Impact of Falling Lake Levels on the Water Quality of Lake Mead

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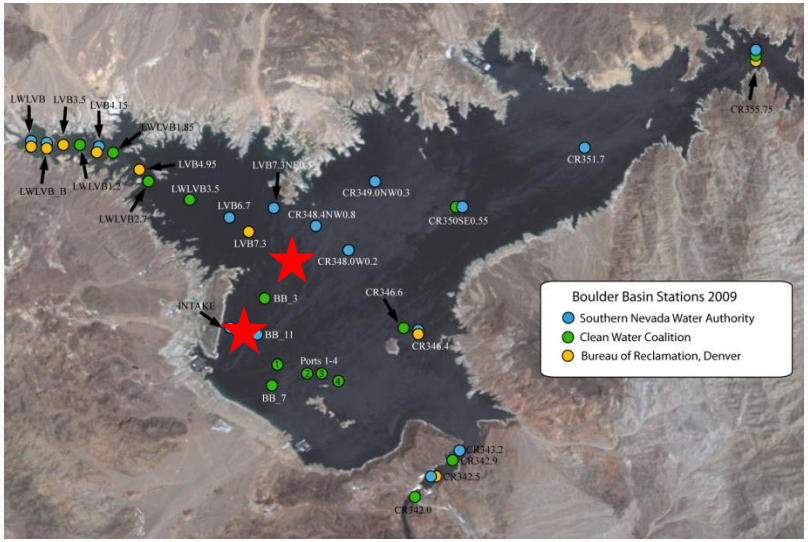
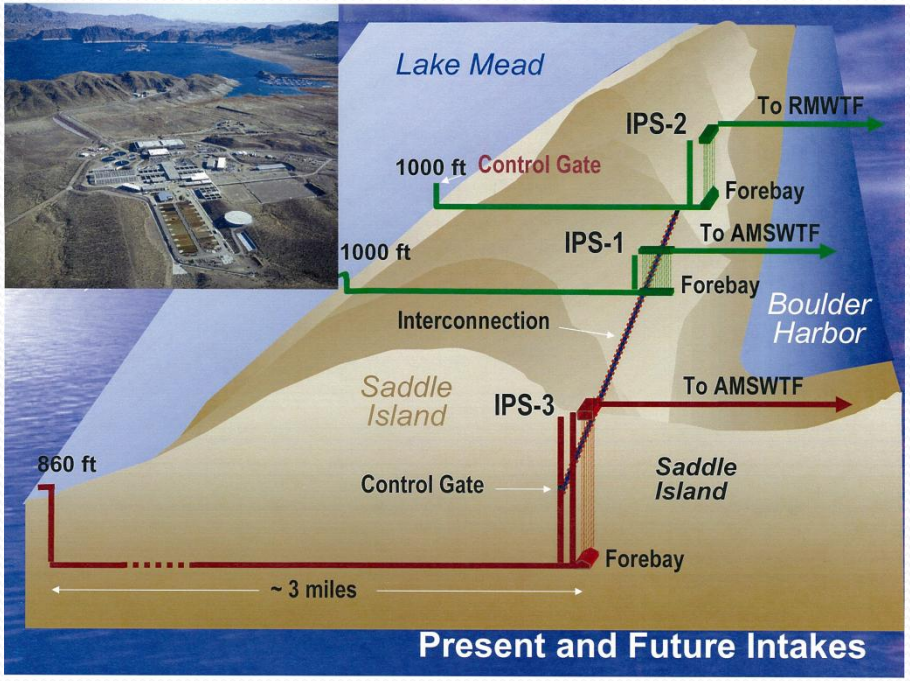
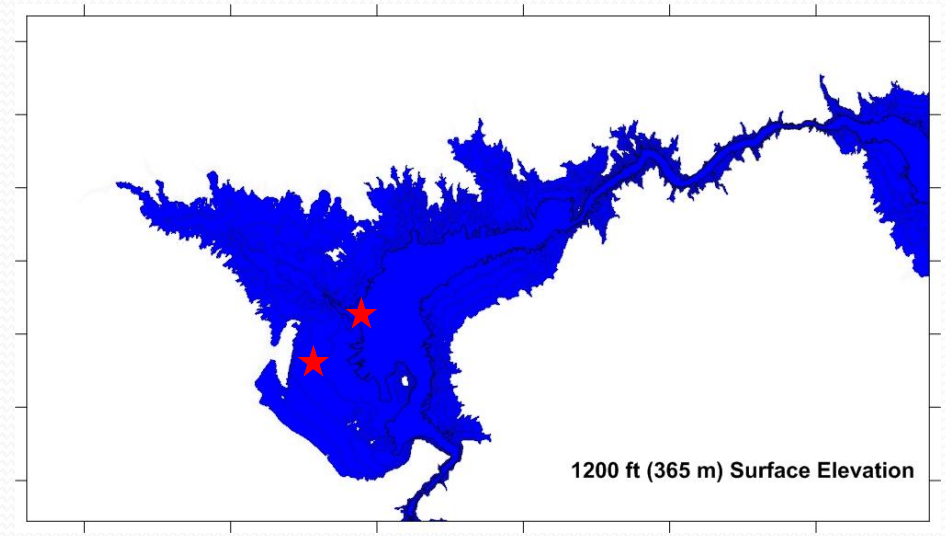
Lake Mead Basics: Water Supply Picture

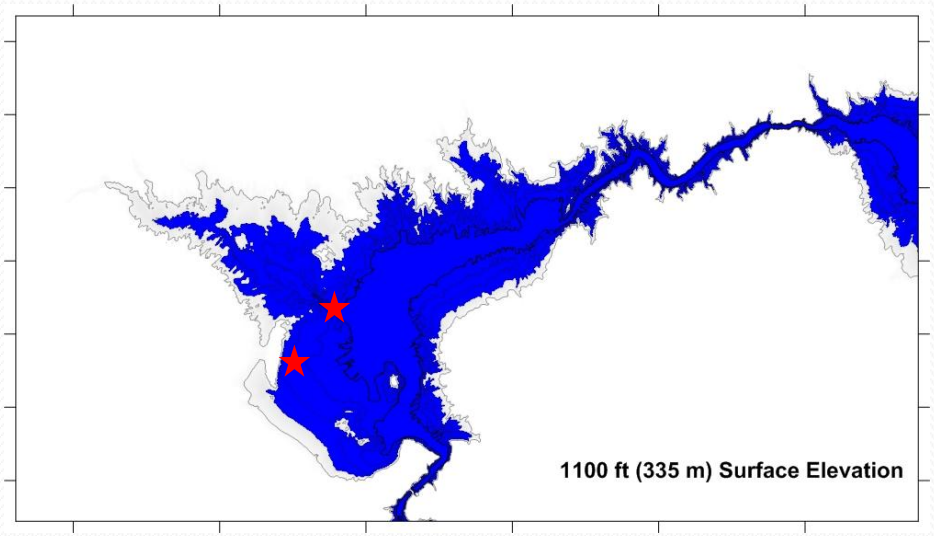
- Southern Nevada Water Systems currently withdraws water from Lake Mead from 2 intakes at 1000'/305 m and is currently constructing an intake at 860'/262

