CITY OF ROSEVILLE CALIFORNIA

**Environmental Utilities Department**
**Engineering Division**
2005 Hilltop Circle
Roseville, California 95747

May 9, 2011

Danny McClure
Regional Water Quality Control Board, Central Valley Region
11020 Sun Center Drive, #200
Rancho Cordova, CA 95670-6114

**RE: Comments on Draft Aquatic Life Criteria for Permethrin and Cypermethrin Developed by the University of California at Davis**

Dear Mr. McClure:

The City of Roseville (City), with assistance from Robertson-Bryan, Inc., has reviewed draft water quality criteria derivation reports for permethrin and cypermethrin prepared by the University of California at Davis (UCD) while under contract to the Central Valley Regional Water Quality Control Board (Regional Water Board). These draft criteria derivation reports were made available for public review through email notice received on March 24, 2011. Comments are due to the Regional Water Board by May 9, 2011.

The City bases the following comments on the detailed review provided in the enclosed attachment. The City formally requests that the Regional Water Board consider these comments, and the items listed in the enclosed attachment, in light of its own review of the UCD documents and before these draft criteria are utilized for any regulatory planning or enforcement purposes.

- The City does not accept the validity of the permethrin chronic criterion. The draft chronic criterion for permethrin may be overprotective. The ACR used to calculate the criterion was heavily influenced by a default ACR derived solely on classes of pesticides whose structures are different, environmental fate is different, and modes of toxic action are mostly different than permethrin.

- The City does not accept the validity of the cypermethrin chronic criterion, particularly the use of the *Daphnia magna* ACR of 949. The draft criteria for cypermethrin appears to misinterpret guidance provided in the methodology. Furthermore, guidance provided in the methodology does not appear to address the specific issues related to cypermethrin and the use and reduction of available empirical data. Related, it is the City's position that the Kim *et. al.* 2008 study on which the ACR of 949 is derived should be excluded from use in derivation of the chronic criteria. The subject study was excluded from derivation of the acute criterion, and no justification is provided as to why the study would be acceptable for derivation of the chronic criterion. Furthermore, authors of the study state that they followed OECD guidance, however OECD test acceptability criteria were not achieved and OECD test methodology were not followed. Given the lack of clear guidance in the criteria derivation

methodology, the apparent misinterpretation of guidance, and the use of a study that should have been excluded from the data set, the City requests that the chronic criterion be re-calculated. Because issues related to the derivation of the chronic criteria are several-fold, the City requests that the cypermethrin criteria document be suitably revised to address our concerns related to interpretation of the methodology and the use of Kim *et. al.* 2008 *Daphnia magna* study, and resubmitted in draft form for public comment. The City requests this additional opportunity for comment because the City believes the methodology, as presently written, does not provide clear guidance and will ultimately require subtle interpretation, on which the City desires the opportunity to review and provide new comment.

- The City does not accept the assumption of dose additivity. Compliance with criteria should not be based on simplifying assumptions of concentration addition as the principals of concentration addition do not necessarily hold true under all possible environmental mixture scenarios. Assumptions of dose additivity are unsuitable for regulatory purposes in this case and as such, the report should specifically recommend against inclusion of dose-additivity assumptions for compliance determination purposes.
- The City disagrees that whole water analysis is valid for criteria compliance. Scientific evidence points to freely dissolved pyrethroid as the bioavailable fraction. Compliance should be measured against that portion of a pyrethroid that is known to be toxic. The draft criteria reports should be revised in a manner that retains the scientifically-based recommendation for compliance determinations based on either direct measurement of the bioavailable fraction or allowing for some compensating factor accounting for particulate matter and dissolved organic matter, but should remove statements regarding the validity of whole water measurements for compliance, which are not supported.
- The limited capability of commercial laboratories in achieving low enough reporting limits is very troubling to the City. Similar to the standardization of minimum mandatory reporting limits in the State Implementation Plan (SIP), the City requests similar effort of standardization for these pesticides. Without such standardization, monitoring and compliance efforts can produce data of limited to no value, and likely at considerable economic expense to the regulated community.

Thank you for the opportunity to comment and we look forward to your response.

