NUTRIENT TAC REPORT

EXECUTIVE SUMMARY

The surface and ground waters of California can be impaired by nutrient leaching and runoff from agricultural and other sources. For the past eight months, Nutrient Technical Advisory Committee (TAC) members have worked hard and carefully to develop recommendations for nutrient management in California which meet the varied interests of those who have a stake in the quality of California's waters.

The TAC recommends that all growers participate in a mandatory self assessment program to determine their potential risks of contributing to nutrient-related nonpoint source pollution, and to develop a management plan to minimize their potential contribution to water quality degradation in California.

The completion of hazard index determines whether a grower must prepare a written nutrient management plan incorporating management practices proposed by the TAC. Hazard index scores can range from two to nine, with a score of six or greater triggering the requirement for a written nutrient management plan. Hazard index scores of less than six exempt the grower from having to prepare a written nutrient management plan, but the completion of a risk assessment matrix and a year-end evaluation is still required.

Section I of this report describes the TAC's purpose, goal and problem statement. A summary of the interest-based approach used to arrive at the TAC's recommendations is also provided. The recommendations of the TAC and descriptions of the proposed management practices appear in Section II. Section III outlines how the recommendations should be implemented and enforced, and describes the institutional changes and educational outreach efforts critically needed for successful implementation of the recommended management strategy. Section IV describes the TAC's required evaluation of the management measures contained in the Coastal Zone Act Reauthorization Amendments guidance document prepared by the Environmental Protection Agency and the National Oceanic and Atmospheric Administration.

Finally, the members of TAC wish to express their gratitude to the State Water Resources Control Board (Board) and its staff who bravely embarked upon an interest-based approach to arrive at fair and equitable solutions to California's nonpoint source pollution problems. The members of the TAC believe firmly that the solutions derived from this approach are far more likely to be accepted by the agricultural community and Board alike, an important first step in improving the quality of California's waters to the benefit of all citizens. The TAC looks forward to seeing its recommendations included in California's nonpoint source management program.

SECTION I

INTRODUCTION

The Coastal Zone Act Reauthorization Amendments (CZARA, 1990) require states to develop and implement plans for reducing nonpoint source runoff from specific source and land use categories. As part of this mandate, US EPA and NOAA jointly prepared a guidance document specifying management measures that would fulfill CZARA requirements. The California Water Resources Control Board (SWRCB) and the California Costal Commission (CCC) share responsibility for implementing CZARA requirements. In response to this mandate, the SWRCB conducted a comprehensive review of its existing Nonpoint Source Management Program and incorporated a step into the process that would verify usefulness of the US EPA/NOAA management measures for California conditions. Where necessary, alternatives to the CZARA requirements are proposed.

For review of the NPS Program, the SWRCB/CCC used committees for technical and policy guidance. They solicited Technical Advisory Committee (TAC) membership from a broad base of interests related to nutrient application activities in agricultural operations. Fifteen people (Appendix I) contributed to the Nutrient TAC, attending eight full day meetings and developing the recommendations presented in this report.

GOAL

Nutrient TAC members agreed to follow the process advocated by the SWRCB in order to meet an agreed goal for identifying statewide water quality problems due to nutrient runoff, and to seek creative solutions to these problems.

PROCESS SUMMARY

The SWRCB/CCC recommended that the TAC use an interest-based process to evaluate the NPS Program while providing the regulated community early opportunity to respond and recommend potentially viable solutions to pollution problems. The process requested that members identify NPS nutrient runoff or leaching problems due to crop production, identify all stakeholders and their interests, propose solutions, compare proposed solutions to stakeholder interests, and then compare solutions with CZARA requirements. The Nutrient TAC followed this process. A comprehensive list of stakeholders and their interests is presented in Appendix II, and a final stakeholders list is provided in Appendix III.

PROBLEM STATEMENT

Initially the group attempted to describe the nature of problematic nutrient runoff. TAC members considered the SWRCB's Program/Problem Statement, SWRCB 1994 Water Quality Assessment (WQA) Report of impairment of beneficial uses of state surface and ground waters, and findings from the 1988 nitrate Working Group report *Nitrate in Drinking Water, 1988, SWRCB* (referenced in Appendix III). The group then brainstormed nutrient sources, arriving at the primary concern over nitrogen. TAC members then discussed priority of affected waters, and decided to consider impacts to both surface and ground water equally. The group further redefined terms and formulated the following problem statement:

The state's surface and ground waters can be impaired due to nutrient runoff and leaching from agricultural and other sources. The focus of the TAC will be on nutrient management associated with agricultural activities.

BACKGROUND INFORMATION

BMP's are the current means of controlling nonpoint source pollution in the area of nutrient management. The options available to the SWRCB for implementation of BMPs under current nonpoint source pollution plans include voluntary, regulatory based encouragement, and waste discharge requirements. Generally, the Porter Cologne Water Quality Act (13360) does not allow the State and Regional Water Boards to specify the manner of compliance when issuing waste discharge requirements. In other words, waste discharge requirements must be structured in terms of the result to be obtained (e.g. characteristics of the discharge or condition of the disposal area for receiving water). This regulatory mechanism lends itself to regulating discharges where compliance with the discharge restrictions can be verified. Such is the case with point sources and some nonpoint discharges where the discharge occurs through a pipe, or ditch. However, most nonpoint discharges are diffuse in nature and there are many sources within an area (i.e. sediment runoff to streams from grazing operations or various types of nonpoint source pollution to groundwater from farming operations) including natural sources. Thus, discharges from an individual source can not be readily measured and relative contributions to a water body from an individual source can not be determined. Additionally, the effectiveness of the BMPs are not completely observable. It may take many years before water quality improvements are noticed. Therefore, in situations where voluntary or regulatory based encouragement have not been successful in implementing BMPs, there are no additional regulatory tools available to enforce implementation.

In addition to the above options, the Regional Water Boards may also adopt discharge prohibitions or waive waste discharge requirements in exchange for implementation of BMPs. Discharge prohibitions would be difficult to adopt for the type of nonpoint pollution previously described because the discharge cannot be monitored and individual contributions assessed. Under this type of release, a regional board cannot prove that a discharge that threatened water quality occurred. Again, if an individual is not willing to implement BMPs in lieu of waste discharge requirements, there are no additional regulatory remedies available.

The regional boards may also enter into Management Agency Agreements with other agencies which have management control of land use (e.g., Bureau of Land Management, Department of Forestry), or who have authority to specify BMPs. Such is the case with control of pesticide runoff into the Sacramento River from pesticide use in rice production. While some of these agreements have been successful, other agencies do not have a mission which provides for the protection of water quality, or they may not have the resources or initiative to enforce such activities. Initially, not all land uses and potential sources of nonpoint source pollution are under the jurisdiction of agency (e.g., some farming activities such as application of fertilizers or organic wastes), such that management agency agreement can be drafted to control nonpoint source pollution.

