CALIFORNIA COASTKEEPER ALLIANCE

March 2, 2018

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Sent via electronic mail to: keithm@sccwrp.org

RE: Comment Letter – Monitoring Strategies for Constituents of Emerging Concern in Recycled Water

Dear Mr. Maruya:

California Coastkeeper Alliance (CCKA) unites local Waterkeeper programs to fight for swimmable, fishable and drinkable waters for California communities and ecosystems. On behalf of CCKA, thank you for the opportunity to comment on draft final report for Monitoring Strategies for Constituents of Emerging Concern in Recycled Water. We strongly support the Expert Panel's recommendations – and we urge the State Water Board to incorporate the expert recommendations. Additionally, we find the Expert Panel's efforts to incorporate best available science into California's CEC Monitoring Program laudable; however, critical issues such as antibacterial resistance (ABR) and cumulative impacts of low CEC exposure should be more thoroughly.

CCKA has been a long-time champion of ensuring water recycling is protective of the environment, that it is used in a reasonable and drought-resilient manner, and that we prioritize resources towards advancing potable reuse. In 2009, CCKA served on the stakeholder working group to develop California's Water Recycling Policy, which among other things, set a state goal to increase water recycling by approximately two million acre-feet per year by 2030. CCKA has since worked with the State Water Board to adopt a clear and consistent regulatory pathway to help California's water agencies meet its water recycling goals. CCKA also supported legislation, SB 918 and SB 322, requiring California to develop regulations for potable recycled water, and to direct the Drinking Water Program to develop the DPR Report.

The local Waterkeepers are also champions for promoting potable reuse. Our Orange County Coastkeeper was a strong supporter of the Orange County Groundwater Replenishment System – the world's largest highly advanced purified water recycling system. The San Diego Coastkeeper was a strong champion of potable reuse during the approval of San Diego's Pure Water Project. And Los Angeles Waterkeeper has been a leader advocating for potable reuse for the Los Angeles region. Los Angeles Waterkeeper has supported large-scale potable reuse at the Hyperion plant that discharges nearly 250 MGD to the Pacific Ocean, recently advocating for a waste and unreasonable use analysis as part of the NPDES permit renewal for the facility to expedite water reclamation. Los Angeles Waterkeeper has also been a vocal supporter of the City's Groundwater Replenishment (GWR) Project that will provide up to 30,000 acre-feet per year (AFY) – more than 9.7 billion gallons – of purified water by 2023 to replenish the San Fernando Groundwater Basin, as well as a recently-approved pilot project being pursued by the Metropolitan Water District to determine the viability of up to 150MGD of water reclamation at the Joint Water Pollution Control Plant in Carson.

While CCKA strongly supports potable reuse, we have growing concerns regarding the use of non-potable reuse. CCKA advocates for environmentally protective non-potable reuse regulations and has fought for rigorous monitoring for chemicals of emerging concern (CECs). In 2012, CCKA worked to prevent AB 2398, an omnibus bill that aimed to remove the Water Boards' oversight of recycled water by no longer considering it a "waste"

under the Water Code. And during California's drought, CCKA and the California Waterkeepers have stressed the need to use recycled water reasonably – particularly when Proposition One funding is involved.
CCKA is concerned that treatment controls are not sufficient to protect the public and the environment from contaminants of emerging concern – particularly ones with ABR and antibiotic resistance genes (ARGs). We further note that California's lack of regulating the cumulative impact of low level CEC exposure is a barrier to the Legislature being more aggressive in advancing potable reuse. A robust CEC monitoring program to protect both the public and the environment is critical to improving the public's confidence in recycled water. With the goal of improving the public's confidence in recycled water that is protective of both public and aquatic health, we offer the following recommendations to the Expert Panel and to the State Water Board:

- Continue to strongly recommend the incorporation of bioanalytical screening methods into the CEC Monitoring Program and invest in research to expand a bioscreening toolbox;
- Make stronger and more specific no-regrets recommendations for the State Water Board to act now to detect and control ABRs in non-potable reuse;
- Recommend the State Water Board reconvene the Expert Panel every three years;
- Make the procedural recommendations for developing a more responsive data management system more prominent;
- Direct future Expert Panels to develop monitoring protocols to detect CECs impacting aquatic health; and
- Direct future panels to investigate the risk and potential health exposure to cumulative CECs at low levels.