Sincerely,

Kelye McKinney
Engineering Manager

Att: 1

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# TECHNICAL MEMORANDUM

Date: May 9, 2011

To: Delyn Ellison-Lloyd, Kelye McKinney, Ken Glotzbach (City of Roseville)

From: Brant Jorgenson, Ben Giudice, M.S., Michael Bryan, Ph.D.

Re: Review of Draft Permethrin and Cypermethrin Aquatic Life Criteria Reports Developed by the University of California at Davis

## 1 Introduction

Robertson-Bryan, Inc (RBI) has reviewed draft water quality criteria derivation reports prepared by the University of California at Davis (UCD) while under contract to the Central Valley Regional Water Quality Control Board (Regional Water Board). Under this contract, UCD has prepared methodology and draft aquatic life criteria for a list of pesticides that the Regional Water Board has identified as posing high risk to water quality. The proposed methodology allows for the derivation of acute and chronic aquatic life criteria for pesticides with limited toxicity datasets. Although these criteria do not represent water quality objectives or standards at present, they may be implemented as quantitative interpretations of Basin Plan narrative toxicity objectives, and thus are of particular relevance to local agencies who manage discharges to water bodies that may be impacted by pesticides. The Regional Water Board recently adopted and submitted to the State Water Board for its approval Clean Water Act Section 303(d) listings for pyrethroid insecticide-related toxicity on Pleasant Grove Creek, South Branch Pleasant Grove Creek, and Kaseberg Creek, making the development of these draft criteria particularly relevant to the City of Roseville's (City) wastewater and storm water management operations.

This technical memorandum (TM) specifically reviews criteria derivation documents that were recently released for public review by the Regional Water Board for the pyrethroid insecticides permethrin and cypermethrin. Comments for permethrin and cypermethrin are due by May 9, 2011. Incorporated throughout these criteria derivation documents is reference to a recently developed criteria derivation methodology. Review of the criteria derivations requires review and comment on the methodology used to derive the criteria and, therefore, review of the methodology also was conducted. Due to the similarities across pyrethroid insecticides, a number of findings included in this TM are similar to those previously provided for bifenthrin, lambda-cyhalothrin, and cyfluthrin. This TM summarizes RBI's findings from this review and assessment and incorporates, where appropriate, comments previously provided for bifenthrin, lambda-cyhalothrin, and cyfluthrin (See RBI TMs dated January 14, 2010 and February 18, 2010).

## 2 Draft Criteria and Background

Draft aquatic life criteria statements from UCD for permethrin and cypermethrin are provided below. Specific comment on the criteria values and means of measuring compliance are provided in Section 3 and 4 of this memo.

> "Aquatic life in the Sacramento River and San Joaquin River basins should not be affected unacceptably if the four-day average concentration of permethrin does not exceed **0.002 µg/L (2 ng/L)** more than once every three years on the average and if the one-hour average concentration does not exceed **0.01 µg/L (10 ng/L)** more than once every three years on the average." (Fojut *et. al.* 2011a)

and,

> "Aquatic life in the Sacramento River and San Joaquin River basins should not be affected unacceptably if the four-day average concentration of cypermethrin does not exceed **0.000003 µg/L (0.003 ng/L)** more than once every three years on the average and if the one-hour average concentration does not exceed **0.001 µg/L (1 ng/L)** more than once every three years on the average." (Fojut *et. al.* 2011b)

These criteria were developed following a methodology published in September 2009. In *Methodology for Derivation of Pesticide Water Quality Criteria for the Protection of Aquatic Life, Phase II: Methodology Development and Derivation of Chlorpyrifos Criteria* (TenBrook *et al.*, 2009), a new method of criteria derivation is formalized and a step-by step procedure for deriving criteria from small toxicity datasets is provided. A new criteria derivation methodology was necessary because these limited datasets are deficient in one manner or another for use with the existing EPA methodology (EPA, 1985). The draft criteria derivation reports, which are the principal subject of this review, follow this step-by-step procedure.

The UCD methodology has been revised based on comments received from both peer review and public comment. In general, the UCD methodology developed for the task of deriving aquatic life criteria for pesticides of concern is scientifically sound. The UCD methodology is rather unique in that it lays a foundation for a regional regulatory body to develop criteria from toxicity datasets found to be incomplete by the conventional EPA method (EPA, 1985), which is most commonly used for criteria derivation purposes.