Monitoring water discharge below the root zone which migrates to groundwater is extremely expensive and almost technically impossible. In some cases, water tables approach the surface resulting in the farmer installation of subsurface drainage systems which brings the water to the surface. Monitoring drainage outlets is feasible, so there is an inducement to place waste discharge requirements on drainage effluents. Imposing discharge requirements on drainage effluents is an anti-strategy, particularly if the criterion is concentration based. A low concentration of nitrate or other chemical can be achieved by the farmer applying large quantities of water resulting in high leaching, thus diluting the chemical.

The University of California conducted an extensive research program on nitrates in the 1970s. Part of that research included monitoring nitrate movement below the root zone in free drainage system without a high water table, and also collecting tile drainage effluents for monitoring. The results of this research were reported in various articles, but one reference is: Letey, Pratt, and Rible, "Combining water and fertilizer management for high productivity, low water degradation". A major conclusion was that there was very poor correlation between the concentration of nitrate-nitrogen in the drainage water and either applied fertilizer or amount of water leached. On other words, the nitrate-nitrogen concentration in drainage water did not accurately reflect management practices. Good management practices cannot be differentiated from bad management practices by merely using the nitrate concentration in the water leached beyond the root zone. Controlling nonpoint source pollution can more effectively be accomplished by monitoring management practices than by monitoring water quality.

Agricultural operations in California are very diverse. Almost every crop is grown on a variety of soils and under various climatic conditions. Under these conditions, it is very difficult to prescribe management plans which are appropriate for every condition. Furthermore, some agricultural operations and settings create a much higher potential for water degradation than others. It would be unreasonable to impose management practices which may be necessary to protect groundwater under the most hazardous conditions to farmlands in which the hazard is minimal. Thus, the prescribed management should be specific for given crops, soils, and potential groundwater hazards. The recommendations of the Nutrient Management TAC were adopted after considering all of these factors.

SECTION II

RECOMMENDATIONS

The committee recommends a self-assessment for growers to determine what their risks in contributing to nonpoint source pollution and to develop management plan to minimize their contribution to water degradation. All growers will participate in a two-part assessment program, but the extensiveness of the management plan depends on the pollution risk of their operation

Part 1 is a hazard index that will determine if a written management plan is necessary. Part II is a Management/Risk Assessment Worksheet that will help growers assess and evaluate their current management practices. All growers scoring 5 or less on the Hazard Index will complete the Management/Risk Assessment Worksheet, but are exempt from having to write nutrient management plans. Growers who score a 6 or higher on the Hazard Index must complete the Management/Risk Assessment Worksheet and develop written strategies for reducing the probability of water degradation by adopting management practices recommended in this report or otherwise available to that grower.

The SWRCB will be the administrating agency and will be responsible for the distribution of the Hazard Index and Management/Risk Assessment Worksheets. All Hazard Index forms, Management/Risk Assessment Worksheets, and written nutrient management reports will be kept on site by growers. Growers will be responsible to have these forms available for immediate review upon request from the SWRCB or its designee.

HAZARD INDEX AND MANAGEMENT WORKSHEET

Nitrogen is a major plant nutrient required for all plant growth. Degradation of groundwater by nitrate is a potential hazard associated with growing crops because (1) nitrogen is commonly applied in crop production; (2) all forms of nitrogen application can be eventually converted to nitrate; and (3) nitrate is soluble and readily transported by water percolating through the soil. The magnitude of the potential hazard for groundwater degradation by nitrate is highly variable and dependent on the crop, soil, and irrigation system. The extent to which nitrogen management practices must be imposed to protect groundwater from nitrate degradation is dependent upon the potential hazard associated with the crop, soil, and irrigation systems.

The first step to developing a management plan is to determine the value of a hazard index (HI) based upon soil, crop, and irrigation system. The following describes the procedure for developing the hazard index.

Soils

The soil is assigned a hazard value of 1, 2, or 3. Soils classified as 1 are those which have textural of profile characteristics which inhibit the flow of water or create an environment conducive to denitrification. Both denitrification and restricted water flow decrease the migration of nitrate to groundwater. Conversely, those soils classified as 3 are most sensitive to groundwater degradation by nitrate because of high water infiltration rates, high transmission rates through their profile, and low denitrification potential.

Soil profiles can be rated into categories of leaching and denitrification potentials. In general, soils with high leaching and low denitrification potential are usually coarse textured soils of low organic matter content with no layers in the profile to restrict water movement. Clayey soils or soils that have clay layers or textural discontinuities in the profile typically have slow water movement, allow low drainage volume, and develop anoxic conditions. These soils have low leaching and high denitrification potential. However, sandy soils with high silt content and low structural stability can have some of the same low water and air transmissives as clayey soils, and well aggregated clay silts can have some features common with sandy soils if they are sufficiently aggregated to create relatively large volumes of macro pores.

Note: It is beyond the expertise or time commitment of the TAC to index the soils of the state. This task must be completed and made available to farmers in a manner that they can determine how to properly index their soils. Different fields on the same farm may have different index values.

Crops

Crops differ in their degree of potential for nitrate leaching. Those with the highest potential for nitrate leaching which have a hazard index of 3 are those with the following characteristics: (1) the nitrogen uptake in the crop is a small fraction of the total nitrogen applied to the crop; (2) the crop requires high nitrogen input and frequent irrigation to insure rapid vegetative growth; (3) the value of the crop is such that there is a tendency to add excess nitrogen to ensure no nitrogen deficiencies; (4) the crop is not adversely affected when more than adequate amounts of nitrogen are applied; and (5) the crop has a shallow root system where a small amount of nitrogen movement would move it beyond the root system thus negating plant uptake.

Crops with the opposite characteristics of those listed above would have a low potential for nitrate leaching and have a hazard index of 1. Crops with intermediate characteristics would be classified with a hazard index of 2. Examples of crops with a hazard index of 1 would include alfalfa, which requires no nitrogen fertilizer input, and efficiently uses the available nitrogen in the soil. Grapes typically require low nitrogen inputs. The mineral nitrogen in soil profiles of irrigated lands planted to grapes have been shown to contain low levels of nitrate. Some crops such as sugar beet have the sugar yield reduced from excess available nitrogen during the latter stages of growth.

Note: It is beyond the expertise and time of this TAC to classify all crops into hazard index of 1, 2, or 3. This should be done and this information provided to the farmers so that they can accurately evaluate their hazard index.

Irrigation System

Nitrate predominately reaches the groundwater if it is transported by water percolating through the soil. The amount of water percolating through the soil is dependent upon irrigation and precipitation. Whereas the farmer has no control over rainfall, he/she does have control over irrigation. Irrigation systems which apply water uniformly across the field and allow precise control on the amount applied are those which have the greatest opportunity for minimum nitrate transport. Pressurized systems such as micro-irrigation or sprinkler allow precise control over the amount of water applied because it is controlled by a valve under the farmers control. Surface irrigation systems do not allow precise control over the amount of water applied because it is dependent upon such factors as soil infiltration rate, length of furrow, time of run, etc.

Irrigation systems can be classified as to their potential for groundwater degradation by nitrate and have a different hazard index.