I. THE EXPERT PANEL SHOULD CONTINUE TO STRONGLY RECOMMEND BIOASSAYS BE INCLUDED IN THE STATE WATER BOARD'S CEC MONITORING PROGRAM TO PROVIDE A NECESSARY ONRAMP FOR DETECTING THE UBIQUITOUS AMOUNT OF NEW CECS ENTERING OUR ENVIRONMENT.

There are over 30 million chemicals registered on the CAS Registry, with over 4000 chemicals added daily. Over those millions of chemicals, the Expert Panel only considered 489 CECs, and decided that only 3 CECs should be used for health-based monitoring. Given that thousands of chemicals are potentially present in recycled water and that information about those chemicals is rapidly evolving, the Panel recommended that the State Water Board continue to rely on a transparent, science-based framework to guide prioritization of which CECs should be included in recycled water monitoring programs both now and in the future as additional data become available.

As originally expressed ruing the 2010 Expert Panel, CCKA remains concerned that the CEC Monitoring Program is not sufficient to identify and add new CECs. We agree that the Panel's risk-based framework is effective in identifying CECs for which pertinent data are available. But more importantly, we agree with the Expert Panel that "the framework cannot capture all possible new compounds that may be entering the market, nor does it adequately address their transformation products." To help identify such compounds that may occur in recycled water and their potential, if any, to affect human health, we strongly support the Panel's belief "that bioanalytical screening methods are a critically important tool." The Panel should continue to recommend "that the Estrogen Receptor alpha (ER-□) and the Aryl hydrocarbon Receptor (AhR) bioassays be used to respectively assess estrogenic and dioxin-like biological activities in recycled water." These assays are now sufficiently standardized and robust for screening level data collection and assessment. These two in vitro bioassays were selected because each have clear adverse outcome pathways that allow specific molecular responses to be adequately standardized for screening recycled water quality at potable reuse projects. Additionally, we strongly support the Panel recommend that the "investment in research and training is needed to provide an expanded, robust "bioscreening toolbox", and to increase capacity for bioanalytical measurement."

The Expert Panel should <u>continue to strongly recommend the State Water Board incorporate bioanalytical screening methods into its CEC Monitoring Program and invest in research to expand a bioscreening toolbox</u>.

II. THE EXPERT PANEL SHOULD RECONSIDER THE SCIENCE OF ANTIBIOTIC RESISTANCE THREATS AND OFFER A NO-REGRETS STRATEGY FOR DETECTING AND CONTROLLING ANTIBIOTIC RESISTANCE IN NON-POTABLE REUSE.

The use of reclaimed water as an alternative water source for agricultural irrigation would greatly alleviate the demand on freshwater sources. This paradigm shift is gaining momentum in California. However, microbial problems associated with reclaimed water may hinder the use of reclaimed water for agricultural irrigation.[1] Of particular concern is that the occurrence of antibiotic residues in the reclaimed water can select for antibiotic resistance genes among the microbial community.[2] Antibiotic resistance genes can be associated with mobile genetic elements, which in turn allow a promiscuous transfer of resistance traits from one bacterium to another.[3] Together with the pathogens that are present in the reclaimed water, antibiotic resistant bacteria can potentially exchange mobile genetic elements to create the "perfect microbial storm".[4] Given the significance of this issue, a deeper understanding of the occurrence of antibiotics in reclaimed water, and their potential influence on the selection of resistant microorganisms would be essential.[5]

The Expert Panel should take antibiotic resistance more seriously in the Final Report. The Panel finds that ARB is "still a major challenge and potentially an issue for any wastewater discharge into the environment" and as a result "[f]ocused investigations are needed to better understand the occurrence, fate and risks associated with ARB and ARGs in recycled water applications across California." However, the Expert Panel only provides the State Water Board a weak recommendation to "encourage the collection of data in reclaimed water and sites within California while keeping abreast of scientific advances related to methods and risk assessment." This statement will not result in the State Water Board taking serious action to address ABR. Given the serious implications of ABR, the Expert Panel needs to make stronger and more specific recommendations for the State Water Board to take a no-regrets strategy now to detect and control ABR.

