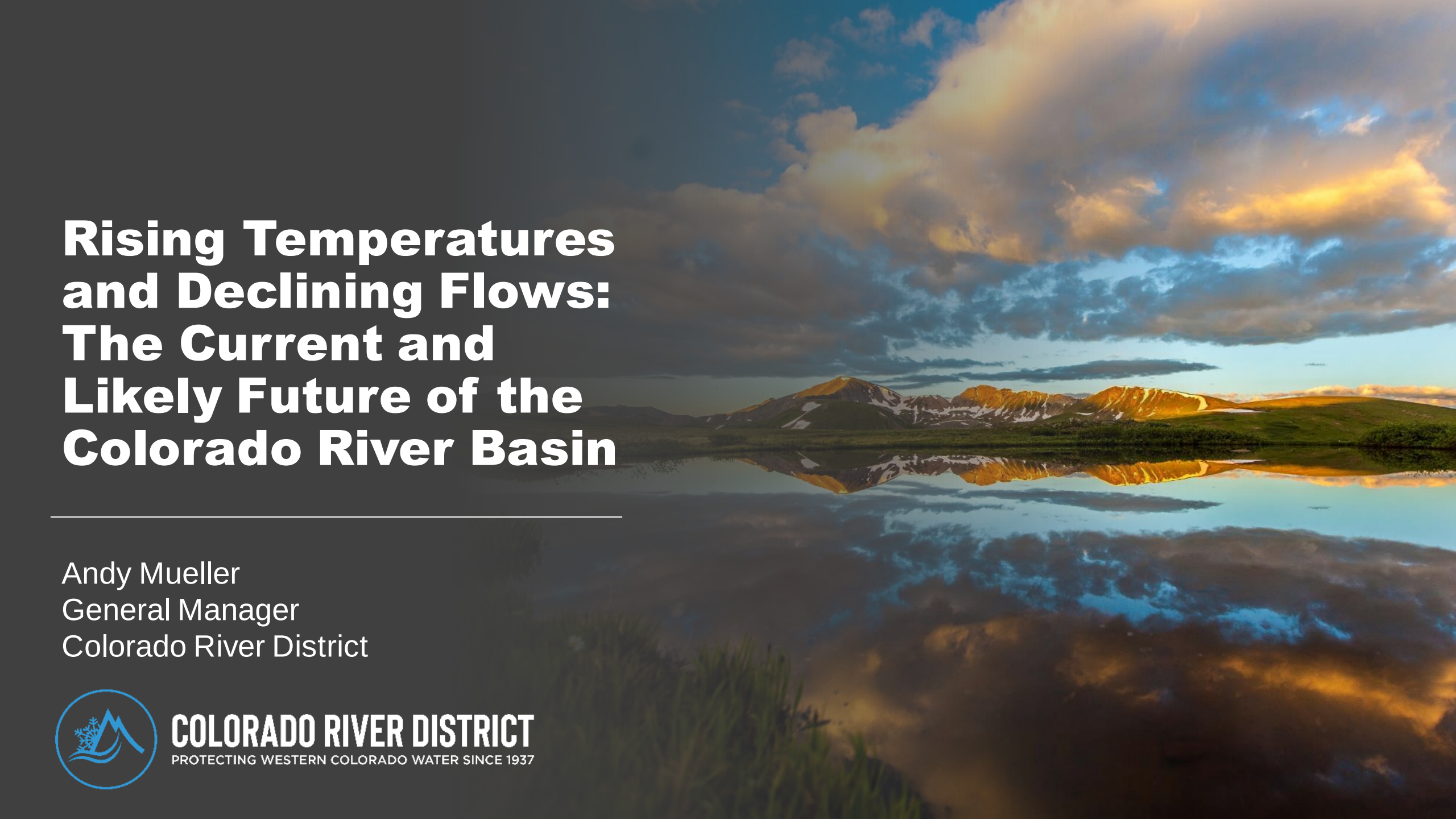
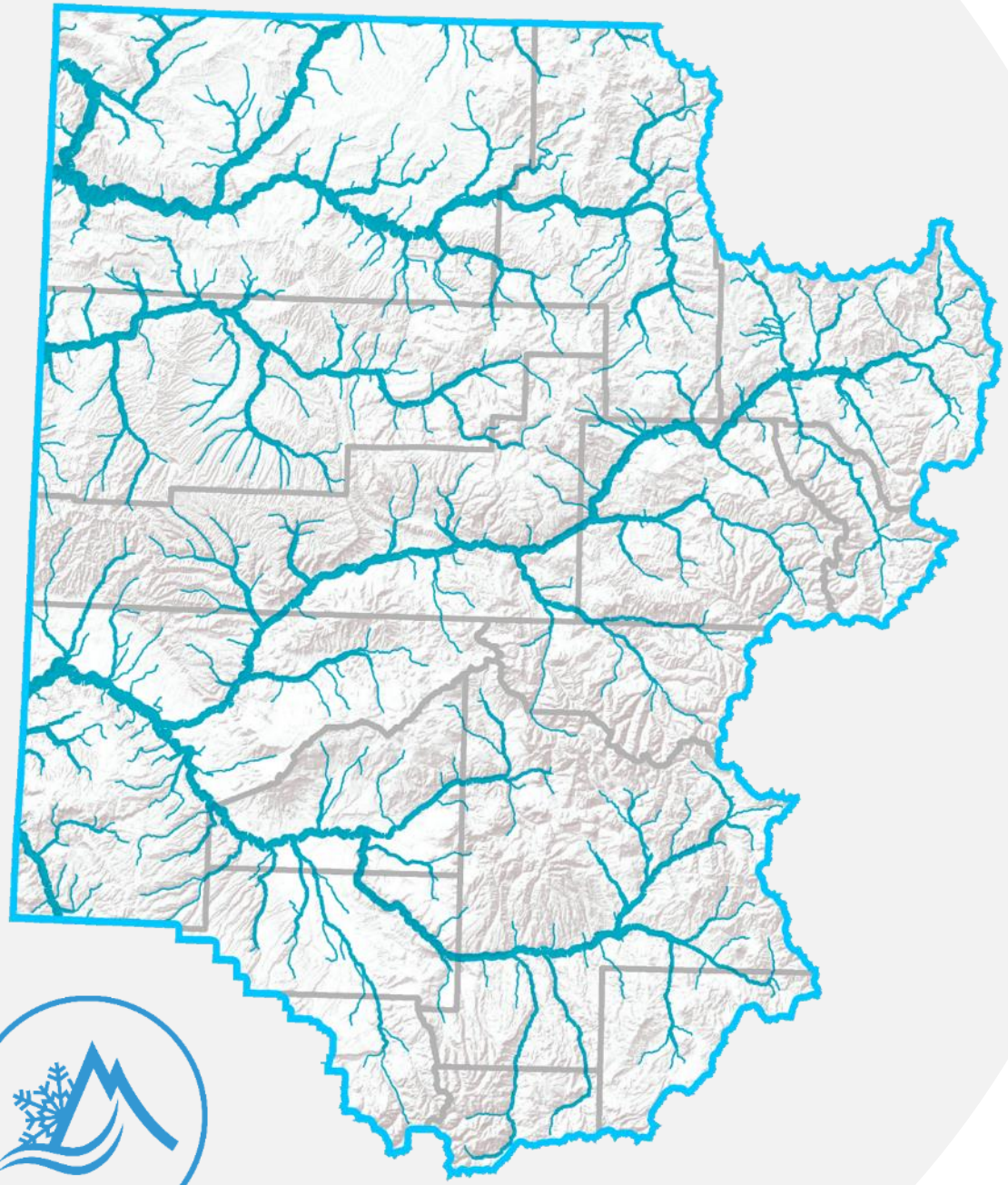
Rising Temperatures and Declining Flows: The Current and Likely Future of the Colorado River Basin



