DATE: **August 22, 2014**

TO: **Water Supply Advisory Committee**

FROM: **Rosemary Menard, Santa Cruz Water Director**

SUBJECT: **Recon Report Response to Questions Related to the supply/demand slide deck**

On Friday August 1, 2014 email WSAC member Rick Longinotti sent the following email to Bob Raucher (see also the attachment provided and referred to in the last paragraph of the email.

This report provides information in response to this request, including a schematic of how the Confluence model works (inputs, process, outputs), specific responses to the question regarding the starting lake level for Loch Lomond used in developing slides 54, 55, and 56, and an explanation of how the model projects lake levels in all the years of the hydrologic record (e.g., what is the rule curve for the operation of Loch Lomond that is used as an input to the model.)

> Dear Bob,
>
> I am putting this in writing in order to spare my colleagues on the WaterSac a long-winded request. At yesterday's meeting, I made a request that the model for the worst-case year (1977) be updated given our experience with this year's runoff conditions. I would like to understand the discrepancy between the model's prediction of a peak season shortfall of 650 million gallons when the water supply forecast given to the Water Commission in April predicts a shortfall of 383 million gallons. The April agenda packet reports, "Staff is forecasting that the river can be expected to run at levels equal to 100% of what occurred in 1977".
>
> I have three additional requests:
>
> 1. that all the assumptions and data for the *Confluence* model be made public.
> 2. that the water supply operations assumptions for the baseline scenario (the do-nothing scenario) include the capital improvements and conservation measures that are already underway or planned by the Water Department.
> 3. that the all scenarios assume that the City will receive state approval of its water rights applications once the fisheries agencies approve of the City's Habitat Conservation Plan.
>
> **Making *Confluence* Modeling Transparent** The *Confluence* model is a very valuable tool for understanding our supply versus demand situation under a variety of scenarios. The California Department of Fish and Wildlife is the only entity outside of the Water Department that became privy to the model's inner workings. To the rest of us it was a black box.
>
> The WaterSAC will probably want to test various assumptions that feed the model. For example, in the past the model assumed that in normal years Loch Lomond would supply an amount of water equivalent to the maximum water rights limit for the reservoir (1 billion gallons/year), when the actual average allocation from the reservoir over a ten year period was about half that amount. Not surprisingly, the model predicted that in a second dry year there would be only 200

million gallons of water available from the reservoir. See the Table 2 from the 2005 *Urban Water Management Plan.*

Table 5-2. Water Supply Reliability for Average, Single Dry, and Multiple Dry Years (millions of gallons)

Source	Average Water Year	Single Dry Water Year	Multiple Dry Water Years	
			Year 1	Year 2
North Coast	1,077	500	400	300
San Lorenzo River	2,008	2,100	2,100	1,800
Live Oak Wells	187	300	300	400
Loch Lomond Reservoir	1,042	900	700	200
Total	**4,314**	**3,800**	**3,500**	**2,700**
Percent of Average	**100%**	**88%**	**81%**	**63%**

City Responses to Questions Raised:

On the next page of this memo, is a simplified schematic of the inputs, processes and key outputs of the Confluence model. This schematic isn't intended to answer every question, but with respect to issues related to how model inputs as they relate to Slides 54, 55 and 56, the schematic helps clarify several issues:

- Demand used in these slides (3500 million gallons/year) was an approximation of current demand. .
- Fish flows release regimes are specified in the graphs – slide 54 has none beyond releases required by current water rights (e.g., 1cfs bypass flow to Newell Creek); slide 55 has Tier 3/2 flows, and slide 56 has Tier 3 flows. A slide in this series created in exactly the same manner as these three slides is now available for the fish flow release regime called DFG-5.
- These slides assume flows from the 1977 hydrologic year which runs from November 1, 1976 to October 31, 1977.
- The basic operating strategy the model uses for dispatching sources is as follows:

  Take all available flows from the North Coast streams first (accommodating agreed upon fish flows, of course). Next go to the San Lorenzo River and take any available water that meets water quality criteria and is within the provisions of our water rights and after meeting agreed upon fish flow releases. If it is winter, go to the lake next, if it is summer, go to groundwater sources next and then to the lake.

