ITRC
moving water in new directions
IRRIGATION TRAINING & RESEARCH CENTER
California Polytechnic State University
San Luis Obispo, CA 93407-0730
Phone: (805) 756-2434
FAX: (805) 756-2433
www.itrc.org

Expert Panel Initial Responses to Questions
June 9, 2014
DRAFT – BRAINSTORMING IDEAS, ONLY*

CONTENTS

Subject 1: Vulnerability and Risk Assessment

Regulatory programs are most effective when they are able to focus attention and requirements on those discharges or dischargers (i.e., growers) that pose the highest risk or threat because of the characteristics of their discharge or the environment into which the discharge occurs. The various Irrigated Lands Regulatory Program (ILRP) orders issued throughout the state by the Regional Water Boards have taken different approaches in their prioritization schemas, some using specific criteria or methodologies, others utilizing measurements of previous known impacts.

SUBJECT:	VULNERABILITY AND RISK ASSESSMENT
Question 1	How can risk to or vulnerability of **groundwater** best be determined in the context of a regulatory program such as the ILRP?

Panel Response #1:

The designation should include the following criteria:

a. Is the groundwater drinkable, when considering all standard drinking water chemical quality criteria except for nitrate?
   If it is not drinkable, it will not be considered a "high risk" due to nitrate.
   If it is drinkable, go to (b) below.

b. Are there drinking water wells at a density of more than ***/square mile, or servicing more than *** people per square mile, in the area?
   If the answer is "no", it will not be considered a "high risk" for health.
   If the answer is "yes", go to (c) below.

c. Is the nitrate concentration in the groundwater in the aquifer that is pumped for drinking water, on the average, greater than *** ppm (note – it is important to specify what "on the average" means, and what ppm nitrate or nitrate-N qualifies for the trigger).
   If the ppm nitrate-N is less than the trigger value, it will not be a "high risk"
   If the ppm nitrate-N is greater than or equal to the trigger value, continue to (d) below.

d. A few conditions will automatically exclude a few remaining areas from being considered "high risk". These are:
   i. Wine grapes grown with drip/micro irrigation on soils that are loams, or heavier in texture – with a coefficient of variation of NDVI index during July of less than 0.20. This is because fields with non-uniform growth will likely have excess deep percolation in spots throughout the field due to non-uniform nitrogen uptake rates.
   ii. Rice grown on heavy (silt loam, clay loam, loam, etc.) soils that are exposed to anaerobic conditions all times during the year that water (rain or irrigation) might deep percolate. This excludes areas with sandier soils that do not have consistent high water tables.

e. Use a modified Nitrate Risk Assessment [NRA] (notice the new name, as opposed to the Nitrogen Hazard Index) to identify any **remaining areas as high risk**. Up to this point, no areas have been identified as "high risk"; rather, many areas have been specifically excluded. The NRA will account for the following:
   i. Crop type
   ii. Irrigation type –soil type combination

iii. Depth to groundwater
iv. Coefficient of variation of NDVI within a field

Panel Response #2:

The measurements currently most used for determining risk are proximity or operation within an impaired water body and the use of a risk calculation such as NHI or Nitrate Loading Factor. Both of these tools create use output values to trigger a lower or higher regulatory burden, but do not give the grower much flexibility to adopt practices or otherwise make changes to their operation to reduce risk or exposure. For example, a grower cannot readily change their crop, soil type, or irrigation source, but these are all significant and high magnitude indicators of risk in the language of the current central coast order. At best the current tools should serve as basin, region, or coalition wide, high level indicators of risk or as an education and awareness tool to bring attention to the magnitude of the growers' subsequent irrigation and fertilization strategies.

Nitrate concentration analyses in well water should not create a disincentive to growers to use wells for an irrigation source if that well exceeds the MCL standards and/or potentially triggers a higher tier or risk profile. The agricultural community is perhaps the lowest cost method of treating groundwater through the "pump and fertilize" method described at various times throughout the testimony heard by the expert panel.

I agreed with the testimony of Berenklau in that risk and vulnerability should be predicted as well as assessed in the current practices. Regions, coalitions, or water districts would be well served to know the resulting risk or vulnerability to groundwater from potential or imminent land use changes.

Panel Response #3:

<u>Vulnerability of Groundwater to Nitrate Leaching</u> is certainly impacted by all past practices that have contributed to current levels of groundwater nitrate in the area, but some soil characteristics, aquifer characteristics and geologic factors must also be involved in determining relative vulnerability. The idea of "aquifer sensitivity to contaminant migration" is certainly important in terms of factors including depth to the groundwater aquifer of interest, overlaying strata and their relative permeability.

In reviewing a range of reports available from various states plus those provided regarding the link between estimates of vulnerability of groundwater and actual groundwater nitrate contamination, it is apparent that while there is a relatively high correlation between areas described as highly vulnerable and groundwater nitrate contamination, not all highly vulnerable groundwater has nitrate groundwater contamination and not all significant nitrate groundwater contamination occurs in areas that would be designated as highly vulnerable.

<u>Groundwater Quality Nitrate Analyses –</u> It seems important that there be some type of monitoring or evaluation of groundwater nitrate analyses particularly from aquifers that are currently or likely to be used as drinking water sources. There needs to be some baseline or background information that the coalitions and regulatory agencies have access to that will indicate how close the existing areas / aquifers are to being a nitrate contaminated aquifer versus

aquifers that are in much better shape currently. It would seem that if you are trying to identify high risk / vulnerable areas, those might include both:

(1) already contaminated areas where you are attempting to prevent even more nitrate loading and perhaps eventual remediation or agricultural use options for long-term use and recovery; and (2) areas where the groundwater nitrate levels are below the groundwater nitrate drinking water standards, where different approaches and emphasis might be appropriate in order to achieve a goal of preventing further contamination.

It is hard to see how evaluations of risk to groundwater / aquifers can be managed effectively without some minimum program of periodic groundwater nitrate sampling to assist in determining target areas for different levels of programs (i.e., As mentioned above, a different approach may be needed in an area with GW already in excess of the drinking water nitrate standard when compared with a much lower GW nitrate situation. It will be <u>important to distinguish this need for groundwater quality data</u> for management decisions and approach purposes from use of sampling wells and targeted groundwater sampling for purposes of trend analysis or for trying to evaluate broad impacts of applied Best Management Practices (BMPs) on groundwater nitrate levels and N loading.

Use of the <u>Nitrate Hazard Index</u> as described by Birkle, et al as "consistent with the recommendations of a Nutrient Technical Advisory Committee (TAC) appointed by the State Water Resources Control Board". They further stated, "The TAC proposed that farmers complete a hazard index for each field on their farm based on the soil, crop and irrigation systems." Some of the earlier comments of more than a decade ago were that a major impediment to the implementation was that many soil series and many crops had not yet been assigned hazard rating values. More recently, however, some of the authors of various evaluations of the Nitrate Hazard Index approach indicated that tables have been developed to now include most major irrigated soils and crops in California and some other western states. From my perspective, even with the inclusion of more soil series handled in the online Nitrate Hazard Index Calculator available online, the Nitrate Hazard Index has several remaining problem issues that seem to make it problematic for use alone as an indicator of RISK or VULNERABILITY:

(1) The index does not take into account any measure of the depth to groundwater and the likelihood that soil characteristics well below the root zone are prone to transport of soluble materials directly to the groundwater within a time frame of concern.

(2) The index does not provide some means to acknowledge whether or not the groundwater may have potential use as a drinking water source, or if some factors other than just nitrate content alone preclude use for drinking water now or in the future.

(3) There is an acknowledgement in this index approach that the practice of DEEP RIPPING could have an impact on the cumulative index rating, increasing the hazard index. This makes some good sense across a large range of soil conditions, and is probably ok. However, there is <u>no acknowledgement of the potential impacts of significant rainfall events during the growing season on the calculated Nitrate Hazard Index.</u> While this effect may be very unimportant for a spring planted annual crop in the Southern SJV, it

could be a very different story for a fall planted winter crop in a higher rainfall zone. Accounting for such factors could be important when trying to rationalize whether or not a combination of conditions resulting in a NITRATE HAZARD INDEX of 20 should be considered HI or not (see comments in #4 below)

(4) From reading through the papers available on the Nitrate Hazard Index, it is difficult to understand why the value of 20 (as an INDEX value) was selected as the threshold value for HI vulnerability. In going through a number of scenarios (crop choice, soil, and irrigation system combinations), this value of 20 seems to be a relatively low threshold value to result in a high vulnerability rating. Intuitively, there are situations with high water holding capacity soils with relatively low infiltration rates, deep rooted crops and sprinkler or even furrow irrigation that result in Nitrate Hazard Index ratings of over 20, but are likely to represent a relatively limited risk in semi-arid zones with low probability of significant rainfall events.

Panel Response #4:

The risk of vulnerability to groundwater is highly variable and related to many criteria. However, the only true test to determine risk would be an isotope study to determine that nitrogen applied was the same nitrogen that was applied to lands previously. Considering the best geography of irrigated lands in California such a test would be very costly and time consuming. Nitrogen applications could be monitored; however, that is not an indication of what may have happened previously on lands. Nitrate testing on every farm site in California does not seem to be cost effective or a step in the correct direction to solve the problem.

Panel Response #5:

(see GARs and justification for development of the GARs, this section is more ideas/dialogues that specifics)

Four basic themes:

a. Science is the foundation for any regulatory program and should not be arbitrary
b. Regional/watershed differences in system function and boundaries including examples of boundary conditions or extremes that demonstrate system boundaries
c. GAR fundamentals help establish vulnerability and provide definition of system
d. Opportunities to reduce paperwork filing and reporting i.e., keep on farm, including HVAs. Less data to manage is better!

It is reasonable to infer that effective regulatory programs will focus the attention on dischargers or discharges that pose the highest risk or thread and that these threats vary widely in irrigated agricultural systems.

Science should be at the foundation of any regulatory program approach recognizing there is imperfect understanding of these systems. What do we know about our soil landscapes and their ability shows they are able to transmit water and nutrients below the root zone thereby exposing the groundwater systems to contamination. The NRCS soil survey has identified thousands of separate soil mapping units in the Central and Salinas Valleys. Regional and watershed approaches will give rise to more effective bracketing of risks as a result of variations in climate, geology, soil formation processes, and system hydrology.

(Crop type, irrigation systems and their management can also be unique characteristics to a region and therefore must be considered as unique combinations of factors that influence the migration of water, salts and nutrients over space and time.)

Example of very tight clays that have extremely low transmission rates when irrigated vs. coarse sandy systems that store very little water and are more vulnerable to deep leaching of nitrogen when water balance is not tightly monitored. This is not to say that all coarse textured systems are vulnerable to nutrient migration, but more precise management of these systems may need to be required. This may mean the inclusion of pressurized irrigation systems that are well maintained with water inputs more closely monitored to meet crop needs.

Third-party data collection and reporting efficiency and focus would be best served if initial data collection efforts are targeted toward individual fields that are more likely to be creating discharges that significantly degrade existing water quality. The Panel finds that data collection, processing and targeted responses should be directed toward those fields, areas/growers that have the highest likelihood for significant discharges to groundwater. By tailoring efforts on the collection, processing and reporting efforts of high risk fields, future measures taken to respond to problem fields or systems are more likely to be effective.

Panel Response #6:

The Nitrate Groundwater Pollution Hazard Index (i.e., Nitrate Hazard Index or NHI), specifically developed for irrigated agriculture in the southwestern states, presently provides by far the best method to identify the risk of nitrate loss below the crop root zone. Documentation and references for the NHI are available at http://ciwr.ucanr.edu/Tools/Nitrogen_Hazard_Index

Purpose of the NHI:

> To provide information for farmers to voluntarily target resources for management practices that will yield the greatest level of reduced nitrogen contamination potential for groundwater by identifying the fields of highest intrinsic vulnerability.

Intrinsic vulnerability:

> Intrinsic vulnerability is related to factors of which the farmer has no control such as the hydrologic properties of the soil and hydrogeologic factors such as proximity of an aquifer to land surface, etc. Although the farmer can choose the crop to grow, the choice is usually made on economic factors. Once a crop is chosen, each crop has an intrinsic vulnerability for groundwater contamination from nitrates. Likewise, irrigation systems may be selected, but each irrigation system has an intrinsic vulnerability.

Specific vulnerability:

> Specific vulnerability is a function of management factors such as quantity, rate, timing, and methods of nitrogen and water application and other agricultural management practices. Therefore, the farmer has some level of control over the specific vulnerability with little or no control over the intrinsic vulnerability.

The following quote is provided (http://wrc.ucanr.org/index.php) because it provides extremely relevant background to the NHI and its applicability to the IRRP and other agricultural orders (**bold** emphasis added):

> The National Academy of Science Water Science and Technology Board appointed a committee on Techniques for Assessing Groundwater Vulnerability. The committee defined groundwater vulnerability as: "The tendency or likelihood for contaminants to reach a specified position in the groundwater system after introduction at some location above the uppermost aquifer." They pointed out that **this definition of groundwater vulnerability is flawed, as is any other**, by a fundamental principle that they stated as the First Law of Groundwater Vulnerability: "All groundwater is vulnerable." They also proposed a Second Law of Groundwater Vulnerability: "Uncertainty is inherent in all vulnerability assessments."

In the context of the ILRP and the development of its waste discharge requirements general orders, groundwater vulnerability has become a highly controversial concept. The main reason for its controversial nature is the difficulty to agree on a definition and the even greater difficulty to spatially determine areas of different vulnerability. The term itself is confusing. In many cases, vulnerability of an aquifer is better characterized as "rapidly responding" to a given input signal (e.g., a waste discharge to land) and the "degree of signal attenuation" that occurs between the point of discharge and point of interest within the aquifer system. Clearly, vadose zone physical, hydraulic and chemical properties are important variables that determine aquifer vulnerability, and so are aquifer characteristics[1]. Unfortunately, we have virtually no quantitative information on these properties, with the exception of highly investigated sites. As a result, groundwater vulnerability cannot be effectively assessed on the scale needed for the ILRP.

More importantly, however, the ILRP's focus on groundwater vulnerability is fundamentally misguided because it confounds the spatial delineation of "risk of nitrate leaching below the crop root zone" with the concept of "impact to groundwater". Since nitrogen subsurface mass loading from agriculture has been occurring for many decades, response time and degree of signal attenuation cannot be easily identified, if at all. Groundwater constituent concentrations are not good estimators of these quantities.

Discussion of NHI for use by ILRP

The NHI was devised by a multidisciplinary team of scientists based on decades of research. Its assessment method is solidly rooted in scientific principles and it is transparent to users. Ample documentation is readily accessible. It has been successfully used by UCCE farm advisors, irrigation specialists, farmers, and other agricultural professionals and enjoys broad acceptance in the agricultural community and academia.

[1] There is an additional source of confusion: In the context of the NHI development, the terms "intrinsic vulnerability" and "specific vulnerability" relate to the soil-water-crop-nutrient system, not to the system below the crop root zone.

The strength of the NHI is its effective way in which three key variables (soil, crop, irrigation method) that all fall within the category of *intrinsic vulnerability* are collectively assessed in an overlay-and-index method to arrive at a single numerical value for a particular field (or any other scale) that represents the risk of nitrate loss below the crop root zone. As such, it brings clarity to a complex and difficult issue, and it prudently avoids the debate of groundwater vulnerability.

The NHI is dynamic in that it can be enriched with additional crops and soil types that may be needed to make it universally applicable in all of California. Similarly, it can be updated/refined with new irrigation technologies or combinations thereof. The purpose of the NHI is perfectly aligned with the mission of the Regional Boards to protect the beneficial uses of the State's waters. The purpose of the NHI is also perfectly aligned with the State Board's Recommendation 6 to the legislature (*Recommendations Addressing Nitrate in Groundwater, State Water resources Control Board, Report to the Legislature,* February 20, 2013) (see **Q#2**).

For all of the above reasons, the NHI should be the Regional Boards' method of choice within the context of the ILRP. It should be used as-is, without any attempts to increase its "resolution" (i.e., complicating it by adding more categories such as depth to groundwater, annual precipitation depth, nitrogen consumption ratio, etc.).

Panel Response #7:

Preface:

One of my foremost concerns is whether or not, high nitrate levels of drinking water pose a human health hazard. It has been believed that nitrate concentrations exceeding the MCL of 45 ppm NO3 constitute a risk, especially for infants. This is not a settled issue, and though a review of the scientific literature and medical conclusions are warranted, I will concede that this is beyond the scope of the expert panel's charge. I suggest that either the regional boards, state board, CalEPA and/or national EPA review the "current" findings. If the data does not support a human health hazard – is a herculean effort to maintain or reduce nitrate in groundwater necessary? (Environmental Health Perspectives, V107 Number 7 p583-586, Journal of Environmental Quality • Volume 37 • March–April 2008)

Overriding Factors:

1. Current or even past fertilizer/irrigation practices have little to no correlation with water quality below the farm in question. Thus this is a regional problem – not an individual farm problem.
2. For the most part, changes in current management practices will have no impact on measurable groundwater quality parameters for decades, and possibly never directly below an individual's farm's property.
3. Because we cannot use changes in groundwater quality as a measure success of management practice implementation, doesn't mean that they shouldn't be implemented.
4. Implementation of nitrogen fertilization BMPs without consideration of irrigation management is useless.
5. Utilization of rigorous "mass balance" estimates on a field basis is useless due to large errors in inputs and outflows estimations at a field level.

6. If there is not an explicit reason for collecting specific data then it should not be required to be collected – what are you going to do with the data?
7. Farming is complex - there are MANY competing factors which influence nitrogen and water applications. These vary by everything one can imagine. Farmers cannot afford to waste money with the application of nitrogen and water without valid reasons.
    a. Management of risk is a valid reason, If a crop becomes unmarketable because a 10 lbs/ac N application was not made, and the crop appearance suffered, especially in the face of widespread competition – that farm will not be competitive
8. The complexity of vegetable farming in the Salinas Valley cannot be over stated. Management units are frequently less than 1 acre even on a multiple 1000 acre farm. Additionally, there are 2 to 4 plantings of managements units per year and the specific location of a management unit is not known in many cases until just a very few days prior to planting. Keeping track of all N and water inputs at this level is incredibly labor and resource intensive. This is not to say that it shouldn't be done, but traditionally it has not been done and it will take years for the industry to adapt to reporting requirements at this level. An aggregated reporting requirement does not lessen the data collection requirements.

What are the goals?

- RWQCB's 3&5 Expectations
- Expert Panel Expectations
- Ag Expectations
- Science Limitations

Major goal is to recommend "things" that – from now on – will minimize nitrate movement to groundwater???

> What are the recommended practice(s) that accomplish the above goal

Formal answer to question #1:

> It seems clear that any one farm cannot be identified as the sole source of high nitrate for a region, thus a regional approach should be used. An audit of nitrogen fertilizer management practices as well as irrigation system performance for all "higher risk" farms should be conducted. Higher risk farms would be those where high levels of nitrogen (> 200 lbs N/yr) is routinely applied and additionally where irrigation / rainfall amounts exceeds ET for the region.

Panel Response #8:

I believe four (4) key factors determine risk or vulnerability to groundwater.

1) Depth to groundwater
2) Slop or potential for runoff
3) Soil Type
4) Cropping Pattern

Shallow aquifers leave little time to buffer excess nitrogen applications. They are much more vulnerable to rainfall and nitrogen leaching. Timely applications of nitrogen can still lead to leaching by unexpected rainfall event.

Uncontrolled rain off of a rain event can lead to risk of nitrogen leaving the crop targeted area and go to non-targeted and potential non-crop areas leading to leaching of nitrate.

Lightly sandy soils have a greater chance for nitrate leaching than heavier loamy type soils. The combination of two (2) or three (3) of the risk factors could lead to a scoring system that was presented to us in the Nitrate Loading Risk Factor.