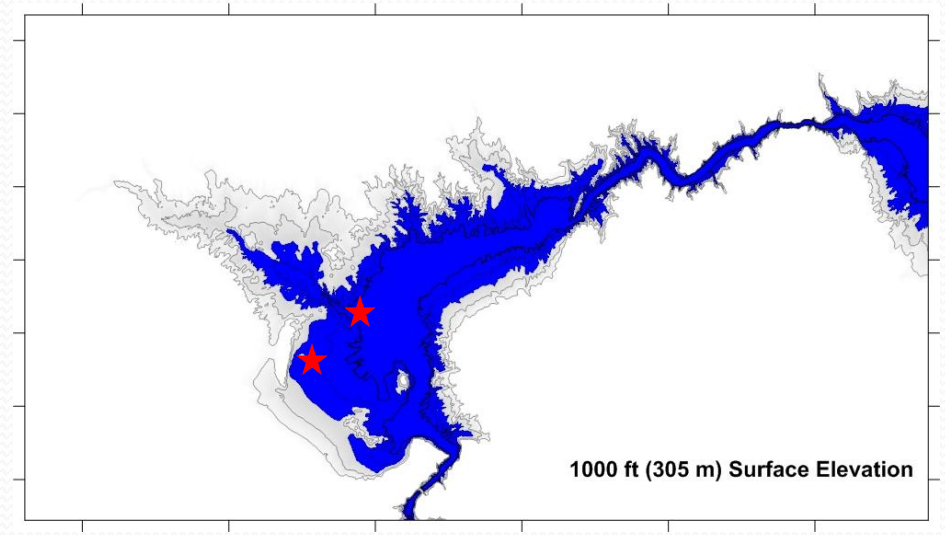


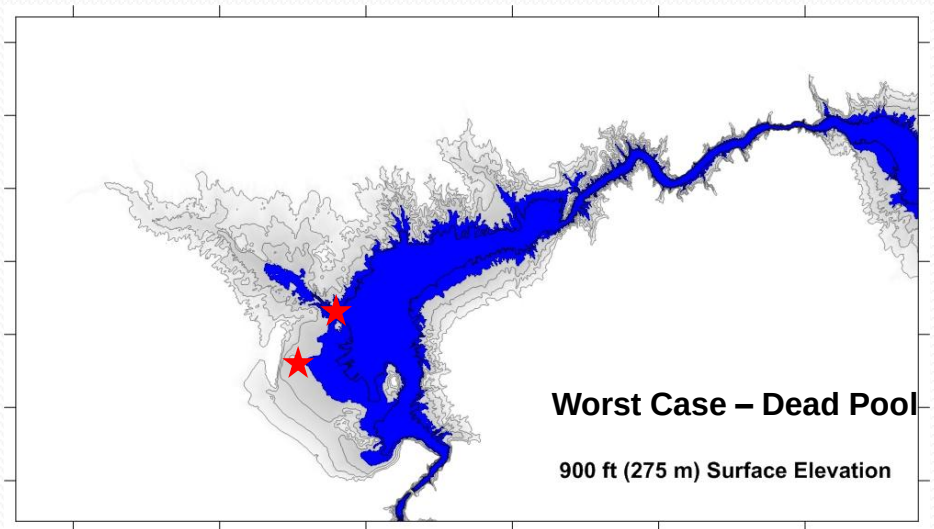


Shrinking of Lake Mead

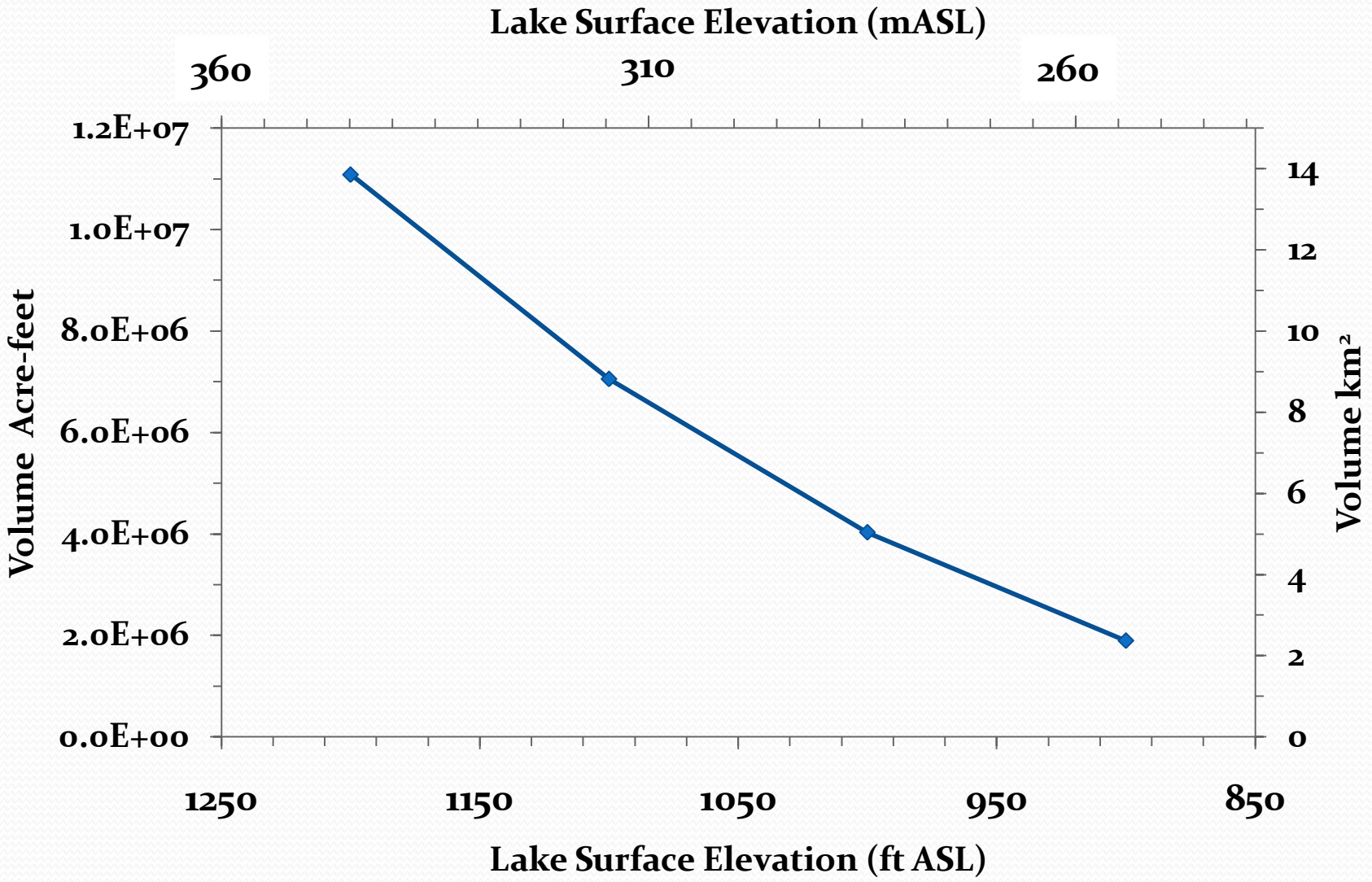






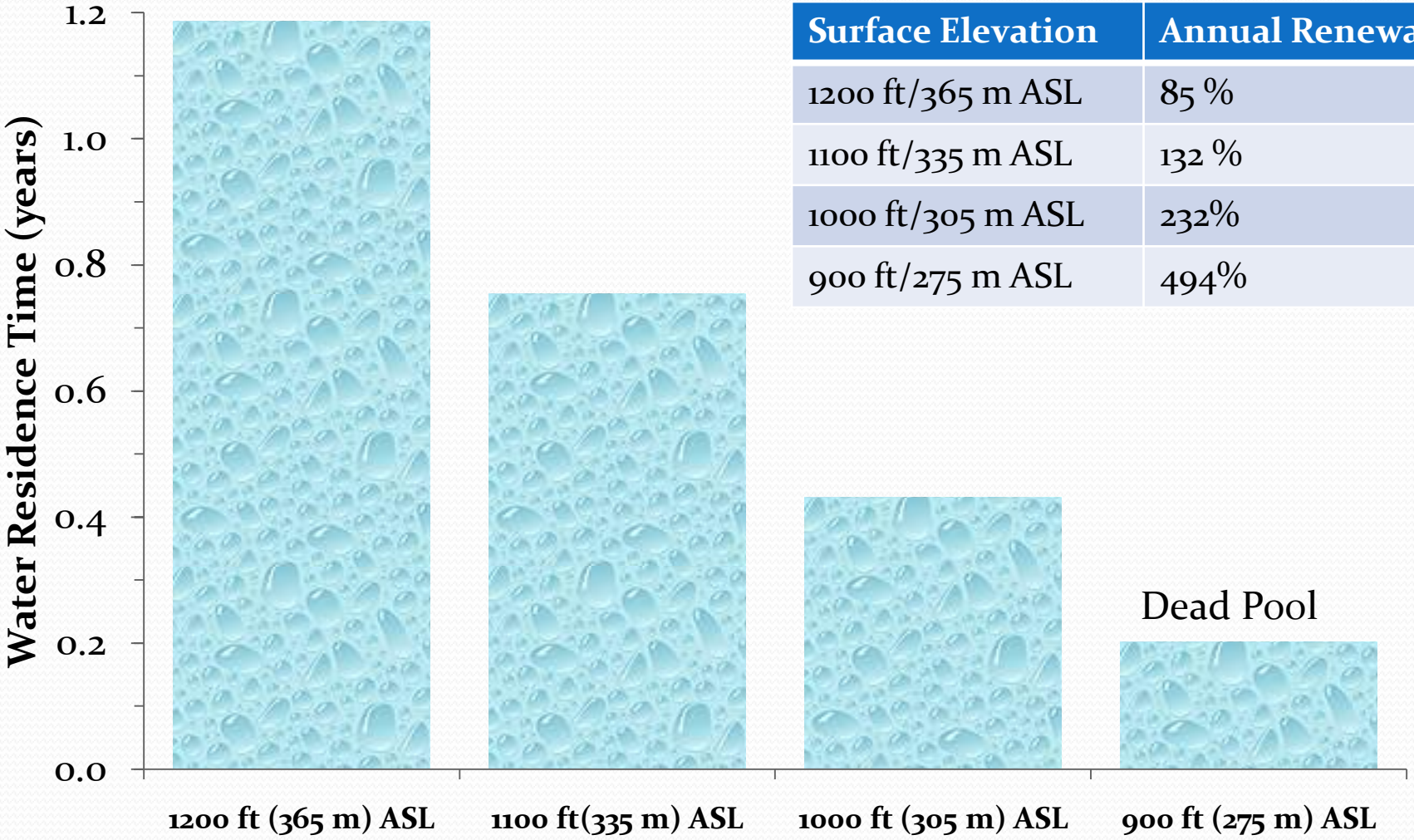


Boulder Basin Volume



Water Residence Time

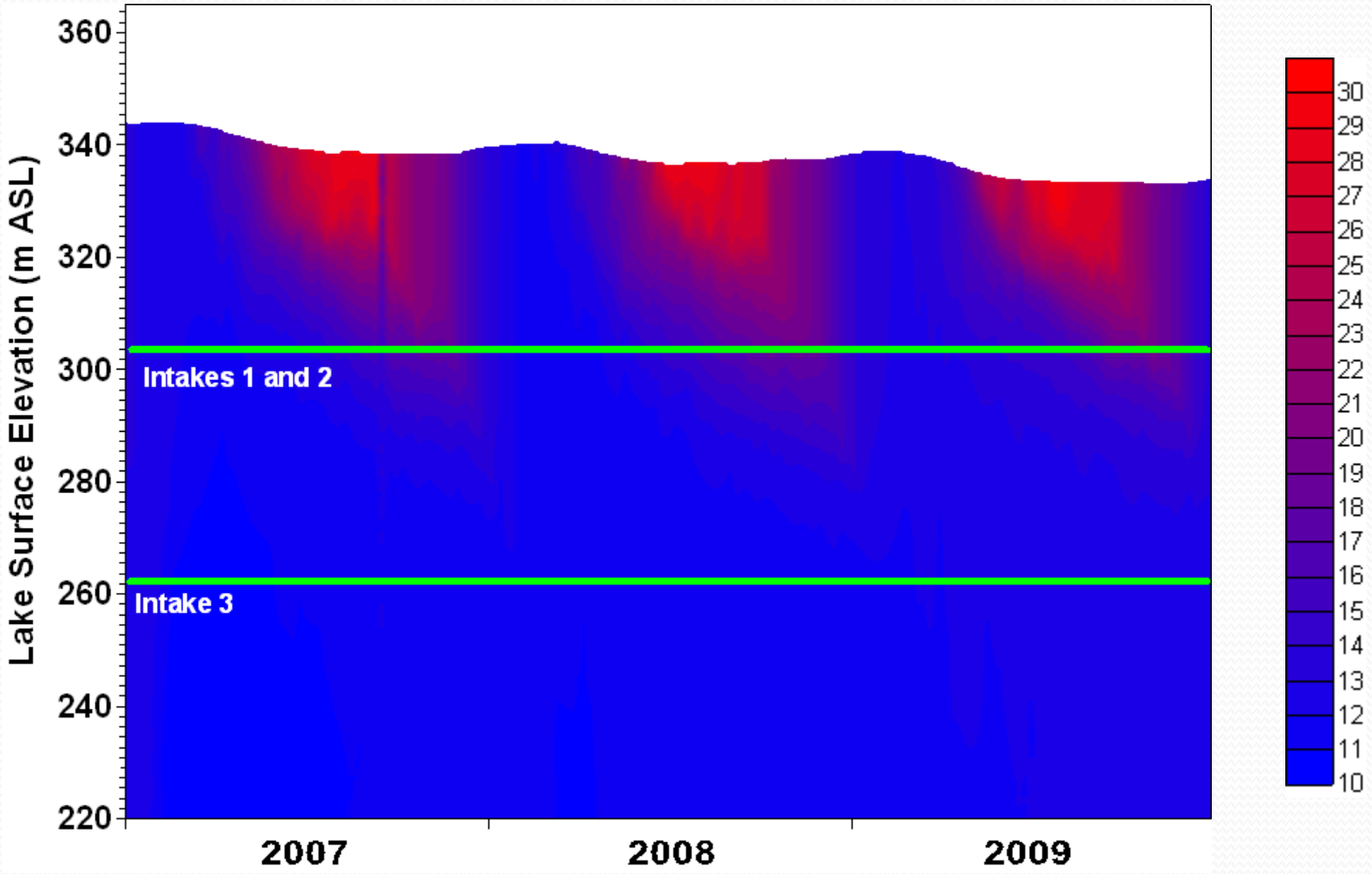
Boulder Basin



Surface Elevation	Annual Renewal
1200 ft/365 m ASL	85 %
1100 ft/335 m ASL	132 %
1000 ft/305 m ASL	232%
900 ft/275 m ASL	494%

