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External Peer Review of Proposed Uniform Water Recycling Criteria for Indirect Potable Reuse Through Surface Water Augmentation

I have carefully reviewed the "Description of scientific assumptions, findings, and conclusions of the Proposed Uniform Water Recycling Criteria for Indirect Potable Reuse Through Surface Water Augmentation" in the Appendix 2. I have also read the Excerpts of California Water Code sections 13560-13569 (Appendix 4) and the Draft Regulations (Appendix 5). I have followed the guidance to external scientific reviewers provided by the staff under the Supplement to Cal/EPA External Scientific Peer Review Guidelines - Exhibit F in Cal/EPA Interagency Agreement with University of California. My review will address the scientific assumptions, findings, and conclusions numbers 1 and 2 as well as the overall perspective.

Please feel free to contact me if there are any questions I may answer.

Respectfully submitted,

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1. *Reducing concentrations of organic constituents of emerging concern (CECs) to levels found in high quality conventional sources is a water quality objective for those constituents that is adequately protective of public health. (Ref §60320.302. Advanced Treatment Criteria)*
   The challenges in creating enforceable regulatory limits on contaminants including 1,4-dioxane and NDMA are extremely difficult due to the evolving toxicological and analytical knowledge on these CECs. In general, the approach used for reducing the CEC concentrations appears reasonable given the limited data available regarding their occurrence and public health impacts. The comparison with high quality conventional sources is presented well, but the selection of 10mg/L organic carbon needs to be better supported. Furthermore, municipal wastewater effluent discharges are a potential source of 1,4-dioxane in receiving water bodies.[1] Operating under the assumption of five percent contribution into water sources places the maximum effluent 1,4-dioxane concentrations at 20 µg/L to maintain compliance with current notification levels of 1.0 µg/L. Interestingly, a recent study of the Cape Fear River watershed in North Carolina found that 1,4-dioxane concentrations varied from 1.3 – 1,405 µg/L depending on the community being served.[2] This magnitude of variation makes it difficult to determine whether 5% is an appropriate minimal dilution factor for the protection of public health for CECs like 1,4-dioxane. Another somewhat weak assumption is that the correlation between bulk organic surrogates for CECs are enough to use for monitoring. I reviewed the linked report, but there was inadequate discussion and referenced studies confirming the correlation between the measurements, so my review primarily focused on the dilution factor in SWA.

2. *A combination of reverse osmosis (RO) treatment and an advanced oxidation process (AOP) will accomplish the water quality objective with respect to organic constituents of emerging concern. (Ref §60320.302. Advanced Treatment Criteria)*

   The incidence of CECs is increasing with recent advancements in analytical detection methods and better understanding of sources and mechanisms of formation of NDMA and 1,4-dioxane in treated water. Recent analyses of 1,4-dioxane in public supply wells show a national average detection rate of 13%.[3] Similarly, NDMA was detected in the effluent of 34% of the chloramine plants tested.[4] Other nitrosamines may be formed as disinfection byproducts, but NDMA was the most frequently detected nitrosamine during UCMR3, accounting for 95% of the nitrosamine detections. While the evolving toxicology of CECs and piecemeal of regulatory standards among state agencies and federal and international bodies creates uncertainty, establishment of stringent action levels for selected CECs is imminent, and will require aggressive treatment of both conventional and recycled/reclaimed water supplies. Despite the high cost and high energy requirements, advanced water treatment using a combination of RO/AOP is recognized as an effective treatment strategy for trace CECs like NDMA, perfluoroalkyl and polyfluoroalkyl substances (PFAS), and 1,4-dioxane in drinking water.[5] It has been reported that RO and AOP can decrease NDMA to below 10 ng/L, which is a likely to be established as federal MCL in the near future. The diverse physical and chemical

properties of CECs unquestionably require multiple treatment trains approach. The effectiveness of AOP treatment can be negatively impacted by multiple compounds in contaminated water streams competing for the hydroxyl radicals.[6] Additionally, the combined approach would be ideal for contaminants like 1,4-dioxane and PFAS that are not efficiently removed from water by RO and UV treatment, but are more susceptible to degradation by hydroxyl radicals and other reactive oxygen species. The combined treatment approach should be an effective strategy to minimize effluent discharges in excess of regulatory limits on CECs. However, rigorous studies must be conducted to identify the CEC degradation products in various water chemistries, especially with humic substances, undergoing various AOP treatments, e.g., UV/H_2O_2 or UV/O_3. The toxicological effects of CEC degradation products on human health as well as indicator organisms in the aquatic environment need to be evaluated prior to implementing the SWA guidelines.

References:

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