Effluents from wastewater treatment plants have been recognized as a significant environmental reservoir of antibiotics and antibiotic resistance genes (ARGs). Yet the Expert Panel states that "information to date is not complete and seems to indicate that the causes for antibiotic resistance are still not well known and the current *studies do not show that antibiotic resistance transmission is a consequence of water reuse practices* considered in this report." We disagree. In a 2013 study[6] a broader range of ARGs were detected after the reclaimed water passed through the distribution systems, highlighting the importance of considering bacterial re-growth and the overall water quality at the point of use (POU). The study screened for pathogens with qPCR indicated presence of Lmip and gadAB genes, but not ecfx or gyrB. In the lab study, chlorination was observed to reduce 16S rRNA and sul2 gene copies in the wastewater effluent, while dechlorination had no apparent effect. ARGs levels did not change with time in soil slurries incubated after a single irrigation event with any of the effluents. However, when irrigated repeatedly with secondary wastewater effluent (not chlorinated or dechlorinated), elevated levels of sul1 and sul2 were observed. This study suggests that reclaimed water may be an important reservoir of ARGs, especially at the POU, and that attention should be directed toward the fate of ARGs in irrigation water and the implications for human health.

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[1] Hong PY et al., Environmental and Public Health Implications of Water Reuse: Antibiotics, Antibiotic Resistant Bacteria, and Antibiotic Resistance Genes. Antibiotics (Basel). 2013 Jul 31;2(3):367-99.
[2] *Id*.
[3] *Id*.
[4] *Id*.
[5] *Id*.
[6] Fahrenfeld N. et al., *Reclaimed Water as a Reservoir of Antibiotic Resistance Genes* distribution system and irrigation implications; Front Microbiol. 2013 May 28;4:130.

A 2015 study[7] aimed to assess the removal efficiency of microbial contaminants in a local wastewater treatment plant over the duration of one year, and to assess the microbial risk associated with reusing treated wastewater in agricultural irrigation. The treatment process achieved 3.5 logs removal of heterotrophic bacteria and up to 3.5 logs removal of fecal coliforms. 16S rRNA gene-based high-throughput sequencing showed that several genera associated with opportunistic pathogens (e.g. Acinetobacter, Aeromonas, Arcobacter, Legionella, Mycobacterium, Neisseria, Pseudomonas and Streptococcus) were detected at relative abundance ranging from 0.014 to 21 % of the total microbial community in the influent. Among them, Pseudomonas spp. had the highest approximated cell number in the influent but decreased to less than 30 cells/100 mL in both types of effluent. Besides the presence of antibiotic-resistant bacterial isolates, tetracycline resistance genes tetO, tetQ, tetW, tetH, tetZ were also present at an average 2.5 × 10(2), 1.6 × 10(2), 4.4 × 10(2), 1.6 × 10(1) and 5.5 × 10(3) copies per mL of chlorinated effluent. The study highlighted that potential risks associated with the reuse of treated wastewater arise not only from conventional fecal indicators or known pathogens, but also from antibiotic-resistant bacteria and genes.