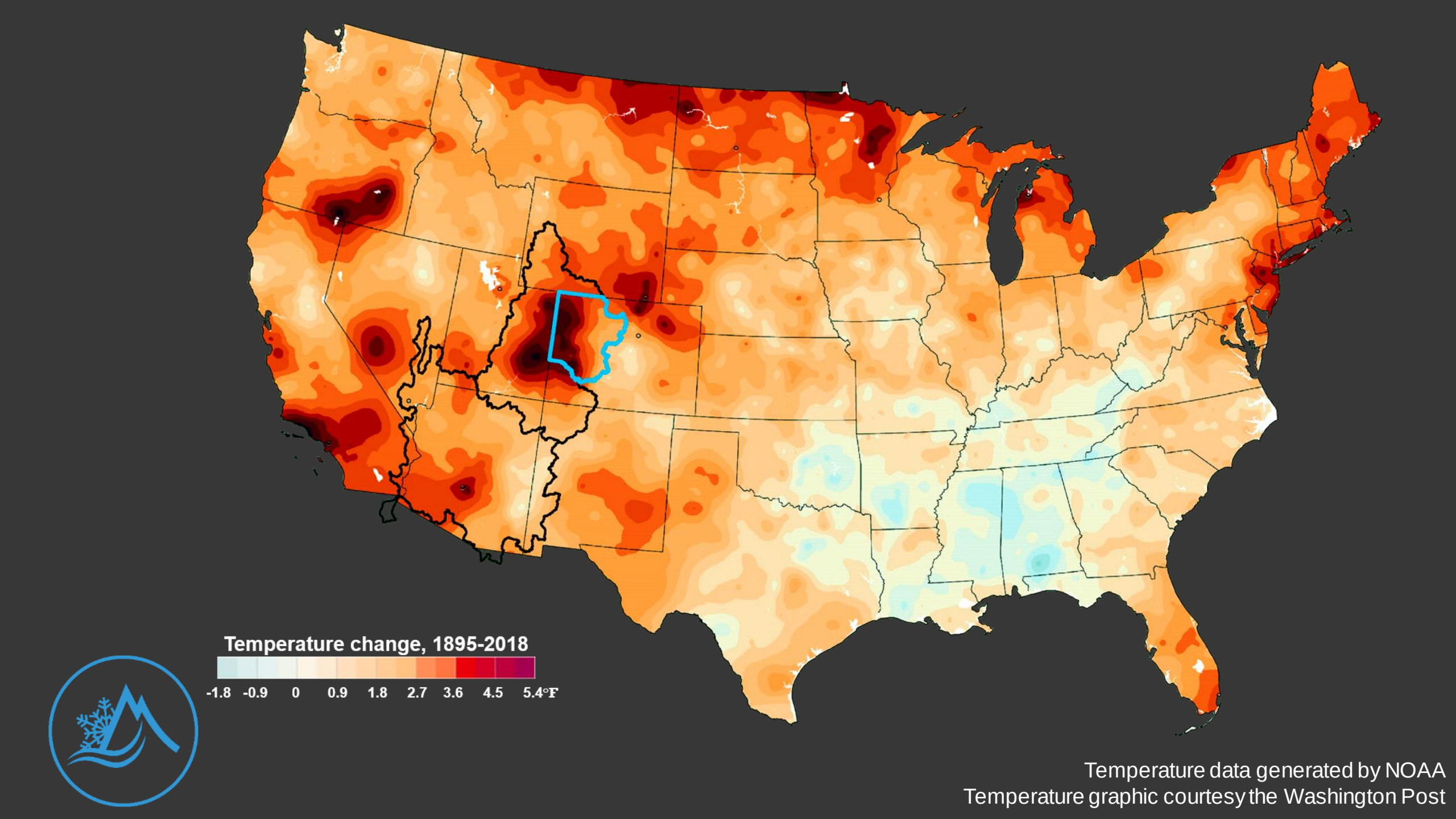
Andy Mueller
General Manager
Colorado River District