The irrigation system is classified into hazard index of 0, 1, 2, or 3. A "0" hazard index is a micro-irrigation system accompanied by fertigation. Small amounts of water and nutrients are frequently applied in quantities to match the crop need. A micro-irrigation system without fertigation is assigned a hazard index of 1. Sprinklers used throughout the irrigation season or for preirrigations for crop establishment is assigned a hazard index of 2. Entire surface irrigation systems such as furrow are assigned a hazard index of 3.

It is emphasized that in assigning these hazard indexes that management of each system will be done to its maximum potential. In other words, a micro-irrigation system which is very poorly designed, maintained, and managed may not be significantly better than other irrigation systems. For each system there is opportunity for variable management. Even furrow systems can be managed differently to alter the nitrate leaching hazard.

HAZARD INDEX AND MANAGEMENT/RISK ASSESSMENT WORKSHEETS

The overall nitrate leaching hazard index is achieved by adding the individual indexes for soil, crop, and irrigation. The total Hazard Index (HI) can have a range between 2 and 9. The higher the number, the higher the Hazard Index.

The Hazard Index is designed to allow growers to determine on their own the potential for nutrient leaching of their operation. By rating the controllable factors (i.e. irrigation) and the noncontrollable factors (i.e. soil type) of their operation, growers will be able to: 1) alert themselves to high risk operations or practices, and 2) possibly adjust practices to minimize potential leaching, thereby allowing a rating that will not require a written management plan now, or prevent them from moving into a higher ratings field in the future. A very high HI (6 or greater) require a carefully designed and implemented nutrient management program to prevent potential groundwater degradation.

Again, completed worksheets should be kept on file at the farming operation. The form will reference Board personnel as to whether that operation requires written nutrient management plans.

FARM HAZARD INDEX WORKSHEET

(To be completed for each cropping unit) A cropping unit is defined as areas with similar soil, crop, and irrigation characteristics.

Determine the hazard index (HI)

Soil 1, 2, or 3	
Crop 1, 2 , or 3	
Irrigation System 0, 1, 2, or 3	
Total (HI)	

Step 1: Use accompanying material to determine whether the soil has a hazard index of 1, 2, or 3. Insert that number in the box. If the field has soils with differing HI, use the highest HI in the table.

Step 2: Use accompanying material to determine whether the crop has an HI of 1, 2, or 3 and insert this number in the table.

Step 3: Insert the HI for the irrigation system in the table using the following classification:

0: micro-irrigation with fertigation
1: Micro-irrigation without fertigation
2: Sprinkler for all irrigation or sprinkler for preirrigation and surface irrigation during rest of season
3: surface irrigation throughout the year

Step 4: Total the HI values for soil, crop, and irrigation systems. This value identifies the degree of hazard for groundwater degradation for your cropping system. Although good nutrient management should be practiced under all conditions, the importance increases with increasing numerical value of the HI.

The Management/Risk Assessment Worksheet was developed as a supplemental guide to the Hazard Index Worksheet to help growers self-assess their operations for BMPs already undertaken, and to identify areas where management practices can be improved through the utilization of BMPs. All growers will complete the Management/Risk Assessment Worksheet identifying current ongoing practices. Growers who scored 6 or above on the Hazard Index Worksheet and need to provide written nutrient plans for practices that result in a high HI rating should use the Management/Risk Assessment Worksheet as a guideline to identify those management or operational practice areas on which the growers need to focus when developing their written management plan. Growers who score 5 or lower should complete the Management/Risk Assessment Worksheet, but as their operations do not pose a real risk in negatively impacting nonpoint source pollution, do not have to provide written nutrient plans. Growers should review the following BMPs, and then complete the attached Management/Risk Assessment Worksheet.

BEST MANAGEMENT PRACTICES

Storage

In order to ensure that fertilizer is being handled in a manner that is as safe as possible, all storage facilities should be adequately maintained and protected from the weather. Secondary containment as well as impervious pads should be utilized for the storage of liquid fertilizers. Additionally, impervious pads and burms should be used whenever possible, for the storage of both dry fertilizers and organics to contain leaching and runoff. The maintenance of these storage facilities should meet both government and California Fertilizer Association standards. In the event of a spill, the spilled material should be isolated, contained, and cleaned up as soon as possible. Other good housekeeping measures that should be implemented to ensure economically and environmentally sound practices of storage would be to maintain proper calibration of fertilizer application equipment, and ongoing education and awareness programs to all levels of fertilizer handlers and users.

Selection of Fertilizers

It is a commonly known fact that the application of fertilizer can enhance production. The most effective management strategy is one that recognizes the crop demand for fertilizers and the release characteristics of all nutrient sources in the system. Nutrients should be selected that provide adequate but not excessive levels of soil nutrients provided throughout the growing season.

The efficient integration of commercial fertilizers and other nutrient sources such as manure or other green materials reduces fertilizer costs by taking full advantage of other nutrient sources. However, extra care must be taken in estimating the release times for the nutrients in these sources, so that the period of maximum plant uptake will coincide with the release time and rates for application of alternative sources of plant nutrient.

Fertilizer Rates

The applications of nutrients should be limited to that amount necessary to meet projected crop needs at the time when the crop needs it most. Potentially, nutrient leaching and runoff could increase rapidly when the amount applied exceeds that required to attain maximum or near maximum yield. When nitrogen or other nitrogen based amendments are applied repeatedly at excessive levels to the same field, it is possible for nitrogen levels to build-up to excessive amounts. In such cases there needs to be ongoing soil testing and plant tissue analysis programs to make sure that the crops total nitrogen requirement is not exceeded. It is recommended that each crop's nutrient needs be managed separately, and that when possible, soil analysis be conducted on at least an annual basis. Growers should be aware of the nutrients already available in the soil before deciding how much to add.

The nitrogen content in irrigation water should also be taken into consideration when fertilizer decisions are being made. By analyzing well water and determining its nitrogen content, a grower can conserve on the amount of nitrogen that is added to their fields, thereby increasing the efficiency of their fertilizer applications.

Timing of Application

Multiple small doses of nutrient are often superior to one or two large applications because larger applications can result in greater nutrient susceptibility to leaching and runoff. Plant growth curves and weekly uptake estimates can be used to determine what portion of a crop's nutrient requirement should be supplied during each different growth stage. The amount of nutrient that a plant takes up is relative to the size of the plants. Therefore, when possible small amounts of fertilizer concentrated around the root zone should be applied for the early growth stages. Decisions on late season fertilizer application can be aided by plant tissue testing.

When a crop is grown during the rainy season, or when making irrigation decisions, a major portion of the plants nutrient needs should not be applied within 24 hours of when a large rainstorm is expected, or before a large irrigation. The reasoning behind this is to not wash recently applied fertilizer out of the root zone.

Soils are susceptible to nitrogen leaching during non-cropped periods. Many vegetable crop fields are left fallow for a period during the fall and winter, which is when the majority of our rainfall occurs. Any nitrogen remaining in the soil during that period is subject to leaching. Where appropriate and economically practical, cover crops are recommended for use on non-cropped or fallowed lands during these periods.

