THE ANALYSIS & TECHNICAL UPDATE TO THE

COLORADO
WATER PLAN

Middle Colorado Integrated Water Management Planning
Greg Johnson & Kara Sobieski
WHAT'S NEW?

NEW APPROACHES AND RESULTS IN THE TECHNICAL UPDATE
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

+ 3.8 °F
& 5% increase in precip.

SIGNIFICANT CLIMATE CHANGE

+ 4.2 °F
& 1% decrease in precip.

NO CHANGE
HOW THE GAP IS DEFINED

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

Surface Water Allocation Model
Model includes:
- Existing infrastructure
- Water rights and priorities
- River operations

Model Results
- Met demands
- Unappropriated supplies
- M&I and Ag gaps
- Streamflow (and input to Flow Tool)
- Reservoir storage

Natural flow water supply
Agricultural diversion demand
M&I diversion 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
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)

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

Adaptive Innovation

Average Basin Adjustment

<table>
<thead>
<tr>
<th></th>
<th>In-Between</th>
<th>Hot and Dry</th>
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</thead>
<tbody>
<tr>
<td>East Slope</td>
<td>4% - 25%</td>
<td>11% - 39%</td>
</tr>
<tr>
<td>West Slope</td>
<td>19% - 26%</td>
<td>30% - 37%</td>
</tr>
<tr>
<td>Colorado River Basin</td>
<td>3% - 26%</td>
<td>7% - 40%</td>
</tr>
</tbody>
</table>
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

A Business as Usual
- 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

B Weak Economy
- 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

C Cooperative Growth
- 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

D Adaptive Innovation
- 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

E Hot Growth
- Vibrant economy fuels population growth
- Regulations are relaxed
- Hot and dry conditions
- Families prefer low-density housing
STATEWIDE GPCD – CURRENT & 2050 PLANNING SCENARIO

- Residential Indoor
- Residential Outdoor
- Non-Residential Indoor
- Non-Residential Outdoor
- Non-Revenue

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Per Capita Demand (gpcd)</th>
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<tbody>
<tr>
<td>Baseline (2015)</td>
<td>163.7</td>
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<tr>
<td>Business as Usual</td>
<td>156.8</td>
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<tr>
<td>Weak Economy</td>
<td>155.2</td>
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<tr>
<td>Cooperative Growth</td>
<td>148.2</td>
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<tr>
<td>Adaptive Innovation</td>
<td>143.2</td>
</tr>
<tr>
<td>Hot Growth</td>
<td>169.4</td>
</tr>
</tbody>
</table>

- Residential Indoor: 12%
- Residential Outdoor: 31%
- Non-Residential Indoor: 17%
- Non-Residential Outdoor: 21%
- Non-Revenue: 19%
COLORADO RIVER BASIN GPCD – CURRENT & 2050 PLANNING SCENARIO

Average Per Capita Demand (gpcd)

- Baseline: 179
- Business as Usual: 153
- Weak Economy: 156
- Cooperative Growth: 145
- Adaptive Innovation: 136
- Hot Growth: 165

Residential Indoor: 78
Residential Outdoor: 53
Non-Residential Indoor: 57
Non-Residential Outdoor: 46
Non-Revenue: 50

Legend:
- Residential Indoor
- Residential Outdoor
- Non-Residential Indoor
- Non-Residential Outdoor
- Non-Revenue
COLORADO RIVER BASIN DEMAND – CURRENT & 2050 PLANNING SCENARIO

[Bar chart showing average annual demand (AFY) for different scenarios and categories like Residential Indoor, Residential Outdoor, Non-Residential Indoor, Non-Residential Outdoor, and Non-Revenue.]
STATEWIDE DEMAND – CURRENT & 2050 PLANNING SCENARIOS
WATER SUPPLY & GAP
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
Cooperative Growth
Adaptive Innovation
Hot 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 many identified project voids. This is primarily due to a lack of specific project data that would allow projects to be modeled. Fortuitously, bonus plan updates will reevaluate projects and consider strategies to address gaps.

2 Gaps Across Scenarios
In the 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 demand. Climate change is included in three of the five scenarios, which drives irrigation, streamflow and storage timing. Modelled storage operations maximize the use of stored water to meet demands and lower gaps.

4 Gap Mitigation
When defining strategies, 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.

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 agriculture 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 maximum, 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
Ag gaps may increase 18 to 43 percent beyond baseline

Ag gaps are less in Adaptive Innovation than Hot Growth despite similar climate
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 – AVERAGE TOTAL AG GAPS
BASIN-SPECIFIC GAP ANALYSIS RESULTS – AVERAGE INCREMENTAL AG GAPS

- Arkansas
- South Platte
- Metro
- Republican
- Rio Grande
- North Platte
- Gunnison
- Colorado
- Yampa-White-Green

Legend:
- Business as Usual
- Weak Economy
- Cooperative Growth
- Adaptive Innovation
- Hot Growth
COLORADO RIVER BASIN – TOTAL RESERVOIR STORAGE
COLORADO RIVER BASIN – STREAMFLOW

Colorado River near Cameo, CO
(USGS 09095500)

Monthly Average Streamflow (acre-feet)

- Baseline
- Business as Usual
- Weak Economy
- Cooperative Growth
- Adaptive Innovation
- Hot Growth
COLORADO RIVER BASIN – STREAMFLOW

Colorado River near Cameo, CO
(USGS 09095500)

Monthly Streamflow (acre-feet)

Baseline  Business as Usual  Weak Economy  Cooperative Growth  Adaptive Innovation  Hot Growth
EVALUATE E&R RISKS WITH NEW TOOLS
ENVIRONMENTAL FLOW TOOL
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 BASIN-SPECIFIC RESULTS
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
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 – STREAMFLOW

Colorado River near Dotsero, CO
(USGS 09070500)
MIDDLE COLORADO BASIN – STREAMFLOW

Colorado River near Dotsero, CO (USGS 09070500)
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