Al Leydecker, PE, Ph.D.

Environmental and Engineering Consultant
Registered Professional Engineer No. 44831

3740 Alcamo Place, #A
Santa Barbara, California 93105
805-569-1748

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RE: comments on the TetraTech water quality modeling proposal

Sir:

Just because a model can simulate nutrient fluxes does not mean it can do so accurately. Or even usefully. I'm reminded of Shakespeare's Henry IV, part 1:

Glendower: *I can call spirits from the vasty deep.*

Hotspur: *Why, so can I, or so can any man; But will they come when you do call for them?*

The water quality modeling problem for the Ventura is complicated since it not enough to merely simulate nutrient fluxes. To be of practical use, the model must simulate these fluxes, and how they vary, during the algal growing season. Since this season only occurs after winter rainfall is past, all the emphasis placed in the proposal on build-up/wash-off processes as the heart of the model would seem to be a total waste of time. Unless, of course, these results will be used to directly estimate water table nitrogen concentrations.

Predicting storm-produced, winter nutrient fluxes on the Ventura River is totally irrelevant to the algal problem. After all, it is groundwater inflows, and the nutrients they transport, that directly fuel algal production during the dry season. The only exception pertains to reaches below the wastewater treatment plant (WWTP) where treated effluent is the dominant source – except, ironically, during peak algal years. And since the WWTP nutrient flux is directly measured, modeling these reaches would seem to be unnecessary.

In the report's section on Model Implementation it's stated that "*The subsurface (groundwater) load of a pollutant is simulated in HSPF as the subsurface flow times a user-specified concentration.*" This would seem to indicate that there is little intention of using the model to estimate groundwater concentrations, or how these concentrations might vary from year to year. The heart of the matter would seem to lie in how TetraTech intends to derive these "user-specified" groundwater concentrations (which remains unmentioned). Will it be based on some recognized and acceptable scientific procedure or be simply an exercise in wish-fulfillment on the part of the modeler?

Another criticism I would offer is that the proposed hydrochemical modeling will be based on gross over-simplification of the actual Ventura situation. An over-simplification bound to produce incorrect results; which, in turn, could easily lead to miss-informed regulatory strictures in the final TMDL. To quote Shakespeare again, from Hamlet:

There are more things in heaven and earth, Horatio, than are dreamt of in your philosophy.

The Ventura algal problem results from a nexus of three factors: flow, nutrient concentrations (usually nitrate or nitrogen), and vegetative succession on the river. The story goes like this. Algal development and growth is at its highest and most obnoxious following big winters – and by big I mean winters with above-average rainfall, rainfall which includes at least one river-scouring storm. These winters provide near ideal algal habitat: (1) open waterways devoid of competitive aquatic plants and other vegetation; (2) plenty of sunlight; (3) coble and gravel river bottoms free of fine sediment for strong and easy algal attachment; (4) increased algal habitat from higher dry-season flows; and, last but not least, (5) these higher flows will be coming from recently recharged groundwater reservoirs with above-normal nitrate concentrations. In contrast, low rainfall winters, especially winters without a scouring storm, (1) leave aquatic plants in place allowing them a completive advantage in the quest for both sunlight and nutrients; (2) result in a narrower, more restricted, stream with less opportunity for algal growth; (3) greatly decreased flows; and (4) reduced nitrogen inputs and fluxes.

Below-average rainfall years are a lot more common than above-average years since the annual rainfall distribution is skewed towards lower values. And should one below-average year succeed another below-average year (which it often does), all the factors that mitigate *against* excessive algal growth noticeably increase and algae rapidly cease to be a problem in almost all reaches – especially in those reaches specifically listed for algae as a water quality limiting problem in this TMDL. This, of course, is nothing new. I keep trying to make these same points over and over in the seemingly countless reports I've been writing since this TMDL process began.