The specific manner in which this new methodology is applied in the derivation of specific aquatic life criteria is of key importance. The UCD methodology provides more than a means to derive numeric criteria; it also considers factors of bioavailability, mixture effects, and the effect of other tangential water quality parameters on pesticide toxicity (e.g., temperature and pH). Considering these other factors is complex, and caution is warranted in how assumptions are employed in developing final criteria statements and execution of those statements.

The remainder of this review summarizes specific findings in the development and execution of these draft aquatic life criteria. Only brief effort was made to review the toxicity value screening procedure because conducting a thorough review of this aspect of the methodology was beyond the scope of this

review effort. However, it should be noted that the screening of available toxicity values largely determines the criteria derivation outcome and, therefore, a thorough review of the toxicity value screening procedure by an outside party is recommended.

# 3 Assessment of Methodology and Draft Derivation of Permethrin and Cypermethrin Criteria

## 3.1 Implementation of Acute to Chronic Ratios

In cases when data from fewer than five taxa are present, the methodology requires that acute-to-chronic ratios (ACRs) be used. Acute-to-chronic ratios for a given pesticide can vary considerably among species. In general, ACRs have been found to vary from 1 to 20,000 (Chapman *et al.*, 1998). In the methodology, the authors acknowledge that "…there is no evidence that default ACR values are appropriate for pesticides in general." They go on to conclude that, nevertheless, some means of calculation of an ACR is necessary, and so accept a default value of 12.4 based on the 80$^{th}$ percentile of ACRs for 8 pesticides, including 5 organochlorine pesticides and 3 organophosphate pesticides (TenBrook *et al.*, 2009). ACRs for pyrethroids have been found to vary between 2 and 415 for a variety of species (Solomon *et al.*, 2001).

### 3.1.1 Permethrin

In the case of permethrin, the final ACR is calculated as the geometric mean of one ACR for *Americanmysis bahia*, and two default values of 12.4, which are based on no data from pyrethroids, but instead are derived solely on classes of pesticides whose structures are different, environmental fate is different, and modes of toxic action are mostly different. The chronic criterion calculated using this ACR is 2 ng/L. The most sensitive maximum acceptable toxicant concentration (MATC) in the data set was 16 ng/L (Fojut *et al.*, 2011a). In this case, the derived criterion may be over-protective, owing to the use of default ACRs which are not based on pesticides with similar mechanisms of action.

### 3.1.2 Cypermethrin

In the case of cypermethrin, three ACRs could be calculated, and were 2.11 (*Arcatia tonsa*), 2.26 (*Oncorhynchus mykiss*), and 949 (*Daphnia magna*). The authors state the following:

> "There was not a clear trend of SMACRs increasing or decreasing as the SMAVs increased, but the ACRs are not all within a factor of 10. In this case, it is recommended that only the SMACRs for species with SMAVs within a factor of 10 of the acute 5$^{th}$ percentile value should be used for the final multi-species ACR (section 3-4.2.1, parts 1-2 TenBrook et al. 2009a), which for cypermethrin is only the SMACR for *Daphnia magna* of 949" (Fojut *et al.*, 2011b).

The portions of the methodology which are referenced read as follows:

> "1) If the SMACR seems to increase or decrease as the SMAVs increase, calculate the ACR as the geometric mean of the ACRs for species whose SMAVs are close to the

acute criterion (this includes species whose SMACRs are within a factor of 10 of the SMACR of the species whose SMAV is nearest the 5th percentile value);

2) If no major trend is apparent and the ACRs for all species are within a factor of ten, calculate the ACR as the geometric mean of all of the SMACRs" (Section 3-4.2.1, parts 1-2, TenBrook *et al.* 2009).

There are numerous issues, both in the methodology and in the draft criterion document, that need to be resolved before accurate interpretation and calculation of an ACR can be made. The following issues have been identified:

1. None of the conditions specified in parts 1, 2, or 3 of section 3-4.2.1 of the methodology are applicable to the cypermethrin scenario. Part 1 only applies when the SMACR seems to increase or decrease as the SMAVs increase, which the authors state is not the case. Part 2 only applies when there is *both* no major trend, *and* when all SMACRs are within a factor of 10, which is not applicable to the cypermethrin case. Part 3 only applies if the most appropriate SMACRs are less than 2, which is not the case for cypermethrin. Finally, the methodology states that if the requirements in bullets 1, 2, and 3 are not met, the ACR should be calculated using the default ACR of 12.4, per section 3-4.2.2. This last method appears to be the path most consistent with the methodology, although the use of a default ACR is dubious to begin with (see discussion on permethrin above), especially when cypermethrin ACRs for *Arcatia tonsa* and *Oncorhynchus mykiss* exist.

2. The authors of the cypermethrin document appear to have attempted to follow Part 1, even though there was no trend apparent. However there are two issues that arise from doing so.

    - Part 1 of the methodology appears to have an internal inconsistency. First, it states that the geometric mean of the ACRs for species whose SMAVs are close to the *acute criterion* is to be used. The parenthetical phrase that follows appears to define what "close" means, that is, species whose SMACRs are within a factor of 10 of the SMACR of the species whose SMAV is nearest the *5$^{th}$ percentile value*. The acute criterion and the 5$^{th}$ percentile value differ by an imposed factor of 2, and in this case, the species whose SMAV is nearest the acute criterion (*Daphnia magna*) is not the same as the species whose SMAV is nearest the 5$^{th}$ percentile value (*Arcatia tonsa*). If the parenthetical phrase is not meant to define what "close" means, then close remains undefined, and the issue remains that ACRs of species whose SMAV is close to the acute criterion are different than the ACRs within a factor of 10 of the species whose SMAV is nearest the 5$^{th}$ percentile value (see also number 3, below).
    - The authors misinterpret the language in Part 1. The authors' state that the methodology indicates that the ACR should be calculated based on the ACRs of species whose SMAVs are within a factor of 10 of the acute 5$^{th}$ percentile value. The methodology does not indicate this. Rather, the methodology appears to indicate that the ACR should be calculated based on those SMACRs which are within a factor of 10 of the SMACR for the species whose SMAV is nearest the acute 5$^{th}$ percentile value (as noted above). However, even if the authors are correctly interpreting the

methodology, which does not appear to be the case, they then have incorrectly applied the methodology to the cypermethrin scenario, as described below.

3. The authors appear to have misapplied their interpretation of the methodology that "only the SMACRs for species with SMAVs within a factor of 10 of the acute 5$^{th}$ percentile value should be used for the final multi-species ACR" (Fojut *et al.*, 2011b). Although it is never specified in either the methodology or in the draft criteria derivation document whether the acute 5$^{th}$ percentile value refers to the median (50% confidence limit) or the 95% confidence limit 5$^{th}$ percentile value, we assume it refers to the median 5$^{th}$ percentile value (0.0126904 µg/L), since this is the value used previously in the acute criterion derivation and used with the ACR in the initial calculation of the draft chronic criterion. If this is so, the authors appear to have erroneously determined that the SMAV for *Daphnia magna* was within a factor of 10 of the acute 5$^{th}$ percentile value, and simultaneously determined that the SMAV for *Acartia tonsa* was not. Table 1 shows the MATC, SMAV, ACR, and the factor between the calculated ACR and the acute median 5$^{th}$ percentile value, for reference. The SMAV for *Daphnia magna* is a factor of 21.2 lower than the acute 5$^{th}$ percentile value, while the SMAV for *Arcatia tonsa* is a factor of 8.52 greater than the acute 5$^{th}$ percentile value. According to the authors interpretation of the methodology and recommendation cited above, the ACR thus should have been calculated as simply the ACR for *Arcatia tonsa*, or 2.11. If the parenthetical expression of part 1 of section 3-4.2.1 is then added to this interpretation, the final ACR should actually be the geometric mean of the ACR for *Arcatia tonsa* and for *Oncorhynchus mykiss* (since this ACR is within a factor of 10 of the ACR for *Arcatia tonsa*), which would have resulted in an ACR of 2.18. Either way, the impact on the initial calculation of the chronic criterion is substantial. Instead of 0.01 ng/L, the chronic criterion would be calculated as 6 ng/L, equivalent to the draft acute criterion.

**Table 1. Acute-to-Chronic Ratios used for derivation of the cypermethrin chronic criterion, and factor between species mean acute value (SMAV) and acute 5$^{th}$ percentile value.**

| Species | Common identifier | MATC (µg/L) | SMAV (µg/L) | ACR ($LC_{50}$/MATC) | Factor [a] |
|---|---|---|---|---|---|
| *Arcatia tonsa* | Marine copepod (invertebrate) | 0.0512 | 0.1081 | 2.11 | 8.52 |
| *Daphnia magna* | Daphnid (invertebrate) | 6.3E-07 | 0.0006 | 949 | 21.2 |
| *Oncorhynchus mykiss* | Rainbow trout (fish) | 0.65 | 1.47 | 2.26 | 116 |

[a] – Factor calculated as SMAV/median acute 5$^{th}$ percentile value in the case of *Arcatia tonsa* and *Oncorhynchus mykiss* (i.e., SMAV > median acute 5$^{th}$ percentile value), and as median acute 5$^{th}$ percentile value/SMAV in the case of *Daphnia magna* (i.e., SMAV < median acute 5$^{th}$ percentile value). Median 5$^{th}$ percentile value was 0.0126904 ug/L.

The authors later adjust the acute criterion, using instead the 1$^{st}$ percentile, 50% confidence limit value to re-calculate the acute criterion, in order to protect sensitive species since the initially determined acute criterion was higher than the SMAV for some species in the data set. The resulting acute criterion is 1 ng/L (Fojut *et al.*, 2011b). Using the calculated ACR of 2.11 or 2.18 with the 1$^{st}$ percentile, 50% confidence limit value results in an adjusted chronic criterion of 1 ng/L, equivalent to the adjusted acute criterion. However, the methodology does

not address selection of appropriate ACRs based on use of the 1st percentile, 50% confidence limit value. When compared to this value (0.0025723 µg/L), the only species with a SMAV within a factor of 10 is *Daphnia magna*, which if used in place of the 5th percentile acute value, would result in an ACR of 949, and an adjusted chronic criterion of 0.003 ng/L. This approach, however, is technically inconsistent with the methodology. Furthermore, *Daphnia magna* is not very acutely sensitive ($LC_{50}$ of 147 ng/L), but apparently very chronically sensitive to cypermethrin, resulting in a very large ACR. Applying this ACR to an acute value driven largely by data for *Hyallela azteca*, which is very acutely sensitive, results in a criterion that is very likely overprotective.

In summary, it appears that if the methodology is to be applied as written, the final ACR should be the default of 12.4, which would result in an adjusted chronic criterion of 0.2 ng/L. However, if the authors' interpretation of the methodology takes precedence over a literal reading of the methodology, the final ACR should be 2.11 and the adjusted chronic criterion should be 1 ng/L, equivalent to the acute criterion. The only chronic value below either of these criteria is the MATC of 0.00063 ng/L for *Daphnia magna*, which, as the authors state, was calculated based on nominal concentrations, and thus the criterion should not be adjusted downward (TenBrook *et al.*, 2009).

As a final note, the study on which the *Daphnia magna* ACR was derived (Kim *et. al.*, 2008) was excluded from the list of studies used in the derivation of the acute criterion. This exclusion appears appropriate, but subsequent use of the study, particularly the acute value determined in the study, in the derivation of the ACR and chronic criterion is questionable. The methodology requires an "appropriate acceptable acute value" to pair with an acceptable MATC value to calculate an ACR (TenBrook *et al.*, 2009). Use of the word "acceptable" implies that the data are from the data set rated "RR", and not those excluded because of deficiencies in the testing or reporting. The authors should reconsider use of the Kim *et. al.* 2008 study entirely or provide more explicit reasoning for its inclusion in the ACR and chronic criterion derivation, despite its exclusion in the acute criterion derivation. Additionally, the ACR for *Daphnia magna* is highly sensitive to the MATC, which in this case was calculated from the geometric mean of the no observable effect concentration (NOEC) and the lowest observable effect concentration (LOEC). In the subject study, the concentration intervals used are based on a factor of 10. The Organization for Economic Cooperation and Development (OECD) guidelines recommend the intervals to be no greater than a factor of 3.2, since larger intervals can introduce significant bias in the calculation of the MATC (OECD 1998). Furthermore, the mean control response (number of young per female) of the Kim *et. al.* 2008 study did not meet OECD test acceptability criteria. For the less than 24 hour old neonates, the mean number of living young should be equal to or greater than 60; mean number of living young in the Kim *et. al.* 2008 study was less than 20. It is possible that a different clone of organism was used than that specified in the OECD guidance, but no evidence is provided in the Kim *et. al.* 2008 study to suggest that this low control response is indeed acceptable.

It is recommended that the authors revisit the methodology and/or the cypermethrin chronic criterion derivation, and subsequently re-release a draft report for public comment. Overall, this issue appears too complex to allow a final revision not subject to peer scrutiny and public comment.

### 3.2 Assumed Dose-Effect Additivity

Environmental toxicologists recognize the importance of considering toxicant mixtures when evaluating and predicting toxicity to an organism. It is a held theory that toxicants of similar mode of action can act additively on an organism. Through such simplifying models of concentration addition, the effect of dose additivity can be predicted.

In past reports, the authors made definitive statements regarding the use of dose-additivity in compliance determination, i.e., "The additivity of pyrethroid mixture toxicity has not been clearly defined in the literature, and in fact, antagonism has been observed, thus the concentration addition method is not recommended for use when multiple pyrethroids are found in a sample." (Fojut et al, 2010). In the permethrin and cypermethrin reports, although definitive statements regarding the interaction of PBO with pyrethroids and, more generally, non-additive chemicals, are made, no definitive statement is made regarding dose-additivity of pyrethroids for compliance determination. The authors do state that results of Trimble et al., 2009 indicate "...that in general, pyrethroid mixture toxicity is additive." (Fojut *et al.*, 2011a; Fojut *et al.*, 2011b). The authors rely on the same set of literature in discussing dose-additivity of pyrethroids in the permethrin and cypermethrin draft reports as they did in the final reports for bifenthrin, lambda-cyhalothrin, and cyfluthrin, and so it is unclear why no definitive statement is made. In absence of such a recommendation, the indication is that the body of evidence supports use of dose-additivity in compliance determinations, which is not the case.

Indeed, in investigations conducted by Trimble et al. (2009) on additivity in binary mixtures of Type I and Type II pyrethroids, although concentration addition models predicted experimental results well, as would be hypothesized, in some cases so did independent action models. Furthermore, actual toxicity often deviated substantially from predicted toxicity at low toxicant concentration, well below expected $LC_{50}$ values (i.e., in the range of the derived acute criterion). There is enough inherent uncertainty in the use and applicability of concentration addition models, be they toxic unit or relative potency factor approaches, that compliance determinations should not be based on assumed additivity. The reports should be revised to clearly state that dose-additivity is not recommended for the purposes of compliance determinations.

### 3.3 Bioavailability

The UCD criteria derivation methodology should be praised for including considerations of bioavailability. In Section 9 of the draft permethrin and cypermethrin criteria reports, the propensity of pyrethroid insecticides to sorb to particulate matter, sediments, and laboratory equipment is discussed. In this discussion several studies are mentioned providing evidence that pyrethroid toxicity in the water column is associated with the dissolved fraction, and that the freely dissolved fraction is the better predictor of toxicity. The reports state:

> "[Studies] suggest that the freely dissolved fraction of permethrin/cypermethrin is the primary bioavailable phase, and that this concentration is the best indicator of toxicity, thus, it is recommended that the freely dissolved fraction of permethrin/cypermethrin be directly measured or calculated based on site specific information for compliance assessment. Whole water concentrations are also valid for criteria compliance

assessment, and may be used at the discretion of environmental managers, although the bioavailable fraction may be overestimated with this method" (Fojut *et al.*, 2011a; Fojut *et al.*, 2011b).

