

# Modeling Water Quality in Lake Mead: Climate Change, Algal Succession, and Operational Effects

**NALMS**

San Diego, CA  
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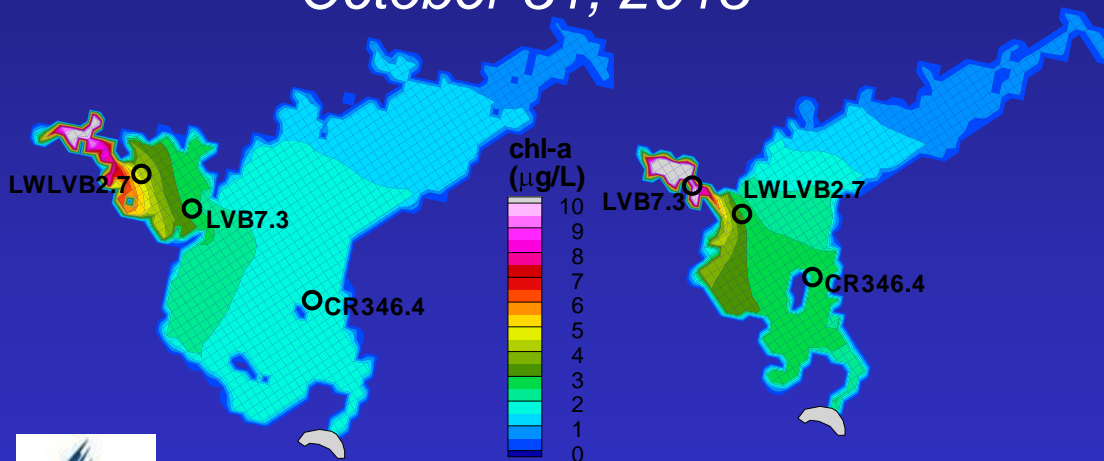
1. Flow Science Incorporated

2. Southern Nevada Water Authority

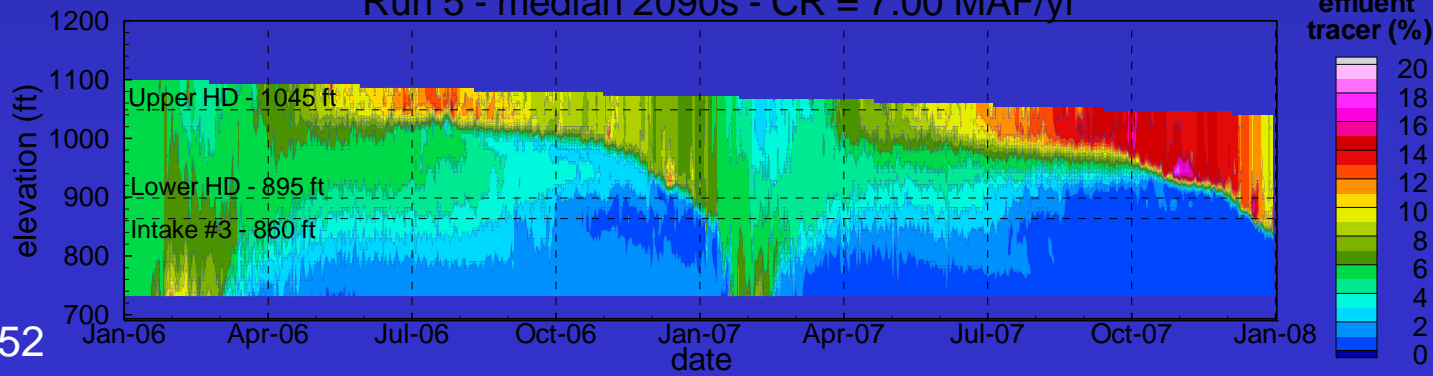
3. San Diego Public Utilities Department

4. Metropolitan Water District

5. California Lake Management Society



Run 5 - median 2090s - CR = 7.00 MAF/yr



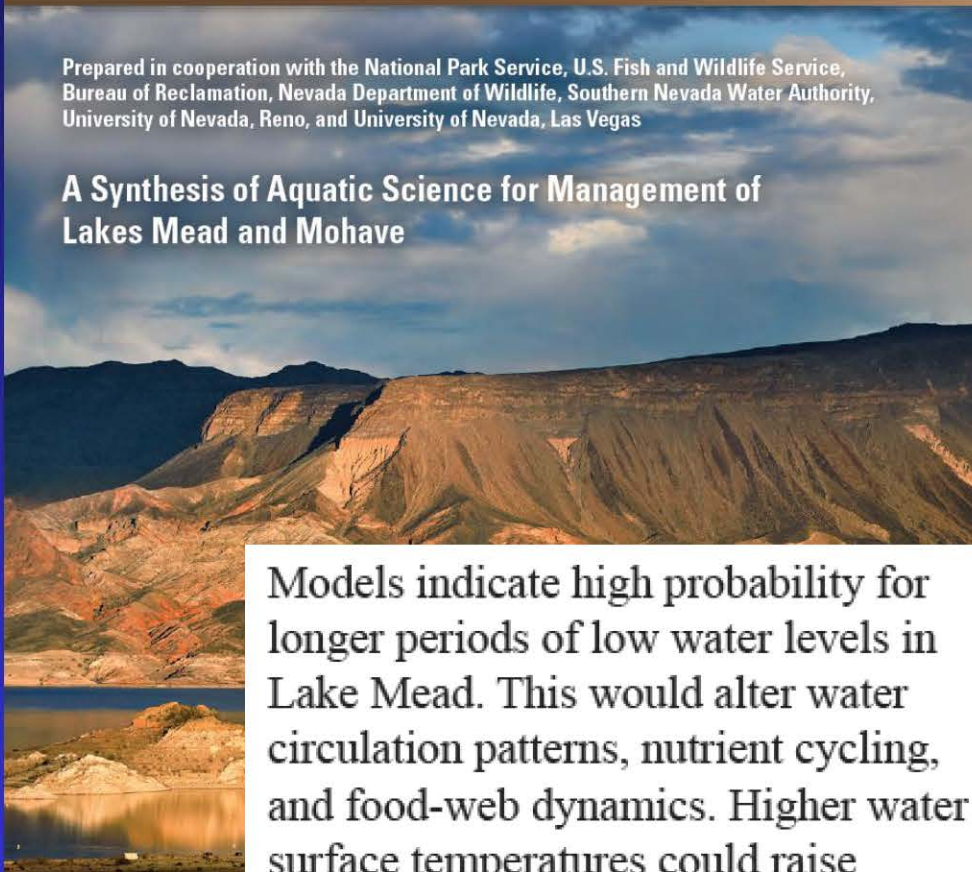
Agreement # R11AP81452

# Information Needed



Prepared in cooperation with the National Park Service, U.S. Fish and Wildlife Service, Bureau of Reclamation, Nevada Department of Wildlife, Southern Nevada Water Authority, University of Nevada, Reno, and University of Nevada, Las Vegas

## A Synthesis of Aquatic Science for Management of Lakes Mead and Mohave



Circular 1381

U.S. Department of the Interior  
U.S. Geological Survey

Models indicate high probability for longer periods of low water levels in Lake Mead. This would alter water circulation patterns, nutrient cycling, and food-web dynamics. Higher water surface temperatures could raise productivity, and also raise the risk of pathogenic organisms to thrive.

Information needed for Lakes Mead and Mohave relates to potential impacts of low flows, lower water levels, increased air temperatures, and increased water temperatures on limnology, ecosystems, fish and wildlife, and recreation and potential pathogens.



# Lake Mead



Las Vegas Wash  
effluent, nutrients,  
TOC, bromide

Colorado River  
dilution, DO  
lower future flows?



