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Date: 27April 2017

Re: Peer review of draft Basin Plan Amendment to incorporate Total Maximum Daily Loads (TMDLs) for selenium in freshwater, Newport Bay Watershed, Orange County, CA

Summary:
This review is my response to request of the Santa Ana Regional Water Quality Control Board (Regional Board) for peer review of the scientific portions of a proposed Basin Plan Amendment (BPA) to incorporate Total Maximum Daily Loads (TMDLs) for selenium (Se) in three freshwater tributary subwatersheds in the Newport Bay watershed (San Diego Creek, Santa Ana-Delhi Channel, and Big Canyon Wash subwatersheds). It is my task to provide comments on the Draft Staff Report (2017) (Draft Staff Report 2017) and Draft Basin Plan Amendment (Draft Basin Plan Amendment - New Chapter 6 2017). My comments below follow the format of The *Description of Scientific Assumptions, Findings, and Conclusions to be Addressed by Peer Reviewers* (Attachment 2 2017).

Note when I allude to "Sections", I refer to Sections, also called "Chapters" in the Table of Contents in the Draft Staff Report (Draft Staff Report 2017) or the Draft Basin Plan Amendment (Draft Basin Plan Amendment - New Chapter 6 2017). When I allude to "Conclusions", I refer to information in The *Description of Scientific Assumptions, Findings, and Conclusions to be Addressed by Peer Reviewers* (Attachment 2 2017). My review is focused mainly on Conclusions 1 to 8, and 11, however, I include some comments about Conclusions 9, 10, and 12. It is my job to evaluate the assumptions, findings, and conclusions in the proposed TMDLs.

Overall evaluation:
To be scientifically defensible, future use of the biodynamic model needs to include quarterly rather than annual monitoring of whole-fish tissue and a minimum sample size of three species. Bird egg tissue can only be collected annually. Whenever possible, sampling should include at least three bird species. As the monitoring plan is now written, as few as one annual sample from one fish and one bird at five field sites is planned. The **assumption** that this plan is adequate is incorrect biologically and in terms of being scientifically defensible. Other recommendations to adaptive management protocols are discussed below.

The fundamental **assumption** that using the biodynamic model, which bases TMDL targets on past tissue concentrations in whole-fish tissue and bird egg tissue rather than total or dissolved Se water

concentrations, is scientifically sound. The biodynamic model provides the highest probability of accurately assessing exposure and biological consequences because the biological availability of selenium (Se) depends on Se speciation that varies among watersheds. Among watersheds, distinctions in water temperatures promote higher solute concentrations (due to evaporative water loss). Both higher solutes and warming temperatures can lower dissolved oxygen levels. Low oxygen levels in the water column decrease redox at, and just below, the sediment-water interface where low redox promotes microbial production of selenomethionine, which is highly bioavailable (Stewart et al. 2010). Moreover, total inputs of solutes vary among watershed.

The **findings** that underlie the biodynamic model are sound and described in detail in the *Revised Newport Bay Biodynamic Model Runs Documentation* (Draft Staff Report Appendix O 2016) as well as peer reviewed scientific publications (Luoma and Rainbow 2005, Luoma and Presser 2009). Regulatory tissue values are based on the most current scientific knowledge available for the relationship between tissue concentrations and subsequent biological responses.

The implementation timeline for compliance in the proposed three-part, phased TMDL is reasonable in terms of logistical concerns and adequate time for changes in effluent inputs to be reflected in the biota within the watershed (Table 6.1) (Draft Basin Plan Amendment - New Chapter 6 2017). The structure of the TMDL Reconsideration step is vague. To be scientifically defensible, clean protocols are needed that determine when additional parameters or factors are required. As above, it is not scientifically defensible to assume that the tissue sampling frequency and tissue size are adequate to serve as the basis for future site-specific objectives (SSOs).

I support the conclusions below if and only if sampling frequency of whole-fish tissue is increased to quarterly and sample sizes are mandated at a minimum of three species for fish and bird egg tissue. Also, the number of sites for tissue monitoring is not internally consistent. Appendix R lists five sites but Appendix T lists six (Draft Staff Report Appendix R 2016, Draft Staff Report Appendix T 2016). Other caveats and concerns are discussed below.

