**UNITED STATES DEPARTMENT OF COMMERCE**
**National Oceanic and Atmospheric Administration**
Office of Oceanic and Atmospheric Research
Earth System Research Laboratory
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Dr. Terrance Fulp
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Dear Dr. Fulp

Thank you for the opportunity to comment on the recent Draft EIS on Proposed Guidelines for Managing the Colorado River During Drought Conditions.

We are pleased to see that Reclamation is taking steps to include the effects of climate variability in its evaluation of management strategies for low reservoir operations of Lake Mead and Powell. We encourage Reclamation to work further to consider how climate change may impact water availability and environmental conditions in the Basin.

As discussed in our scoping comments for this EIS, we recommended that management strategies for low reservoir operations of Lake Mead and Powell should include the effects of climate variability and long-term trends in climate. We suggested that Reclamation should consider including information on long-term climate variability (such as paleoreconstructions of flows from tree rings), potential climate change impacts the potential of ENSO-based seasonal forecasts and intraseasonal forecasts to contribute to reservoir management. Reclamation has made some effort to incorporate our scoping comments (e.g. Appendix N), but we believe more could be done.

Since the Scoping process, several studies have been released which can provide information to assist in incorporating the potential impacts of climate change in the evaluation of alternatives. These include the Summaries for Policymakers of the Intergovernmental Panel on Climate Change (IPCC 2007a,b), the IPCC Regional Climate Projections (Christensen et al., 2007) a National Academy of Sciences report, *Colorado River Basin water management: Evaluating and adjusting to hydroclimatic variability* (NAS, 2007), and several journal articles including, *Global pattern of trends in streamflow and water availability in a changing climate* (Milly et al., 2005), *Model projections of an imminent transition to a more arid climate in Southwestern North America*: *A multimodel ensemble approach to assessment of climate change impacts on the*

*hydrology and water resources of the Colorado River basin* (Christensen and Lettenmaier, 2007), and a special issue of Southwest Hydrology including an article by Hoerling and Eischeid (2007), *Past peak water in the southwest?*.

Some of the key findings are summarized below.

The IPCC international panel of experts finds observed changes in climate including:

- An increase in the rate of global average temperature rise to 0.74°C (1.3°F) [range 0.56 - 0.92°C, 1.08 - 1.6°F] for 1906-2005.
- Discernible human influences now extend to other aspects of climate, including ocean warming, continental-average temperatures, temperature extremes and wind patterns.
- Widespread changes in extreme temperatures have been observed, including less frequent cold days, cold nights and frost, and more frequent hot days, hot nights, and heat waves.

Future impacts relevant to the Western U.S. and the Colorado River Basin include:

- Over North America, annual mean warming is likely to exceed the global average. Over western North America, median temperatures are projected to increase by 3.5°C, 4°C, and 5°C by 2100 under the B1, A1B, and the A2 emissions scenarios, respectively.
- In the southwestern U.S., warming is likely to be the largest in summer
- Warmer and fewer cold days and nights are virtually certain as are warmer/more frequent hot days and nights over most land areas
- Warm spells and heat waves are very likely to increase over most land areas
- There is very high confidence that high elevation warming is projected to cause decreased snowpack, more winter flooding, and reduced summer flows
- Annual mean precipitation is likely to decrease in the southwestern U.S.
- The area affected by drought is likely to increase, with more widespread water stress and water shortages and reduced hydropower generation potential
- The global models likely underestimate the warming at high altitudes due to the snow-albedo feedback.
- Snow season length and snow depth are very likely to decrease over most of North America.

The NAS report notes that temperature records and climate model projections both suggest that temperatures across the Western U.S. will continue to rise in the foreseeable future. The NAS report, Hoerling and Eischeid (2007), and Christensen and Lettenmaier (2007) all point to the negative impacts of higher temperatures on water supply in the West. The IPCC 2007 findings also point to the impacts of rising temperature on water supplies in already arid areas, and note that areas like the U.S. West are particularly vulnerable because its economies are closely linked with climate-sensitive resources, its rising population, urbanization, and dependence on already highly utilized water resources.

It is noteworthy that the IPCC 2007 model runs consistently show a reduction in water supplies in the American Southwest even when precipitation stays approximately the same. This is due to temperature increases and the resultant widespread drying. The results in Milly et al (2005),

Hoerling and Eischeid (2006), Christensen and Lettenmaier (2007), and Seager and et al. (2007) all indicate a reduction in water supplies, albeit with some significant differences in magnitude. Models used in the IPCC Third Assessment Report in 2001 (IPCC 2001) and the National Assessment of the Potential Consequences of Climate Variability and Change in (USGCRP, 2000) showed no such consistency with some models indicating more precipitation and some less.

These and other recent studies are showing that the use of historical hydrology for the Colorado River cannot adequately capture the likely future variability of water supply. We strongly encourage Reclamation to consider ways to generate hydrology representative of likely future conditions and to continue to utilize the paleo record to investigate climate variability outside that of the historical period.

We have been pleased to participate in a panel of experts convened to consult with Reclamation and assist in addressing these questions. The NOAA and the NOAA-University of Colorado Western Water Assessment are happy to continue to work with Reclamation, to assess the potential effects of climate variability and change, as well as the opportunities for the use of seasonal climate forecasts, in studying how best to operate Lakes Powell and Mead during low reservoir conditions

Sincerely,

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