I believe this could be managed easily by water coalition groups in Region 5 (Central Valley). In Region 3 I believe that the collaborative effort between grower sand perhaps U.C. extension personnel could come up with a risk grid to identify the worst areas and put together each farm's risk potential.

Cropping patterns lead to a variety of irrigation measures that have endless possibilities and almost no practical solution for evaluation. Monoculture crops like almonds, walnuts, peaches, etc. can establish a risk potential by also incorporating the other three (3) risks that I listed.

SUBJECT:	VULNERABILITY AND RISK ASSESSMENT
Question 2	Evaluate and develop recommendations for the current approaches taken to assessing risk to or vulnerability of groundwater: a. Nitrate Hazard Index (as developed by the University of California Center for Water Resources, 1995), b. Nitrate Loading Risk Factor (as developed by the Central Coast Regional Water Quality Control Board in Order R3-2012-0011), c. Nitrogen Consumption Ratio, d. Size of the farming operation, e. High Vulnerability Areas Methodology (as developed by the Central Valley Regional Water Board in a series of Waste Discharge Requirements issued to agricultural coalitions in the ILRP).

Panel Response #1:

NHI – This index has appeal to those who automatically fall into the low risk categories. Naturally, they want to retain this. But the NHI is unacceptable in several very important ways:

i. There is no apparent logic as to why a maximum value of 3 is assigned to one variable, and 5 assigned to another variable.
ii. The mathematical method of combining (multiplication) the 3 values makes no sense.
iii. It does not address the inter-relationship between soil type and irrigation method. They are treated independently, whereas they should be considered together.

Certainly, there is no justification for expansion of the soils information, as was proposed to the Panel in Sacramento.

NLRF of the Central Coast Regional WQCB. Some of the deficiencies of the NHI have been noted. Because the NHI is one of three criteria of the NLRF, this makes it weak. The nitrogen concentration in the irrigation water indicates the groundwater nitrate level, so it is worthwhile including somehow in an index. The irrigation method, by itself, provides very little information. On the Central Coast, the facts that some crops are very shallow rooted, intensively farmed, and subject to unforeseen rainfall events are much more important than the irrigation method.

Nitrogen Consumption Ratio. The determination of a Hazard or Risk index should be relatively straightforward, and possible to perform "at a distance." The Nitrogen Consumption Ratio requirements that are not easily understood or obtained, and requires excess effort for the purpose of establishing this index.

Size of Farming Operation. This defies logic for the purpose of determining a Hazard or Risk index. In addition, one could argue that small operations might be much more poorly managed than large operations, or vice-a-versa.

Vulnerability areas from the East San Joaquin Water Quality Coalition Groundwater Quality Assessment Report. This has many interesting concepts. However, the emphasis on linear regression and other statistics appears to go well beyond the requirements that should be necessary for establishing an index. The strength of the statistics are likely unsupportable in light of the lack of extensive, high quality data. Therefore, a more simple method should be used that will cost less and be outside the realm of modelers.

Panel Response #2:

There is no existing nitrate risk assessment tool, in its current state, that sufficiently addresses the myriad of agricultural production variables such that its data output could be impactful to groundwater, useful for a regulator, or could justify an increase in reporting burden to the grower. However, of the various tools available and mentioned below, the NHI should be the focus of improvement efforts as its inputs are generally known and available, calculations simple, and outputs are at least informative to various stakeholders.

a. **Nitrate Hazard Index (NHI)-**The nitrate hazard index (NHI), in its current form, should be limited to use as an informational tool to an agricultural operation to inform of their general risk of nitrate leaching to groundwater. The NHI is suitable as a high level view risk assessment tool for groundwater coalitions and regional water quality control boards and is not suitable as an indicator of risk at the field level or as a trigger for tier designation or reporting. NHI does not allow for multiple irrigation types as it only considers the highest risk irrigation system in its calculation. The irrigation system used most or the system which delivers the majority of the irrigation or nutrient volume is not taken into account in the calculation. The NHI should include a more complete and current list of potential fertilization practices including fertilization method (split vs. single). Additionally, it's recommended that the State Board partner with an academic institution to pursue the improvement and validation of the NHI as a predictor of nitrate flux by soil type and increase the meaningfulness and usability of resulting values. Finally, this improved tool should be tied into existing web tools such as SoilWeb and the NRCS Soil Survey.
b. **Nitrogen Loading Factor (Central Coast)** is not widely used outside of the Central Coast area and is generally only used as an alternative to the NHI when sufficient soils data does not exist.
c. **Nitrogen Consumption Ratio-**This tool provides a very general view of what is applied to a cropping system versus what is removed. This tool could be useful for high level risk assessment, for example, to assess the effects of potential crop type conversions and resulting nitrogen consumption ratios. There would be a limit to the effectiveness of this method as a risk assessment tool at the farm level as the spatial and temporal components of nitrogen application, in addition to the losses such as volatilization and bio assimilation, are not considered nor accounted for. During the panel deliberations we were presented with examples of this ratio value being consistent across instances in which leaching was very different.
d. **Size of Farming operation-** Scale is not predictive of potential nitrate discharge to either surface water or groundwater. It is possible and common to have continuous acreage of one crop being grown by different entities. Larger operations are potentially more likely to possess the technical competency to precisely manage irrigation and nutrient delivery. Additionally, larger farms would be more likely to possess the capital to purchase technologies and or services that would aid in monitoring and regulatory compliance. I

have not experiences, read, or heard testimony during the nitrate panel deliberations thus far that prove otherwise.

e. **High Vulnerability Areas Methodology** (as developed by the Central Valley Regional Water Board in a series of Waste Discharge Requirements issued to agricultural coalitions in the ILRP). This tool includes some of the elements missing in NHI and the loading factors above including depth to GW and soil type, but does not address irrigation type, crop type, or management practices. As I currently understand this tool and due to these missing elements, it seems that the high vulnerability areas methodology is an incomplete tool for assessing risk and vulnerability at the field level.

Panel Response #3:

Many approaches exist to assess vulnerability and risk. It is recognized that when you are trying to assess a wide range of situations across very large geographic areas, there is some need for a simplified approach. However, simple but incomplete will not get the job done. The methods that look at soil factors, irrigation methods and systems, and crop characteristics are heading in the right direction, in my opinion, but some may not include more specific important characteristics such as relative levels of rainfall and intensity of rainfall events, and it seems like some do not consider the depth to groundwater or special concerns with shallow groundwater areas,

a. Nitrate Hazard Index (as developed by the University of California Center for Water Resources, 1995),

Many comments on this approach were made under question #1 (see those comments)

b. Nitrate Loading Risk Factor (as developed by the Central Coast Regional Water Quality Control Board in Order R3-2012-0011),

This approach is based on a crop type hazard rating, and irrigation system hazard rating, and a rating based on the concentration of nitrate in the irrigation water being used. It would seem to be a most useful approach when you are in an area widely affected by groundwater contamination issues (nitrate and other components of the water), since it is similar to the Nitrate hazard index described above, but with the soil hazard index rating removed as a factor.

To some extent, it would seem that removing the soil characteristics thought to be important to potential for movement of water and soluble materials to the groundwater is an oversimplification. There may be some validity to the idea that if the irrigation water being used is being taken from groundwater wells underlaying the property being evaluated, then high irrigation water nitrate concentrations imply a set of conditions (at least in the past) where soil conditions plus management practices resulted in a lot of nitrate being moved down to the groundwater. While this may in fact be the case for some areas where: (1) groundwater depth is relatively shallow with a moderate transit time (perhaps single digit years rather than decades) from surface application until it reaches the groundwater aquifer; (2) where soil strata are relatively permeable with no significant water flow restricting layers between the vadose zone and aquifer; and (3) where applied irrigation water or applied water plus rainfall are adequate at least some of the time to move water and solutes substantial distances.

Despite the name, this approach does not seem to be a sensitive indicator of loading (of N) risk. The bar seems set pretty low (ie. 10 or less) to achieve a “LOW” rating for nitrate loading risk. As long as the irrigation water nitrate concentration is below 45 mg NO3-N/liter, a below 10 value for Nitrate Loading risk could be achieved growing: (1) wheat using surface irrigation; (2) onions, lettuce or pepper grown using sprinklers for pre-irrigation and microirrigation afterwards; or (3) microirrigated spinach or broccoli or lettuce. For any of these three examples plus others, all it would take for a grower to have an actual significant Nitrate Loading Risk would be to apply higher fertilizer levels, or make some moderate errors in timing of N fertilizer applications or irrigation water applications. Even if generally considered useful in Region 3, there are reasons to assume worse performance if moved to other Regions.

c. Nitrogen Consumption Ratio,

This value is developed based on the identification of the component parts of the Nutrient Management Plan.

d. Size of the farming operation,

Other than the fact that performing any set of processes on a much larger scale has the potential to impact more acres and a larger volume of groundwater underlaying that ground, it does not inherently make sense to have the stated scale of farming operations impact the criteria for risk assessment. This is stated with the understanding that the three sizes used for the different Tiers and criteria in Region 3 are: (less than 50 acres; 50 to 500 acres, and over 500 acres). If the smallest size evaluated was closer to 5 acres or less (just to pick a size that is more representative of an urban or suburban area strawberry field), this might make sense from the standpoint of the complexity of the calculations and associated paperwork for a very small family operation. However, it seems improper to assume that farming operations as large as nearly 50 acres should be allowed different practices and evaluations than a larger farm, particularly if both size areas are farmed in a manner that potentially loads N to the soil profile. I am not sure that I see the rationale for why 10 small (<50 acre) operations totaling nearly 500 acres are inherently less of a threat in terms of nitrogen loading than one nearly 500 acre farming operation operating under the same set of rules as well as the same expectations in the marketplace.

e. High Vulnerability Areas Methodology (as developed by the Central Valley Regional Water Board in a series of Waste Discharge Requirements issued to agricultural coalitions in the ILRP).

The approach outlined by the Eastern SJV Coalition within the context of a GAR has: 1) hydrogeologic sensitivity evaluations; (2) soil and land use considerations; and (3) groundwater quality analyses at its core, and the idea of incorporating available information on published, available data (when available) sounds like a solid approach toward having improved knowledge of specific situations where you want to assess levels of risk of groundwater contamination. My understanding is that their efforts to assess groundwater vulnerability of the Eastern SJV watershed involved regression approaches to evaluate relationships between multiple variables describing the physical characteristics of the soil profile with depth and the variable observed groundwater quality. They describe evaluations of several models, including the Shallow Wells Model to relate hydrogeologic / soil characteristics to groundwater well nitrate levels.

My primary questions (which I am not qualified to answer in terms of expertise and background) are:

(1) whether or not the available data needed for these soil and hydrogeologic evaluations are available for large regions of interest? Are similar approaches suggested for other regions and coalitions, and if so, how different will be the types of data needed and assumptions made for model evaluations? (i.e,. How unique are the characteristics that impact model performance assessing impacts on groundwater nitrate?)

(2) There are a number of assumptions regarding the primacy of the impacts of intrinsic factors (soil and hydrogeologic characteristics) as opposed to impacts of current and past land use – the approach recommended based on intrinsic physical properties independent of land use conditions has some practical appeal in terms of simplicity and the idea that these physical properties are less likely to undergo any rapid shifts. I am not sure I understand that the case is made that this is true for a wide range of conditions across a lot of land uses, particularly if this approach is transferred and tested in other crop production regions with some rainfall pattern, crop water use and water application method differences?

It would seem that for recommendations to be made for model use and incorporation over a wide range of locations and conditions, there would need to be evaluations by not only staff at the coalition level, but by other researchers (SWRCB, University of DWR) for purposes of consistency of approach and recommendations. Such analyses could provide some level of sensitivity analyses to determine the consistency of the findings and relate whether or not inherent measured variability in component factors describing the hydrogeolic / soil characteristics is too large (variability is too great) in terms of confidence in the model and assessment of impacts on predicted groundwater nitrate levels.

Panel Response #4:

a. Nitrate Hazard Index (as developed by the University of California Center for Water Resources, 1995)

The Nitrate Hazard Index can be used as a tool to identify sites of higher or lower risk, however, the Nitrate Hazard Index should not be used to determine site specific criteria for regulation. Where areas are mapped the Nitrate Hazard Index could be used to determine the proper location of monitoring wells. Many areas are not completely mapped. Using the Nitrate Hazard Index to apply regulation would burden a farmer who uses best management practices the same as a farmer who does not and has a higher potential to discharge. That approach burdens good growers in an unfair manner.

b. Nitrate Loading Risk Factor (as developed by the Central Coast Regional Water Quality Control Board in Order R3-2012-0011).

The Nitrate Loading Risk Factor is a tool that will be helpful to the Coalition to track nitrogen contamination risk. The numbers submitted should be used by the Coalition to evaluate trends and possibly locate areas or specific farms that may require further investigation. This measurement could be time consuming to a vegetable grower with numerous small fields that are served from a single source of water and/or chemigation system.

c. Nitrogen Consumption Ratio

The Nitrogen Consumption Ratio is a tool that would raise grower awareness of their site specific nitrogen balance. This method could be useful if you considered the results over numerous years of crop production. More information would be needed by crop to determine residual levels of nitrogen in plant mass after harvest as well as nitrogen volatized off to the atmosphere. This method, over a period of time, could help growers determine if their nitrogen fertilization program is in line with relative levels of production.

Due to variation of production, timing of applications, and other variables the Nitrogen Consumption Ratio could be misleading without knowing other information about the site. Specifically the method of nitrogen application and the method of irrigation could be as important as the amount of nitrogen applied as it relates to the amount of nitrogen that moves below the root zone.

d. Size of Farming Operation

Size of the farming operation has little, if any, to do with nitrogen in groundwater. Therefore farm size should not be a factor to determine any criteria as it relates to protecting groundwater.

e. High Vulnerability Areas Methodology (as developed by the Central Valley Regional Water Board in a series of Waste Discharge Requirements issued to agricultural coalitions in the ILRP).

High versus low areas of vulnerability could be used as a tool to help coalitions manage the level of risk to groundwater. In large geographic areas that have distinct variations of historical data that strongly suggest variation it is reasonable to focus the attention of remediation on those areas that show the highest risk. For example those areas with higher risk should have more extensive groundwater monitoring. It is not productive to monitor areas that do not show contamination levels. However, those areas with known contamination should have additional focus. Additional reporting of nitrogen usage, in some manner, could be a valuable tool to determine a more focused approach by coalition management. This method would help coalitions budget resources to problem areas. Resources will be a limiting factor to addressing problems.

Panel Response #5:

a. Nitrate Hazard Index (as developed by the University of California Center for Water Resources, 1995).

The Nitrogen hazard Index (NHI) was developed to be a practical tool that can combines 3 key field elements aimed at parameterizing a fields risk or vulnerability to leaching nitrogen into local groundwater. It categorizes and assigns values for crop type, irrigation system type, and soil type for a given location and provides an estimate of the leaching potential for water and solutes to local groundwater.

There are several advantages to the index including its ease of use, since the Index has been characterized for virtually all of the irrigated lands in the Central and Salinas Valleys. It also provides a model that represents many of the diverse cropping systems that we have in the region including estimates for shallow, medium and deep rooted crops. The Index also numerically assigns a value to the varied types of irrigation systems used in the region weighting systems that have more controlled and uniform applications of irrigation inputs more favorably that those that rely on soil infiltration characteristics for instance to determine the potential for deep water movement.

There are several notable shortcomings of the NHI method that include:

- the soil index ratings are imperfect and based on the opinions of a small number of experts.
- Not all soils or mapping units are rated
- Does not consider climate variation and its potential impact on deep leaching in some locations
- NHI uses soil series as a distinguishing characteristic rather than soil mapping units that may include multiple soil series or types within a mapping unit leading to more difficult interpretation of mapping unit behavior.

Given the multiple benefits and shortcomings of the NHI, the Panel finds use in the current application of the NHI and feels that this approach could continue to be used in the short term. There also appears to be consensus in the scientific community that improvements on the current model can and should be developed. Given the importance of this index in the ILRP, efforts to improve the NHI should be pursued as well as a serious effort to document newly developed Index method approaches.

A more developed model of NHI can and should be developed to assist in the evaluation of relative site vulnerability. Any new model should continue to use available soil data bases, crop and irrigation system type information as primary components and should be continuously updated based on data obtained by Third parties and others involved in conducting and evaluating various management systems. Third Party aggregators are encouraged to submit periodic and appropriate changes to the methodology used to determine vulnerability designations including documentation that supports the changes being proposed to the Executive officer.

Even in areas considered as a high vulnerability by approved Indexing methodology, considerations should be given to fields that have extenuating practices that should be factored into the decision of prioritizing system vulnerability. Examples of conditions that would otherwise be considered high vulnerability systems could include: 1. Fields that have annual total field applications of less than 50 lbs(?) N per acre per year. 2. Fields that have annual field applications less than 75 lbs.(?) per acre per year and use pressurized irrigations systems combined with appropriate irrigation scheduling methods to meet all crop irrigation needs. 3. Documentation of these exceptional (overriding) conditions should be documented and reported on an annual basis. This could have the added effect of encouraging growers to reduce applications who are on the periphery of these exceptional conditions thereby reducing reporting time and certification. This override approach is consistent with and provides justification for existing Board decision to eliminate WDR Orders from areas dominated by vineyard production (e.g., Paso Robles GW basin).

c. Nitrogen Consumption Ratio.

Though no nitrogen balance method is without its problems and complications, the Panel believes that efforts to estimate nitrogen needs of the crop as well as identifying the primary sources to meet those needs can be scientifically justified in most cropping systems. The nitrogen consumption ratio method proposed for example by the ESJVWQ Coalition is an attempt to develop a partial mass balance of the cropping system. The basic approach attempts to compare the major nitrogen sources in the system with the nitrogen removed from the system through the harvest of all materials removed from the field. There are several key advantages of this approach including:

- Introduces residual soil nitrate as an element to the available sources of N
- Includes an estimate for organic sources of nitrogen applied or to be applied to the field
- Includes nitrate applied through the irrigation water
- Allows for a reasonable estimate of all major cropping system N sources prior to fertilizer N applications.
- Introduces to the grower/manager a basic approach to determine the need for supplemental N to meet the required crop N goals.

Because each field system has a considerable variation in farming practices and resident site N conditions, it is in the grower’s interest to identify and utilize those sources of N already available. Some sites for instance have relatively high nitrate concentrations in the irrigation waters used; other sites get a large proportion of their plant available nitrogen from previous crop residues or through the addition of composted or non-composted organic matter. Methods exist that allow the field manager to estimate the available N from each of these sources. By incorporating methods that estimate existing sources of crop available N, nitrogen recommendations can be made that reduce the risks to grower that ensure optimum crop yields while reducing the risk of making supplemental N applications that applications that are likely to result in significant leaching losses.

e. Size of the farming operation.

Consider separate reporting consideration for fields/plantings less than 10-15 ac. Delayed reporting time for small acreage farmers is appropriate and recognizes the additional challenges of getting acreage certified and growers educated toward the reporting requirements. Ability/methodology to aggregate and streamline process for multiple plantings in reports. How did planting method/application differ approach differ from field 1?

Panel Response #6:

<u>Nitrate Hazard Index (NHI)</u>

Purpose of the NHI:

> To provide information for farmers to voluntarily target resources for management practices that will yield the greatest level of reduced nitrogen contamination potential for groundwater by identifying the fields of highest intrinsic vulnerability.

The authors identify intrinsic vulnerability as follows:

> Intrinsic vulnerability is related to factors of which the farmer has no control such as the hydrologic properties of the soil and hydrogeologic factors such as proximity of an aquifer to land surface, etc. Although the farmer can choose the crop to grow, the choice is usually made on economic factors. Once a crop is chosen, each crop has an intrinsic vulnerability for groundwater contamination from nitrates. Likewise, irrigation systems may be selected, but each irrigation system has an intrinsic vulnerability.