COLORADO RIVER DISTRICT
PROTECTING WESTERN COLORADO WATER SINCE 1937

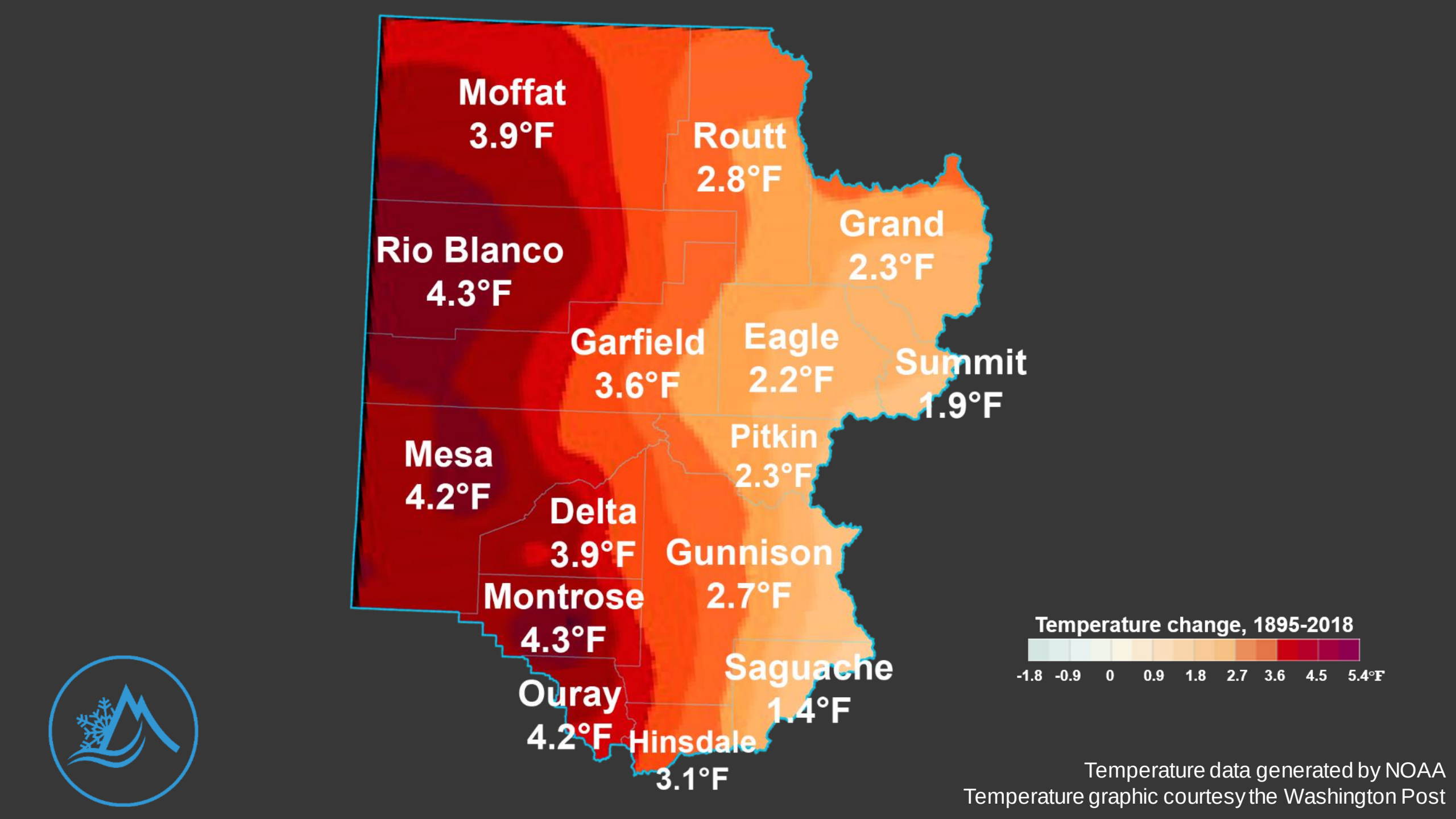


To lead in the **protection, conservation, use, and development** of the water resources of the Colorado River basin.

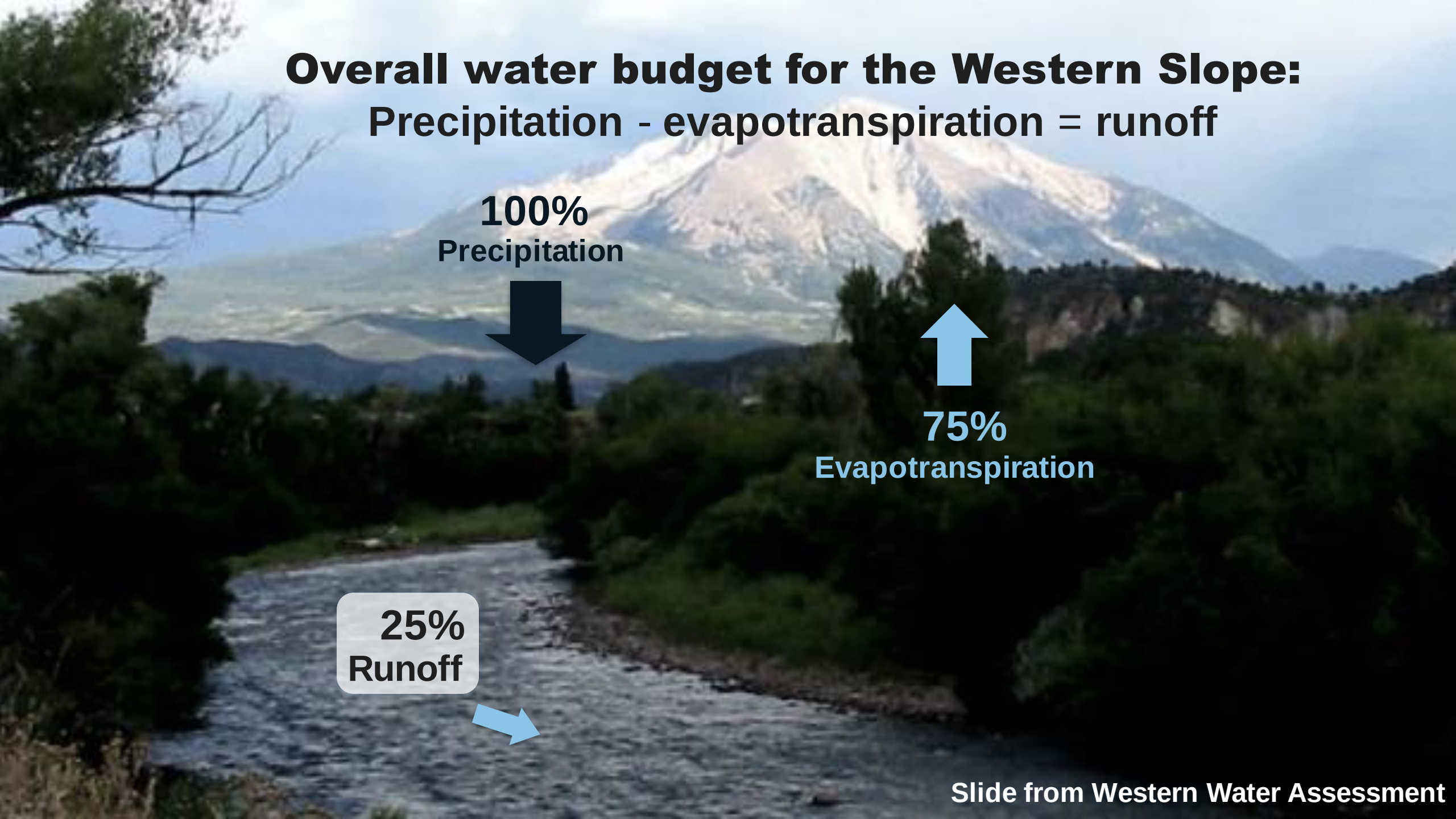

Colorado River Basin
Wyoming
Cheyenne
Flaming Gorge Reservoir
Wasatch Front
Green River
Colorado River District
Colorado Front Range
Nevada
Utah
Colorado River
Colorado
Aspinall Unit
San Juan River
SWCD
Lake Powell
Lee Ferry
Navajo Lake
Lake Mead
California
Lake Mojave
Little Colorado River
San Juan Chama Project
Lake Havasu
Arizona
New Mexico
Colorado River Aqueduct
Central Arizona Project
Imperial and Coachella Valleys
Gila River
Mexico
COLORADO RIVER DISTRICT
PROTECTING WESTERN COLORADO WATER SINCE 1937