The use of reclaimed wastewater (RWW) for the irrigation of crops may result in the continuous exposure of the agricultural environment to antibiotics, ARB and antibiotic resistance genes ARGs. In recent years, certain evidence indicate that antibiotics and resistance genes may become disseminated in agricultural soils as a result of the amendment with manure and biosolids and irrigation with RWW.[8] Antibiotic residues and other contaminants may undergo sorption/desorption and transformation processes (both biotic and abiotic), and have the potential to affect the soil microbiota.[9] Antibiotics found in the soil pore water (bioavailable fraction) as a result of RWW irrigation may be taken up by crop plants, bioaccumulate within plant tissues and subsequently enter the food webs; potentially resulting in detrimental public health implications.[10] It can be also hypothesized that ARGs can spread among soil and plant-associated bacteria, a fact that may have serious human health implications.[11]

The overuse of antibiotics in livestock farms is general, leading to a wide distribution of ARGs in aquatic environment adjacent to livestock farms. In a 2015 study[12] wastewater and surface water samples were collected from 12 livestock farms (four pig farms, four cattle farms, and four chicken farms) in Jiangsu Province of China. The prevalence, abundance, and distribution of 22 ARGs were investigated, which were categorized into six groups, including nine tetracyclin resistance genes, three sulfonamides resistance genes, three quinolone resistance genes, two macrolide resistance genes, three aminoglycoside resistance genes, and two multidrug resistance genes, employing quantitative real-time PCR (qPCR).[13] The results suggested that all of the 22 ARGs were detected in samples.[14] Sul1, sul2, and tetM were the most abundant with the average concentration of 3.84 × 10(1) copies/16S recombinant RNA (rRNA) gene copies, 1.62 × 10(1) copies/16S rRNA gene copies, 2.33 × 10(1) copies/16S rRNA gene copies, respectively.[15] Principle component analysis revealed that the comprehensive pollution of ARGs in northern Jiangsu was more serious. ARGs in wastewater were more abundant when compared to that in surface water.[16] A preliminary study regarding the fate of ARGs after an aerobiotic process showed that tetA, tetC, sul1, sul2, oqxB, and qnrS were significantly increased.[17] And, among the tetracycline resistance genes, the efflux pump genes were enriched while the ribosomal protection protein

[7] Al-Jassim N. et al., Removal of bacterial contaminants and antibiotic resistance genes by conventional wastewater treatment processes in Saudi Arabia: Is the treated wastewater safe to reuse for agricultural irrigation? Water Res. 2015 Apr 15;73:277-90.
[8] Christou A. et al., The potential implications of reclaimed wastewater reuse for irrigation on the agricultural environment: The knowns and unknowns of the fate of antibiotics and antibiotic resistant bacteria and resistance genes - A review; Water Res. 2017 Oct 15;123:448-467.
[9] *Id.*
[10] *Id.*
[11] *Id.*
[12] Chen B. et al., Prevalence of antibiotic resistance genes of wastewater and surface water in livestock farms of Jiangsu Province, China; Environ Sci Pollut Res Int. 2015 Sep;22(18):13950-9.
[13] *Id.*
[14] *Id.*
[15] *Id.*
[16] *Id.*
[17] *Id.*

encoding genes were decreased in the aerobiotic process.[18] The prevalence of ARGs in surface water is of concern; and more surveillance is required to determine the pollution level and pattern of ARGs.

ABR is also concerned in public places that are irrigated with non-potable reuse. Irrigation of urban parks with treated wastewater significantly increased the abundance and diversity of various antibiotic resistance genes. In a 2016 Australian study[19], a total of 40 unique ARGs were detected across all 12 park soils, with genes conferring resistance to β-lactam being the most prevalent ARG type. The total numbers and the fold changes of the detected ARGs were significantly increased by reclaimed water and marked shifts in ARG patterns were also observed in urban parks with reclaimed water compared to those without reclaimed water. The changes in ARG patterns were paralleled by a significant effect of reclaimed water on the bacterial community structure and a co-occurrence pattern of the detected ARG types. There were significant and positive correlations between the fold changes of the integrase intI1 gene and two β-lactam resistance genes (KPC and IMP-2 groups), but no significant impacts of reclaimed water on the abundances of intI1 and the transposase tnpA gene were found, indicating that reclaimed water did not improve the potential for horizontal gene transfer of soil ARGs. Taken together, the study's findings suggested that irrigation of urban parks with reclaimed water could influence the abundance, diversity, and compositions of a wide variety of soil ARGs of clinical relevance.