Method of Application

Proper placement of fertilizers will help to ensure that more nutrients are available to a crop during periods of maximum growth. Therefore, the application of fertilizers should be by a method designed to deliver it to the area of maximum crop plant uptake. The idea is to position and concentrate the fertilizer near the majority of the crop roots, instead of leaving it spread out over 100 percent of the field. This practice would include either placing fertilizer on the seed row and watering it in, knifing fertilizer near the seed row, or broadcasting fertilizer and then listing it up into the bed.

When applying fertilizers, applicators should take special care to be sure that application valves are shut off during turns and that equipment be properly calibrated to insure even applications at proper agronomic rates. Growers should be sure to maintain ongoing safety and environmental education training programs. All wells connected to an irrigation system equipped for fertigation need to be protected against fertilizer flowing back into the well. Vacuum relief valves, low pressure drains, air gaps, interlocking circuits between the irrigation pump and the injection pump, and check valves installed between the pump discharge pipe and injection point can all be used in some combination to prevent backflow.

Irrigation

Deep percolation and nutrient losses can be minimized by monitoring crop and soil conditions to determine when to irrigate, and replacing the water that has been depleted since the last irrigation. Operating irrigation systems accurately can provide adequate water for maximum crop production without removing plant nutrients from the root zone. Therefore, the application of irrigation water should be timed to minimize water and nitrogen loss by leaching and runoff. However, providing adequate irrigation water for the evaporation and transpiration losses must be integrated with other requirements, such as leaching of excess salts.

Growers must be able to accurately determine crop water use through plant and soil water measurements or by estimations based on weather data. Any irrigation scheduling technique must recognize crop-specific soil moisture requirements.

Organic Materials

Numerous types of organic materials may be incorporated into the soil. These include incorporating crop residues, cover crops, various types of manures, sewage sludge or compost. Incorporation of organic matter can improve soil physical conditions and stimulate beneficial microbial activity. Organic materials also contain organic forms of nitrogen which can be mineralized into ammonium and eventually nitrate, both of which can serve as plant nutrients for succeeding crops. When organic materials are added to soil, consideration must be given to the amount of nitrogen applied as well as the release times. The rate of release can be highly variable, depending on types of organic material. Normally the release of inorganic N is relatively slow so that high mineral N concentrations in the soil does not occur.

Application of some forms of organic matter may also pose hazards. Sewage sludge may contain significant concentrations of undesirable trace elements, depending on the source of the sludge. Animal manures tend to have fairly high concentrations of salts. Composted green waste from urban areas may contain pesticide residues or weed seeds, depending on the source of origin or composting procedures. Disposal of urban organic wastes on agricultural lands is a rather recent phenomenon and comprehensive evaluation of this practice is in the developmental stages. Growers should be aware of current EPA standards in the use of wastes and should maintain appropriate records of amounts of wastes used and ongoing testing, in case of future problems.

MANAGEMENT/RISK ASSESSMENT WORKSHEET

Complete the following Nutrient Management Worksheet and Good Nutrient Management Checklist.

Nutrient Management Worksheet

A. Soil and/or plant tissue analysis. If you do not use soil or plant tissue analysis, insert "0". If either soil or plant tissue analysis is used to guide N application, insert "1". If both soil and plant tissue analysis are used insert "2". __________

B. Frequency of fertilization application. If total crop requirement is made on one application, insert "0". If N is split into two applications, insert "1". If N is split into more than two applications, insert "2". __________

C. Fertilizer placement (Row Crops). If fertilizer is broadcast on land, insert "0". If fertilizer is broadcast and then listed into bed, insert "1". If N is banded or knifed into row crop bed, insert "2". __________

D. Foliar N application. If your crop is conducive to foliar N application and some is applied in that manner, insert "1". __________

E. Cover crops. If your field will be fallow for a few months during the rainy season and you do not utilize cover crops, insert "0". If your field will remain fallow during the rainy season and you do plant a cover crop, insert "1". __________

F. If you apply much of the nitrogen in the fall before the rainy season, insert a "minus 1" (-1). __________

G. If considerable organic crop residue is left on the field or you apply organic matter and the N in the organic matter is accounted for in assessing the need for fertilizer application, insert "1".

____

H. If you use CIMIS or other irrigation scheduling guidelines, insert "1". _________

Total the numbers for the above 8 items. A high number indicates a high level of nutrient management to minimize leaching to groundwater.

Any irrigation or nutrient management practice you institute to reduce nitrate leaching should be accompanied by a reduction in total N application. In other words, you now only need to supply the crop need - not the crop need plus that which was previously leached below the root zone.

<u>Good Nutrient Management Checklist</u>

The following are practices which should be instituted where applicable. Insert "N/A" if it is not applicable to your situation. Remember to explain in your written management plan why that practice does not apply to your operation. Place a check for items you are doing. Place a "0" if you are not following the practice and work toward replacing "0" by a check mark. You should note in your written management plan how you are working towards implementing a recommended practice.

A. Handling Fertilizer Materials

1. When transporting fertilizer, do not overfill trailers or tanks and cover or cap loads properly. _________
2. Avoid spills when off-loading fertilizer into on-farm storage or into fertilizer applicator. _________
3. All storage facilities are properly maintained and protect from weather. _________
4. Clean up fertilizer spills promptly. _________
5. Shut off fertilizer applicators during turns and utilize check valve. _________
6. Maintain proper calibration of fertilizer application equipment. _________
7. Distribute rinse water from fertilizer application equipment evenly through the field. _________

B. Use of manure and other Organic Materials

1. Consider nitrogen applied with the organic material in your overall N application requirement. __________

2. Consider mineralization rates of your organic material to determine time of nitrogen availability. __________

3. Incorporate organic material into soil. If added avoid excessive erosion of the material. __________

C. Nitrate in Irrigation Water

1. If your irrigation water has significant concentrations of nitrogen, consider that it is providing some of the crop need. __________

If the total Hazard Index value is 6 or greater, there is a high potencial for groundwater degradation by nitrates from your operation. This situation requires implementation of management practices to minimize the hazard. using the Nutrient Management Worksheet, the Good Nutrient Management Checklist, and other information you may acquire as reference, write a detailed management plan that you will follow to protect groundwaters from nitrate degradation. The managment plan should include record keeping of all activities such as amount and time of fertilizer application, results of soil or plant analysis, etc.

SECTION III

IMPLEMENTATION

Each farm must complete a Hazard Index and Management/Risk Assessment Worksheet for each cropping unit. The Hazard Index will determine which classification (or tier) the farm site will fall under. Within each tier, the following items will be required of the grower:

Tier #1: Low Risk

Requirements:

- Complete a Hazard Index Form.
- Complete a Management/Risk Assessment Worksheet and Good Nutrient Management Checklist.
- Keep worksheets on site.
- Complete an annual program review.