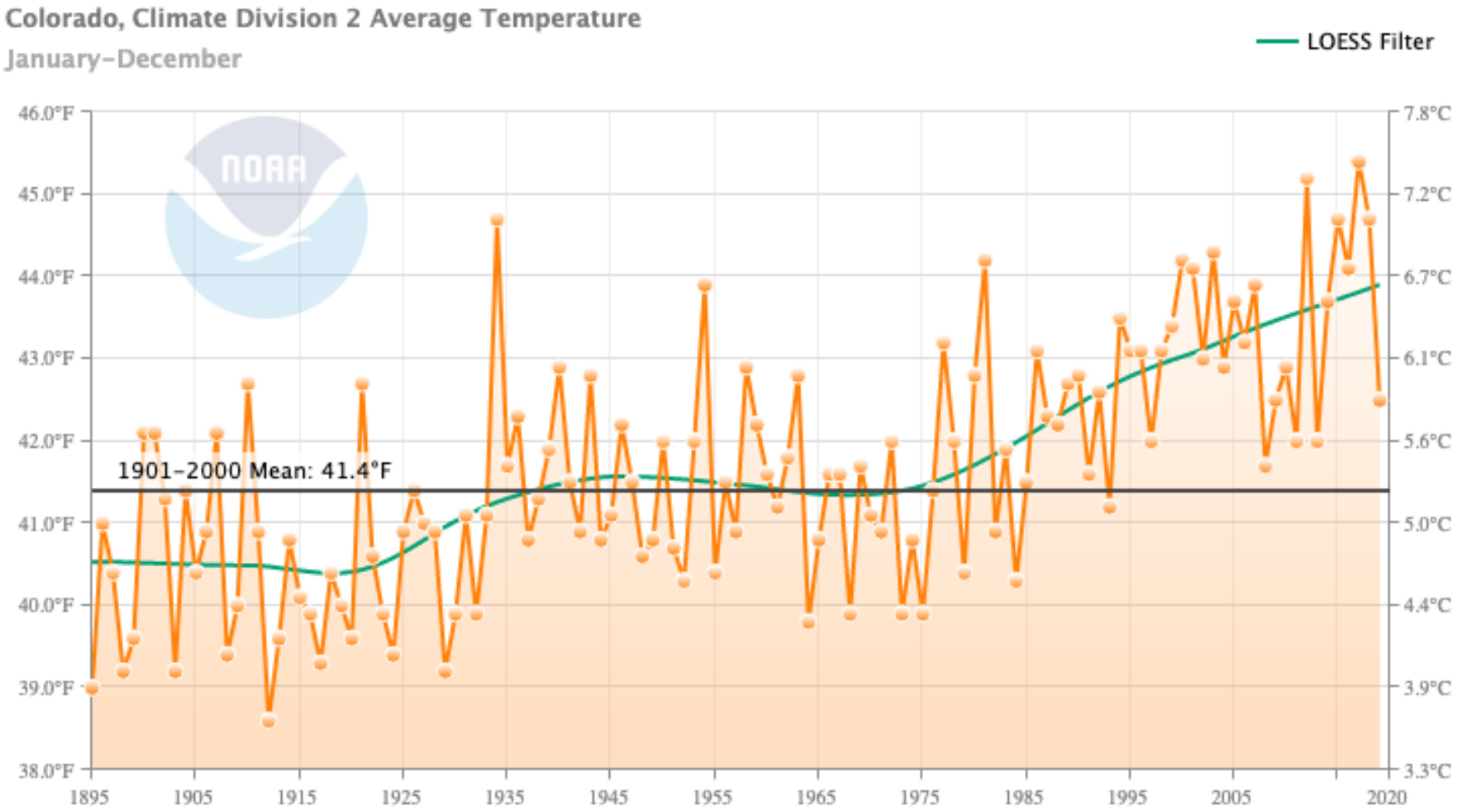
Temperature data generated by NOAA
Temperature graphic courtesy the Washington Post



Temperature data generated by NOAA
Temperature graphic courtesy the Washington Post


Overall water budget for the Western Slope:
Precipitation - evapotranspiration = runoff
100%
Precipitation
75%
Evapotranspiration
25%
Runoff
Slide from Western Water Assessment

