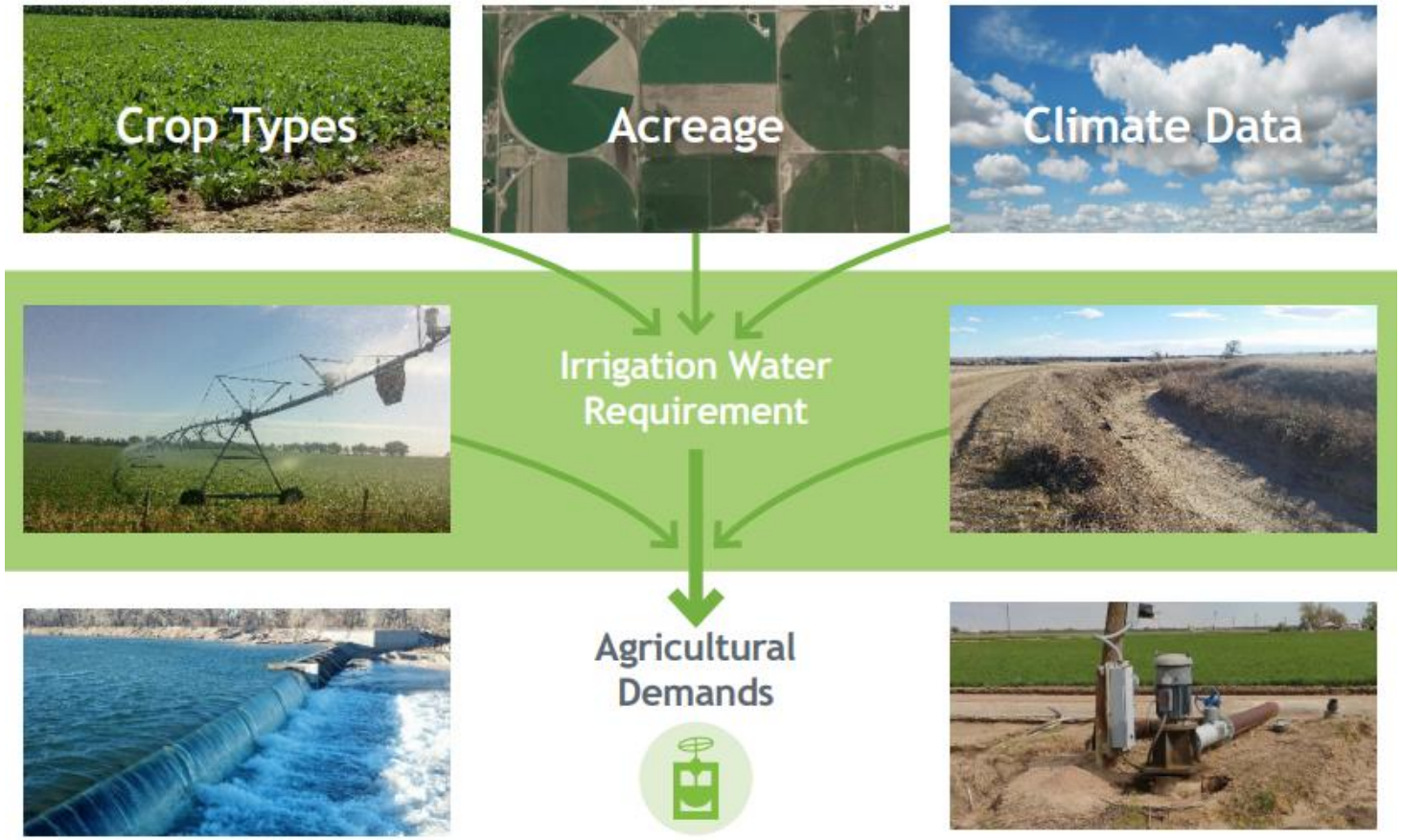
METHODOLOGY

HOW WAS THE TECHNICAL UPDATE INFORMATION DEVELOPED?

AGRICULTURAL DIVERSION DEMANDS

METHODOLOGY

AGRICULTURAL DIVERSION DEMANDS



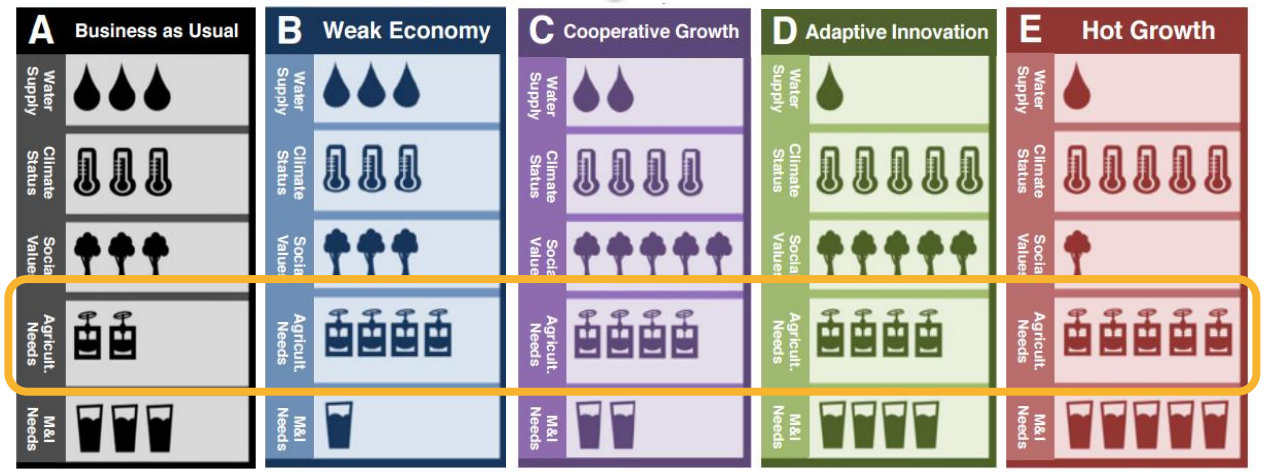
"The amount of water supply that needs to be diverted or pumped to meet the full crop irrigation water requirement"

METHODOLOGY

PLANNING SCENARIO ADJUSTMENTS

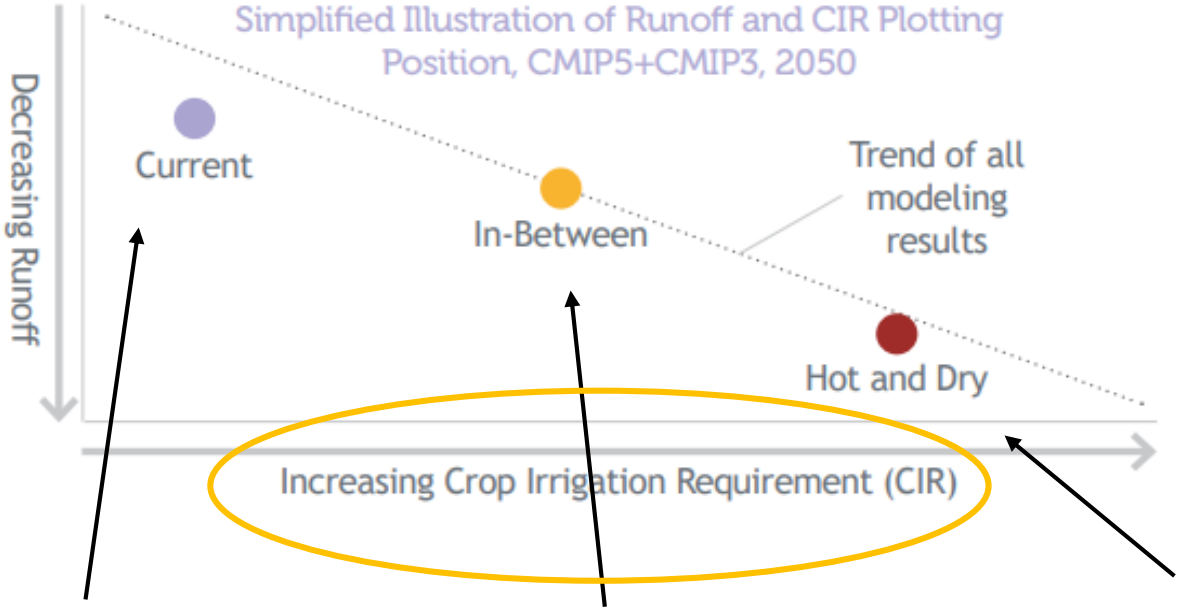
1. Urbanization
2. Planned Agricultural Projects
3. GW Acreage Sustainability
4. Climate
5. Emerging Technologies

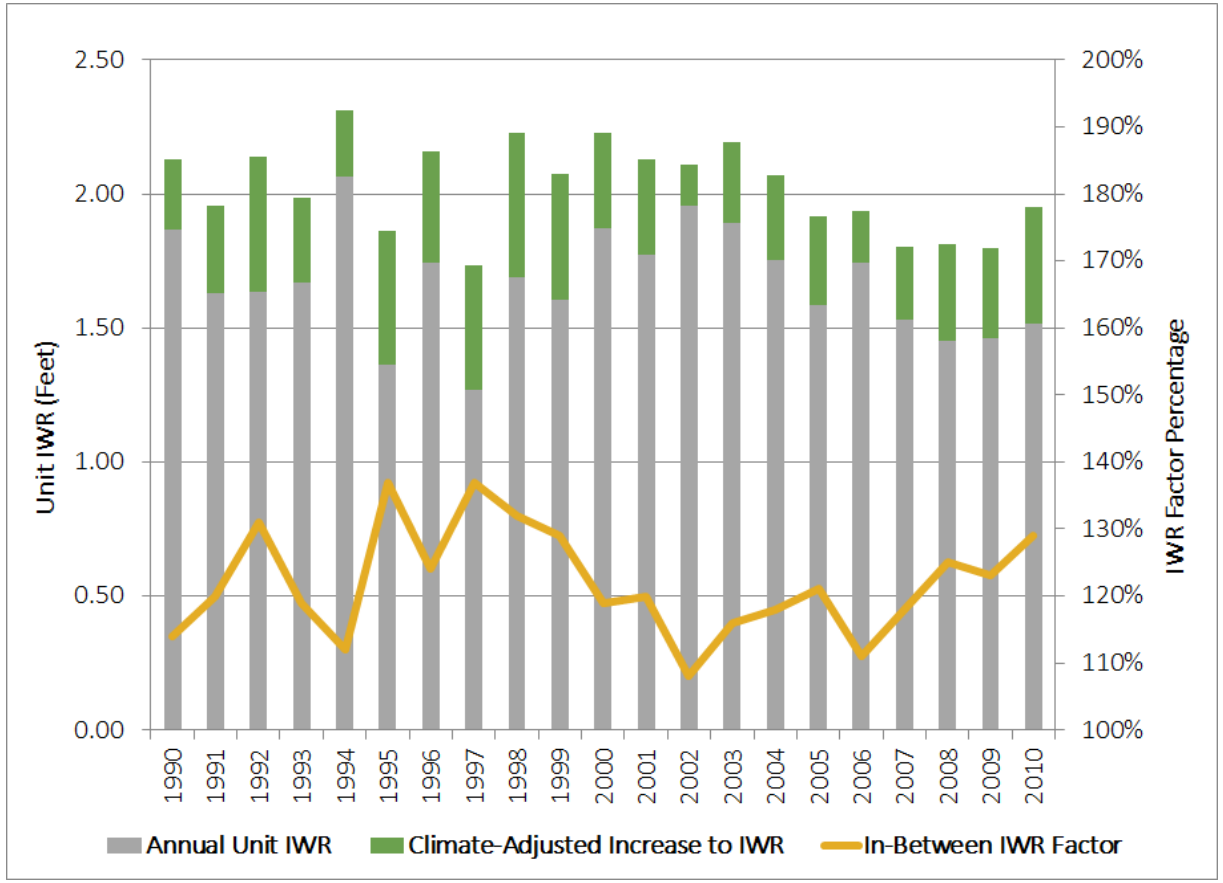
- Acreage
- IWR/Crop Demand
- System Efficiency



METHODOLOGY

CLIMATE





Business as Usual
Weak Economy

Cooperative Growth
(+3.8 °F increase)
(5% increase in precip)

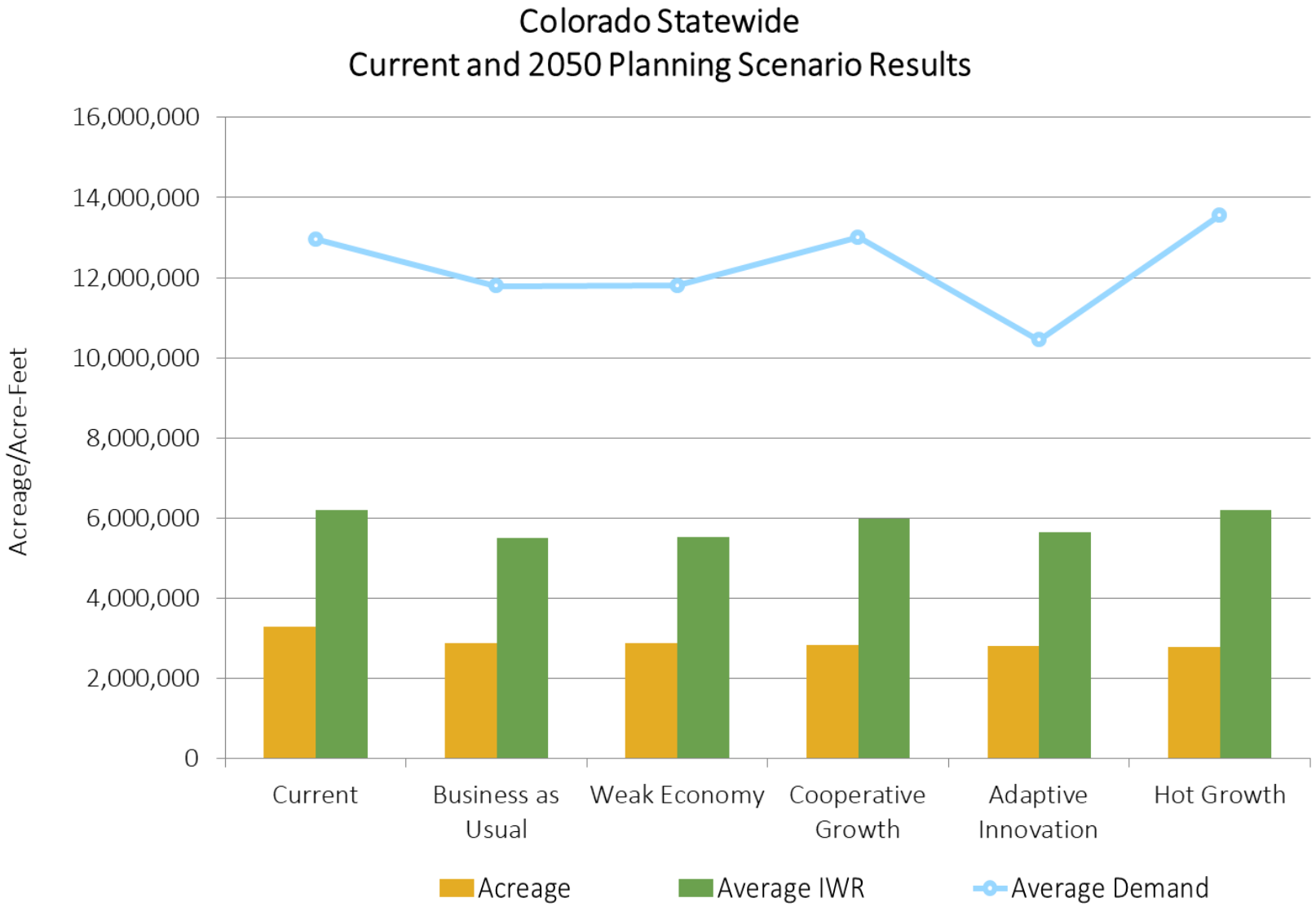
Adaptive Innovation
Hot Growth
(+4.2 °F increase)
(1% decrease in precip)

Average Basin Adjustment	In-Between	Hot and Dry
East Slope	4% - 25%	11% - 39%
West Slope	19% - 26%	30% - 37%
Colorado River Basin	3% - 26%	7% - 40%

STATEWIDE DEMAND – CURRENT & 2050 PLANNING SCENARIO

By 2050:

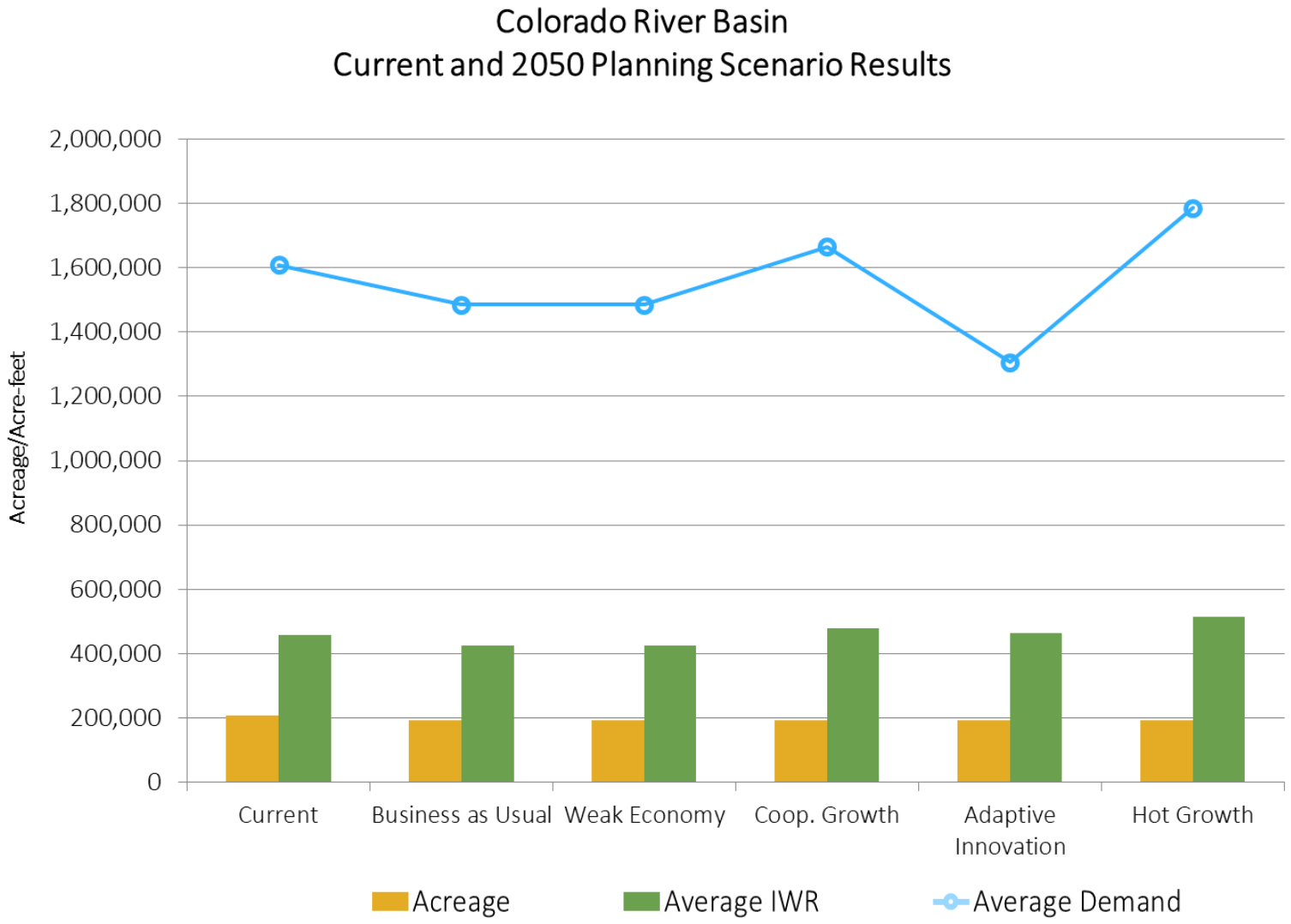
- Nearly 10.4 to 13.6 million AF of diversions + pumping
- Will be needed to meet 5.5 to 6.2 million AF of crop demand
- On 2.8 to 2.9 million acres of irrigated acreage