To illustrate the dry-year/wet-year differences, and how plant succession plays a vital role in whether or not there is an algal problem, I've included two sets of photos taken at Channelkeeper sampling points on reaches 2 and 3. You will note that in 2004, a year with below-average rainfall (8 inches below average at Ojai) algae were not a problem since almost no open water was available for algal growth – aquatic plants covered almost all of the water-way. But in 2005, a year with far above average rainfall (23 inches above the Ojai average), dry-season algal growth proved to be truly impressive.

As the TetraTech report points out, Reaches 1 and 2 are listed for algae, not nutrients. The report gets around this by conflating algal density with increasing nutrient levels – more specifically, nitrogen as the limiting nutrient – as if an increase in one was synonymous with an increase in the other. However, in these reaches this relationship not only breaks down, but is invalid. Nitrogen levels on the lower Ventura River were higher in 2004 – a year with no significant algal problem – than they were in 2005 – a truly spectacular algal year; nitrogen concentrations were twice as high in the reach directly below the wastewater treatment plant (WWTP). Nitrogen levels below the WWTP are *always* higher in below-average rainfall years because less upstream flow is available for dilution of plant effluent, yet these are *always* years without significant amounts of algae.

This brings me to another point I keep trying to make: We do have over-enrichment problems in various reaches of the Ventura watershed. This nutrient over-enrichment sometimes expresses itself as an algal problem, but more often than not it doesn't. On the lower river it most often expresses itself as excessive growth of aquatic plants.

Elsewhere, San Antonio Creek being the prime example, it expresses itself as *neither* an aquatic plant *nor* an algal problem thanks to the blessings of riparian shade.

The real problem is that algae are not really the problem, but only one symptom of the problem. And not a very reliable symptom at that. Although it's not TetraTech's responsibility, if you begin with an inaccurate statement of the problem it's not very likely that you'll come up with a satisfactory solution. And since nutrient concentrations and fluxes on the Ventura system are actually conflated with flow (due to the high inter-annual variability of rainfall in this region) and not with algae, questions concerning pumping and water diversions should also not be considered separately.

I've commented below on specific paragraphs in the report that seem to have particularly raised my ire. In conclusion, I don't believe that the modeling effort will result in any useful results for this TMDL. First, because I'm not convinced a realistic hydrochemical model is possible given the present state of the science. And second, because the TMDL, as proposed, is envisioned as regulate algae and, as I've tried to stress, there is no strong correlation between algae and nutrient concentrations (I've included a copy of a graph, from the report mentioned in the next section, as Figure 1 to illustrate this point).

However, I'm not against continuing with a model if it is done in a dynamic, time-step, mode (at least monthly; a steady-state model being completely useless given the inter-annual and seasonal variations that I've tried to point out). One shouldn't look a gift horse in the mouth and, as Channelkeeper has very good monthly nutrient data for the Ventura system, and as Ventura County flow has reasonable flow data, it will be very interesting to see how close the model approaches reality. I might even say I'm looking forward to it.

Sincerely,

Al Leydecker

Specific Comments:

Page 6, paragraph 7: Ventura Stream-team estimates of algal cover are based on nothing more than the subjective opinion of the individual making notes. That particular individual usually varies from month to month and there are no objective standards (such as "typical" photos representing various ranges of percent cover to be used as a guide) nor are there any specific guidelines or training for observers. In addition, plant cover is sometimes assumed to be algal cover; the best example being patches of duckweed. "Green" is often miss-interpreted as algae. As a result these data should not be used for any analysis or modeling. On the positive side, there is an extensive collection of monthly photographs covering most of the problem reaches, beginning in 2001-02 for Reach 1 and 2 (a later starting date for other sections) and extending to the present, that would lend themselves to a more objective analysis of percent cover. This, of course, would require further cost and effort.