Western Colorado has **warmed by >2ºF** since 1980



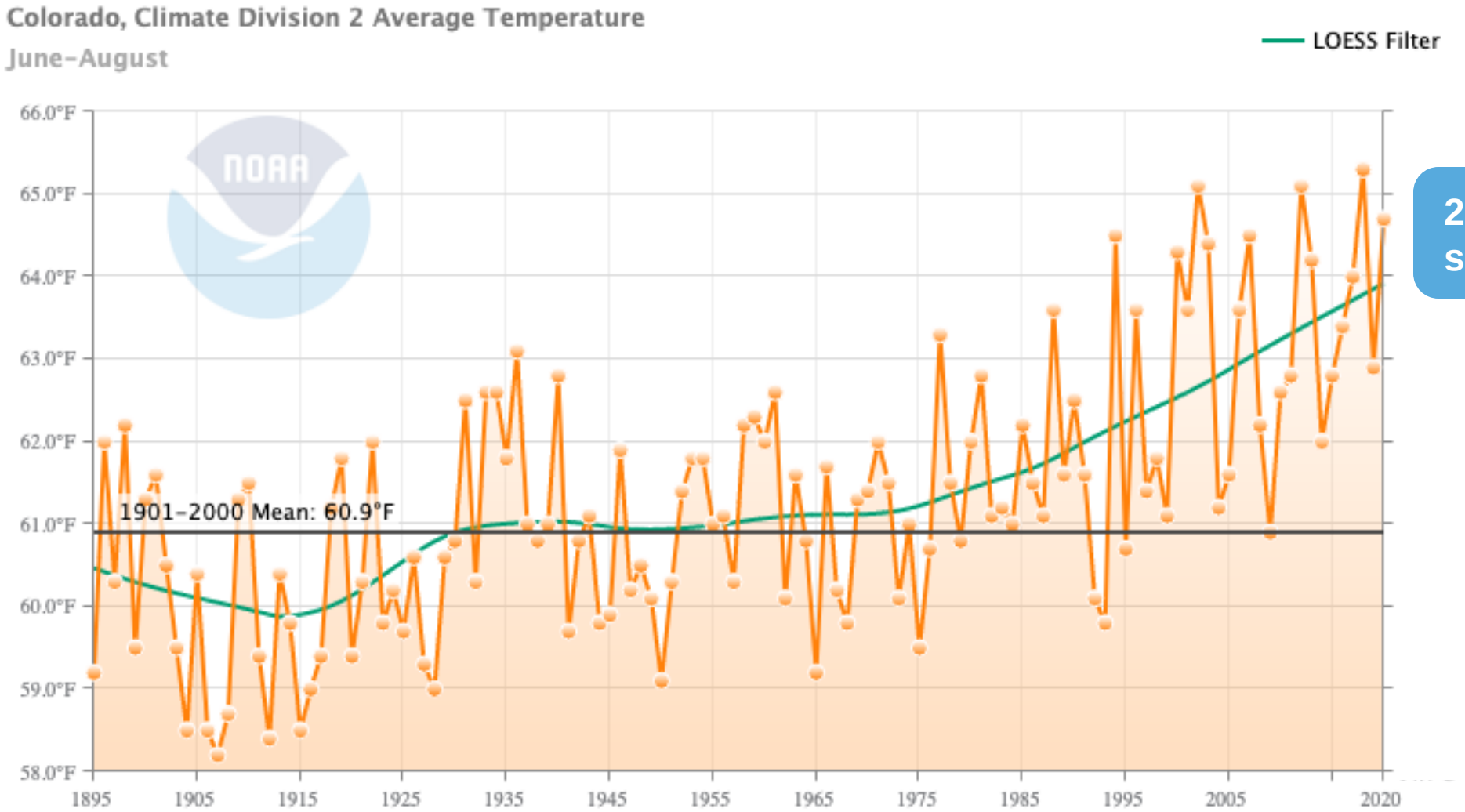
WESTERN WATER ASSESSMENT
A NOAA RISA TEAM

CIRES

University of Colorado Boulder

Slide from Western Water Assessment

Summers in Western Colorado have warmed even more than annual temperatures



2020: 4th hottest summer on record

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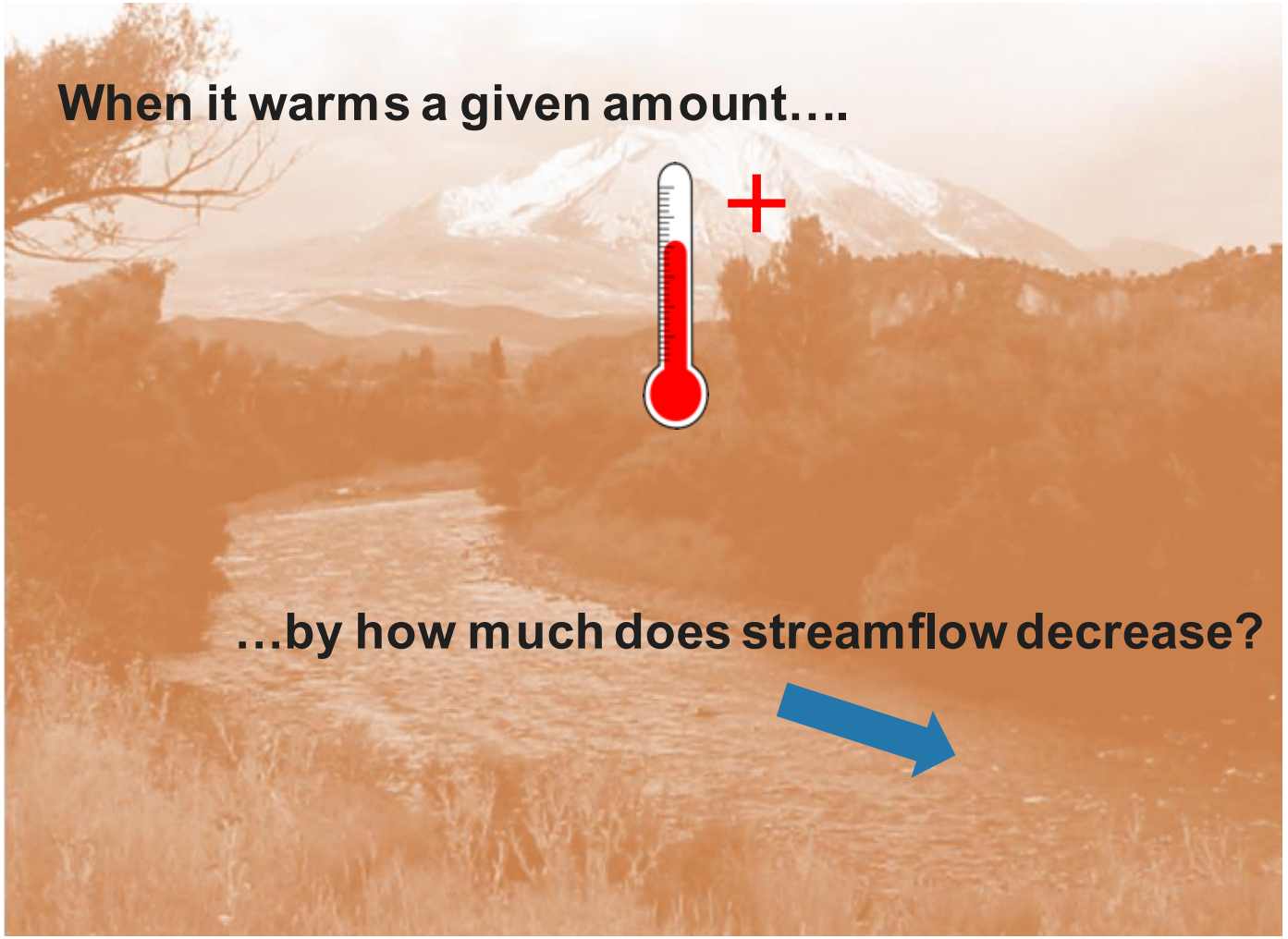
Slide from Western Water Assessment

Recent studies: Upper Colorado River Basin streamflow sensitivity and attribution of recent changes

- McCabe and Wolock (2007)
- Das et al. (2011)
- Nowak et al. (2012)
- Vano et al. (2012)
- Vano and Lettenmaier (2014)
- Udall and Overpeck (2017)
- McCabe et al. (2017)
- Barsugli and Livneh (2018)
- Xiao et al. (2018)
- Hoerling et al. (2019)
- Milly and Dunne (2020)



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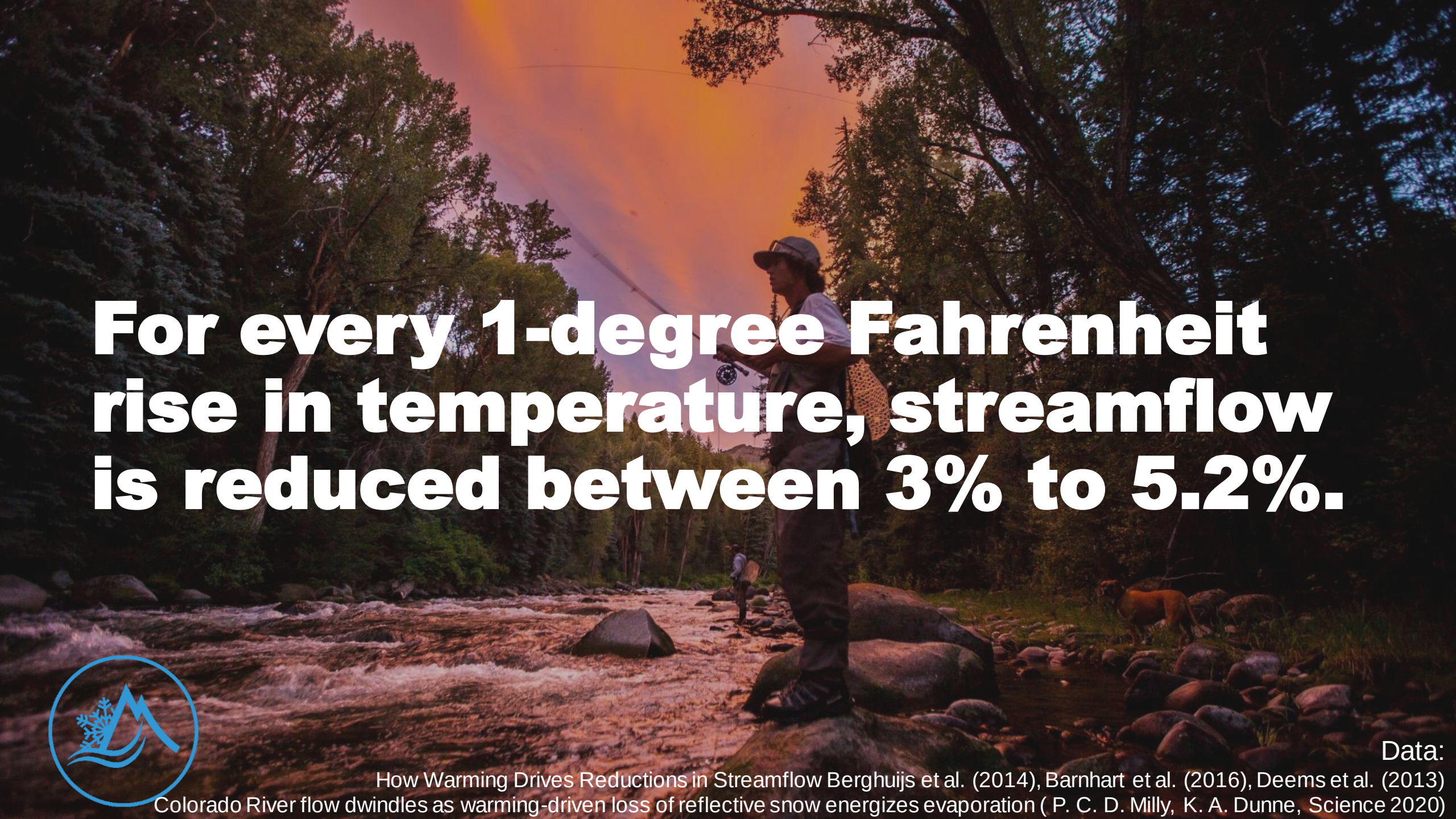
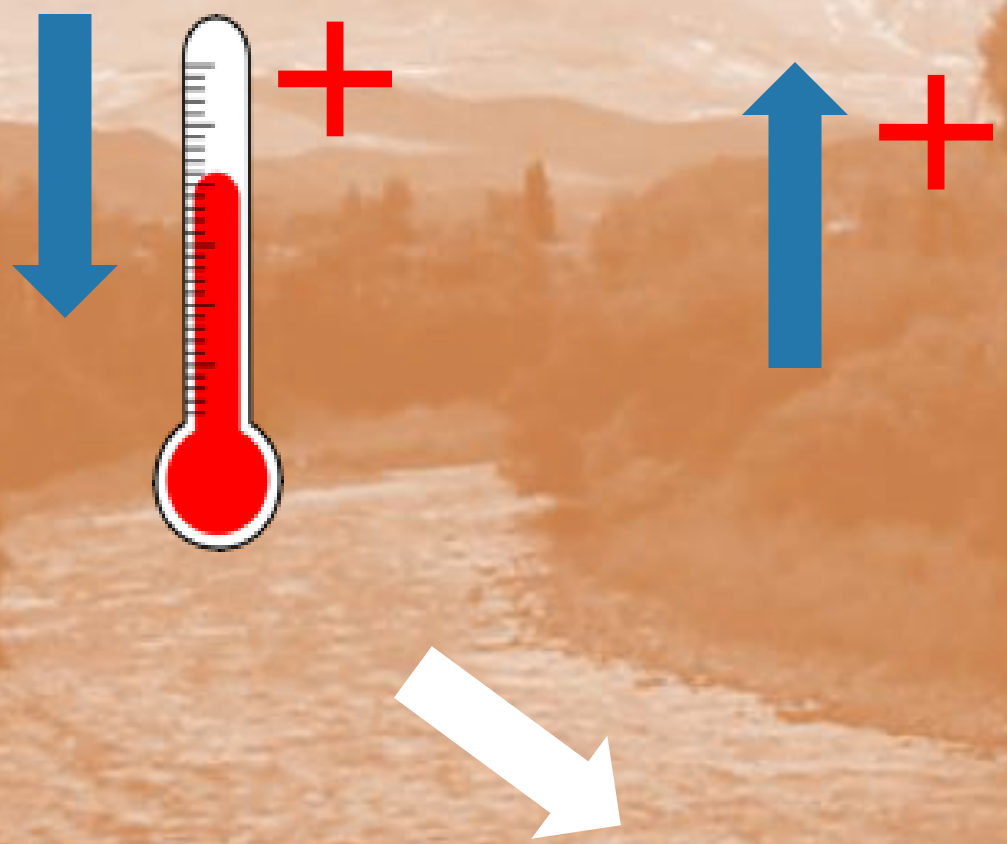


