TOPICAL RESPONSE 3: CLIMATE CHANGE AND ITS EFFECTS

Comments point to uncertainty in future conditions that may affect water supplies, such as declines in fish species in the Bay-Delta and climate change due to global warming. The comments state that global warming should be accounted for when assessing water reliability in California, relying upon an article entitled, *Emissions Pathways, Climate Change, Impacts on California*, by Katharine Hayhoe, *et al.*, dated August 24, 2004 (*Emissions Pathway Report*). The comments also correctly point out that Department of Water Resources (DWR)'s CalSim-II model does not yet incorporate modifications to account for the impacts of climate change on precipitation and runoff patterns in California.

The purpose of this topical response is to assess DWR's response to information concerning climate change and its effects on State Water Project (SWP) delivery reliability. First, DWR's planning documents, discussed below, address the uncertainties surrounding global climate change and its effects on water supplies. Second, DWR has acknowledged reports and other literature addressing climate change effects on California's water resources. According to this information, DWR has reported that California's future hydrologic conditions will likely be different from patterns observed over the past century -- although the precise causes, extent, and timing of the changes remain uncertain. DWR has further acknowledged that, as more sophisticated tools are developed and additional studies are completed, better quantification may be possible of global climate change and its effect on water supplies. However, according to DWR, until then, the CalSim-II model studies represent the best available assessment of the delivery capability of the SWP. Based on this information, the City of Santa Clarita has made the factual determination that global climate changes and their effects on SWP water supplies are too speculative at this time for any further evaluation.

1. DWR PLANNING DOCUMENTS

DWR's *SWP Delivery Reliability Report, Public Review Draft*, dated November 16, 2005 (*Reliability Report*) presents information from computer simulation studies of the operation of the SWP. *Reliability Report*, p. 9. Using the CalSim-II model, DWR has simulated SWP operations, using historical rainfall and runoff data, which is then adjusted for changes in water and land use that have occurred or may occur in the future. The computer simulations were conducted over a 73-year period (1922-1994) of the adjusted historical rainfall/runoff data. This modeling approach incorporates the assumption that the next 73 years will have the same rainfall/snowmelt amount and pattern, both within-year and from year-to-year, as the historical 1922-1994 period. *Id*.

Based on this modeling assumption, DWR has noted that, currently, the CalSim-II model does "not incorporate any modifications to account for changes related to climate change" that could disrupt SWP

deliveries. *Id*. However, DWR makes clear that "[a]s tools are developed to address these risks and the resulting studies become available, the information will be incorporated into the assessment of SWP delivery reliability." *Id*. In the meantime, however, DWR has confirmed that the results of CalSim-II model studies conducted for the updated delivery reliability report "represent the best available assessment of the delivery capability of the SWP." *Id*.

In response to concerns about future climate conditions that may affect water supplies, DWR has stated that information pertinent to climate change and its effects on water supplies "is evolving rapidly, but has not reached a level at which it can be quantitatively incorporated into delivery projections of the SWP."[1] Nonetheless, DWR has acknowledged the existence of literature and other "broad brush estimates of potential impact on the SWP 50 to 100 years into the future if no additional conveyance facilities or upstream reservoirs are built."[2] DWR has further acknowledged that the published literature and other information are "helpful in developing strategies for the future management and development of the State's water resources, including improvements to the SWP." *Id*.

To ensure that this literature and other developing information are being included and assessed, DWR's publication, *California Water Plan Update of 2005* (2005 Water Plan), has addressed uncertainties associated with global climate change and its potential effect on water supplies.[3] In Chapter 4 of the 2005 Water Plan, DWR has summarized the "predictions" surrounding global climate change, and they "include increased temperatures, reductions to the Sierra snowpack, earlier snowmelt, and a rise in sea level, although the extent and timing of the changes remain uncertain." *Id*. p. 32. DWR has further stated that these predicted changes "could have major implications for water supply, flood management, and ecosystem health. The prospect of significant climate change warrants examination of how California's water infrastructure and natural systems can be managed to accommodate or adapt to these changes, and whether more needs to be done." *Id*. DWR has acknowledged that, for over the past ten years, "scientists have been publishing formal, peer-reviewed recommendations for integrating the results of climate change research into policy." *Id*.