COLORADO RIVER BASIN – CURRENT & 2050 PLANNING SCENARIO

By 2050:

- 1.3 to almost 1.8 million AF of diversions + pumping
- Will be needed to meet 425,000 to 515,000 AF of crop demand
- On 193,000 acres of irrigated acreage

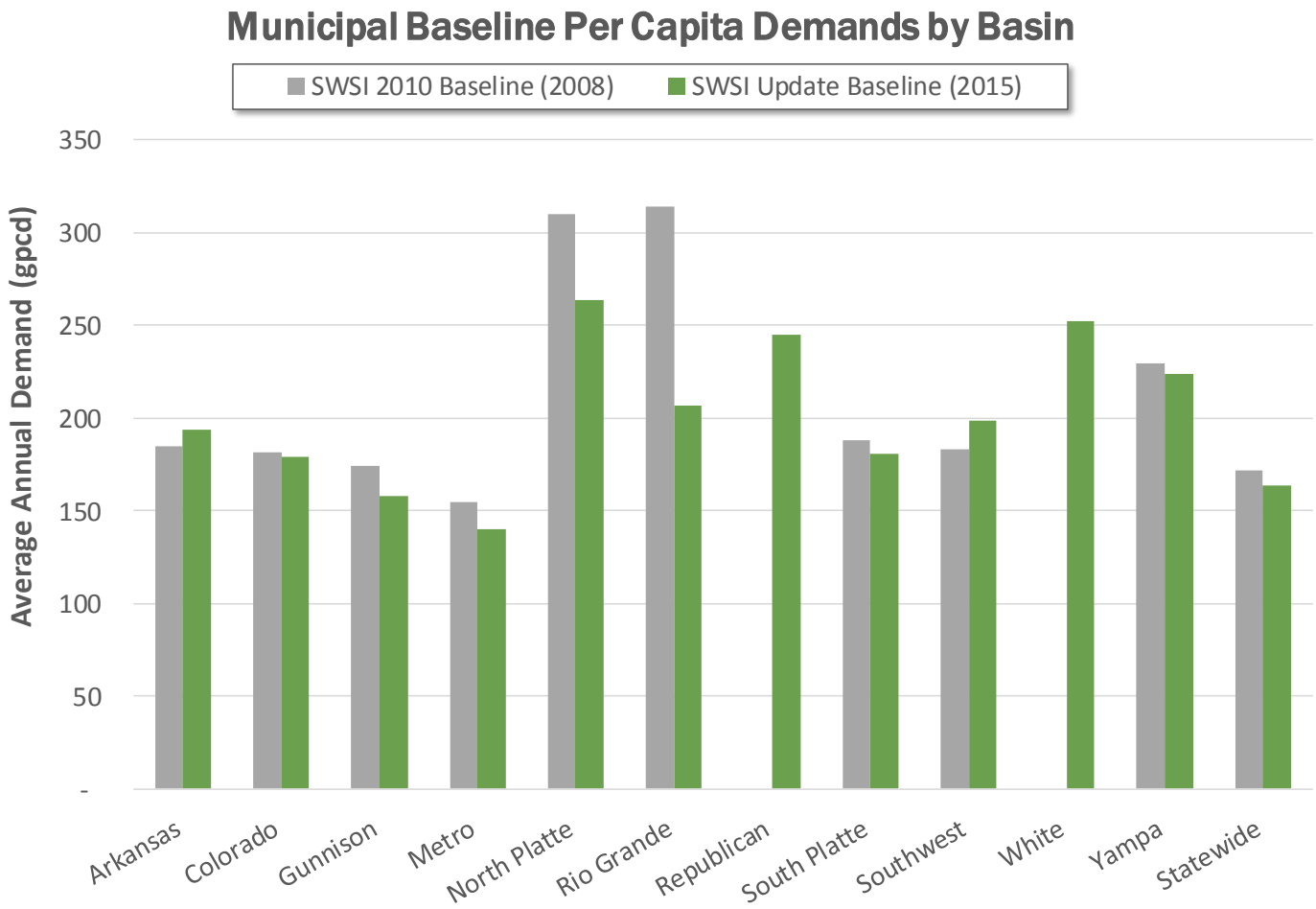


MUNICIPAL DEMANDS

METHODOLOGY

MUNICIPAL DEMANDS

- Total Demand = Population * GPCD
- 5.5 million people in Colorado in 2015
- Updated Baseline Rate of Use
- Statewide per capita demands decreased from 172 to 164 gpcd
- Most water provider per capita demands have decreased



PLANNING SCENARIO ADJUSTMENTS

- Recent **trends continue**
- Regular **economic cycles**
- Slow increase in **denser developments**
- Social values and regs **remain the same**
- Water **conservation efforts** slowly increase
- Climate is **similar**

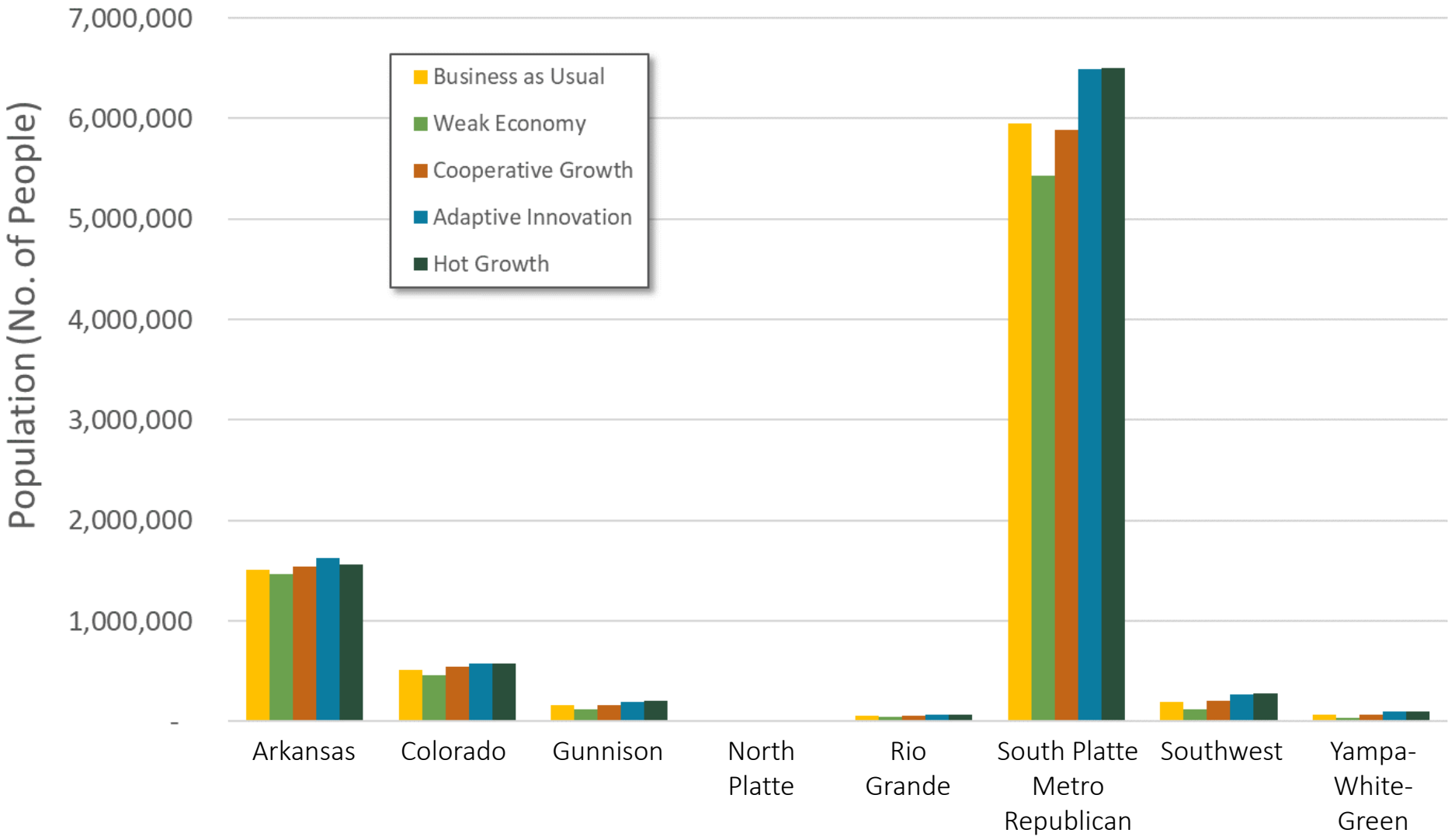
- **Population growth lower** than currently projected
- Economy **struggles**
- Maintenance of infrastructure becomes **difficult to fund**
- **Little change** in social values, levels of water conservation, urban land use patterns, and environmental regulations
- Climate is **similar**

- **Population growth consistent with current** forecasts
- **Integrated and efficient** planning/development
- More development in **urban centers and mountains**
- Embrace water and energy **conservation**
- New water-saving **technologies**
- **Moderate warming** of climate

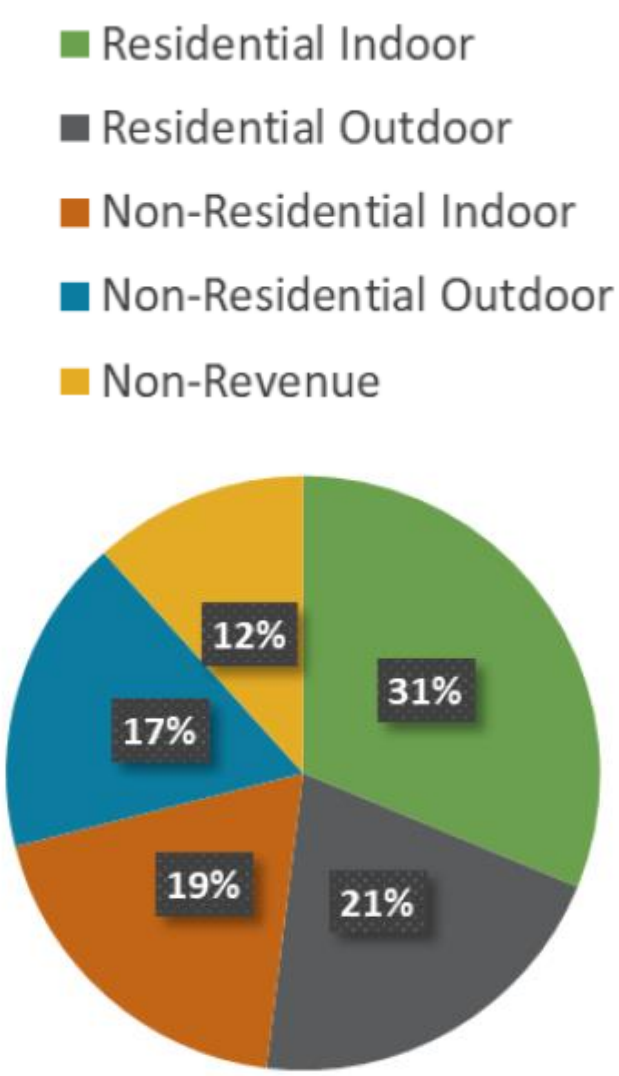
- **Population grows faster** than current
- Social attitudes shift towards **shared responsibility**
- Warmer climate increases irrigation demand, but **technology mitigates increases**
- **Higher water efficiency** helps maintain streamflows
- More **compact urban** development

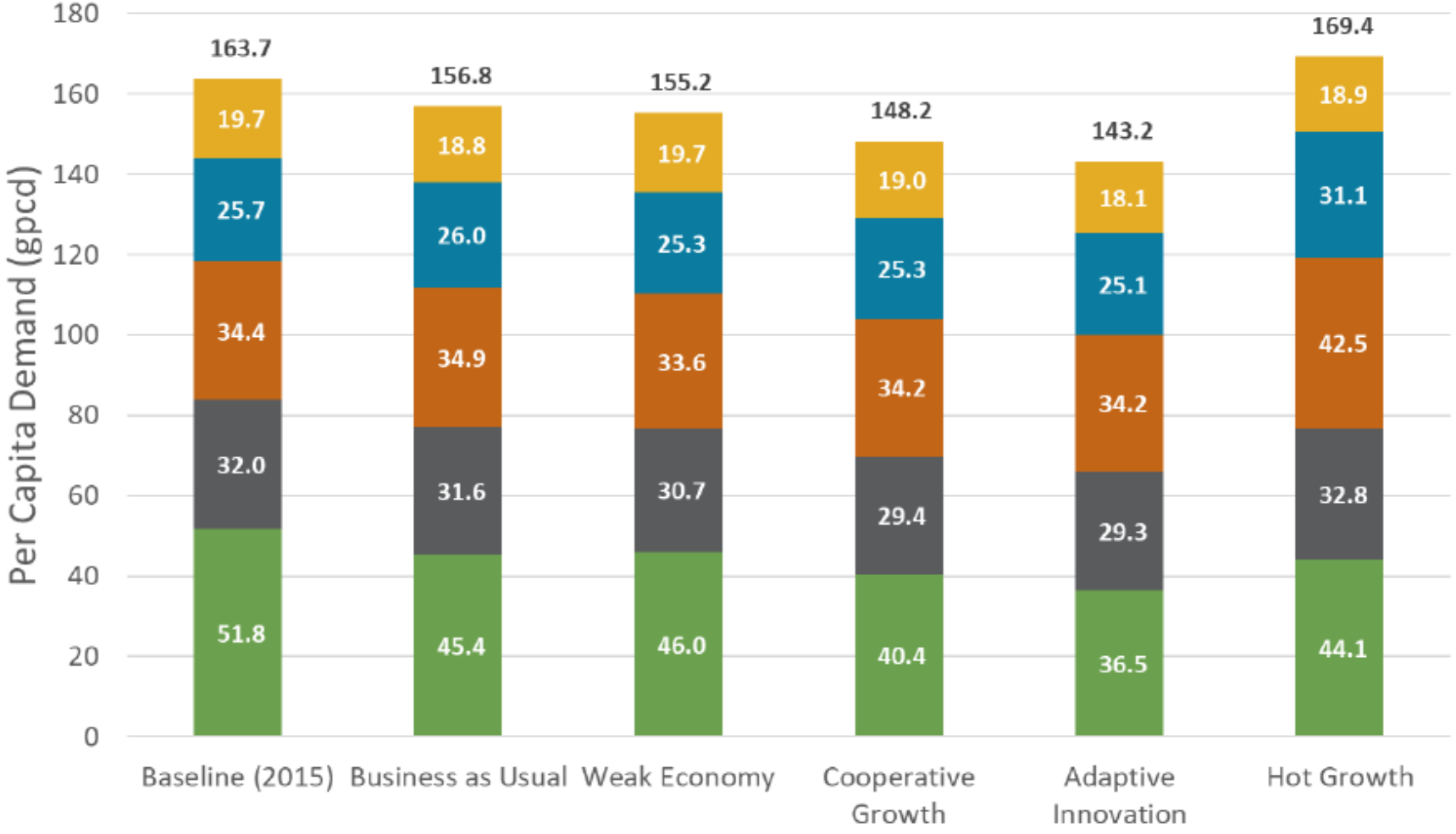
- Vibrant economy **fuels population growth**
- **Regulations are relaxed**
- **Hot and dry** conditions
- Families prefer **low-density housing**