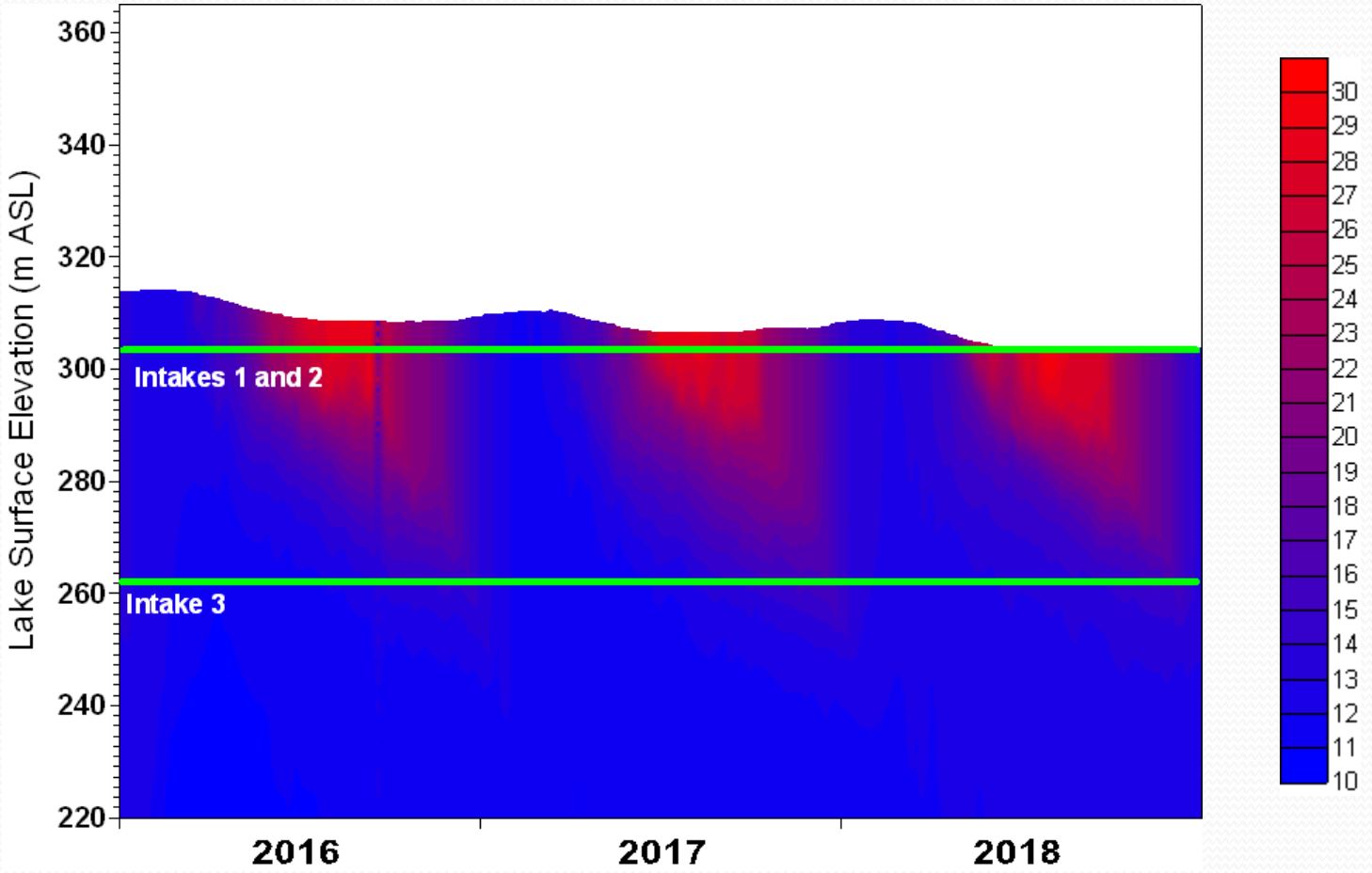
Recent Temperature Data

~1115 ft / 340 m ASL



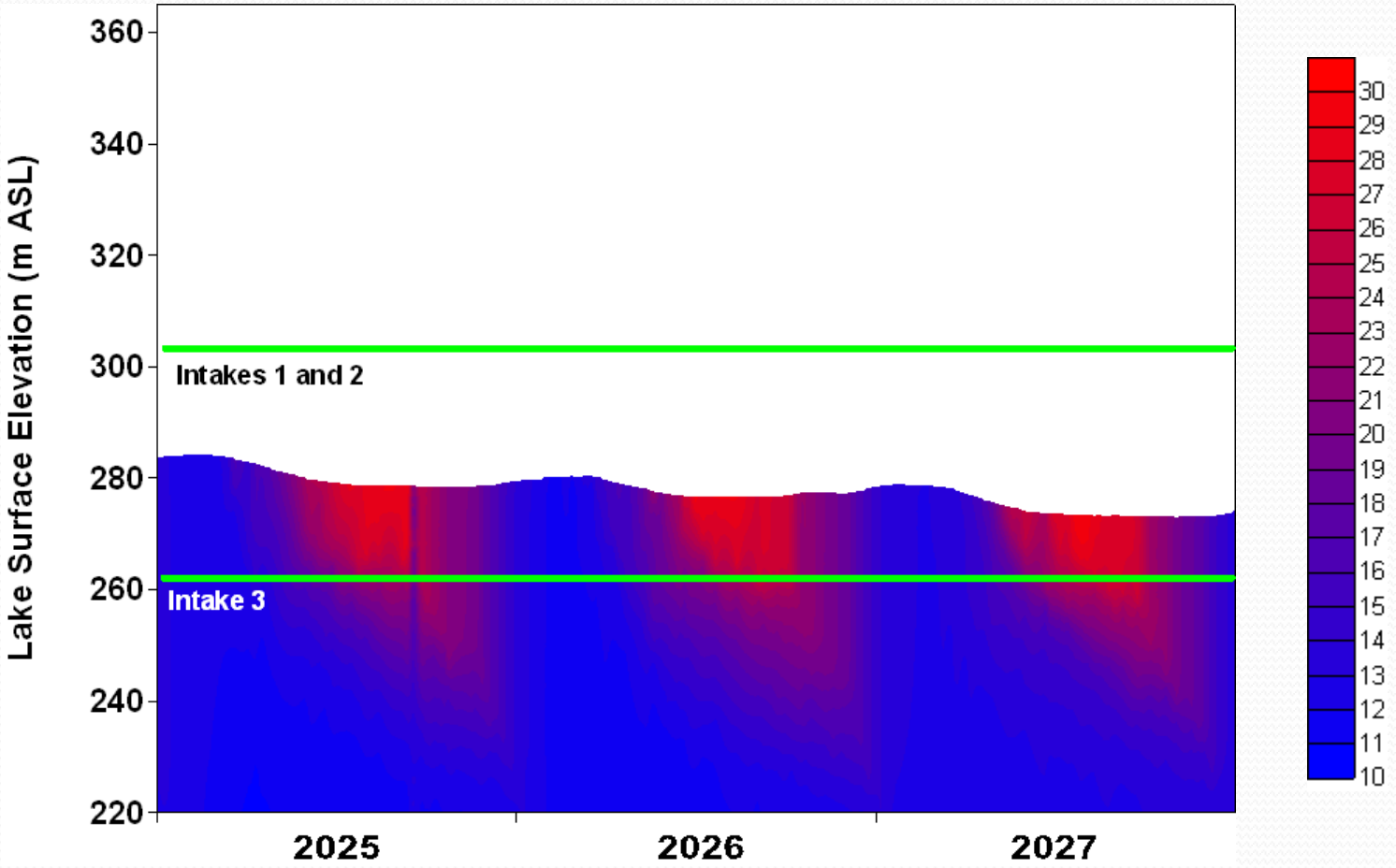
Forecast Temperatures (°C)

~1025 ft / 312.5 m ASL



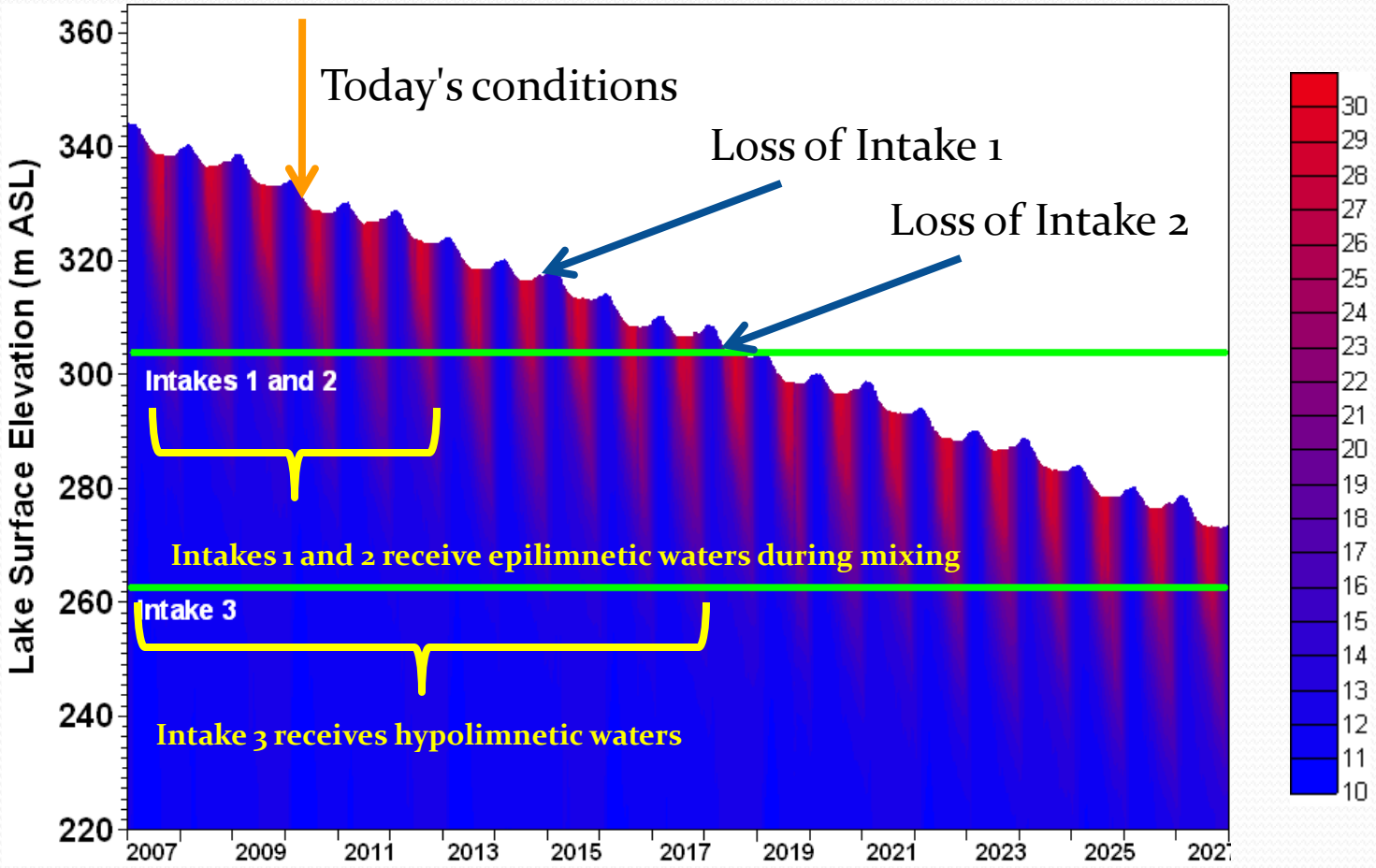
Worst Case Temperatures (°C)

~900 ft / 275 m ASL – Dead Pool



Forecasted Temperature (°C)