- The model runs underlying these slides assume base infrastructure, which reflects ongoing improvements to the North Coast pipeline and limited summer production from Beltz well 12.

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Refers to agenda item #6

Schematic of How the Confluence Model Works

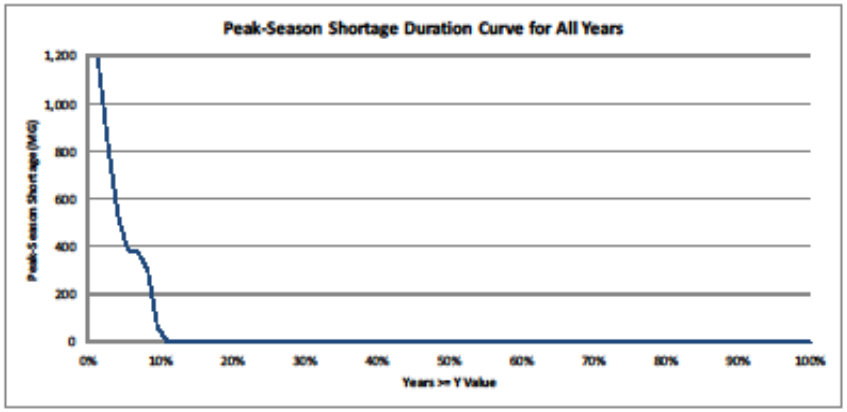
Confluence Model Inputs

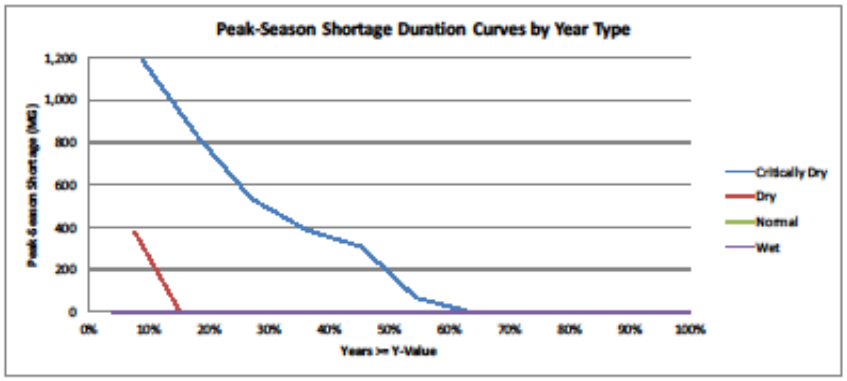
Confluence Model Output (examples only)

- Hydrologic Record
- Fish Flows (subtracted from flows in the hydrologic record)
- Operating constraints for each water supply/ infrastructure component, including reservoir rule curves and water rights
- Forecasts of System Demand (e.g., demand in 2013, current demand, demand in 2020)
- Rules for dispatching system components to meet demand

The Confluence model simulates system operation for a specified combination of hydrologic conditions and demands and generates outputs relating to system reliability, source production and reservoir levels.

Model results are often presented in the form of the curves shown at the right. Such curves have proven to be quite useful in understanding the expected frequency and severity of shortages