STATEWIDE POPULATION – CURRENT & 2050 PLANNING SCENARIO

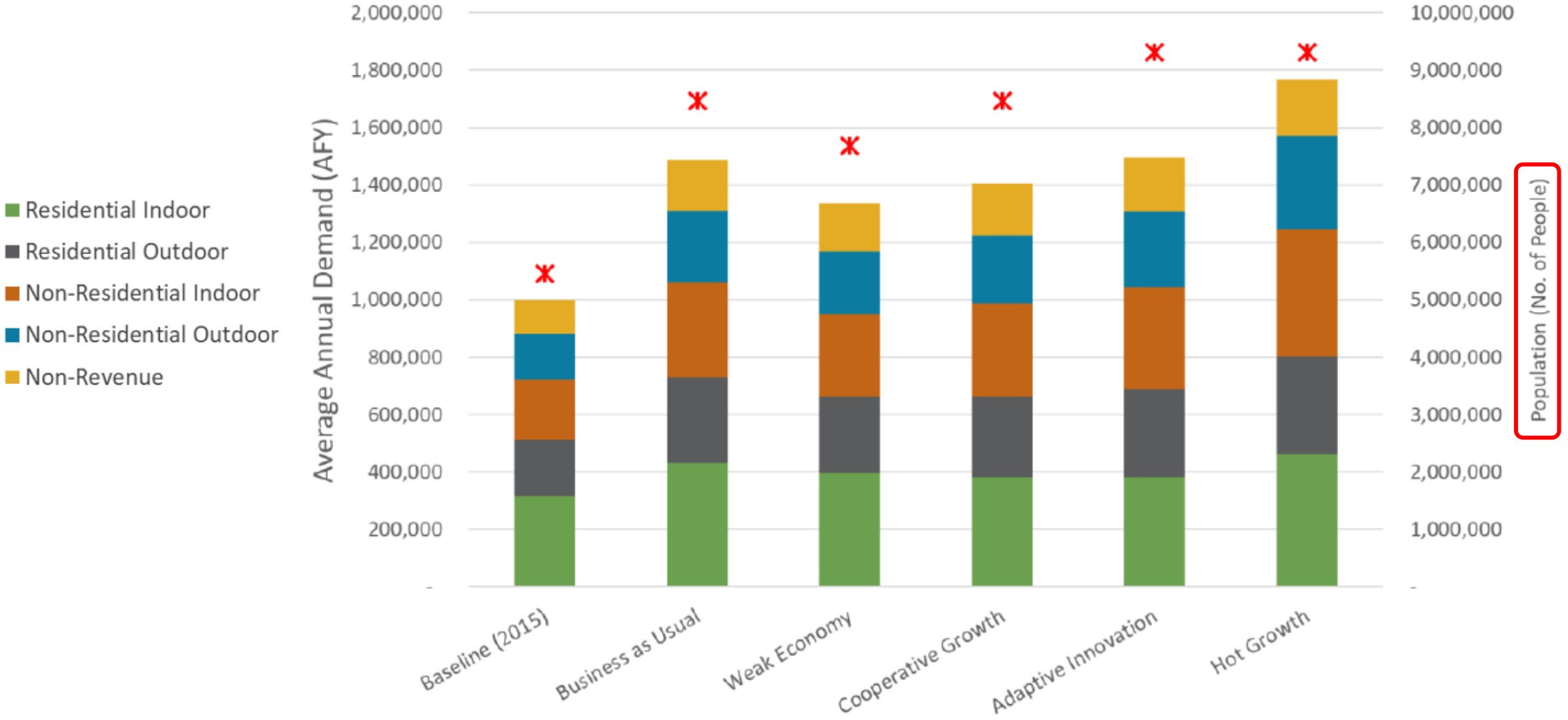


STATEWIDE GPCD – CURRENT & 2050 PLANNING SCENARIO

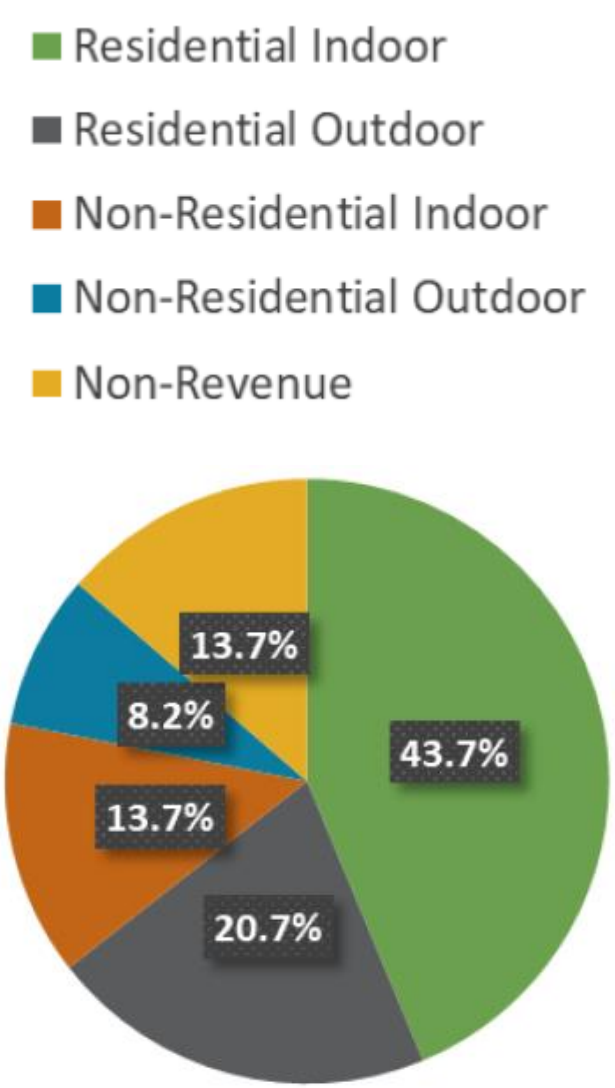


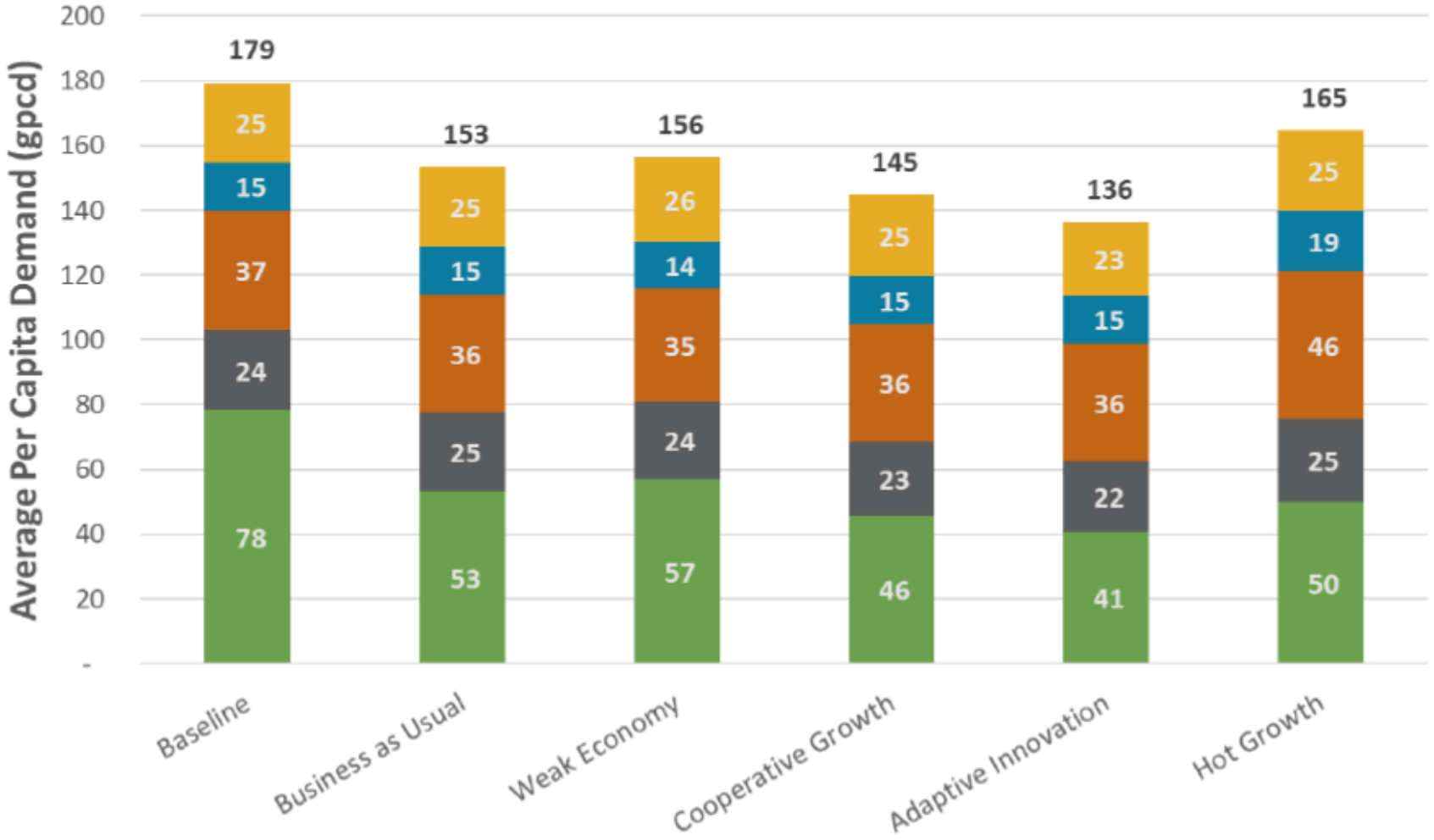


STATEWIDE DEMAND – CURRENT & 2050 PLANNING SCENARIO

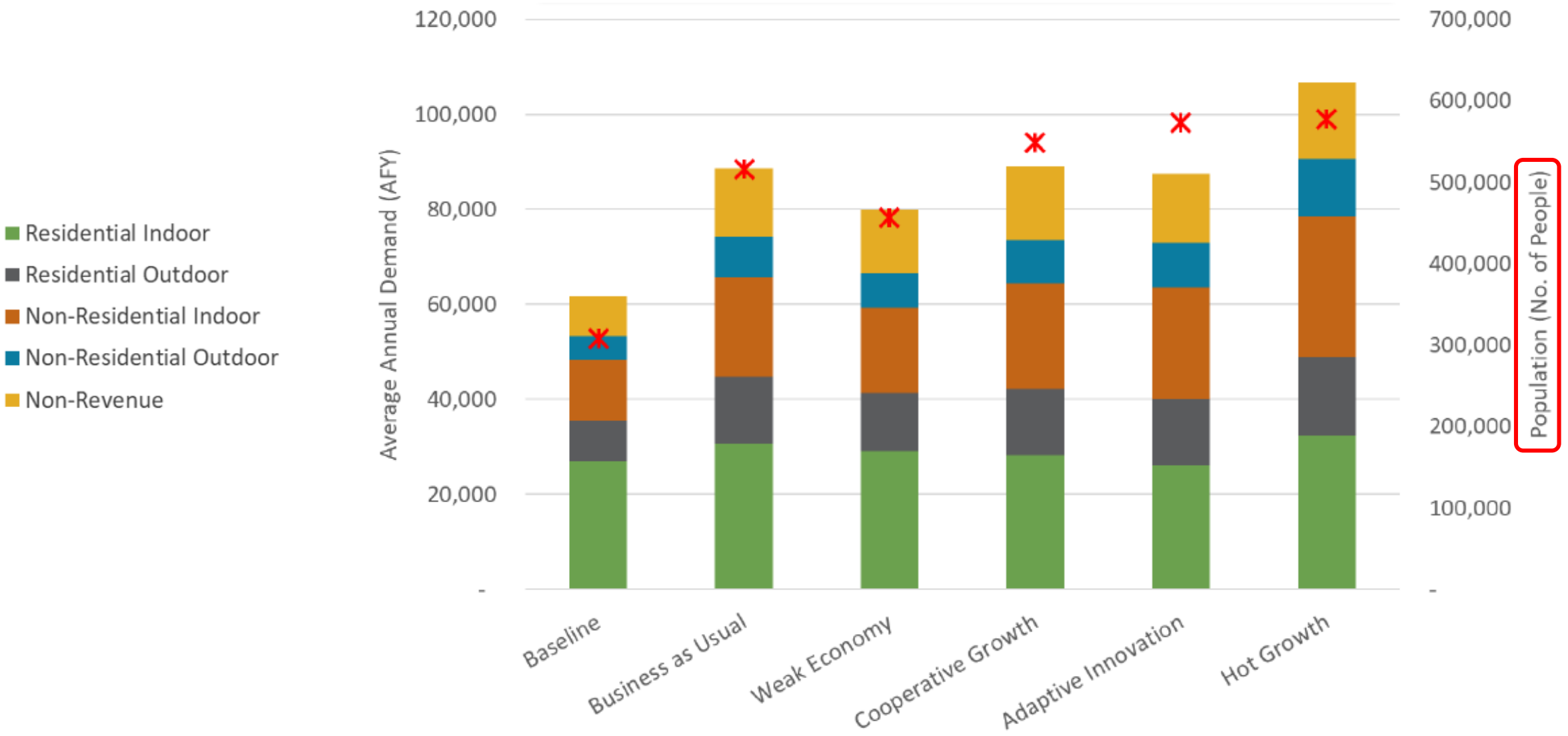


COLORADO RIVER BASIN GPCD – CURRENT & 2050 PLANNING SCENARIO

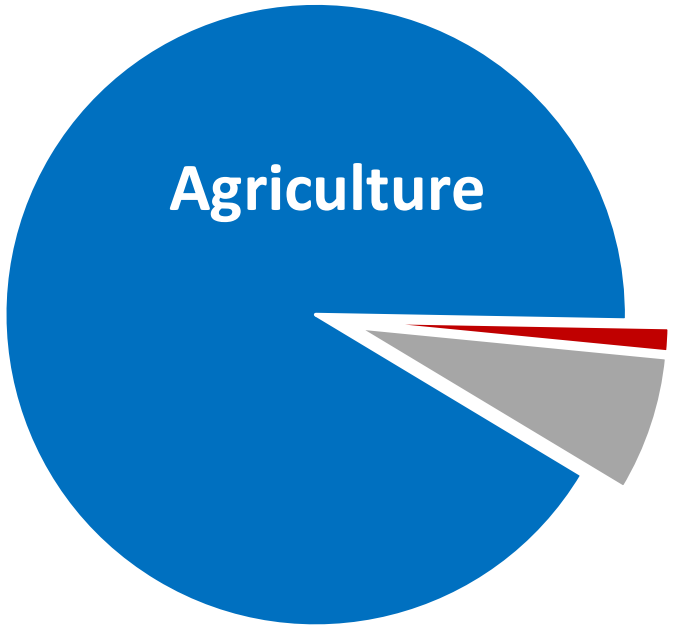


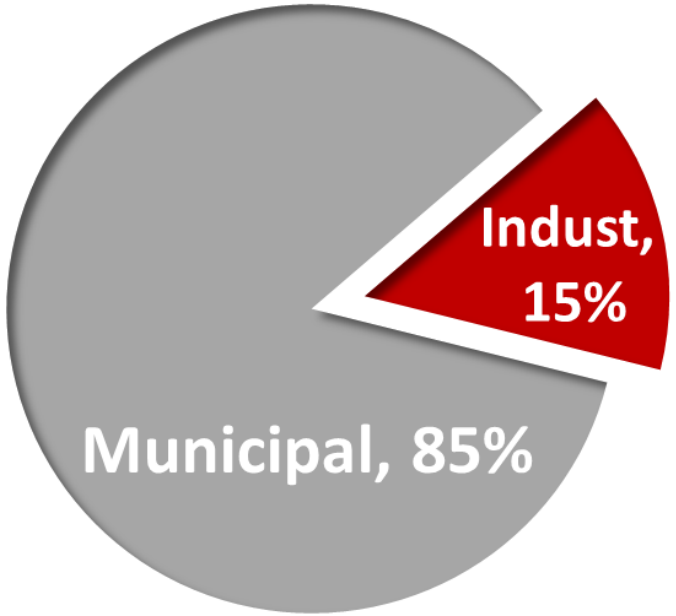


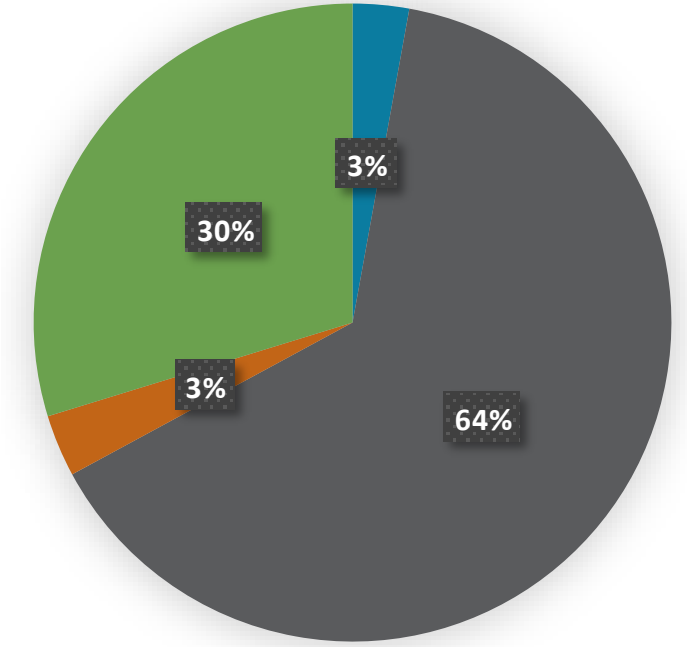
COLORADO RIVER BASIN DEMAND – CURRENT & 2050 PLANNING SCENARIO



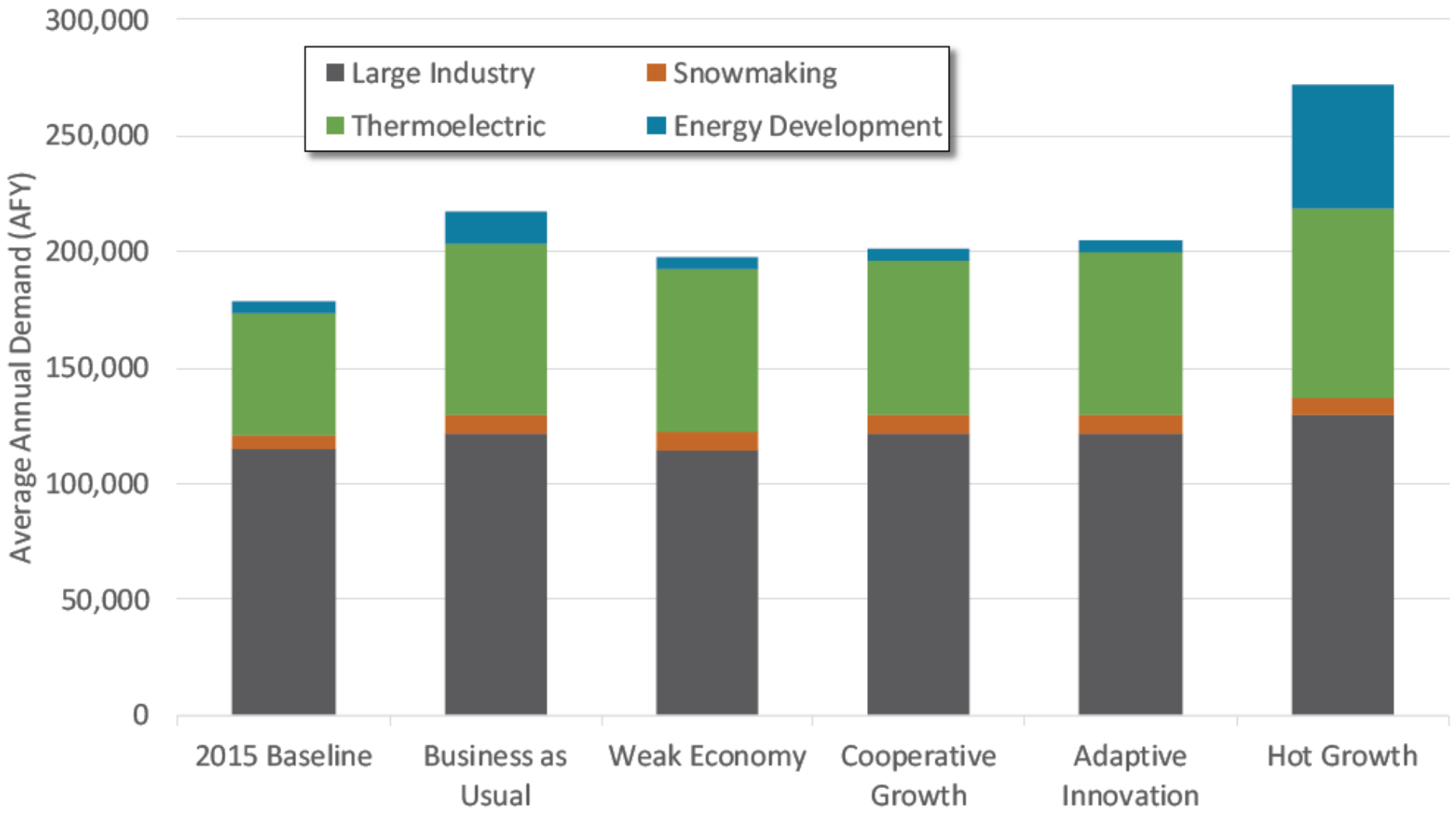
INDUSTRIAL DEMANDS







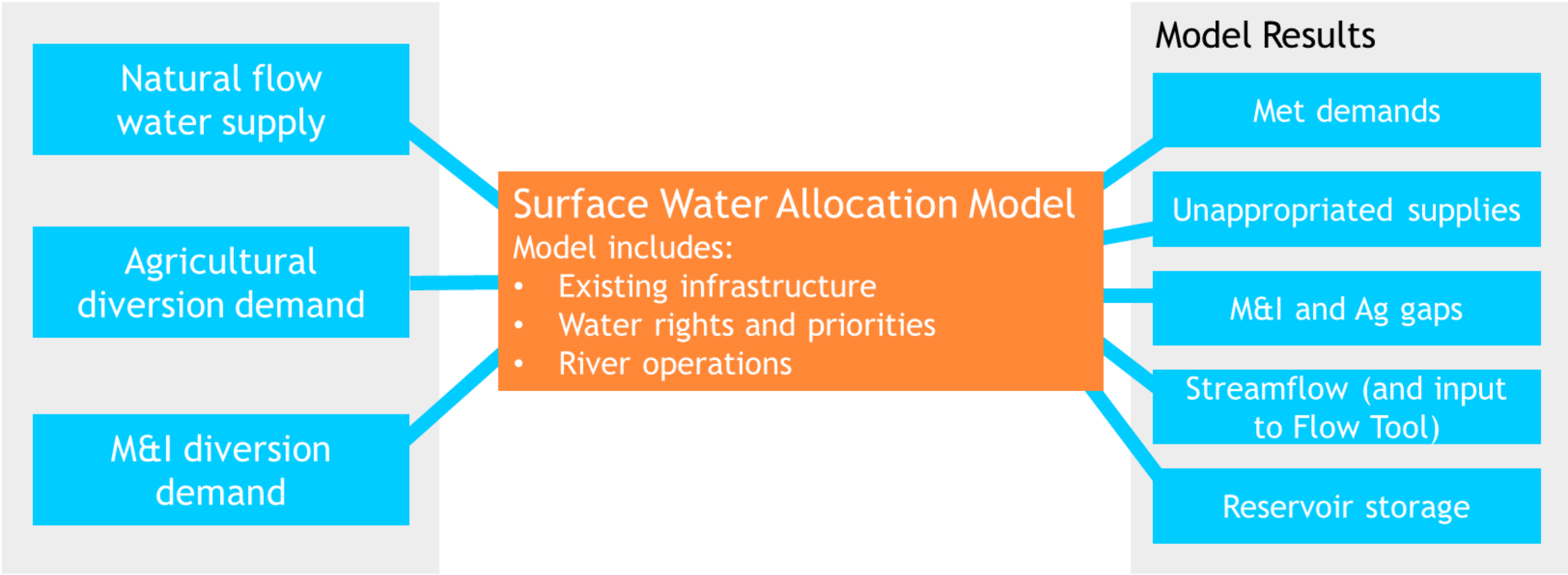
STATEWIDE DEMAND – CURRENT & 2050 PLANNING SCENARIOS



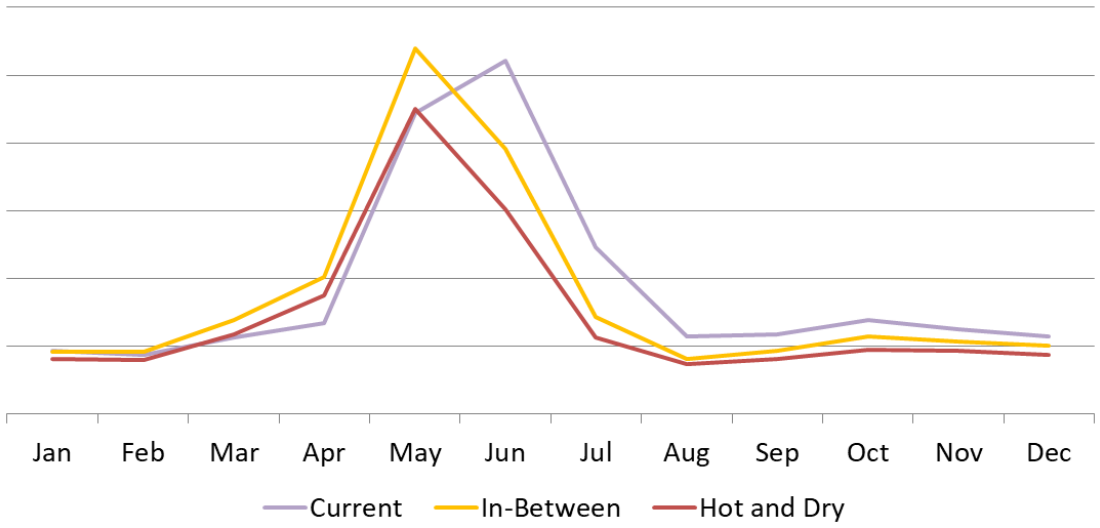
WATER SUPPLY & GAP

GAP ANALYSIS

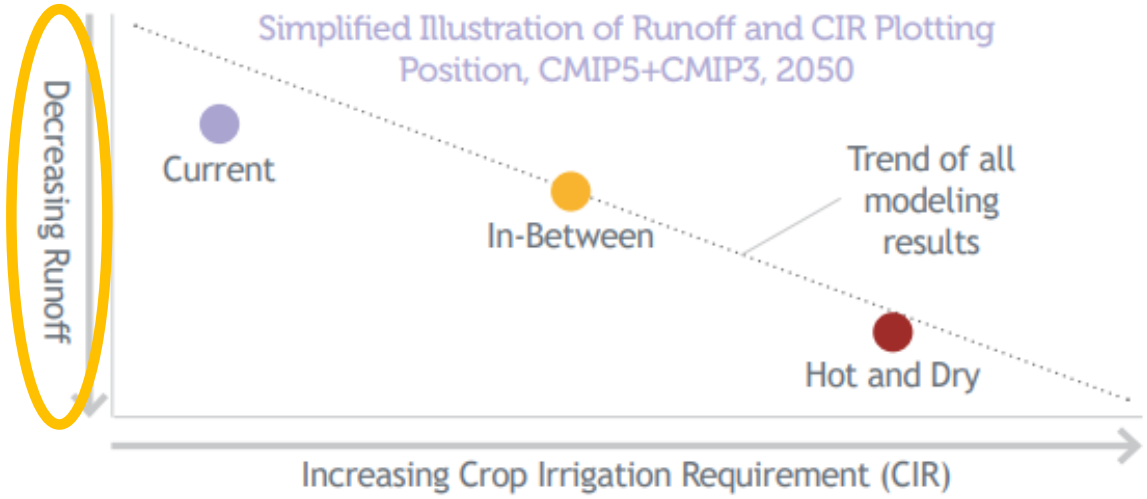
The amount of additional water supply that would need to be diverted or pumped to meet any demand



CLIMATE ADJUSTED HYDROLOGY



Example Average Monthly Hydrology



Business as Usual
Weak Economy

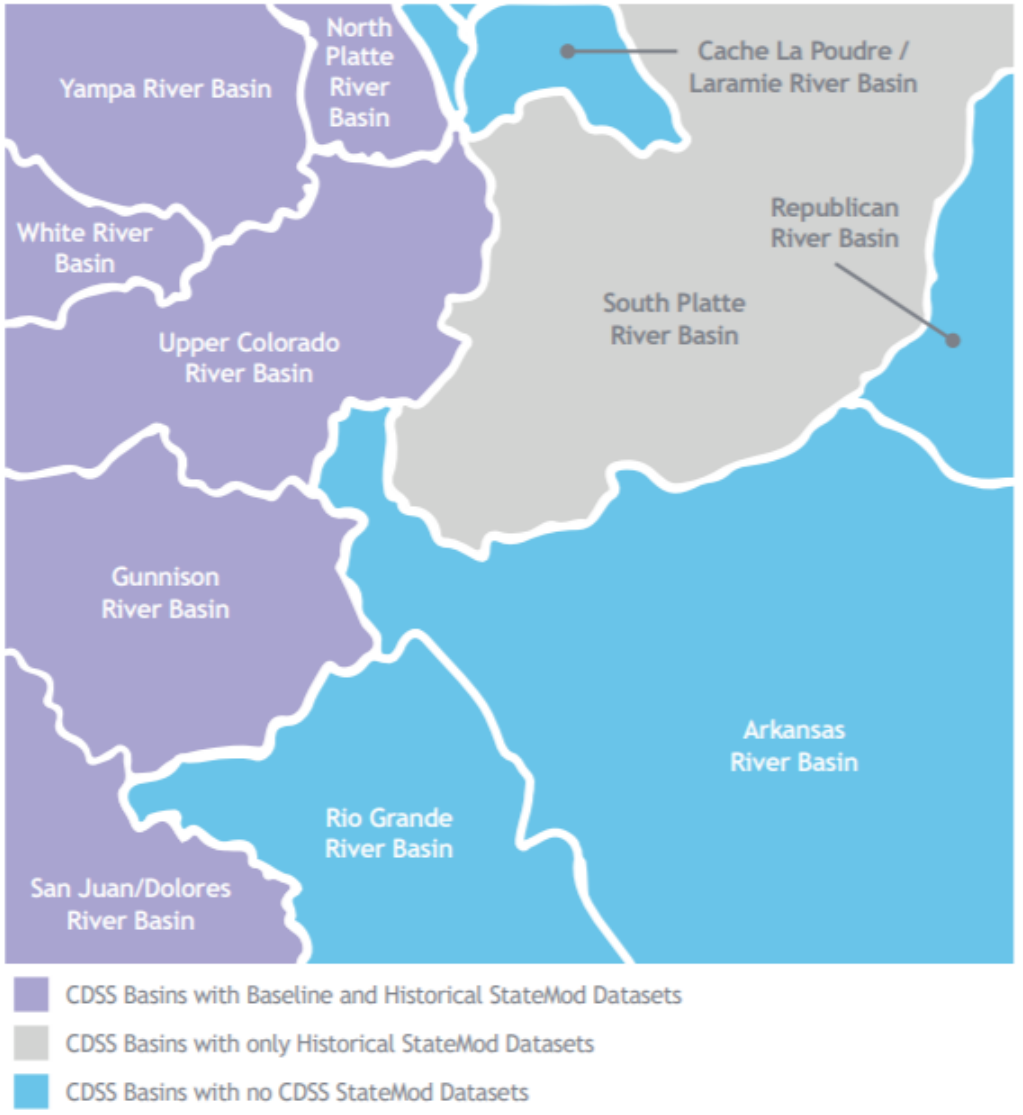
Adaptive Innovation
Hot Growth

Cooperative Growth

GAP ANALYSIS

LIMITATIONS

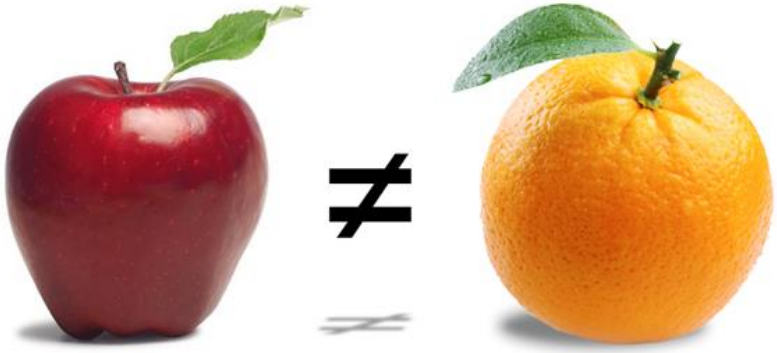
- Basin-wide Planning Models
  - Monthly time step, regional-level detail
- Model calibration
  - Dependent on input data, appropriate for regional study
- Representation of operations
  - Captures typical operations
- Groundwater pumping and transbasin imports
  - Reflects current/historical amounts



RESULTS

OF TECHNICAL UPDATE ANALYSES

COMPARING GAP NUMBERS



COMPARING THE 2015 WATER PLAN GAP NUMBERS TO GAPS IN

THE TECHNICAL UPDATE

SIMILAR GAPS. ABSENT PROJECTS. LOWER POPULATION. LOWER DEMANDS.

1 Gaps Absent Projects

Gap projections in the Technical Update do not include estimates of basin identified project yields. This is primarily due to a lack of specific project data that would allow projects to be modeled. Forthcoming basin plan updates will reevaluate projects and consider strategies to address gaps.

