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TO: Kari Kyler
Environmental Scientist
Bay-Delta Unit
State Water Resources Control Board

RE: Peer Review of Technical Reports on the Scientific Basis for Alternative San Joaquin River Flow and Southern Delta Salinity Objectives

As requested, I have reviewed the Technical Reports prepared by SWRCB staff and Dr. G. Hoffman with a focus on the science topics of concern supporting the proposed flow and water quality (WQ) objectives for the South Delta portion of the San Joaquin River system. My particular focus is on the salinity-related WQ objectives (issues #7, 8 & 9) and I provide some general comments on the other issues when able. Comments related to each issue are summarized below.

1. **Adequacy of the Technical Report's hydrologic analysis of the San Joaquin River basin comparing unimpaired flow with actual observed flows in representing changes that have occurred to the hydrograph of the san Joaquin River basin in order to provide background and support for the remaining chapters of the Technical Report.**
   Generally, this is a very informative set of chapters describing the SJR basin hydrology and the effects of reservoir development on major tributary flows. Overall the methods and analysis appear adequate in setting the stage for later chapters of the Technical Report. Though perhaps included in a general heading of "consumptive use" there is little if any discussion of the decreased annual sub-basin water yields associated with reservoir evaporation after about 1940. As reservoir development continued during the next several decades, presumably evaporation losses increased thereby progressively reducing sub-basin water yields and as a result, the estimated "unimpaired flows". Some discussion of how large this effect may be on the estimated unimpaired flows is needed. Similarly, though more explicitly acknowledged in the analysis, are the effects of climate change on (a) shift of the spring snowmelt period to weeks earlier on average during the past several decades alone, and (b) possible greater rain-snow variability in the Sierras and its affect on reservoir operation and ability to contain rain-on-snow flood events.

2. **Determine that changes in the flow regime of the San Joaquin River basin are impairing fish and wildlife beneficial uses.**
   This section appears to be clear and is beyond my expertise.

3. **Appropriateness of the approach used to develop San Joaquin River flow objectives for the reasonable protection of fish and wildlife beneficial uses and associated program of implementation.**
   This section appears to be clear and is beyond my expertise.
   Overall, this subject is difficult scientifically in terms of appropriate data collection and analyses. For example, the curve in Figure 3.8 on p.3-27 is practically meaningless given the few points available; perhaps this why no R^2 value is provided. I suggest simply eliminating the curve. In Figure 3.10, there is extremely low fish "escapement" from the Merced River during 1950-1968 that would seem to "skew" results. Is there any explanation for this dearth of salmon in this period? Is it real or an artifact of sampling? In Figure 3.11, there is clearly an increase in recovered salmon as a function of the number released as might be expected, but the statistical interpretation is strained. Basically, averaging the 2-3 data points per number released indicates that approximately 2.5% salmon 'recovery' at releases of ~50,000 and 2.8% 'recovery' at releases twice as great (~100,000), leading to the possible observation that for releases up to ~100,000 fish recoveries between 2.5-3% might be expected. The single point at large value release (~128,000) suggests a greater recovery fraction (~5%), but it is only one point. Given the wide variability in the recovery numbers, I suspect that these recovery fractions are not statistically different. Perhaps a different analysis is more appropriate here.

4. **Determination that more flow of a more natural spatial and temporal pattern is needed from the three salmon bearing tributaries to the San Joaquin River during the February to the June time frame to protect San Joaquin River fish and wildlife beneficial uses.**
   This section appears to be clear and is beyond my expertise.
   I concur with the overall geomorphic summary presented in Section 3.7.4 and that the processes identified support that the more widely variable flows suggested should enhance salmon habitat.

5. **Appropriateness of using a percentage of unimpaired flow, ranging from 20 to 60%, during the February through June time frame, from the San Joaquin River basin rivers as the proposed method for implementing the narrative San Joaquin River flow objective.**
   This matter is discussed in Sections 3.8 and 3.9 of the Technical Report and summarized in several tables and figures. The Report would be strengthened by inclusion of a summary table (see beow) after Table 3.20 that is based on the previous related tables and indicates the SWRCB's conclusions, or recommended flow rates to be met or exceeded each month of the year and with what frequency (% exceedance). From such a table, the figures in section 3.9 and selection of the

20-60% of unimpaired flows can be more readily comprehended. It would be helpful to assign monthly exceedence fractions to the general designations of "critical", "dry", "above normal" etc. water years to flows at Vernalis (e.g. Table 3.17 or from Figure 2.5 where wet years are ~0-30%, above normal years are ~30-50%, etc.). Basically, this comparison table might take the form below from which justification for use of the 60% fraction of unimpaired flows could be supported.

Table 3.2X. Summary of Above Normal (40, or 60% exceedance) water year San Joaquin River flows (cfs) at Vernalis for doubling of fall-run Chinook population from 1967-91 average.

