MEMORANDUM

TO: Rick Raymondi
FROM: Chuck Brendecke
SUBJECT: Comments on Contor Memo of October 17th
DATE: October 31, 2006
CC: ESHMC members

This memo conveys my thoughts and responses to the summary memo of October 17, 2006, prepared by Bryce Contor. In his October 17 memo, Bryce attempted to summarize the discussions and conclusions of the September 28-29, 2006, meeting of the Eastern Snake Hydrologic Modeling Committee (ESHMC) as they pertained to the development of a replacement for the existing Base Case scenario. In addition to summarizing the meeting discussions and conclusions, Bryce presented a list of "details to be worked out" in the development of this replacement scenario (to be known as the "Current Water Use Practices Scenario").

Meeting Discussions and Conclusions

In general, I think Bryce did an accurate job of summarizing the discussions and conclusions of the ESHMC meeting. I would offer only the following clarifications and affirmations to his description thereof. The absence of comment (below) on specific statements contained in Bryce's memo should be interpreted as agreement with them.

- Item 5, 2nd Para. – I am curious to know why IWRRI believes that question #1 under "Time Horizon" does not merit being addressed. I do agree that both question #1 and question #3 require different model scenarios than question #2, and that the uses of these scenarios will differ. However, there are conceptual similarities between #1 and #2 that suggest they be done as a package, and we should expect that the Water Resource Board will ask question #1.

- Item 5, 3rd Para. – My recollection is we concluded *against* making any data adjustments in the new scenario to represent future changes in such things as diversions and efficiencies (which affect incidental recharge). The conclusion was to use the information in the existing model data set and to reflect more the recent characteristics of the water budget solely by using more recent portions of that existing data set.

- Item 6, 1st Para. – My recollection is we concluded long-term scenario results need to be displayed in probabilistic form. In my view, the simplest way to do this is to collapse annual results (e.g., end-of-season water level in cell XYZ, annual reach gain between X and Y) from a representative

multi-year model run (only one such run should be needed) into a depiction of the range of that data. Box-whisker plots, frequency histograms or probability distributions could all convey the probabilistic nature of the result, and would allow simple comparison with current observed values of those parameters. Charts should be backed up by more extensive tabular data for readers wishing to delve deeper.

- Item 7, 2nd Para. – My recollection is we concluded that, if we are to address time horizon question #1, the model needs to be updated (possibly synthetically) to run through the period from the end of calibration to the near-present. If we do not address question #1, then such an update is not essential and could wait until real (as opposed to synthetic) data can be used. A synthetic update could be useful, however, in expanding the re-sampling base used for creation of representative hydrologic traces (to address a later concern about the size of the re-sampling base).

- Item 7, 3rd Para. – My recollection is we concluded a re-sampling approach should be used to define representative hydrologic traces (for both time horizon question #1 and #2) rather than simply repeating a subset of the years in the calibration data set. This is because, among other things, the latter does not contain equal representation of wet and dry years.

- Item 8 – My recollection is that we concluded the existing model data set (possibly extended synthetically) would form the base from which samples would be drawn (with replacement) to create representative hydrologic traces. The data-set-years drawn from this base would be selected using key hydrologic indices (known as *feature vectors*) for which long periods of record exist. I would suggest that these indices be ones that are not subject to human manipulation, because the types of and reasons for such manipulation have changed over time. Two indices that seem to me to be good candidates for use in this re-sampling approach would be the unregulated flow at Heise and the Palmer Drought Severity Index (or variants such as PHDI). These two indices reflect both water supply and demand, have long periods of record, and aren't affected by human activity.

Detail Questions and Issues

The discussion below attempts to answer or address the list of "details to be worked out" presented at the end of Bryce's memo.

a. *How do we include representation of probability or variability in our results?* I favor box-whisker plots. They are simple to understand and several of them can be placed on a single chart (e.g., water levels or reach gains in several locations). It would be easy to superimpose on them the current observed values of the parameters

of interest. Supporting data for the plots should be provided in tabular form.

b. *What limits of variability do we use?* I favor exceedance probabilities rather than multiples of standard deviation because the former explicitly convey likelihood. Standard deviation only conveys likelihood for readers who are familiar with probability distributions.

c. *Do we attempt to address both time horizon questions #1 and #2.* Addressing #2 is more important than addressing #1. However, most laymen will probably interpret the results from #2 as being the answer to #1, so it may be prudent to do both at the same time. The difference between them will be more obvious to laymen if both are presented.

d. *How do we present long-term results?* Box-whisker plots are the most succinct way to present these results and can be easily created by collapsing annual values from a multi-year model run. Supporting data for the plots should be provided in tabular form.

e. *How do we present short-term results?* Because such runs do imply prediction, it makes sense to show them as time-series line plots with real dates on them. The range of predicted future conditions could be shown by using multiple lines (including the median prediction) or shaded areas.

f. *How do we construct synthetic data for May 2002- present?* The re-sampling approach works well for both long- and short-term analyses. Some global scaling of re-sampling results may be necessary for the short-term case to insure that the simulated "current" state of the aquifer reasonably matches actual current observations.

g. *Do we adjust synthetic data component-by-component or globally?* In general, I would suggest we use only global scaling so as to preserve interrelationships in the data and insure that we maintain balanced water budgets. However, there have been questions raised about the representation of return flows in the model data sets and some thought should be given to whether this item should be scaled individually, or perhaps adjusted before global scaling.

h. *Which hydrologic sequences should we use as indicators?* Two indices that seem to me to be good candidates for use in a re-sampling approach would be the unregulated flow at Heise and the Palmer Drought Severity Index. These two indices reflect both

water supply and demand, have long periods of record, and are not significantly affected by human activity.

i. *How do we construct the index from the hydrologic data series?* Not much construction is required if we use unregulated flow at Heise and PDSI. The monthly values of the PDSI would need to be aggregated into a single annual value, and both indices would need to be normalized before being used to guide re-sampling.

j. *How do we use the index (indices) to extract data from the calibration data set?* I would suggest we use a nearest-neighbor algorithm, where nearness (similarity) is calculated as the Euclidian distance between the normalized index (Heise and PDSI) values for years in the re-sampling base and normalized index values of years in the longer indicator record. Alternatively, years in the re-sampling base and years in the indicator record could be categorized, and years in the index record populated with model data sets of like-category years in the re-sampling base.

k. *Do we exclude the 1997 data?* I am generally reluctant to remove "outliers" as it is difficult to apply the concept objectively; however in this case it is probably justified. Removing it will reduce the representation of wet years in the proposed 1992-2001 re-sampling base, and some investigation is warranted into whether other wet years in the calibration period could be substituted for 1997.

l. *What do we do if the 1992-2001 period doesn't include a "full suite of conditions"?* The re-sampling base could be expanded to include earlier years or synthetic data for the 2002-2006 period (though the latter is obviously dominated by dry years).

m. *How do we ensure that the data set provides the correct long-term average recharge?* The long-term average recharge of the constructed (from indexes) data set will be determined by the recharge embodied in the re-sampling base and the sequence of index years used. The length and position of the sequence could possibly be adjusted to achieve the average found in the re-sampling base or some other average deemed more correct, though it may be desirable to fix the sequence to correspond to the current 30-year NWS "normal" period (1971-2000). Alternatively, the re-sampling base could be defined so as to present the correct long-term average as a whole and then other steps taken to insure that the re-sampling base is more or less equally represented in the constructed sequence.

n. *Can we do this?* We know we can't if we don't try. If we are objective and use sound science, we will have done the best we can.