The authors identify specific vulnerability as follows:

> Specific vulnerability is a function of management factors such as quantity, rate, timing, and methods of nitrogen and water application and other agricultural management practices. Therefore, the farmer has some level of control over the specific vulnerability with little or no control over the intrinsic vulnerability.

The following quote is provided (The Hazard Index Concept, http://www.waterresources.ucr.edu) because it provides extremely relevant background to the NHI and its applicability to the IRRP and other agricultural orders (**bold** emphasis added):

> The National Academy of Science Water Science and Technology Board appointed a committee on Techniques for Assessing Groundwater Vulnerability. The committee defined groundwater vulnerability as: "The tendency or likelihood for contaminants to reach a specified position in the groundwater system after introduction at some location above the uppermost aquifer." They pointed out that **this definition of groundwater vulnerability is flawed, as is any other**, by a fundamental principle that they stated as the First Law of Groundwater Vulnerability: "All groundwater is vulnerable." They also proposed a Second Law of Groundwater Vulnerability: "Uncertainty is inherent in all vulnerability assessments."

The NHI was devised by a multidisciplinary team of scientists based on decades of research. Its assessment method is solidly rooted in scientific principles and transparent to users. Ample documentation is easily accessible.

The strength of the NHI is its effective way in which three key parameters (soil, crop, irrigation method) that all fall within the category of *intrinsic vulnerability* are collectively assessed in an overlay-and-index method to arrive at a single numerical value for a particular field (or any other scale) that represents the risk of nitrate loss below the crop root zone. The NHI willingly sacrifices precision in favor of accuracy but it retains sufficient precision to be highly useful and to achieve its stated purpose. It brings clarity to a complex and difficult issue. It masterfully avoids a debate of groundwater vulnerability. It has been successfully used by UCCE farm advisors, irrigation specialists, farmers, and other agricultural professionals and enjoys broad acceptance in the agricultural community and academia. The NHI is dynamic in that it can be enriched with additional crops and soil types that may be needed to make it universally applicable in all of California. Similarly, it can be updated/refined with new irrigation technologies or combinations thereof. The purpose of the NHI is perfectly aligned with the mission of the Regional Boards to protect the beneficial uses of the State's waters. Finally, the purpose of the NHI is also perfectly aligned with the State Board's Recommendation 6 to the legislature (see below under *High Vulnerability Areas Methodology*).

For all of the above reasons, the NHI should be the Regional Boards' method of choice within the context of the ILRP. It should be used as-is, without any attempts to increase its precision (i.e., complicating it by adding more categories such as depth to groundwater, precipitation, nitrogen consumption ratio).

Nitrate Loading Risk Factor (NLRF)
The NLRF is defined in Order R3-2013-0101 (p. 89) as follows:

> A measure of the relative risk of loading nitrate to groundwater based on the following criteria a) Nitrate Hazard Index Rating by Crop Type, b) Irrigation System Type, and c) Irrigation Water Nitrate Concentration.

The Order does not explain how the NLRF is actually computed, what the rationale for devising this measure was, or what its purpose is. It is unclear whether its authors truly mean "risk of loading nitrate to groundwater" or risk of nitrate loss below the root zone. The NLRF does not consider soil properties, which critically weakens its ability to estimate nitrate leaching risk. The substitution of irrigation water nitrate concentrations for soil properties does not provide an apparent positive contribution to this method because nitrate content in irrigation water typically constitutes a small portion of the overall nitrogen applications. The only case which would justify this consideration is given by irrigation water nitrate concentrations that are so high (combined with no means to dilute irrigation water) that this loading alone (i.e., without additional fertilizer application) would result in excessive fertigation. In addition, the ranges of constituent concentrations employed for the indexing are very narrow and unrealistically suggest significant differences in the relative contribution.

The NLRF ranges from 1 to 64. Its subdivision in three risk levels (i.e., low, moderate, and high) with the moderate level ranging from 10-15 implies an unrealistic precision or confidence in the results.

In conclusion, the modifications that were made to the NHI in the design of the NLRF substantially weaken the NLRF's utility. Its use is not recommended.

Nitrogen Consumption Ratio (NCR)
This ratio is defined in a letter from Parry Klassen to Pamela Creedon (2013-04-11) on behalf of the East San Joaquin Water Quality Coalition (ESJWQC) as the amount of nitrogen supplied divided by the amount of nitrogen the crop needs.

It is impossible to understand from the letter what this ratio actually represents. The term "amount of nitrogen supplied" does not appear anywhere else on the Nitrogen Management Plan Worksheet. There is "Total available N applied", which includes synthetic and organic fertilizers, but it is unclear whether all nitrogen in the organic fertilizer is accounted for or only the inorganic fraction. Also, it is unclear how "Soil Nitrogen Credits" factor into the equation. "Total available N applied and credits" is defined as the sum of "Total available N applied" and "Total N credits" but it is unclear if "Total available N applied and credits" is equal to "amount of nitrogen supplied".

The divisor (i.e., "the amount of nitrogen the crop needs") is also ill-described. It appears that this quantity can either be "Crop N needs to meet actual yield" or "N needs to meet projected yield". Whether actual or projected, it is unclear what these quantities are supposed to represent (e.g., N taken up by the crop, N removed in the crop harvest, or some estimate of a hypothetical N uptake plus allowances for N losses.

Based on the above, the utility of the NCR cannot effectively be assessed without substantial additional clarification from Parry Klassen.

The template would benefit from comparing its approach and terms to established terminology such as apparent nitrogen recovery (ANR) and nitrogen input requirement (NIR).

Size of Farming Operation

Region 3 uses the size of irrigated acreage in its tier system. The size of irrigated acreage on a farm is not an indicator for risk of nitrate leaching. This is illustrated by considering all of irrigated agriculture in California: it does not matter if all of irrigated acreage belonged to one farm, one thousand farms, or any other number of farms. It is recognized that the consideration of this parameter has a certain appeal from a regulatory perspective. However, there is no technical rationale in support of it.

High Vulnerability Areas Methodology

In Recommendations Addressing Nitrate in Groundwater (State Board, 2013-02-20), Recommendation 6 states:

> The Water Boards will define and identify nitrate high-risk areas in order to prioritize regulatory oversight and assistance efforts in these areas.

The Regional Board issued their first WDRs to growers within the Eastern San Joaquin River Watershed (R5-2012-0116-R2; revised October 2013 and March 2014). In this Order, the term "nitrate high-risk area" (or related) appears once. The term "vulnerability" or "vulnerable" (or related) appears 157 times, predominantly in connection with groundwater. Clearly, there is a fundamental disconnect between State Board and Regional Board.

The State Board clearly articulated the purpose of nitrate high-risk areas: "to prioritize regulatory oversight and assistance effort in these areas". This purpose should carry over into R5-2012-0116-R2 but it is not clear that it actually does because the Regional Board changed the straightforward concept of "nitrate high-risk" to a difficult and more complex concept of "high vulnerability", which involves both intrinsic and specific vulnerability.

The Regional Board defined high vulnerability area in Attachment E to R5-2012-0116-R2:

> High vulnerability area (groundwater) – Areas identified in the approved Groundwater Quality Assessment Report "…where known groundwater quality impacts exist for which irrigated agricultural operations are a potential contributor or where conditions make groundwater more vulnerable to impacts from irrigated agricultural activities." (see section IV.A.3 of the MRP) or areas that meet any of the following requirements for the preparation of a Groundwater Quality Management Plan (see section VIII.H of the Order): (1) there is a confirmed exceedance (considering applicable averaging periods) of a water quality objective or applicable water quality trigger limit (trigger limits are described in section VIII of the MRP) in a groundwater well and irrigated agriculture may cause or contribute to the exceedance; (2) the Basin Plan requires development of a groundwater quality management plan for a constituent or constituents discharged by irrigated agriculture; or (3) the Executive Officer determines that irrigated agriculture may be causing or contributing to a trend of degradation of groundwater that may threaten applicable Basin Plan beneficial uses.

This definition creates much ambiguity. For example, arguably in most areas of the Central Valley floor "irrigated agricultural operations are a potential contributor" to nitrate concentrations in shallow and deeper groundwater bodies. Furthermore, the statement: "where conditions make groundwater more vulnerable to impacts from irrigated agricultural activities" is so relative that it carries virtually no meaning. Lastly, regarding the "confirmed exceedance", this too, adds unnecessary complexity and difficulty because point measurements have to be related to an area. Also, exceedances will likely exist in areas of lower nitrate leaching potential due to long time periods over which loading has occurred.

Due to the reasons discussed above, the shift to the concept of vulnerability already created and will continue to create large expenditures for the coalitions for the definition and delineation of high-vulnerability areas in Groundwater Assessment Reports for no apparent benefit.

In conclusion, this approach should be abandoned and replaced with the NHI approach.

Panel Response #7:

Each of the methods listed have problems, not the least of which is the amount of N typically applied is not a consideration. The NHI will require extensive modification so that soil mapping unit, as opposed to soil series, is the basis. A greatly expanded irrigation system selection representing current methodologies needs to be developed also.

As far as farm size is concerned, it is more or less irrelevant when trying to determine if a particular farm is a risk for nitrate movement below the root zone, and should be discarded. That being said, farms less than a particular size, perhaps 10 acres, could be excluded from a regional assessment.

Many large farms are the ones with the resources to effectively monitor nitrogen and irrigation management practices sufficiently to limit nitrate movement

---

Panel Response #8:

I personally prefer the Nitrate Hazard Index as a tool for assessing risk to groundwater. Once risk has been identified then a management plan can be developed to reduce potential for nitrate contamination. I think it can also be adapted to any farm size. (I say this knowing mixed vegetable fields of small acreage could be very hard to assess). It is not an absolute but a workable tool for growers to manage potential risk and focus them on the most vulnerable areas of their farming practice.

Nitrogen Consumption Ratio is too simplistic a way to determine leaching potential. The nitrogen removed by the crop is valuable information for nitrogen budgeting but to narrow to evaluate leaching possibilities. I would suggest we focus some research projects (from F R E P possibly?) on nitrogen consumption rates that focus on specific crops. The Patrick Brown model on almonds comes to mind as a useful example of the type of research that will be needed.

The High Vulnerability Areas Methodology has been in use in region 5 for pesticide monitoring and has a successful track record finding exceedances and locating the sources. Also has documented progress with limiting any further releases going forward. I believe it could have merit in nitrate tracking of high risk areas.

SUBJECT:	VULNERABILITY AND RISK ASSESSMENT
Question 3	How can risk to or vulnerability of surface water best be determined in the context of a regulatory program such as the ILRP?

Panel Response #1:

The determination must depend upon the local conditions. Surface water discharges from individual fields may cause no problems to larger water bodies. For example:

1. Some irrigation districts recycle all, or most of, their surface drainage from individual fields.
2. Some farms have tailwater return systems that capture surface runoff from multiple fields. Many of these farms have no surface runoff from the farm itself.

If this question is related to nitrates, it is likely that most surface runoff from fields has low nitrogen concentration. However, if the runoff in an open drain contains tile water, or subsurface inflow, the nitrogen concentration could be high. Policy should distinguish between the two situations.

Panel Response #2:

No response

Panel Response #3:

Still doing reading to see if I can provide informed comments that might be useful. It is assumed that components of the High Vulnerability Areas Methodology incorporates:

- Backflow prevention and well head protection
- Fertilizer handling and dry and liquid fertilizer storage for loss control
- Limits or restrictions on waste water retention reservoirs or tailwater recovery system design if these systems are in use in areas subject to storm water flows where overflows could be significant issues).

The basic component approaches identified in Question #4 seem appropriate, although the farm size issue again seems out of place and not appropriate if you are actually trying to control high risk activities with potential to impact groundwater.

Panel Response #4:

Determining the contamination risk to surface water will never be 100% accurate.

Considering the geographic diversity and weather events, it seems even the best plan would fall short of certainty. Some of the factors to consider are elevation changes, soil type, soil nitrogen loads, weather events, irrigation discharges, as well as others. For example, the lands on the western side of Fresno County with less than 2% slope and less than 8 inches of rainfall have very little potential to pollute surface water. Whereas flooded rice fields could pose a greater risk.

This risk assessment will best be evaluated and monitored by the coalitions. Local knowledge of sites will have a higher chance of protecting surface water.

Panel Response #5:

Themes: a. Most fields don't drain into surface waters of the state therefore it is more manageable to monitor return flows to waters of the state. B. Runoff water makes up a very small quantity of total water volume in surface systems and only in instances of high volume return flows can water quality

Assessing the vulnerability of surface water can in many cases be more simplified when adopting and monitoring regional water quality control systems. Because the large majority of growers parcels rarely if ever discharge runoff into waters of the state.

Panel Response #6:

I have not got the expertise to address these questions.

Panel Response #7:

This would best be accomplished by 3rd party audits of fertilizer, irrigation and management practices of those farms that are adjacent to and/or have at least seasonal waterways that flow though there proper.

Panel Response #8:

I think that by identification of High Vulnerability Area you should be able to monitor on a much smaller basis than trying to monitor all surface waters. The coalitions have taken the burden off individual growers, but in region three (3) that burden falls on each grower with surface water. There needs to be plan developed to allow growers in high risk areas to monitor surface water and apply those results to all their area of farming.

SUBJECT:	VULNERABILITY AND RISK ASSESSMENT
Question 4	Evaluate and develop recommendations for the current approaches taken to assessing risk to or vulnerability of surface water: a. Proximity to impaired water bodies. b. Usage of particular fertilizer or pesticide materials. c. Size of farming operation. d. High Vulnerability Areas Methodology (as developed by the Central Valley Regional Water Board in a series of Waste Discharge Requirements issued to agricultural coalitions in the ILRP)

Panel Response #1:

It is unclear how items (a-c) can have value. As mentioned in Question #3, one must examine where the surface runoff from fields goes, and how it is recycled.

Panel Response #2:

No response

Panel Response #3:

Still doing reading to see if I can provide informed comments that might be useful.

Panel Response #4:

a. Proximity to impaired water bodies.

In areas that topography has a greater than 2% slope, proximity to impaired water bodies is important. That risk should be addressed in a sediment plan. Educating the managers of these lands will have the greatest impact. The State and Regional Boards already have all the tools needed to force compliance. There may be need for further identification of high risk sites but no additional regulations are needed.

b. Usage of particular fertilizer or pesticide materials.

The usage of a particular fertilizer or pesticide is not as important as the choice of right time, right place and right amount. The State or Regional Boards mandating certain products to be used would be erroneous and intrusive while not solving the problem. There is no evidence that if used as according to directions, that any properly registered product has cause harm.

Education of growers would result in higher returns to water quality. But, if a grower was to use the safest form of nitrogen possible in an inappropriate manner we would most likely see contamination occur.

c. Size of farming operation.

Size of the farming operation is irrelevant. A longer time period for small growers would be acceptable. However, all must eventually come under the same guidelines. Local coalitions would be best to set the standards of time for compliance.

d. High Vulnerability Areas Methodology (as developed by the Central Valley Regional Water Board in a series of Waste Discharge Requirements issued to agricultural coalitions in the ILRP).

Local coalitions assessing risk is a good approach. Considering a limited resource of time and focusing on the areas of higher risk is prudent. High vulnerability areas could be requested to adhere to practices that low vulnerability areas may not need. The local coalitions would be the best entities to evaluate the risk to surface water. We must remember risk to surface water and risk to ground water are two different standards.

Panel Response #5:

No response

Panel Response #6:

I have not got the expertise to address these questions.

Panel Response #7:

Obviously a and b are essential elements for individual farms and/or regions. Again, farm size is irrelevant as larger operations may be the very ones who can implement management practices to limit runoff.

Panel Response #8:

A) Proximity alone does not present the only risk. Where the farm located in relation to the water body is is much more important. Obviously up slope is of greater concern than down slope. Soil type around the body of water is critical. Rainfall potential is another important concern. It is almost impossible to put an absolute number of feet away from the water because of these variables. It really is a case by case evaluation.

B) Fertilizer and pesticides that can be attached to soil particles and subject to runoff would be ones to be avoided particularly if they were to be applied up slope from the water body.

C) I believe any size farm should be considered in risk assessment. The smallest farm in the wrong location, doing poor management practices can be more dangerous that the largest farm in a good location doing the best management practices. Size of farming operation does not equate to potential risk.

D) I have already commented on the methodology used by coalitions in region 5. I believe this approach has been proved quite effective in regards to pesticides and should also be effective on nitrogen discharges.

Subject 2: Application of Management Practices

The application and use of management practices for the control of nonpoint source pollution is a fundamental approach taken by many Water Board orders, and considered a key element in the State Water Board's Policy for Implementation and Enforcement of the Nonpoint Source Pollution Control Program, May 20, 2004. Management practices that are cost-effective and are easy to implement have the best chance of being adopted and successful. However, when comparing management practices, consideration should also be given to the likelihood that a management practice will be effective in reducing nitrogen loading to surface and groundwater. The Regional Water Boards have included specific management practices in their various orders, as well as requiring the growers to identify and implement management practices on their own.

SUBJECT:	APPLICATION OF MANAGEMENT PRACTICES
Question 5	What management practices are expected to be implemented and under what circumstances for the control of nitrogen?

Panel Response #1:

This is the same as the previous and later question.

Panel Response #2:

It was mentioned at various times during testimony and panel deliberations that perhaps the best focus area for preventing nitrate transit to groundwater would be to assure that water does not move beyond the root zone. The irrigation approach, in which a high efficiency and precision water delivery method, seems to be a low cost and low technical complexity method of assuring that nitrate transit to groundwater is minimized. The following are a few basic, foundational practices that should be present in a growers plan under most, if not all circumstances of risk or vulnerability designations.

a. Distribution Uniformity (DU)-ensures the precise application of both water and the nutrients transported by water to the root zone. A DU interval should be determined at the coalition/region level by crop and irrigation system type. It's unlikely that this would be needed on a frequency exceeding every two years. Perennial crops and annually reinstalled systems on the same property/location could be a much longer interval.
b. Water volume monitoring-The scale of the area to be monitored will have to be considered by region and crop type. Monitoring by property or well is not a burden and is the foundation for calculating nitrogen loading via irrigation water, however, monitoring by production unit could present additional cost, complexity, or burden. This information is useful to both the regulator and the grower. Irrigation strategies and water use should be treated as trade secret data and should be made available only to a coalition.

Panel Response #3:

<u>Improvements in irrigation management practices</u> with many horticultural / vegetable crops such as strawberries, other berries, processing tomatoes and onions, and with tree and vine crops. These improvements are generally not being driven by concerns over nutrient use efficiency or

costs or fate of nutrients, but by water cost and availability issues in combination with a recognition that some crop species have favorable: (1) crop establishment; (2) yield; and/ or (3) quality responses to higher frequency irrigation or avoidance of more intense water or nutrient stresses.

Expectations are that growers will continue to improve approaches for better irrigation scheduling to avoid critical periods of water stress, but also to better match water applications to growth stage differences in crop water use. As with above, much of the initial impetus for these improvements will be more related to water cost and availability issues more than to achieve improvements in fertilizer (N, etc.) use efficiencies.

Some emphasis with many growers is for more routine use of fertigation practices, particularly with microirrigation, resulting in more spread out, low dose applications of all fertilizer nutrients, including nitrogen. To some extent, these improved practices are occurring because they are one of the inherent capabilities of the changes in irrigation systems. Some growers are recognizing that some crop species also respond favorably in yields or quality to higher frequency irrigation and higher frequency low dose nutrient applications.