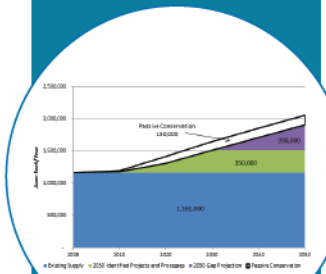
2 Gaps Across Scenarios

Unlike past projections which estimated high, medium and low gaps at 2050, the Technical Update identifies 2050 gaps for each of the five scenarios in the Water Plan.

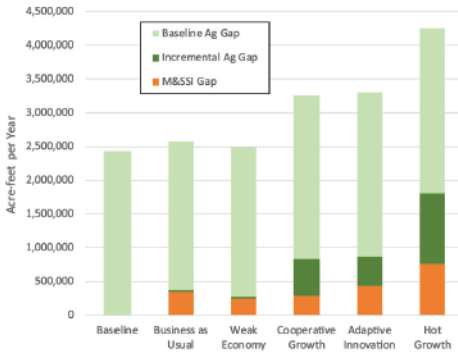
3 Gap Influences

Some of the main drivers (population; climate) and assumptions (storage operations) heavily influence the gaps in the Technical Update. Population projections, while lower than in previous analyses, remain a major driver of demands. Climate change is included in three of the five scenarios, which drives irrigation, streamflow and storage timing. Modeled storage operations maximize the use of stored water to meet demands and lower gaps.

GAPS SHOWN IN THE 2015 WATER PLAN



GAPS SHOWN IN THE 2019 TECHNICAL UPDATE



4 Gap Mitigation

When basins reevaluate plans it will be important to evaluate core projects that represent low-regret actions to meet future needs under any scenario. The Adaptive Innovation scenario, for example, illustrates how adaptive actions (e.g. efficiency) can help offset impacts from climate change and population growth.

190K - 630K AFY
2050 M&I GAP

250K - 750K AFY
2050 M&I GAP

1,722,000 AFY
2050 AG SHORTAGE

23,000 - 1,053,000 AFY
2050 INCREMENTAL AG GAP

5 Gaps: Max, Average & Incremental

Gaps are shown in a manner that reflects the difference in how M&I and agriculture plan in any given year. Feedback on earlier studies suggested that agriculture gaps may have been overstated because many agricultural producers live with annual shortages (especially in over-appropriated basins).

To address this, agricultural gaps are expressed in terms of average and incremental gaps — the degree to which gaps may increase in the future. Maximum agricultural gaps can also be found in the Technical Update results. At the same time, M&I gaps are primarily expressed in terms of maximums, which is consistent with firm yield planning.

STATEWIDE GAP ANALYSIS RESULTS

M&I Gap

245,000 to 754,000 AF

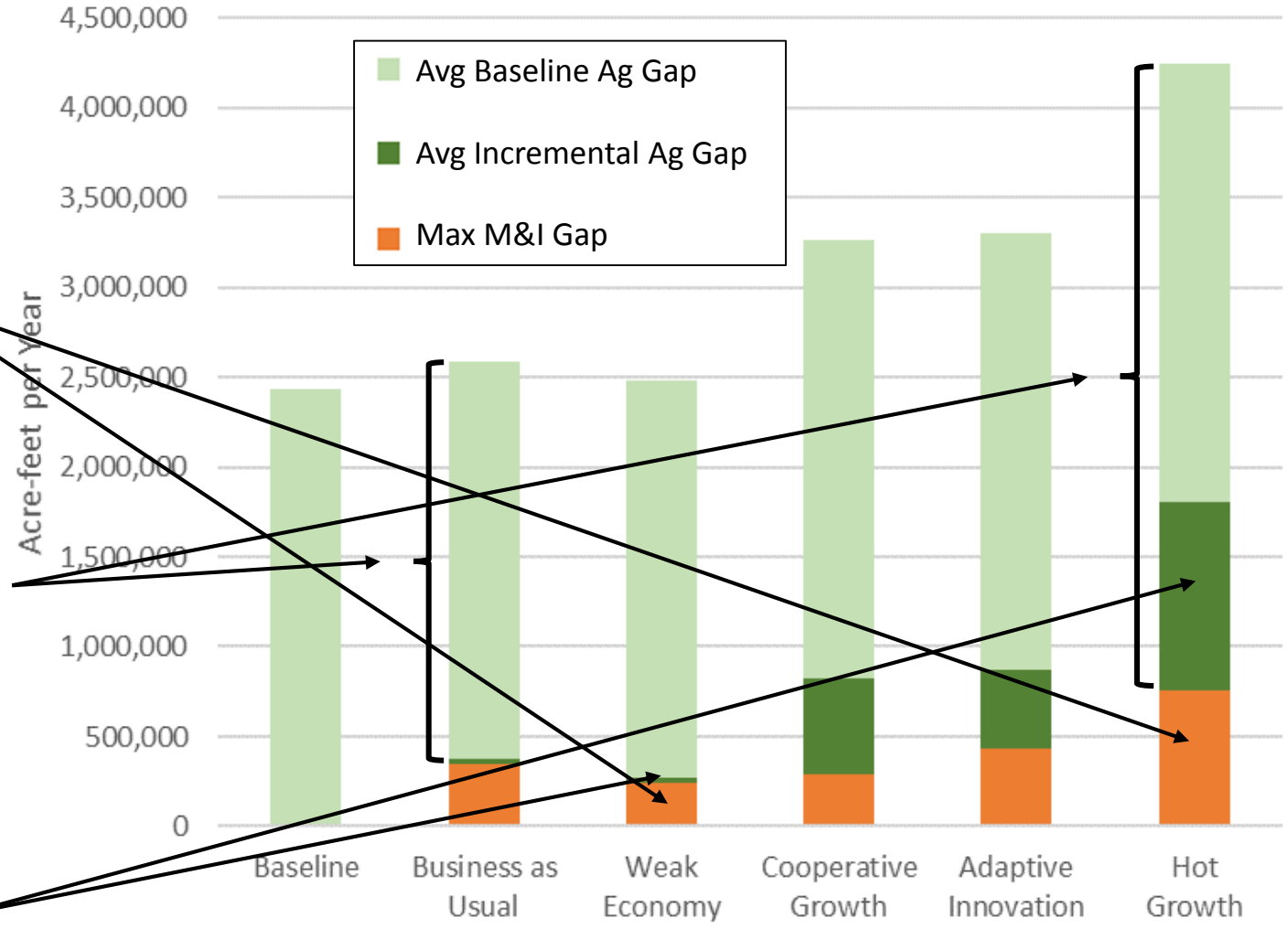
(Does not include projects)

