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Nitrate Expert Panel
Summary of Points – June 9, 2014 Meeting

Risk and Vulnerability

When discussing the identification of "risk" and "vulnerability", the Panel determined that there are basically two indicators being discussed[1]. First, there are certain intrinsic characteristics that can be used to determine if a general area is "vulnerable" to rapid groundwater contamination: soil characteristics, depth to groundwater, etc. Second, human-influenced factors such as crop type, irrigation system, and management practices can determine if a particular farm is at "risk" of further contaminating the groundwater. Therefore, you can have a high-risk farm in a low-vulnerability area, or a low-risk farm on a high-vulnerability area.

Key point: the Panel was not confident that the designation of high or low "risk" or "vulnerability" should even be relevant.

The existing indexing and identification tools used by regional boards for "risk" or "vulnerability" are insufficient. Some are too complex, others do not take enough variables into account, and others do not seem to make mathematical sense. For example, the NHI value depends upon the multiplication of three variables, yet there is no good logic for even using a multiplication process.

Certain inputs, such as the size of a farming operation, are not relevant to the topic from a scientific standpoint. The panel recognizes that there may be administrative or political justifications that impact using a farm operation size, but there is no technical merit.

Information is already available regarding concentrations of nitrate in the groundwater. But the existence of low nitrates today does not mean that the nitrates levels in groundwater at a point will increase or decrease in the future.

[1] The terminology used here is that which was most commonly spoken in the meeting, rather than the hydrologic terms such as "sensitivity"/"probability" put forth by Till Angermann

Identification of the source of existing groundwater nitrates is problematic at best due to the lag times, lateral and vertical flows in the aquifer, lack of knowledge of depths of perforations in well screens, mixing of water between groundwater zones in wells, and the heterogeneous nature of the aquifer and vadose zone.

Key point: There is no reliable and practical method available, that is generally applicable, to accurately pinpoint the causes and sources of groundwater nitrates found at any point (horizontal and vertical) in an aquifer.

The Panel members agree on the following key point:

Key point: The only way to reduce nitrate deep percolation from crop root zones is to reduce the volume of deep percolation water (irrigation or rainfall), and to also match the available nitrogen to the plant needs.

There are numerous factors that might impact deep percolation – factors which can be used to create exhaustive lists of best management practices, intrinsic soil properties, etc. Some indexes (such as NHI) attempt to mesh both aspects – information about the soil plus something about the irrigation method. But the use a single index to lump numerous complex inter-relationships together is merely a proxy to answering two basic questions: Are the nitrogen and water needs of the crop being managed in a reasonably good manner?

The same argument applies to any attempt to link groundwater monitoring to nitrate deep percolation on fields above an aquifer. Groundwater monitoring results for this purpose are merely a proxy to answering two basic questions: Are the nitrogen and water needs of the crop being managed in a reasonably good manner?

Key point: Using a hazard index of conditions above ground such as with NHI, or an index based on groundwater nitrate levels, are both poor proxies to answering two basic questions on farms/fields: Are the (i) nitrogen and (ii) water needs of the crop(s) being managed in a reasonably good manner?

The Panel heard ample evidence of the futility of using short term (less than 10-20 years) trend data of groundwater nitrogen levels as a means to evaluate the effectiveness of a program.

Key point: The Regional and State Boards need some metric (index or tool) to evaluate the effectiveness of fertilizer management programs. However, groundwater nitrate levels, examined over periods of less than 10-20 years, cannot be expected to demonstrate such an impact. A different metric must be used.

If the objective is to reduce or maintain nitrate levels in the groundwater, improvements have to start at the surface, which means on-farm. Current groundwater conditions should not trigger reporting or regulation of above-ground activity. Current groundwater conditions can likely be useful for grower awareness by providing:

- Knowledge of whether his/her farm is in an area that has high nitrates in the groundwater.

- Knowledge of the level of nitrates in the groundwater that he/she is using as his/her irrigation water

The Panel agrees that the progress of groundwater nitrate concentrations should also be monitored, in order to track general aquifer conditions over multiple years.

The Panel members discussed in length if improved proxies were available or could be constructed. Some of the key points from those discussions are:

There was clear testimony that there have been large challenges by the East San Joaquin Valley Coalition, in just obtaining correct locations of fields.