In areas where growers are using microirrigation systems or improved, well designed sprinkler systems:

- Expect more growers to apply fertilizers (including N fertilizers) using multiple low dose applications by fertigation. With this approach, growers can apply fertilizers efficiently, avoid larger applications during low crop use periods or periods of more exposure to rainfall potential and leaching losses, and can respond to changing crop conditions or status by altering N application plans as the crop develops and more information is available.
- The water applications should be metered and injection rates recorded so that exact amounts and time of application can be recorded and crop responses noted for future reference.

In areas where there is a high potential for losses to surface water supplies, or where irrigations are not expected to be very uniform due to irrigation system design and soil water intake characteristics, N fertilizer applications using surface irrigation methods (border check, furrow irrigation) should be discouraged.

Fertilizer application management practices to consider for fields with moderate to more severe estimated leaching hazards:

- Do not make fall fertilizer applications for winter or spring planted crops
- Preplant fertilizer applications should be limited to moderate amounts (perhaps no more than 50 to 60 lbs N/acre) in crops planted in the spring, particularly if multiple sprinkler irrigations are likely needed for establishment of seeded or transplant annual crops, or where significant probability of planting time rainfall exists.
- When possible, consider sidedress, split application of N within-season for at least 2/3 of the total applied N in order to keep stored levels of N in the soil profile at reduced levels with less potential for leaching losses associated with a random rainfall event or an uneven, lower distribution irrigation.

Panel Response #4:

We heard about a lot of management practices. Not all of these practices are effective in all the regions. An example, of this would be a sediment management plan. There is no reason to require a farmer to complete a sediment management plan on land that has less than a 2% slope and low rainfall amounts. However, on sites with significant elevation changes a sediment plan is warranted.

Even though Regional and State Water Boards cannot come up with a good reason to report nitrogen applied, some form of nitrogen use reporting will be required. In areas of low vulnerability the requirement should be reconsidered. Focus the effort on areas of high vulnerability. A good education program of proper use of nitrogen would be more helpful in low vulnerability areas.

Coalitions should be given the flexibility to require what reporting is needed. This will be a burden on management that adds cost to production without the ability to recoup that cost. Small farmers will be damaged the most from such mandates.

Panel Response #5:

General discussion of what a management practice is and why it is considered. Why all management practices are not appropriate in all locations.

Management practices that have the effect of increasing NUE on the farm should be considered as having the potential to reduce the movement of nitrogen below the root zone. These practices include the incorporation of highly efficient irrigation practices that may include system type, design, management and maintenance of those practices. The other primary practice element includes the applications of and application decision making tools used to determine actual N applications.

Panel Response #6:

Widespread implementation of management practices for the control of nitrogen loading to groundwater is more likely if:

1. MPs have strong support from commodity groups, trade organizations, and services providers.
2. Commodity groups and trade organizations play an active role, including massive and sustained outreach to their constituency.
3. Farmers understand the overall problem, the need to address it, and their critical role as part of the solution.
4. Farmers have access to high-quality professionals that can help them identify an array of MPs most beneficial for their specific farm.
5. The initial threshold to first try a new MP is low (e.g., implementation cost is reasonable for the farm, there is a return on investment, the risk of crop loss is low, etc.)
6. Farmers are ultimately in control of the choice of MPs they implement on their farm on a schedule that fits within their specific farming operation.
7. MPs result in tangible benefits to the farmer such that the motivation to continue implementation comes from within.

Panel Response #7:

Although, not a "management practice", but required education regarding the fate of N on farms with respect to N application, both rates and timing, and the interaction of

Farmers currently track fertilizer applications to crops for cost accounting purposes, but necessarily for potential movement of N. A formalized auditable accounting of N additions as well as irrigation water and rainfall additions needs to be implemented. This information does not need to be submitted to the regional boards, but should be reviewable by a 3rd party. Additionally irrigation system evaluations should be conducted on recommended basis that is specific for the farm being regulated.

Irrigation and nutrient management plans (INMP) need to be developed for "high risk" farms (not areas). There should be templates developed that can utilized but are not required to be followed. The plans should be reviewed by qualified personnel, which may include "certified" growers, CCA's or other qualified professionals.

The plans should include rationale for fertilizer and irrigation additions. They should be fairly encompassing, including timing of fertilizer additions based on crop uptake patterns.

Panel Response #8:

I believe that the first series of management practices should include:

1) Prevent runoff of any irrigation water if at all possible
2) Record keeping of nitrogen applied during a calendar year
3) Establish nitrogen needed for desired crop yield based on removal rates and crop demand
4) Create a nutrient management plan that addresses high vulnerability areas as well as low vulnerability zones
5) Adopt irrigation practices that limit runoff and penetration beyond the root zone when applying nitrogen.
6) Work on irrigation efficiency for even distribution of water and nutrients
7) Whenever possible use ammonium based fertilizers that will have less leaching potential until they convert to nitrate in the soil
8) Prevent any deep placement of nitrogen fertilizer when applying
9) Consider all sources of nitrogen when considering your nitrogen budget for you're your crop cycle (applied, in water, and carry-over N)
10) Create a planning schedule for nitrogen application based on crop demand and uptake capabilities

SUBJECT:	APPLICATION OF MANAGEMENT PRACTICES
Question 6	What management practices are recommended for consideration by growers when they are selecting practices to put in place for the control of nitrogen?

Panel Response #1:

For a regulatory program, it is important to provide meaningful guidance. There can be a tendency to develop a list of almost every possible measure that could be employed – and such lists typically remain in reports. Such an example is Table 2.4 Management Measure Summary of Technical Report 3 of the UC Davis Report for the SWRCB SBX2 1 Report to the Legislature. If one examines such list, there are still numerous details that are missing for it to be effective.

Therefore, the choices are:

1. Make a general list of practices such as Table 2.4 which is lengthy but still insufficient.
2. Make a more detailed list of practices, including small details such as flushing of drip hoses, injecting with chlorine at 0.5 ppm at a pH of 6.5….except if it is organic farming in which case the farmer needs to inject….. etc. This is again an interesting exercise for the creators of the list but of little practical value.
3. Provide practices which are more structural or programmatic in nature.

Management practices will depend upon numerous local factors such as irrigation method, crop, soils, climate, size of field. Making a statewide comprehensive list of specific details is the wrong direction for a regulatory program.

Fundamentally, management practices that influence nitrogen leaching can be distilled down to the following key elements.

1. Amount of nitrogen applied, to match total plant needs from external inputs.
2. Timing of nitrogen application, to match plant N uptake patterns
3. Amount of irrigation water applied, to match the ET requirement of irrigation water
4. Timing of irrigation water application, as compared to ET requirements.
5. Uniformity of irrigation water application
6. Uniformity of plant uptake (as noted by uniformity of plant growth throughout a field)

The first management practice, therefore, is to collect and organize some basic information on a field basis (in the case of produce crops, this may be a composite of many small fields that have similar practices). This basic information includes:

1. The estimated nitrogen (lb/acre) that will be removed from the field.
2. The ETiw requirement for a field, both in annual volume and scheduling
3. The flow rate and volumes of irrigation water applied to a field.
4. The nitrogen application (lb/acre) to a field.
5. The uniformity of the irrigation system

The second management practice is to develop a plan to apply water and nitrogen effectively.

The third management practice is to evaluate the effectiveness of the plan implementation.

Panel Response #2:

An annually updated list of best management practices should be developed that is specific to the crop and region. It is critical that the set of tools from which the grower selects is not limited and that there is a clear and inclusive mechanism for management practices to be updated on a recurrent timeline. Flexibility is needed as information for various crops or by crop between regions is not uniformly available. For example, a strawberry nitrogen demand curve may be available for use as a best management practice, but a neighbor may grow a crop for which this information does not exist. The latter producer may decide to more frequently test soil nitrate levels or use drip tape instead of sprinklers.

This regional and crop variation highlights the need for a regional coalition based approach to this process. The criteria used in selecting the BMPs menu at the regional level should include feasibility by crop assessment and should address or incorporate at least one of the 4Rs: right time, place, form, and rate.

In assessing best management practices the a best management "menu" should include (but should not be limited to) the following areas.

- Irrigation scheduling via soil moisture sensors-Manual read or telemetry based systems can provide the grower with real time soil water availability data for irrigation scheduling.
- Irrigation scheduling via evapotranspiration-The use of this tool is limited to crops with crop coefficients and to areas with CIMIS or other weather monitoring infrastructure availability.
- Fertilizer (specifically nitrogen) applications should be documented and maintained by the grower. When selecting BMPs, there should be various nutrient delivery methods by irrigation system available from spoon feeding via drip to single side dressed applications. If available this documentation should be combined with a crop nitrogen demand curve. As with water applications above, these records should only be submitted at the coalition level in order to protect trade secret information.

Panel Response #3:

<u>Changes in Irrigation Systems, Management of those alternative Systems</u>
In some of the prior reports and available information related to SWRCB discussions, plus the testimony of growers from Region 3, there was a relatively heavy emphasis on the irrigation and nutrient management benefits of the conversion of irrigation methods from surface irrigation plus sprinkler to micro-irrigation (mostly surface and subsurface drip in Region 3). There are references to this approach in several areas of UCD Technical Report 3, and we heard a heavy emphasis on this approach from grower giving comments at the San Luis Obispo public meetings. It is vitally important that there be an emphasis not just on conversion of irrigation systems, but also on design characteristics and maintenance that can strongly influence performance and ability to actually deliver improvements in uniformity of application and reduced opportunities for leaching. Another consideration is that it will be important to consider proper design and maintenance as key factors influencing any grower's ability to achieve more efficient nutrient applications and limited leaching losses. For some crop and farming situations, there also can be some serious economic constraints limiting ability to convert over to micro irrigation.

Consideration of Utility of Sequential Crops in the Rotation to Utilize and Tie Up Nitrogen (this recommendation is both for the growers and the regulatory community – it is too easy to try to apply all plans to individual crops, or to tie them to a specific time period such as a calendar year.) Neglecting the potential contribution of good choices for rotation crops and the sequence of rotation crops could remove consideration of an effective, good tool for reducing N losses.

I would suggest that proper sequential crop selections could have some significant impact, particularly in areas where leaching potential is moderate to severe as identified in some leaching potential evaluations/maps. There may be a more profitable sequence of crops for growers to consider, so if they are to use a better rotation crop sequence with N-scavenging potential, there may need to be credit or other incentive to pursue this judiciously.

- This may take evaluations to a multi-year, cropping sequence plan in order to give credit for this approach?
- Consideration of cropping sequence, including sequential crop differences in rooting depth, likelihood of deep soil nitrate capture in rotation crops.
- Specific Crop Rotation Approaches that could be incorporated into BMP's include:
    - Follow low N use efficiency, shallow rooted crops with a deeper rooted crop such as corn, safflower, sugarbeets or cotton that could use deeper available soil N.
    - Follow legumes such as alfalfa with higher N use crops with moderate to deeper rooting crops (corn, sorghum, small grains, etc.) that can utilize N left in the profile by the legume
    - Where water supplies or rainfall are adequate to support them, consider use of cover crops to scavenge upper soil profile available N that can be incorporated into plant matter and harvested or returned for the subsequent crop.

Restricted N Application Rate Per Unit Ground Area Considerations:
- I do not consider these as "recommended practices", but think the approach is worthy of discussion, since it obviously is part of the "Nitrogen Mass Balance" approach or the "Nitrogen Balance Ratio" discussions.
- A restriction per unit land area on some time basis (per year, per crop) could in some (but not all) circumstances be effective in reducing potential N leaching losses, and would be one of the simpler regulatory approaches.
- Some of the key problems with use of N fertilizer and organic N application limits are associated with:
    - (a) uncertainty regarding how to adjust allowable N applications based on various N credits (irrigation water, release from soil OM, residual upper soil profile NO3-N, etc.);
    - (b) limited predictability of various possible soil nitrogen transformations due to soil, climatic parameters such as temperature and rainfall, and crop residue incorporation differences; and
    - (c) verifying for growers whether or not upper limits on N applications restrict yield level or impact harvest quality as new cultivars are developed or new crops are grown for which there is little research data on N removal, N responses for these crops.

Panel Response #4:

The following management practices should be offered for consideration. Not all of these practices are viable in all situations.

1. Preplant soil sampling.
2. Consider, or use the advice of a CCA when deciding the use of nitrogen.
3. Make multiple small dosages of nitrogen over the growing season to avoid loading the soil.
4. Encourage methods and timing of irrigation that lower the leaching potential.
5. Use of variable rate application of nitrogen when possible.
6. Petiole sampling of proper times.
7. Soil sampling below the root zone.
8. Installation of proper well head protection equipment.
9. Education of growers on proper methods of nitrogen application.
10. Follow recommended guidelines for total amount of nitrogen required.
11. Conduct Uniform Distribution Audits on irrigation systems.

This is not a complete list to consider. Not all of these methods will be workable in all situations. Coalitions will be a better venue to determine the tools that have the highest possible potential.

Panel Response #5:

Recommend specific practices:

Irrigation system types: general preference toward pressurized systems.

Panel Response #6:

With the help of five expert panels and a total of 35 panel participants, Dzurella et al. (2012) compiled an array of four Basic Principles addressing the control of deep percolation, NUE, and off-target fertilizer discharges that apply to virtually every farm. These Basic Principles were further organized in ten Management Measures (MM), each of them composed of two to nine Recommended Practices (RP) for a total of 50 RPs. The authors provide detailed discussions for every RP including the extent of their current use and barriers to increased adoption. This provides an excellent framework for farm evaluations with the objective to identify RPs most appropriate for implementation at individual farms. It also serves as a guide to focus research and commodity-specific funding needs. For example, *MM 8: Improve rate, timing, placement of N fertilizers* is composed of 9 RPs; and four of them identify insufficiently developed technology or research needs as barriers to increased adoption. This barrier is even more pronounced with the application of animal manure and organic amendments (i.e., four out of six RPs). For comparison, only four of the remaining 35 RPs associated with the other eight MMs share the same barrier.

There are other valuable resources for management practices available. Resources specific to California agriculture include but are not limited to the University of California Cooperative Extension, UC Division of Agriculture and Natural Resources, California Polytechnical

University's Irrigation Training and Research Center and other California State University programs, CDFA and FREP, and USDA NRCS.

It is important to recognize that there are many practices known to decrease deep percolation and increase plant nutrient use efficiency, and many of them have been known for decades. A first step that should be taken to address the nitrate issue is a comprehensive farm evaluation with the goal to identify the farm-specific potential for improving the control of deep percolation and subsurface mass loading, and help farmers in the selection of a suite of appropriate practices (see **Recommendation 1**).

Panel Response #7:

Although, not a "management practice", but required education regarding the fate of N on farms with respect to N application, both rates and timing, and the interaction of

Farmers currently track fertilizer applications to crops for cost accounting purposes, but necessarily for potential movement of N. A formalized auditable accounting of N additions as well as irrigation water and rainfall additions needs to be implemented. This information does not need to be submitted to the regional boards, but should be reviewable by a 3rd party. Additionally irrigation system evaluations should be conducted on recommended basis that is specific for the farm being regulated.

Irrigation and nutrient management plans (INMP) need to be developed for "high risk" farms (not areas). There should be templates developed that can utilized but are not required to be followed. The plans should be reviewed by qualified personnel, which may include "certified" growers, CCA's or other qualified professionals.

The plans should include rationale for fertilizer and irrigation additions. They should be fairly encompassing, including timing of fertilizer additions based on crop uptake patterns.

Panel Response #8:

(Same as Question 5) I believe that the first series of management practices should include:

1) Prevent runoff of any irrigation water if at all possible
2) Record keeping of nitrogen applied during a calendar year
3) Establish nitrogen needed for desired crop yield based on removal rates and crop demand
4) Create a nutrient management plan that addresses high vulnerability areas as well as low vulnerability zones
5) Adopt irrigation practices that limit runoff and penetration beyond the root zone when applying nitrogen.
6) Work on irrigation efficiency for even distribution of water and nutrients
7) Whenever possible use ammonium based fertilizers that will have less leaching potential until they convert to nitrate in the soil
8) Prevent any deep placement of nitrogen fertilizer when applying
9) Consider all sources of nitrogen when considering your nitrogen budget for you're your crop cycle (applied, in water, and carry-over N)
10) Create a planning schedule for nitrogen application based on crop demand and uptake capabilities

SUBJECT:	APPLICATION OF MANAGEMENT PRACTICES
Question 7	Evaluate and make recommendations regarding the usage of the following management practices: a. Nitrogen mass balance calculations and tracking of nitrogen applied to fields. This should include consideration of measuring and tracking Nitrogen: i. Applied to crops or fields. ii. In soil. iii. In irrigation water. iv. Removed from field. v. Estimation of losses. b. Templates for determining nitrogen balance. c. The usage of nitrogen balance ratios. d. Nutrient management plans.

Panel Response #1:

The needs at the moment are very basic – obtaining reasonable management and accounting for nitrogen and water. Nitrogen balance ratios, templates for determining nitrogen balances, etc. are all interesting and helpful, but they are several steps ahead of where most farmers need to be in the next few years.

<u>The key to all of this is to have a qualified individual create a customized, field-by-field plan for nitrogen and irrigation water management</u>. One must therefore focus on proper education and certification of the "qualified individual" rather than the details of what is most appropriate for every farmer.

The big question in the mind of farmers are these:

1. What exactly needs to be reported, and to whom?
2. What will be done with this information?
3. What records are needed to be retained on-site?

In spite of the obvious problems with the analogy, a simple income tax statement provides very little detail to the federal government. And individual income statements are not released to the public. But the general information can be quite useful in developing widely publicized information about income trends, and so on.

IF the program ultimately requires the development and execution of a simple management plan for water and nitrogen, the focus should be on empowering people to develop and execute such plans, rather than on enforcing the employment of individual practices. If the benefits to farmers (less nitrogen cost, less water cost, higher yield) are truly as great as many people say, this improved knowledge and organization should have tremendous benefits to the groundwater, also.

Panel Response #2:

Nitrogen mass balance-tracking of Nitrogen applied to fields. Include measurement and tracking of nitrogen.

The nitrogen mass balance approach incorporates elements that are unknown or very difficult to quantify such as volatilization and sequestration in the plant material. Even biomass sequestration could be variable within a crop and region depending on growth characteristics. There is not enough current information to accurately predict or determine what portion of inputs applied is lost to groundwater. Leaching is typically seen as the only remainder from a complex set of interactions that are variable based on soil type, climate, crop, etc.

a. Applied to crops or fields- Unlikely that mass balance can accurately track or serve as a tool to control nitrate leaching at the farm scale. It will not serve to inform the grower as to how he can change cultural practices to reduce impacts of nitrate to groundwater. Refer to comments above in nitrogen consumption ratio for more complete comments on nitrogen mass balance approach.
b. In soil-Nitrogen is a critical and foundational tool for determining nitrogen budget and for assessing long term soil health. This should be taken on an annual basis at a minimum. Potentially and dependent on a given area's cropping patterns a grower would be better informed as to soil N status if sampling occurred before and after each crop cycle.
c. In irrigation water-Irrigation water on an annual basis and should be expressed as in either nitrate or nitrate-nitrogen form as mg/L. The results of analysis plus the projected irrigation volume would be used to calculate potential load and factored in to the nitrogen budget.
d. Nitrogen Removal Ratio: would be especially difficult to track in annual crops due to the common occurrence of incomplete harvest due to changing market conditions. Additionally, crop residues left in ground can be variable based on soil type, harvester, etc. There are many instances in the Central Coast of variable and small crop scales. There were various mentions during the testimony of a 1000+ acre ranch having treatments as small as 2 acres. For crops such as strawberries or raspberries, only a portion of the plant biomass is harvested with the marketable product. The variability in plant size and architecture can vary by block, which would create a complex and burdensome calculation of remaining biomass. The data yielded from this process, with the exception of a highly uniform crop which is completely and predictably harvested every season, would not likely be useful for either the grower or the regulator.
e. There seems to be complete data available for only almonds and cotton. The State Board should partner with cooperative extension or other academic institutions to develop accurate mass balance figures for a prioritized list of crops in each region. The prioritization could consider the percentage of acreage dedicated to that crop by region, the crops nitrogen demand curve steepness (and resulting likelihood of application error). Additional considerations could include specific crop's predominance in soils that have been shown to have high fluxes of water and nitrate to groundwater.
f. Nutrient management plans-This tool should be reserved for only the highest risk or vulnerability areas and should have a list of basic elements including all of those listed above in addition to a spatial and temporal application plan based on a guiding demand curve or other target.