The statement that "whole water concentrations are also valid for criteria compliance" is troubling. After extensive discussion of the scientific reasoning behind the author's recommendation of using the freely dissolved fraction for compliance, there is no support or discussion for the assertion that whole water concentrations are valid for this purpose. The recommendation that compliance determinations be based on the freely dissolved fraction reflects scientific understanding of pyrethroid bioavailability in the environment, and there is no clear basis, scientific or otherwise, for the authors' assertion that whole-water concentrations are valid for compliance determination. In light of the current scientific understanding of pyrethroid bioavailability, any total recoverable measurement unadjusted to account for the fraction that is not bioavailable represents a knowingly biased measurement and should not be used for compliance determination.

### 3.4 Analytical Concerns

For compliance testing purposes through National Pollutant Discharge Elimination System (NPDES) permits, EPA approved methodologies must be used. Existing analytical methods for the measurement of semi-volatile organic pollutants such as pyrethroid insecticides are limited in the capability of achieving the draft criteria values derived for permethrin and cypermethrin. Only the most diligent commercial laboratories can achieve reporting limits near the draft chronic permethrin and acute cypermethrin criteria using these analytical methods and employing good laboratory practices and standard quality assurance. No methods exist for the detection and quantification of cypermethrin near the draft chronic cypermethrin criterion, and indeed, such capabilities will likely not be seen for many years to come. There is limited commercial analytical capacity in California, and at present most laboratories could only assure reporting limits several times greater than the draft acute and chronic criteria. This limits the utility of criteria altogether, and potentially returns the regulated community to a position of providing the Regional Water Board with analytical results containing varied reporting limits. When using such criteria, maximum matrix-specific reporting limits should be considered so as to avoid the potential of reporting false positives and errant detections.

## 4 Summary of Review Findings

Review findings are summarized as follow:

1. The draft acute criteria for permethrin and cypermethrin are based on a species distribution approach and result in supportable criteria.

2. Available data indicate that the draft chronic criterion for permethrin may be overprotective. The ACR used to calculate the criterion was heavily influenced by a default ACR derived solely on classes of pesticides whose structures are different, environmental fate is different, and modes of toxic action are mostly different than permethrin.

3. Regarding cypermethrin, there are several inconsistencies and/or errors in the methodology, in the authors' interpretation of the methodology, and in the application of that interpretation that result in an unsupported ACR and, therefore, an unsupported chronic criterion. Instead of the draft chronic criterion of 0.003 ng/L, if the methodology were applied as written, the cypermethrin adjusted chronic criterion should be 0.2 ng/L. However, if the authors' interpretation of the methodology takes precedence over a literal reading of the methodology, the adjusted chronic criterion should be 1 ng/L. Furthermore, the authors use a study in the derivation of the chronic criterion which was previously excluded from the derivation of acute criterion, thus introducing a methodological inconsistency. It is recommended that the authors revisit the methodology and/or the cypermethrin chronic criterion derivation, and subsequently re-release a draft report for public comment. The issue appears too complex and substantial (in terms of its effect on the proposed criterion) to allow a final revision not subject to peer scrutiny and public comment.

4. For all draft criteria, it is not clear whether the assumption of dose additivity between pyrethroids of similar mode of toxicity is assumed for compliance determination. Caution is advised in applying concentration addition principals to compliance measurements. Dose additivity is not settled science, and its accuracy as a model predictor is sensitive to many variable factors and thus not always good. Where science is not settled, compliance should not be based on simplifying assumptions.

5. The current scientific understanding regarding pesticide bioavailability should be applied to criteria compliance determinations. The freely dissolved fraction of pyrethroid insecticides, including permethrin and cypermethrin, is a far better predictor of the bioavailable fraction than is total recoverable measurements. Therefore, compliance determinations should be based on measurements that most accurately predict toxicity. Either compliance should be determined using analytical procedures measuring the dissolved fraction, or compliance should be determined using total recoverable methods but adjusted for pyrethroid sorption to particulate matter and dissolved organic matter. There is no scientific support for using whole-water concentrations for compliance determinations.

6. Achieving commercially available analytical reporting limits below the draft criteria utilizing EPA approved methods is currently lacking or limited. Maximum matrix-specific reporting limits should be considered so as to avoid the potential of reporting false positives and errant detections.

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