Key Point: Programs must meet the challenge of being meaningful without being overly complex. Programs with excess complexity and excessive data collection/reporting will fail.

Some Regional Board testimony distinguished between data that needs to be collected, versus data that needed to be reported, versus data that needed to be maintained on site for inspection by a farmer.

Key Point: The cost and hassle of data collection for a farmer is the same whether it must be reported or not.

Key Point: Detail about the blends of fertilizer and the timing of fertilizer applications is considered to be the same as a trade secret by most farmers. The Panel feels that details of this type do not needed to be shared for any reasonable nitrogen management program.

Applied water volumes to individual fields are not known in many cases with a high degree of accuracy. Many irrigation districts in California are currently struggling to meet a +/- 12% accuracy standard for measurement of annual volumes at district turnouts. Once district water is beyond the turnout, it is often split, applied to a large number of fields, mixed with groundwater in common pipe systems, and is generally not measured to individual fields.

Key Point: A requirement of deep percolation information on individual fields will guarantee failure of a near-term regulatory program.

Detailed nitrogen cycle computations for individual fields, for a growing season, will be fraught with error and unnecessary expense. It is well known that even one aspect of the nitrogen cycle – the rates of mineralization of organic residues – is tremendously complex. To obtain an accurate value, one would need to know the nitrogen forms in residue, the residue concentrations at various levels in the soil, the temperatures and moisture contents in various levels, and have some indication of many key factors that influence the microbiological conversions. Even research studies have difficulties with this.

Key Point: It is highly unadvisable to require annual nitrogen cycle computations for fields.

Some crops have relatively simple growing conditions, and nitrogen requirements have been well researched. For example, almonds and pistachios grown in Kern County (with minimal rain) without cover crops have a relatively simple and accepted relationship between harvested yield and nitrogen removal. But these are very simple crops. Field crops (corn, cotton,

safflower, alfalfa, etc) and produce crops (lettuce, cauliflower, broccoli, etc) are typically much more complex in the sense that they are grown in rotation with other crops, often experience heavy rainfall events (if not grown in Kern County, for example), and do not have neat and well known nitrogen uptake rates. Furthermore, there is often considerable art (non-transferrable knowledge) in farming some produce crops because of the need to green color and shipping quality. Produce crops are often grown with 2-3 crops/year, and in very small plots.

Key Point: Describing and understanding the nitrogen management of a 160 acre almond orchard is relatively simple as compared to describing and understanding the nitrogen management of 16 – 10 acre produce crop fields.

****Note by Charles Burt – we did not explicitly discuss this, but I think it's an important point****

Efforts to improve agricultural nitrogen fertilizer management will be challenging, in part because of common terminology and recommendations that have traditionally been offered by the University of California extension. For example, consider the following statement in a 2009 UC extension publication:

> *Compared to most other vegetable crops, lettuce has a moderate nitrogen requirement, taking up on average only 100 to120 lb N/acre. Many replicated trials have demonstrated that, with efficient water management, seasonal nitrogen application of about 150 lb/acre should be adequate to achieve high yield and quality; in fields with significant residual concentration of nitrates in the soil even lower nitrogen rates can be adequate*.
> (http://www.ipm.ucdavis.edu/PMG/r441311411.html)

Although there is mention of "significant residual concentration of nitrates in the soil", the recommendation above clearly illustrates two common concepts:

1. Common recommendations are phrased in terms of "requirements" or "demand" and talk about the N uptake from the soil – not the N removal from a field at harvest.
2. Common recommendations have a built-in inefficiency. For example, one could interpret the statement above to say that the plant needs 100 lb N/acre, and the recommendation of application is 150 lb N/acre – a guaranteed efficiency of 67%.....not including the difference between plant uptake and plant N removed.

Simultaneously, it is very clear that some members of the UC extension service have spent considerable time distinguishing between plant uptake of N, and harvested (or removed) N. But that message is often lost in common recommendations.

Key Point: Common terminology and recommendations for Nitrogen applications that farmers are accustomed to hearing, do not focus on matching N applications with N removal from fields.