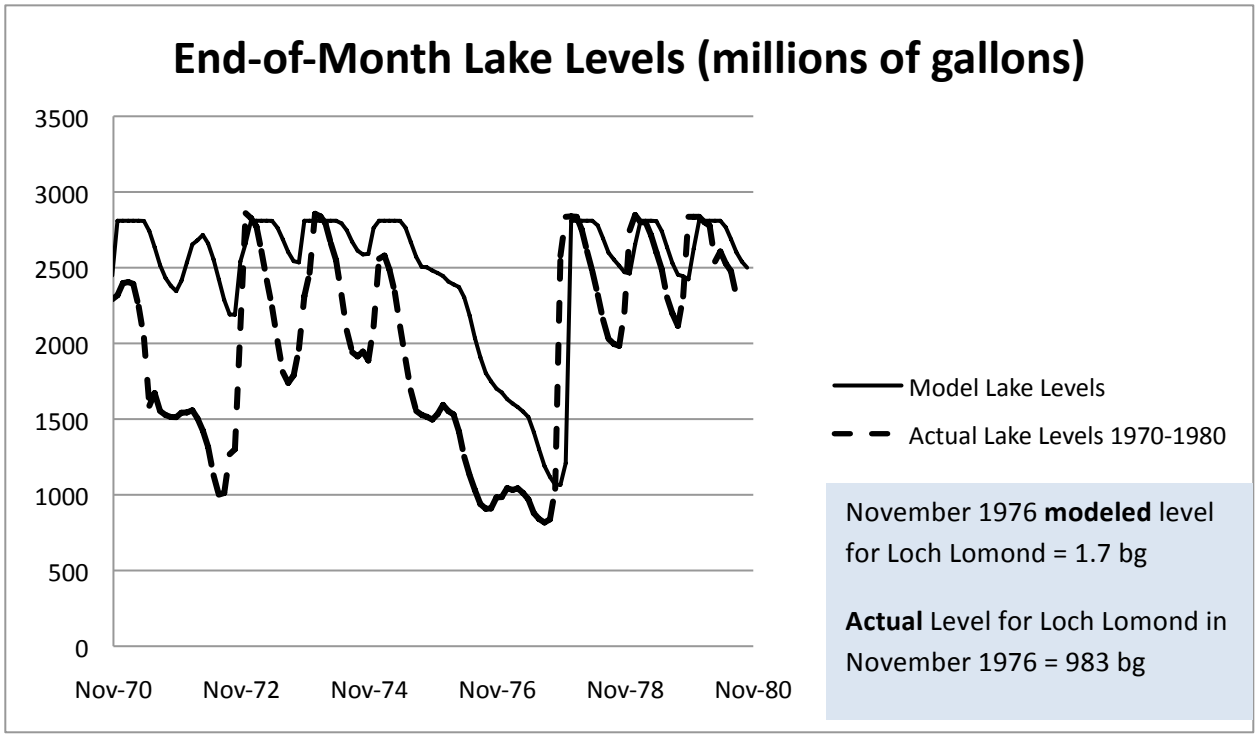




Question: What was the starting lake level used in preparing the graphs shown in Slides 54, 55, and 56?

Answer: The lake level at any point is not an input to the Confluence model; rather it is a product of the model simulation. Likewise, the model is not "programmed" to release a specified amount of water for any year. Like in real life, the lake is always the last source of water dispatched in the model, and is treated as the source of last resort after all other supplies are fully maximized. The model governs the operation of the lake using something called a rule curve that determines whether the lake level at any point in the peak season is high enough to allow the lake to fully meet remaining demand, or whether lake draw down must be slowed, resulting in a shortage during the dry season. The chart below shows the lake levels that result from a model run that assumes Natural flows, current demand levels, and a 10-year hydrologic sequence running from water year 1971 through 1980. The chart also shows the actual lake levels for that 10-year period (dashed line). The differences between the two are due to a variety of factors, most notably differing demands, and changes since the 1970s in how the system is operated.

Among other things, this chart tells us that in Slide 54, which is also based on a simulation assuming Natural flows, the starting lake level on November 1, 1976 is 1.7 billion gallons. The starting lake levels for slides 55 and 56 will differ because of different flow assumptions.



Question: Does Table 5-2 from the 2005 Urban Water Management Plan in any way reflect or direct water system operations in normal years?

The answer to this question is no. The graph on page 6 shows both the modeled lake levels and the actual lake levels for the period November 1970 to October 2009. Particularly since 1995, lake levels

have seldom fallen below 2 billion gallons and in recent years, actual lake usage has typically been in the neighborhood of no more than 600 million gallons per year. It appears that the purpose of Table 5-2 may have been more related to theoretical capacities rather than operational practices, especially those occurring over the last 20 years.

In reviewing the chart on page 6, I want to call reviewers' attention to information that will help them understand and appropriately interpret what they are seeing.

The solid black line is modeled lake levels that are based on actual hydrology and constant demand equal to current demand levels (i.e., 3.5 bgy). The dotted black line is actual lake levels and has been influenced by management decision-making about how to use the lake in responding to the water supply situation in any given year.

It is interesting to note how much closer the modeled and historical lake levels are in recent years than in earlier years. This is to be expected, as modeled and actual demands as well as modeled and actual operating regimes have converged.

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Refers to agenda item #6