SOUTHERN NEVADA  
WATER AUTHORITY

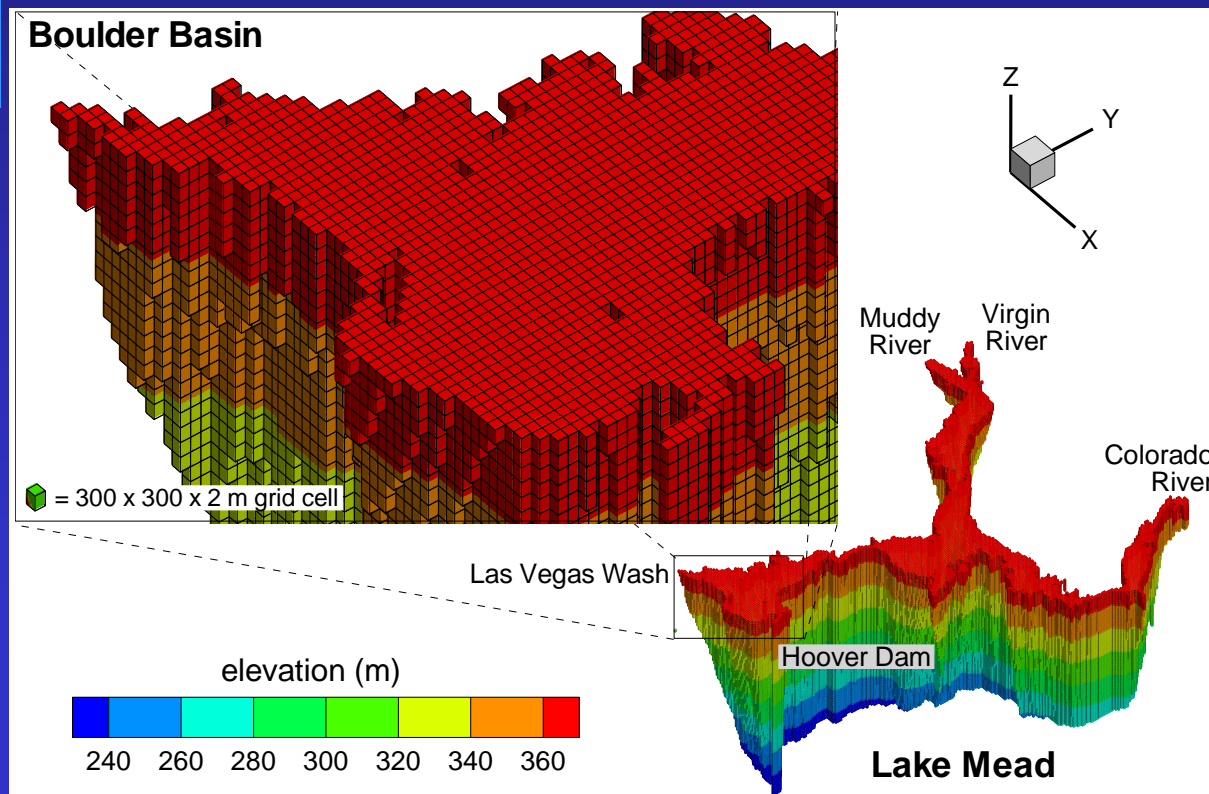
Hoover Dam  
outflow elevations

Nevada

California, Arizona, Mexico

# Lake Mead Model

- Lake Mead Model (LMM) uses ELCOM/CAEDYM codes
- ELCOM
  - 3-D hydrodynamic model, stratification, wind mixing, temperature, salinity, conservative tracers
- CAEDYM
  - Water quality module, algae (chl-a), nutrients, TOC, DO, pH



- ELCOM/CAEDYM developed by Centre for Water Research (UWA)
- LMM Funded by Clean Water Coalition, SNWA and National Park Service



# Adjustment of LMM inputs

■ Air temperature

■ Inflow water temperature

} Primary drivers  
CMIP3 projections

■ Inflow rates

■ WSEL

} Difficult to quantify. Uncertainty.  
Upstream inflows are controlled.  
Examined extremes.

■ Inflow water quality

} Difficult to quantify.  
Not considered.

■ Wind speed

■ Rainfall

} Climate projections indicate  
generally small changes.  
Not considered.

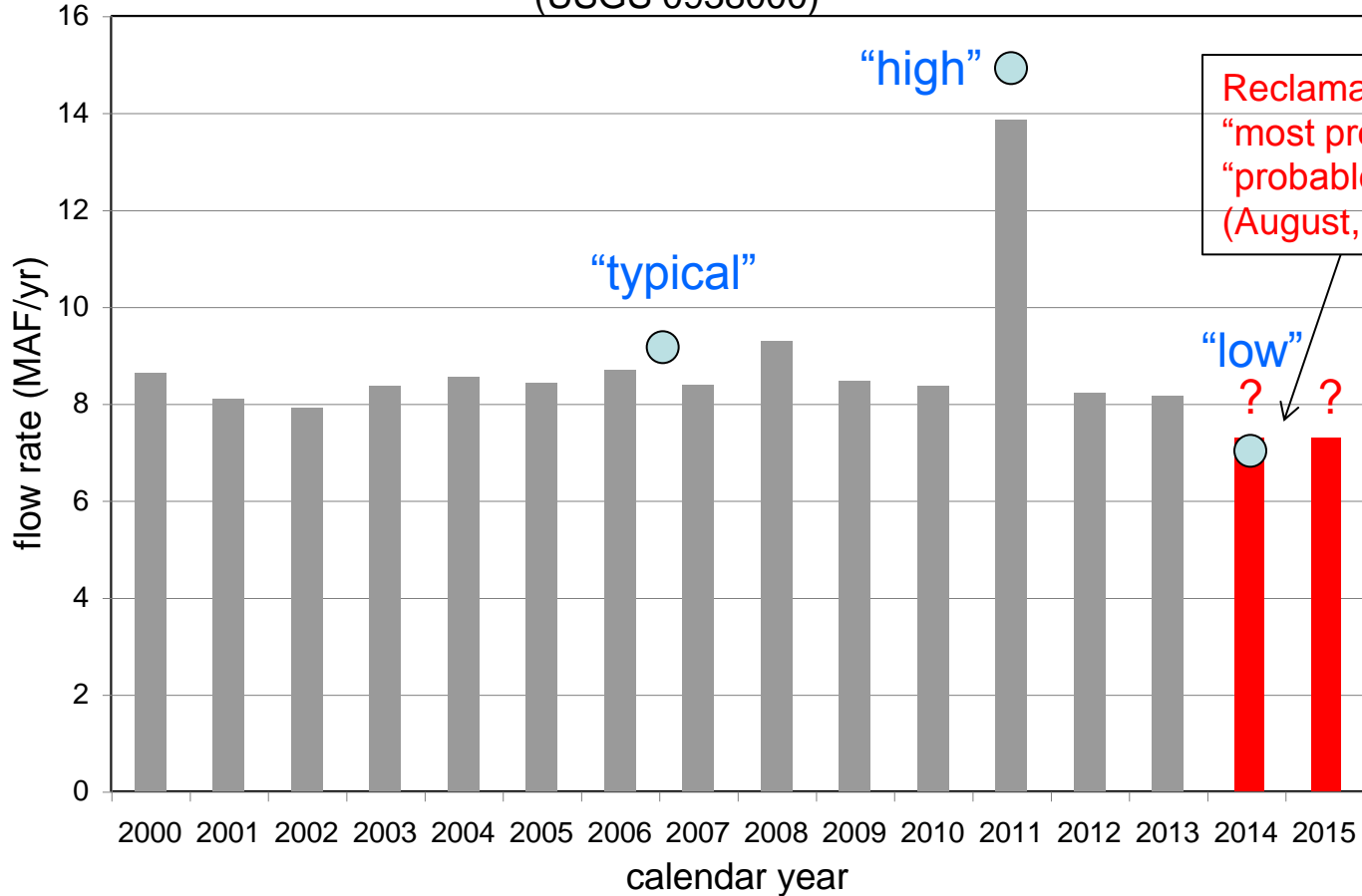
■ Relative humidity

■ Solar radiation / cloud cover

} Climate projections  
did not provide direct  
information.  
Not considered.

# Variable Future Colorado River Inflows

Colorado River at Lees Ferry  
(USGS 0938000)



Colorado River  
dilution, DO  
lower future flows?



Nevada

Hoover Dam  
outflow elevations

California, Arizona, Mexico

3 simulations:

- "typical" 9.23 MAF/yr
- "high" 14.78 MAF/yr
- "low" 7.00 MAF/yr



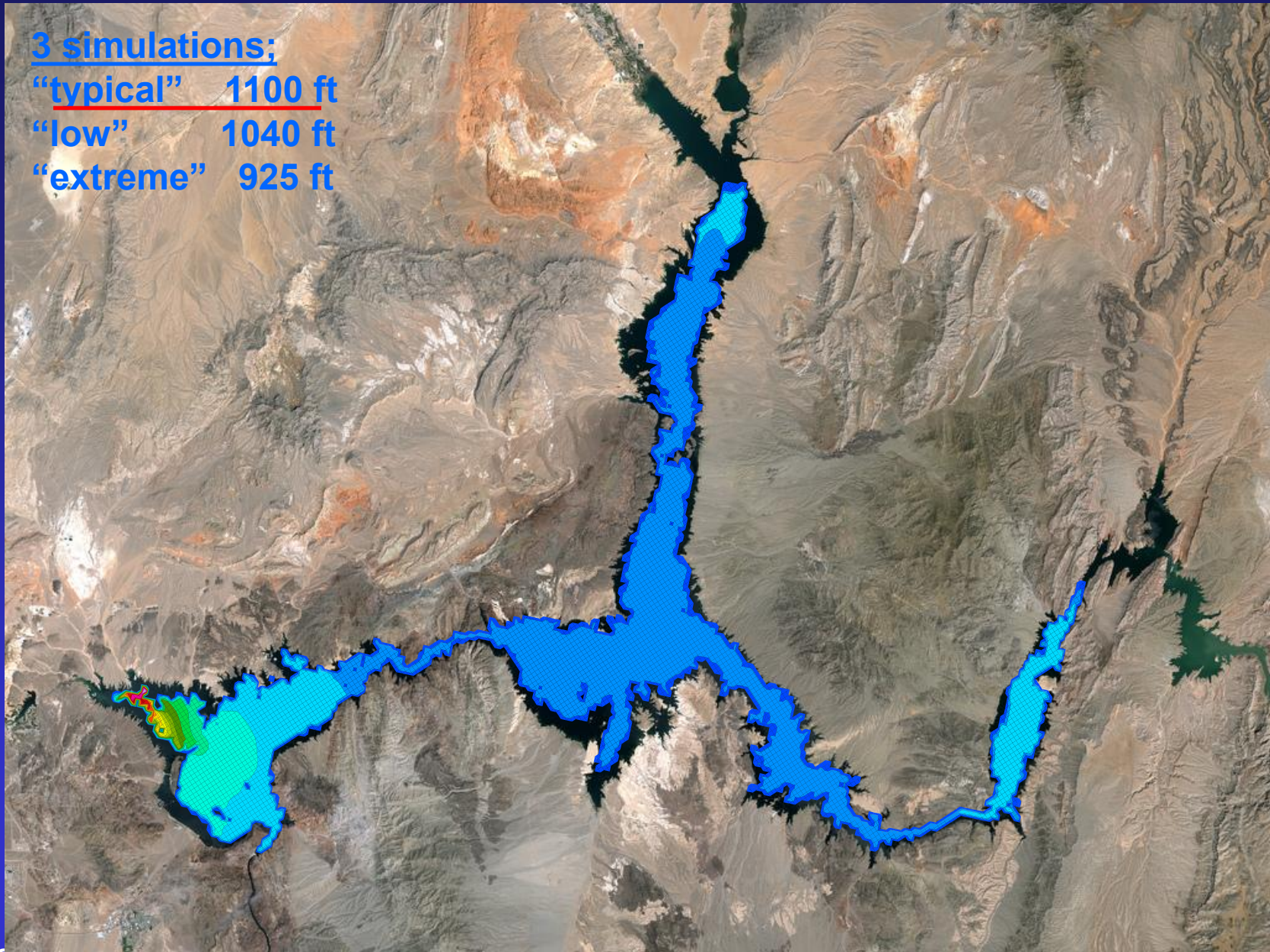
# Lower Water Surface Elevation

3 simulations;

“typical” 1100 ft

“low” 1040 ft

“extreme” 925 ft





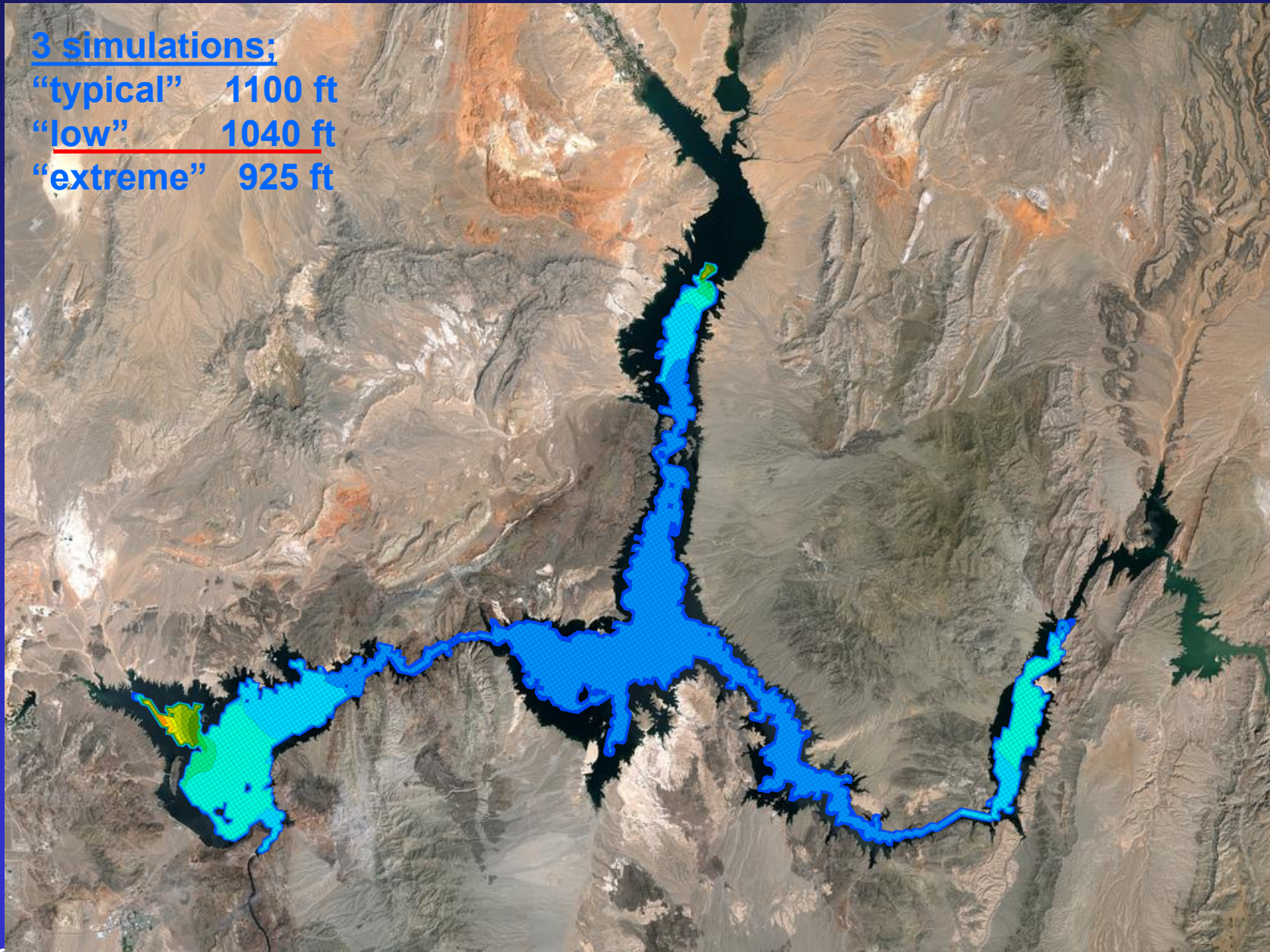