Panel Response #3:

See comments below under section (b). There will need to be some general guidelines given for the sake of uniformity in assessing all the different components of "applied N". Fertilizer applied should be relatively straightforward to supply, but assumptions involved in compost, manure, residual plant matter from prior crops and an accounting of likely N contributions and fate /availability issues will need to be addressed and guidelines provided. The consequence of not providing general guidelines to direct grower/consultant efforts will be a wider range of assumed values and some disputes regarding the assumptions when they are assessed by some third party.

The strong suit of recommendations to use the N Budget / N Balance approach is that it will get / force growers and consultants (and others) to start doing a better job collecting and starting to use and evaluate all potential N sources. Some of these N sources over and above manures and synthetic fertilizers will not have been considered by a fair number of these managers. An improved understanding of these other sources and better yet, a better knowledge of the relative levels of N added by these different material additions is a real advantage in terms of growers and consultants developing an even better idea of what management practices will have the most impact in terms of groundwater protection. Since this has to be balanced against the desire to achieve acceptable / very good yields and quality if at all possible, more knowledge should be good and provide better decisions based on an attempt at a balanced approach.

However, weaknesses of this approach are many, including:

- Uncertainty of crop removal estimates for many crops (the data in many cases just may not exist or there may not have been updates that are appropriate regarding changes in production practices or in levels of yields achieved)
- Uncertainty of within field variability in yields achieved (and decisions regarding what part of the field you are managing for?)
- Suggestions that all losses shown in the balance approach will be associated with leaching losses if calculated by difference, when other inefficiencies such as volatilization will in some areas and situations represent big potential diversions from plant use.

b. Templates for determining nitrogen balance.

The templates discussed as part of the CDFA "Nitrogen Tracking and Reporting Task Force" and used in some forms during the CAPCA and CDFA /UC Nitrogen Training Courses for CCA's and other consultants are potentially useful, if they are provided with some fairly detailed training and hopefully written background instructions so that the methods employed to fill in the various components are done correctly and consistently (to the best of available data to do so). There could be some inherent assumptions and differences of opinions regarding:

- Crop nitrogen needs to meet projected yields (due to lack of available data for some crops or for crops at the yield levels of interest, or differences in available data sets)
- Actual yield projections (and whether or not growers and consultants farm to the levels of the bulk of the field area, or to the weak areas to improve yields, or what approach they will use?
- Organic matter in the soil and the rate of release of those materials – what analyses and methods to use?

- Similar issues with compost and manure application assumptions and rate of release over time?
- Available N carryover from crop residue (whose estimates do you use?)

It will be important to have training and some written materials to refer to (peer reviewed by consultants, University and other researchers) to improve chances of acceptable assumed values.

c. The usage of nitrogen balance ratios.

See comments under (a) and (b)

d. Nutrient management plans.

For such a plan to be useful it needs to cover several key items but needs to remain relatively simple in order to increase the chances of adoption and more routine willingness to use the information in management decisions. If it is set up as a yearly (12 month cycle) type of plan, it should include information on:

- The current crop and expected yield goal
- Prior crops and yield realized
- Crop and fertilizer specific management practices to limit potential for leaching losses, including:
    - 4 R's approach: Right Amount, Right Time, Right Placement, Right Source of N (more details below)
    - Method of application (banding, foliar, sidedress, fertigation)
    - Split applications to make multiple lower dose applications, targeted to growth stages with most likely impacts
    - Timing and amount of application to avoid crop low use periods, likely periods with more rainfall potential, etc.
    - Fertilizers with potential to be more stable in terms of losses (urease inhibitors, nitrification inhibitors)
- Soil test nitrate analysis data, preferably for the upper 2 to 3 feet of the soil profile
- Available N estimates from existing soil OM, manure or compost additions, and prior crop incorporated residue including prior legume crops on the site
- Expected amount of supplemental N to be applied during the current crop, including chemical fertilizers, compost, manures, etc.
- Irrigation water nitrate contribution, if applicable

<u>A significant issue with many of these Nutrient Management Plans may be a tendency to completely neglect some of the advantages possible with crop rotations between shallow rooted crops and deeper rooted crops with some potential to scavenge for leftover available soil nitrate N with depth in the soil profile.</u>

<u>General Comments Regarding Use of BMP's and Likely Successes or Problems with Their Use</u>
By their nature, the BMP's under consideration will include:

(a) physical, structural changes (such as changes in fertilizer application equipment, changes in irrigation systems such as from surface irrigation to microirrigation, installation of drains, tailwater runoff or sediment basins; or

(b) Changes in crop management practices and timing of operations in terms of crop growth stages, periods targeted as high nutrient uptake periods, or periods when crop yield and quality components are most sensitive to N management

Problems with the physical and structural changes are that there are costs associated with equipment changes and installations, and the capital costs have to be paid by somebody. Most of these types of changes in physical structures such as irrigation systems, ponds or basins, etc. also will require adequate funds for continuing maintenance going forward. If there is a government program for payments or some type of cost-sharing, it would probably help speed up implementation for at least some people. Otherwise, covering the costs for implementation and continued operation of new improved physical practices / equipment has to occur because there is some economic benefit or impact on the grower.

GENERAL CRITIQUE OF HOW WE MIGHT USE AND GIVE CREDIT FOR BEST MANAGEMENT PRACTICES THAT MIGHT BE IDENTIFIED AS HAVING POTENTIAL IMPACT ON N LOSSES?

Many practices covering infrastructure installations or improvements, irrigation system improvements, changes in type and handling of fertilizers, more careful match of nutrient applications and types to crop uptake periods and needs, improvements in irrigation scheduling and assessments of soil water and nutrient levels to limit the amount of N in time and position to be leached below the root zone ….. all of these many practices can be listed, and described as being used by growers or consultants in an effort to employ improved management practices to limit or reduce nitrate leaching losses to the groundwater and surface waters.

A major problem with this approach is that under the circumstances in place under different soil/crop/hydrogeology and weather situations, <u>not all BMP’s that might be identified are created EQUAL in terms of impacts on likelihood of nitrate losses below the root zone. Letey et al and others mention some of the issues in trying to assess scaling of BMP’s and abiity to influence N use and losses, and again.</u> They use a model ENVIRO-GRO for testing impacts of different combinations of practices to assess impacts on nitrate, and that may be an interesting example of an approach to consider.

NOTE – IMPORTANT:
The overall listing “Summary of management Practice current extent of use and barriers to increased adoption” shown as Table 2 (pages 57-61) and following text in TECHNICAL REPORT #3 provides a good, relatively comprehensive summary of types of practices to consider and some of the issues to consider in implementing them. However, <u>It probably will not generally adequate or reasonable to just say that land managers need to just employ a certain number of BMP’s (such as 5 practices for some risk level, or 7 practices for a higher risk level) in order to meet criteria for reducing nitrate leaching risk</u>. How do we “weight” or provide a scaling factor to consider when assessing the relative and likely levels of impacts of specific BMP’s on nitrate movement and potential for losses below the root zone? ….

…. Maybe uses of models such as suggestions from Letey et al need to be evaluated specifically in terms of how accessible inputs are that are needed to run the model, can the model be used for a sensitivity analysis of the impacts of specific BMP's or groups of BMP's on Nitrate losses and leaching potential, and whether or not they are simple enough for practitioners to use (either at the level of individual growers and consultants, or more likely, consultants likely to be involved in this a great percent of their time, or perhaps consultants or others employed at the level of the Coalitions as a service).

Panel Response #4:

a. Nitrogen mass balance calculations and tracking of nitrogen applied to fields. This should include considerations of measuring and tracking nitrogen.

Nitrogen use reporting is useless if State and Regional Boards do not have a specific purpose for the data. Mass balance calculations may be a tool for farmers in their nitrogen management programs, however, there are many variables that could result in mislead conclusions. There are so many variables in farming that would need to be explained with each field. A recent example of this variation occurred during the 2013 tomato growing season. A virus effected many acres of tomatoes that decreased yields significantly. For some growers that virus cut yields in half during the latter part of the growing cycle. The grower did everything correct but using any sort of mass balance calculation he/she would fall far short of perfection.

Since nitrogen is a significant cost of production, most all growers are not going to over fertilize. Grower education would be more valuable than reporting nitrogen applied. There needs to be more study of the nitrogen removed from the field before that becomes a reliable part of the plan.

Growers should do well nitrogen testing and consider that contribution into their total nitrogen applied. The estimation of lost nitrogen has so many variables in field applications that much more science needs to be done for a reliable conclusion.

b. Templates for determining nitrogen balance. c. The usage of nitrogen balance ratios.
d. Nutrient management plans.

For areas of higher vulnerability, as determined by the coalitions, some method of determining nitrogen balance could be useful. This may be as simple as completing a Farm Evaluation and keeping that on file at the farm to the other extreme of requiring the filing with the Coalition of a Nitrogen Management Plan over seen and signed by a CCA.

The Nitrogen component that volatizes off to the atmosphere is such an unknown that the value of the numbers is questionable without more extensive knowledge of the nitrogen that escaped below the root zone.

Which one of the tools may work best, and how, should be left up to the Coalitions. A clear written plan of action that growers could easily understand and use will yield the best results. Coalitions would be prudent in asking for more nitrogen information if and when the risk is increased. Starting with nitrogen balance ratios would be helpful to educate growers.

Panel Response #5:

a. Nitrogen mass balance calculations and tracking of nitrogen applied to fields. This should include consideration of measuring and tracking Nitrogen.

Nitrogen mass balance calculations can be an effective tool in identify fields that have sustained levels of high losses over time. These losses may or may not be explained by high leaching losses, but may point to other high level losses that the grower may be able to control by modifying management practices. Identifying fields or areas that sustain high losses can be

The emphasis of the nitrogen mass balance monitoring should be directed toward:

- educating growers with the goal to improve grower N management in systems where improved N management is feasible
- To inform Third Parties of specific growers, fields or cropping systems that are more likely to be impacting groundwater
- To inform the regional Board of growers, practices or systems that may be increasing risk to groundwater.
- Lastly as a tool to initiate enforcement actions.

i. Applied to crops or fields.

Efforts should be made to determine the appropriate amount of nitrogen needed to maintain crop yield objectives as well as be protective of water quality. This includes primary nitrogen sources such as organic soil amendments as well as foliar and soil applied synthetic fertilizer sources. Amounts of all significant N applications should be quantified for each field and used in combination with residual soil N sources expected to be available to the plant during the season. Although this element of the nitrogen balance is key to grower tracking of fields and important for Third parties to identify potential growers that may be more likely to discharge, the amounts of N applied to the field should not be considered necessary to report to the Regional Water Boards. Applied N can be misleading when used alone and by itself is a poor indicator of a field or areas likelihood for deep leaching of N.

ii. In soil.

Residual soil N sources are often available to the cropping season and can meet a large portion of the total N available during the season. Soil N sources include existing soil nitrates and N made available through the mineralization of crop residues. Each of these sources should be estimated either through direct measurement or through reasonable estimates previously documented on the field. Residual nitrate measurements conducted early in the season are particularly useful in determining the immediately available N contributions while N contributions from previous crop residues must be developed on site or from credible research values established for that crop.

iii. In irrigation water.

Irrigation water nitrates should be monitored annually if the source is determined to contribute a significant portion of the N applied during the season (>= 10 percent of total crop need). All applied waters may not need to be tested if multiple sources are used if the applied water traditionally tests low as in the case of low N surface irrigation waters. If multiple wells are used and deemed significant sources, an estimate of the proportion of each well used as well as a determination of each wells nitrate content. Estimated contributions of irrigation water N should be based on the amount of water used in crop transpiration rather than crop ET or total applied water.

iv. Removed from field.

Nitrogen in plant materials that are removed from the field can come from multiple sources including the harvest of the crop as well as the harvest of many incidental plant parts such as leaves, stems, seeds, hulls etc. Occasionally the removal of plant parts such as prunings can be significant and should be estimated if determined to be significant. Where possible, the records of each field/planting unit should be used and include the estimate of N removed by the crop combined as well as the incidental N removed by plant parts that are not returned to the field.

v. Estimation of losses.

Nitrogen losses are inevitable in all cropping systems and should be an expected part of the nitrogen balance calculations. Losses due to denitrification, volatilization, runoff, and deep percolation can collectively be high for any agricultural system. It should be considered a management goal to minimize the losses of N in all agricultural systems. Indicators of high system losses of N can be inferred from the nitrogen ratio calculation which is an indicator of total system losses and not individual component losses. Estimating these losses can be very useful in identifying field conditions that are like to leach N to the ground water, or have higher than desired losses due to other management or site factors that limit nitrogen use efficiency.

b. Templates for determining nitrogen balance.

Basic templates to be used for determining nitrogen balance should include clear instructions and definitions of each type and category estimated in the nitrogen balance template. Key elements include the components that make up the crop nitrogen demand or sink and the components that contribute to the sources of nitrogen. Nitrogen Management Templates should be the primary method by which growers report nitrogen balance specifics to Third Parties and will be used as a primary aggregating tool for N reporting and tracking. Template format may differ for certain crop types bases on the emphasis or need to include key evaluation parameters that support the appropriate development of a nitrogen balance.

c. The usage of nitrogen balance ratios.

Properly developed nitrogen balance ratios (NBR) provide a useful indicator to the field manager wanting to control risks of excessive loses of nitrogen and should be weighted over multiple years to provide perspective on field or area Nitrogen Use Efficiency. Sustained low ratios indicate systems that experience low Nitrogen loss risk, including deep leaching losses and can be an indicator of improvements in N management made over time. High N balance ratios on the other hand are indicators of systems out of balance or systems that are experiencing high nitrogen losses. NBRs can be a useful tool used by growers, Third Party Aggregators and the Regional Board to better understand the nature of system N losses that could include movement of N to groundwater. It can be useful in identifying practices or systems that have unusually high gaseous N losses. The NBR when aggregated can also be an indicator of general improvements in Nitrogen Use Efficiency.

Panel Response #6:

Field-scale nitrogen accounting as a management practice

Understanding plant-soil-water-nutrient relationships is important for service providers to comprehensively evaluate the farm-specific potential for controlling deep percolation, increasing NUE, and help farmers in the selection and implementation of appropriate practices. Some quantitative knowledge of the amount of nutrients applied to the crop or field is needed in this endeavor but only represents a small portion of quantitative, semi-quantitative, and qualitative information regarding irrigation systems and management, farm infrastructure, pest management, site-specific soil conditions, field observations of plant health, water availability, and many other variables that are taken into consideration by farmers to make daily decisions. Many of these variables can change unexpectedly and abruptly and impart substantial control on the overall nutrient budget. In addition, nutrient applications on a field scale will always be estimates and there is tremendous uncertainty involved in these estimates even if they are based on measurements[2]. The same applies to estimates of harvest removal, changes in soil N-storage, and losses from the plant-soil system (i.e., to the atmosphere or to deep percolation).

Nutrient accounting including the calculation of application-removal differences and ratios can provide a good planning tool, a good basis for formulation of goals for improvements, and valuable feedback to the farmer, if considered within the framework of individual farms and with the awareness of the uncertainties surrounding specific computations. The level of accuracy and precision that is either needed or can be accomplished will vary between commodities, within individual farms, and probably even on a field scale between different plantings. Therefore, data collection efforts should be allowed to vary, too. For example, in a cropping system with an annual nitrogen throughput of 500 lbs/ac, annual nitrogen sampling in a deep groundwater production well with low and relatively stable nitrogen concentrations is not needed because it would only provide a very small amount to the overall nitrogen input. It has to also be recognized that it is not realistic to expect rigid, field-scale nitrogen accounting to be feasible on many farms. Examples are many vegetable growers that deal with multiple plantings per year on small plots (i.e., some growers deal with >1,000 plantings per year).

It is apparent that the complexity of decisions that need to be made every year to grow a crop and their relative effect on deep percolation and subsurface loading cannot be captured with check lists. Furthermore, it is apparent that the largest potential to make substantial improvements lays in the cooperative relationship between farmers and their trusted outside professional help (see

[2] This is especially true for farming operations that use organic fertilizer sources such as animal manure.

Recommendation 1). At the same time, farmers must be allowed to retain the flexibility in their choice of practices because, arguably, every farm will need a custom job.

Template for determining nitrogen balance

Presently, nitrogen balance calculations are being carried out without explicit goals for their accuracy and precision. Sampling and testing is conducted without regard to data quality objectives. Sampling protocols for several critical quantities that are required under the Dairy General Order are known to produce highly misleading data (e.g., lagoon liquor sampling, manure sampling, and silage sampling). Templates for nitrogen accounting should have the following minimum characteristics.

1. Defined purpose with associated goals for accuracy and precision
2. Defined data input requirements
3. Guidance on sampling and testing protocols that have undergone a vetting process and are deemed sufficient to support goals for accuracy and precision

Proposed Farm Evaluation Templates

The Central Valley Regional Board prepared Proposed Farm Evaluation Templates for third-party groups representing growers within the Tulare Lake Basin area and other water quality coalitions under the ILRP. Out of one of these documents (i.e., Proposed Farm Evaluation Template under General Order R5-2013-0120; April 8, 2014), select data collection requirements are examined to illustrate the questionable nature of much of the required data. The quint essence is that much of the presently proposed data collection is useless for purposes of groundwater quality protection.

Part A – Whole Farm Evaluation, Item 1

Not checking the boxes for “County Permit Followed”, “Follow Label Restrictions”, “Monitor Wind Conditions”, “Monitor Rain Forecast” and others would equate to self-indictment. This begs the question, who would be naïve enough to do this? The answer is, probably nobody. Further, how can Regional Board staff verify the veracity of answers? They cannot. Therefore, the information that would be supplied to regulators would have no value for any type of analysis.

Part A – Whole Farm Evaluation, Item 2

What kind of regulatory action is planned for any combination of check marks under this item? Will regulators dictate to farmers what kind of professional they consult for their nutrient application plan? If professional licensure is required for the preparation of a specific document, identification of such licensure on the document itself should be sufficient.

Part B – Field Specific Evaluation, Items 2, 3, and 4

What kind of regulatory action is planned for any combination of check marks under these items? The fact is that none of this information helps protect groundwater quality. Checklists of this sort are not useful. Rather, they instill a misguided feeling of “mission accomplished” or “Farmer A is doing better than Farmer B”.

Part C – Irrigation Well Information

- What does “Standing water avoided around wellhead” mean? For example, how about a well with a 5ft x 5ft concrete pad which is in between two flood irrigated fields (i.e., surrounded by standing water)? If indeed, standing water was observed by the farmer after a rainstorm, would (s)he be likely to report it?
- “Good Housekeeping Practices” such as keeping the area around wellheads clean of trash, debris, and empty containers are not an indicator of good nutrient management. This exemplifies the misconception that a farm that looks orderly and clean must be doing a good job at controlling deep percolation and achieve high NUEs.

Panel Response #7:

Mass balance is a concept that should be included in INMPs but is useless to implement at a field or farm level. The estimates of error on the removal side of the mass balance equations are just too large for meaningful conclusions to be achieved.