For example, in conjunction with affected state agencies, the Public Interest Energy Research Program (PIER) administered by the California Energy Commission has developed and is implementing a climate change research plan for California. The PIER program established a regional climate change research center with the goals of (1) improving the understanding of the possible physical and economic impacts

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1 See, DWR letter to Mindy McIntyre, Water Program Manager, Planning and Conservation League, dated April 20, 2006 (DWR's April 20, 2006 letter), which is found in **Appendix Q** of the Final Additional Analysis.

2 DWR's April 20, 2006 letter, p. 3.

3 Pertinent portions of DWR's 2005 Water Plan are summarized above and incorporated by this reference. A complete copy of the 2005 Water Plan is available online for public review by accessing DWR's website (http://www.waterplan.water.ca.gov/cwpu2005/index.cfm).

of climate change; and (2) developing robust adaptation and mitigation strategies for California. (See, 2005 Water Plan, p. 32, Box 4-9, PIER Program and Climate Change Research.) In support of future updates of the 2005 Water Plan, the newly-created research center is funding the (1) development and maintenance of a comprehensive climatic database for California and the analysis of meteorological and hydrological trends; (2) monitoring of meteorological and hydrological parameters in some key remote locations using innovative remote sensing devices; (3) development of climate projections for the state using regional climate models at levels of resolution appropriate for water resources impact analyses; and (4) study of water resources impacts under different climatic projections. DWR is a key co-sponsor of these research activities, and DWR staff is participating in the modeling efforts. *Id*.

Other ongoing research includes work performed by the Pacific Institute for Studies in Development, Environment and Security (Pacific Institute). The Pacific Institute, in a literature search report for DWR, summarized recommendations for coping with and adapting to climate change from key peer-reviewed publications. The Pacific Institute's report entitled, *Climate Change and California Water Resources: A Survey and Summary of the Literature,* by Michael Diparsky and Peter H. Gleick, Pacific Institute (*Climate Change Report*), is included in the Volume 4 Reference Guide to the 2005 Water Plan.[4]

In the *Climate Change Report*, the Pacific Institute surveyed existing literature on climate change and its impacts on water resources in California. This report reviewed projected effects of climate change on the state's water supply, delivery, and quality, and explored the economics involved in meeting the challenges that those affects could bring about. (*Climate Change Repor*t, p. vii.) In general, the report confirmed temperature increases and their effects include a snowpack higher in elevation, with either lower or higher precipitation depending upon the information source (*Climate Change Report*, pp. 6, 10); either greater or lesser amounts of runoff depending upon the information source (p. 14); a greater number of extreme flood and drought events (p. 13); and reductions or increases in projected water use by plants (p. 10), again, depending upon the information source. Thus, depending upon the information presented, California could have more water available due to increased humidity and rainfall, or less water available due to reductions in snowpack, greater evaporation, and no change or slightly less rainfall.

The *Climate Change Report* concluded that managing water resources to address climate changes could prove different than managing for historical climate variability because (1) climate changes could produce hydrologic conditions and extremes of a different nature than current systems were designed to manage; (2) they may produce similar kinds of variability but outside of the range for which current infrastructure was designed; (3) traditional water resource management assumes that sufficient time and

4 See, *Climate Change Report*, found in **Appendix H** of the Final Additional Analysis.

information will be available before the onset of large or irreversible climate impacts to permit managers to respond appropriately; and (4) traditional management assumes that no special efforts or plans are required to protect against such uncertainties.

The *Climate Change Report's* literature survey resulted in specific recommendations for the following areas:

- Water planning and management
- Sea level concerns
- Modifying operation of existing systems
- New supply options
- Demand management, conservation, and efficiency
- Economics, pricing, and markets
- State water law
- Hydrologic and environmental monitoring

The *Climate Change Report* further recommended that a more comprehensive assessment of all of these areas, supported by multiple state agencies and including the participation of a wide range of stakeholders, would be a valuable tool for policymakers and planners, and it was urged that such an assessment to be undertaken in the near future. *Id*.