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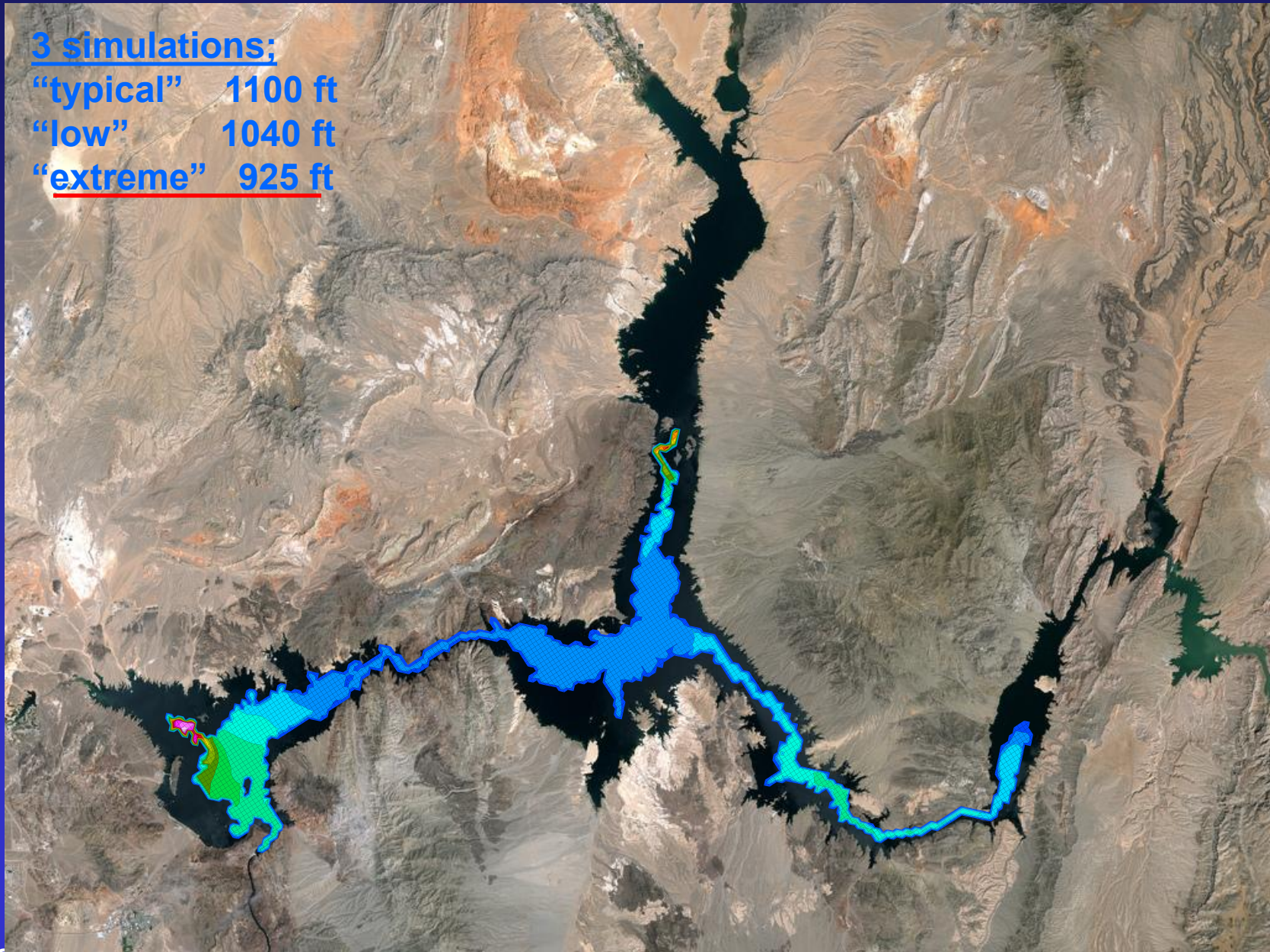
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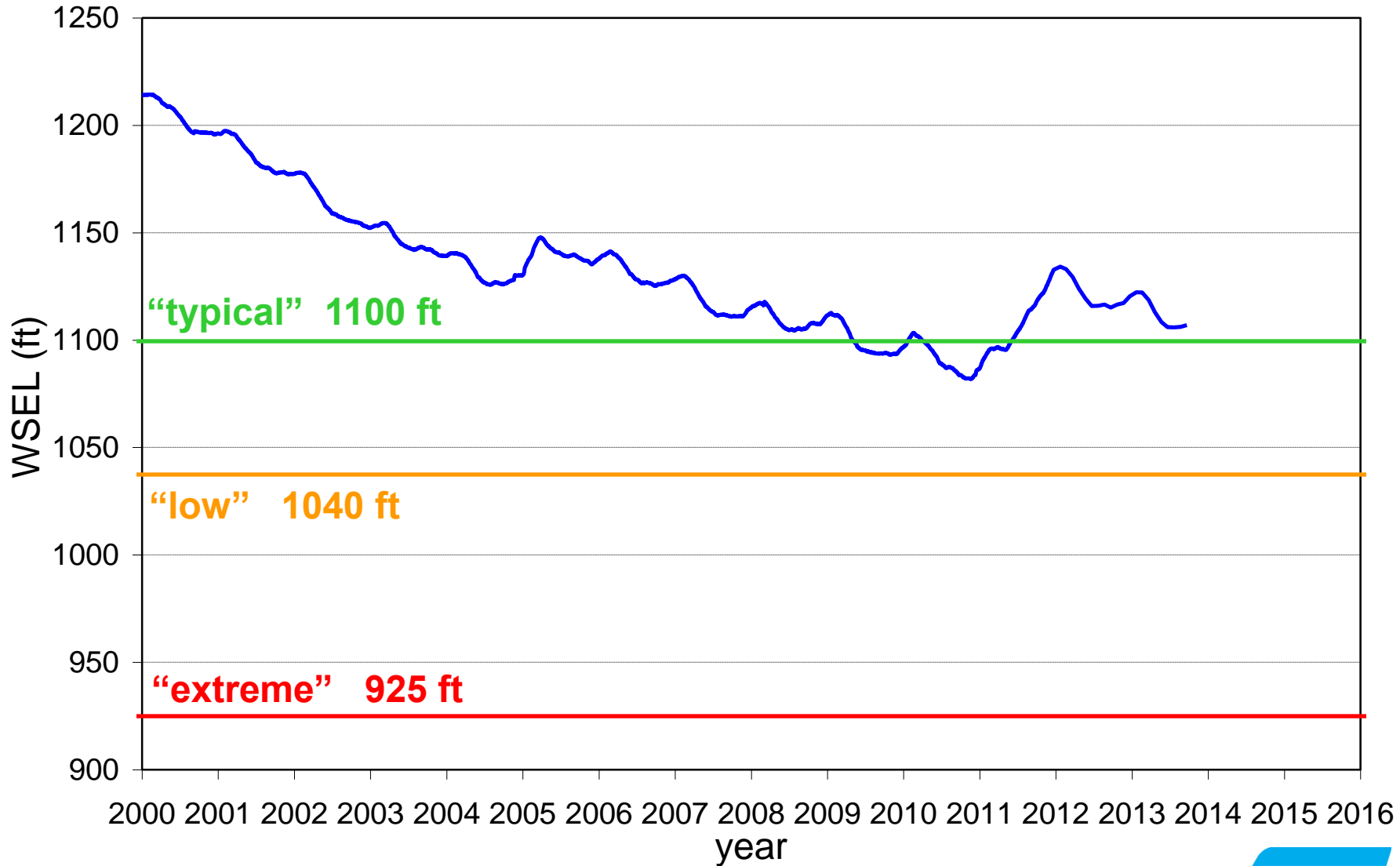
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# Lower Water Surface Elevation