Tier #2: High Risk

Requirements:

- Complete a Hazard Index Form.
- Complete a Management/Risk Assessment Worksheet and Good Nutrient Management Checklist.
- Complete a written plan with an explanation of strategies for improvements in nutrient management.
- Maintain a written copy of this plan on site for review by the SWRCB
- Complete an annual program review.

Problem Areas (where a recognized water body has been declared impaired)

Requirements:

- Complete a Hazard Index Form.
- Complete a Management/Risk Assessment Worksheet and Good Nutrient Management Checklist.
- Write a plan of BMPs used.
- Document corrective measures to be implemented towards improving current practices to be kept on site.
- Written records of education programs.
- Monitor program throughout year.
- Complete an annual program review.

The implementation of this program can be completed by a proactive cooperative effort between agriculture and the regulatory community. However, institutional changes should be addressed and implemented to create a system that can address the problem of nonpoint source pollution in a cost effective manner.

INSTITUTIONAL CHANGES

Nutrient management is a simple concept when seated in front of a computer with values for each nutrient source (soil, water, liquid and solid nutrient amendments). However, the usefulness of the computer exercise depends on the precision of the data used. There are no existing agencies (regulatory, technical or educational) that can fully provide such services or even educate those in allied industry who will provide the services.

Requirements for nutrient management plans generates two questions:

1) Who will write the plans? and

2) Who will review the plans?

The answers to these questions will suggest needed institutional changes.

Currently, certified professionals who provide services to growers may write these nutrient plans. Growers can certainly do their own plans, but can also opt to have a consultant provide the plans.

It is not in the scope of responsibility for the staff of the Natural Resource Conservation Service (NRCS) or the University of California Cooperative Extension Service (UCCE) to provide such services. However, these individuals should be actively involved in the education process and where they have the resources to provide growers with management recommendations do so.

Details needed for a nutrient management plan must be accessible. At this time, there is information in parts of the state related to specific crop nutrient needs that can be useful in other parts of the state. UCCE Farm Advisors, growers, and seed companies have accomplished tremendous amounts of research over the years. Unfortunately, there is no central clearinghouse where individuals can go to get specific information. This information is especially important for specialty crops. Research needs to be summarized (if completed) or designed to answer questions related to nutrient uptake, availability and potential leaching under different conditions in California. Previously accomplished research may behold answers to nutrient use efficiency.

The committee does not recommend any major change in institutions but recommends a change in focus. The SWRCB is responsible for the nonpoint source pollution control. Inasmuch as nonpoint source pollution can only be reduced through land management, the SWRCB should focus on monitoring management practices. We propose that the SWRCB be responsible for preparing and distributing all materials relevant to the preparation of the mandatory hazard index and management/risk worksheets. Furthermore, RWQCB should monitor and evaluate the completion of the management plans. If adequate authority for requiring the completion of a hazard index, management/risk assessment worksheet, or management plan does not exist, then the SWRCB/ should obtain that authority. It is recognized that the Board does not have authority to enforce the implementation of any given management plan. Nevertheless, they have the opportunity to encourage effective management by reviewing the proposed management plans. If effective management is not voluntarily adopted by the agricultural community, it may become necessary in the future to seek broader-ranging enforcement authority through the appropriate legislative procedures. The Committee, however, with the exception of one member (see Attachment I), does not recommend broader regulatory authority at this time.

EDUCATION

The Committee is unanimous in agreeing that the education of all players (growers, allied industry, technical and financial assistance personnel, etc.) is the key to the success of nutrient management plans. There needs to be a commitment from individuals, grower organizations and other agencies for this to work effectively.

Increasing the farmers' awareness of the importance of BMP-based nutrient management plans is essential to making changes in current fertilization practices. "Grower friendly" educational program that farmers can attend and benefit from should be designed and implemented. Aside from the regulatory compliance requirements that BMPs fulfill, BMPs are a very viable cost saving tool that growers should utilize. As growers become more aware through proactive efforts, they will be more fully utilized by growers.

The Committee recommends that the State Water Board advocate greater nutrient management education programs. Farming organizations such as the Farm Bureau, California Alliance of Family

Farmers, U.C. Cooperative Extension, Fertilizer Research & Education Program, Agricultural Commissioners, Soil Conservation Service as well as Grower Shipper Association, California Fertilizer Association and other industry based entities should participate in the planning and implementation of educational programs.

The Committee recognizes that the preparation of the hazard index and management/risk assessment worksheets, and if necessary development of a detailed nutrient management plan are educational activities. Each farmer becomes aware of potential for nitrate pollution from his/her agricultural operation, along with guidelines for mitigating the pollution. The necessity to complete these forms will provide an inducement for farmers to seek additional information. Thus, educational activities presently in place may be more actively sought out by farmers. For example, UC Cooperative Extension farm advisors can develop workshops to comply with farmer demands. Many farmers may seek professional consultants, so there will be an incentive for the development of a professionally competent consulting profession. Indeed, the profession may pose standards for competency in their profession.

Additional comments regarding educational activities are included in an attached minority report (Attachment II).

ENFORCEMENT

The committee recommends that the current status of the program using voluntary implementation by growers be maintained at least until the state has developed and made available to all growers, Best Management Practices sensitive to the diversified nature of California's agriculture.

As stated earlier, this committee believes that as the agronomic, economic as well as environmental benefits of improving management practices become better known and understood by growers, they will be utilized extensively. The committee believes that the state would be better served to increase the education available to growers to address this problem thereby eliciting a positive action by growers to correct problems, than it will by using negative incentives to force growers to take minimum actions to meet agency mandates. As a result, the committee recommends that no new negative incentives be implemented in the development of this program. The Committee strongly recommends, with the exception of one member (see Attachment I), the State Water Board to adopt a positive incentive based program to implement its nonpoint source pollution program, and not move towards the traditional negative fees and penalties type programs of the past that result in antagonistic rather than cooperative relationships between the regulatory community and the private sector it's supposed to work with. Other agencies like the State Air Resources Control Board have adopted this strategy of a strictly positive incentive based program, without any fees or penalties, to implement the U.S. EPAs Federal Implementation Plan for the reduction of air pollutants. We believe that the State Water Resources Control Board should adopt the same type of proactive cooperative program.

SECTION IV

CZARA EVALUATION

In developing management measures (general goal statements) for reducing nonpoint source pollution from nutrient sources, the committee considered the management measures listed in the CZARA guidance along with others developed in the western region. These included those listed in the Arizona Environmental Quality Act of 1986 and the recommendations of the Nitrate Working Group to the California Department of Food and Agriculture. The management measures from the three sources are similar in that they all consider refinement of fertilizer application to meet crop needs in quantity, timing, and placement. The California report was deemed to be most appropriate because it evaluated nitrate pollution in groundwater in California and offered solutions specific to the conditions of California. The committee adopted the six management measures recommended in the California report an included two additional measures. These additional measures deal with irrigation management and use of nonsynthetic fertilizers (green wastes, manures, etc.).

