June 11, 2008

Jeanine Townsend, Clerk to the Board
State Water Resources Control Board
1001 I Street, 24th Floor
Sacramento, CA 95814

Re: Comments on Draft Construction Permit

Dear Ms. Townsend:

I was retained by Flow Science and asked to review and comment upon the proposed Draft General Permit for discharges of storm water associated with construction activities and supporting documents. I have reviewed the sections of the Draft Order[1] and associated Fact Sheet that discuss numeric effluent limits (NELs) and action levels (ALs).

My qualifications.

My professional background as a statistician began with my research specialization in that field for my Ph.D. in mathematics from Cornell in 1966. Since that time, I have been continuously engaged in research and teaching in statistics at Northwestern University, UC Berkeley, and the California Institute of Technology (Caltech), where I have been Professor of Mathematics since 1977 and was department chair from 2003 to 2006. I am a fellow of the Institute of Mathematical Statistics and have been active for the last forty years as a statistical consultant for Caltech and JPL colleagues and for various governmental agencies and private firms. I have also served as a statistical expert witness in a variety of legal and regulatory matters, including statistical issues related to water quality.

Statistical issues in determination of numerical limits for storm water.

Storm water data I have analyzed typically show very large site-to-site differences and high year-to-year and storm-to-storm variability. Such data do not fit a normal or lognormal distribution, particularly in the behavior of their higher percentiles, as was pointed out in the oft-cited paper of Shumway, *et al.* (2002)[2]. Consequently the calculation of typical summary statistics such as

[1] Order No. 2008-XX-DWQ, Waste Discharge Requirements for Discharges of Storm Water Runoff Associated with Construction Activity, March 18, 2008 version.

[2] Shumway, R.H, Azari, R.S. and M. Kayhanian. Statistical Approaches to Estimating Mean Water Quality Concentration with Detection Limits, (2002). Environmental Science and Technology 36:3345-3353.

sample means and sigmas does not lead to useful models of the probabilities of high values, and therefore relatively large sample sizes are required to obtain useful information about the probabilities of exceeding numerical limits.

For example, if one uses "the mean plus 3 sigma" as the basis for setting a numerical limit under lognormal or normal distribution assumptions (and as the Draft Order proposes to do to establish a NEL for pH), the result should be that only $1/8^{th}$ of one percent of measurements will exceed that limit. If the same low frequency—about 1 out of 740-- is to be achieved without relying on unrealistic "normal distribution" assumptions, the sample sizes required to obtain any reasonably accurate estimates of frequency of exceedance are on the order of 500 to 1000 measurements. With samples sizes in that range, so-called "semiparametric" statistical methods can be used to estimate exceedance probabilities reasonably accurately without relying on unrealistic attempts to find a universally applicable mathematical formula to describe the probability distributions of storm water data.

Caltrans data.

I have examined the raw data in the Caltrans dataset cited in the Fact Sheet for both pH and turbidity. There are 30 measurements for turbidity, made over a two-year period, and 76 for pH, made at 16 sites in California.

Not only are these sample sizes much too small to support statistically adequate calculations as a basis for numeric limits, but there is a more fundamental problem: combining small samples of haphazard sizes from a small number of sites for which data happen to be available will certainly not lead to a meaningful "single distribution." Examination of the data indicates that different sites have very different data distributions. For turbidity, the measurements for different sites have different orders of magnitude; for pH, the different sites yield data that cannot meaningfully be combined into a single distribution.

For example, two of the 16 sites accounted for 14 pH measurements less than 7.0 and 2 measurements greater than 7.0. The other sites accounted for 7 pH measurements less than 7.0 and 53 measurements greater than 7.0. At the other end of the pH range, two sites had 60% of pH values greater than 8.0 while the other 14 sites had only 6% of their pHs greater than 8.0. This indicates that pH distributions from the sites are significantly different, depending perhaps upon local soil conditions or other site-specific factors, and that it is erroneous to assume that data contained in the Caltrans dataset are drawn from a single statewide population.

NALs and NELs.

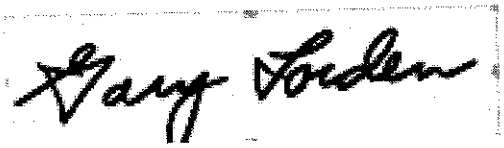
Given the very different practical effects of Action Levels and enforceable Numeric Effluent Limits, the latter should be based upon more reliable information. The proposed General Construction Permit has NELs for which there are scant supporting data. For turbidity, it appears that four data points from the Sacramento area played a major role in deriving the limit. For pH, the 76-point Caltrans dataset, as discussed above, is far from adequate to determine frequency of exceedance of limits, and no analysis has been made of the site-to-site or year-to-year differences—indeed none could be made from this very limited dataset.

Suggestions for a scientifically reasonable approach to numeric limits.

Board member Wolff requested commenters to consider the tiered compliance structure—NALs and NELs, and the possibility of creating a scientifically valid database via third-party "random" monitoring of management practice performance. The monitoring system should provide for multiple samples per storm rather than single samples, so that the substantial intrastorm variability is captured along with the interstorm variability.

In my opinion, the tiered compliance structure is the right approach, and what is needed for setting NELs is at least a five-year program of systematically designed third-party monitoring and data collection. The design should aim not at building up one amorphous, haphazard set of measurements for each feature of water quality across all sites and storms, but rather should aim at estimating the variable ranges of measurements associated with different sites and storm events. A database of that kind would provide a basis for scientifically supportable Numeric Effluent Limits.

Sincerely,



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