The abundance of ABRs in non-potable reuse is a concern for public and aquatic health. The Expert Panel should reassess its findings that "information to date is not complete and seems to indicate that the causes for antibiotic resistance are still not well known and the current studies do not show that antibiotic resistance transmission is a consequence of water reuse practices considered in this report." From the studies above, it seems evident that ABRs in non-potable reuse is a concern and needs to be addressed by the State Water Board. We therefore recommend the Expert Panel *make stronger and more specific no-regrets recommendations for the State Water Board to act now to detect and control ABRs in non-potable reuse*.

III. THE EXPERT PANEL SHOULD STRONGLY ENCOURAGE RECONVENING THE PANEL EVERY THREE YEARS AND URGE THE STATE WATER BOARD TO TAKE ACTIONS TO STREAMLINE CEC ASSESSMENTS.

Given the quickly evolving nature of CECs, the State Water Board should require the Expert Panel be reconvened every three years. The Panel recommends that the State Water Board reconvene an independent Panel to review proposed changes to CEC monitoring recommendations every three years. Panel should be done every 3 years - these programmatic upgrades should be reviewed internally as well as by independent experts on a relatively frequent (e.g. triennial) schedule. Due to the uncertainty that is inherently associated with the universe of chemicals that might occur in recycled water now and in the future, the need to establish a formal CEC monitoring and assessment program for recycled water that is responsive to rapidly changing CEC issues is critical.

A 5-year Expert Panel reconvening is unacceptable. Convening a Panel to review every 5 years could result in errors and missing data. Applying the risk-based framework recommended by the 2010 Panel requires structure and consistent protocols yet no formal update of the selected CECs occurred until 2018. Reliance on health and performance-based indicators provides assurance of proper operation but is not suitable to account for new CECs. A 3-year Expert Panel cycle will lead to more up-to-date on and off ramps. We request the Expert Panel continue to *strongly recommend that the State Water Board reconvene the Expert Panel every three years*.

A more flexible and responsive program should be developed to update CEC monitoring recommendations in response to rapidly emerging science, technology advances and monitoring (screening) data collected. In this context, the State Water Board should take a more active role in procuring, managing and accessing CEC

[18] *Id.*

[19] Han XM. et al., Impacts of reclaimed water irrigation on soil antibiotic resistome in urban parks of Victoria, Australia; Environ Pollut. 2016 Apr;211:48-57.

monitoring data and associated toxicological thresholds. The State Water Board needs a more responsive program to adjust to new information. The State Water Board should streamline implementation of Panel recommendations and make data widely available in easy to use format. We support the Panel recommends that the State Water Board consider taking several procedural steps to clarify roles and responsibilities for the State and Regional Water Boards (as described in Section 2.3) for permitting of potable water reuse projects, to improve the management of potable water facility monitoring data (i.e., CEC, bioanalytical, and high-frequency operation data), and the reporting of potable water operations to the public.

We request that the Expert Panel make their procedural recommendations on creating a flexible and responsive CEC Monitoring Program by making the recommendations more prominent in the Executive Summary by highlighting the following recommendations: *developing a data management system for potable water facility monitoring data; using high-frequency operational monitoring data; developing consistent permittee electronic reporting requirements; and developing a protocol for providing the public an annual report summarizing performance of potable reuse projects*.

IV. THE EXPERT PANEL SHOULD ANALYZE CEC IMPACTS TO HUMAN AND AQUATIC HEALTH.

The Expert Panel should be considering impacts to aquatic health when developing an appropriate CEC Monitoring Program for California. Just like in 2010, the State Water Board has once again failed to instruct the Expert Panel to assess CEC impacts to aquatic health. The Panel was "instructed to evaluate potential risks for all routes of exposure, except potential exposures associated with consumption of crops irrigated with recycled water, but to limit their deliberations to impacts on human (*and not ecological*) health." (Emphasis added.)