Total Ag Gap

2,213,000 to 3,379,000 AF

Incremental Ag Gap

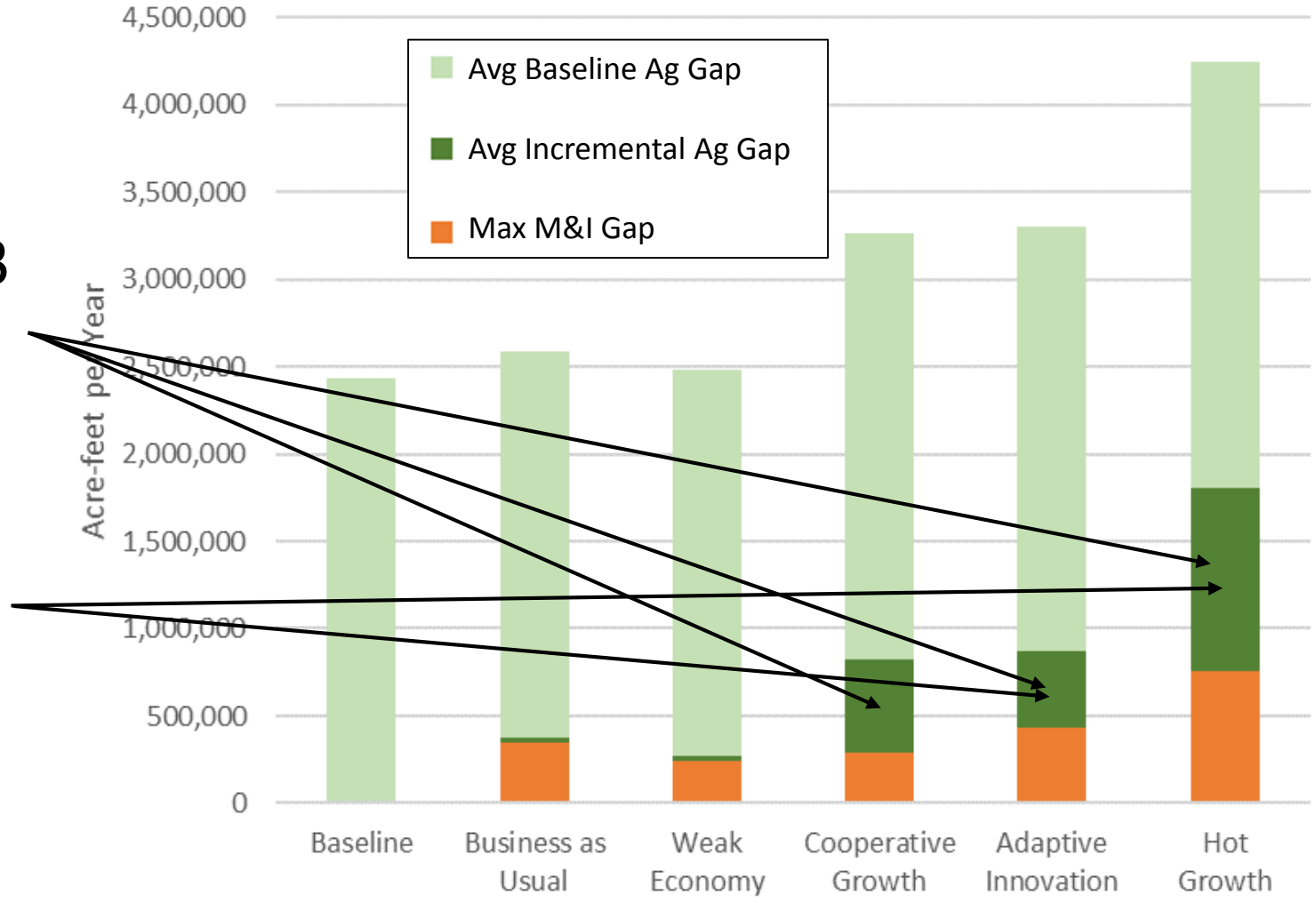
23,000 to 1,053,000 AF



GAP ANALYSIS OBSERVATIONS

Ag gaps may increase 18 to 43 percent beyond baseline

Ag gaps are less in Adaptive Innovation than Hot Growth despite similar climate

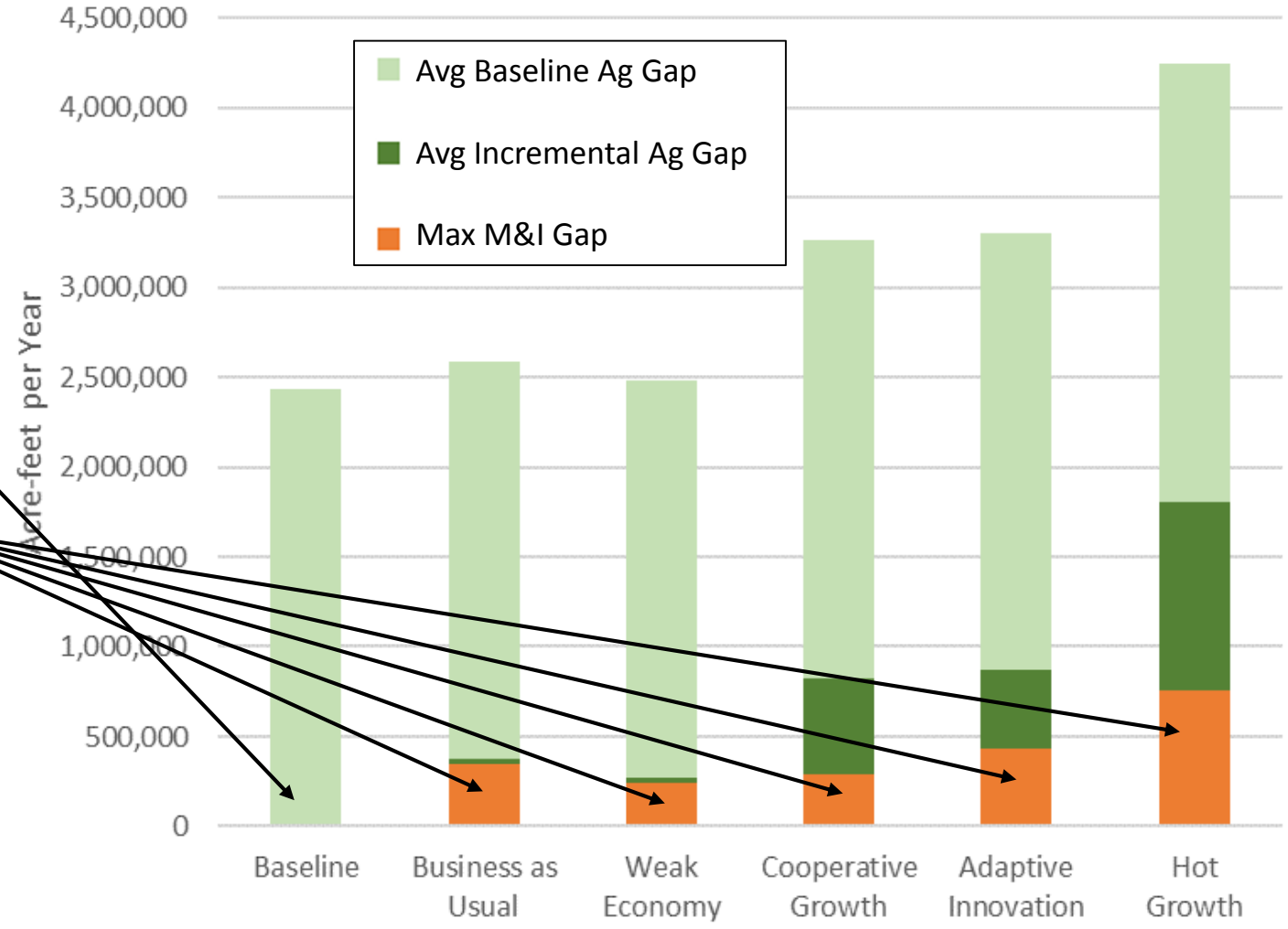


GAP ANALYSIS OBSERVATIONS

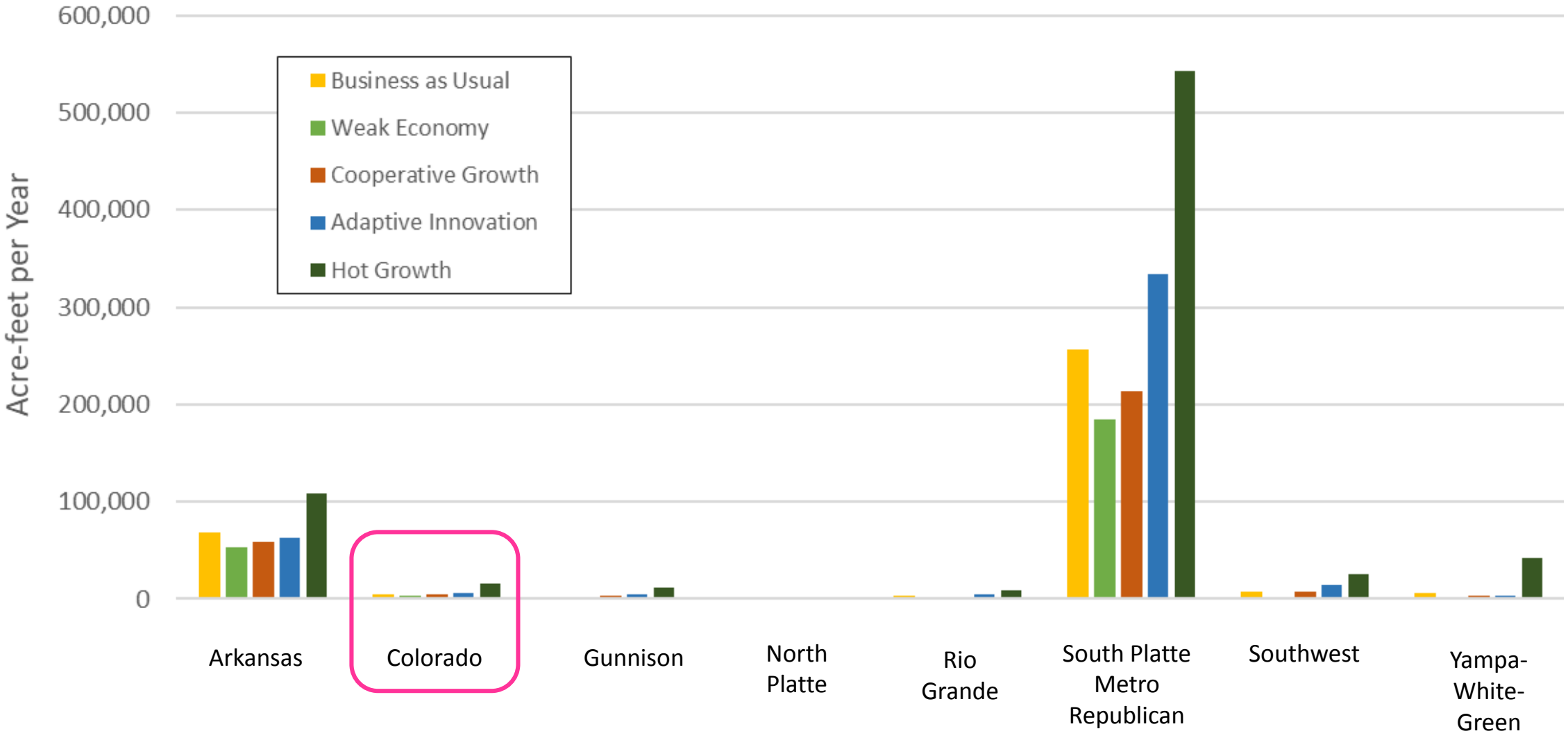
M&I does not currently experience a gap

Increasing population and warmer climate will create gaps in the future despite efforts to conserve

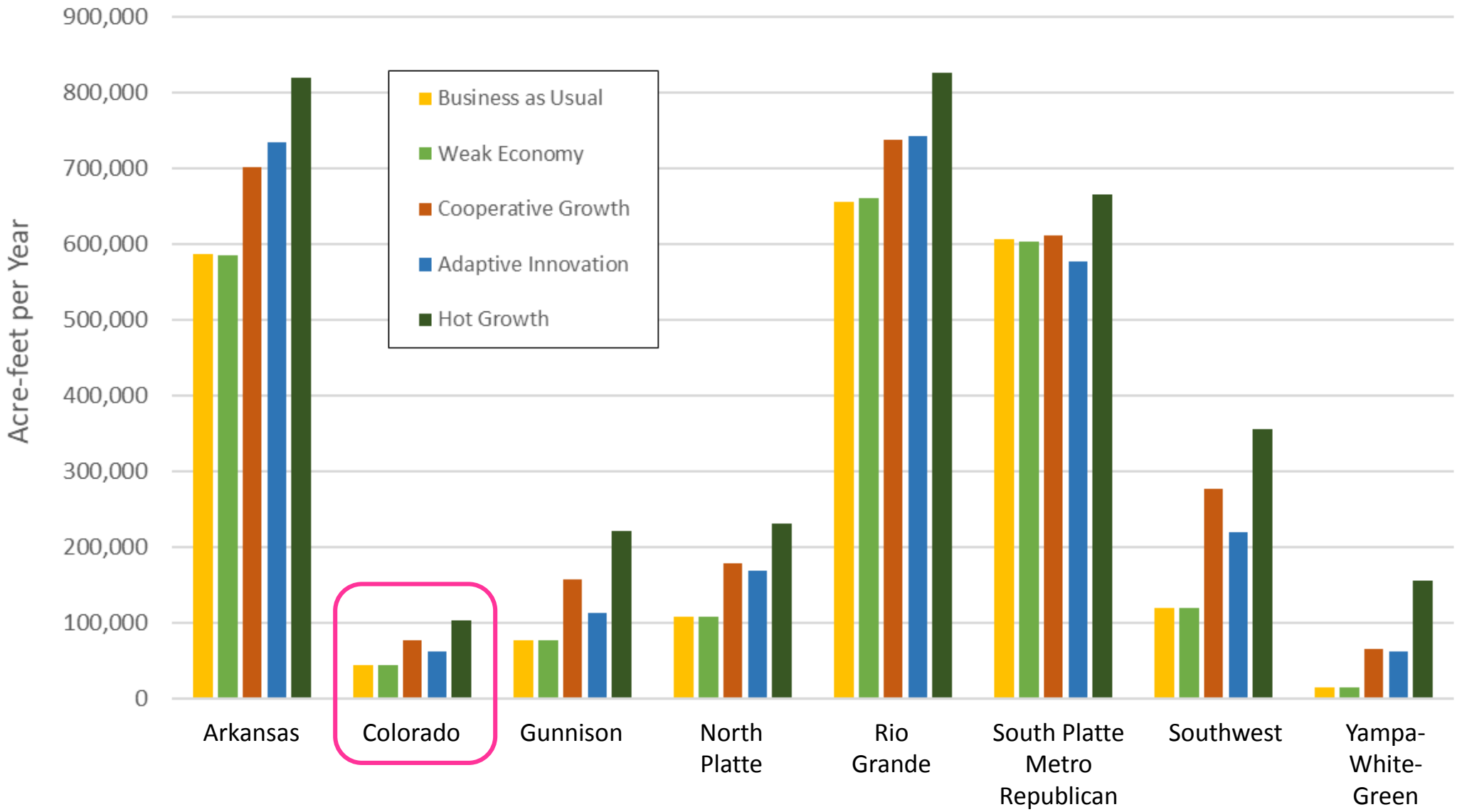
- Additional conservation could be implemented



