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Global Warming Effects on Hetch Hetchy Hydrology -

Bruce J. McGurk, Ph.D., Operations Manager and Hydrologist, Hetch Hetchy Water and Power, Moccasin, CA 95347. email: bmcgurk@sfwater.org

The San Francisco Public Utility Commission is responsible for providing water to 2.4 million retail and wholesale customers in the Bay Area. Eighty-five percent of the water supply comes from the Hetch Hetchy Water and Power Division that collects water in Hetch Hetchy Reservoir and other reservoirs in the Tuolumne River Basin. Hetch Hetchy is at 3,800 ft elevation and has a 459-mi^2 watershed on the west side of Yosemite National Park that extends to an elevation of over 12,000 feet. SFPUC staff has begun an analysis of global warming effects and is reviewing its forecasting and planning activities to evaluate potential issues.

A literature review of recent studies on climate change was conducted to identify the current status of available information and to determine potential impacts of climate change on SFPUC water resources. Based on the review, climate change could result in the following types of water resources impacts in California, including on the SFPUC regional water system and associated watersheds:

- Reduction in the average annual snowpack due to a rise in the snowline and thinner snowpack in low- and medium-elevation zones
- Changes in the timing, intensity, location, amount, and variability of precipitation, including a shift in snowmelt runoff to earlier in the year, and an increased amount of precipitation falling as rain instead of as snow
- Long-term changes in watershed vegetation and increased incidence of wildfires that could affect water quality
- Increased water temperatures with accompanying adverse effects on some fisheries
- Increase in evaporation and concomitant increased demand by SFPUC customers

SFPUC staff performed an initial evaluation of the effect on the regional water system of a 1.5 degree Celsius (^{o}C) temperature rise between 2000 and 2025 (SFPUC, 2006a). The temperature rise of 1.5 ^{o}C is based on a consensus among many climatologists that current global climate modeling suggests a 3 ^{o}C

rise will occur between 2000 and 2050 and a rise of 6 °C will occur by 2100. The evaluation predicts that an increase in temperature of 1.5 °C will raise the snowline approximately 500 feet every 25 years. The elevation of the watershed draining into Hetch Hetchy Reservoir ranges from 3,800 to 12,000 feet above mean sea level, with about 87 percent of the watershed area above 6,000 feet, as shown in Figure 1. In 2000, the average snowline in this watershed was approximately 6,000 feet during the winter months. Therefore, the SFPUC evaluation indicates that a rise in temperature of 1.5 °C between 2000 and 2025 will result in less or no snowpack below 6,500 feet and faster melting of the snowpack above 6,500 feet. Similarly, the snowline will have risen to 7,000 feet in 2050 and to 8,000 feet in 2100. The snow-free portion of the basin will rise from 13% in 2000 to 57% by 2100. This shift in snowline implies that more of the basin will receive rain during a storm and less will receive snow. This change will produce a shift in runoff timing: more runoff during the early winter and less snowmelt at the end of the winter.

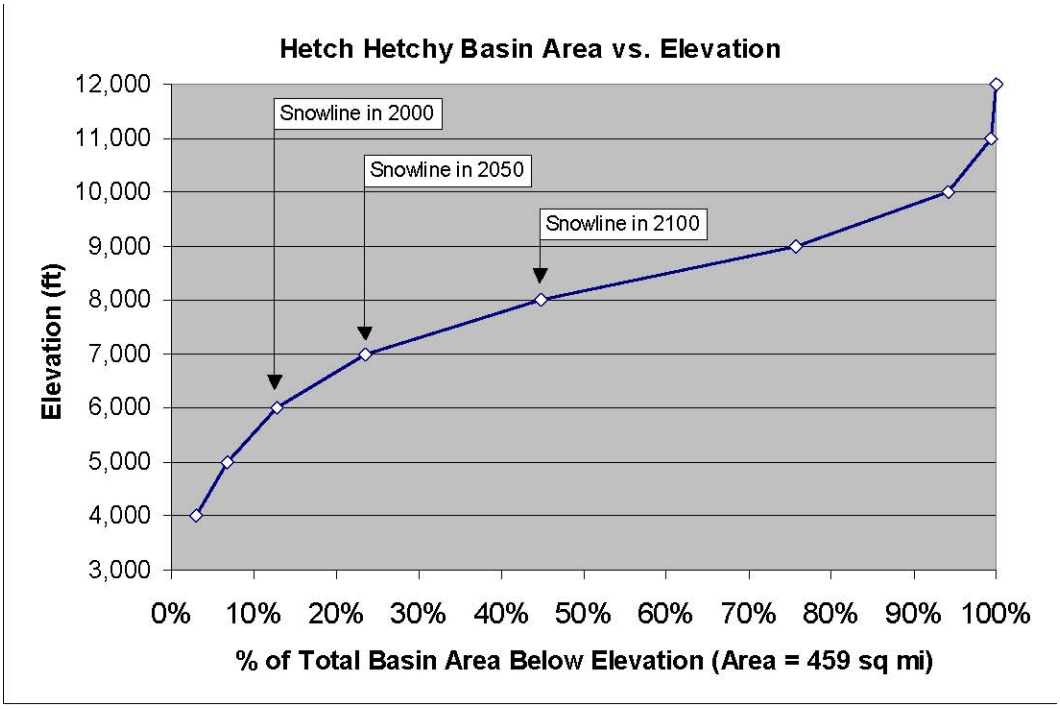

Figure 1. Area vs. elevation for the Tuolumne basin above Hetch Hetchy Reservoir.

The SFPUC evaluated the shift in the timing of runoff with their current runoff forecasting model. By raising daily maximum and minimum temperatures to simulate climate change, the results indicated that about 7 percent of the runoff currently draining into Hetch Hetchy Reservoir will shift from the spring and summer seasons to the fall and winter seasons in the Hetch Hetchy basin by 2025. This percentage is within the current interannual variation in runoff and is within the range accounted for during normal runoff forecasting and existing reservoir management practices. As the warming process continues and if even larger shifts occur, reservoir operational strategy will have to be changed. The predicted shift in

runoff timing is similar to the results found by other researchers modeling water resource impacts in the Sierra Nevada due to warming trends associated with climate change. The SFPUC is beginning studies with models capable of modeling warming out to 2100, and may then examine the changes in runoff patterns by implementing an operations model. The SFPUC is committed to understanding the effects of global warming on the water supply and developing strategies to adapt to continue to meet their water supply responsibility.