Data:

How Warming Drives Reductions in Streamflow Berghuijs et al. (2014), Barnhart et al. (2016), Deems et al. (2013)
Colorado River flow dwindles as warming-driven loss of reflective snow energizes evaporation (P. C. D. Milly, K. A. Dunne, Science 2020)

Summers in Western Colorado have warmed even more than annual temperatures



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Slide from Western Water Assessment

Water year 2020: What happened to the snow?

103% of normal (April 1)

53% of normal (April–July)

Fall: Very dry soils

November – March: Okay snow

April-May: Record-dry

March-August: Near-record- warm

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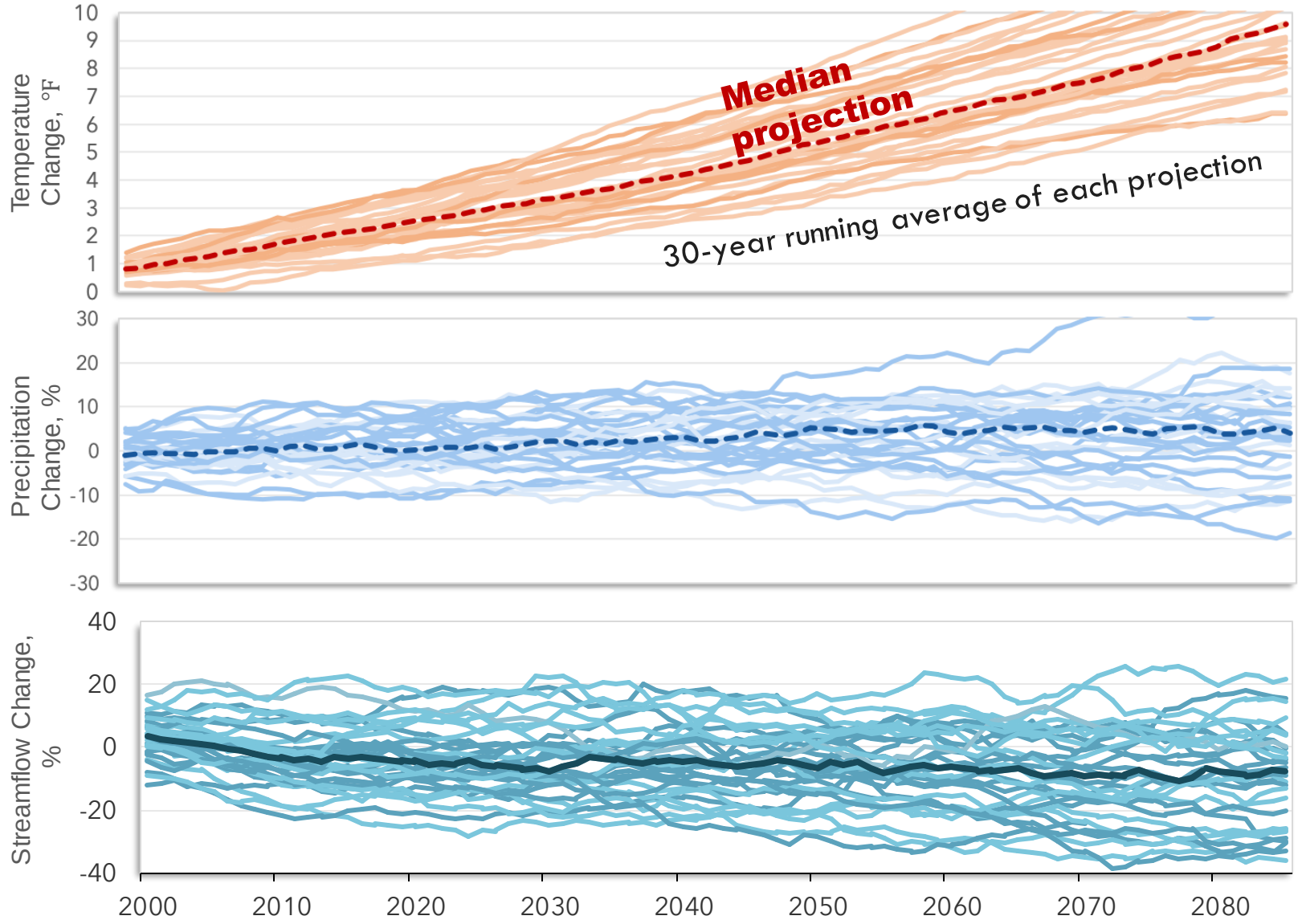
Slide from Western Water Assessment