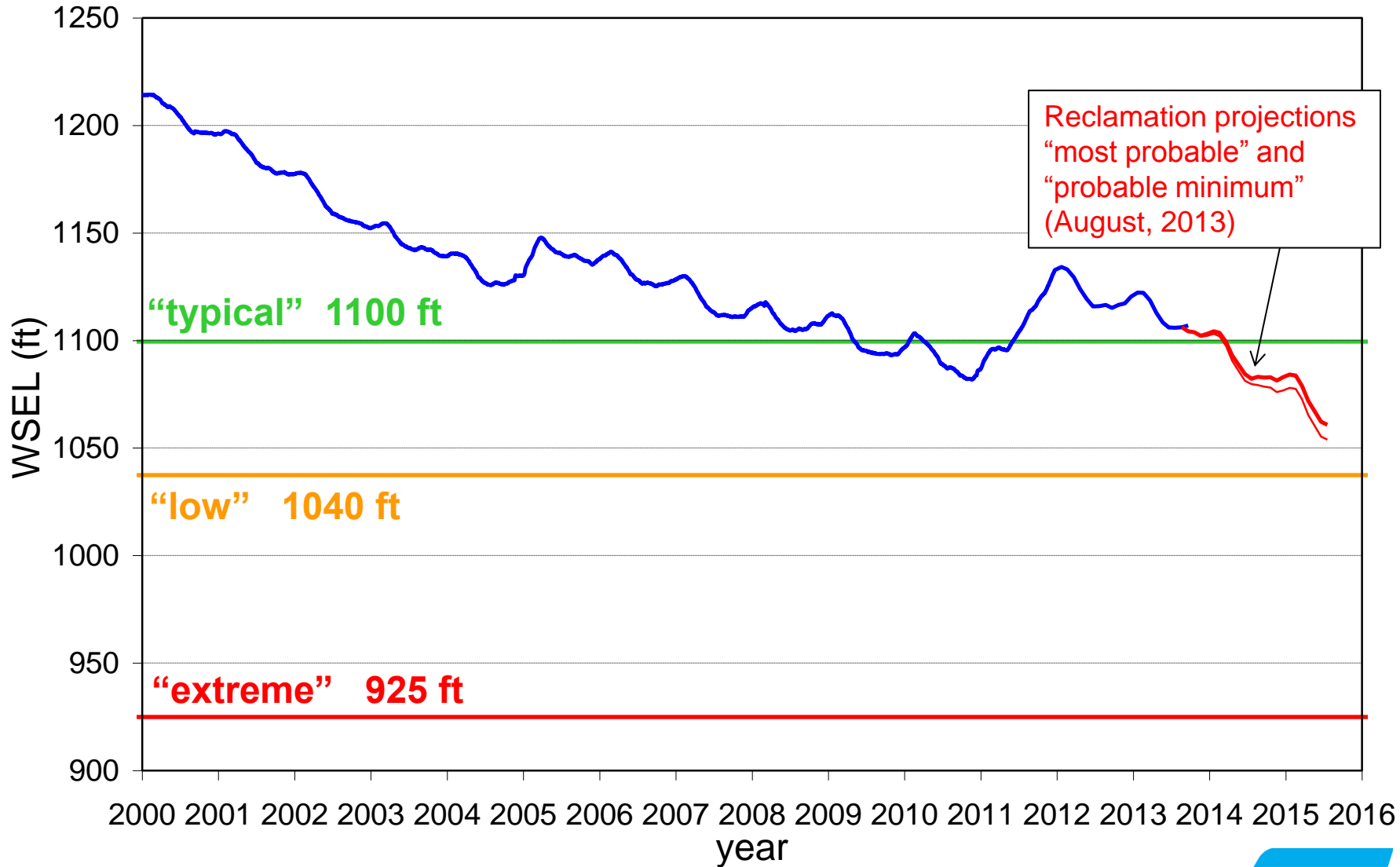
## Lake Mead Water Surface Elevation





# Lower Water Surface Elevation

## Lake Mead Water Surface Elevation



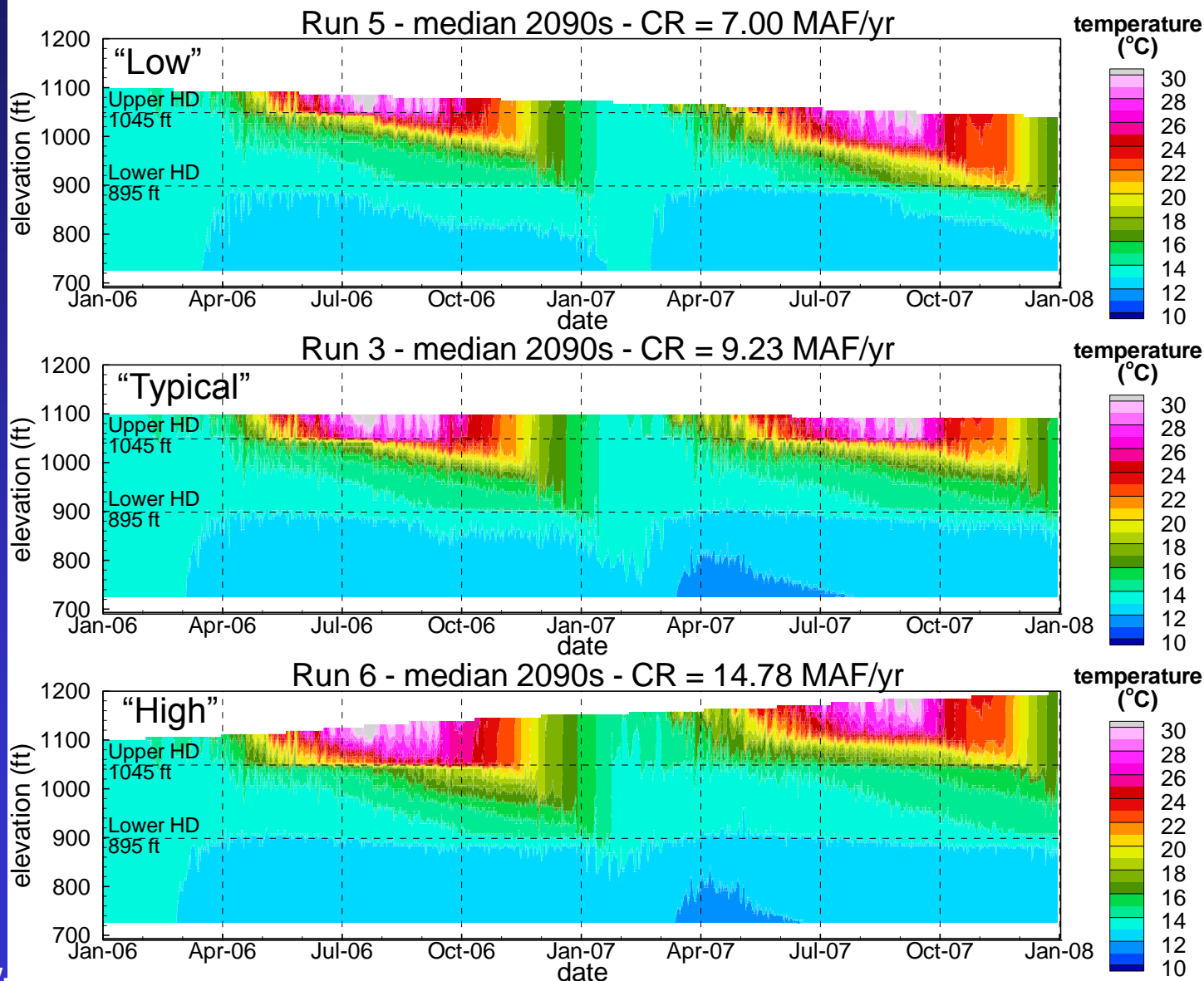
# Results

- “Hoover Dam effect”
  - Withdrawals from epilimnion
- WSEL
  - SNWA Intake #3
- Algae (Chlorophyll a)



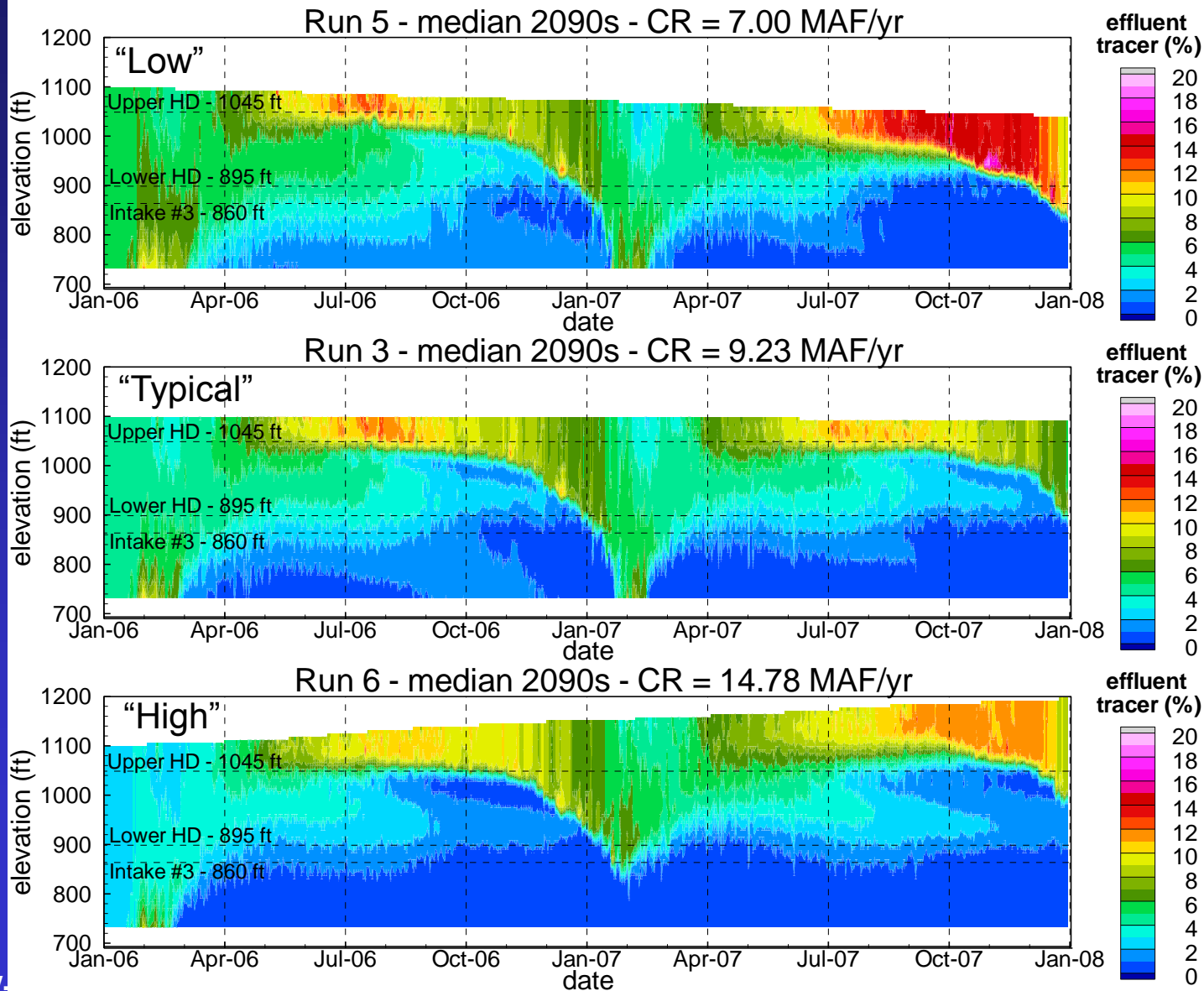
# “Hoover Dam Effect”

