Attachment 2
Scientific Issues to be Addressed by Peer Reviewers

The statute mandate for external scientific peer review (Health and Safety Code section 57004) states that the reviewer's responsibility is to determine whether the scientific portion of the proposed rule is based upon sound scientific knowledge, judgment, methods and practices.

We request that each reviewer's responsibility is to make this determination for each of the following issues that constitute the scientific basis of the proposed regulatory action. An explanatory statement is provided for each issue to focus the review.

The State Water Resources Control Board (State Water Board) requests that the peer reviewers review the draft amendment to the State Water Board's Recycled Water Policy regarding monitoring requirements for constituents of emerging concern (CECs) in recycled water and the report "Monitoring Strategies for Chemicals of Emerging Concern (CECs) in Recycled Water – Recommendations of a Scientific Advisory Panel" (Report). This Report includes the scientific information that is the basis for the draft policy amendment.

1) **Sufficiency of potential water contaminant lists of CECs.**

   CECs are a broad category of compounds, such as pharmaceuticals, personal care products, pesticides, and industrial chemicals that are not regulated in water at the federal or state level. The approach for selecting CECs to screen relied on the United States Environmental Protection Agency (USEPA) Candidate Contaminant List 3 (CCL3) selection process. CECs were also selected as identified by the Unregulated Contaminant Monitoring Regulation (UCMR) program and California Department of Public Health (CDPH) unregulated notification compounds, referred to in the Report as non-CCL compounds. Section 2 of the Report presents the approach for defining the universe of CECs to consider for monitoring in recycled water.

2) **Appropriateness of the approach for selecting CECs of toxicological relevance to monitor for recycled water uses.**

   The Panel used a risk-based screening process to identify CECs of toxicological relevance. This screening process consists of four elements as follows:

   a) **Compilation of CEC occurrence data for municipal recycled water in California.** The Panel obtained CEC monitoring data from water and wastewater utilities, the WateReuse Association of California, commercial laboratories, and research laboratories. The samples for this data were collected from recycled water facilities in California from 2007 through 2009. Within the Report, CEC monitoring data are referred to as measured environmental concentrations (MECs). Based on the compiled data, the Panel calculated the 90^{th} percentile MEC for each CEC. Section 4 of the Report presents the approach for determining the toxicological relevance of CECs in recycled water to human health. Section 5 of the Report describes the methodology for determining a

CEC's MEC occurrence concentration.

b) Assignment of a toxicologically relevant concentration level, referred to as an initial monitoring trigger level (MTL), to individual CEC for each recycled water exposure scenario. The Panel derived initial MTLs for groundwater recharge reuse from published drinking water benchmarks obtained from several sources. The include:

i) three regulatory agencies - United States Environmental Protection Agency (USEPA), California Department of Public Health (CDPH), and Australian Environmental Protection and Heritage Council;

ii) two papers published in scientific journals (*Human pharmaceuticals in US surface waters: A human health risk assessment* [Schwab *et al*. 2005]; *Toxicological relevance of emerging contaminants for drinking water quality* [Schriks *et al*. 2009]); and

iii) two peer-reviewed research reports focusing on the development of toxicological benchmarks for CECs (*Toxicological Relevance of EDCs and Pharmaceuticals in Drinking Water* [Snyder *et al*. 2008], *Identifying Health Effects Concerns of the Water Reuse Industry and Prioritizing Research Needs for Nomination of Chemicals for Research to Appropriate National and International Agencies. Final Report.* [Cotruvo *et al*. 2010]).

The Panel derived MTLs using the drinking water benchmarks and potential exposure to the CECs through consumption of recycled water. Section 4.3.1 of the Report presents the approach for selecting initial MTLs. Section 8.2 of the Report presents the assumptions and approach for prioritizing drinking water benchmarks to establish the initial MTLs.

c) Comparison of the MEC to the MTL. The Panel compared the CEC's 90th percentile MECs to the initial MTLs for each recycled water use scenario. It selected CECs with MECs greater than their respective initial MTLs to be potential candidates for monitoring. Section 4.2 of the Report presents the screening process used to select health-relevant CECs for monitoring.

d) Evaluation of robust analytical method availability. The Panel screened the CECs to remove those that did not have commercially available, robust analytical methods.

3) Determination of initial MTLs for the landscape irrigation.

For landscape irrigation, the Panel selected incidental ingestion to be one percent of the total daily drinking water intake. The basis for the incidental ingestion water intake was drawn from studies on ingestion from park irrigation; *Wastewater reclamation and reuse* (Cooper, R.C. and A. W. Olivieri. 1998), *Wither the Multiple Treatment Barrier?* (Sakaji *et al*. 1998), and *Faecal contamination of greywater and associated microbial risks* (Ottoson, J. and T. A. Stenstrom. 2003). Section 4.3 of the Report presents the methodology for determining MTLs for recycled water used for landscape irrigation.

4) Adequacy of the selected performance indicator CECs.