In spite of all the problems and challenges mentioned above, the Panel proceeded with consensus on two major points:

1. The State and Regional Boards must have some way of measuring progress over time on a regional basis. But measuring groundwater was deemed unreliable, because the source of the nitrates cannot be pinpointed. Fertilizer sales are also unreliable indicators of regional nitrogen applications.

2. Any improvements in nitrogen management on the ground must require the development and implementation of simple and pragmatic nutrient and water management plans by farmers. A key element of any field/farm nutrient management program is a record of the nitrogen applied to fields.

Key Point: Rather than use proxy measures such as NHI index or groundwater nitrate concentrations, it is best to obtain direct data of the nitrogen applied by field/crop.

Key Point: A reporting of the **nitrogen applied to fields (along with the crop type and acreage)** will serve three purposes:

1. The State and Regional Boards will have good data that demonstrates if trends are indeed occurring.
2. Farmers will need to develop this information, in any case, so it will not require extra data collection.
3. Coalitions (discussed later) can provide simple information to farmers that allow them to compare their nitrogen applications for a crop against the nitrogen applications of others with the same crops.

The Panel emphasizes that such N application data should only be used to provide a multiple-year picture of nitrogen use in an entire region. Data should not be compared year-to-year, but rather examined as multi-year trends (over 5-10 years) in a region. Many factors, such as residual nitrogen and nitrogen removal rates, vary by year and by crop rotation. These differences tend to even out over multiple years. In collecting initial data, the regional boards will be able to report to the State Board a specific multi-year baseline for future comparison. This baseline can be used to indicate progress in the long term. Similarly, when viewed on a regional basis, areas with a relatively high nitrogen use can be easily identified based on this data.

The Panel clearly recommends that the data collected be used for education and later development of management plans, not for enforcement. Grower understanding and improvements are vital, and growers will be reluctant to participate in programs if they fear self-incrimination.

The nitrogen application computation should include the nitrogen applied as:

- Organic applications (manure, etc.)
- Synthetic fertilizer applications
- Irrigation water

The Panel acknowledges that this method (reporting applied N) is imperfect. For example, a crop planted after alfalfa is removed will have a smaller nitrogen requirement than one that does not follow a legume. Nitrogen requirements will depend upon many factors. But as stated earlier, multiple years and multiple fields will create an averaging effect.

The benefit of N reporting is that it is simple and gets to the root of the issue. It also fits into the most important element – which is not enforcement. The most important element of any program is increasing awareness by fertilizer users, and improvement of fertilizer management practices. The nitrogen application values are key ingredients of any such farm program.

Pump and Fertilize:

It was discussed whether a program that requires reporting nitrogen concentration in groundwater might provide a disincentive for farmers to use high-nitrate water. The Panel members believe that there should be no dis-incentive to pump high-nitrate water, and coalitions and Regional Boards must be especially careful to finesse guidelines that emphasis this point.

Communities with Domestic Water Wells:

The Panel notes and emphasizes that there are two distinct issues:

1. Communities with high nitrate drinking water in wells.
2. Agricultural nitrogen management programs.

This does not mean that there has been no relation between agricultural nitrogen and high nitrate in drinking water wells. What it does mean is that:

1. When all well nitrate levels in a large area are averaged together to classify an area, one loses the distinction between problems in areas of community drinking water, and areas without community wells.
2. There is an immediate concern about high nitrates in drinking water wells. But it is clear that changes on the ground surface, of any type, will usually not have a significant impact on those nitrate levels for many years. Meanwhile, the nitrate levels may rise or fall. Drinking water nitrate problems need to be addresses immediately if they are health issues. They will not be solved immediately by fertilizer management changes.

Coalitions:
The Panel agrees that grower coalitions are vital and should be strongly encouraged by regional boards. The Panel recommends strong, local, third-party participation in all regions for the administration of whatever program is put into place.

Key Point: Idea was that coalitions would get reports from multiple years. They will likely investigate instances of extremely high applications, compared to the average. This will be done by the coalitions. It could be explained by incorrect data entry, high yields, unusual events. The coalition would encourage the farmer to make changes if necessary.

Surface Water (Q3-4):
The Panel does not feel adequately prepared to answer questions about surface water. The Panel has solicited written comments from the public on the topic, which will be submitted to the State Board and reviewed by the Panel before the next meeting.