## Comparison of Temperature Profiles at Hoover Dam Outlets



# “Hoover Dam Effect”

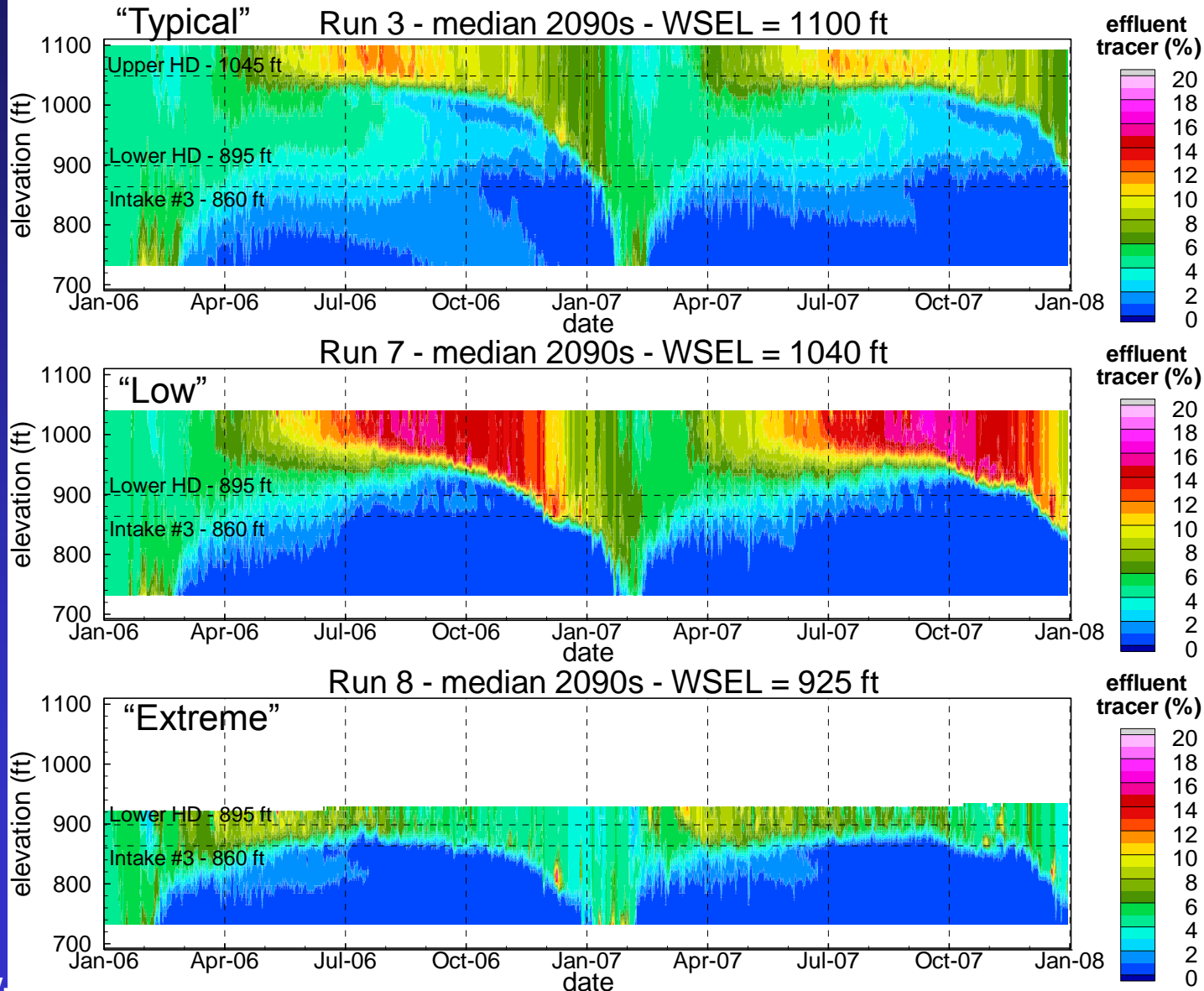
## Comparison of Effluent Tracer Profiles at Station CR346.4





# WSEL ( and Hoover Dam Effect )

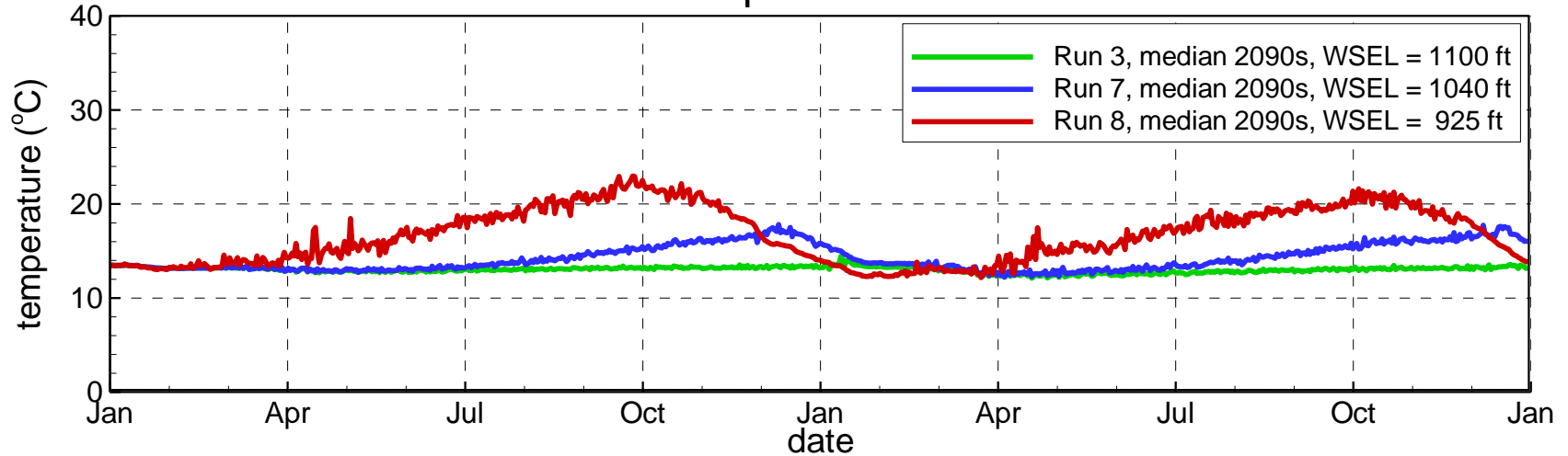
## Comparison of Effluent Tracer Profiles at Station CR346.4