An indicator compound is an individual compound occurring at a measurable level that represents certain physiocochemical and biodegradable characteristics of a family of trace organic constituents that are relevant to fate and transport during treatment. The selection of multiple indicator compounds, representing a range of properties, enables assessment of treatment of identified and unidentified compounds, provided they fall within the same range of properties of the indicator compounds. The underlying concept of the use of indicator constituent is that the absence or removal of an indicator constituent during a treatment process would also ensure absence or removal of unidentified chemicals with similar properties. Thus, the use of a limited number of indicator constituents allows for assessment of groups of constituents with similar properties, rather than monitoring for numerous constituents.

The Panel selected performance indicator CECs based on their high occurrence in recycled water and their ability to be removed by a treatment process that is operating according to its technical specifications. The removal of specific CECs varies by treatment process; therefore performance indicator CECs were selected as appropriate to monitor specific treatment processes.

The Panel selected performance indicator CECs for each recycled water application method. It based the selection on several studies; *Development of Indicators and Surrogates for Chemical Contaminant Removal during Wastewater Treatment and Reclamation* (Drewes *et al*. 2008), *Applying surrogates and indicators to assess removal efficiency of trace organic chemicals during chemical oxidation of wastewaters* (Dickenson *et al*. 2009), *Development of Surrogates to Determine the Efficiency of Groundwater Recharge Systems to Remove Trace Organic Compounds* (Drewes *et al*. 2010a), and *Chemical monitoring strategy for the assessment of advanced water treatment plant performance* (Drewes *et al*. 2010b).

Section 8.3 of the Report presents the performance indicators selected and the use of indicators to evaluate treatment process performance in removing CECs.

5) Adequacy of the selected surrogates for monitoring treatment process performance.

A surrogate parameter is a quantifiable change of a bulk parameter that can measure the performance of individual unit treatment processes or overall operations in removing trace organic compounds. Examples of surrogate parameters include conductivity, total organic carbon, and turbidity. The rationale for utilizing surrogates consists of an approach in which a limited number of non-CEC analytes are used to evaluate treatment process performance and provide an indication of the general removal of CECs from recycled water. Reduction in the level of surrogates in recycled water during treatment processes correlate with the removal of CECs, provided the surrogates are good predictors of CECs. Changes in surrogate parameters during a treatment process can be utilized to define normal operating conditions or provide an indication when a treatment process is not operating to design specifications. A treatment processes failure to remove CECs and other chemicals is indicated by a poor or less than expected reduction of surrogate parameters.

Several studies have demonstrated that changes in bulk parameters (surrogates) in recycled water correlate with changes of indicator CECs in soil aquifer treatment or during reverse osmosis and advanced oxidation processes. Surrogates were selected for each recycled water application method for the specific treatment process (i.e., soil aquifer treatment and reverse osmosis with advanced oxidation processes). Selection of appropriate surrogates to monitor for each treatment process was based on the findings of several studies; *Development of Indicators and Surrogates for Chemical Contaminant Removal during Wastewater Treatment and Reclamation* (Drewes *et al*. 2008), *Applying surrogates and indicators to assess removal efficiency of trace organic chemicals during chemical oxidation of wastewaters* (Dickenson *et al*. 2009), *Development of Surrogates to Determine the Efficiency of Groundwater Recharge Systems to Remove Trace Organic Compounds* (Drewes *et al*. 2010a), and *Chemical monitoring strategy for the assessment of advanced water treatment plant performance* (Drewes *et al*. 2010b).

Section 8.3 of the Report presents the surrogates appropriate for each treatment process and/or recycled water use scenario and the application of surrogates to evaluate treatment process operational performance.

6) Validity of expected percent removal of surrogates and performance indicator CECs for a treatment process.

To assess the efficacy of a treatment process to remove CECs, the Report provides "expected removal" percentages of surrogates and performance indicator CECs by treatment process. The expected removal of surrogates and performance indicator CECs differs by treatment process. These treatment processes are soil aquifer treatment and reverse osmosis with advanced oxidation. A significant amount of research has been previously conducted on the performance of different treatment process to remove surrogate parameters and CECs, and is discussed in *Development of Indicators and Surrogates for Chemical Contaminant Removal during Wastewater Treatment and Reclamation* (Drewes *et al*. 2008) and *Development of Surrogates to Determine the Efficiency of Groundwater Recharge Systems to Remove Trace Organic Compounds* (Drewes *et al*. 2010a). Section 8.3 of the Report presents expected removal percentages for surrogates and CECs for each treatment scenario.

7) Appropriateness of tiered risk quotient thresholds and corresponding degree of response for evaluating monitoring results for health-based CECs in recycled water.

The Report presents a multi-tiered framework for interpreting recycled water project monitoring results for health-based CECs and determining appropriate further actions based on the monitoring results. The framework is composed of several tiers of MEC/MTL quotient thresholds and corresponding courses of appropriate response action commensurate with potential risk.

The Panel used best professional judgment as the basis for recommending the tiered thresholds for evaluating health-based CEC results in Section 8.4.2 of the Report. As presented in the Report, multiple levels of conservatism were incorporated into the risk quotient calculations used to select health-based CECs for monitoring.