Management Practices (Q5-6):
The Panel agrees that optimized nitrogen use efficiency should be the focus of management practices encouraged as a result of this report.

There seem to be two approaches. Previous panels have focused on laundry lists of practices, computations, etc.
This Panel believes that the 3 key BMPs are:

1. Creation of irrigation and nutrient management plans specific to each grower and similar management unit
2. Implementation of the management plans.
3. Internal (private) review and assessment of the impacts (crop quality, amount of fertilizer and water used, gross costs).

The details of these plans should be used for management only, and not for reporting purposes. The management plans should aid growers in determining the current status of their nitrogen use, as well as develop tools and practices to minimize nitrogen applications. After the plan is implemented, progress should be checked after a certain interval, and the effectiveness of the plan evaluated for any necessary modifications.

The concept of "high-vulnerability areas" should be irrelevant to the creation of a management plan. No matter what the topography, soil characteristics, or depth to groundwater exists in an area, any nitrogen that leaches past the root zone will eventually reach the groundwater. It may take decades longer in some areas than others, but the Panel agrees that the programs implemented today should look toward even the distant future. Therefore, growers in "low-vulnerability" areas should be held to the same standards as those in "high-vulnerability" areas.

To begin the creation of a management plan, the grower must be knowledgeable about certain data (which should be current data that is updated at some interval). These data include:

- How much nitrogen is being applied from all sources, including fertilizers and irrigation water, as well as the timing and uniformity of the applications
- How much nitrogen is removed, by crop type
- The distribution uniformity of existing irrigation systems
- The volume of water applied to a field.

Key point: All management plans must include estimates of nitrogen applied, nitrogen removed, the distribution uniformity (DU) of the irrigation system, and the volume of water applied to a field.

A first step for many management plans will be to develop the develop the data collection process (water and fertilizer), and data organization procedures and tools to accomplish this (which can range From these data, an appropriate nutrient management plan, an appropriate irrigation schedule, and a plan for irrigation system maintenance should be developed based on system type and crop demand.

Starting in 1982, Cal Poly ITRC developed the standardized procedures for Distribution Uniformity (DU) evaluation for the California DWR. Over the years, these procedures have been frequently updated and have been used for an estimated few thousands of evaluations. It is

recommended that ITRC develop "short" versions of DU evaluations for various irrigation methods, along with web-based instruction. This will be essential for rapid adoption of DU evaluations.

Key Point: An essential detail for nutrient and irrigation management plan development is "Who will be deemed qualified to create and evaluate these plans"? The Panel believes that the state and regional Boards should agree on the qualifications of the individuals who will create and evaluate these plans, and the basic simple requirements of the plans. But the Board staff will not review plans.

The regional boards could offer a "laundry list" of options for growers to implement, but the problem with laundry lists is that they almost always lack sufficient detail to be of interest to farmers. Experts do not need to refer to such lists. The Panel agrees that lists of most specific practices should be in the form of heightened awareness for consideration only, rather than requirements.

Education (topics mentioned)

All members of the Panel emphasize the high need for education, both in terms of educating growers as well as consultants and professionals who will be assisting growers in creating their management plans. Most importantly, growers must understand why the programs that are implemented are important, what the impacts will be to their specific operation, and how they can meet the requirements and recommendations that will be set forth. Additionally, any agricultural consultants, commodity groups, trade organizations, service providers, etc. need to be on the same page about the program.

Several topics were emphasized as vital components of a good grower education program:

- Water and nitrogen needs specific to particular crops – separating uptake versus removal.
- How to create an appropriate irrigation schedule.
- The standing of other growers in a region. In other words, what is the range of N applications/year for crop "Z"?
- Correct timing of nitrogen applications
- "Spoon-feeding" of fertilizers and other chemicals, rather than large-dose applications, should be emphasized. Currently, most growers have neither the equipment nor adequate education to do this; however, education about and adoption of these techniques should be encouraged.
- Lower-dose, split applications of nitrogen throughout a growing season are highly recommended to reduce N fertilizer applications. This is similar in concept to "spoon-feeding".
- Maintenance requirements of different irrigation systems.