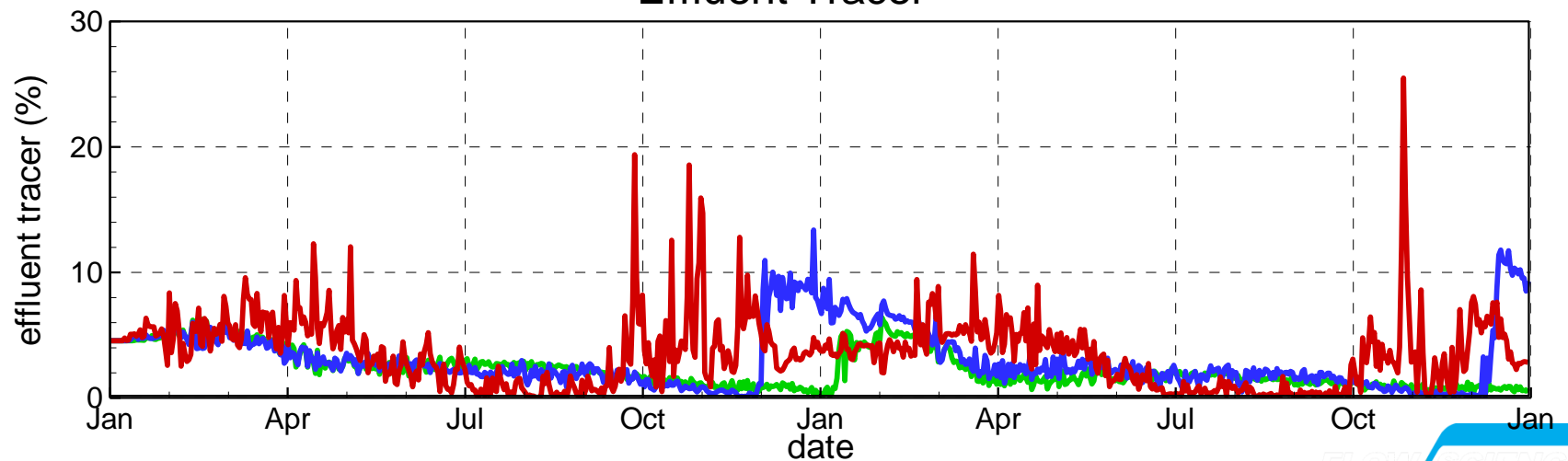
# SNWA Intake #3

## Temperature and Effluent Tracer at SNWA Intake #3

### Temperature



### Effluent Tracer

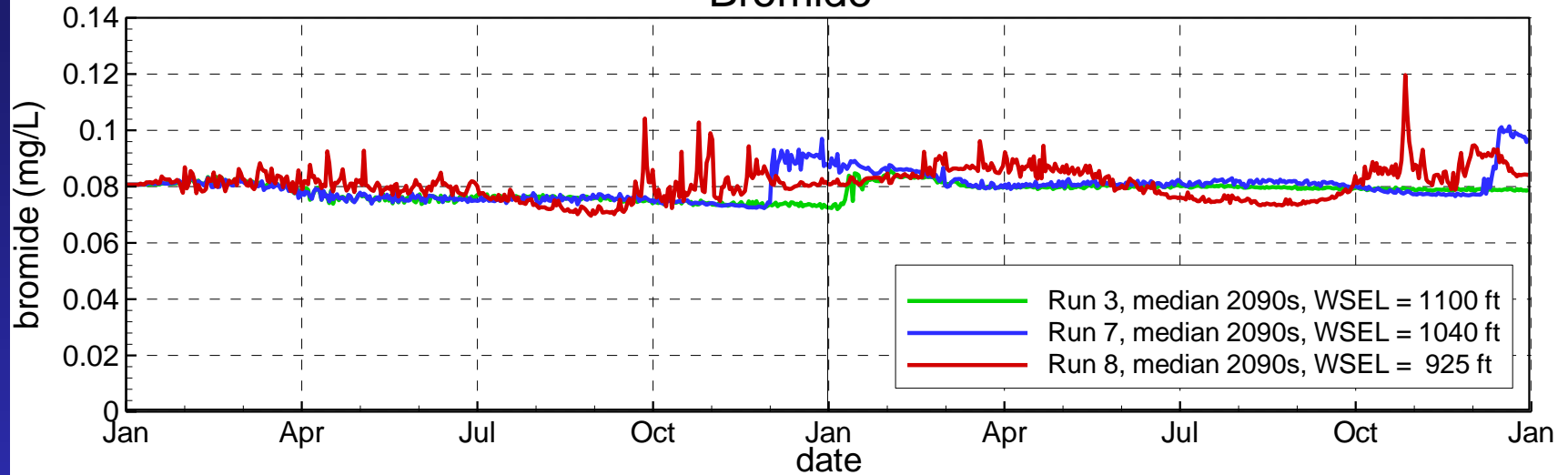




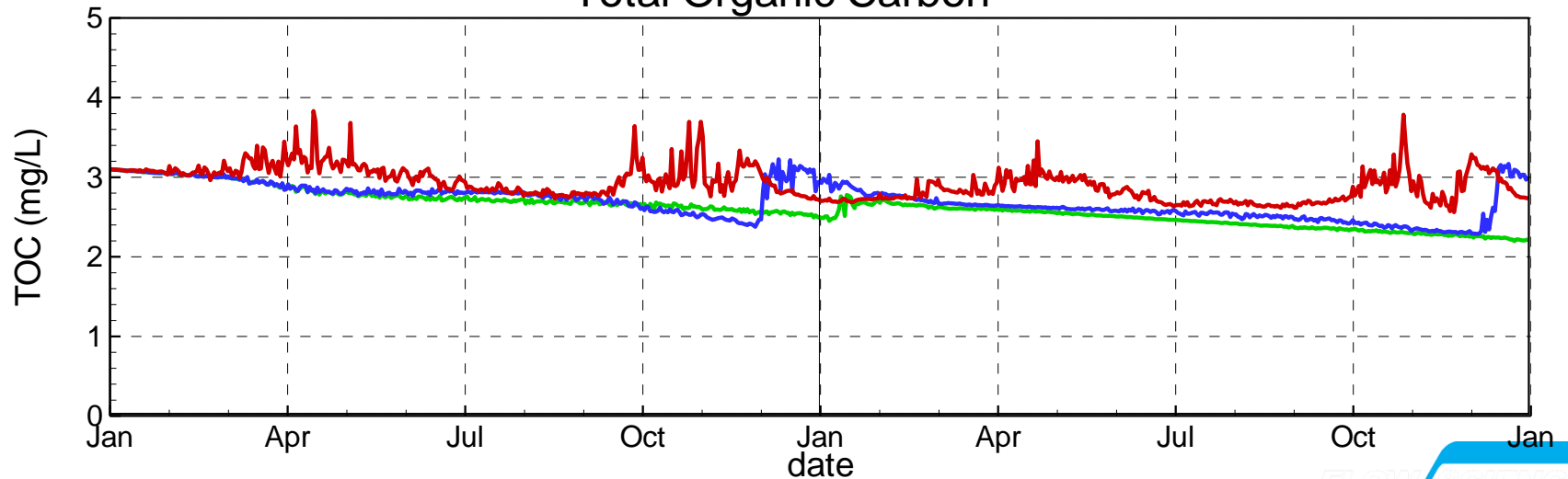
# SNWA Intake #3

## Bromide and TOC Concentrations at SNWA Intake #3

### Bromide

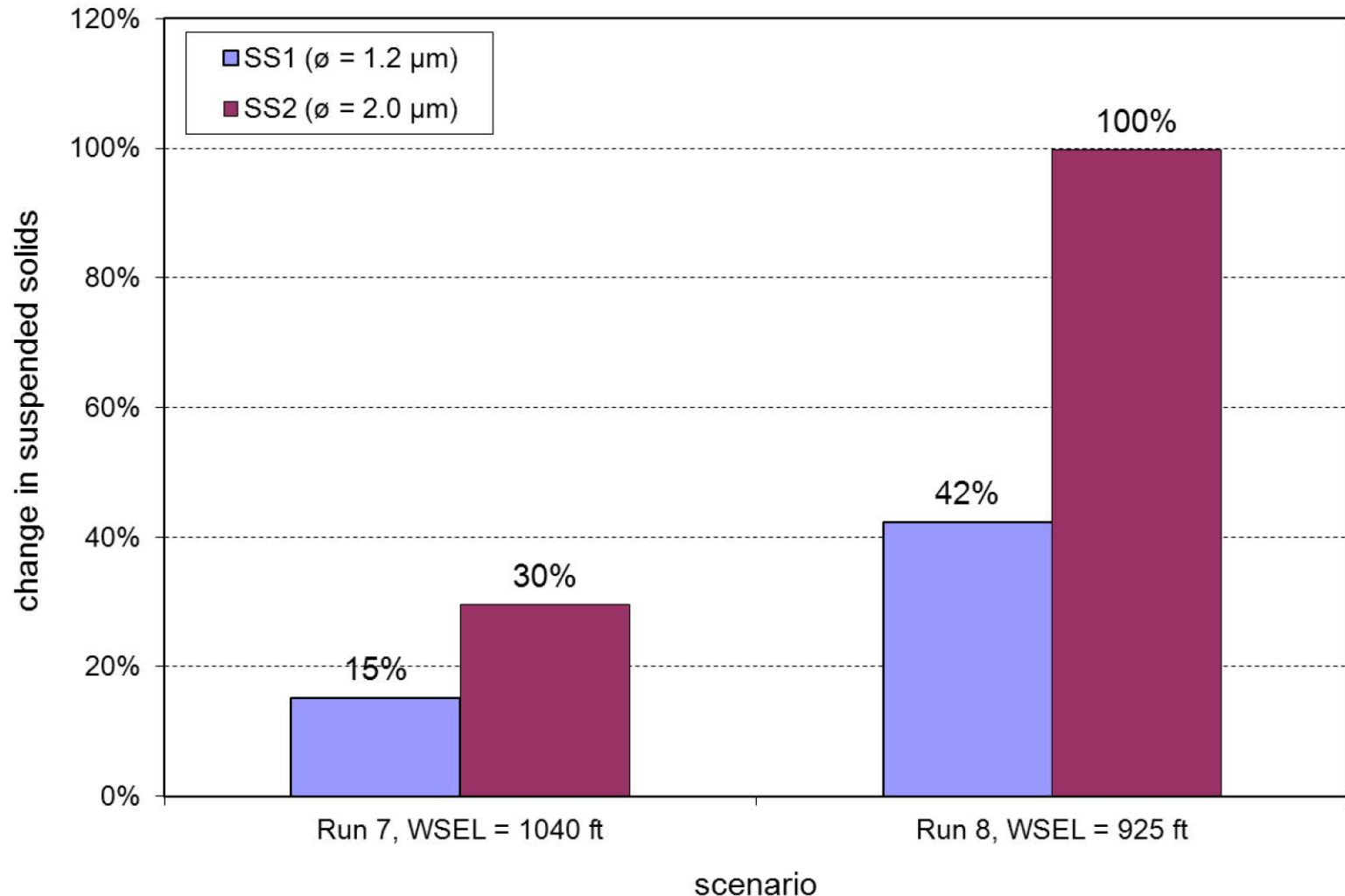


### Total Organic Carbon



# SNWA Intake #3

Change<sup>1</sup> in Average<sup>2</sup> Suspended Solids Concentrations at SNWA Intake #3