Month	AFRP	TBI/NDC	CSPA/CWIN	SWRCB Rec.?*
March	5162	2000-5000	13,400	6000?
April	8157	20,000	7800	10,000?
May	13732	7000	11,200 to 1200	16,000?
June		2000	1200	12,000?

*Taken from Figures 3.16-3.19 for 60% of unimpaired flows at 40% exceedance.

6. **Appropriateness of proposed method for evaluating potential water supply impacts associated with flow objective alternatives on the San Joaquin River at Vernalis and the basin rivers.**
   This matter is discussed in Chapter 5 of the Technical Report and overall the basic mass balance approach seems appropriate. A section similar to section 5.2 describing the CALSIM model applicable to the discussion in Chapter 4 would be helpful at the beginning of Chapter 4. My primary technical concern on the WSE analyses and the previous discussions also in Chapter 4 is that a monthly time-step of total flows is used. Such a time step is incongruent with daily management decisions used for reservoir operation, irrigation diversions and probably the flows and salinity encountered by the fish; a daily time-step seems to be more relevant and a justification for the monthly time-step (beyond computing resource limitations) should be provided. In addition, the objectives call for running averages of *daily* means.

7. **Sufficiency of the statistical approach used by the SWRCB staff in the Technical Report to characterize the degradation of salinity conditions between Vernalis and the interior southern Delta.**
   This matter is discussed in Section 4.3 of the Technical Report and overall the basic mass balance approach is acceptable with the caveat noted above about use of a daily time-step rather than monthly may be more appropriate. In developing the Tributary contributions to delta salinity, EC-Flow relationships observed from the recent period (1994-2003) may not represent that from the un-impaired or pre-dam flow conditions. Realizing the lack of pre-dam data, this matter should be addressed with a general discussion of what the earlier period conditions may have been relative to the present. Also for the Tributary EC calculations (p. 4-4 & Table 4.2), use of the power function is okay; however, one might expect the power function coefficients to be similar for all three tributaries unless

dramatically different hydrologic/geologic conditions can be described for the Stanislaus as compared to the Merced and Tuolomne River sub-basins. Such power functions are sensitive to the data spread, especially at low values (flows). The very small R^2 value (0.18) for the Stanislaus River is practically meaningless and I suspect that use of K_s ~ 455 and b ~ -0.35, values more consistent with those for the other two tributaries, would result in an R^2 value not that much different and certainly no less significant. Overall, observed salinities at Vernalis are generally less than 1 dS/m suggesting that the proposed WQ objective will likely be met most of the time, including during periods of greater flow releases for fisheries.

8. Sufficiency of the mass balance analysis presented by SWRCB staff in the Technical Report for evaluating the relative effects of the NPDES permitted point sources discharging in the southern Delta.

This matter is discussed in Section 4.3 of the Technical Report and overall the basic mass balance approach is acceptable with the caveat noted above about use of the daily time step and the observations below about possible typos or discrepancies between the text and figures. On p.4-11 (1st paragraph) there is the observation that was implicit throughout Chapters 4 and 5 suggesting that "beneficial uses are affected more by longer term salinity averages" such that monthly values are used. As noted above this claim should be further justified and explained so as to better support the proposed objectives and how monthly averages (flow or salinity) can, or should be reconciled with daily measurements. Preferably, such a justification would occur much earlier in the Report.

9. Determination by the SWRCB staff that the methodology and conclusions in the January 2010 report by Dr. G. Hoffman, regarding acceptable levels of salinity in irrigation water, are appropriate for reasonable protection of agricultural beneficial uses in the southern Delta.

The Salt Tolerance Report prepared by Dr. Hoffman provides an excellent summary of the state of current knowledge about soil salinity impacts on irrigated agricultural production. The focus on moderately sensitive alfalfa hay production and sensitive bean production provide a good range from which to determine possible adverse salinity effects in Delta agriculture. Overall, I support his Conclusions in Section 6 and Recommendations in Section 7 and offer general comments on his Report below.

Since boron more readily accumulates in soils (not as readily leached as salinity), I concur with Hoffman's observation (pp. 7-8) concerning boron concentrations in irrigation diversions; this subject may require more investigation and appropriate water sampling or monitoring within the South Delta so as to separate possible toxicity effects from those associated with salinity.

I also agree with Hoffman's observations on (p. 21) the limited data available for determination of bean salt tolerance. This data is relatively old, based on greenhouse pot studies and bean varieties unlikely used today commercially. Field studies in typical Delta clay soils (dominant soil type) considering salt tolerance of commercially grown beans in the Delta are needed. Nonetheless, based on salinity thresholds for other “sensitive” crops grown in the South Delta (Table 3.1), salinities of 1 dS/m appear adequate.