SNWA Intake Location



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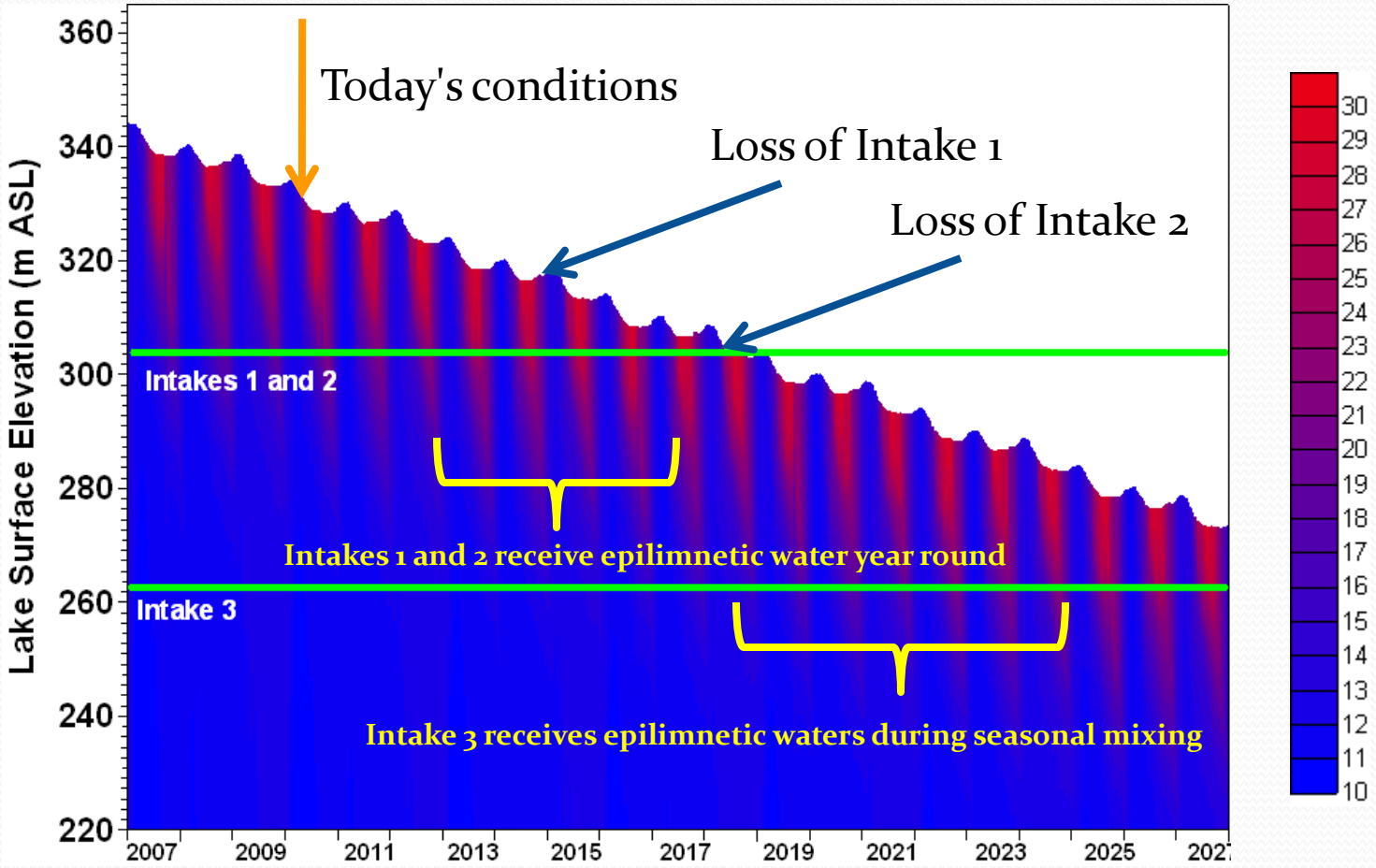

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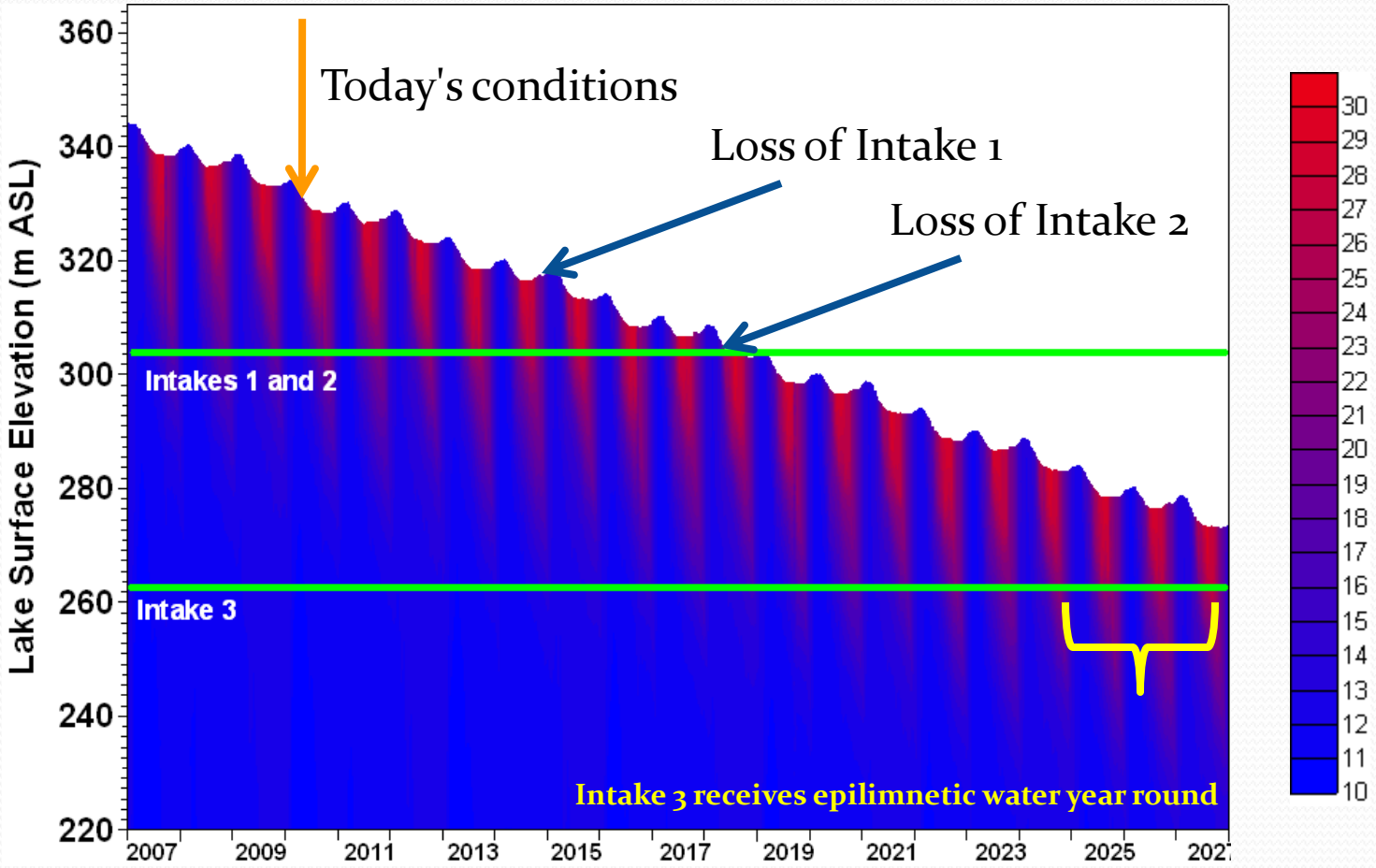
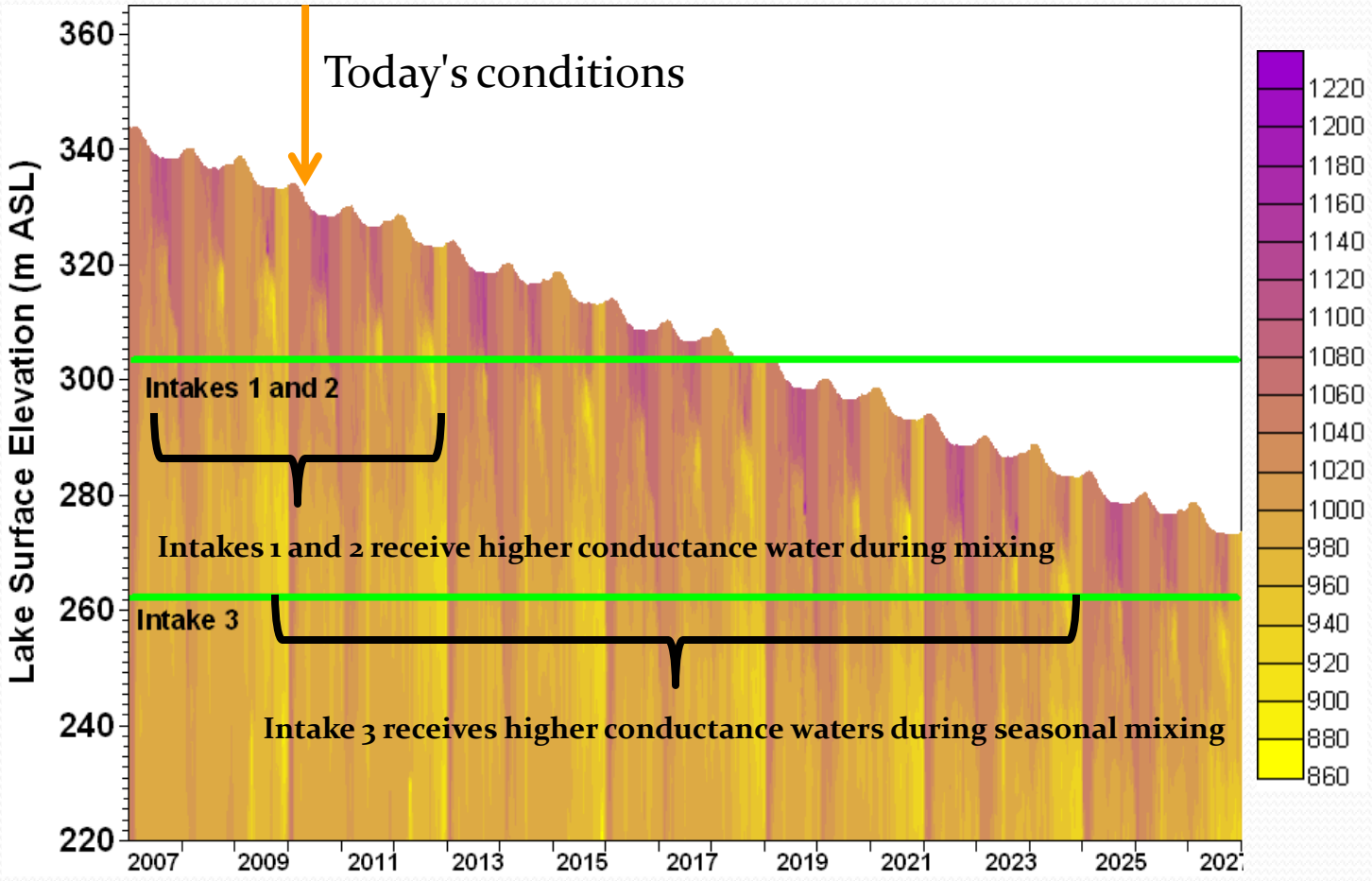