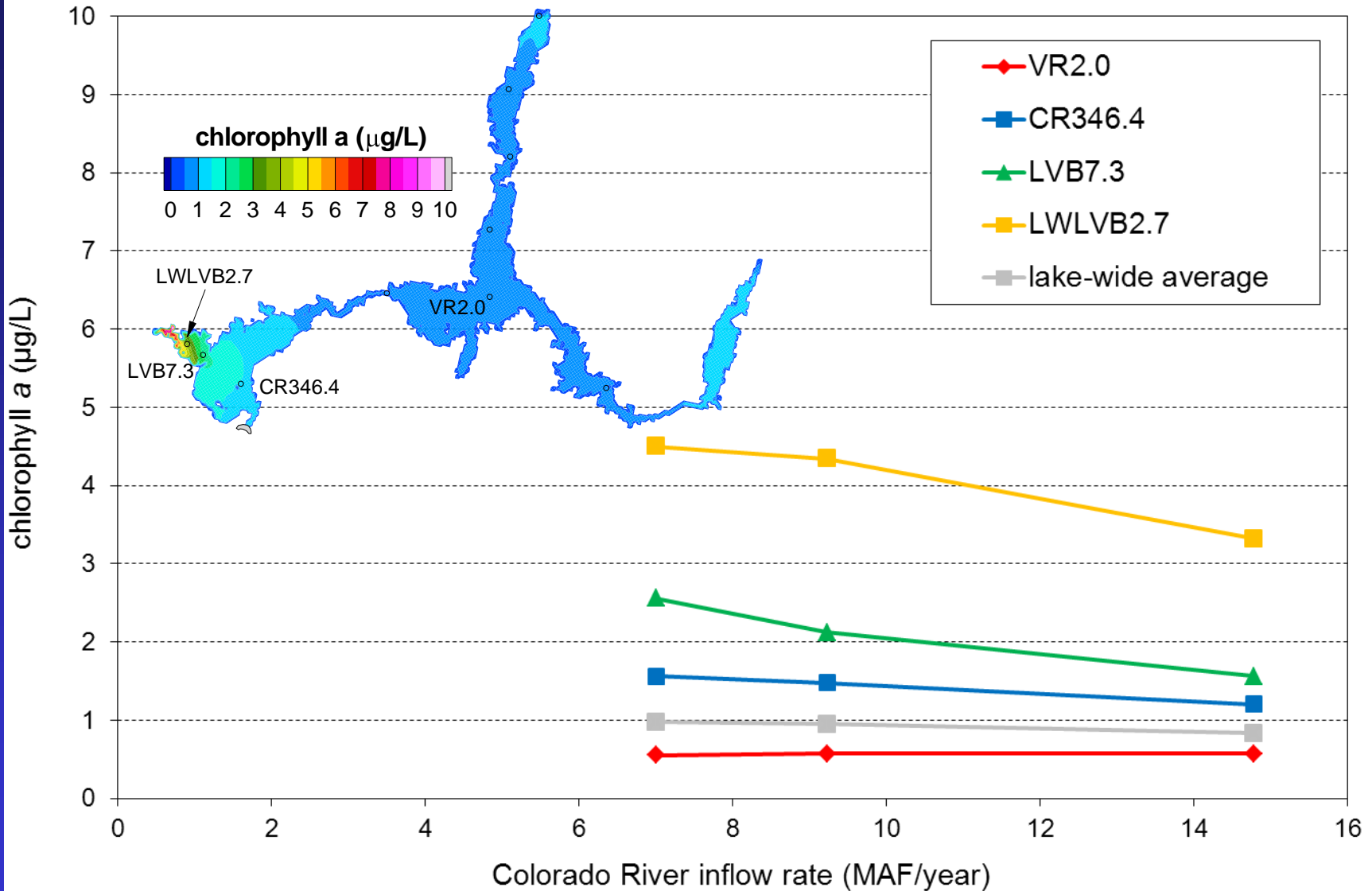


1. Change is percent change in concentration relative to Run 3, WSEL = 1100 ft.
2. Average is annual average for second simulation year.



# Algae ( Chlorophyll a )

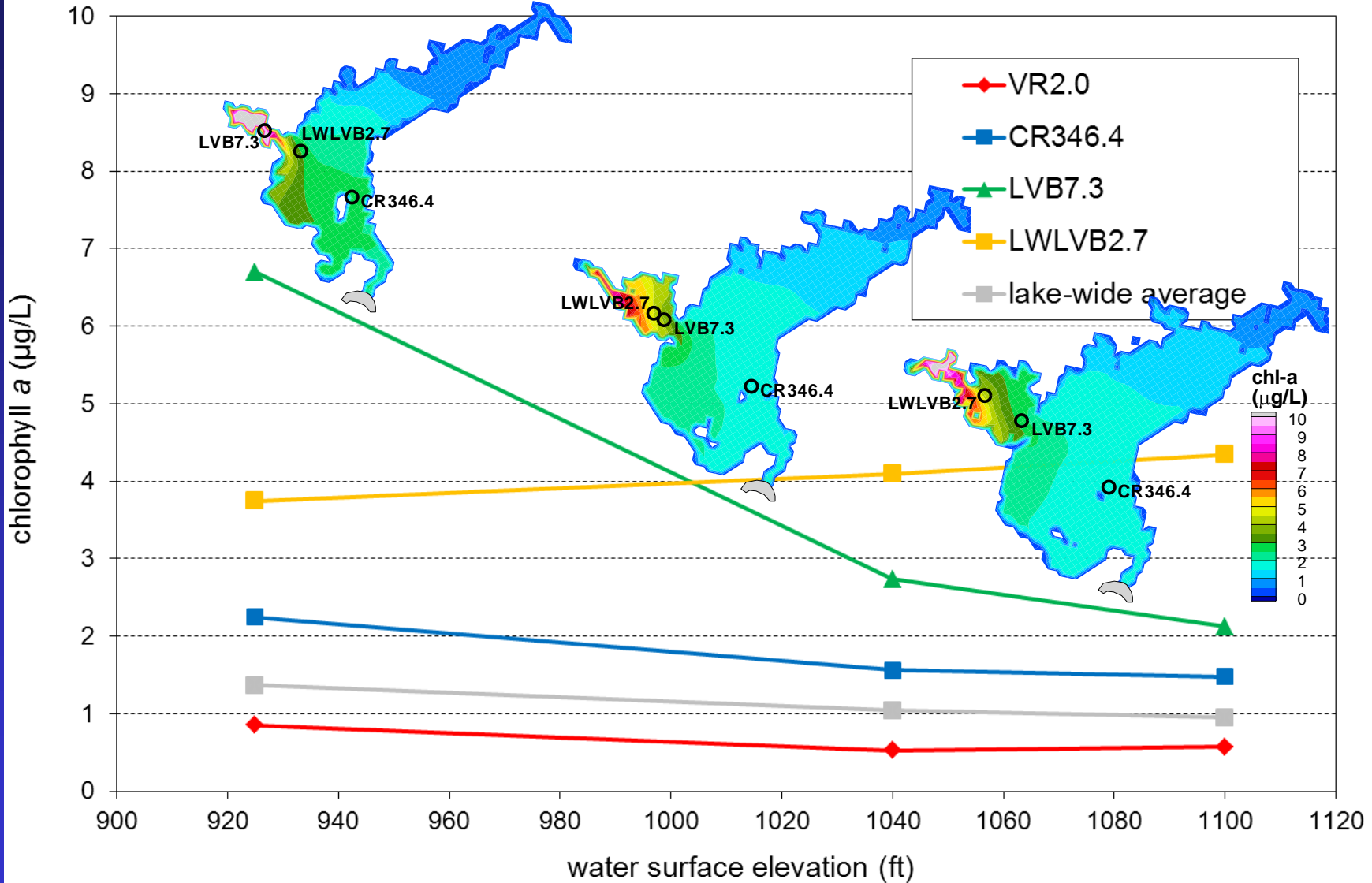
# Annual Average Chlorophyll a Top 5-m Average versus Colorado River Inflow Rate



Values are for the second simulation year.



# Annual Average Chlorophyll a Top 5-m Average versus Water Surface Elevation



Values are for the second simulation year.

# Conclusions

## ■ Hoover Dam effect

- Withdrawals from epilimnion

## ■ Lower WSELs

- Higher suspended-solids concentrations
- Higher water temperatures, bromide, and TOC concentrations at SNWA Intake #3

## ■ Chlorophyll a Concentrations increase due to

- Lower WSEL
- Lower Colorado River inflow rate

## ■ These changes could occur in the near future!

# Acknowledgements

- U.S. Bureau of Reclamation
- Southern Nevada Water Authority
- Clean Water Coalition
  - City of Las Vegas
  - City of Henderson
  - City of North Las Vegas
  - Clark County Water Reclamation District



# Questions

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