Salt leaching of clay soils as outlined (pp. 28-30) suggest that effective leaching fractions can be limited or are reduced through preferential flow in cracks thereby reducing alfalfa hay yields. Extensive field studies in the Imperial Valley on Holtville and Imperial silty clay soils suggested leaching fractions of ~10% under ponded or border-check irrigated conditions (Grismer, 1990 & 1992; Grismer & Tod, 1994; Grismer & Bali, 1997). Thus, a leaching fraction of 10% would likely set a conservative lower limit in the steady-state salinity modeling employed by Hoffman. Similarly, a four-year study with alfalfa hay production on Holtville silty clay found that upward flow from saline shallow groundwater (water table) at a depth of 6 ft provided nearly 20% of the crop demand in the first year decreasing to ~5% as soil salinity continued to increase into the fourth year. A single cropping of corn following the alfalfa salinity study returned soil salinities to near pre-study conditions (Bali et al., 2001a & 2001b). Under similar field conditions, more shallow rooted sudangrass hay was found to use little shallow groundwater (Grismer, 2001; Grismer & Bali, 2001). Though the water table may be shallow in parts of the South Delta, providing adequate irrigation would limit upward flow contributions to crop water use wit the exception of possibly alfalfa hay when water stressed.

The relatively large leaching fractions apparently occurring in the South Delta clay soils of ~25% suggest that current water use and irrigation is adequate to maintain soil salinity conditions within acceptable ranges (Tables 3.10 & 3.11). The very low leaching fraction values of ~10% are similar to those found for heavy clays of the Imperial Valley under alfalfa hay production and supported in the modeling efforts here. Hoffman quoting Letey (p. 67) suggests that most irrigation strategies are such that irrigations occur when soil-water contents decrease by half, thereby doubling the soil-water salinity concentration should likely be verified. My experience with deficit irrigation suggests reductions to about one-third the maximum soil-water content implying a salinity concentration by a factor of three rather than two. Of course, this affects the modeling assumptions of section 5.1.2, but at the large leaching fractions (>20%) for row or truck crop production encountered in the South Delta, such deficit irrigation is unlikely and soil-water salinity concentrations would be in the range suggested by Hoffman’s modeling results (section 5.2.1). I concur that salinity affects at the proposed EC objective are not expected to adversely affect alfalfa hay production as outlined in section 5.2.2.

The ability of Delta growers to maintain high leaching fractions into the future as competition for water resources intensifies and climate change adds hydrologic uncertainties suggest that some of these issues be regularly re-visited within an Adaptive Management framework as outlined below.

10. Other issues – General remarks.

Overall the Technical Report fairly describes a workable methodology and support for assessment of the proposed water quality and flow objectives for the

San Joaquin River at Vernalis. Presumably these objectives are considered within an Adaptive Management context that not only identifies the goals of these objectives (e.g. beneficial uses for irrigated agriculture, doubling salmon populations etc.) and outlines the knowledge limitations and gaps, but also sets out the monitoring required to determine if the beneficial use goals are achieved and additional knowledge gained, as well as the possible revised management strategies (flow and water quality objectives) that should be developed and possibly implemented. Of course, Adaptive Management is a continuous process that requires regular and focused monitoring, use of management "triggers" should target goals not be met and continued knowledge acquisition (critical towards accommodating say climate change effects as they arise).

Noted Typos:
p. 3-5; 4th para. mmnos to mmhos
p. 3-17; 2nd para. last sentence appears to be missing a phrase, has extra comma
p.4-7; Figure 4.6. the text and the figure are mis-labeled – 20% not 40%
p.4-11; Figure 4.12. the figure labeling is incongruent with the text above (2nd para). The 3-point source load should be a constant based on maximum allowed WWTP discharges and salinities. Suspect that the graph should be re-labeled, or discussion above changed.
p. 4-13; item j. last line should read "which lead to higher estimates of soil water salinity"
p. 5-2; Table 5.1. mis-spelling of New Don Pedro
pp. 5-9 to 5-11; Figures 5.3-5.5, as CALSIM is also a model, perhaps the better word to use is "calibration" to CALSIM rather than "validation".
In Hoffman Report, p.65, Table 4.1, appears to be a missing value for Oat Lr for 2EC model, 0.0X?

Citations

Bali, K.M., Grismer M. E., and R. L. Snyder. 2001a. Alfalfa water use pinpointed in saline, shallow water tables of Imperial Valley. California Agriculture 55(4):38-43.

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Grismer, M. E. 1990. Leaching fraction, soil salinity, and drainage efficiency. California Agriculture 44(6):24-27.

Grismer, M.E. 1992. Cracks in irrigated soil may allow some drainage. California Agriculture 46(5):9-12.

Grismer, M.E. and K.M. Bali. 1997. Continuous ponding and shallow aquifer pumping leaches salts in clay soils. California Agriculture 51(3):34-37.

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Grismer, M. E. and I. C. Tod. 1994. Field procedure helps calculate irrigation time for cracking clay soil. California Agriculture 48(4):33-36.