The management measures selected by the committee are in conformity with the (g) guidance because it includes all of the elements of the guidance and goes beyond by including other control measures. The additional control measures include storage management, irrigation management, and management of non-synthetic fertilizers.

APPENDIX III
FINAL LIST OF STAKEHOLDER/INTEREST GROUPS

The TAC initially listed nearly 35 stakeholders. During the process of identifying interests, the list was reduced to 17 stakeholders. All stakeholders listed in the brainstorming process may be found in Appendix II. The interests which were ascribed to identified stakeholders are listed below:

1. **FARMERS -** Survival, productivity, independence, image-taboos, maximize profit, healthy environment, competitiveness, stewardship, minimize red tape, global, optimize benefits, fairness, sensibility, sustainable ag., control own business, education, ag systems integration, technical assistance, management decisions, PR outreach.
2. **WATER DRINKERS** -Health, taste, cost, availability, quality.
3. **SUPPLIERS (NUTRIENTS)** - Profit, livelihood, customer satisfaction, education, control product quality, QA/QC, independence, OSHA, stewardship of the environment, minimize red tape, image competitive, local economy, job security, management decisions, liability.
4. **CROP ADVISORS** - Education, information, liability, competitiveness, land sustainability.
5. **LAND OWNERS** - Property rights, value (land), liability, stewardship, profit, neighbors, minimize red tape, independence.
6. **REGULATORS** - Economic feasibility, enforceable standards, regulations and measures, protect beneficial uses, worker health/safety, maintain water quality, right of enter/monitor/inspect, PR, education, outreach, funding sources, valid data, fairness, equity, fish & wildlife, air quality, sustainability, water quality, habitat, environment, recreation.
7. **TRANSPORTATION INDUSTRY -** Profit, regulatory compliance, good roads, liability.
8. **EDUCATORS** - Objectivity, convey facts, quality info, research grants, receptive audience.
9. **GENERAL PUBLIC -** Water quantity/quality, health, safety, recreation, food (affordable), air quality.
10. **MUNICIPALITIES** - Regulations, marketplace, profit, public acceptance (good PR), avoid liability, minimize red tape.
11. **FARM LABOR** - Local economy, job availability, health/safety, quality of life, water quality/quantity.
12. **ENVIRONMENTAL ADVOCATES** - Sustainability, land use control, protect natural resources, air quality, ecosystem management, water quality/quantity, watershed management, biodiversity, habitat, population growth control, increased/tougher regulations, enforceable standards, accountability, citizen involvement, funding, economic considerations, education.
13. **EQUIPMENT MANUFACTURERS** - Economic feasibility, R & D, market

research, profit, regulatory compliance, worker safety/training.

14. **BANKERS** - Environmental compliance, security interests, regulatory compliance, liability, compliance monitoring, profit, image, clear/objective regulations.
15. **WATER PURVEYORS** - Liability, regulatory compliance, standards, funding monitoring, water quality/quantity, customer satisfaction, bn\eneficial uses.
16. **MANUFACTURERS** - Regulations, disposal, by-product utilization, profit, liability, R & D, market availibility, minimize red tape, local and gobal pressure, economic distribution.
17. **POLITICIANS** - Re-election, funding, represent constituency, positive change.

APPENDIX IV
BEST MANAGEMENT PRACTICES RESOURCE CITING

Arizona Environmental Quality Act, Arizona Department of Environmental Quality, 1986

Best Management Practices For Cool Season Vegetable Production in Coastal Regions of California, Stuart Pettygrove-Project Lead, University of California, Davis, 1994

Combining Water and Fertilizer Management for High Productivity, Low Water Degradation, Letey, Pratt, and Rible, California Agriculture, 1979

Guidelines for Protection of Water Quality at Retail Fertilizer Facilities, California Fertilizer Association, 1988

Nitrate and Agriculture in California, California Department of Food & Agriculture, 1989

Nitrate in Drinking Water, State Water Resources Control Board, 1988

Our Priceless Water, California Farmer, 1994

Western Fertilizer Handbook - 8th Edition, California Fertilizer Association, 1994

ATTACHMENT A

Minority Report of Al Vargas

For the most part, I am in agreement with the technical aspects of the nutrient technical advisory committee (TAC) report. However, I feel that the report is deficient with respect to institutional reforms necessary to bring about changes in nutrient management and the desired result of improvement of water quality. I do not believe that the committee' s recommendation will succeed at bringing about change in nutrient management as it relies primarily on voluntary implementation and does not propose an enforceable mechanism to ensure implementation. The problem statement and enforceable mechanisms and the policy recommendations which arise are the subject of this minority report.

Problem Statement

Ground and surface water of the state have been impaired by nutrients from irrigated agriculture through leaching and runoff. The actual extent of the impairment may be much greater than currently assessed. The problem has developed to its current state because of lack of an adequate regulatory program and lack of economic consequences from irresponsible nutrient management.

The actual extent of impairment of the water of the state may be much greater than currently defined. Information regarding the extent of impairment is based primarily on monitoring of municipal groundwater drinking supplies. Municipal groundwater wells are generally deeper and less susceptible to contamination by nitrates than private drinking water wells, which are generally shallow and located in rural areas, primarily agricultural. Private wells are, however, generally not monitored as they are not subject to state monitoring requirements. Consequently, the extent of groundwater contamination may be greatly underestimated.

In California nutrients play a lesser role in the impairment of surface water than they do nationwide. This, however, may be due to how impairment is evaluated in California rather than to actual less impairment. Currently, the only guideline for evaluating nitrate contamination in California is the 45 mg/L MCL. This standard is based upon human health concerns. Nitrates may impact surface water long before this limit is reached. The most obvious of these impacts is the growth of aquatic vegetation which may interfere with navigation, recreation, and water pumping operations. Not as readily recognized as an impairment is increased algal production due to elevated nitrate levels. Increased algal production may be detrimental to aquatic systems because they may depress dissolved oxygen, increase turbidity, and restrict light penetration. This will have a negative effect on the aquatic ecology, although it may not be a nuisance to man. Consequently, recognizing other impacts of nutrients to surface water, other than those that pose health hazard to humans or which are a nuisance may result in additional surface water being classified as impacted.

In the 1991 Water Quality Assessment Report, sewage treatment plants, industrial, urban runoff, and land disposal accounted for approximately 15% of the impairment to streams and rivers. Nonpoint sources of pollution accounted for the remaining sources. Agriculture alone accounted for 50%. With respect to groundwater, nutrients accounted for more than twice the impaired ground water than non-pesticide organics. Despite the contribution of nonpoint sources to impairment of streams and rivers, regulatory programs and resources are focused primarily on point sources of pollution. Additionally, the existing regulatory framework is designed for controlling point sources and does not deal adequately with nonpoint sources.

The committee explored, to a limited extent the use of positive incentives, such as pollution credit trading as a means to manage nutrient water pollution. However, no situations were identified where this mechanism could be used. A tier tax was proposed for nitrogen fertilizers to discourage excessive nitrogen application (in excess of that required for optimum crop yield), however this suggestion was rejected by the TAC. Currently, the only deterrence to excessive nitrogen application is dictated by the crop. For a small number of crops (e.g., grapes and sugar beets) excessive nitrogen application results in decreased yields and thus an economic incentive exists for responsible nutrient management.