Although the data is still developing, the *Climate Change Report* has confirmed that a consensus in the literature is emerging to suggest that temperatures globally are increasing. Given that climate change is a complex topic, and that the world's climate has changed in cycles for hundreds of thousands, if not millions, of years, according to DWR, the cause of these climate changes and their effects have not reached a level at which such information can be quantitatively incorporated into the delivery projections of the SWP.[5]

In addition, a DWR report on climate change impacts and the recommendations for further research has been prepared and included in the Volume 4 Reference Guide to the 2005 Water Plan. The report is entitled, *Accounting for Climate Change*, by Maurice Roos, Chief Hydrologist, DWR (*Accounting Report*).[6]

The *Accounting Report* noted that evidence of global climate changes continues to develop, and this developing information has suggested that global climate change can affect the amount, timing, and form of precipitation (whether rain or snow) that California receives, as well as the sea level of the Pacific Ocean. This report disclosed that changes in weather, especially temperature and atmospheric

5 DWR's April 20, 2006 letter, p. 2.

6 See, *Accounting Report* found in **Appendix C** of the Final Additional Analysis.

composition, can affect water use and consumption. (*Accounting Report*, p. 1.) In addition, the *Accounting Report* indicated that most scientists feel that changes during the last several decades are likely mostly due to human activities, but natural causes and variability cannot be ruled out as significant components. The *Accounting Report* also stated that projections of the amount of warming and other climate changes during the 21st century are wide-ranging, depending on assumptions and models. The findings summarized in the *Accounting Report* provide that:

> *"Whatever the causes, the prospects of significant changes warrant examination of how the State's water infrastructure and natural systems can accommodate or adapt to climate changes and whether more needs to be done to detect, evaluate and respond to water resource system effects. Many uncertainties remain, primarily on the degree of change to be expected. Responsible planning requires that the California water planning community work with climate scientists and others to reduce these uncertainties and to begin to prepare for those impacts that are well understood, already appearing as trends, or likely to appear."* (Accounting Report, *p. 1.)*

DWR's 2005 Water Plan has also referenced modeling efforts undertaken by the University of California, Davis (with funding from the Resource Agency, CALFED, and the California Energy Commission). The University used the "CALVIN" model to evaluate how California's water system might adapt to long-term climate warming. This preliminary analytical tool was used to integrate "existing surface water, groundwater, and water demand data in an integrated economic-engineering framework for California's inter-tied water system (covering 92 percent of California's population and 88 percent of its irrigated area)." 2005 Water Plan, p. 33. Although a useful analytical tool, DWR noted that:

> *"In developing the computer model [CALVIN], significant weaknesses and gaps in water data were identified and documented. The model and its results have been peer reviewed and show preliminary insights into economically promising possibilities for California water management. More importantly, the tool demonstrated concepts in advanced data management, documentation, and analysis that may be useful for future statewide and regional water policy and planning analysis. The CALVIN model has been applied preliminarily to examine statewide potential for regional and statewide water markets and how California's water system might adapt to long-term climate warming (through the [PIER] Program)."* Id.

In addition, DWR's 2005 Water Plan has referenced computer modeling of global climate change scenarios, which predict significant future reductions in the Sierra snowpack.[7] *Id*. pp. 33-34. The model's simulation of potential changes in snowpack during the 21st century predicts a 52 percent reduction in the annual April through July runoff for a 2.1 degree C (3.8 F) of warming, which, according to DWR, is "well within the 1.4 to 5.8 degrees C (2.5 - 10.4 F) range predicted by global climate models for this century." *Id*. p. 34. According to DWR, "[c]hanges in the timing of snowfall and snowmelt, as a result of climate change, may make it more difficult to fill reservoir flood control space during late spring and early summer, potentially reducing the amount of surface water available during the dry season. . . .