32 future projections of Upper Basin climate and hydrology

Temperature

Precipitation

Streamflow at Lees Ferry



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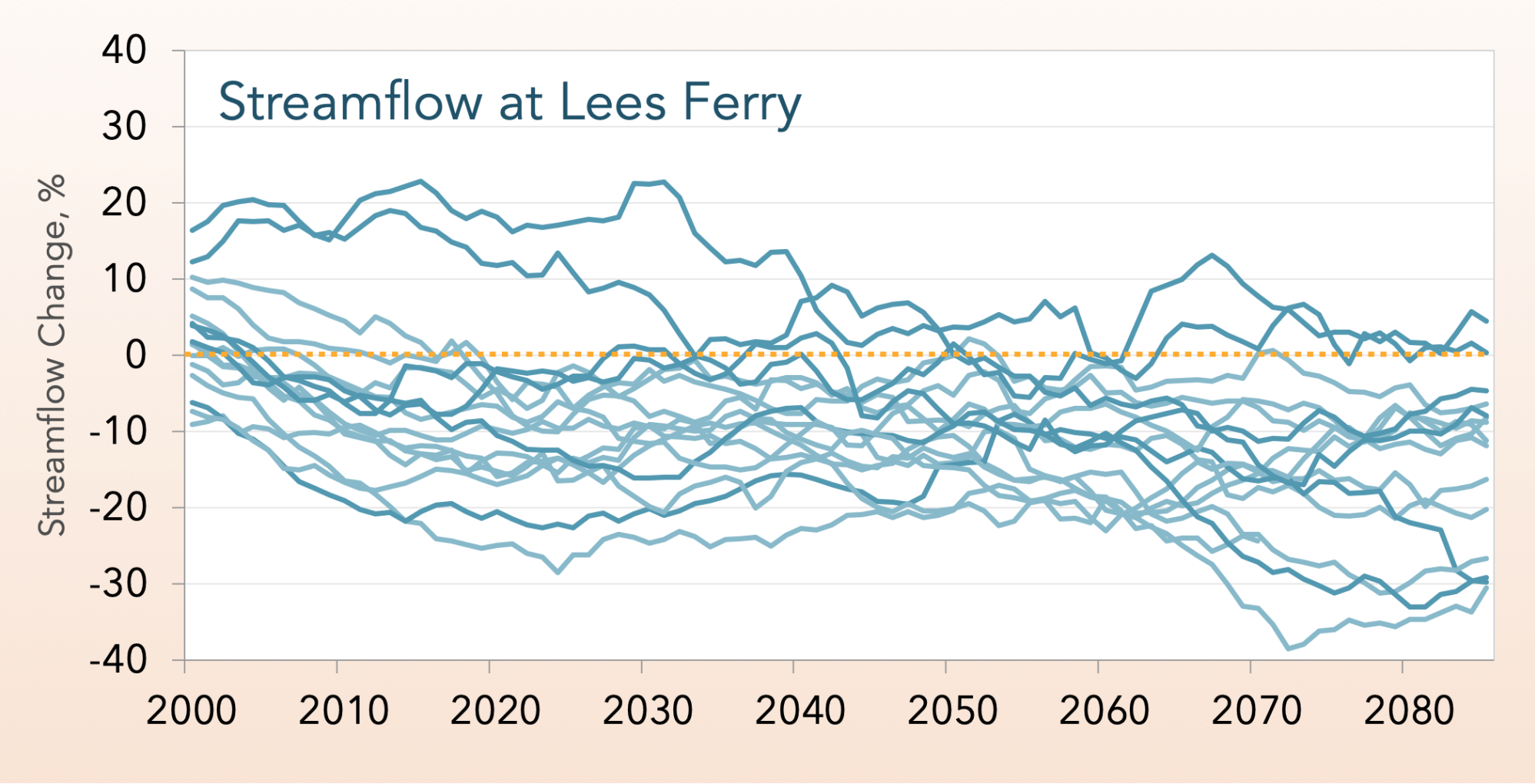
Data: CMIP5-LOCA-VIC dataset, RCP8.5
(Reclamation, USACE, NCAR, et al.)

16 future projections of Upper Basin hydrology that show less 21st century precipitation change



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Data: CMIP5-LOCA-VIC dataset, RCP8.5
(Reclamation, USACE, NCAR, et al.)

Summary

- Precipitation still drives hydrologic variability, but the **warming is causing overall drying**
- Studies strongly indicate that warming is already reducing Upper Basin streamflows
- Future warming will drive further reductions in streamflows
- Warming will also shift snowmelt and runoff earlier, increase crop water use, and generally worsens drought impacts
- **Warming also increases wildfire risk**

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Population Growth

State of Colorado: 9 million by 2050

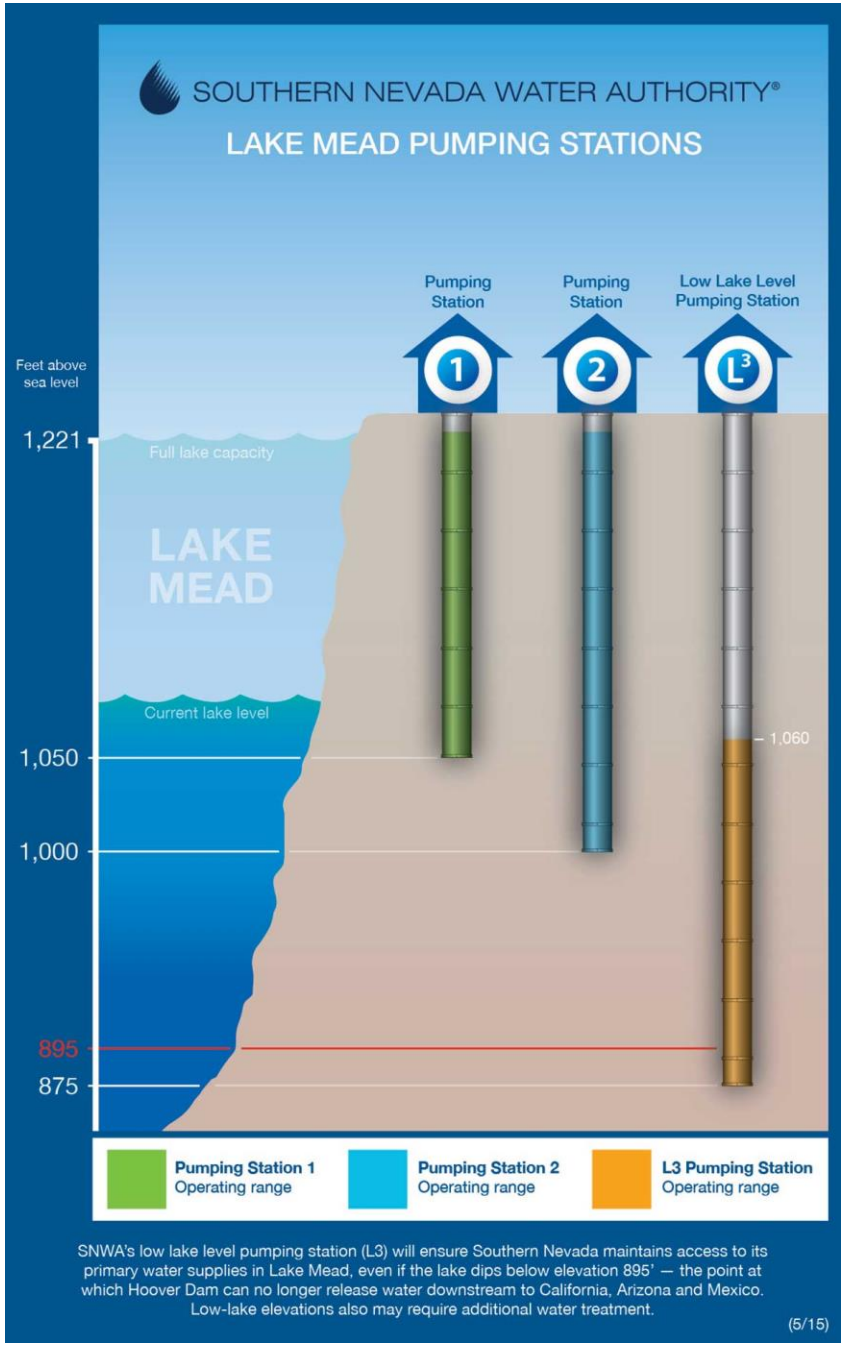
Colorado River Basin: 70 million by 2060