Comments on Specific Conclusions:

Conclusion 1 (Staff Report: Sections 4, 4.1, 4.1.1, 4.4).

The most current available information informed the decision of the Regional Board staff to select the chronic criterion for Se in whole-body fish of 8.1 µg Se/g dw as the recommended numeric target for Se in fish. This is the most protective chronic criterion of three tissue-based targets recommended by the USEPA's 2014 Draft Criterion.

Although the whole-body fish concentration of 8.1 µg Se/g dw is suggested as protective of fish health, Appendix I states that the toxicity threshold for fish ranges from 4 to 6 µg Se/g dw (Draft Staff Report Appendix I 2016). This suggests that the fish tissue numeric target of 8.1 µg Se/g dw is a compromise. A brief statement about fish fecundity or other aspects that make this level acceptable would be helpful.

The assumption that monitoring whole-body Se concentration in fish rather than fish eggs is scientifically and logistically sound. The method will encourage compliance since gravid female fish are seldom collected in the Newport Bay watershed.

Conclusion 2 (Staff Report: Sections 4, 4.1, 4.1.2, 4.4).

Based on various feeding studies and the references cited, the conclusion is sound that a fish tissue numeric target of 5.0 µg Se/g dw will meet the essential dietary needs of shorebirds will little likelihood of reproductive effects. The conclusion is based on findings that the biodynamic model takes local Kds into account to show that even endangered species are protected in the three watersheds under consideration (Draft Staff Report Appendix O 2016).

Conclusion 3. (Staff Report: Sections 4, 4.2, 4.4)

The assumptions underlying the proposed regulatory bird egg tissue concentration are scientifically sound for the following reasons: 1) background concentrations of <5 µg Se/g dw in bird eggs; 2) effect levels in black-necked stilt eggs range from 6-7 µg Se/g dw to 14 µg Se/g dw; 3) a range of 3-8 µg Se/g dw provides reasonable no effects concentrations; 4) EC_{10} values overlap with no effects concentrations in many datasets; and 5) expert opinion judges 8 µg Se/g dw egg concentrations as protective of bird species in Newport Bay watershed, including federally listed least tern and Ridgway's rail. Points 1 and 2 illustrate the knife-edge between Se essentiality and toxicity and identify that boundary to the best of our knowledge.

Conclusion 4. (Staff Report: Section 4 and Table 4.3)

The assumption that it is sound conservation strategy to base the attainment of the bird egg target as the ultimate protective target for each watershed's TMDL is based on scientific findings and precautionary principles. As noted, in some instances managers must apply a more stringent fish tissue target if the bird egg tissue level of 8 µg Se/g dw is not met. Moreover as stated in the proposed Draft Basin Plan Amendment (2017), the more stringent TMDL will also better protect fish.

Conclusion 5. (Staff Report: Sections 4, 4.3, 4.4)

The initial sentence in Conclusion 5 is based on scientifically sound assumptions. Although water column concentrations of Se differ for lotic and lentic waterbodies and cannot be tied to selenium effects, until tissue-based criteria are adapted, the 5 µg Se/L water concentration is a reasonably protective numeric target.

I suggest that the timeline in the Draft Basin Plan Amendment (2017: Table 6.1, Se. 2) be placed at the beginning of the Draft Basin Plan (2017) Some of the narrative is unclear and seemingly contradicts itself mainly because a timeline for implementation for the shift from the CTR chronic criterion to the Se TMDLs is buried in narratives. For example, the text states that, "Until tissue-based objectives are approved, the CTR chronic criterion [of 5 µg Se/L] for selenium in freshwater must serve as the final numeric target for Se…for the Newport Bay watershed." In the second paragraph, the narrative states that "…at this time these selenium TMDLs do not incorporate USEPA's recommended water column

elements as a TMDL numeric target. Instead the TMDLs use site-specific data and modeling to translate tissue targets into appropriate surrogate water column concentrations…"

Conclusion 6. (Staff Report: Section 6, 6.1, 6.2; Appendices N and O)

The assumption of linkages from sediments into the food webs captured by the biodynamic selenium model is scientifically sound with a very high probability that accurate Se water concentrations can be estimated from tissue concentrations and vice versa because: 1) It was based on all available data for the three subwatersheds under consideration. (i.e., data on water, sediment, algae, suspended particulates, fish, and bird egg tissue); 2) Thus, we can assume that site-specific, local variance is included in species-specific trophic transfer factors; and 3) The duration of sampling from 1999-2007 followed by targeted sampling from 2008 to 2014 is adequately long to have accurately captured the lag time between Se concentrations in water and tissue concentrations in fishes and birds via food webs.

