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USEPA Grants Final Approval to California's 2002 §303(d) List

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On July 25, 2003, the U.S. Environmental Protection Agency gave final approval to California's 2002 §303(d) list, which contains 684 water quality limited segments (WQLS) and 1,881 segment-pollutant combinations, an increase of 30 percent over the prior EPA-approved list from 1998.

A shorter §303(d) list of 679 WQLS and 1,852 segment-pollutant combinations was submitted by the California State Water Resources Control Board (SWRCB) in February 2003, and was given partial approval and disapproval on June 5, 2003, when the EPA approved the listing of 679 WQLS but disapproved the state's decision not to list 5 additional water bodies and additional pollutants in waters already listed by the state. After a public comment period related to the identification of those additional waters and pollutants, the EPA gave final approval to the expanded list.

Laosheng Wu

The Clean Water Act (CWA) requires each segment-pollutant combination on the §303(d) list to be given a priority rating for Total Maximum Daily Load (TMDL) development. