Public Comment
Agricultural Expert Panel Draft Report
Deadline: 8/7/14 by 12:00 noon

UNIVERSITY OF CALIFORNIA, DAVIS

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RECEIVED
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SWRCB Clerk

State Water Resources Control Board
1001 I Street, 24th Floor
Sacramento, CA 95814

Re: Comments on the Draft Report "Conclusion of the Agricultural Expert Panel, July 2014"

Following recommendation 14 of its SBX2 1 Report to the State Legislature, the State Water Board (SWB), earlier this year, convened a panel of agricultural experts ("Ag Expert Panel") to assess existing agricultural nitrate control programs. The objectives were to develop recommendations, as needed, to ensure that ongoing efforts are protective of groundwater supply quality, and to provide a more thorough analysis and long-term statewide recommendations regarding many of the issues implicated in State Water Board Order WQ 2013-0101. Further, it included indicators and methodologies for determining risk to surface and groundwater quality, targets for measuring reductions in risk, and the potential use of monitoring to evaluate practice effectiveness.

This letter provides technical and scientific comments on the Ag Expert Panel draft report issued on July 7, 2014. The comments in this document reflect a consensus among our group of experts in agricultural and hydrological sciences at the University of California Davis. Comments are provided specifically on the thirteen questions deliberated by the panel. Questions are grouped together for conciseness. Please feel free to contact us with questions on our comments.

Sincerely,

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Enclosures

1. How can risk to or vulnerability of groundwater best be determined in the context of a regulatory program such as the ILRP?
2. Evaluate and develop recommendations for the current approaches taken to assessing risk to or vulnerability of groundwater.
3. How can risk to or vulnerability of surface water best be determined in the context of a regulatory program such as the ILRP?
4. Evaluate and develop recommendations for the current approaches taken to assessing risk to or vulnerability of surface water.

Q1-4: Development or assessment of vulnerability analysis schemes to assess agricultural pollution sources of surface water or groundwater degradation requires significant knowledge of the hydrologic processes governing agricultural landscapes in California, both in the subsurface and across the watershed. A committee of experts with appropriate technical background should be selected to answer the above questions. For example, the National Research Council Committee on Techniques for Assessing Groundwater Vulnerability (NRC, 1993) consisted of national experts in hydrologic sciences and in agricultural water sciences. Significant guidance can be found in the report issued by this committee (NRC, 1993), but also in Vruba and Zoporozec (1994) and elsewhere. A general summary discussion on groundwater vulnerability schemes can also be found in Harter (2008).

5. What management practices are expected to be implemented and under what circumstances for the control of nitrogen?
6. What management practices are recommended for consideration by growers when they are selecting practices to put in place for the control of nitrogen?

Q5-6: The University of California Davis team preparing the report "Addressing Nitrate in California's Drinking Water" (Harter et al., 2012) was tasked, among other charges, with evaluating potential measures for nitrogen source reduction to protect groundwater quality. The 1998 UCANR publication "Nitrogen and Water Management for Cool-Season Vegetables" written in response to the Coastal Zone Management Act, provided a starting point for identifying these practices.

Recognizing that existing studies do not cover the range of crop, soil, and irrigation system combinations represented in California's diverse agricultural landscape, five expert panels were convened to discuss and refine and amend the draft list of practices and to provide insight into the current state of farm management practices specific to the two study areas (Tulare Lake Basin and Salinas Valley). The following five expert panels met to review and refine the draft list of suggested practices, estimate their current extent of use and identify the barriers to increased adoption:

- Salinas Valley cool-season vegetable and strawberries
- Woody perennials (vineyards, tree fruits, and nuts)
- Agronomic/field crops not receiving dairy manure
- Forage/silage crops receiving dairy manure
- Tulare Lake Basin vegetables and other truck crops.

Panels were set up as 6-10 person roundtable discussion. The five panels included 35 agricultural experts, including Cooperative Extension farm advisors, growers, crop management professionals and other industry personnel (most of which were Certified Crop Advisors).

These efforts by specialized experts provided the opportunity to significantly expand and revise earlier listed California management practices. In its detailed Chapter 2 of Technical Report 3 (Dzurella et al., 2012), the UC Davis report describes 10 management measures for reducing nitrate leaching to groundwater. A total of 50 recommended practices for achieving these management goals are reviewed in depth in this report.

Recommended measures and practices to maximize plant N recovery and reduce nitrate leaching to groundwater fall into one of four categories:

1. Design and operate irrigation and drainage systems to reduce deep percolation
2. Manage crop plants to capture more N and decrease deep percolation
3. Manage N fertilizer and manure to increase crop N use efficiency
4. Improve storage and handling of fertilizers and manure to decrease off-target discharge6

For each category, the report provides a narrative description of the associated management measures and their accompanying practices follows. Extent of current use and barriers to adoption were analyzed. While cost savings can often be realized with more efficient use of nitrogen and water, the barriers considered include:

- Real or perceived risks to crop yield or quality
- Capital costs (infrastructure, equipment)
- Operating cost (labor, management, training needs, energy, physical inputs, etc.)
- Ranch logistics barriers
- Land tenure constraints
- Grower education, training, or demonstrations needed to speed technology transfer
- Insufficient adaptation of technology to local conditions

The findings and a thorough analysis of literature and case studies show unequivocally that nitrate leachate reductions are possible with the adoption of improved farm management strategies.

Details of recommended practices are provided in Chapter 2 of Technical Report 3 (Dzurella et al., 2012), available online.

The efforts by this team of 35 agricultural experts represents an authoritative and perhaps the most comprehensive, scientifically based effort to date focused on systematically cataloguing and summarizing management measures and recommended practices for major cropping systems in Central California.

7. Evaluate and make recommendations regarding the usage of various nitrogen management and accounting practices.
12. Evaluate and make recommendations on how best to integrate the results of the Nitrogen Tracking and Reporting System Task Force with any above recommendation regarding management practices and verification measures.

Q7, Q12: It is critically important to distinguish between nitrogen management and nitrogen tracking and reporting:

- **Nitrogen management** is needed to insure economic sustainable crop production, while also minimizing cost and environmental impacts. It involves the planning, implementation, monitoring, and assessment of nitrogen and water management practices at the field scale on a frequent basis, through the individual grower, and possibly their consultant(s), peers, and/or peer groups. Nitrogen (and water) management is intrinsic to agricultural management. Nitrogen management can be improved through metrics for water application, nutrient application, crop growth, crop water and nutrient status, crop harvest, soil water and nutrient status, climate, etc., but also by efficient data tracking and data processing.
- **Nitrogen tracking and reporting** serves an administrative purpose to control the discharge of a potential pollutant into groundwater. Nitrogen tracking and reporting provides an economical and effective opportunity to serve as a less expensive (but also perhaps less accurate) alternative ("proxy") for estimating the actual discharge of nitrate to groundwater. The economizing occurs because the data needed to create this proxy metric of groundwater nitrate discharge does not require additional

instruments or data collection efforts but can be extracted from data already collected for good nitrogen management (see above). Data appropriate for tracking and reporting are extracted and summarized from ongoing nutrient management efforts, in a manner specific to serve the purpose of the proxy: creating a representative metric of annual nitrate discharge to groundwater.

California's Porter-Cologne Water Quality Control Act ("Porter-Cologne") defines general requirements for measuring discharge of waste to groundwater and surface water. The State Water Board and its Regional Water Boards have a half century history of administrating waste discharge permitting and monitoring programs for point sources of potential surface water and groundwater discharges. Technological and scientific advances over that period have greatly assisted the regulated community (mostly urban/industrial dischargers) and the regulatory agencies to develop, implement, and adaptively improve these monitoring programs over time.

The scientific basis for point source regulation was developed over decades with support from state and federal governments, from research institutions, as well as industry and industry associations. **With proper industry, regulatory, and scientific support, a similar development of science, technology, and regulatory programs will emerge for controlling and monitoring agricultural discharges to groundwater and surface water**. Conversely, without such support, non-point source contamination problems will continue to grow and associated controversies will remain unnecessarily intense.

With respect to groundwater, the geography and hydrology of agricultural N sources are very different from typical point sources, for example, industrial contamination:

- Sources are contiguous, with individually managed sources (fields, farms) located next to other sources, which have potentially similar discharge strength
- Sources are internally heterogeneous with nitrate leaching to groundwater strongly varying within individual fields
- Sources are managed to actively leach at least some water for salinity control and groundwater recharge (whereas many industrial point sources currently regulated, such as underground storage tanks, are typically managed to be sealed)
- Sources of nitrate are not as "hot" as typical industrial sources: nitrate concentrations in recharge from agricultural fields are typically within much less than one to two orders of magnitude of the drinking water limit, whereas industrial sources often leach contaminants at concentrations that are several orders of magnitude above drinking water limits.
- In contrast to nonpoint source pollution of surface water, where representative measurements are often obtained at the watershed (or sub-watershed) outflow, groundwater does not have a single outlet that could be used for representative monitoring at a single discharge location.

As a result of these differences, current monitoring (and remediation) tools developed for controlling point sources of groundwater, cannot be readily transferred to agricultural sources.

This finding also applies to a key monitoring tool in controlling point sources: Monitoring well networks established in first encountered groundwater around (upgradient and downgradient of) individual sources. The number of individually managed agricultural sources (fields) is simply too large to afford this approach in a manner that allows for effective discernment of individual sources' contributions, even though the science and technology to do so currently exists.

The need for, on one hand, regulating individual sources in some manner under Porter-Cologne, and, on the other hand, the specific constraints imposed by the hydrologic realities of agricultural groundwater nitrate sources, **necessitate the use of an alternative monitoring approach**. We strongly support the Central Valley Regional Water Board's approach, applied in the Irrigated Lands Regulatory Program, of a fundamentally **three-tiered monitoring approach**:

- **Monitoring a proxy metric, rather than actual discharge via "Nitrogen tracking and reporting"**: Instead of a monitoring well network around each individual source (fields, farms), the ILRP uses a more economical proxy that can reasonably estimate the discharge of nitrate to groundwater. The N mass balance is the currently most effective proxy tool.
- **Scientifically based evaluation of the link between proxy metric and actual discharge via a "Representative practice evaluation"**: Require field research at representative sites (for key representative crops and key representative water and nutrient management practices) that further establishes the actual relationship between the N mass balance (the proxy) and the actual nitrate discharge to groundwater (of interest for administering Porter-Cologne) through detailed instrumentation of the root zone, the soil below the root zone, and/or through monitoring wells. Scientific approaches and appropriate technologies to implement such research exist and have been documented in the hydrologic literature (for examples, see the extensive list of literature cited in Viers et al., 2012, p. 257 ff., or the CDFA FREP research database) and continue to be developed. This also includes many of the groundwater monitoring tools developed for hazardous waste sites (for example, ITRC online guidance).
- **Regional, spatio-temporal trend monitoring network**: establishing a regional monitoring network of wells (including monitoring, domestic, irrigation, or public supply wells) that provides a statistically representative measure of regional groundwater quality to be used to establish long-term trends and sub-regional or landuse specific differences in groundwater quality and to assure that broader compliance with groundwater quality objectives is met.

A conceptually similar, three-tiered approach is already in place for controlling pesticide discharges to groundwater under the Federal Insecticide, Fungicide, and Rodenticide Act and administered in California by the Department of Pesticide Regulations (DPR): DPR maintains a pesticide use reporting system, a research program to develop and evaluate management practices, which also supports development of pesticide use guidelines, and a regional monitoring network (Troiano et al., 2013).

Proper nitrogen tracking and reporting is therefore an effective, efficient, and very central part of implementing Porter-Cologne. The recommendations of the Final Report of the CDFA Nitrogen Tracking and Reporting System Task Force (Task Force) reflect a broad consensus among agricultural and environmental stakeholder groups, regulatory agencies, and technical-scientific experts represented on the Task Force regarding the framework for such an nitrogen tracking and reporting system. The Task Force recommended eight critical elements that need to be part of an effective nitrogen tracking and reporting system:

- System structure
- Data elements
- Role, responsibilities and data accessibility
- Benefits of participation
- Verifiability
- Societal benefits of a recommended system
- Limitations and
- System phase-in

The Task Force report clarified that other factors were not considered by the Task Force, which include "details related to database development, data gathering by aggregators, data transmittal, the definition and designation of high-risk areas, and groundwater quality monitoring and reporting. These factors offer numerous complexities and **are all essential components** to a broader comprehensive administration strategy" [emphasis added]. The Task Force recognized that there are scientific and methodological uncertainties and "emphasized the importance of further scientific research to strengthen available methods". We strongly support these findings of the Task Force.

The Task Force clearly identified key data elements for such a reporting system, which included, among other elements: all nitrogen applied, all nitrogen removed, residual nitrogen credits, and irrigation methods. We concur with the Task Force.

The Ag Expert Panel recommendation to solely focus on applied nitrogen is neither justified by the broader consensus already established nor by the need to establish a practical measure of evaluating nitrogen discharge to groundwater.

Annual nitrogen discharge to groundwater is most closely controlled by and correlated to the difference between nitrogen applied and nitrogen removed, especially over a multi-year time period. Considering both, nitrogen applied and nitrogen removed, avoids penalizing growers with excellent management practices that result in high yields, high nitrogen removals relative to nitrogen applied, and therefore significant improvements to nitrogen discharge to groundwater.

The Ag Expert Panel report leaves the impression that all monitoring data is suspect, and therefore of questionable value; this de-incentivizes additional innovation and research, which is clearly needed. Regarding nitrogen (N) reporting requirements, the ability to estimate potential N loading is important for regulators, and would require the reporting of both N application data and N harvest removal estimates. Effective tools for estimating N removal exist.

Requiring individual growers to report N removal estimates does bring its own set of difficulties:

- Are marketable yields trade secrets? Publically reporting yields, perhaps even to coalitions, may generate resistance among some growers.
- Do we have good estimates for N content per unit yield for all important crops, and how variable is N content per unit yield? If growers (or their consultants) are asked to report N removal estimates, there would probably be a wide range of assumptions made, and the quality of the reported data may be suspect.

We agree with the Task Force in envisioning a transition period into N reporting. Initially, growers focus on reporting good N application data (all sources), as suggested by the Ag Expert Panel, but also on reporting good yield data (including any plant material removed). The aggregating entity would estimate N removal based on individually reported yield and plant removal information, using uniform and standardized estimation methods for N content per unit of harvest that are based on defensible scientific methods and research on N removal in harvest and plant materials. At the same time, research should be initiated to develop effective on-farm methods to measure N removal at the farm level, which can then be incorporated into the reporting system to improve N tracking accuracy at the field/farm level. Already, all produce is tested at the receiving warehouse/packing plant for quality attributes – adding an N test would be trivial and could provide a direct measure of N export. Packing houses could also establish acceptable levels thereby further enhancing incentives.

8. Evaluate and make recommendations regarding the most effective methods for ensuring growers have the knowledge required for effectively implementing recommended management practices.

Q8: **We fully concur with the Ag Expert Panel's recommendation that an extensive, ongoing grower education through a variety of extension and education programs, offered by the University of California, the Cal Poly Irrigation & Training Center, California State Universities and other qualified extension and education institutions. Funding will be needed to greatly expand the current capacities in the State to perform such education and extension programs.**

9. What measurements can be used to verify that the implementations of management practices for nitrogen are as effective as possible?
10. Evaluate and make recommendations regarding the usage of listed verification measurements of nitrogen control.

Q9-10: Based on our own research and the scientific literature, we find that soil measurement protocols and instrumentation are available to estimate water and nitrogen losses to below the root zone with e.g., Onsoy et al., 2005].

With currently available instrumentation, models, and properly implemented (including sufficient replication of instrumentation across a field), nitrogen and water leaching estimates (pounds per acre per year) can be made to within approximately 10% - 30% of total N applied, for example:

- ±15 lb/ac/yr for crops with total N applications of 50 - 150 lb/ac/yr
- ±30 lb/ac/yr for crops with total N applications of 100 – 300 lb/ac/yr
- ±60 lb/ac/yr for crops with total N applications of 200 – 600 lb/ac/yr

For purposes of scientific calibration of methods and standards, groundwater monitoring wells, properly installed in first encountered saturated aquifer materials, in areas with shallow groundwater, can be used to estimate groundwater nitrate loading from a field, in pounds per acre per year, to similar or better accuracy. Monitoring wells, typically constructed with screen lengths ranging from a few feet to 20 feet, capture an age-mixed sample of water: younger water enters the top of the screen, somewhat older water enters at the bottom of the screen. Depending on local hydrogeologic conditions and well construction, the age range captured with and mixed within a monitoring well sample is typically less than 6 month at the top of the screen, and between less than 1 year to 5 years at the bottom of the screen (age computed as time since recharge to the water table, not including travel time in the vadose zone). Because of this mixing within the well-bore, monitoring well water samples represent recharge history over a period of time, typically exceeding one year, but less than 5 years. Domestic and production wells typically have longer screens that mix groundwater with a much larger age range.

We therefore concur with the Ag Expert Panel finding that the most significant metric of groundwater nitrate loading is a multi-year (e.g., 3-year) running average of annual nitrate leaching to groundwater. Computation of a running average, however, requires that the reporting is done for an annual time horizon, that is, the annual N mass balance. To the degree that errors in the annual N mass balance vary from year to year, a running average of the annual nitrate leaching to groundwater will be more accurate than the annual estimate itself.

In California, the average nitrogen application to cropping systems is on the order of 200 lb/ac/yr, with a nitrogen removal rate on the order of 100 lb/ac/yr. Given that a desirable target for groundwater nitrate loading (based on historic recharge rates and the drinking water limit for nitrate) is on the order of 30 lb/ac/yr, a finding of a leaching rate of 100 lb/ac/yr, even if 30% inaccurate, is sufficient to determine that significant reductions in N leaching are needed to meet environmental targets.

We therefore disagree with the Ag Expert Panel that the imprecision that is intrinsic to hydrologic measurements within a heterogeneous aquifer or soil system leads to useless results.

11. Evaluate the relative merits, and make recommendations regarding the usage of, surface water measurement systems derived from either receiving water or a discharge monitoring approach to identify problem discharges.
13. Evaluate and make recommendations on the reporting requirements to report budgeting and recording of nitrogen application on a management block basis versus reporting aggregated numbers on a nitrate loading risk unit level.

Q11, Q13: No specific comments.

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