Conclusion 7. (Staff Report: Sections 6, 6.2, 6.2.4; Appendix O)

I support the assumption that biodynamic model development is scientifically sound. During model development, managers represented site-specific conditions based on a variety of findings: 1) Using a range of water-shed specific partitioning coefficients and trophic transfer factors; 2). Basing the model on either direct measures or metadata collected for Newport Bay and the San Diego Creek watershed from 1999-2007 with targeted data from 2008 to 2014 collected within the three subwatersheds; and 3) altering model parameters after verifying that predicted values were comparable to observed tissue concentrations.

Conclusion 8 (Staff Report: Sections 6, 6.2, 6.2.5; Appendix O).

I agree with the assumptions, findings, and conclusions in this section. Clearly, the ecology of the animals was understood and considered in model development—a factor that is often ignored. For example in applying the biodynamics model, the validity exercise indicated that fish tissue was a more reliable indicator of environmental exposure than bird tissue because of bird mobility and different feeding preferences among birds. Also, modelers recognized that because of sediment-detrital feeding by mosquito fish the model design for Big Canyon Wash should directly link fish tissue concentration using the Kd rather than the invertebrate trophic transfer factor. The discussion on water column concentrations demonstrates situations in which water concentrations are not predictive. For example, in the UCI wetlands Se levels in fish are below the tissue target. Whereas, in the Santa Ana-Delhi Channel, fish tissue Se over predicted the water column Se. Regardless of nuances in fit, or the desire to use the model to predict water column concentrations from tissue concentrations, Se levels in water must be made consistent with the conservative target of 5 µg Se/g dw in fish tissue, if the bird tissue target is not met.

One concern is that language specifying the timing of monitoring is not explicit in Section 8.5.3, Assessment Area Monitoring. Basing regulation on Se tissue levels in eggs is biologically irrelevant (i.e., ineffective) if monitoring does not take place during the breeding season. Some sections state that monitoring must take place during the dry season (1 April to 30 September), other sections do not. I

recommend that wording throughout for the Resolution R8-2017-0014. For example, in Section 8.5.3.1 consider changing "should" to "must" for the TMDL Evaluation Monitoring *"Bird egg collection **should** be conducted during the nesting season (generally March through August). Fish collection **should** be at the same time of year to capture the potential effects of fish as bird dietary items and for effects to spring fish reproduction (common timing for most of the target species)"*.

Conclusion 9. (Staff Report: Section 7).

While the guidelines for the Tiers of sampling and frequency of sample collection are included in the Appendix A of Appendix R, (See Text above and Table 2. *Summary of Monitoring Constituents*), those details are needed in the body of the Draft Staff Report. I am sensitive to the desire of the Regional Monitoring Program to be flexible, particularly in areas such as the Santa Ana-Delhi where no birds are found nesting. The text needs a table describing sampling even though it includes guidelines stating that the WLAs are tied to sampling requirements for NPDES permits, and that permits differ among locations (USEPA 2010), and that quality assurance / quality control must meet the California's Surface Water Ambient Monitoring Program (SWAMP). To avoid confusion among regulators searching for the information, I recommend including a table of QA/QC requirements and the specific benchmarks that determine whether sampling is sufficient to evaluate targets. Obviously, collection of bird eggs can only occur during the dry weather period and may be impossible if only endangered species occur, but fish can be sampled year round. The specific passages that concern me begin on page 8-25, at Section 8.5.3.1 (Draft Staff Report 2017):

> The frequency of sample collection must be sufficient to evaluate the WLAs and LAs (including the seasonal evaluation) and must be specified in the Regional Monitoring Program.
>
> The frequency of sample collection must be sufficient to evaluate the tissue-based numeric targets, provided sufficient samples can be collected during target sample collection times, and must be specified in the Regional Monitoring Program. At a minimum, an attempt to collect samples must be conducted annually in each assessment area.