As part of the ILRP requirements and as I have mentioned above, N additions on a per field/planting basis should be required for all high risk farms. The N addition should include: fertilizer additions (method of application is not important), N in irrigation water, N in other inputs such as compost or manure, and some estimate of soil contribution, based on soil sampling prior to first planting (at a minimum) on a field basis.

It is critical to assign some reasonable level of nitrogen uptake efficiency to each of the sources of N. Additionally irrigation methodology and management will influence N uptake efficiency – so this also needs to be included in the input calculations. The calculations and assumptions need to be included in the INMP. This should be reviewable by the regional boards, but be required for submittal.

The N applied from all sources should be compared to “typical” rates of N use for the commodities grown, but trying to estimate actually N removal is useless due to the reasons indicated above.

There needs to be allowance for extraordinary N applications having to do with weather events that are outside the control of the farmers. Farmers should have access to typical N additions for the commodities they grow so they can compare their N additions.

A 3rd party audit should review a significant proportion of farms each year. This should begin within 2 years, but keep in mind that not all growers have the same ability to comply rapidly with this requirement.

Panel Response #8:

A) When considering mass balance calculations it will be important to use all the potential sources of nitrogen that could be applied, but I believe it is important that we encourage “pump and fertilize” as it will recycle nitrate from ground water and had the best immediate potential for nitrate reduction. If we make regulations that are punitive to this type ground water, growers will not use this water and just abandon these sources. This would slow the remediation of these sites.

Mass balance calculations work fairly well for permanent crops taking into consideration for a single harvest. This can be accomplished with a template we saw that some coalitions have designed. The template can be refined as we go forward but for now it will serve as a good starting place. The mass balance does not work as well in multiple cropping scenarios. Carry-over N is so variable depending on previous crop harvested that it would be next to impossible to allow for how much N is available to the next crop. Also you can have no harvest in some parts of fields and complete harvest in parts of the same field. I believe that we can only calculate an annual use of Nitrogen on blocks that have multiple crops grown in the same calendar year. This should balance the usage our on all crops harvested vs. total nitrogen applied from all sources.

B) I already commented on the only template that we saw in testimony. The coalitions are trying to come up with more of a “one size fits all” approach. This needs to be messaged a bit to allow for multiple crop scenarios. Also how will we determine estimation of nitrogen loss? Patrick Brown has been using an 80% efficiency in his models, but is that accurate beyond his almond and pistachio work?

C) The nitrogen balance ratio is currently being used in the dairy order. They have taken a 1.4:1 ratio for now. This may work for them as they have a limited number of crops that they grow. However given the number and complexity of crops that are grown outside the dairy order I believe we should work more on an efficiency basis. Efficiency will work better to minimize more losses rather need because they are still within the ratio guidelines.

D) I think the nutrient management plan is going to be the cornerstone of nitrogen tracking and balancing for the grower. I believe it will bring focus to the grower on how he can control nitrogen and still maximize yields. They will be working documents that should be evaluated yearly and adjusted as is necessary. They can also evaluate the management practices that were adopted and quantify the effectiveness after the year is over.

SUBJECT:	APPLICATION OF MANAGEMENT PRACTICES
Question 8	Evaluate and make recommendations regarding the most effective methods for ensuring growers have the knowledge required for effectively implementing recommended management practices. Consider the following: a. Required training. b. Required certifications. c. Workshops sponsored by third parties such as: CDFA, County Agricultural Commissioners, Farm Bureau, UC Cooperative Extension. d. Usage of paid consultants – e.g., CCAs/PCAs. e. UC Cooperative Extension specialists.

Panel Response #1:

It is astounding that the Cal Poly ITRC has not been listed. Cal Poly ITRC spearheaded the Designer Certification efforts of the national Irrigation Association – a program that is now 30 years old and requires training, testing, and certification. ITRC provides about 60 short courses a year, and has been the state leader in numerous efforts such as fertigation, design of drip/micro systems, design of surface irrigation systems, evaluation of irrigation methods, etc.

There are several areas that need to be addressed:

1. Filling in knowledge gaps and publish them widely in simple bulletins. Perhaps these are well known by some people, but they are certainly not well advertised. The primary gaps in knowledge are:
    a. Harvested (removed) N for various crops.
    b. Timing of uptake of N for various crops
    c. Requirements for other nutrient balances, to ensure proper N uptake.
    d. Justification for the inherent inefficiency that is embedded in UC recommendation of fertilizer applications, that assume a 70% or so inefficiency. The current UC recommendations of application appear to guarantee an unacceptable level of nitrate leaching.
2. First, make a clear decision on what the obligations of individual farmers will be, and the justification for those obligations. If the obligation is to develop and implement a good but simple management plan, this will be a major advancement for many farmers. The plan, however, must be developed by a qualified individual (either a consultant, employee, or the farmer). The farmer must certify that he/she will adopt the plan and implement it fully by 2017, as an example. The key elements of each annual plan, for each representative field, could be:
    a. Keep records on all nitrogen inputs and timing.
    b. Keep records on all irrigation inputs (flows and volumes) and timing. This requires a means of measuring the flow rates and volumes into individual fields – **which is a major advancement for most farmers**.
    c. Have recent measurement of the distribution uniformity of the irrigation system, or from a comparable irrigation system on the farm.
    d. Summarize, in a neat table, the inputs and the expected consumption of water and nitrogen.
    e. A list of improvements to be made the coming year.

3. Define the training venue. If this is to be a long-term program, there must be consistency over many years, with the ability to upgrade and expand training. There are several different venues:
    a. One would be the approach that UC used in its recent workshop effort with Certified Crop Advisors. Benefits appear to include:
        i. It was very quick.
        ii. It reached a large number of people.

        Disadvantages are:
        i. This is difficult to sustain, and difficult to provide over the long haul with consistency because it consisted of numerous people who were evidently quickly pulled together.
        ii. There was no testing, so there was no way to objectively evaluate the effectiveness of knowledge transfer.
    b. A second approach would be to have formal1-3 day workshops such as those that Cal Poly has at ITRC. These are based on structured educational material, and are usually taught by only one or two individuals, each. Advantages include:
        i. Because the educational material is standardized, participants obtain a consistent message from year to year.
        ii. The timing is published well in advance, so people can plan on these classes every year.
        iii. Many of the classes dovetail with Irrigation Association certification programs, which require that students pass classes.

        Disadvantages include:
        i. These classes require that people travel to San Luis Obispo.
        ii. Because these classes are often lab-intensive, they can be expensive to provide.
    c. A third approach is to develop distance learning modules, which include testing and accounting of registration, etc. ITRC has developed this type of program for several topics. Advantages include:
        i. People can study when they want.
        ii. People can study from home.
        iii. The material is standardized, so everyone receives the same information from year to year.
        iv. The teaching quality does not depend on the instructor of the moment.
        v. The distance learning can be augmented by written materials, or local lab exercises.
        vi. A "distance learning package" can serve as a backbone training tool for an in-person training session. That is, an instructor can be present in Merced, for example, to help stimulate discussion, answer questions, etc – but use the "distance learning module" as the primary teaching tool.

        Disadvantages include:
        i. A high quality distance learning package is much more expensive than most people think. You can't pay for these from student registrations. They need to be developed with up-front funds.
        ii. A high quality distance learning module takes months to develop. It's not the same as throwing together a powerpoint presentation.

   d. A fourth approach is to develop standardized training materials, and then have local qualified individuals – not necessarily from a university – lead the training. Some trade associations do this. Advantages include:
      i. This can get local people heavily involved.

      Disadvantages include:
      i. It is often very difficult to get qualified people to teach the courses
   e. Some mix of 1-4.
4. Develop standardized training materials to provide knowledge transfer to those who will develop the plans.
   a. A key item will be to build upon existing knowledge. For example, ITRC has been teaching a short course on Fertigation for about 30 years that should be built upon rather than starting from scratch.
   b. The specific topics must be standardized and well defined. For example, topics might be:
      i. How to fill out the basic cover sheet for a management plan.
      ii. How to determine timing of nitrogen applications.
      iii. How to determine lbs/acre needed, making various assumptions about the nitrogen cycle in the soil.
      iv. How to check for adequacy.
      v. Interaction of N with other nutrients.
      vi. Fertigation principles
      vii. Fertigation equipment
      viii. Irrigation system evaluation.
5. Define the process for certification of "planners". Some key principles exist:
   a. "Grandfathering" people into certification is undesirable.
   b. Simple attendance at classes is insufficient for demonstrating knowledge.
   c. Evaluation of course effectiveness is best done by evaluating (through testing) knowledge of the class participants. A simple course evaluation based on subjective statements such as "I learned a little, a lot, or nothing" is fairly meaningless. Most good instructors know that there is a huge difference between the student's perception of what the student knows, and what the student actually knows. Good course reviews are easy to obtain by having humorous instructors who require very little, and if coffee and donuts are readily available during the class with lots of bathroom breaks.
   d. Exams need to be standardized, but have a good selection of randomized questions to prevent cheating. Grading must also be standardized. This is a major effort. ITRC has developed excellent expertise in this, both for university classes and for on-line classes.
   e. A big question is if people need to have degrees in Soil Science or Agronomy. There are likely too few people who have these degrees.
   f. Another big question is if people who make management plans should already be certified in some other program. It is interesting that the UC training of Certified Crop Advisors has focused on crops and fertilizers, with almost no attention to irrigation. Another existing program is the Certified Agricultural Irrigation Manager (through the Irrigation Association), which is the opposite – it focuses more on irrigation. It would seem that some blend would be acceptable. But there is no doubt

about the importance of irrigation knowledge, and the present Certified Crop Advisors are not adequately trained in this subject.

g. Trainers must be well qualified. This is a serious challenge. People who understand the plant physiology aspects of water management often mistakenly assume they also know about irrigation system design and management – a very different topic, requiring a different skill set.

h. It is difficult to maintain consistent momentum, year-in, and year-out. Therefore, there must be some official organization to manage any certification program.

6. Develop the examinations, if applicable.
7. Implement the program.

Panel Response #2:

As was presented at various points during panel deliberations and testimony, education in itself, will not be sufficient to adequately prepare growers and provide them with the tools necessary. In order to increase the nitrogen use efficiency and reduce losses of nitrate to soil leaching, growers will need to participate in training associated with the adoption and ease of use of new technologies such as nutrient tracking programs, soil moisture sensors, etc. Education should be treated as a forum for knowledge exchange which will increase the rate of adoption and comfort with new BMPs. In general, growers have a desire to understand not only the condition of their resource inputs, but also the possible steps they can take that will lead to enhanced protection of those resources.

A very preliminary list is included below. It would be helpful to review this and others proposed lists in the panel's next meeting:

- Interpretation of soil and water analyses
- Soils-hydraulic conductivity, use of web tools in identification
- Risk assessment tools that can be of education value to the grower, regardless of value as a risk indicator i.e. NHI
- Irrigation system design and distribution uniformity
- Irrigation scheduling
- Nitrogen cycle and mass balance approaches are useful to inform the grower even if not able to effectively be used as a regulatory or planning tool.
- Leaching and salinity management training will be needed to ensure that the growers response to reduced nitrogen leaching requirement do not reduce their attention to or ability to manage harmful salinity constituents such as sodium, chloride, and boron.
- Proper well construction to reduce direct well conduit groundwater contamination.

Training should only be required by a coalition or other regional function as a requirement for membership in that organizations the necessary skill sets for reducing nitrate losses to groundwater will only be known at the local or regional levels.

A self-certification process, such as the one outlined in the Central Valley ILRP, should be allowed if a grower or coalition feels that the CCA process does not adequately incorporate local or regional resources and crop composition or if attendance or participation in the CCA training poses significant logistics or time constraints. Additional justifications for self-certification include the potential current shortage of certified CCA's available for the development of farm or nutrient management plans. All certification processes should require a common set of acquired skills that would aid the CCA in developing farm, irrigation, and nutrient management plans. A local approach would more adequately incorporate local, iterative knowledge into the training program than would a potential state wide approach. Frequency and need for credit hours, desired skill set outcomes, approved educational materials, and most importantly a criteria for certification of trainers is needed.

Panel Response #3:

a. Required training.

I think the training needed for growers and consultants could be provided by several approaches, and CCA's and other Certified Professionals in Agronomy, Horticulture, Soil Science or appropriate engineering backgrounds could meet the needs. I think Options A, C and D are acceptable under some circumstances, provided that there is a committee or group to determine acceptability of training and educational materials, but Option B seems too loose in terms of oversight and proof of adequacy of training and comprehension.

The approach outlined by the East SJV Coalition (Handout entitled "Grower Self Certification Continuing Education Approach" suggests OPTION A (one option out of the four available options for getting a plan certified under the Central Valley Region LT-ILRP.). While the approach sounds good and I think it is correct in saying that there are some well qualified, intelligent growers who may want to be certified and trained to represent their own farming operations, I think there will need to be more discussion regarding what constitutes "adequate initial training" and "adequate follow-up, continuing education". For instance, the Eastern SJV Coalition, if I understand them correctly, in the their White Paper on option A, suggests that the training hours needed could be 6 hours of credits every 3 years, with three of the hours required from a self-certification class conducted by a trainer from Option C, and the other 3 hours would come from any selection of training ranging from a Nutrient Management Seminar or coalition sponsored outreach or education events. The approach mentioned sounds basically ok, although the 3 hours formal training and 3 hours less formal events every 3 years seems a little limited in terms of effort expended to prove that you understand the program and are following up on evaluations and need for improvements. Perhaps in such as case, additional hours could be granted for one on one or group evaluations with Coalition Staff.

b. Required certifications.

not sure – see comments in (a) above

c. Workshops sponsored by third parties such as: CDFA, County Agricultural Commissioners, Farm Bureau, UC Cooperative Extension.

All of these seem ok for delivering information, but I think for this type of program there needs to be a central "clearing house" or group where educational materials and course agendas could be sent to assess if they are meeting objectives and up to date in terms of content, messages delivered, any forms to submit, etc.

d. Usage of paid consultants – e.g., CCAs/PCAs. UC Cooperative Extension specialists.

For both of these groups ([paid consultants and CE Specialists), there needs to be verification that the individuals have either had some specific training or that they have relevant expertise as judged by some authority group.

While some UCCE Specialists could serve in this role, since the background and expertise of many UCCE specialists does not necessarily cover nutrient management, and not all CE Specialists have crop commodity assignments, I do not think CE Specialists as a general group can meet all training needs. They certainly could join other qualified trainers coming out of industry, other backgrounds, but all of these individuals would need to meet some standards to be properly suited for training.

<u>In terms of messages being delivered in meetings and trainings:</u>

I think there needs to be some discussion regarding how to present information on best practices, and some guidelines developed regarding how to communicate potential impacts of recommended practices on potential for nitrate loss and leaching below the root zone. Every trainer or educator has areas of strength and better knowledge, and there needs to be developed some background educational materials that can help sort through BMP's that are recommended so that trainer or educator bias does not play too strong a role in the education process (regarding what BMP's are emphasized, which are ignored). The emphasis needs to be on BMP's with a better, cost effective opportunity to be successful in reducing nitrate losses below the root zone.

The Best Management Practices and other component practices with the best chances for implementation and continued use are probably those for which:

- There are strong reasons other than N management and GW quality concerns to implement (such as microirrigation systems because of water cost, water availability concerns, crop responses to this method of water and nutrient applications); or
- Practices for which there is an economic incentive provided by some sort of cost sharing program, such as a program for conservation tillage or precision farming operations through NRCS, other agencies.

Panel Response #4:

Grower education will have the largest impact on future groundwater contamination from fertilizer. All growers need to increase their awareness and knowledge of using nitrogen fertilizer. Some level of certification should be required for all growers or their agents. If growers are in Tier II or Tier III, and/or high vulnerability areas the level of certification be higher.

Growers should have the option of self-certification or hiring CCA's to certify their plans. A problem may exist with the number of CCA's available for this work. Also there needs to be some attention paid to the liability that a CCA would be accepting with his/her signature on documents. This could further complicate the number of CCA's available and willing. Most PCA's would be capable of doing this work.

Workshops and training could be done by many third parties such as CDFA, U.C. Cooperative Extension, Commodity Groups, Coalitions and Farm Bureaus just to name a few. This training should be open to anyone that desires to attend. Coalitions could require a one-time lower level certification for low vulnerability areas but an annual requirement for higher risk area managers. This training program could be a part of the training that is now required for pesticide permit licensed holders.

Panel Response #5:

The education of farm nutrient management decision makers is a key element of the compliance approach and should be considered a vital and important component in reducing N losses in highly vulnerable areas. Educational approaches that encourage broad understanding of nutrient management issues in farming systems including methods to optimize Nitrogen Use Efficiency as well as identifying and limiting farm system elements responsible for groundwater degradation will be important to meeting groundwater quality objectives.

To illustrate the value of training programs, a recent poll was conducted following a Nitrogen Management Training Certification Program asking California Crop Advisors their opinion of the training program. Summary poll results indicated that 87 percent of attendees were better able to address nitrogen mitigation regulatory requirements, 8 percent of respondents indicated they may have improved their abilities to respond and 5 percent indicated no change in their ability to address regulatory requirements. These responses clearly point to the value of thorough training programs that address a number of nitrogen management issues including information related to:

- Nitrogen sources
- Nitrogen cycling
- Nitrogen management
- Nitrogen budgeting
- Irrigation management
- Nitrogen tools and resources available

a. Required training.

Mandated training should only be required on high vulnerability designated lands.
The Panel acknowledges that many sources of information are available related to nitrogen management planning for many of the crops grown in the Central and Salinas Valleys. Information developed by commodity groups, water quality coalitions, NRCS, university scientists, farm trade publications and others help support the industries need to be educated on relevant nutrient management issues. While these sources are useful and important to ongoing educational needs of the industry, they are not often delivered in a consistent, targeted and unified effort that provides the comprehensive information needed to make well informed farm nutrient management decisions across the many crops and farming conditions that exist in the region.

It is therefore important to develop training programs that are targeted to providing curriculum and information tools that deal with broad principles and specifically examples of well documented unbiased information. Appropriate training materials will need to be developed that are aimed to deal with the diverse combinations of farming practices present in the region. These materials should be focused on initial training needs but should also include elements important to continuous training needs. Growers have the option of Self Certification or can authorize nutrient certified professionals to sign off on farm Nitrogen Management Plans.

b. Required certifications.

Professional agronomic certifications such as the ASA's CCA program, Certified Professional Soil Scientists (ASA) or other related professional certifications should be considered supplemental but not required in order to certify nutrient management plans. However, Certification programs approved by CDFA and the Board should be required of individuals "Certifying" farm Nitrogen Management Plans. The certification process documents an individual's attendance and completion of a CDFA approved nitrogen management program similar in structure to the recent CDFA/UC CCA certification program.

Certification of non-CCA growers or other individuals wanting to certify farm Nitrogen Management Plans should be considered a viable certification alternative. To accomplish this the panel recommends that a curriculum development program be developed to accommodate the many Non-CCA individuals that wish to self-certify. The self-certification training materials are to be developed by highly trained university researchers and extension educators versed in nutrient management science with materials approved by CDFA and the RWQCB. Training materials should be developed in a manner that is consistent with the CCA training materials and provide relevant and detailed information covering the 6 NMP topics covered in the CCA training program. The materials presented should include a level of breadth and detail that will allow the trainee to apply the information in a manner that facilitates a properly developed NMP. The curriculum development team will also be responsible for establishing a process for continuing education programming. This includes but would not be limited to developing a curriculum outline that includes minimum continuing education content requirements.

The panel recommends that the self-certification curriculum to be developed using two options. Option 1 would include the development of materials that would be available to individuals that want to use a self-study method to obtain certification. A required instructional class visit would be required that lays out the regulatory framework and process and provide basic instruction on how and where to access materials as well as defining knowledge expectations. Option 2 would include a classroom format that uses the same materials outlined in option 1, but would be taught by certified CCA's, university specialists or other certified professions that have been approved by CDFA and have completed certification of a program similar to the CCA NMP training program.