The discharge of CECs to California's receiving waters occurs daily due to recycled water. As recycled water becomes an increasingly important part of California's water supply portfolio, the State faces the challenge of monitoring and regulating the discharge of CECs into surface and groundwater. Many streams in Southern California are effluent-dominated streams with 80-95 percent of dry weather flows coming from recycled water discharges, and many Northern California streams receiving recycled water effluent interact regularly and closely with groundwater. As such, the importance of monitoring for CECs is critical to identify risks posed to public health and aquatic life.

The Recycled Water Policy established the Expert Panel for "describing the current state of scientific knowledge regarding the risks of emerging constituents to public health and the *environment*." (Emphasis added.) The Policy further called on the Panel's Report to "recommend actions that the State of California should take to improve our understanding of emerging constituents" because "[r]egulating most CECs will require . . . more specific determinations as to how and at what level CECs impact public health or *our environment*." This mandate was directed at an expert Panel because, as the Report notes, "[t]here needs to be additional research . . . to determine *potential environmental* and public health impacts." (Emphasis added.) This research is further needed to implement the Policy's direction to agencies to "minimize the likelihood of CECs impacting human health and *the environment* by means of source control and/or pollution prevention programs." (Emphasis added.)

The Panel did not expressly acknowledge the fact that discharge of recycled water to receiving waters occurs daily, that many streams in southern California are effluent-dominated streams with 80-95 percent of dry weather flows coming from recycled water discharges, or that many northern California streams that may receive recycled water effluent interact regularly and closely with groundwater. As such, the importance of including monitoring recommendations for those CECs that potentially pose a risk to aquatic life and ecosystems is critical. By failing to recommend a robust monitoring program even in the short-term considering this dearth of data, the Report will only delay the increased, safe use of recycled water that California needs to ensure a sustainable water future.

We disagree with the Expert Panel's focus on monitoring solely for assessing human health impacts. This approach is contrary to the Recycled Water Policy's clear direction to include ecological assessments, as well as the Policy's goal of using recycled water more frequently than under the current environmental conditions examined by the Panel. We request that the Expert Panel *recommend that the State Water Board direct future Expert Panels to develop monitoring protocols to detect CECs that impact aquatic health.*

V. THE EXPERT PANEL SHOULD RECOMMEND THE STATE WATER BOARD DIRECT THE PANEL TO INVESTIGATE THE RISK AND POTENTIAL HEALTH EXPOSURE TO CUMULATIVE CECS AT LOW LEVELS.

CECs demonstrate low acute toxicity but cause significant reproductive effects at very low levels of exposure. In addition, the effects of exposure of aquatic organisms to CECs during the early stages of life may not be observed until adulthood. These chemicals may also have very specific modes of action that affect only certain types of aquatic animals (e.g., vertebrates such as fish). Therefore, the EPA has suggested that traditional chronic toxicity test endpoints specified in the Guidelines may not be sufficiently comprehensive, and Guidelines requirements for taxonomic coverage in toxicity testing may not be appropriate to derive aquatic life criteria for these chemicals.

We note that specific issues such as the potential for joint interactions affecting toxicity exist for many CECs that may occur in mixtures in the environment and which may also interact with environmental variables such as temperature. Such possible interactions should be considered. As more information is developed to account for the interactive effects of CECs, it is possible that water quality criteria may be revised up or down for individual CECs based upon data on joint interactions; use of such data would produce more risk-based criteria.

Mixtures of CECs with comparable modes of action may result in higher effective concentrations than would be expected based on the concentrations of any single compound. Therefore, research is needed to determine how aquatic life criteria for CECs can consider the fact that aquatic organisms are exposed to mixtures of chemicals with similar modes of action.

We request that the Expert Panel *recommend the State Water Board direct future panels to investigate the risk and potential health exposure to cumulative CECs at low levels*.

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We look forward to working with you to ensure California is conducting robust CEC monitoring that is protective of both public and aquatic health to build public confidence in recycled water so that we can reach our water recycling goals and make California's water supplies local and resilient.

Sincerely,

Sean Bothwell
Policy Director
California Coastkeeper Alliance