Current wording indicates that compliance could be based on only one sample per year to be increased to two if targets are not met.

As suggested, **quarterly** sample collection of fish tissue should be separated into the fall and winter months (1 October to 31 March) versus the dry weather period (1 April to 30 September) because the influence of groundwater during the dry period increases Se concentrations in water. The dry period also coincides with breeding and development of offspring.

Conclusion 10.

The assumption that monitoring is adequate is met for all compartments **except** tissue analyses. Guidelines for TMDL Evaluation Monitoring and BMP Effectiveness Monitoring are described (e.g. must comply with NPDES permits). As stated above, I recommend including a table describing the timing and criteria for determining whether sampling is adequate. I strongly disagree that collecting a single annual sample is an acceptable minimum for determining that TMDL criteria are met.

Conclusion 11.

If and only if future monitoring of whole-fish tissue is performed quarterly and whenever possible, bird egg tissue annually with a minimum of three fish species, then I agree with Conclusion 11, which is based on the assumption that target TMDLs within each watershed will be selenium SSOs that differ depending on whether numeric targets for the recommended fish tissue and bird egg tissue concentrations (section 4.0 in the Draft Staff Report (2017).

The numeric values for fish and bird egg tissue "are currently under development" and the TMDLs discussed herein "have been purposefully structured as Phased TMDLs to account for the regulatory flux of selenium standards at the federal, state, and local levels throughout the drafting, establishment, and implementation of these TMDLs" (Section 4.1 in Draft Staff Report (2017). In other words, depending on tissue Se concentrations during monitoring, adaptive management practices will include TMDL Reconsideration of the Kds, and TTFs in each watershed, which could alter compliance targets for water TMDLs.

I strongly recommend that the thresholds for assessment criteria (e.g. lack of reduction in Se input to the watershed) and acceptable timing for compliance in the essential data that is the basis for the Se TMDL and for the SSOs (e.g. future tissue concentrations) be stated explicitly, preferably in a table format so it is easy to find.

The fundamental idea that SSOs be established according to site-specific Kds and TTFs is based on sound scientific reasoning (Stewart et al. 2010, Draft Staff Report Appendix O 2016). My concerns are that these documents do not always explicitly state how acceptance criteria are ranked among the quantitative numeric targets. For example, the USEPA 2014 Draft Criterion stated in footnote 2 that fish tissue, "overrides any water column element when both fish tissue and water concentrations are measured" (Table 4.1 in the Draft Staff Report (2017). The same protocol is inferred on page 4-6, Section 4.1.1 in the Draft Staff Report, however, as discussed above the document states that the TMDLs are in a "regulatory flux" during the Phased establishment of this TMDL. Clear criteria for changing the target TMDLs are needed.

If future bird egg concentrations exceed the proposed target of 8 µg/L, it is clear that tissue targets for fish will be set at 5 µg/L. What is not clear is the timeline by which fish tissue must meet this target, or what actions occur if the compliance timeline is not met. Finally, if the biodynamic model is used to recalculate target water concentrations, the timeline for establishing and enforcing new SSOs is unclear.

The future monitoring protocol for tissues must be improved for the SSOs. Based on what I have been able to glean, both fish and bird egg tissues will be collected only once per year. First, the assumption that annual monitoring of Se tissue concentrations in fish and bird eggs is adequate is not biologically sound or scientifically-defensible policy. Moreover, unlike the USEPA 2014 Draft Criterion (Table 4.1 in the

Draft Staff Report (2017), which states that fish whole body concentrations can never be exceeded, the proposed TMDL is based on the geometric mean of samples. The geometric mean of fish is not adequately protective, particularly if tissues are monitored only yearly using the tiny sample sizes discussed below.

In Section 4.5.2 on page 25 of Appendix A within Appendix R, contains a description of sample sizes for fish and bird egg tissues.