An exam that tests the individual's knowledge skills and provides supplemental information to incorrect responses will be imbedded in the testing component.

c. Workshops sponsored by third parties such as: CDFA, County Agricultural Commissioners, Farm Bureau, UC Cooperative Extension.

Workshops sponsored by third parties should be considered appropriate if they meet the minimum content requirements established by CDFA curriculum development program identified for self-certification.

d. Usage of paid consultants – e.g., CCAs/PCAs

CCA's and other professionally recognized individuals with NMP Certified individuals should be encouraged to deliver continuing education training following initial certification.

e. UC Cooperative Extension specialists

UC Cooperative extension specialist and advisor with a high level of nutrient management training should be encouraged to develop NMP certification curriculum content and deliver continuing education training following initial certification.

Panel Response #6:

There is an enormous need to transfer knowledge to farmers so that they can successfully fulfil. their critical role in controlling deep percolation and discharges to groundwater. Likewise, there is a need to educate the agricultural leadership. The following is a list of recommended efforts. These efforts should occur in concert and need to be coordinated including the preparation of curricula and devising protocols to evaluate the success of these efforts.

1. Workshops sponsored by third parties such as CDFA, County Agricultural Commissioners, Farm Bureau, UCCE, ANR, NRCS, commodity groups, trade organizations, and voluntary partnerships (e.g., California Dairy Quality Assurance Program [CDQAP]).
2. Conferences such as the annual Almond Conference organized by the Almond Board of California or the biennial Western Dairy Air Quality Symposium organized by the Western States Dairy Producers Trade Association.
3. The workforce of UCCE specialists needs to be dramatically increased. It is apparent that farmers need more access to expert advice, including one-on-one consultations, outside of the arena of paid consultants to cope with increasing regulatory pressures.
4. Consultants hired by farmers will continue to fulfil a critical role in working with farmers, identifying opportunities to improve operations, and imparting knowledge.
5. Certification programs should be considered. CDQAP provides an excellent example of a very successful, voluntary, third-party certification program in environmental stewardship.
6. Training, continuing education, and certification programs (e.g., for farmers, farm managers, and service providers) should be considered as they may prove successful, especially if they further one's professional career.

Panel Response #7:

Education of farmers and other decision makers is the most component of an effective plan to reduce nitrate movement to groundwater. Farmers are incredibly busy people and as important as nitrogen and irrigation management is – it is only a component of a viable farming enterprise. The education requirement needs to be relevant and easy to obtain.

Required training is necessary but required certification should only be required of those who will sign off on an INMP.

Workshops are important and the organizations listed can all play a part. However, not all farmers or decision makers will be able to attend workshops. It is important that other methods of education be developed to have the greatest outreach possible. This should include written material (English and Spanish) as well as online courses. Some mechanism of insuring comprehension of the material should be developed.

Paid consultants can play a valuable role in addressing issues in the different regions. However, the PCA standards and testing requirements do not include fertilization. Unless a PCA becomes certified by some other agency (CDFA, Cal EPA) in nutrient and irrigation management they should not be allowed to sign off on INMPs. There is also a potential conflict of interest between CCA who also sell fertilizer and signing off on INMP. Ideally it would be best if the conflict of interest could be avoided.

There may need to be a “category” for other “similarly qualified individuals” to be able to approve INMPs. This can probably be addressed on a regional board level, but the knowledge and educational requirements should be clear.

Finally – UCCE “specialists” is a term relating to a particular group within UCCE whose primary tasks are to develop new information (applied research) and communicate that information as well as other technical support to county based UCCE staff. They are not meant to be the first line of interaction with the farmer community, though occasionally they are. Therefore item “e” should be removed.

Panel Response #8:

A) I think annual training or continuing education needs to be in place similar to pesticide applicator training. This will help bring the focus of the grower to solving this nitrate problem. The beginning training could be done by Ag Commissioners in conjunction with Extension. They are already doing continuing education on pesticide permits so this would just be an additional piece of their training for the growers.

B) If growers want to be self-certified to write their own management plans then there will need to be a course developed for the grower to attend. It can be similar to the nitrogen management course that CCA’s had to attend to be certified to approve management plans on nitrogen. The course would have to be more extensive to bring growers knowledge level up to close to CCA level.

C) The workshops should be a collaborative effort between all agencies as that the information is consistent across all agencies. Outside companies that would like to train growers for a fee would have to have their curriculum certified before it would be accepted.

D) CCA’s that approve nutrient management plans for growers must be trained in nitrogen management like the ones C D F A just put on. I also still believe growers would need a level of awareness training even when using a CCA for their management plans. There currently are not enough CCA’s to do all the management plans, so I believe that more CCA’s will be needed along with some grower certifications. This should be a 1-2 year process to get enough qualified people in place.

Subject 3: Verification Measures

Utilization of verification measures to determine whether management practices are being properly implemented and achieving their stated purpose is another key element to the success of a nonpoint source control program. Because of the nature of nonpoint source discharges, direct measurements are often difficult or impossible to obtain and other means of verifications may be required.

SUBJECT:	VERIFICATION MEASURES
Question 9	What measurements can be used to verify that the implementations of management practices for nitrogen are as effective as possible?

Panel Response #1:

Verification can require huge amounts of money and produce almost nothing in near-term results.

There are two types of verification that have been mentioned:

1. Monitoring the groundwater.
2. Some type of intensive research with pilot plots.

Neither of these should be considered for verification of individual practices on fields. While groundwater monitoring will indicate long-term trends – but often only after many years – it is very clear that it is unrealistic to expect that groundwater nitrate trends under a field necessarily reflect the practices on that field.

There is no need for intensive research on pilot plots – to demonstrate typical good management practices. It is already very clear how nitrate leaching can be reduced – minimize over-application of nitrogen and water. There are hundreds of related details that pertain to the wide range of individual fields throughout the state.

What appears to be most valuable is to obtain larger, broad-brush statistics. <u>The bottom line is whether the nitrogen applications (lb/acre), for specific crops in an area, are reduced over time.</u> While it is true that numerous factors influence the need for nitrogen on a particular crop for a particular year, in the end it all reduces down to long-term annual nitrogen application (combination of synthetic and organic N). All of the details of nitrogen cycle changes even out over time.

Furthermore, the best management practices only influence whether or not less nitrogen is applied. If there is less irrigation water leaching and better distribution uniformity (DU), it is only logical that less nitrogen is needed. This has been known for years. Therefore, there is no need to delve into all the details of the practices. The details of how to improve DU and irrigation scheduling have been known for years. The State Board does not need to experiment with this, or to have a report that re-iterates that certain practices are wise.

How the State Board obtains the information on nitrogen applications and specific crop acreages is another issue. Broad regional numbers can be obtained (with perhaps +/- 20% accuracy) from fertilizer sales records, and crop acreage reporting can be accomplished many ways.

However, for verification there is a large value in being able to match crop types with fertilizer application. It could be very easy to get carried away with this and try to categorize every type of crop variation imaginable. But even broad crop categories, with matching fertilizer applications, will be very valuable in targeting areas of concern. This information is likely only available via direct reporting by farmers.

Panel Response #2:

Verification measures should focus on the identification and increased adoption of BMPs that are likely to provide a groundwater health benefit as well as a benefit to the grower. Many of these BMPs were described in response to earlier questions. This is the most cost effective and outcome aligned process for the parties involved. Measuring emissions from various Emission based controls are complicated by the difficulty of monitoring nonpoint source pollution and its diffuse nature.

It is extremely difficult, if not impossible, to monitor groundwater with the goal of identifying contaminant sources or trends. An effective method for assessing effectiveness of a BMP has not been presented to the panel to date.

Long term regional and basin wide monitoring will be required to assess the effectiveness of the policy. This monitoring period will widely vary and will be dependent on specific hydro geologic conditions.

Panel Response #3:

Still working on this question and question #10 since not an area of much of my expertise.

Panel Response #4:

The reality is that verification of the best and most successful program may be years, if not decades away. Testing for nitrates in ground water is an obvious first step, however, a positive test does nothing to tell us the source or age of the nitrogen.

The idea of drilling wells to first encountered ground water as proposed by State Water Board staff is very expensive. Considering that fir encountered ground water could fluctuate more than twenty feet in given year that would mean drilling more than twenty wells to bet one result. Multiply that across just high vulnerability area and the cost would be huge.

A better method would be to use existing wells to monitor. Some of these wells may be obtained from municipalities.

One measurement not discussed could be how growers were applying nitrogen ten years ago versus how they are applying nitrogen today. A component of the growers training could be a questioner of practices now and then.

Panel Response #5:

No response

Panel Response #6:

No single measurement or suite of measurements exists that can be used to verify success of management practices to control nitrogen with regard to subsurface loading or discharge to groundwater. This is evidenced by the fact that any evaluation of management practices depends on the accurate, preferably quantitative, characterization of the management practice itself. This characterization (e.g., a semi-quantitative mass balance on the scale of a field or a farm) can be used as a surrogate measure for subsurface loading. However, large uncertainties will remain regardless of the scope of the data collection effort and, as a result, surrogate measures will not provide a tool to clearly indicate when regulatory enforcement is warranted, except, possibly in the most egregious cases. This demonstrates the very limited use of surrogate measures for enforcement purposes, including much of the data that the IRLP seeks to have collected by farmers, and much of the data already collected under the Dairy General Order.

In the absence of existing verification measurements, research efforts including intensive field- and farm-scale data collection in combination with detailed nutrient accounting is needed to investigate effects of specific practices on soil salinity and fertility, plant health, deep percolation, groundwater quality, and subsurface loading. Modeling efforts will play a large role in these efforts. These research activities will help in the understanding of current agricultural impacts on field-, farm-, and regional scales, and the development of new, improved practices. The results of these research efforts should not be used to support regulatory enforcement.

Long-term monitoring in carefully designed regional well networks consisting of water production wells such as domestic wells, and municipal and agricultural supply wells will provide a feedback mechanism for the effect of implemented practices on regional groundwater quality. However, even this type of groundwater monitoring is not a direct verification measure of agricultural practices because over the long time frames that this monitoring will need to extend (i.e., essentially indefinitely but at least several decades), changes in groundwater quality will not be solely attributable to changes in agricultural practices. Instead, changes of land use patterns and changes of the regional hydrologic regimen (e.g., as a result of continuing groundwater level declines, increased groundwater banking and recharge projects, rain water collection programs, increased in-stream storage via new reservoirs, climate change, etc.) will also affect groundwater quality. Therefore, in this effort, too, modeling will play a large role. Similar to research efforts, the results of the long-term monitoring and modeling should not be used to support regulatory enforcement.

In conclusion, the single most critical recognition is that Regional Boards do not and will not have adequate tools to fulfil their mission in the context of agricultural, non-point source discharges to groundwater. This recognition should be the basis for the development of a new approach to strive for groundwater quality protection (see **Recommendation 1**).

For the sake of completeness, two enforcement approaches are discussed, both of which would, at least in theory, improve groundwater quality. However, either one of these enforcement approaches would cause colossal crop yield reductions. Therefore, their consideration necessitates a much larger discussion including fundamental concepts such as the stabilization of food production and the departure from a growth-dependent economy to a steady-state economy.

Strict enforcement of the MCL for nitrate in first encountered groundwater

Strict enforcement of the MCL for nitrate in first encountered groundwater would protect groundwater quality. If implemented, management practices would not need to be monitored and the associated data collection could be eliminated. However, since a representative monitoring approach is not congruent with the idea of direct measurement (i.e., representative monitoring depends on the use of surrogate measurements such as the characterization of management practices), millions of acres of land in agricultural production would need to be equipped with monitoring wells. From a technical perspective, such groundwater data collection efforts would only make sense in areas where a causal link can be unambiguously established between farm operations and groundwater quality. This limits the utility of this approach to aquifers that show rapid response to practices on the ground surface (i.e., very shallow groundwater conditions and highly transmissive unsaturated zones)

This enforcement tool would eliminate water conservation efforts and any efforts to improve irrigation uniformity and efficiency. Lastly, based on current knowledge and technology, it is extremely doubtful that nitrate-N concentrations below 10 mg/L can even be achieved in first encountered groundwater without drastically reducing nitrogen inputs and agricultural production in California.

Strict enforcement of a cap on fertilizer applications

Strict enforcement of a cap on the total amount of fertilizer applied to a field or crop would reduce subsurface loading and protect groundwater quality (even though the MCL for nitrate may not be achieved in first encountered groundwater) if the fertilizer cap were sufficiently low. Essentially, this would require an application rate that is so low that the crop yield falls purposefully and significantly short of its potential yield.

While this approach is straight forward from an enforcement perspective, it would arbitrarily enforce against dischargers ranging from those with poor nitrogen control to those with stellar nitrogen control because nitrogen application is a dismal surrogate for subsurface loading estimates and it does not account for site-specific conditions. Due to uncertainties related to the quantification of nutrient content in organic fertilizers such as manure, use of organic nitrogen sources would probably need to be excluded from this approach.

Panel Response #7:

A suite of management practices, ranked into classes of effectiveness, needs to be developed. It is impossible to rank them on a quantitative basis (i.e. will produce a 17% reduction in nitrate movement to groundwater) so a qualitative scale needs to be developed (highly effective, effective, of limited effectiveness). Where possible this qualitative ranking should be supported by field research, but where that information is lacking, a group of experts should be able to develop it.

It is clear that monitoring all but the shallowest wells is irrelevant in verifying effectiveness of management practices. Additionally, due to spatial and temporal variability in movement of nitrate to ground water, other techniques, such as lysimeters, are almost useless in a commercial field situation. It would take 10’s of lysimeters (at $500 per) and massive disturbance of natural conditions with their installation to begin to be able to characterize nitrate flux.

Panel Response #8:

I believe that the best area to measure is the zone below the rooting areas the beginning date could be compared pre-season and post season to measure nitrogen that has escaped. I am not sure a methodology currently exists to make these measurements economically. However using the same management practices in a test plot with lysimeter wells cold prove the efficacy of the management practices.

For long term success there needs to be a measurement of nitrate that exist today in groundwater wells and monitor annually over several years to see if a positive impact occurred over time.

My experience with the shallow monitoring wells has been very erratic. It also needs several years of monitoring to be able to make a valid claim of success. I believe they can be used as a tool in an overall nitrate measurement system.

SUBJECT:	VERIFICATION MEASURES
Question 10	Evaluate and make recommendations regarding the usage of the following verification measurements of nitrogen control: a. Sampling first encountered groundwater via shallow monitoring wells. b. Direct sampling of groundwater from existing wells, such as an irrigation well or domestic drinking water well, near the field(s) where management practices for nitrogen are being implemented. c. Sampling of the soil profile to determine the extent to which nitrogen applied to a field moved below the root zone. d. Representative sampling of a limited area and applying the results broadly. e. Sampling water in surface water containment structures for their potential discharge to groundwater. f. Estimating discharge to groundwater based on nitrogen balance model and measured irrigation efficiency.

Panel Response #1:

It has been clear from the testimony that all of these have serious problems with cost and usefulness. The bottom line is if the nitrogen application is reduced or is at a reasonable level for the crop type. Everything else is indirect measurement with numerous assumptions.

While soil and groundwater sampling is easy (although often very expensive), those who are intimately familiar with actually making sense of them for verification will generally agree that the results are very difficult to interpret. Stick with the basics: If little nitrogen is applied, over the long term, very little nitrogen will leach.

Panel Response #2:

a. **Sampling first encountered groundwater via shallow monitoring wells.** I have not located any literature nor was there any model or data presented during the testimony that would lead me to believe that there are monitoring methods available to link BMPs to groundwater. Although the methods might not currently be available, it's likely that monitoring of this zone will be the best proxy for the measurement of the effectiveness of BMPs. However, this process would likely need to be in a controlled and well known environment such as at a research or cooperative extension site. This area, however, is not my expertise, and I look forward to hearing answers and discussion from other panel members on this subject.
b. **Direct sampling of groundwater from existing wells, such as an irrigation well or domestic drinking water well, near the field(s) where management practices for nitrogen are being implemented.** There are far too many variables at play for this data to be useful for anything other than long term basin nitrate trend monitoring or for use of a grower in calculation of their nitrogen load in a "pump and fertilize" scenario. This data does not serve as an indicator of effectiveness of any BMP in reducing nitrate contamination of groundwater.
c. **Sampling of the soil profile to determine the extent to which nitrogen applied to a field moved below the root zone.** To my knowledge, the technology for this monitoring method

does not yet exist or is imperfect due to preferential flow (for example in suction lysimeters) and due to issues of cost and feasibility. The development of improved lysimeter or real time soil nitrate monitoring technology and additional tools which can accurately paint a picture of what is happening immediately beneath the root zone should be high priority for the State Water Board.

d. **Representative sampling of a limited area and applying the results broadly.**

e. **Sampling water in surface water containment structures for their potential discharge to groundwater.**

Panel Response #3:

Still working on this question and question #9 since not an area of much of my expertise.

Panel Response #4:

As mentioned in question 9, sampling first encountered ground water would be expensive and the results not conclusive. Direct sampling of existing wells would be informative and much less expensive. A positive result could be misleading. Positive results from a broad area could lend valuable information.

Sampling below the root zone would indicate nitrogen that potentially could reach groundwater, but we have to investigate the sub surface soil strata and irrigation methods to help determine the actual risk to groundwater.

Due to soil variability, ground water migration, irrigation methods etc., applying limited data to broad areas can result in poor decisions. The unknown variations will limit the usefulness of limited data. For the same reason sampling water in containment structures has limited usage. Proper construction is important. Estimating the discharge to groundwater based on nitrogen balance models is not a reliable method to determine risk due to the extreme variation in nitrification, mineralization, DE nitrification, etc. Measuring irrigation efficiency is helpful because it lends much information to the potential to push nitrogen below the root zone.

Panel Response #5:

1. Sampling of the soil profile to determine the extent to which nitrogen applied to a field moved below the root zone.
    - Can be useful as a general tool to identify fields that have a higher risk for deep N movement.
    - Most helpful when evaluated before and after potential deep leaching events.
    - Can confirm low risk locations when properly timed.
    - Very difficult to develop quantifiable information without sampling numerous soil zones.

2. Representative sampling of a limited area and applying the results broadly.
    - Representative sampling can refer to multiple sample locations composited to produce and average condition or can be used to represent a range of conditions in the sampling unit.

- Representative sampling can be very indicative and therefore verifiable of larger areas providing the range of conditions sampled is in fact a reflection of the larger system being compared.
- Is more useful and precise in system conditions that have low variability.

Panel Response #6:

No single measurement or suite of measurements exists that can be used to verify success of management practices to control nitrogen with regard to subsurface loading or discharge to groundwater (see **Q#9**). The merits of several types of measurements are discussed below. None of these measurements, either alone or as a suite, should be used as a regulatory enforcement tool.

Sampling of first encountered groundwater

Under favorable conditions (e.g., very shallow groundwater (e.g., <20 feet below ground surface), highly transmissive unsaturated zone, and strong and steady input signals), groundwater monitoring can provide a good means to evaluate changing constituent concentrations in response to changing management practices. Groundwater quality information in tandem with information on management practices can be used in conjunction with numerical models to estimate deep percolation and subsurface loading rates. Also, groundwater quality trends in response to changes of practices can be evaluated. It is important to recognize that the ability to establish a causal link between groundwater chemical characteristics and management practices implemented on specific fields quickly diminishes with increasing depth to groundwater water, decreasing unsaturated zone transmissivity, decreasing input signal strengths, and increasing variability of management practices.