Furthermore, the Panel contends that the multiple tiers for interpreting values of risk quotients resulting from future monitoring efforts are appropriate due to the uncertainty in occurrence and toxicological data used to establish the original listing.

8) Adequacy of monitoring frequencies for CECs and surrogates and the phased monitoring approach.

A phased approach is proposed for monitoring programs to assess CEC and surrogate parameters in recycle water for groundwater recharge reuse projects. Under the phased monitoring approach, the frequency of monitoring decreases by phase as greater information is obtained regarding the occurrence and removal of CECs and surrogate parameters (i.e., parameters that provide an indication of the effectiveness of a treatment process to remove CECs) and the operational performance of the treatment process. The phased monitoring provides an investigative approach for incremental information gathering on emerging contaminants in recycled water and their removal during treatment processes.

During the initial phase of assessment (referred to in the Report as “piloting” and “startup”), CECs are proposed to be monitored on a quarterly basis for one year for the purpose of gathering information on the occurrence of CECs and surrogates. Following the initial assessment phase, a baseline monitoring phase is conducted to (1) provide confirmation of prior monitoring findings, (2) monitor treatment process performance through the use of surrogates, and (3) provide monitoring data to evaluate levels of CECs and the need for adjusting monitoring requirements. Monitoring of CECs during the baseline phase is proposed to be conducted on a semi-annual basis for three years. Based on the findings of the baseline monitoring phase, monitoring requirements (i.e., CECs and monitoring frequency) may be refined to monitor the continuing operation of a facility. Following the baseline monitoring phase, Standard Operation Monitoring, CECs may be monitored on either a semi-annual or annual basis for facilities that demonstrate consistent treatment process performance (i.e., removal of CECs and surrogates) and recycled water quality. Requirements for monitoring frequency of surrogates are designed to detect treatment system failures which could result in exposure of the user population to considerable disease and contamination risks. Monitoring frequencies vary for each surrogate and range from continuously to quarterly. The proposed monitoring frequencies for CECs and surrogates for the phase monitoring approach are the result of the best professional judgment of the Scientific Advisory Panel. Section 8.4.1 of the Report presents the frequency for monitoring CECs and surrogates for the piloting/startup and baseline phases. Section 8.3 of the Report presents the conclusion for semi-annual and/or annual monitoring of CECs following the baseline phase.

Additional monitoring frequency requirements for surrogates, not presented in the Report, are provided in the attachment to the amended Recycled Water Policy. The additional requirements provide supplementary detail on surrogate monitoring frequencies for the initial assessment and baseline monitoring phases, and standard operation of a facility. The additional information of surrogate monitoring frequency was subsequently provided to Staff by Dr. Jorg Drewes (Panel Chair). The proposed monitoring frequencies for CECs and surrogates for the phase monitoring approach are the result of the best professional judgment of the Scientific Advisory Panel. The Standard Operation Monitoring Requirements, not present in the Report, are

proposed from Staff. These requirements are based on the baseline monitoring phase requirements, and allows for refinement by the Regional Water Quality Control Boards based on the finding of the baseline phase and the tiered threshold/response action approach. Requirements for the frequency of monitoring CECs and surrogates for the initial assessment phase, baseline phase, and standard operation of a facility are summarize in Tables 3 through 5 of the attachment to the amended Recycled Water Policy.

9) **Additional consideration for the peer reviews:** Due to the time and resources constraints of the Panel's charge, the Panel developed "initial MTL" values in the screening process to select health-relevant CECs for monitoring. These initial MTLs were derived from drinking water benchmarks, as discussed in issue 2) b) above. However, the Panel presented a preferred method for deriving MTL values based on an approach using screening level allowable daily intakes (ADI's), default bodyweight, average consumption, and relative source contribution (RSC). This preferred approach for deriving MTLs may be implemented in the future, but would require establishment of RSCs for CECs. The peer reviewers are asked to review the appropriateness of this alternative approach for deriving MTLs (Section 4.3).

<u>The Big Picture</u>

Reviewers are not limited to addressing only the specific issues presented above, and are asked to contemplate the following questions:

a) **In reading the Panel's report and the proposed implementation language are there any additional scientific issues that are part of the scientific basis of the proposed rule not described above?**

b) **Taken as a whole is the scientific portion of the proposed rule based upon sound scientific knowledge methods and practices?**

c) **In reviewing the Attachment A (draft amendment), does the proposed language adequately characterize and implement the Panel's recommendations for monitoring of CECs for recycled water use in groundwater recharge and landscape irrigation.**

Reviewers should also note that some proposed actions may rely significantly on professional judgment where available scientific data are not as extensive as desired to support the statute requirement. In these situations, the proposed course of action is favored over no action.

The preceding guidance will ensure that reviewers have an opportunity to comment on all aspects of the scientific basis of the proposed Board action. At the same time reviewers also should recognize that the Board has a legal obligation to consider and respond to all feedback on the scientific portions of the proposed rule. Because of this obligation, reviewers are encouraged to focus feedback on scientific issues that are relevant to the central regulatory elements being proposed.