> *"4.5.2. Numbers of Tissue Samples. The targeted numbers of samples for fish tissue analysis should be up to three samples of composited, whole-body fish, consisting of five similar-sized, same-species fish per sample for up to three fish species (up to nine composited fish samples per site). In addition, fish eggs and ovaries from gravid females may be analyzed if USEPA adopts selenium water quality criteria that are based on selenium concentrations in fish eggs and ovaries.*
> *For bird eggs, up to eight bird eggs per site for up to three species should be analyzed. Only one egg can be taken from each nest. In the case where only one egg is in the nest, no sample will be taken.*
> *In general, for both bird eggs and fish, the total number of tissue samples per year is expected to be less than the theoretical maximum number of samples because many of the sites are limited in biota abundance, diversity, and/or accessibility."*

Thus, the SSOs for the three sub-watersheds could be based on as few as one annual sampling of one analytical sample ("up to 3 samples of composited, whole-body fish") possibly from only one fish species ("up to three fish species") could be collected annually. Similarly for bird eggs, as few as one egg from one bird species ("up to eight bird eggs per site for up to three species"). Five sample sites are proposed for Tier II, III, and IV sampling (Tier IV is tissue and algal sampling) but subject to change as needed.

Looking at Appendix T, I see that out of many millions of dollars spent, the annual analyses for fish and bird egg tissue—the linchpin upon which the TMDL rests for the SSOs—is ~$30,000 annually excluding labor. For decisions to be scientifically defensible, increase this component of the budget to cover costs of monitoring fish tissue quarterly and bird egg tissue annually.

Basing draft criteria on the USEPA's criteria is an excellent approach (see p 4-5 in (Draft Staff Report 2017). The biodynamic model protects non-piscivorous birds because invertebrates contain less Se than fish in the same system (i.e. one lower TTF) (Draft Basin Plan Amendment - New Chapter 6 2017). Similarly, any additional tissue accumulation of piscivorous fish is implicitly considered by the fish tissue numeric target of 8 µg Se/g dw.

More description for establishing SSOs is needed where invertebrates only are sampled. Invertebrates may not be valid surrogates because "contaminated sites have found effects on fish and birds in the absence of changes in invertebrate assemblages" inferring greater tolerance for Se (Draft Staff Report Appendix C 2016).

I applaud the inclusion of the Draft Basin Plan Amendment as a new Chapter 6, primarily because of its excellent description of the biodynamic model with a listing of K_ds and Trophic Transfer Functions (TTFs) for the proposed TMDL (Draft Basin Plan Amendment - New Chapter 6 2017). The timing for TMDL implementation and compliance is clear and reasonable (Table 6.1. Se.2). However, what are the protocols for enforcing compliance if TMDLs exceed the SSOs (see p. 25 in the Draft Basin Plan Amendment)?

Conclusion 12

The assumption that relying on the biodynamic model for establishing Se TMDL is scientifically sound for the site specific constraints of the Newport Bay watershed because: 1) water Se concentrations do not correlate will with ambient tissue concentrations in fish and bird eggs, 2) fish tissue in San Diego Creek over predicted bird egg tissue, 3) In Santa Ana-Delhi, fish tissue over-predicted water column Se concentrations, and 4) In Big Canyon Wash, bird egg tissues all exceeded 5 µg/g dw. Thus, its WLA and LA levels were established at 1 µg/L.

The big picture

Here are a few final considerations.

1. One additional benefit of quarterly monitoring of whole fish tissue is capturing differences in Se bioavailability due to interannual variability in climate.
2. What is the status of monitoring sites? The narrative indicates that monitoring sites were chosen because they constitute suitable habitat for aquatic organisms and for aquatic-dependent birds, and yet, no birds were nesting in the Santa Ana-Delhi watershed. This brings up two issues.
    a. The area is highly urbanized and thus, may never provide suitable habitat. In the short term, for the purposes of this TMDL for Se, it makes sense that when bird egg tissue is not available, tissues from surrogate parameters (e.g., macroinvertebrates, reptiles, amphibians) are used. Wise use of data might be to evaluate the extent to which surrogate tissue data might correlate with fish tissue Se in the Santa Ana-Delhi Channel as well as with Se in fish and bird egg tissue collected at the other two watersheds annually and at the end of the 8-year period.
    b. The second issue is whether sampling locations are state or federally protected. If not, then future urban sprawl might engulf all three watersheds, making it impossible to collect even surrogate tissues for assessment.

Please contact me if you have any additional questions.

Sincerely

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References

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