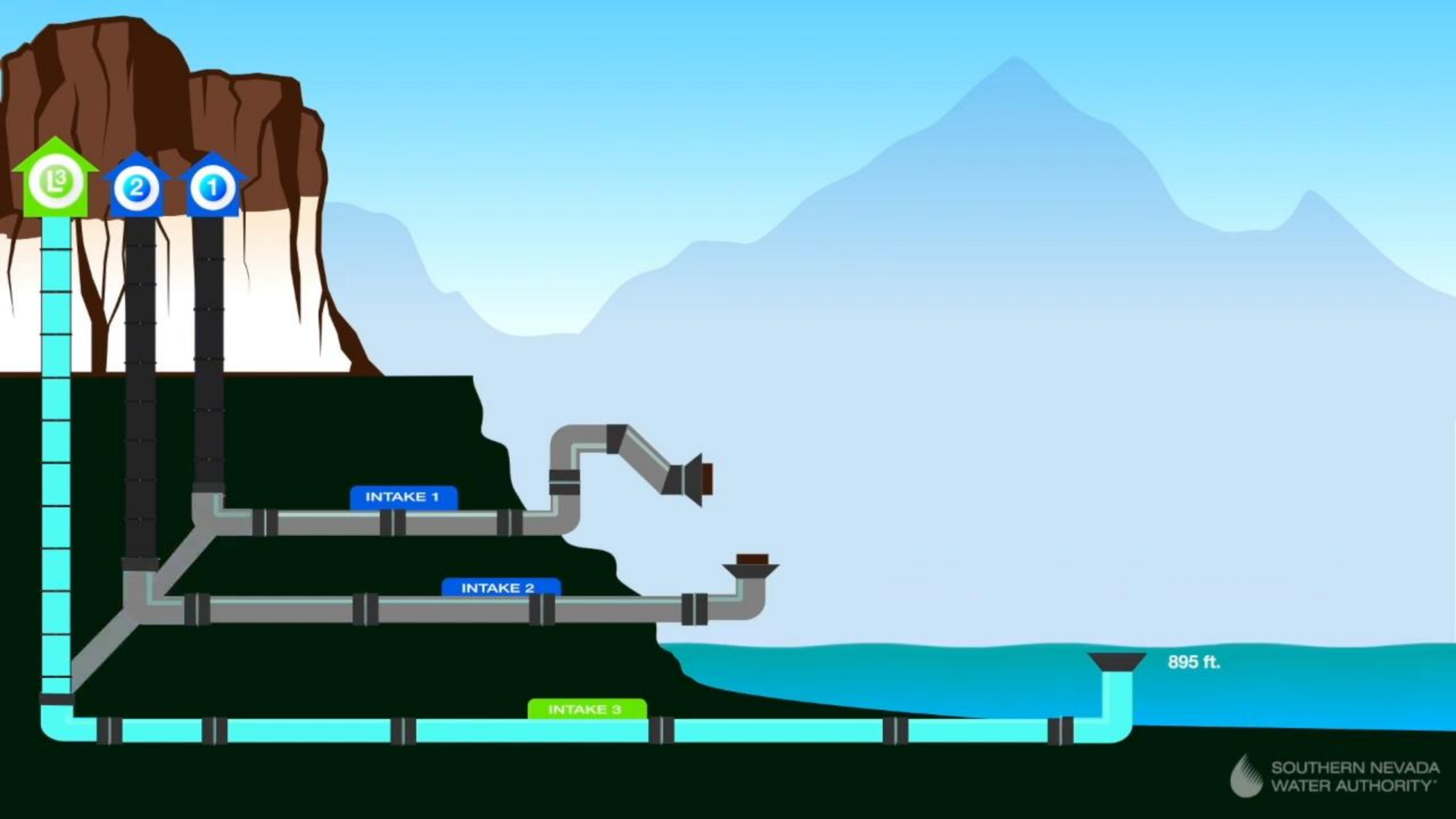
Colorado data from
Colorado Water Plan Technical Update (2016)
Photo courtesy Colorado Public Radio

Colorado River Basin data from U.S. Bureau of Reclamation
Colorado River Basin Water Supply and Demand Study (2011)
Photo courtesy Visit Phoenix

Moving forward

- **Needs and Solutions:**
  - Greater conservation (Ag, Urban, Industrial)
  - Increased trans-basin re-use
  - Stream flow Adaptation/Mitigation
  - Science based watershed health
  - Improved forecast reliability
  - Snowpack enhancement via cloud seeding
  - Basin-wide snowpack data inventory with forecast integration
  - More snow!


SOUTHERN NEVADA WATER AUTHORITY®
LAKE MEAD PUMPING STATIONS
Pumping Station
Pumping Station
Low Lake Level Pumping Station
1
2
L3
Feet above sea level
1,221
Full lake capacity
LAKE MEAD
Current lake level
1,050
1,000
895
875
1,060
Pumping Station 1 Operating range
Pumping Station 2 Operating range
L3 Pumping Station Operating range
SNWA's low lake level pumping station (L3) will ensure Southern Nevada maintains access to its primary water supplies in Lake Mead, even if the lake dips below elevation 895' — the point at which Hoover Dam can no longer release water downstream to California, Arizona and Mexico. Low-lake elevations also may require additional water treatment.
(5/15)


L3
2
1
INTAKE 1
INTAKE 2
INTAKE 3
895 ft.
SOUTHERN NEVADA
WATER AUTHORITY

Questions?

coloradoriverdistrict.org

Colorado River District

@ColoradoWater

ColoradoRiverDistrict

COLORADO RIVER DISTRICT

PROTECTING WESTERN COLORADO WATER SINCE 1937