Interestingly (and irrespective of how bad the data is), the plots in Figure 3, contrary to the report's basic assumption that percent algal cover should decrease with increasing flow, do correctly show a correlation with higher flows. This comes about because high flow years – which follow winters with above average rainfall – produce the most extensive algal growth on the river. In contrast, low flow years – following low rainfall winters (and below average rainfall *is* the typical condition) are characterized by low algal densities. I would also point out that flows during the algal season are almost invariably lower than 180 cfs – very much lower. Higher flows occur only during the winter when algal growth is either totally absent or negligible. Even with no questionable data, and perfect representation of the wide variety of actual conditions, there would be no simple relationship between percent cover and flow. (However, the 180 cfs figure did engage my curiosity and I calculated how many days daily Foster Park flow exceeded this amount from October 1, 2000 to September 30, 2009. It turned out to be 112 days: 12, 0, 1, 2, 74, 11, 0, 12 and 0 from water-years 2001 to 2009, respectively. 2001, 2005, 2006 and 2008, or 12, 74, 11 and 12, were the big algal years.)

Page 6, paragraph 8: Although these data did show a strong relationship between Chl-a and total nitrogen they are not without their problems. While there is a general relationship between Chl-a and nitrogen it is not as well-defined as the UCSB report indicates (see Figure 1). I comment on this in a report titled The Chl-a vs. TDN relationship, available as a download from
http://sbc.lternet.edu/~leydecke/Al's_stuff/Ventura%20Nutrient%20TMDL/My%20PDF%20files%20on%20algae%20&%20nutrients/

(All studies and reports that I have personally authored on the proposed Ventura TMDL are available at this location.)

However, despite my reservations, since these data, and data collected by Julie Simpson and myself in 2003 (see the above mentioned report and another titled Chl-a Back in 2003), represent the total of all scientifically collected and estimated Chl-a and percent cover data collected in the watershed, not including them in the TetraTech model would seem to be a serious mistake. I also wonder why no mention of the 2003 data which do fall within the proposed simulation period? And why no effort to include these data in the modeling effort?

VR01, Main Street Bridge: looking upstream: Feb. 2, 2005 (upper), Oct. 2, 2004 (lower). I would point out that algae were not a problem in this reach in 2004 (8" below average rainfall), but were a significant in 2005 (23" above average rainfall) even though nitrogen concentrations were 10 % higher during the 2004 dry-season..

VR03, Shell Bridge: looking upstream: Feb. 2, 2005 (upper), Oct. 2, 2004 (lower). The same situation existed here. Algae were obviously not a problem in 2004, but were in 2005; nitrogen concentrations at this location, closer to the WWTP, were twice during the 2005 dry-season as they were in 2005.