Forecasted Specific Conductance ($\mu S\ cm^{-1}$)

SNWA Intake Location



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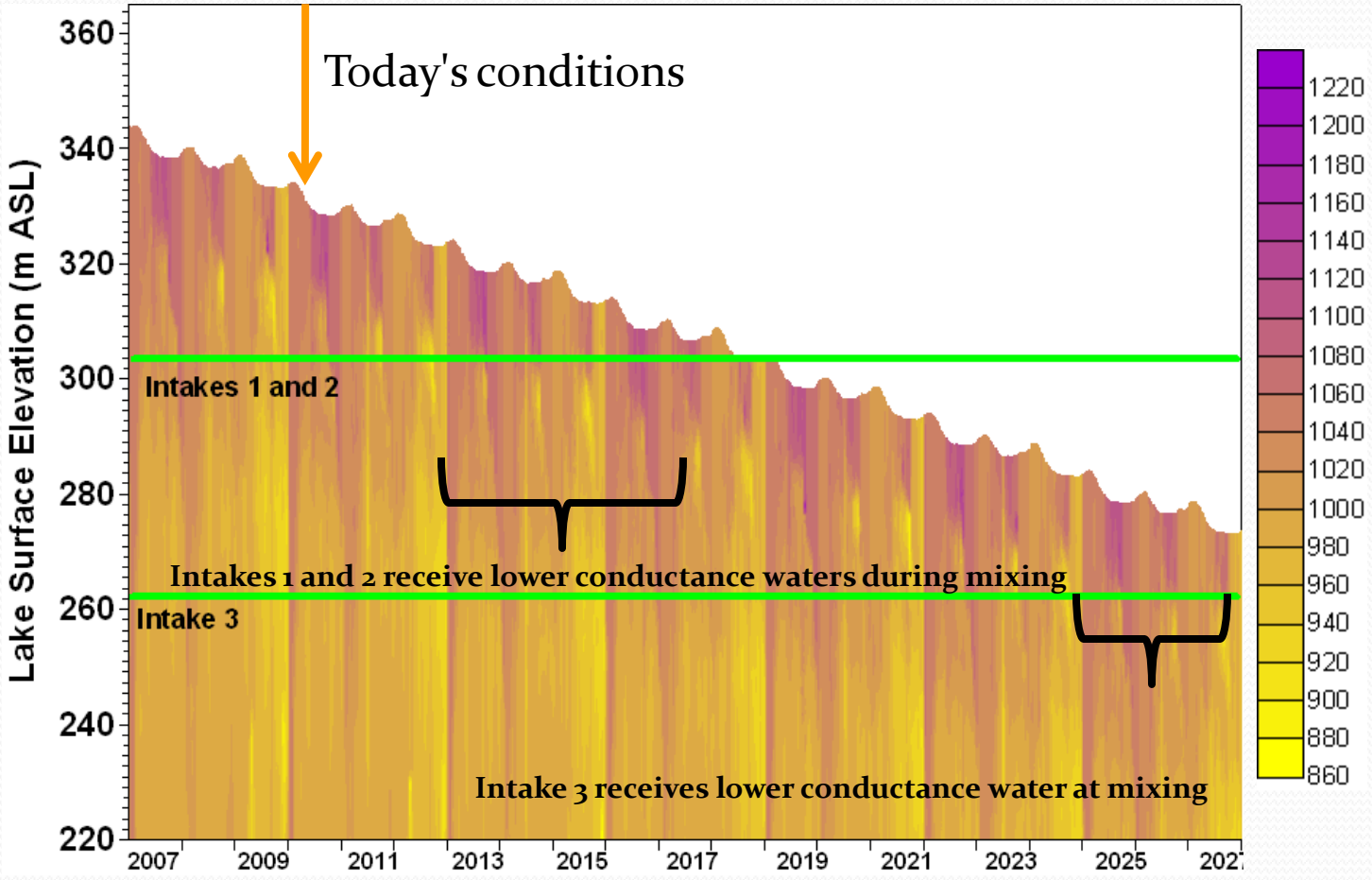
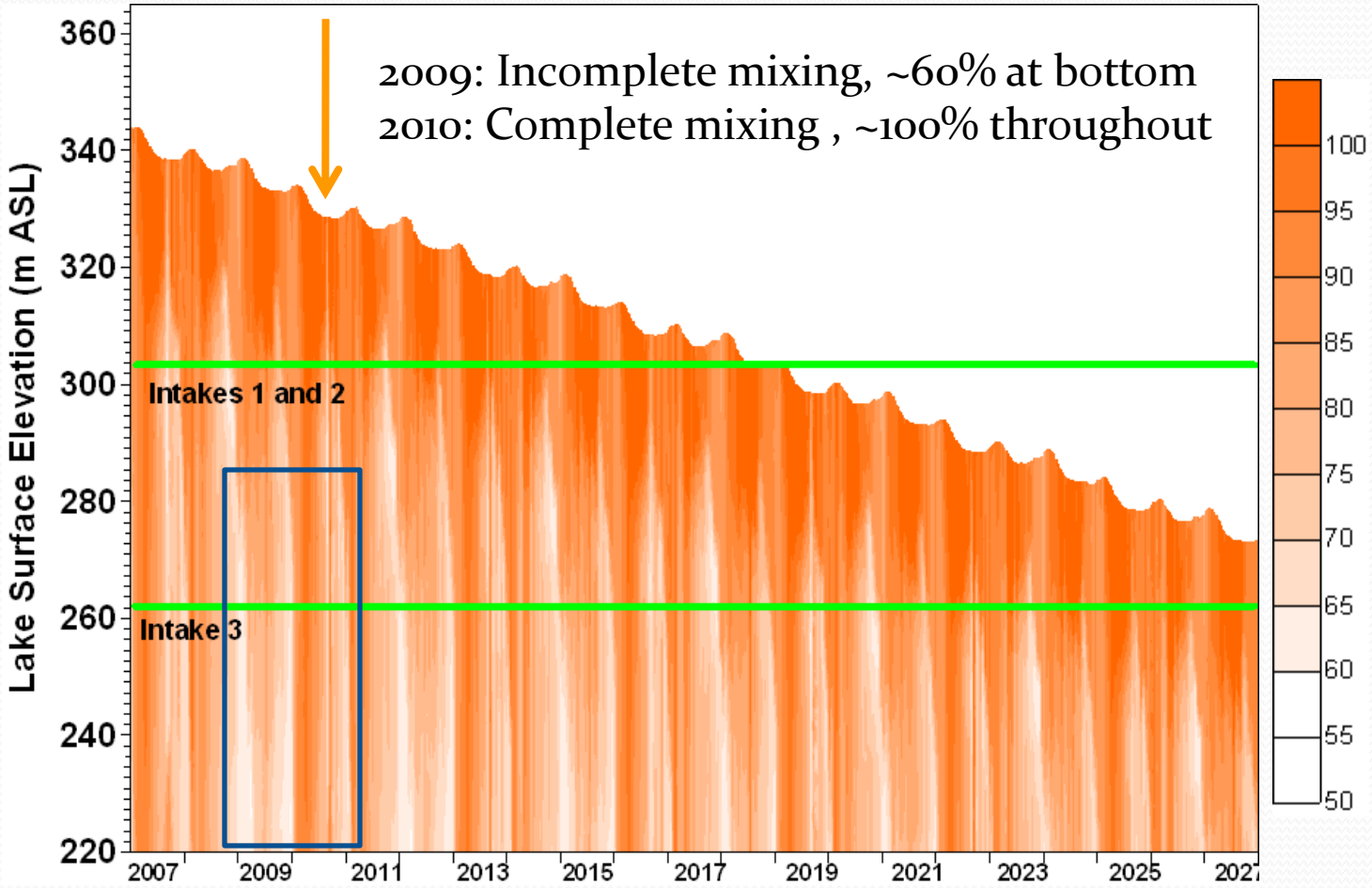


Forecasted Dissolved Oxygen (% Sat)

SNWA Intake Location



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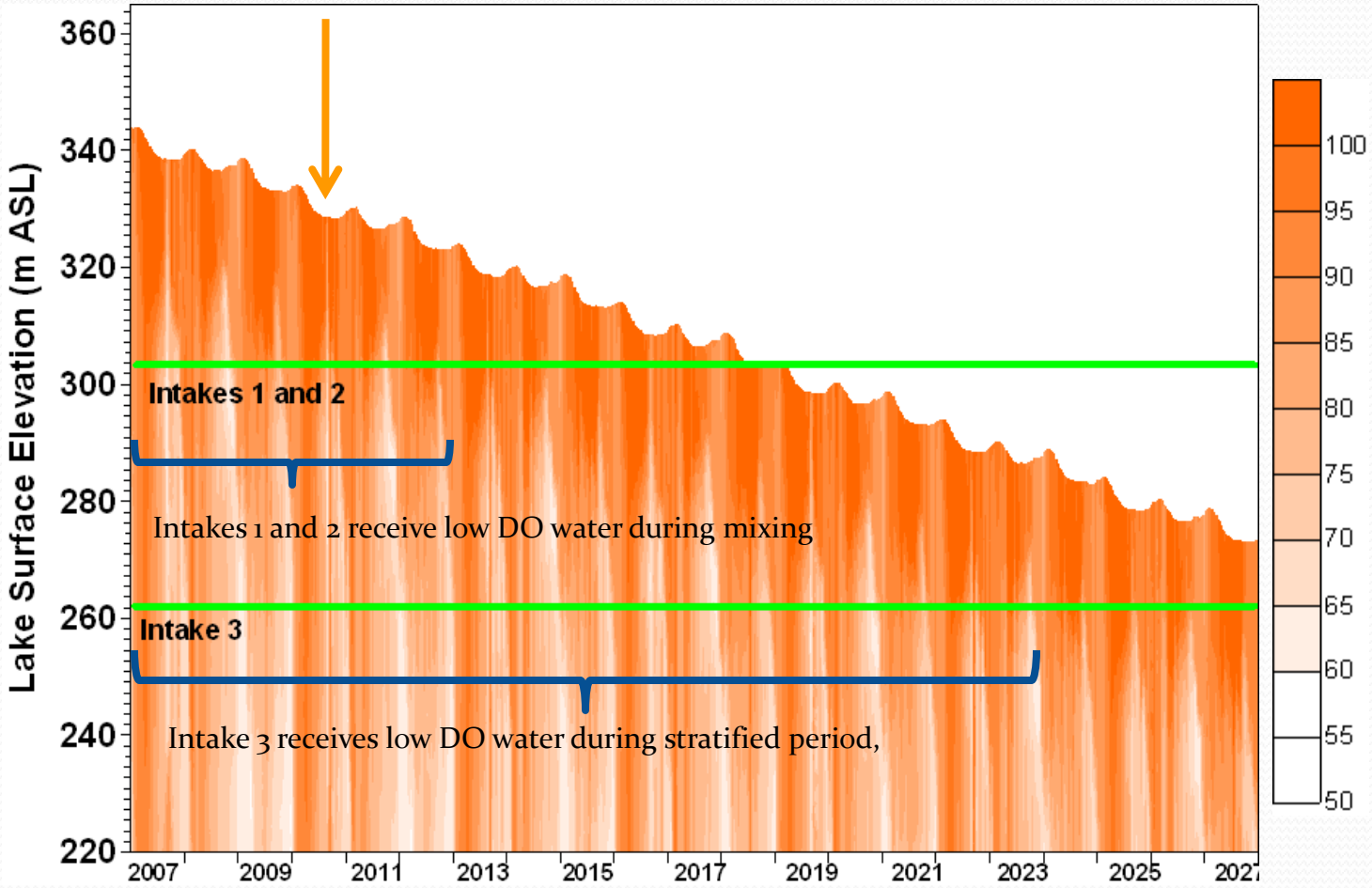