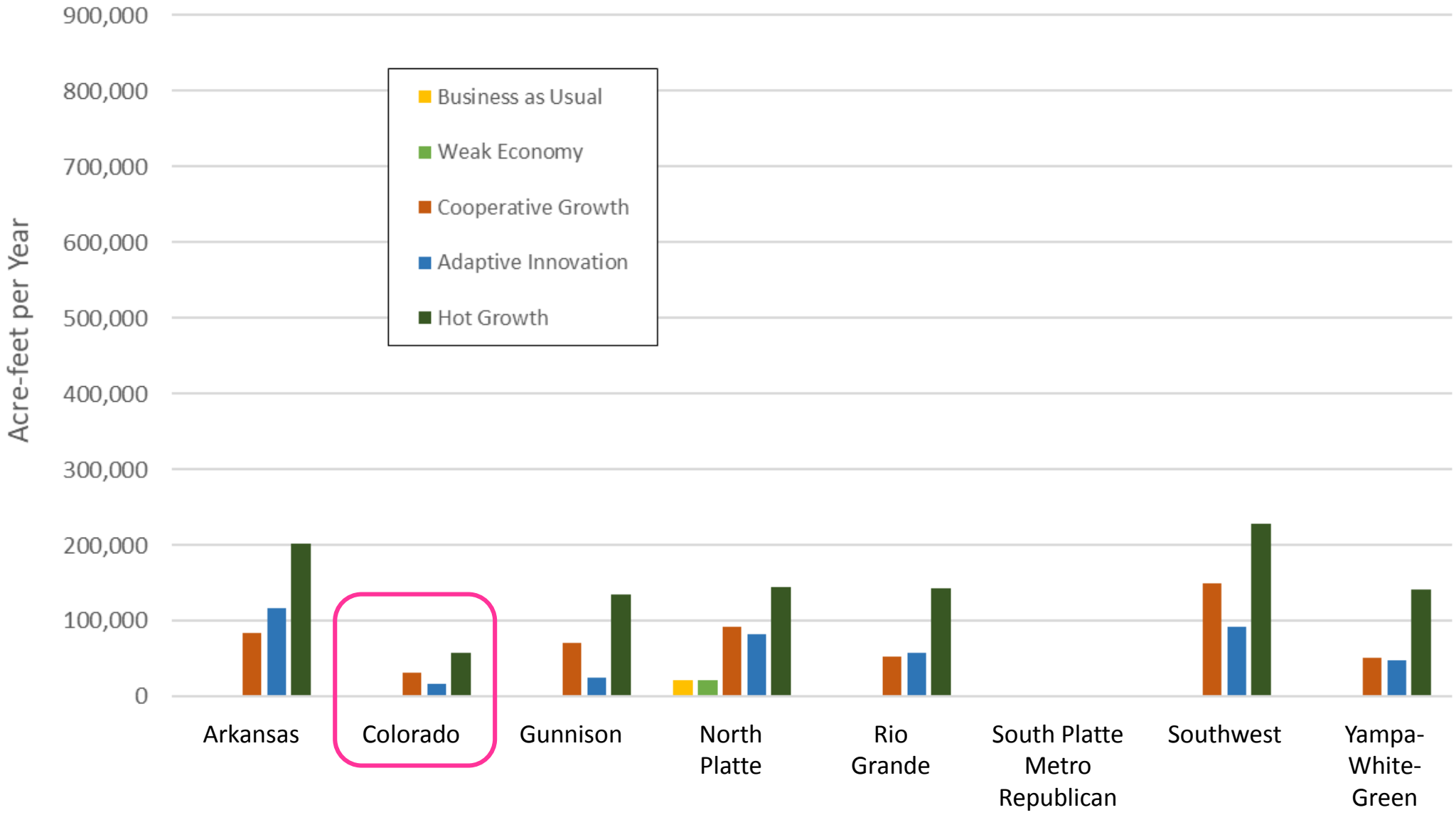
BASIN-SPECIFIC GAP ANALYSIS RESULTS – MAX M&I GAPS



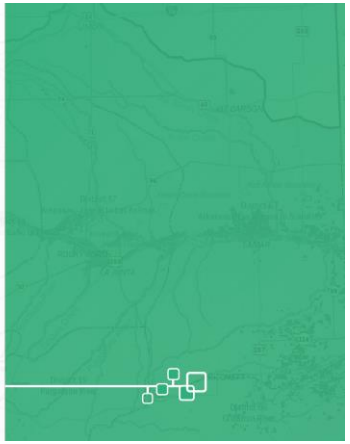
BASIN-SPECIFIC GAP ANALYSIS RESULTS – AVERAGE TOTAL AG GAPS



BASIN-SPECIFIC GAP ANALYSIS RESULTS – AVERAGE INCREMENTAL AG GAPS

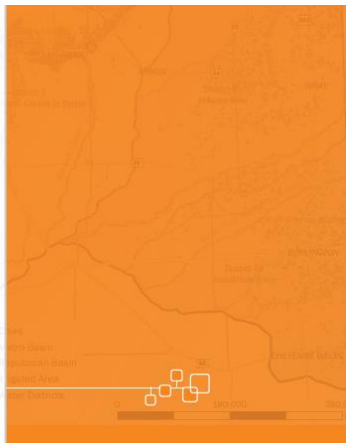


ARKANSAS

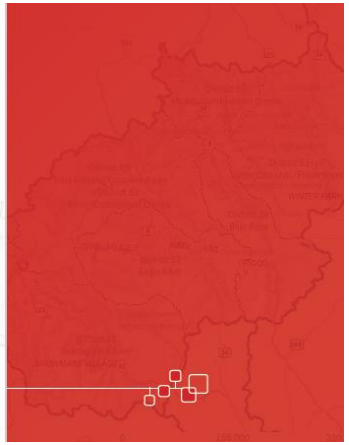


NORTH PLATTE

SOUTHWEST



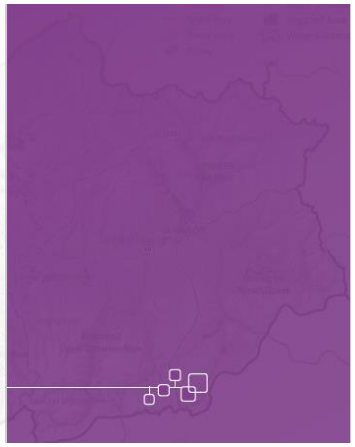
COLORADO



RIO GRANDE

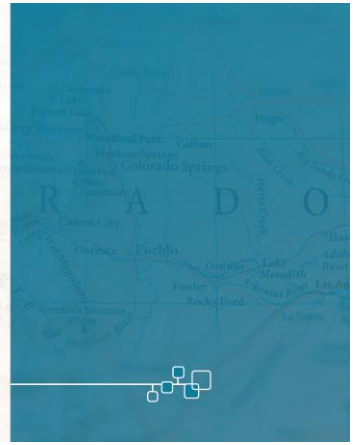
YAMPA WHITE GREEN

GUNNISON

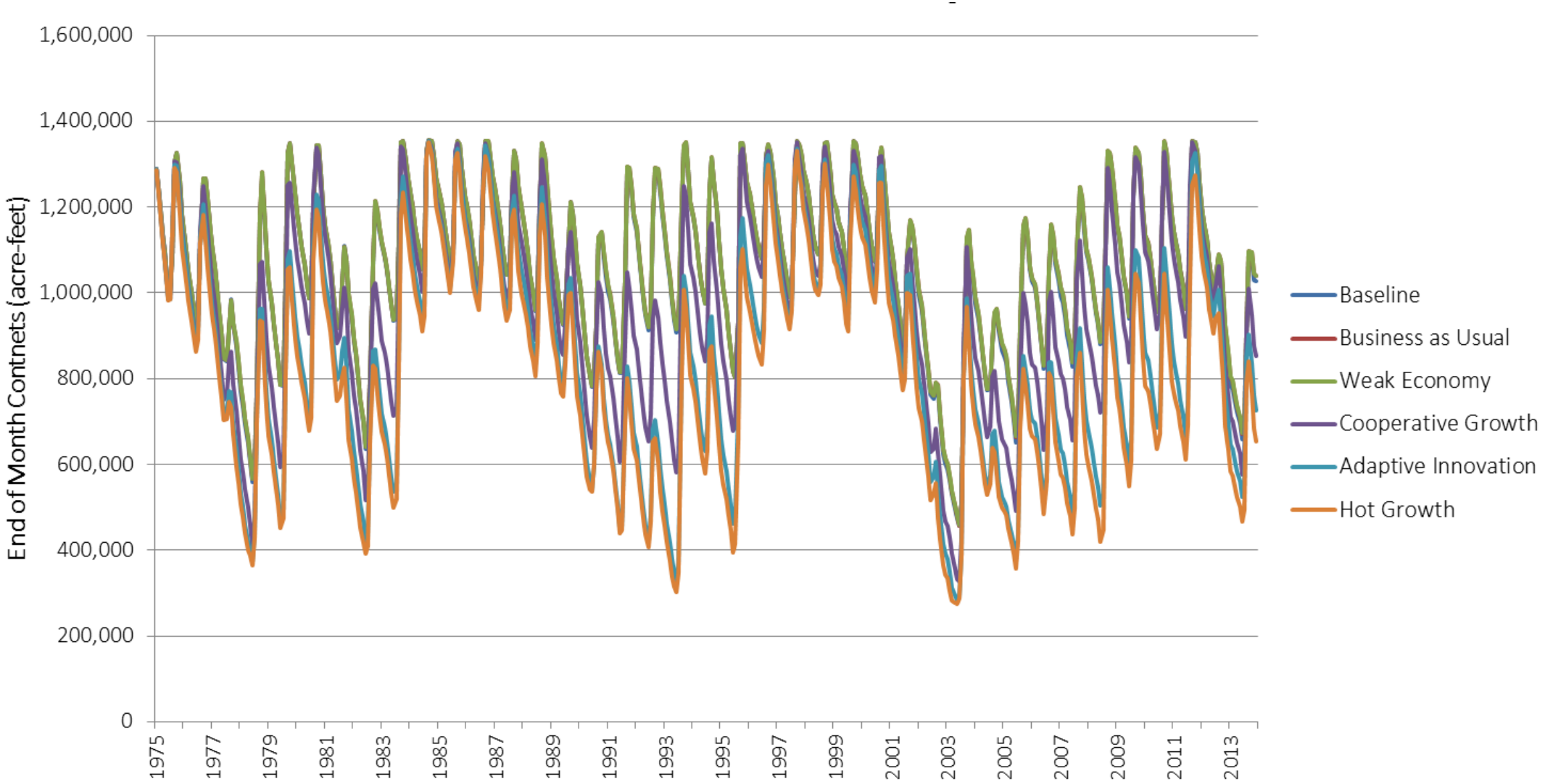


SOUTH PLATTE / METRO

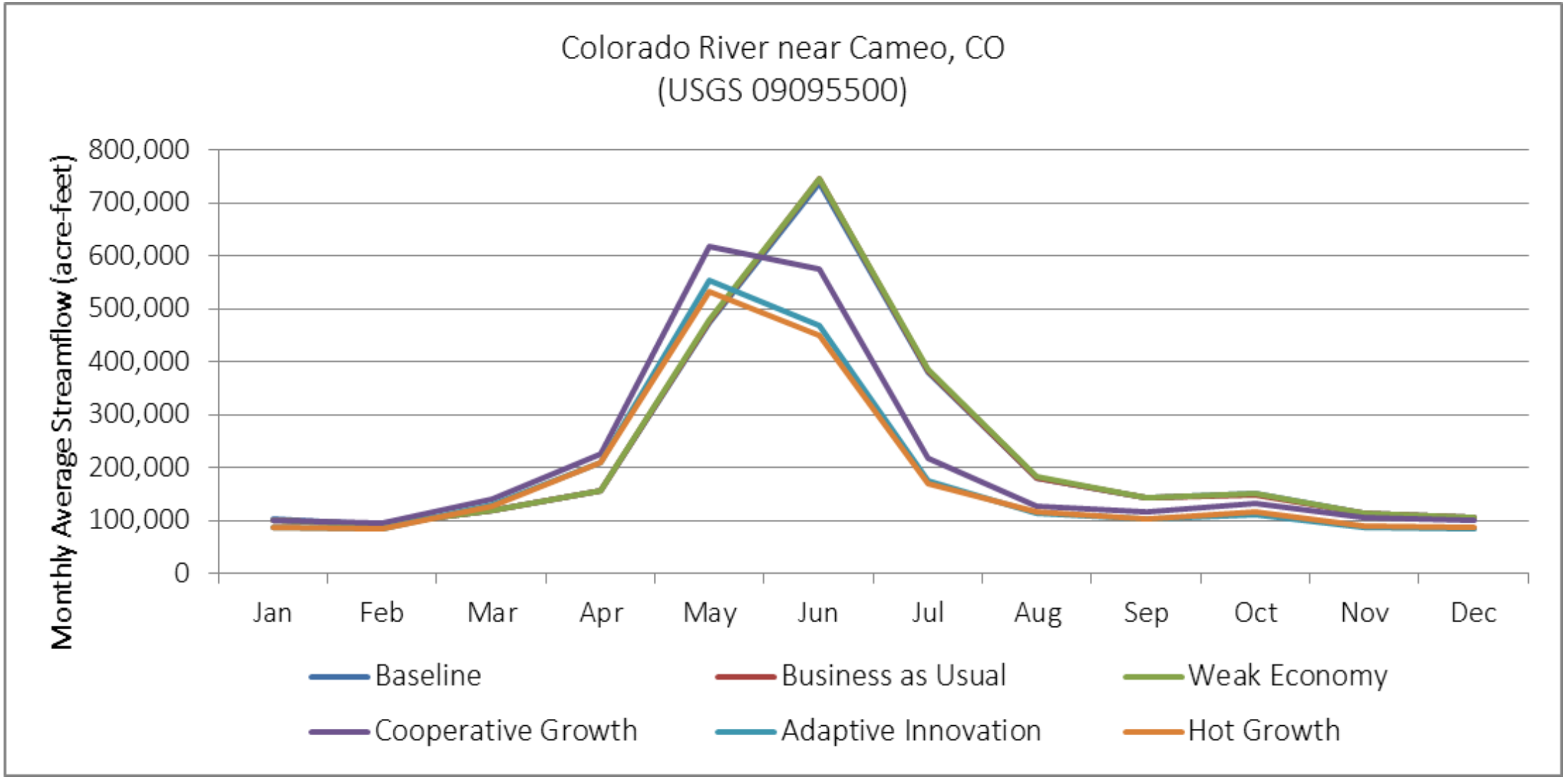
STATEWIDE



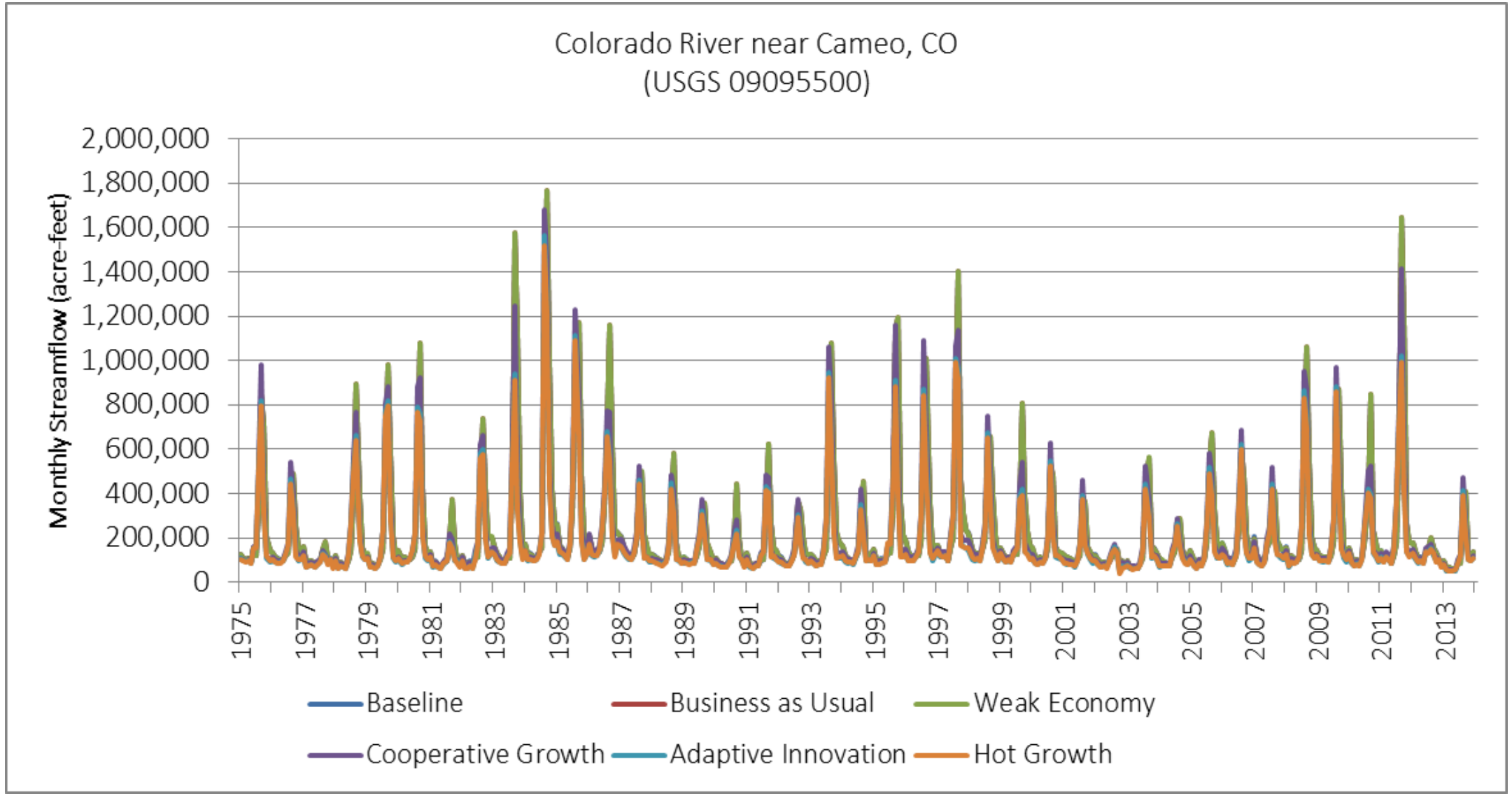
COLORADO RIVER BASIN – TOTAL RESERVOIR STORAGE



COLORADO RIVER BASIN – STREAMFLOW

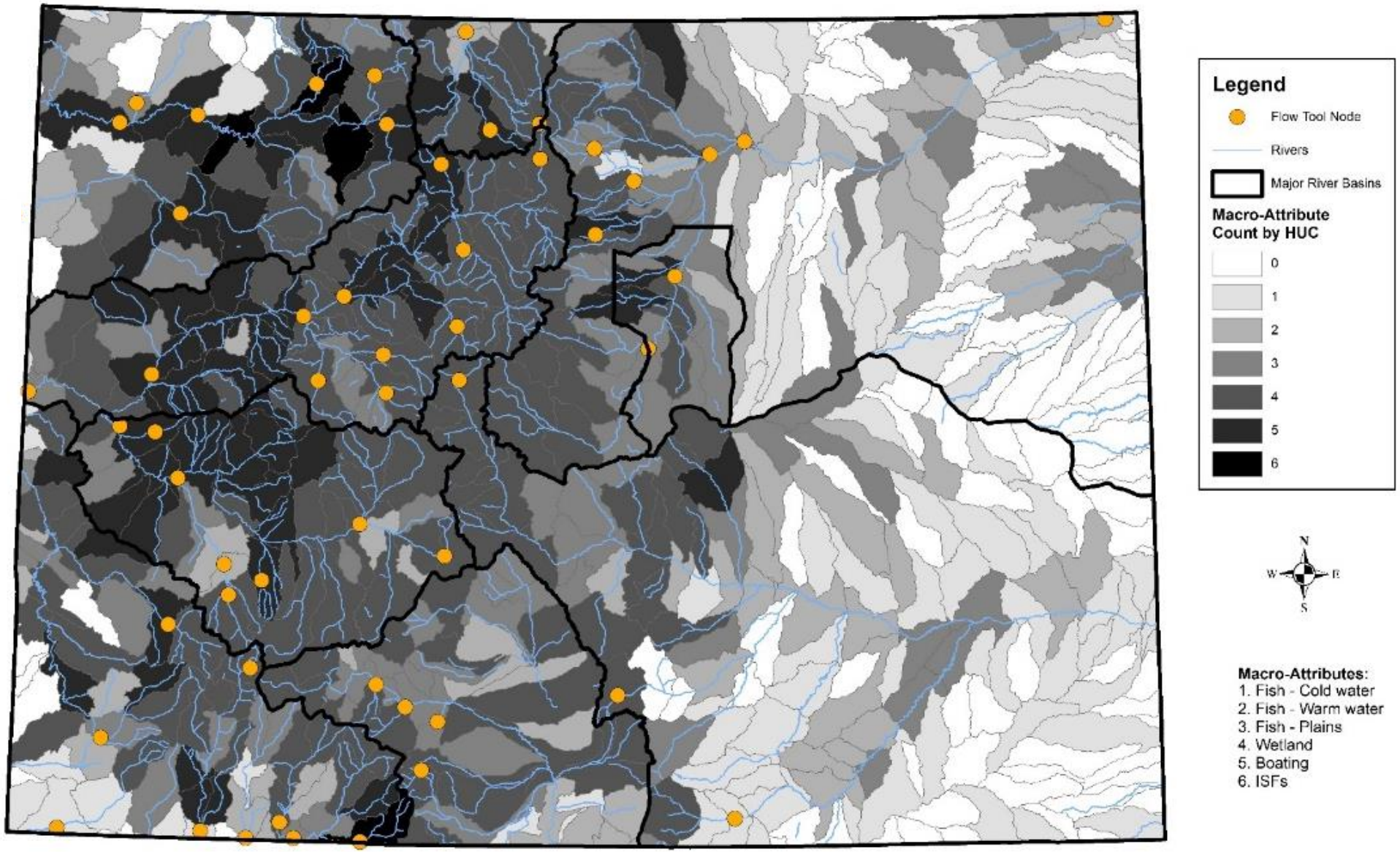


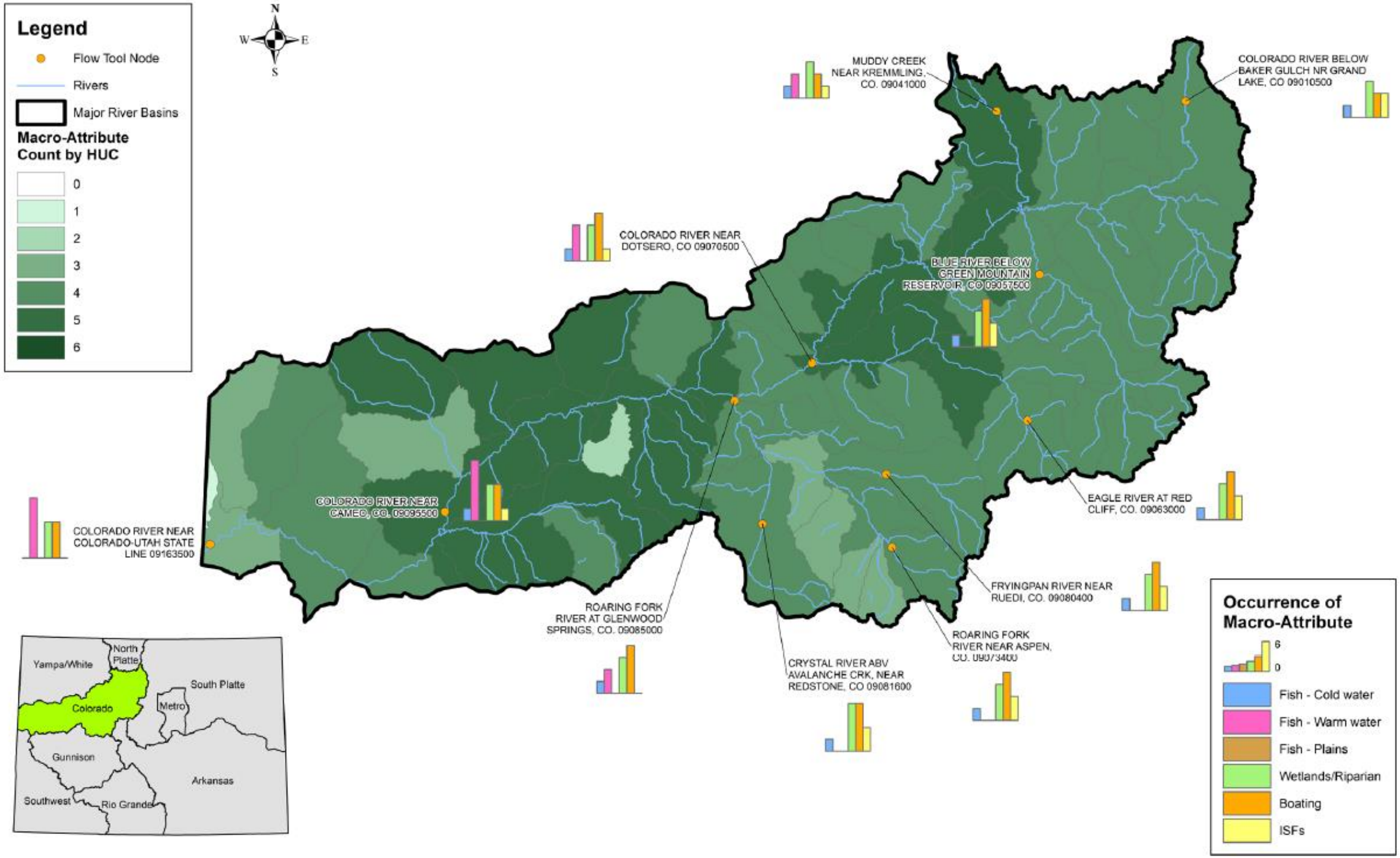
COLORADO RIVER BASIN – STREAMFLOW



EVALUATE E&R RISKS WITH NEW TOOLS

ENVIRONMENTAL FLOW TOOL

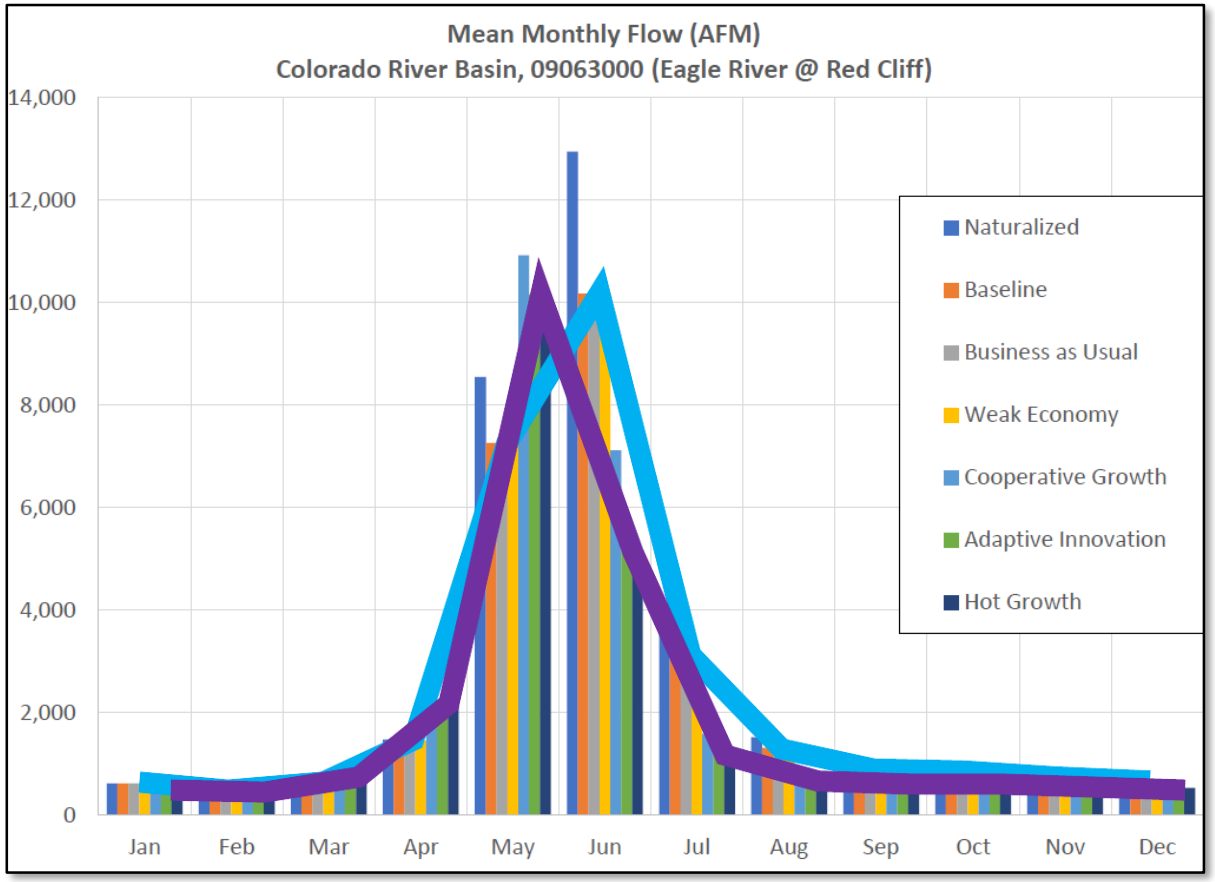


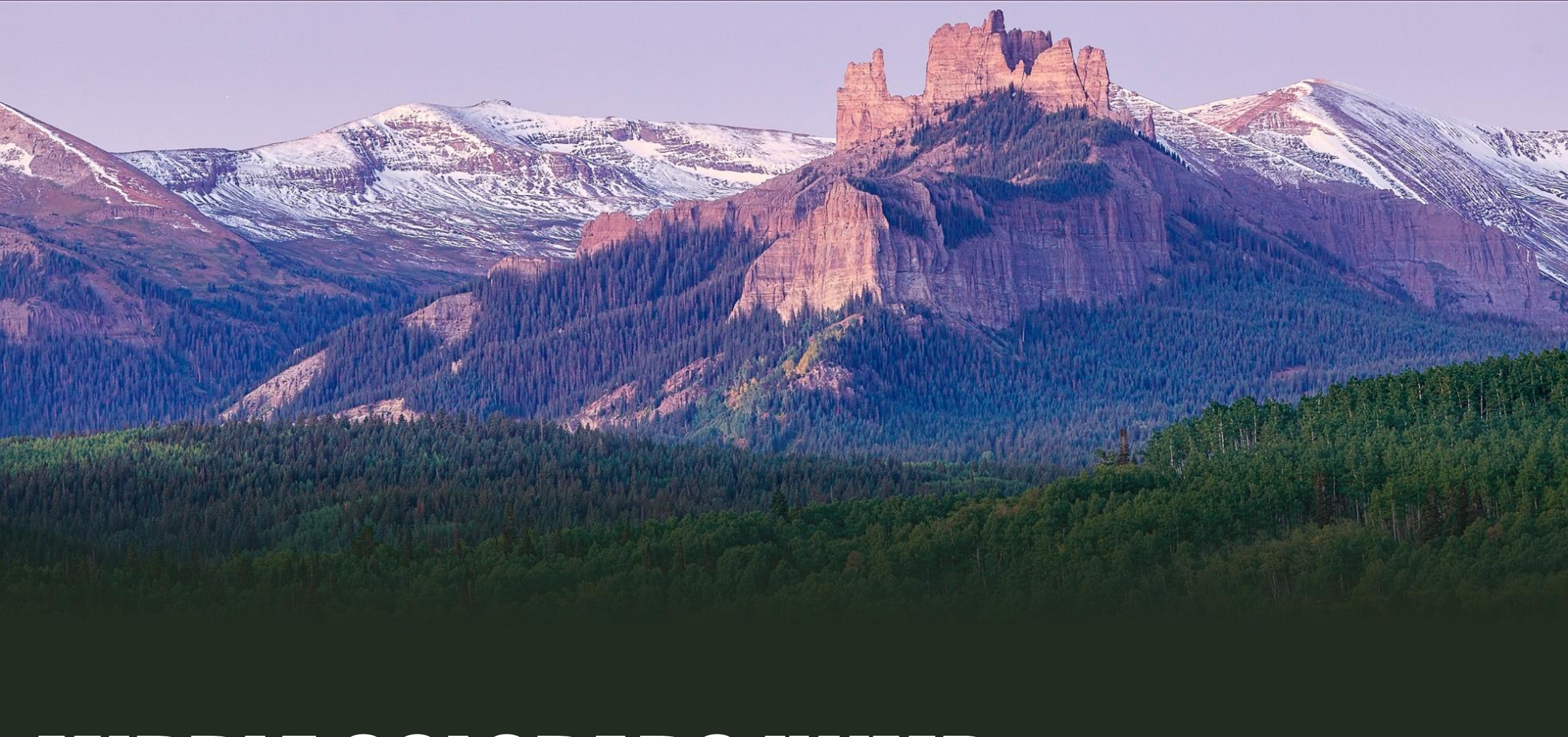

Legend
Flow Tool Node
Rivers
Major River Basins
Macro-Attribute Count by HUC
0
1
2
3
4
5
6
N
W
E
S
MUDDY CREEK NEAR KREMMLING, CO. 09041000
COLORADO RIVER BELOW BAKER GULCH NR GRAND LAKE, CO 09010500