It is also important to recognize that improved farming practices may or may not result in decreased groundwater solute concentrations. For example, increased irrigation uniformity (IU) and efficiency (IE) are means to increase nutrient use efficiency (NUE) and water conservation, and are generally regarded positive goals. However, while they decrease the soil water flux below the crop root zone (i.e., recharge to groundwater) and decrease subsurface mass loading, soil water solute concentrations and, therefore, groundwater solute concentrations in first encountered groundwater can be significantly increased.

Sampling of wells that tap deeper groundwater

This should be part of regional, long-term monitoring efforts to evaluate the effect of implemented practices on regional groundwater quality (see **Q#9**).

Soil nitrogen sampling

I have not got the expertise to address this question. However, I think that the utility and scope of soil sampling (including testing protocols and frequency of testing) should be determined on a farm-specific basis.

Representative sampling of a limited area

Representative sampling will be a key element contributing to the evaluation of management practices.

<u>Sampling water in surface water containment structures</u>
For the estimation of subsurface mass loading linked to containment structures, three quantities are needed: wetted area, constituent concentrations, and seepage rate. Whether or not such measurements are needed is better addressed on a case-specific basis.

Panel Response #7:

a. Not effective on a broad scale – can be used for monitoring example and/or test locations where expense is adequate to obtain representative sampling and reduction in experimental error is adequate to draw conclusions at a reasonable level of certainty.

b. Essentially useless – little to no correlation between current surface management practices and well water quality

c. Close to useless as spatial and temporal variability and required number of replicates in order to reduce experimental error so that conclusions with a reasonable level of certainty are too high

d. This may be valuable as part of an experimental protocol in developing the qualitative ranking of management practices, but is impractical outside of that.

e. Highly dependent on specific nature of containment structure. A well-engineered structure should have minimal potential to discharge waste to groundwater. The integrity of containment structures would have to be "estimated" and due to questionable ability for that to be accurately estimated, this is of minor effectiveness.

f. This can be used as an education tool, but it cannot be extrapolated to actual field conditions. The errors in nitrogen cycle input and output parameters are too large to make this a valuable regulatory tool other than in an educational opportunity.

Panel Response #8:

First there needs to be an identification of the areas that impacted groundwater with nitrate then establish some parameters to evaluate where best measurement tools should be placed.

A) Shallow monitoring wells that measure first encountered groundwater must be placed near the impacted area. Because of the variability, they will be required to test frequently to allow a pattern to be developed. (At least four (4) times a year or possibly monthly). Till Angermann's experience with the dairy order should be invaluable to the timing for collection for samples.
B) Since these wells are ultimately what we need to clean up they must be tested annually. Testimony we heard, explained how long it could take for nitrate to move into groundwater. With this information it is clear to me that these measurements are only good for long term improved from management practices.
C) This will not be effective because of cost and variability. You can use my lysimeter well test to prove effectiveness of practices.

D) The representative sampling through lysimeter wells would yield results that I believe could be applied broadly. Growers could also apply management practices across NHI parameter where there was enough similarity of soil type and farming practices.
E) I am not sure I understand what is meant by containment structure and how it would then discharged to groundwater. So I will not comment until I read other comments from the panel.
F) Irrigation efficiency is key to distribution of nitrogen and potential overwatering that can lead to increased leaching. Irrigation efficiency testing can be part of a nutrient management plan and results can be retained in the grower's documents. Irrigation efficiency in concert with nitrogen balancing should be at the cornerstone of the management practices.

SUBJECT:	VERIFICATION MEASURES
Question 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.

Panel Response #1:

Unclear.

Panel Response #2:

No response.

Panel Response #3:

No response.

Panel Response #4:

Nutrient efficiency is related to water use efficiency in irrigated agriculture. Thus measuring surface water delivery is a tool to be used by growers and coalitions to help identify efficiency, but the method needs to have more detailed information to be an enforcement tool.

There needs to be a method in the reporting that allows growers to identify the amount of water applied by each method of irrigation. Many growers may germinate a crop with sprinklers and then use drip for the balance of the production period. The present system does not allow growers to differentiate the method of application.

Monitoring discharges in problem areas will most likely have to be a part of a process. However, in non-point source discharge monitoring, further evaluation to determine the source will need to be completed to identify the source.

Panel Response #5:

No response

Panel Response #6:

I have not got the expertise to address this question.

Panel Response #7:

I have little expertise in this area, but believe that a well-structure in-stream (waterway) monitoring system can be developed on a regional basis to identify specific sources of pollutants. This is not a trivial undertaking and the season nature of waterway flow in both duration and volume make this an especially difficult task.

Panel Response #8:

Any surface water that contains nitrogen should be accounted for in your nitrogen balance equation. The same is true for any discharge as it has nitrogen that will be unaccounted for. The merit in measuring these is that you have accounted for another potential source of nitrogen for crop use on the receiving side and a potential source of nitrogen contamination on the discharge side.

Subject 4: Reporting

The ILRP orders issued by the Regional Water Boards require reporting to both determine compliance and inform overall management of the discharges associated with agriculture. Also, specifically in regards to nitrogen, the California Department of Food and Agriculture convened the Nitrogen Tracking and Reporting System Task Force, called for by Recommendation 11 of the State Water Board's report to the Legislature, which makes recommendations on a potential reporting system.

SUBJECT:	REPORTING
Question 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.

Panel Response #1:

This appears to be the product of a group that was tasked with developing a very complex methodology without considering the relationships between costs, ability to report, and benefits.

Panel Response #2:

(*same as answer to Question 13*): Reporting needs to be streamlined and potentially overlap with current reporting such as for food safety, for pesticide use reports. Scale of reporting is a complicated question and will vary by region. I'll again refer to the Central Coast small leafy green grower with treatment sizes of 2 acres vs. the 100 acre treatment size central valley process tomato grower. Reporting of water and nutrient use of the former will be exceedingly difficult. Reporting requirements should not, however, be so burdensome that they discourage growers from scaling down their tracking or monitoring approach. The reduction of managed scale increases the precision delivery and water and nutrients as this approach can parse a field into more uniform management units.

Reporting of nitrogen at a "nitrate loading risk unit" would not yield a clear benefit other than a high level risk assessment tracking tool most likely for use at the coalition or regional level.

Panel Response #3:

The list of data to be tracked by growers (shown as SECTION A in the Task Force Report) shows a large listing of data that are site descriptors as well as measurements and calculated values. Many of these are relatively straight forward and can easily be provided, but there are several that require calculations that may be difficult under some circumstances (such as site specific or partial field area yield levels) or that are based on research data that may or may not be available for the specific crop being grown or for the current yield levels achieved at the farm site (such as N removed measurements versus estimates). For other inputs, there are either imprecise estimates if the data collectors use average values (such as average N concentrations in materials such as manures, composts, etc.) or there are costs associated with actual measurements made to give more correct values for organic matter and manure N content, irrigation water nitrate levels, and soil nitrate levels at different times of the growing season.

Key concerns that I have regarding the Nitrogen Mass Balance approach used (whether the focus is the difference between applied and removed, or the ratio approach) are the actual accuracy possible when the grower/consultant is trying to fill in all of the data to be tracked, and the possible significant inaccuracies in assumptions that come with items such as:

- Expected yields (and variability within the field)
- Nitrogen needs of the crop (this may be fairly well known for some crops per unit residue and yield removed, but for quite a few crops may have to be based on data from older studies at much lower yield levels or from studies done with different cultivars in other states and conditions)

I remain unconvinced that good estimates of Nitrogen Removed are available for many of the crops grown in Regions 3 and Region 5, and where that may be the case, it is hard to see how fair use can be made by aggregators or agencies in interpreting the nitrogen mass balance data. It still seems to me that the best use of the mass balance data set is as an educational tool and also to demonstrate areas of needed data to come out of future field crop research.

The task force members recognize in the report (on page 15) that:
"Calculation of nitrogen mass balance (the quantity of nitrogen applied minus the quantity of nitrogen removed) represents nitrogen that is not currently accounted for, including but not limited to nitrogen available for leaching to the groundwater." There does not appear to be enough emphasis on the fact that the difference is NOT all available for leaching. The difference can also be made up by other losses, transformation and additions that occur such as denitrification, volatilization, atmospheric deposition, mineralization, immobilization, plant uptake and removal, assimilation, etc. It is vital to not attribute all differences between quantity applied minus quantity of N removed as available for leaching, since that is not the only and assured fate of the applied N during the current or later crop years.

In addition, it is apparent that a key issue that impacts the actual movement of nitrate out of the effective crop rooting zones and towards groundwater is irrigation water management and related soil factors that influence water movement through the profile. The irrigation method is noted as a data collection item in the Task Force recommended inputs, but not irrigation management practices that might impact water storage and movement. The impacts of irrigation water management are not addressed as a direct part of the Nitrogen Tracking and Reporting System as described in the Task Force report, and this can be a significant deficiency in our semi-arid agriculture in California. If the amounts of applied water are in excess of crop water use by a large amount, if water application distribution uniformity is marginal or worse, and the timing of water applications relative to the time of crop water use and uptake is a poor match, then irrigation water applications will in certain areas of the fields and at certain times be significantly in excess of water use. These situations can result in movement of both water and soluble materials present in the soil profile to areas below the active root zones of crops, and this can be a more dominant factor than any fertilizer application methods, types of fertilizers or even timing of application of fertilizer materials.

Panel Response #4:

The number one suggestion of the California Department of Food and Agriculture's Nitrogen Tracking and Reporting System Task Force is to raise funding by taxing agriculture in some manner. There is no known means to clean groundwater in an economical manner. Further research on this subject is warranted, however, developing additional bureaucracies will not clean ground water. The Coalitions should work with State and Regional Boards to develop a plan to remedy the problem.

Further discussion of this question involving our entire committee would be helpful.

Panel Response #5:

The Panel believes the NTRS Task Force report is a useful document that can assist in guiding the development of RWCB general required reporting elements. The identification level of detail set forth in the 8 recommendations allows the development of a program that provides a reasonable balance between creating a process that documents the appropriate uses and need for N applications while informing growers, aggregators and the Board of vulnerability.

The reporting Unit should be large enough to protect individual growers from exposing individual fields or growers to public data access methods that could be used to expose individual farming practice methods to public. The reporting unit should be small enough to identify local conditions present that may help explain reasons for data skewing based on local or area conditions such as soil type, depth to groundwater, crop type or irrigation method as examples. The Panel agrees that a township level aggregating unit suggested as proposed by the Coalitions is an appropriate and useful unit.

Reporting of nitrogen application amounts should be confined to the Third Party level and not aggregated by the Third Party in their report to the Board.

Panel Response #6:

The December 2013 Final Report of the Nitrogen Tracking and Reporting Task Force (Task Force) makes a recommendation for a "potentially viable way of establishing a nitrogen tracking and reporting system for nitrate high-risk areas".

The Final Report identifies the intended outcome of the recommended Nitrogen Tracking and Reporting System (NTRS) as "contributing to improved water quality". However, it leaves unaddressed how this will actually be accomplished. The only explicit feedback to the farmer is tied to "where the nitrogen ratio is considered an outlier in reported values". This is a very poor way to "identify" who might need help in the effort to reduce subsurface mass loading. In fact, the Final Report states itself that the concept of the nitrogen balance "…is only 'one piece of the puzzle' in determining excess nitrogen that could potentially reach groundwater…". Yet, it appears to be the only piece of information used to focus help. Irrigation management, probably the most important component in this context, is ignored.

Data aggregation occurs at the farm level, at the level of the 3rd Party Aggregator and the Regional Boards. It is unclear what kind of information Regional Boards and the State Board would actually be receiving in the submitted reports. The Final Report states that the State Board will get the information to "compile an annual report on 'status and trends' with respect to management and fate of nitrogen applied in irrigated agriculture". However, it remains uncertain how that can even be done because data on management practices are not collected. It is also unclear what the intended use is for the aggregated information submitted to the Regional Boards and State Board, i.e., how Boards will act upon it.

Verifiability

The Final Report lists four mechanisms to "verify the accuracy of the data that the system generates". These mechanisms are quoted below with comments following.

A. Growers retain their field-level data (Section 2.A.) for the term required by existing laws and regulations, and make records available to the data aggregator and the Water Board upon request.

Comment A: The ability to review records has nothing to do with verifying data accuracy.

B. The data aggregator is responsible for ensuring the accuracy of the data it reports, and to that end, investigates apparent exceptions in reporting patterns. The aggregator assists growers in implementing appropriate nitrogen management practices to improve water quality.

Comment B: What constitutes "apparent exceptions in reporting patterns"? Given inaccuracies and uncertainties inherent in the measurements and estimates that are part of this data collection effort, "apparent exceptions" could be easily avoided while uncandidly reporting. Further, these inaccuracies and uncertainties will likely mask a large proportion of operations that would benefit from outside help. It is clear that the vast majority of data collected can simply not be verified with regard to their accuracy or their suitability as a quantity that contributes to mass balance calculations.

C. The Regional Water Boards are responsible for ensuring the accuracy of the data they receive and may consider developing an audit mechanism.

Comment C: This is not an independent mechanism. It essentially repeats the first mechanism, i.e., the fact that Regional Boards have access to data kept on the farm.

D. Technical assistance providers, such as Certified Crop Advisors and staff from the Resource Conservation Districts, can play a valuable role in assisting growers and data aggregators to implement the nitrogen tracking and reporting system effectively (e.g., through assistance in developing nitrogen management plans for growers).

Comment D: This is not a verification system.

Conclusory Thoughts

The NTRS promotes an enormous data collection effort without clear goals, data quality objectives, and without indication how data will be used by regulators. In addition, the effort implicitly assumes that farmers will candidly report the data collected on the farm despite the fact that there is no compelling incentive to do so, and no way to verify the accuracy of data submittals. In some or even many cases, candid reporting may equate to self-indictment.

It appears that the NTRS is designed to primarily satisfy regulatory desires, specifically the enormous data collection effort (creating the illusion of progress) in conjunction with the data aggregation efforts (optimizing limited state resources) and the simplistic analysis of nitrogen balances (aligned with a traditional, check-list type regulatory approach). Fundamentally, however, the framework of the NTRS and its data collection effort are not conducive to improving management practices. Societal benefits that are listed in the Final Report are unlikely to be achievable with this effort.

Based on the above, I believe the NTRS should not be implemented.

Panel Response #7:

I commend that task force for a job well done, but have some specific concerns. I don't understand the need for APN identifications. Many APN's are only partially farmed and utilization of that information may lead to erroneous conclusions being drawn.

I especially liked the report and data consolidation ideas presented in the report and fully endorse them.

There was only a limited amount of recommendations in regards to irrigation management and performance. The movement of nitrate to groundwater is inseparably linked to both of the areas and that would need to be expanded on.

Panel Response #8:

The Nitrogen Tracking and reporting System task Force left open the need for further research needed to be done to confirm that verification measures were effective. It appears to me that we are going down a path that suggests best management practices and then requires is to verify their effectiveness before we are certain they are effective. I don't know that we have a long time to put both components into practices but we must acknowledge what adjustments will probably be needed as go through this process. The Task Force has relied on mass balance as the measuring criteria with little date to confirm its effectiveness. A great deal research into mass balance and how well we can evaluate nitrate leaching will need to be done as soon as possible.

Also much more research will needed on many other crops to determine Nitrogen removal rates. This system of reporting has no basis if we can not reasonably understand the pounds of nitrogen removed by the crop being grown.

SUBJECT:	REPORTING
Question 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. (Definitions of "management block" and "nitrate loading risk unit" are contained in State Water Board Order WQ 2013-0101.)

Panel Response #1:

These look realistic. There is no reason to report on every field individually. However, it is important to specify that the flow and volume measurements (of water) and the nitrogen tracking need to be done on management units.

But the underlying point is this: This question assumes a high level of reporting, which may not be necessary to accomplish the objectives.

Panel Response #2:

(*same as answer to Question 12*): Reporting needs to be streamlined and potentially overlap with current reporting such as for food safety, for pesticide use reports. Scale of reporting is a complicated question and will vary by region. I'll again refer to the Central Coast small leafy green grower with treatment sizes of 2 acres vs. the 100 acre treatment size central valley process tomato grower. Reporting of water and nutrient use of the former will be exceedingly difficult. Reporting requirements, should not, however be so burdensome that they discourage growers from scaling down their tracking or monitoring approach. The reduction of managed scale increases the precision delivery and water and nutrients as this approach can parse a field into more uniform management units.

Reporting of nitrogen at a "nitrate loading risk unit" would not yield a clear benefit other than a high level risk assessment tracking tool most likely for use at the coalition or regional level.

Panel Response #3:

No response

Panel Response #4:

Farmers in low vulnerability areas should be asked to do very little reporting. Those farmers should accomplish some form of education on nitrogen management. In areas of high vulnerability, the reporting should be to the Coalition level.

The Coalition will have to report to the Regional Boards some form of nitrogen usage. This reporting should include some level of off take of nitrogen by the crop. The subtraction method of what goes to ground water as proposed by the U.C. Davis report is not acceptable.

If the Coalitions have issue with a particular grower the first contact should be between grower and Coalition. If the grower is unwilling to adjust their practice, the Coalition should engage the Regional Boards. The Regional Boards have the tools necessary to force compliance.

The committee should have more discussion of this question.

Panel Response #5:

No response

Panel Response #6:

Region 3 gives farmers the option to choose from the following two methods to aggregate nutrient data for reporting purposes.

<u>Management Block</u>

> A management block is any portion of a discharger's land that is planted with the same crop and receives the same fertilizer inputs. Management blocks may consist of multiple fields and/or divisions of a single field.

<u>Nitrate Loading Risk Unit</u>

> A nitrate loading risk unit is a subdivided unit of the ranch/farm. Factors that a discharger may consider in subdividing the farm into nitrate loading risk units include but are not limited to irrigation system type, crop type, nitrate concentration in the irrigation water, soil type, number and size of management blocks that would have to otherwise be reported under Method 1 in subsection C.5 below. The nitrate loading risk unit may be the total ranch, a number of blocks, or an individual block. If a Discharger chooses to subdivide the ranch/farm into individual nitrate loading risk units, the Discharger must maintain individual record keeping, and conduct monitoring and reporting for each nitrate loading risk unit.

The Management Block method benefits from a clearer definition although "same fertilizer inputs" needs clarification (e.g., does it just pertain to the same total mass of fertilizer that was applied in a given reporting period, or are there other considerations included?). The Nitrate Loading Risk Unit gives a lot more flexibility to the farmer as it refers to variables that "may" be included and is open-ended to what else may be considered. Also, it may aggregate data over an entire farm/ranch.

I think it positive that farmers are given the opportunity to aggregate data. I support both options and favor none.

Panel Response #7:

The data recording needs to be done at the smallest uniformly treated unit on a farm, be it a field or an individual planting. The reporting to regulatory agencies can be consolidated at whatever level captures the required data. It is also very important that a 3rd non-governmental party separate data report between farmers and regulators.

The level of detail the farmer will be collecting will characterize their farming practices in great detail. The intricacy of those practices, for many farmers, constitutes "trade secrets" and "intellectual property" that should be protected from public record requests. Additionally the level of detail is not needed by the regulatory staff to adequately perform their mission, and therefore, except in specific enforcement situations should not be required.

Panel Response #8:

Most of the reporting requirements will be fairly easy for growers to compile. However we will need to allow for annual crop reports rather than individual crop data, for example being vegetable a grower with 2-3 crops and 4-6 harvests per year. I think total nitrogen in the system in one year measured versus the total nitrogen removed or otherwise accounted for makes more sense to me. Annual or monoculture crops would be accounted for the same way giving continuity to the reporting.

I believe growers are much more likely to give up the data to Third Party Aggregators than to the regional water Boards. The confidential nature of this information will be accepted more readily if growers are confident their information will just be blended into the report and not be identified individually. It then puts pressure on the regional Boards to make sure they have identified Aggregators in all areas.