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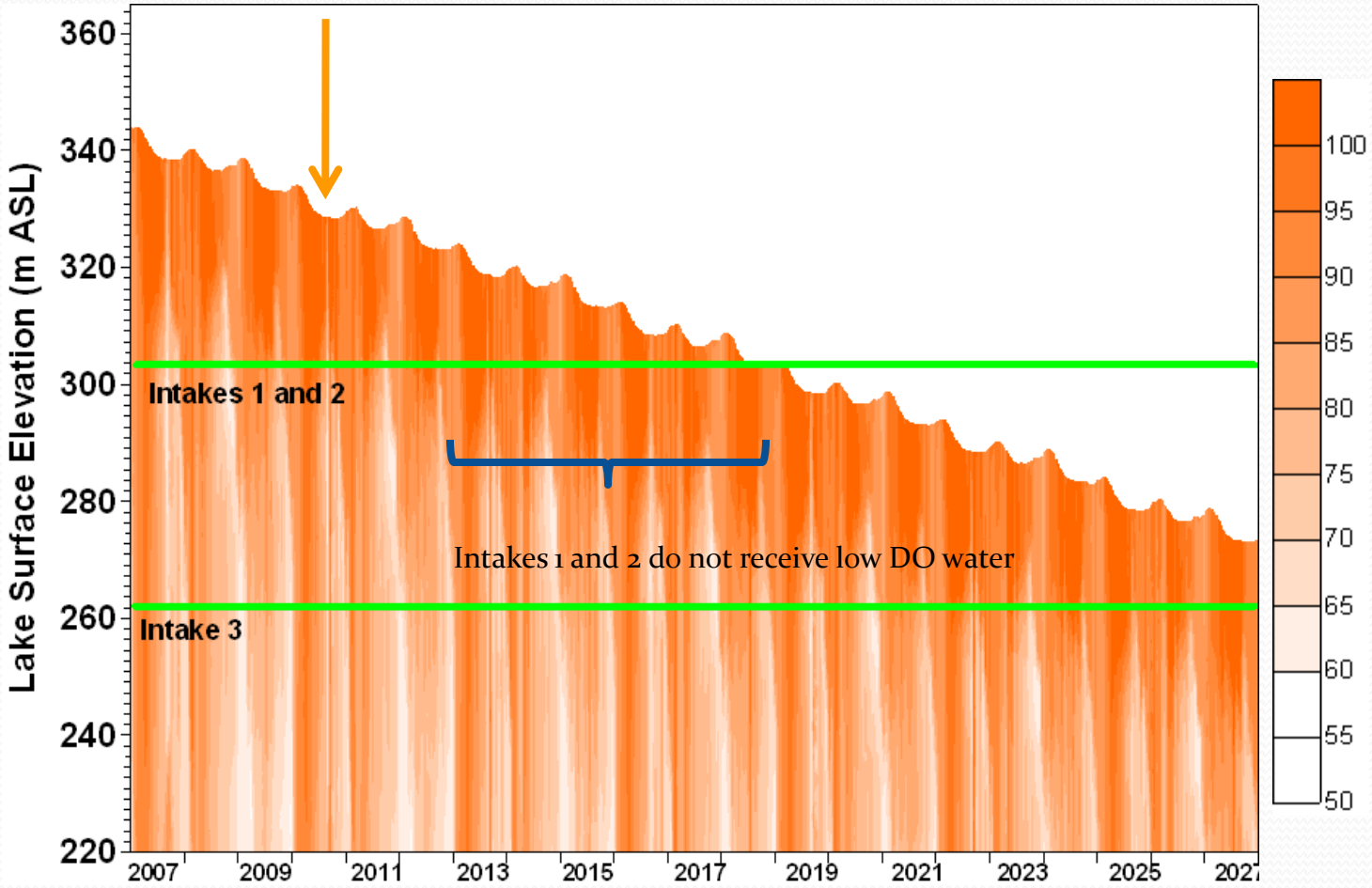
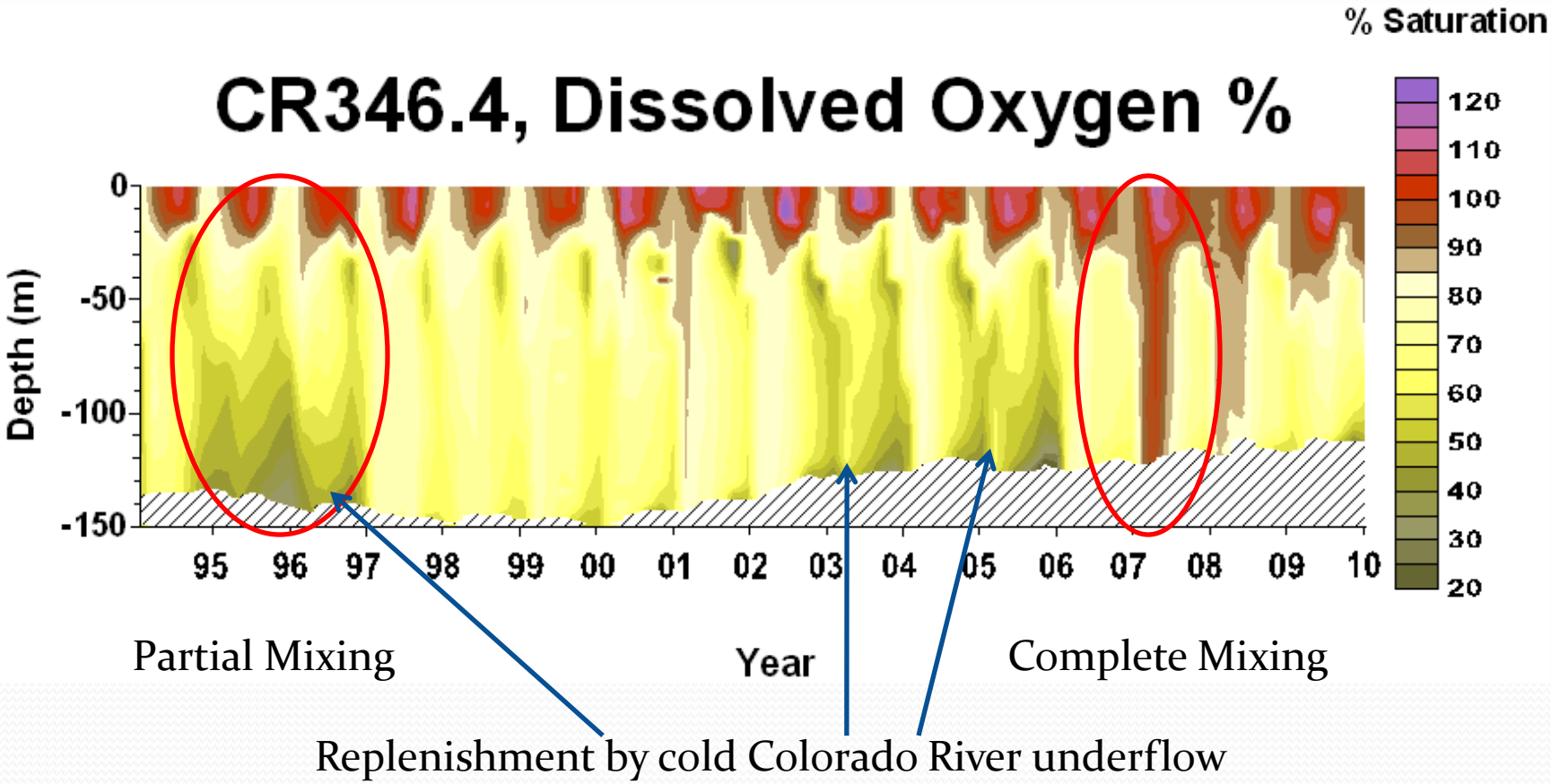
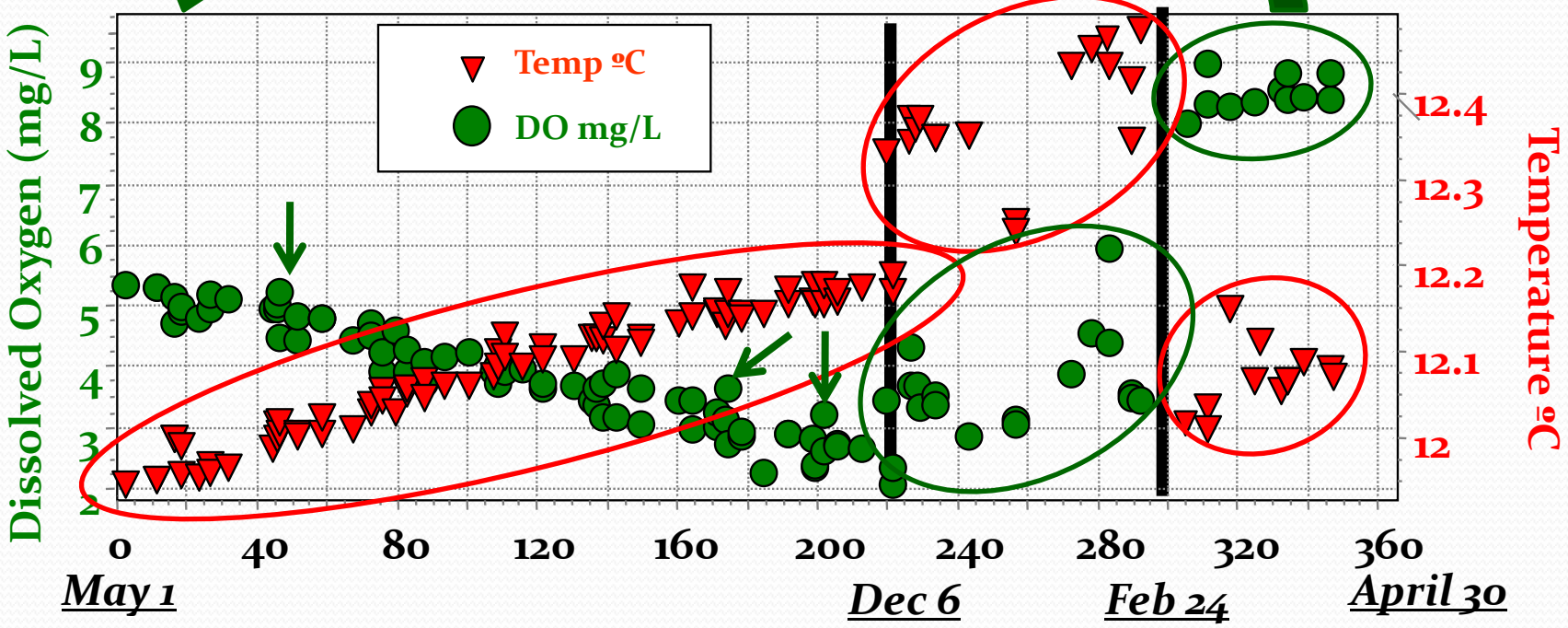