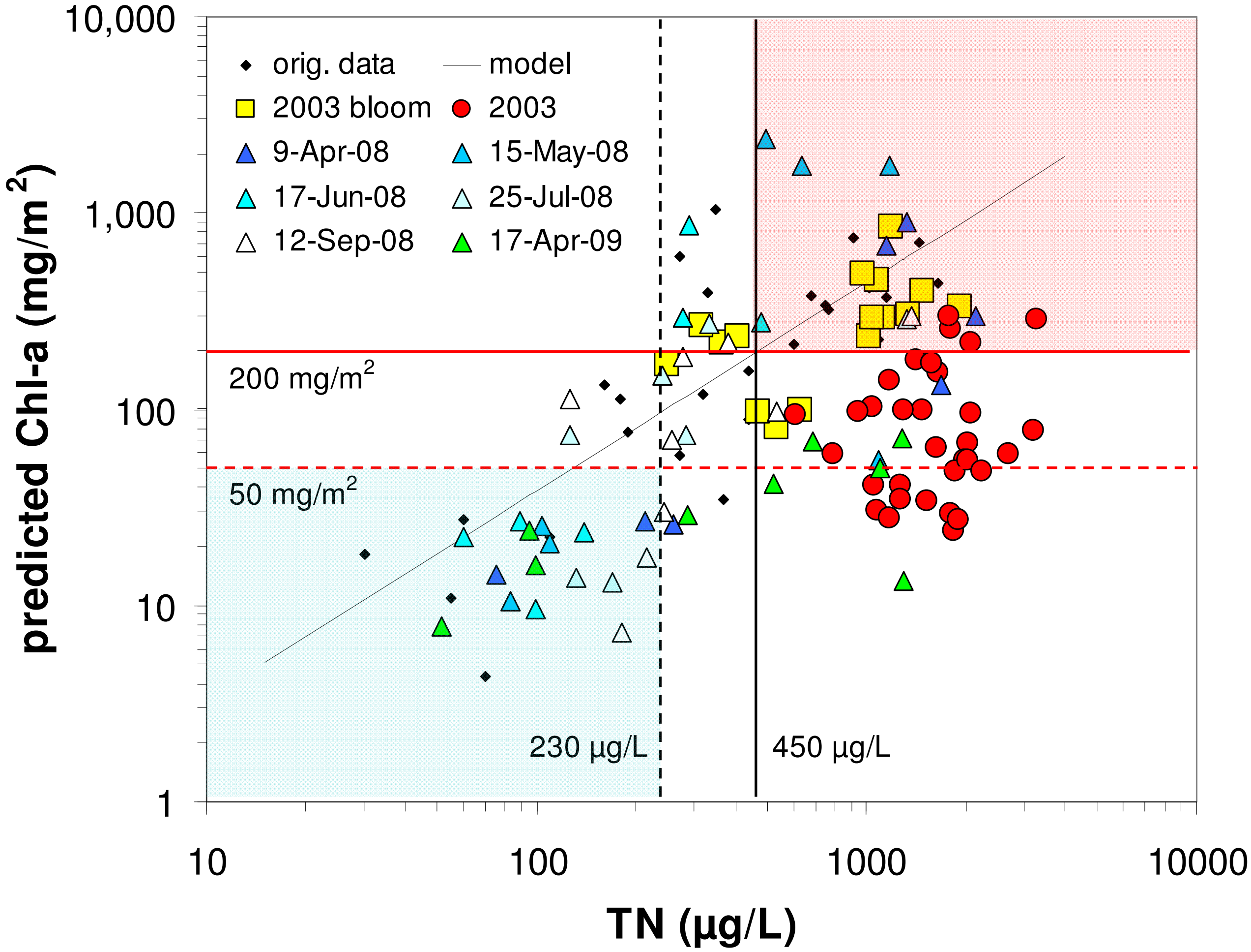

Figure 1. Estimated and measured chlorophyll-a densities (Chl-a) are plotted against total nitrogen concentrations (TN). The black dots and line represent Kristie's original 2008 data and the regression model derived from that data. Measured Chl-a values from 2003 were sub-divided as explained in the text: "bloom" signifying Cladophora as the dominant species, with the remaining data collected from aquatic plant dominated environments. Chl-a estimated from diel measurements of delta-DO and flow are shown as triangles identified by the date of data collection. The graph also shows the recommended impairment thresholds for Chl-a (50 and 200 mg/square-m) and total nitrogen (230 and 450 µg/L) as red and black lines – dashed for the lower threshold below which no impairment exists, solid for the upper threshold above which a reach is definitely impaired. Colored areas delineate the region of *both* algal and nitrogen impairment in red and the region of no impairment in blue. The majority of data now fall within the white areas that define "further study" for possibly excessive amounts of either nitrogen or algae (Chl-a), or both. Note the wide range of Chl-a values that have been found in locations where total nitrogen concentrations exceed 1000 µg/L: Chl-a varying between 10 and 2000 mg/m^2. It should be emphasized that all these points represent the same handful of locations. Indeed the range would be even greater were data from an unbiased selection of high-nitrogen locations included. Sites in narrow, shade-dominated reaches were excluded from the 2008 dataset – the emphasis being placed on surveying algae where they were and not where they weren't. Ironically, the only shade dominated or partially shaded locations included in the UCSB survey were low-nitrogen reference sites, which may have further biased the initial Chl-a vs. TN results.