For the majority of crops, however, excessive nitrogen application does not result in reduced yields. In fact the cost of additional fertilizer (in excess of what is required for optimum yields) is so low in comparison to the cash value of the crop that growers are likely to over apply in order to ensure maximum yields. Therefore, an economic incentive is necessary as a means to encourage responsible fertilizer use.

Agriculture is unique from all other industries in that it is not held accountable for most of the pollution it causes and thus, there is no economic consequence. For example, agriculture does not remediate or pay for the ground or surface water it contaminates with pesticides or nitrate. Currently those that bear the consequences of ground water pollution by agriculture are the citizens of the state primarily those in rural communities as they loose a source of drinking water or must pay higher rates to treat. Accountability for the pollution and linking an economic consequence with irresponsible nutrient management would probably result in a change in practices. As a start an exchange program of water supplies should be instituted. This was adopted by the TAC but deleted from the final report.

Enforceable Mechanisms

The TAC felt that the obligation to complete the risk assessment (Hazard Index and Nutrient Management Worksheet) and the nutrient management plan (where appropriate) constituted the enforceable mechanism. I felt this did not go far enough because it did not ensure the implementation of the "Best Management Practices"

(BMP) outlined in the nutrient management plan without implementing the BMPs would result in no improvement with respect to mitigating nutrient pollution. Therefore, the enforcement must be directed at enforcing adoption of BMPs. The strategy would still call for a self directed program the allowed the grower flexibility with respect to selection of BMPs that are most suited for his operation. Enforcement would only be used in situations of non-compliance. Under current state law the State Water Resources Control Board and the California Regional Water Quality Control Boards can not enforce implementation of BMPs (Porter-Cologne Water Quality Control Act Section 13360). Therefore, legislative initiative would be required to provide the regulatory agencies with this power.

<u>Policy Recommendations</u>

There are a number of policy recommendations that arise from the above discussion. These are enumerated as follows:

1. Define extent of groundwater impairment by focusing on shallow, rural water supply wells which are the most susceptible to be impacted by nitrates.

2. Develop criteria for nitrates in surface water. Such criteria would go beyond human health hazards and nuisance to man and would recognize detriments to the aquatic system from elevated nitrate levels.

3. Re-evaluate resource allocation for water quality regulation. The allocation should be in relation to areas that would have the most impact in improving the water quality of the water of the state. These would be nonpoint sources and agriculture in particular.

4. Institute a tier tax on fertilizers. This tax would apply only to units of nitrogen fertilizer greater than those required for optimum yields. Thus only growers which apply nitrogen fertilizer of excess of what is needed would be subject to the tax and would have no negative economic impacts on growers who are responsible nutrient managers.

5. Institute exchanges of water supplies between irrigation districts with good quality surface water supplies and communities with contaminated groundwater. This exchange would be mutually beneficial. Agriculture would benefit because growers would apply less nitrogen fertilizer and thereby increase profit margins. One-acre foot of water containing 10 mg/L nitrogen as nitrate would supply 27 pounds of nitrogen per acre.

6. Seek legislative authority to enforce BMP implementation. Current law does not allow for specifying the manner of compliance with the exception of land disposal facilities and deep well injection. In the case of nonpoint source pollution, BMP enforcement would be appropriate since this is the only method by which the results can be achieved.

7. Develop a nonpoint source control strategy apart from the point source strategy. As was noted in the "Background" section of the TAC report, the current nonpoint source strategy was adopted from a regulatory framework developed for regulating point discharges. This system does not lend itself to many nonpoint sources, since discharges can not be monitored. Therefore, a new framework is needed for dealing with the primary source (nonpoint source) of impairment of the state's water. This framework should include authority to enforce BMPs.

ATTACHMENT B

November 21, 1994

TO: Plant Nutrient TAC Members
FR: Jill Klein, Community Alliance with Family Farmers Foundation
RE: Minority Nutrient TAC Report

Because my point of view is not reflected in the October 6 Draft Nutrient TAC Report, I am submitting this minority report to provide another perspective on how to reduce nitrates in groundwater.

The Nutrient TAC Report does not approach farming as an integrated, biologically based system, but rather reduces farming into separate components. Though looking at these components (soil, nutrients, water, plants) is useful for purposes of analysis, they need to be treated as a whole when developing management plans to improve nutrient cycling in complex farming systems.

Healthy soil is at the heart of a biologically managed farming system. Soil is host to a broad variety of micro flora and fauna in addition to the micro and macro nutrients which immediately feed the plant. Carbon-based soil fertilizers and amendments feed soil biota which are important to the turnover and longterm availability of nutrients. Cover crops play a variety of important roles in this system, from fixing atmospheric nitrogen (if legumes) to adding organic matter to the soil to providing food and habitat for beneficial insects. Proper management of cover crops is important to realizing their full benefit while minimizing potential negative impacts such as nitrate leaching. Composted manure, if properly made, provides a stable form of nitrogen and enhances overall soil health. Thus, soil should be viewed as more than a medium for holding a plant which can be spoon fed with water and synthetic nitrogen through drip irrigation and fertigation. What farmers really need is a menu of options that can fit into a whole systems approach to reducing overall chemical fertilizer and pestcideuse.

If the value of looking at the whole farming system were better appreciated, then TAC members might share my frustration that the Nutrient TAC has not been integrated with the Pesticide TAC Report; something we had agreed to do in one of the first meetings. Additionally, for implementation of whole systems approach to be successful at the farm level, the report must include a technical support program for growers to assist them in adopting proven alternatives to their farm. This is critical if any of the practices recommended by the Nutrient TAC are to be implemented broadly. Following is a discussion of where the current Report falls short, evidence for why an alternative approach is called for, and a description of a successful chemical fertilizer and pesticide reduction program.

Shortcomings of the Nutrient TAC Report

In one of our original meetings, we decided to work closely with the Pesticide TAC, particularly in the final stages of developing the report. I am dismayed that this consensus decision was never acted upon. Research has demonstrated direct correlations between high levels of applied nitrogen and an increased incidence of pests and disease (e.g. Ieafhoppers in grapes and brown rot and hull rot in stone fruits, respectively). By looking at the whole farming system and how fertility management can influence other elements we can develop more appropriate solutions.

Many in efficiencies occur in the use of synthetic fertilizers and pesticides; changing these practices can be achieved with sticks in the form of tighter regulations or carrots in the form of carefully developed incentives programs. The Nutrient TAC Report takes a third approach, creating additional paper work for growers without either the carrot or stick to insure action. Thus, without any provisions for enforcement or technical support in the Nutrient TAC Report, there is little reason to believe that growers will take the time to fill out more paper work, much less actually change their practices.