Colorado River Replenishment





Slow warming – Weak vertical mixing with slight downward heat and DO transfer

Faster warming – Partial mixing; Some DO transfer

Intrusion of colder Colorado River water; Reoxygenation to 80% saturation

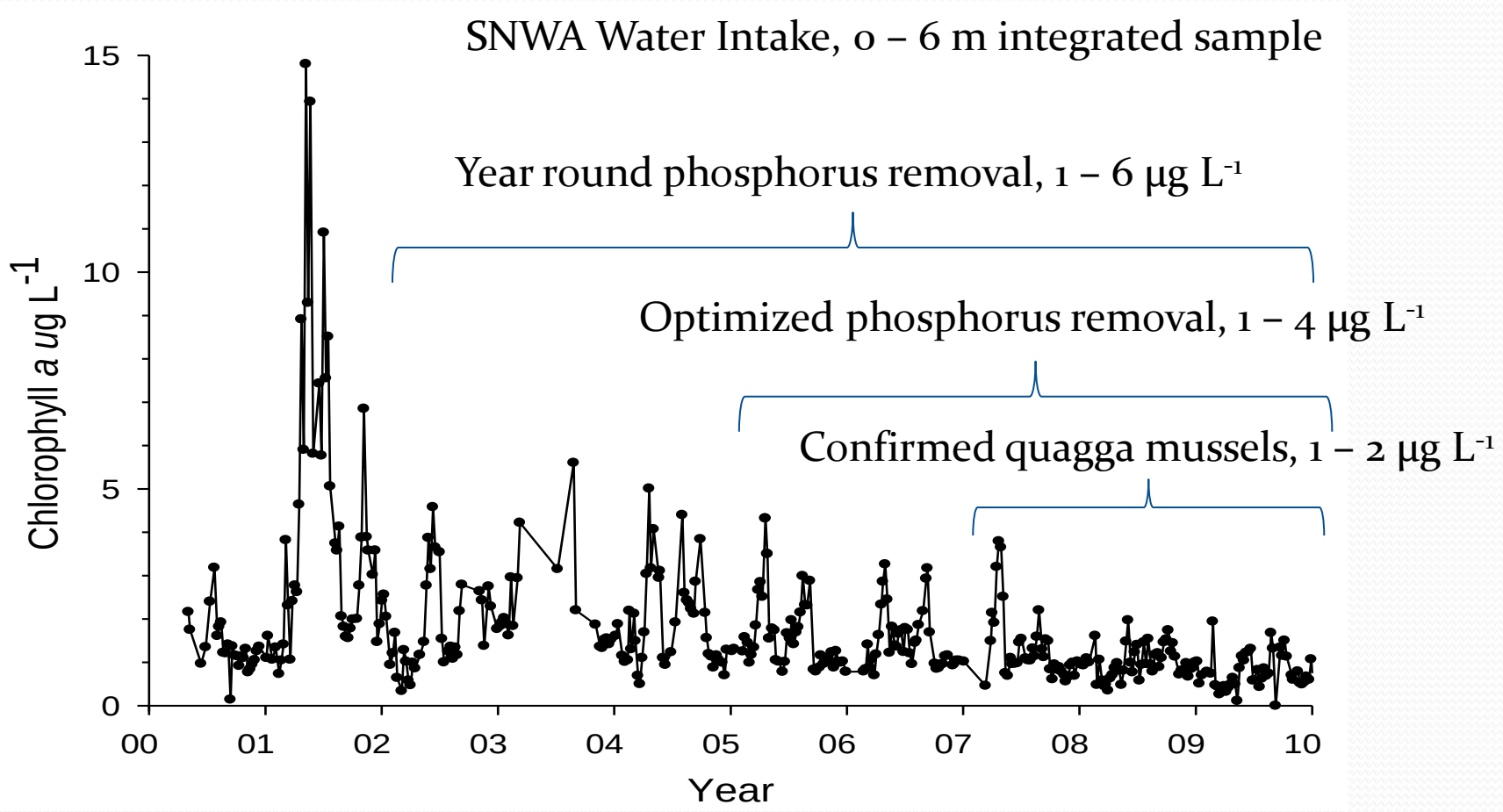
Intrusion of colder Colorado River water--Oxygen uptake recommences

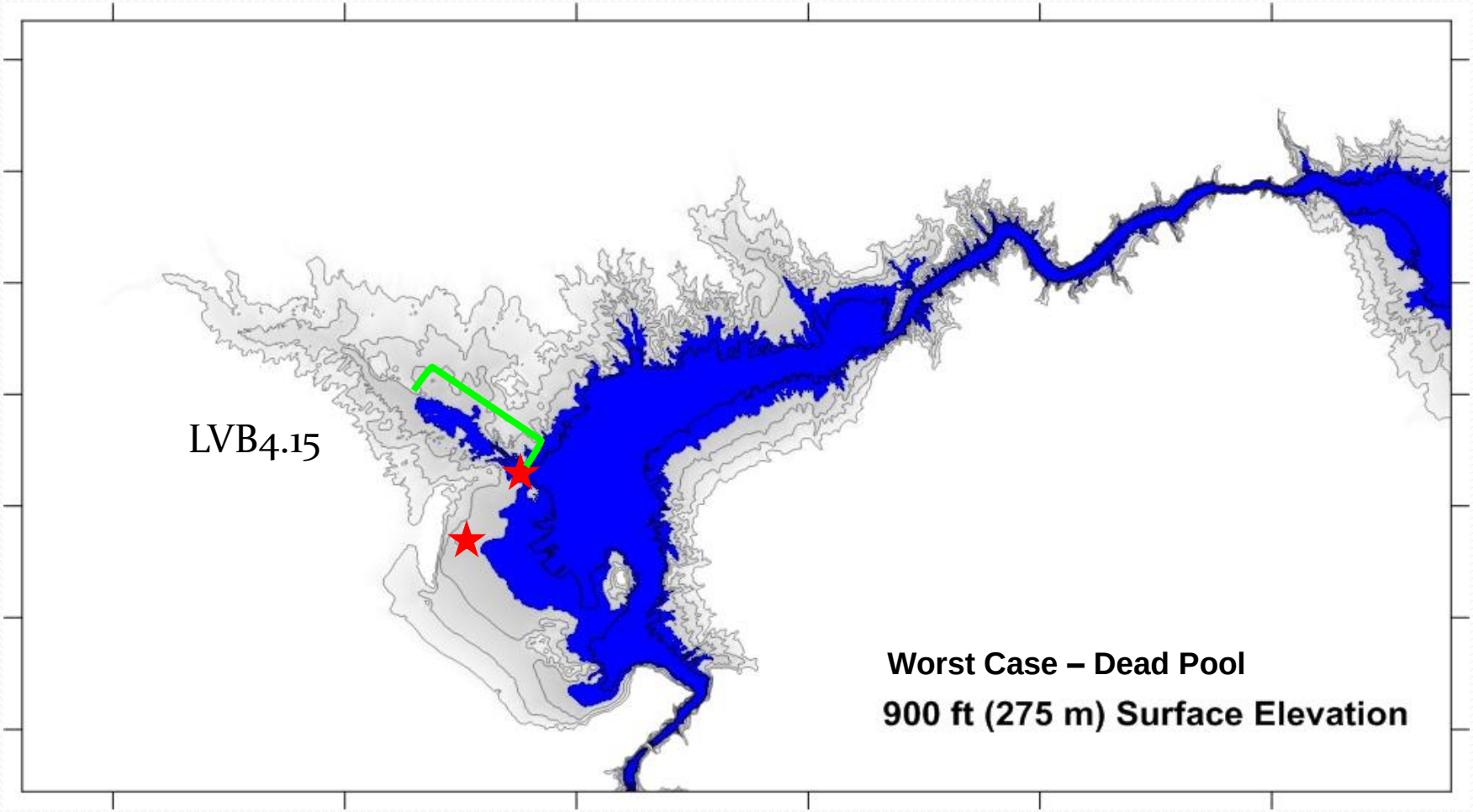
Increased Water Temperature

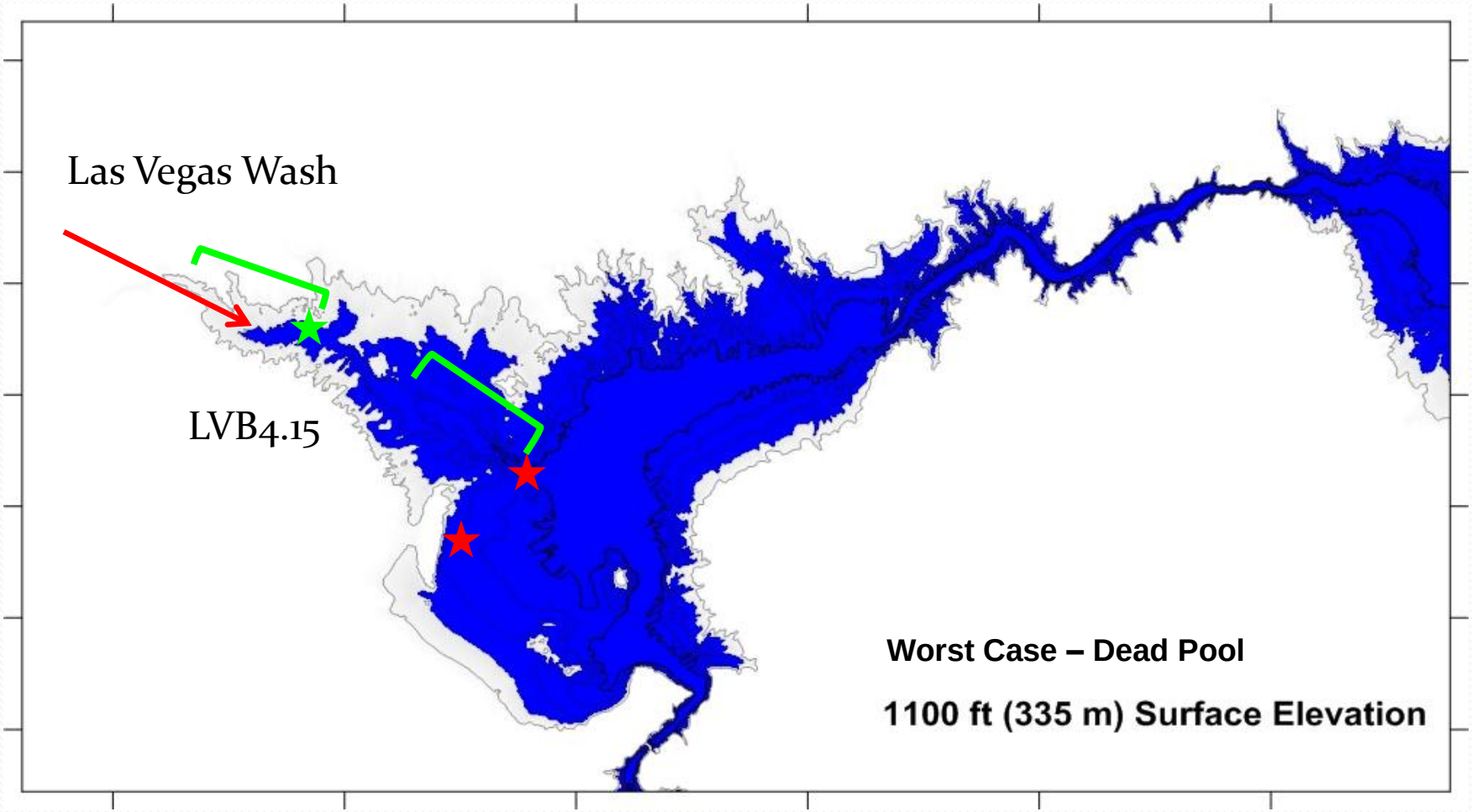
- We can calculate the likely changes in dissolved oxygen depletion rates with increased temperatures
  - Based on 2009 depletion rates