COLORADO RIVER NEAR DOTSERO, CO 09070500
BLUE RIVER BELOW GREEN MOUNTAIN RESERVOIR, CO 09057500
COLORADO RIVER NEAR CAMEO, CO. 09095500
COLORADO RIVER NEAR COLORADO-UTAH STATE LINE 09163500
EAGLE RIVER AT RED CLIFF, CO. 09063000
FRYINGPAN RIVER NEAR RUEDI, CO. 09080400
ROARING FORK RIVER AT GLENWOOD SPRINGS, CO. 09085000
ROARING FORK RIVER NEAR ASPEN, CO. 09073400
CRYSTAL RIVER ABV AVALANCHE CRK, NEAR REDSTONE, CO 09081600
Yampa/White
North Platte
South Platte
Colorado
Metro
Gunnison
Arkansas
Southwest
Rio Grande
Occurrence of Macro-Attribute
6
0
Fish - Cold water
Fish - Warm water
Fish - Plains
Wetlands/Riparian
Boating
ISFs

CLIMATE CHANGE IMPACTS E&R

…AND EVERYTHING ELSE

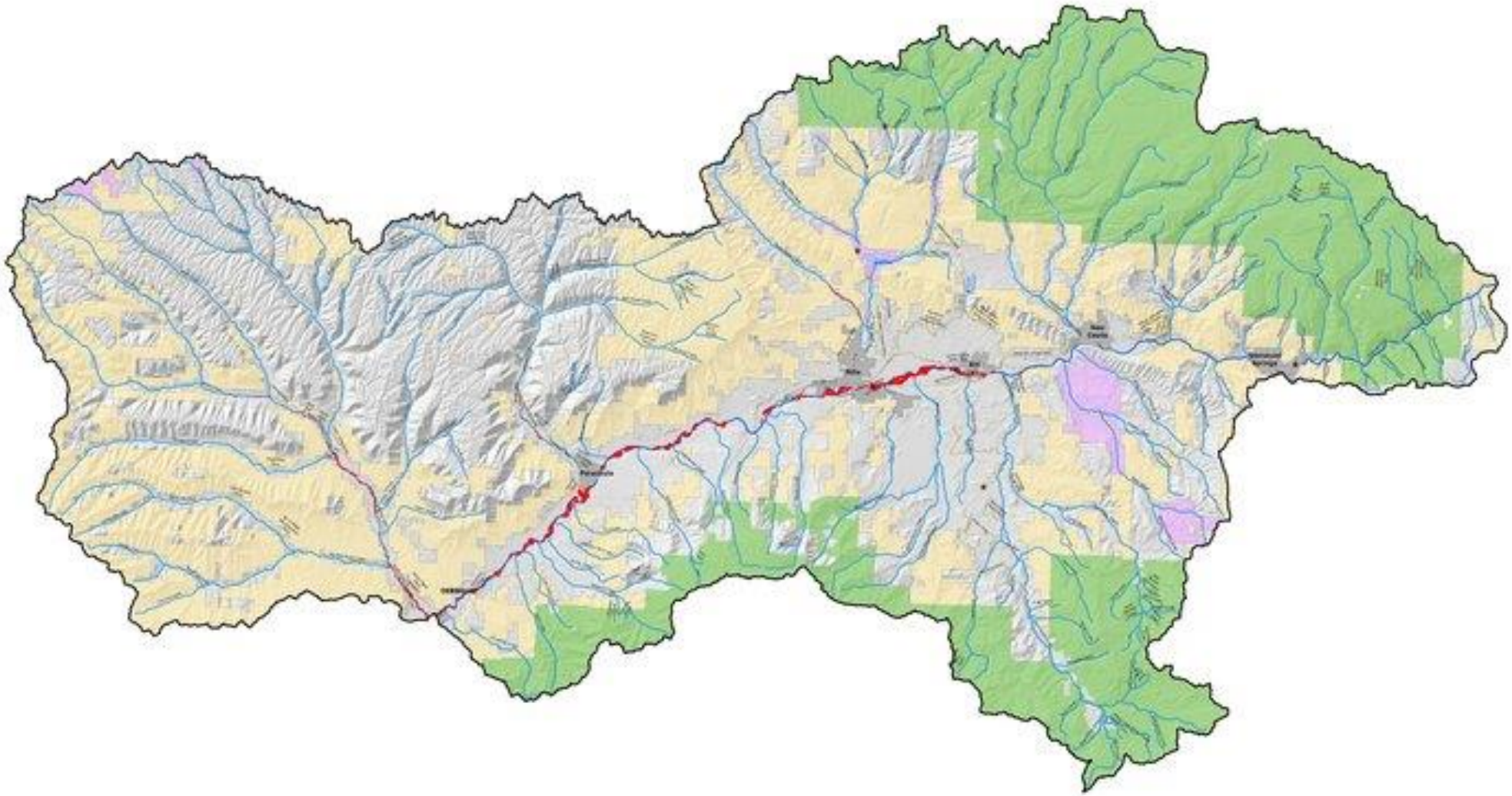
- Increases risk to streams, fish, recreation, etc.
- Increases crop water needs on farms.
- Increases outdoor water needs in cities.
- Increases precipitation falling as rain vs. snow.
- Increases fire, flood and drought risks.
- Shifts runoff up a month; impacts storage, etc.





MIDDLE COLORADO IWMP

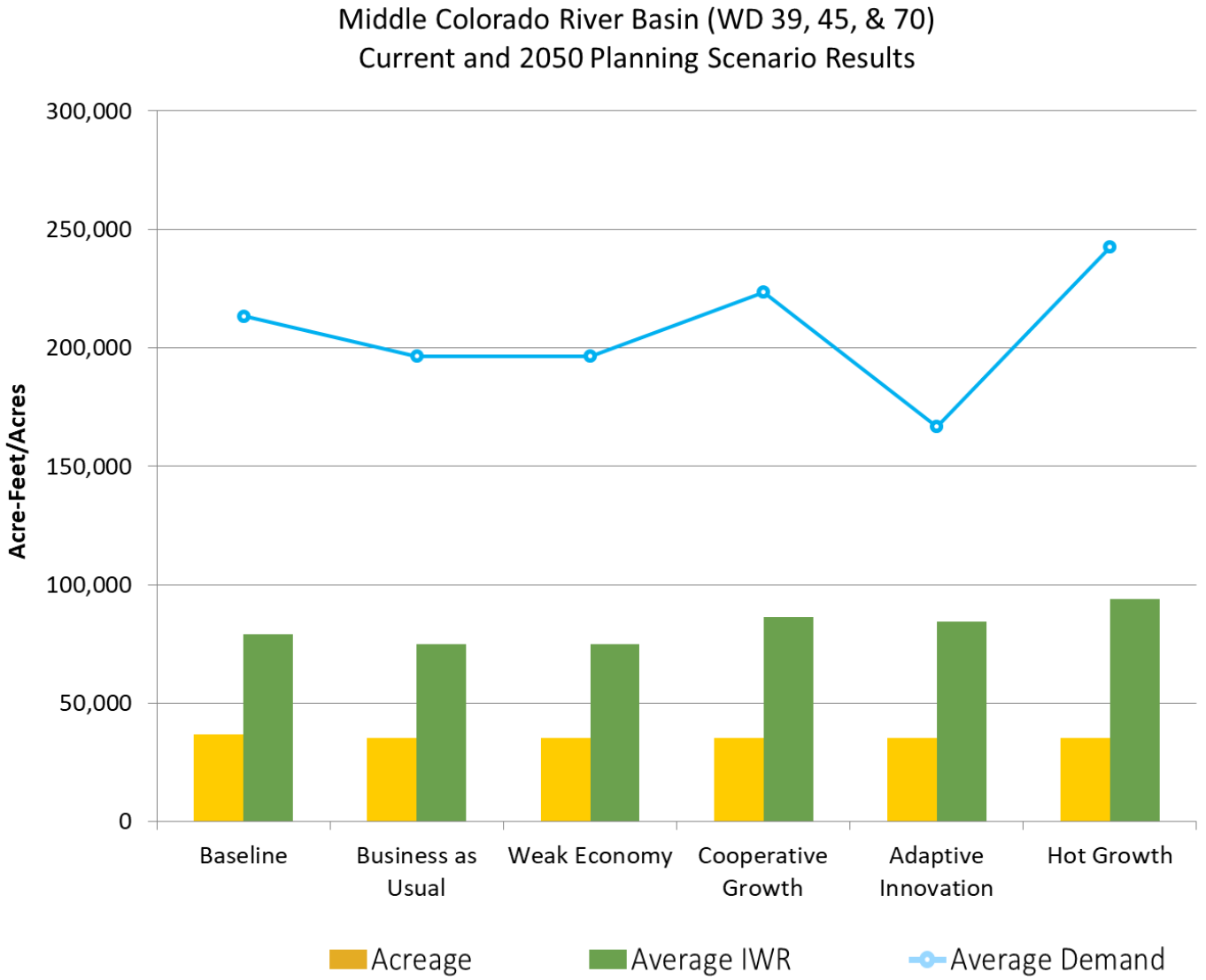
MIDDLE COLORADO BASIN-SPECIFIC RESULTS



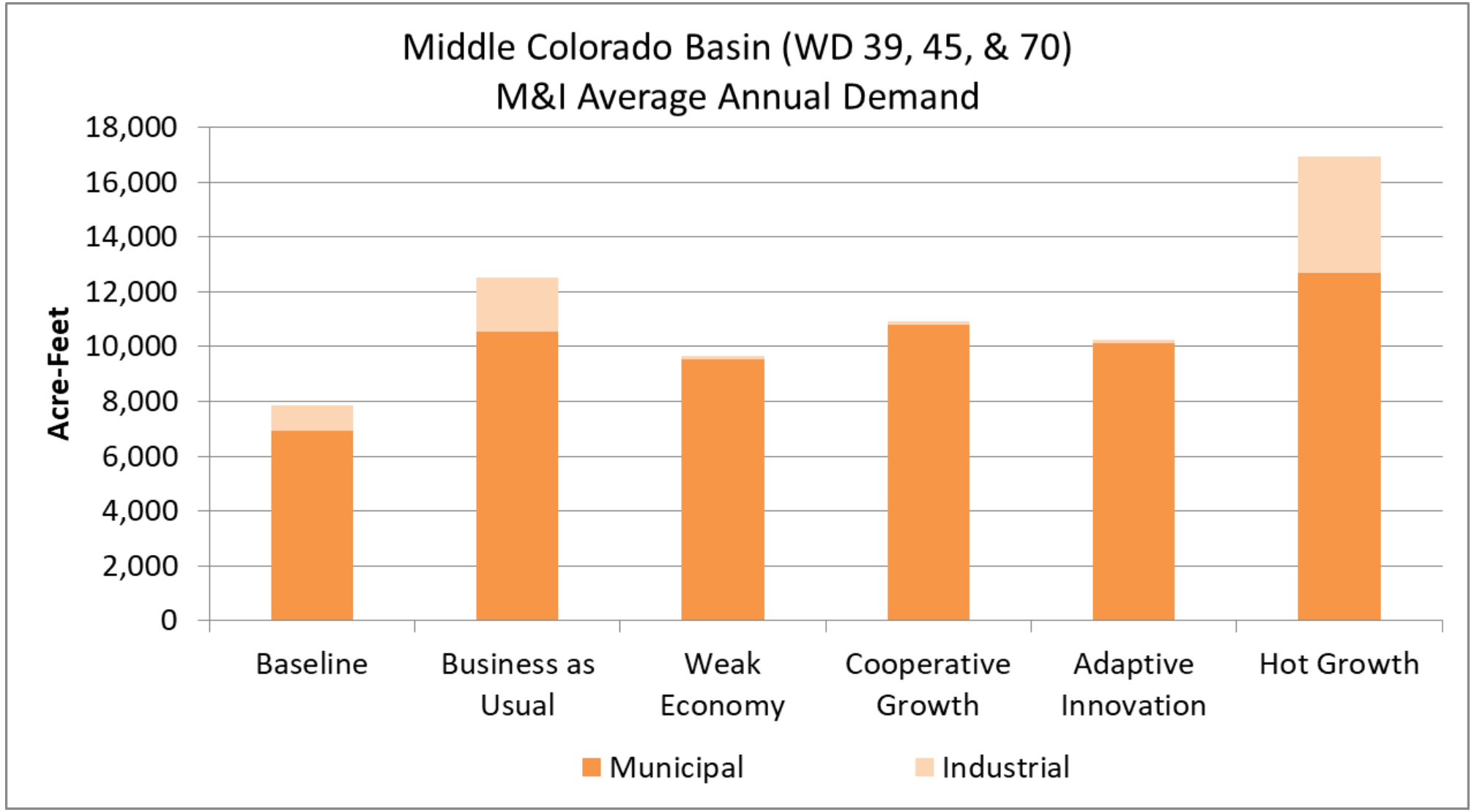
MIDDLE COLORADO BASIN – AGRICULTURAL DEMAND CURRENT & 2050 PLANNING SCENARIO

By 2050:

- Between 160,000 to nearly 250,000 AF of diversions + pumping
- Will be needed to meet 75,000 to 94,000 AF of crop demand
- On 36,000 acres of irrigated acreage



MIDDLE COLORADO BASIN – M&I DEMAND
CURRENT & 2050 PLANNING SCENARIO



MIDDLE COLORADO BASIN – GAP RESULTS

M&I Gap

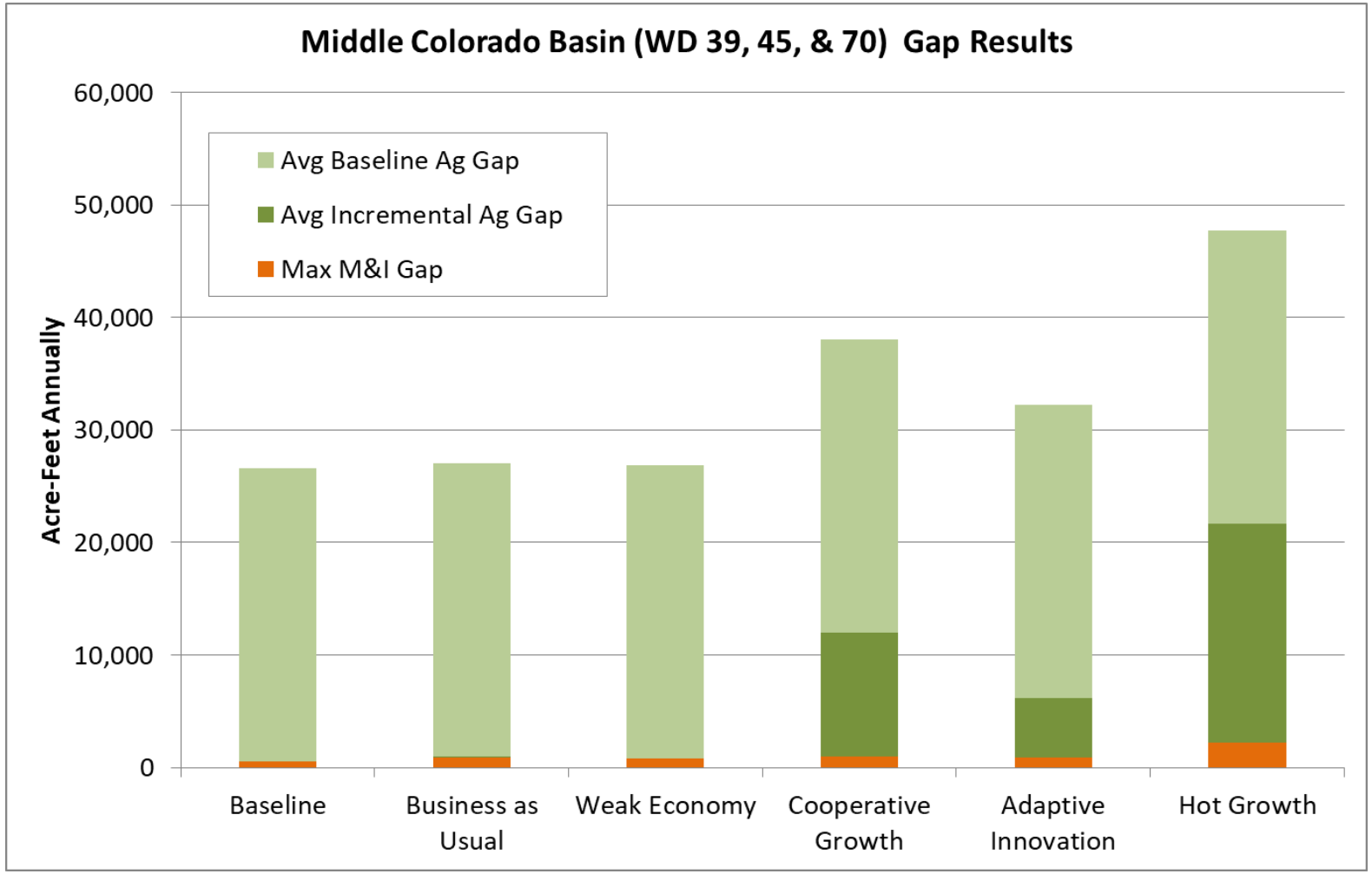
550 to 2,240 AF

Total Ag Gap

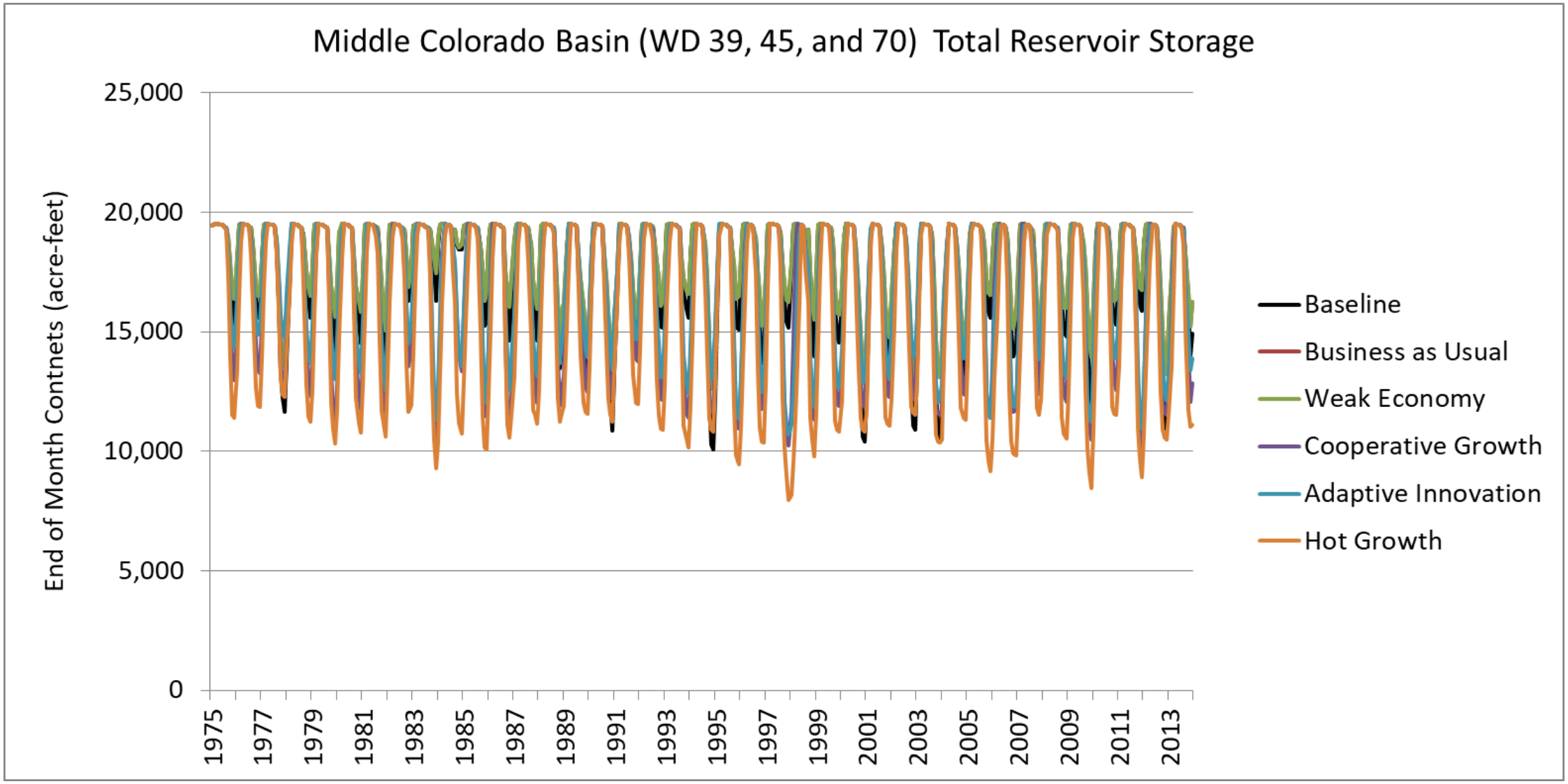
26,000 to 45,000 AF

Incremental Ag Gap

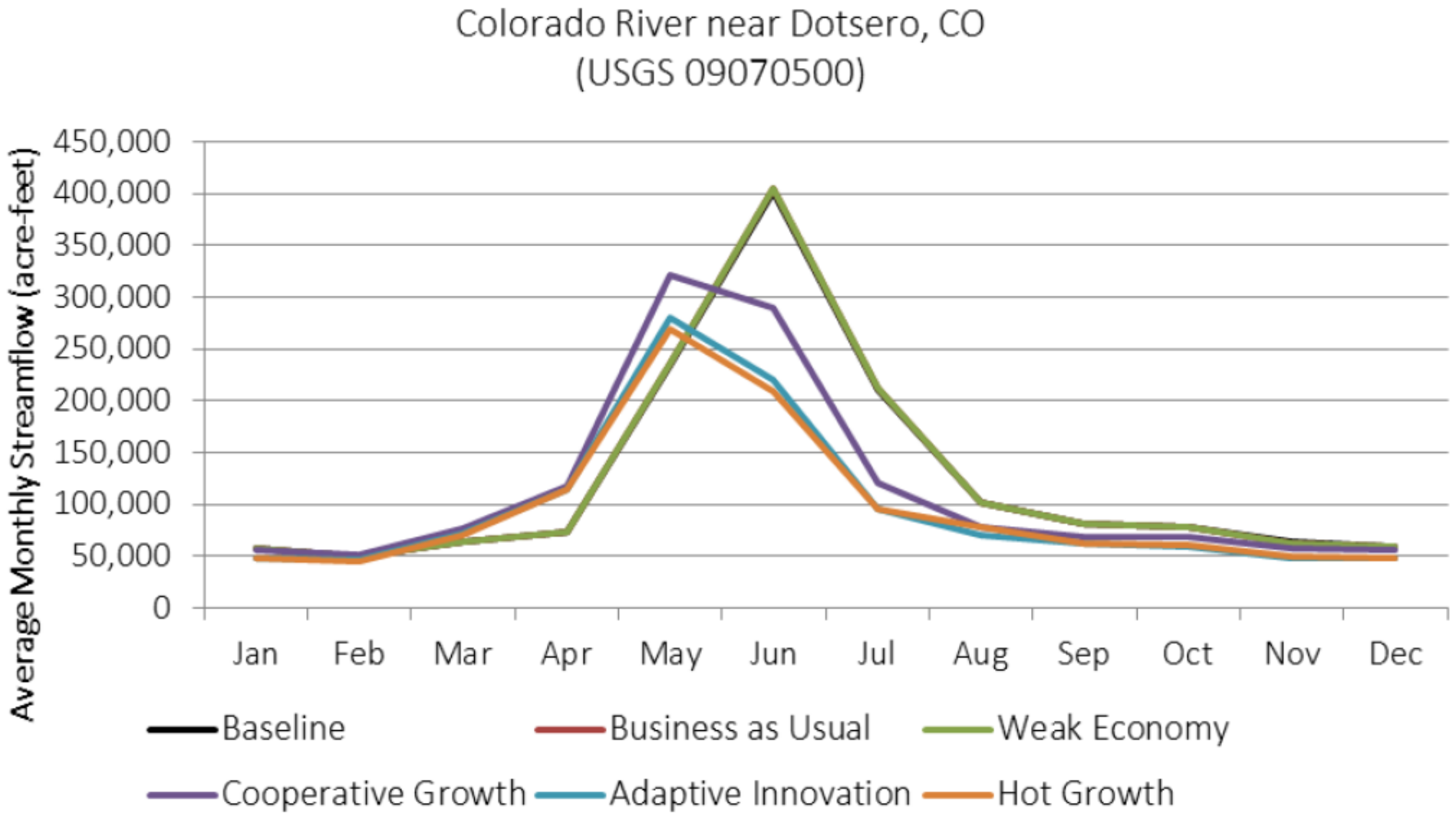
5,200 to 19,400 AF



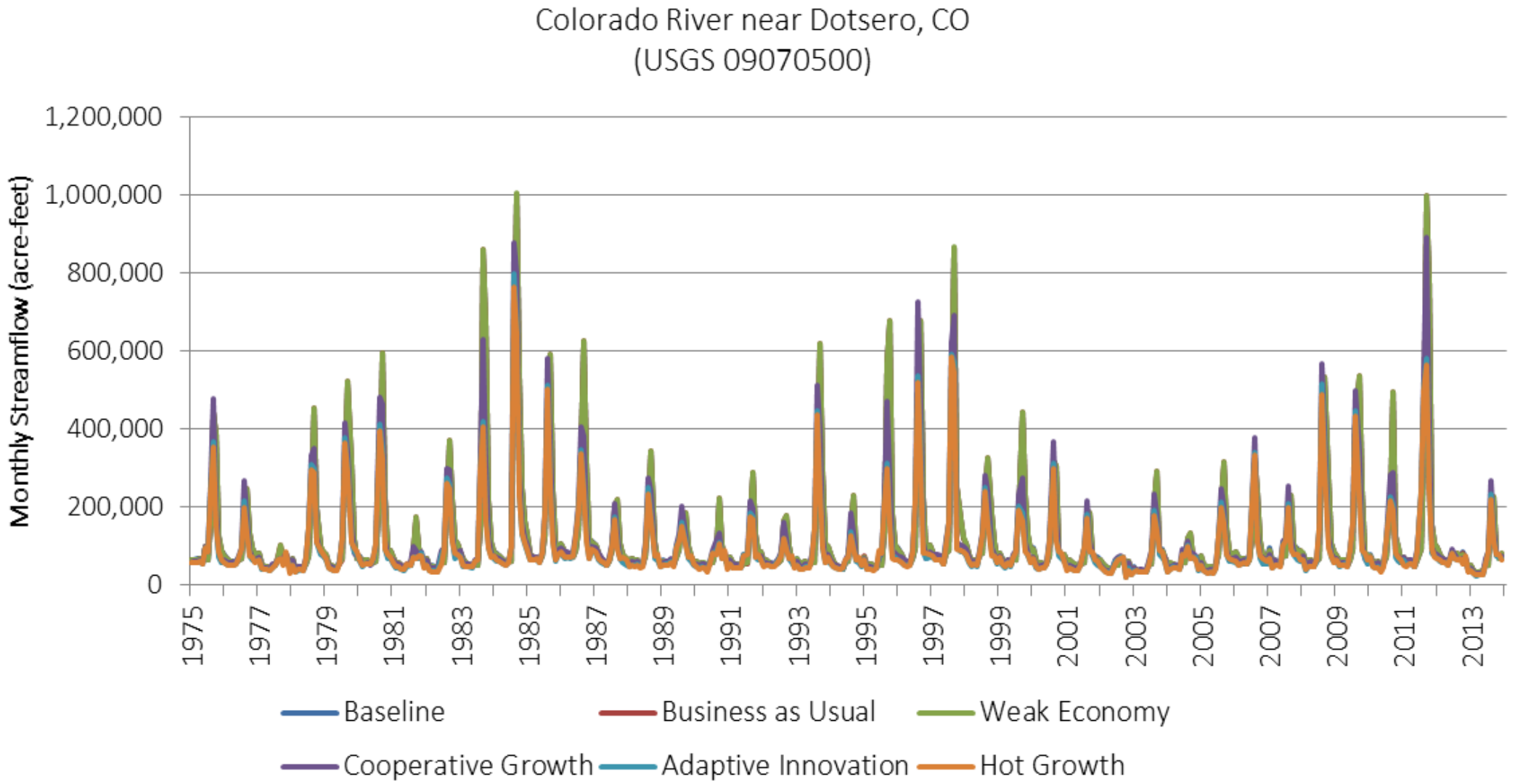
MIDDLE COLORADO BASIN – RESERVOIR STORAGE RESULTS



MIDDLE COLORADO BASIN – STREAMFLOW



MIDDLE COLORADO BASIN – STREAMFLOW



MIDDLE COLORADO IWMP – MODEL CONSIDERATIONS

- Refine current model representation with more detailed information?
  - Agricultural demands
  - Municipal demands & operations
  - Add more reservoirs
  - Add small tributaries
- Use some/all Planning Scenarios?
  - Query model output for area-specific results
- Refine Technical Update 2050 modeling assumptions?
  - Agricultural demands (e.g. urbanization, efficiencies)
  - M & I demands (e.g. population, conservation)
  - Climate-adjusted demands & operations

QUESTIONS

COLORADO
Colorado Water Conservation Board
Department of Natural Resources