Furthermore, the current Report lacks a strong education component, leaving growers with little or no information or incentive to experiment with alternatives. For example, in Recommendations, it is stated that growers will need to "develop a management plan to minimize their contribution to water degradation." Growers who score a 6 or higher on the Hazard Index must develop written strategies to further control the problem. A strong education component is key to these recommendations actually being implemented. It has been my experience that focusing education and resources on technical advice which provides viable options gives growers an incentive to change their practices. It is not enough of an incentive to know that Best Management Practice's (BMP's) are cost saving tools, as stated in the document. Nitrogen fertilizer is relatively cheap, and more carefully timed applications may even be more expensive. In fact, if BMP's are so cost effective, then why aren't more growers already implementing them?

Management options which have multiple benefits, even if they cost a little more, are better than those which provide a singular solution to a problem. As an example, I will describe a recent field day I helped to organize in the Salinas Valley. More than 110 farmers and others in ag-related business were in attendance to tour an on-farm composting operation. One reason the farmer whose operation we visited gave for using compost on his 700 acre vegetable farm is its nitrogen contribution. His compost contains 1.6% total nitrogen; when applied at 5 tons/acre, it yields 160 Ibs N/acre. During this discussion, the local farm advisor reported that his findings revealed that only 5% (8 Ibs) of the nitrogen is in a leachable form (nitrate), the rest is in a slow release form. The compost also contains 5.4% calcium, which is comparable to the amounts applied as lime or gypsum when used as a soil amendment to improve soil structure and water infiltration. In addition to the benefits of slow release nitrogen (there was sufficient N for a crop of peppers 4 months after application) and calcium, the compost also supplies other macro and micro nutrients, beneficial soil microorganisms, and organic matter. Since switching to compost as his primary fertilizer, this grower reports that he no longer has problems with soil borne pathogens and that his crop is healthier and less susceptible to insect damage. Consequently, he has sharply reduced nitrate leaching and pesticide use.

Evidence for an Alternative Approach

There is emerging evidence that organic sources of nitrogen such as leguminous cover crops can act as a slow release nitrogen, although this issue was disputed by members of the committee. Research conducted at the University of California - Davis, has shown that leguminous cover crops can fix up to 200 Ibs of nitrogen/acre/year (Miller, et al., 1989). After the first few years of using a cover crop, it seems that the soil comes to a new equilibrium where organic forms of nitrogen are less likely to leach. Additional research which compared conventional, low input, and organic farming systems corroborates this theory (Temple, et al., 1993). The organic system included the annual incorporation of a leguminous cover crop over a five year period. After the fifth year of the experiment, researchers reported that:

> In the organic system, N03 levels were very low early in the season and steadily increased to 8-10 ppm by mid-May. Both N03 and NH4 levels were considerably lower in organic soils. . . This changing pattern in the organic soils may reflect long-term changes in soil microbiology and N dynamics that have occurred during the transition from fertilized to organic management. . . Fertility, microbial and nematode soil data suggest that significant differences exist between organic and conventional systems in microbial ecology, resulting in different available nitrogen levels. Higher microbial activity and biomass linked to lower available nitrogen in the organic system suggests that there was more efficient N use and possibly less potential for N03 percolation loss from the surface soil. Although the petiole data showed much lower petiole N03 in the organic plants, this did not translate to reduced yields, suggesting that the petiole test cannot be used to assess plant fertility status on organic systems when based on sufficiency/deficiency criteria established for fertilized systems. The results also indicate that currently recommended tissue nitrogen levels may exceed actual plant nitrogen requirements in conventional systems.

Building in a Technical Assistance Program

Based on these alternative options for sources of nitrogen which are not leachable, propose an expanded education component for the Nutrient TAC Report. This proposal is compatible with a modified evaluation of the growers current practices in the form of a Hazard Index and Risk Management Form. The following plan is based on a program, which I cocoordinate, that has succeeded in recruiting farmers to voluntarily reduce both pesticide and nitrogen fertilizer applications while maintaining the same economic bottom line. This project, known as Biologically Integrated Orchard Systems, or BIOS, is designed as a three-year information and technology transfer pollution prevention program for reducing synthetic nitrogen fertilizers and pesticides used in California crop production, thereby reducing contamination of surface and ground waters.

The project establishes on-farm demonstrations of University research and farmer-developed production systems, allowing growers to adapt new methods which reduce their reliance on farm chemicals. The broader farm community is made aware of these practices through field days, frequent update mailings, and the publication of document describing the practices being demonstrated. Continuation of the project's goals will be assured through active involvement of commodity boards, U.C. Cooperative Extension, USDA - ASCS and SCS and local Resource Conservation Districts.

Specific components of the program include: 1) training farmers and their agricultural consultants to use techniques including the use of cover crops, targeted release of beneficial insects, and careful monitoring of pest and beneficial insects; 2) developing a customized management and monitoring plan for each parcel enrolled in the program; 3) conducting facilitated monthly meetings in which beginning and experienced practitioners collaboratively solve problems; 4) organizing on-farm demonstrations of techniques and methods; 5) monitoring, organizing and interpreting field data; 6) publicizing the methods used by BIOS growers to the greater grower community. BIOS also recruits local representatives from key government agencies, as well as from the commodity boards, to serve as an ongoing source of information and support for farmers not enrolled in the program who are a BIOS-style farming approach.

The BIOS management team oversees all elements of the program, including creation of farm management plans and monitoring protocols, providing technical support to farmers in the program, and making presentations at BIOS field days. The management team includes representatives from the University of California extension service and researchers, farmers, professional PCAs and program coordinating staff. Currently, CAFF Foundation provides overall administration and coordination for BIOS.

BIOS creates opportunities for cooperation between various state and federal agencies whose mission includes concern over the use of farm chemicals. This program is designed to support institutionalization of the biologically integrated approach to achieving source reduction in agriculture. In order to further extend the impact of the program, BIOS is forming a local advisory committee, including participation from the local farm extension, county agriculture commissioners, ASCS, Resource Conservation Districts (RCD), SCS and representatives from appropriate commodity boards, to serve as an ongoing source of information and support for farmers wishing to reduce their use of leachable nitrogen and pesticides by adopting BIOS style techniques. Working with commodity boards will provide an opportunity to reach out beyond the circle of "innovative" farmers interested in finding new ways to farm, and into the larger mass of conventional growers. The advisory committee can continue this technical support network at the conclusion of the three-year pilot program.

Resources for coordinating this kind of program could come from the fertilizer industry and commodity boards who share in the interest of improving water quality in the state. The State Water Board could help with many aspects of the project's coordination.

It may be that some of the information provided here does not sit well with the representatives of the fertilizer industry and others who sit on the TAC, but it is important in recognizing the direction this TAC should be going. I think it is more realistic that the TAC look at whole systems instead of components; that growers have many options instead of few; that we encourage naturally occurring biologically based systems of fertilization and pest management instead of synthetic sources; and that we encourage an incentives-based technology transfer approach. I believe that if the report does not include these recommendations we will not be living up to our commitment to provide farmers with viable solutions to the problems we identified at the outset.