Hypolimnetic Temperature °C	HVOD Rate mg O_2 m^{-3} Day^{-1}	HVOD Rate mg O_2 L^{-1} $month^{-1}$
10	6.91	0.21
12 (Actual)	7.70	0.23
15	9.77	0.29
20	13.88	0.42
25	19.55	0.59

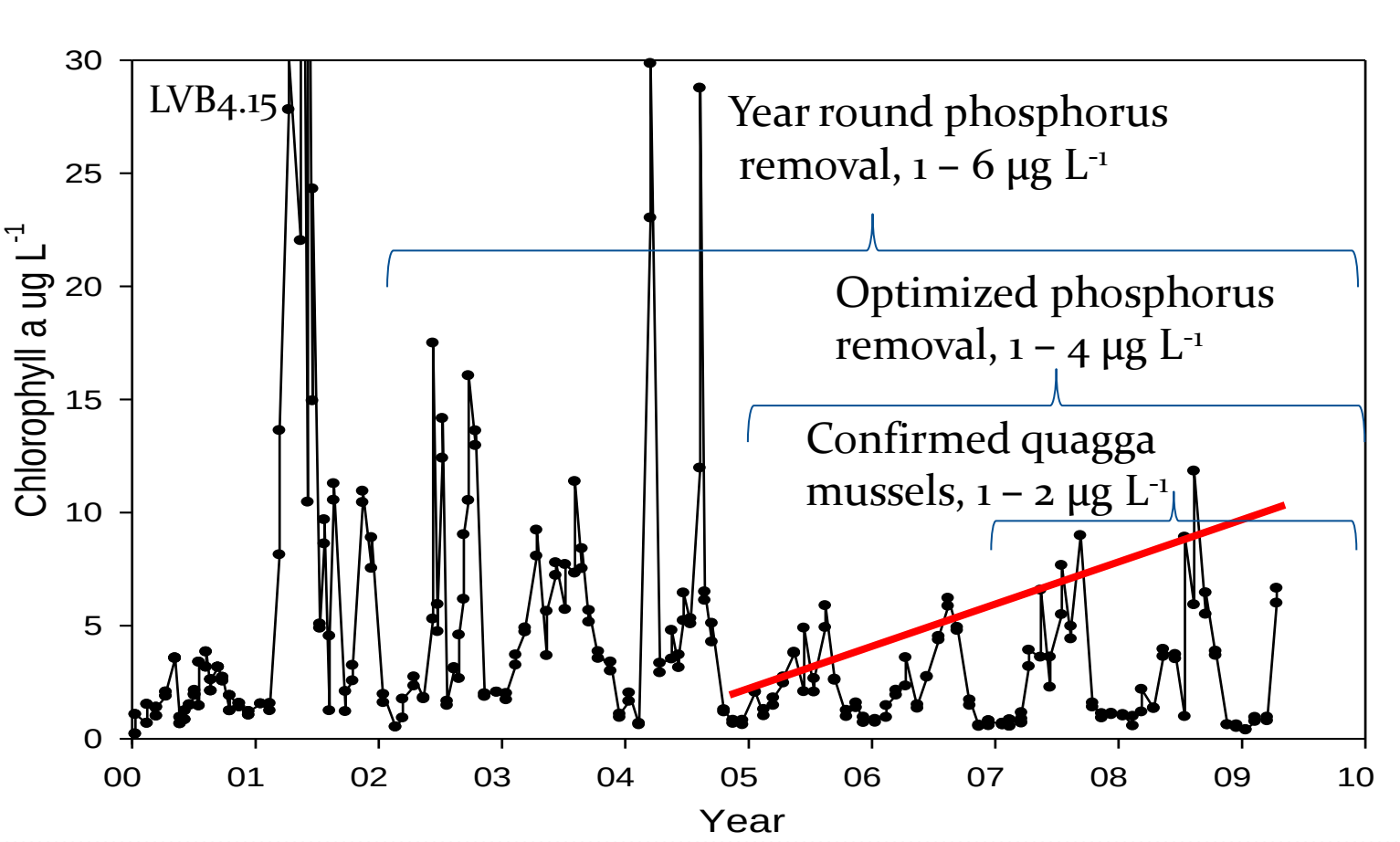
Chlorophyll a Concentrations



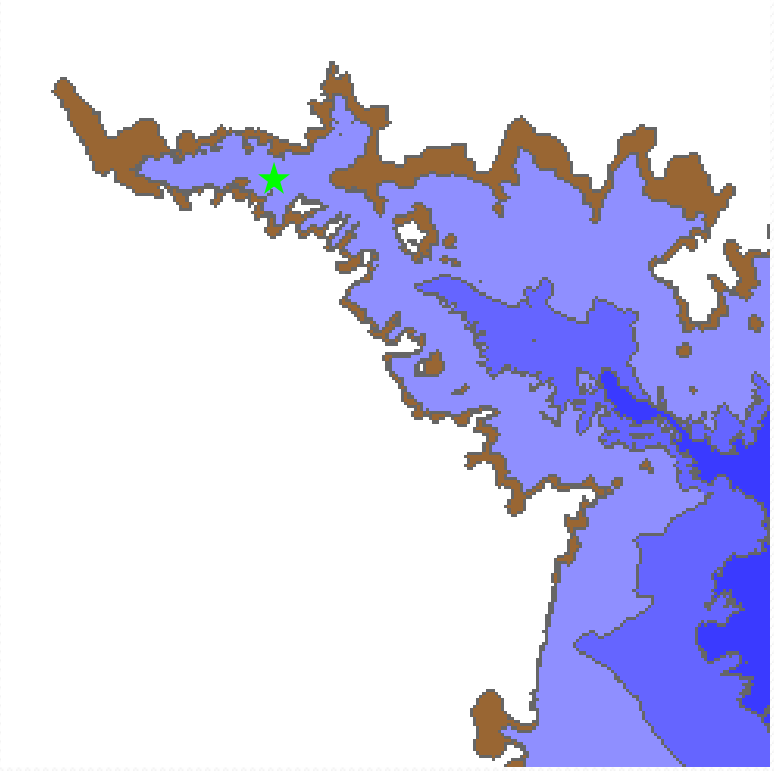

LVB4.15
Worst Case – Dead Pool
900 ft (275 m) Surface Elevation


Las Vegas Wash
LVB4.15
Worst Case – Dead Pool
1100 ft (335 m) Surface Elevation

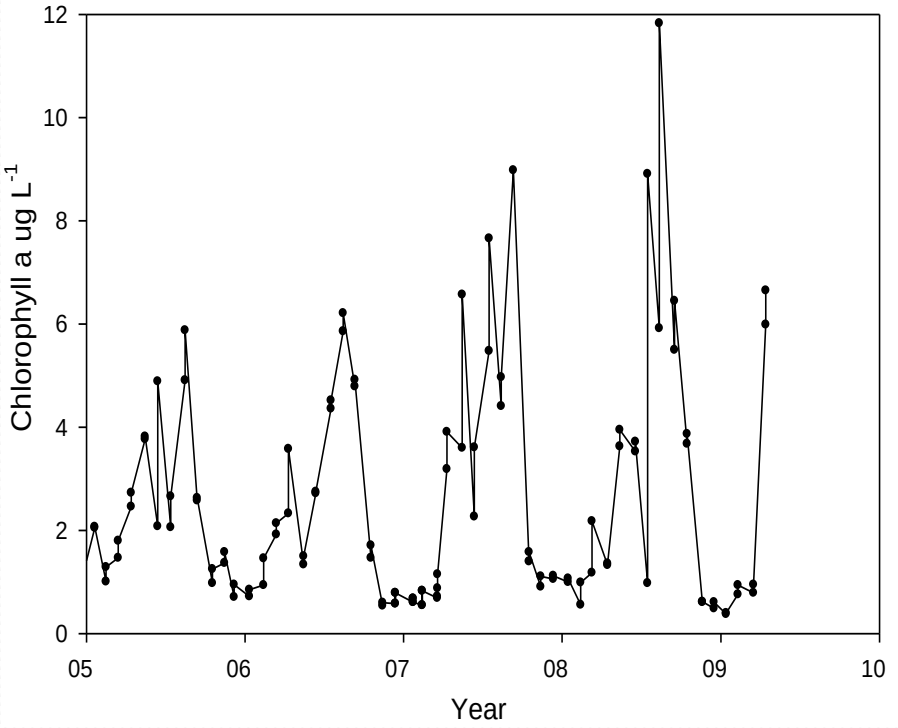
Las Vegas Bay, Near Las Vegas Wash



As inputs get closer to the sampling site, chlorophyll increases



Brown area = change in surface elevation
~1 mile / 1.6 km horizontal difference



Doubling of peak concentrations

Caveats and Conclusions

- The predicted change in temperature does not include a general warming of the lake
  - With less water to warm, the lake will warm faster
    - Will winter water temperatures be warmer?
    - Will stratification be stronger due to warmer surface waters?
- Changes in specific conductance/salinity are influenced by the proportional contribution of different sources
  - What will be the impact of the high conductance, Las Vegas Wash water
    - Decreased water residence time may enhance dilution
    - The importance of the Las Vegas Wash will continue to be large

Caveats and Conclusions

- The density of the Colorado River inflow will determine the frequency and strength of the hypolimnetic dissolved oxygen replenishment flows
  - Warmer/less dense flows will be less likely to provide oxygen to the hypolimnion
  - Continued cool/dense flows will continue to provide this oxygen
- This change in oxygen dynamics may be compounded
  - Elevated temperatures will increase oxygen consumption rates and may decrease the supply of oxygen to the bottom waters

Caveats and Conclusions

- Algal production is likely to increase
  - Supply of the limiting nutrient (phosphorus) will be nearer the drinking water intakes
  - There are 3 possible outcomes of this increased production
    - There will be an increase in algal biomass, the newly produced algae accumulate
    - The added production will be lost downstream due to the decreased water residence time, newly produced algae are carried away
    - Some combination, including channeling up the food chain

Conclusions and Caveats

- Other concerns
  - Perchlorate
  - Selinium

  } Impact will be determined by the surface elevation and stratification

  - Endocrine Disrupting Compounds/Personnel Care Products
    - Potential for greater microbial degradation at higher temperatures
  - Total Organic Carbon
    - Likely to increase in conjunction with increased algal production
    - Potential for greater microbial degradation or channeling up the food chain

Not Considered

- The impact of relocation of the Muddy, Virgin and Colorado River inflows closer to Boulder Basin
  - Turbidity, suspended sediments
  - Nutrients and chlorophyll
- Resuspension of existing delta materials
  - Nutrients
  - Pollutants
- Broader biological impacts of elevated temperatures
  - Increased metabolism at all levels

Questions?

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