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August 25, 2004

Craig J. Wilson
TMDL Listing Unit
Division of Water Quality
State Water Resources Control Board
P.O. B\ox 100
Sacramento, CA 95812-0100

Subject: Comments on statistical issues in the draft Water Quality Control Policy,
Appendix A, concerning Section303(d) listing and delisting decisions

Dear Mr. Wilson:

I have been asked by Flow Science Incorporated to offer my opinion as a statistical
expert on the July 22, 2004 version of the Functional Equivalent Document, Appendix A,
concerning Water Quality Control Policy. My professional background as a statistician
began with my research specialization in the field for my Ph.D. in mathematics from
Cornell in 106. Since that time, I have been continuously engaged in teaching statistics at
Northwestern University, UC Berkeley, and the California Institute of Technology
(Caltech), where I have been Professor of Mathematics since 1977 and department head
since 2003. In recognition of my research contributions I was elected in 1973 as a Fellow
of the professional society called the Institute of Mathematical Statistics, and throughout
my academic career I have been active as a statistical consultant not only for scientific
and engineering colleagues, but also for various governmental agencies and private
companies. I have also served as a statistical expert witness in a variety of legal and
regulatory matters.

My opinion is that the approach to listing and delisting decisions outlined in this latest
draft is very sensible and statistically sound. The virtues of the "Exact Binomial
Method" are as I outlined in my February 18, 2004 letter to you: it provides a robust,
distribution-free statistical framework for making listing decisions. That letter
concerned the December 2, 2003 SCRCB draft policy. I think the current draft is
considerably better, in that it provides an "even-handed" treatment of the null and
alternative hypotheses for the test. For example in Table 3.2 concerning conventional
pollutants, the hypothesis that the actual exceedance proportion is less than 10% and
the competing hypothesis that it is greater than 25% are treated symmetrically in the
sense that the probabilities of error in not choosing the correct hypothesis are equal,
or at least as nearly equal as possible. This avoids interminable arguments about which
hypothesis should be accorded the status of "null hypothesis" and puts the emphasis on
the "operating characteristic curve", which is more fruitful. In teaching hypothesis
testing to scientists and engineers over the last forty years, I have vigorously encouraged
the same kind of "even-handed" specifications as a means of choosing tests.
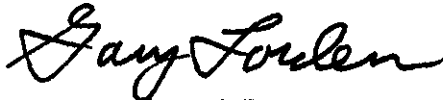
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Another virtue of the statistical approach outlined in the July 2004 document is the elegant symmetry of the listing and delisting criteria. For example, comparison of Tables 3.2 and 4.2 illustrates that a given number of exceedances out of a given sample size will always yield the same result—"should be on the list" or "should not be on the list"—regardless of whether the water body is currently on the list or not.

For what it's worth, to satisfy my curiosity I independently verified that the numbers in Table 3.2 are correct, given the criterion of minimizing the absolute value of the difference between the two error probabilities.

I think it is quite reasonable to include the "exception process" to address multiple lines of evidence, to be analyzed separately and then synthesized. It is also a good idea, I think, to be careful about making listing decisions based on negative trends in water quality, with safeguards of the sort listed in section 3.1.10.

In summary, I think the current draft of the policy represents solid progress in your effort to create a statistically sound framework for Section 303(d) listing and delisting decisions.

Sincerely,

Gary Lorden, Ph.D.

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