[7] The source of this modeling is cited in the 2005 Water Plan References as: Knowles Noah, and Cayan D. 2002. *Global Climate Change: Potential Effects on the Sacramento/San Joaquin Watershed and the San Francisco Estuary*. Geophysical Research Letters 29(18). This article is provided in **Appendix AE** of the Final Additional Analysis.

Reductions in snowpack may require changes in the operation of California's water systems and infrastructure, and increase the value of additional flood control space in reservoirs." *Id*. p. 34.

In short, then, opinions vary regarding the implications of future climate changes. Regardless of the information used, the literature cited by DWR has noted that, over time, California water supply managers will need to modify the methods used to manage water supplies in order to build in the flexibility needed to address a dynamic water supply environment. However, it appears that more information is needed in order to draw definitive conclusions regarding the implications of climate changes on water supplies. DWR has also pledged to continue to incorporate new information in successive updates to the California Water Plan.

2. OTHER LITERATURE SOURCES

The *Emissions Pathway Report*, cited in comment letters, has discussed the magnitude of future climate changes based on climate projections from the modeling of greenhouse gas emissions scenarios out to the year 2100. This report shows that, by the end of the century, due to increased temperatures, the Sierra snowpack could be reduced by 30-70 percent under one emissions scenario to as high as 73-90 percent under another emissions scenario. The increased temperatures, along with impacts on runoff and stream flow, combined with modest declines in winter precipitation, could fundamentally disrupt California's water resources. (*Emissions Pathway Report*, p. 1.)

Other literature calls attention to the ongoing debate over global warming and its effects. For example, in an article presented in *Nature* (Online Version) entitled, *Pondering a Climate Conundrum in Antarctic*, it has been suggested that there are cooling trends, not necessarily global warming. In that article, the authors noted a "[u]nique, distinct cooling trend discovered on the Earth's southernmost continent Antarctica overall has cooled measurably during the last 35 years - despite a global average increase in air temperature of 0.06 degrees Celsius during the 20th century - making it unique among the Earth's continental landmasses."[8]

3. CONSIDERATION OF ISSUES BY CITY OF SANTA CLARITA

The City of Santa Clarita's Planning Commission has undertaken its own independent assessment of SWP reliability delivery issues, including a presentation by Katherine Kelly, DWR, and Jonas Minton, Planning and Conservation League (PCL). This presentation took place at a Planning Commission meeting on June 29, 2004 and included discussion on a number of items such as SWP water supplies, the reliability of those supplies, DWR's use of the CalSim-II model, including its strengths and weaknesses, and a variety

8 See, *Pondering a Climate Conundrum in Antarctic*, dated January 13, 2002, *Nature* (Online Version), which is found in **Appendix AL** of the Final Additional Analysis.

of other related issues, such as global warming effects on SWP supplies. It was not an item specific to a proposed development, or any particular project. The purpose was to receive a presentation from a representative from DWR and a representative from Planning and Conservation League with different perspectives and differing opinions on the above SWP water supply issues.[9] This presentation also is relied upon to support the City's water-related determinations, including those specific to climate changes on SWP water supplies.

4. CONCLUSION

In summary, then, DWR's CalSim-II model does not yet incorporate parameters to account for climate changes; however, as the literature and modeling tools continue to develop in order to assess such risks, DWR will incorporate such information into successive updates to the California Water Plan and the assessments of SWP delivery reliability. In the meantime, DWR reports that the results of its CalSim-II studies conducted for the updated *Reliability Report* represent the best available assessment of the delivery capability of the SWP.

Accordingly, based on the above data, the City agrees with DWR that it would be speculative at this time to quantify the effects of climate changes on the reliability of the SWP, but as information continues to develop, the City urges DWR to utilize such information in developing strategies for the future management and development of California's water resources, including improvements to the delivery projections of the SWP. At this time, the City believes it is appropriate to terminate any further analysis of potential future climatic changes, consistent with Section 15145 of the California Environmental Quality Act Guidelines.

9 For the transcript of the Planning Commission proceedings held on June 29, 2004, specifically, pages 5 through 95, please see **Appendix AN** of the Final Additional Analysis.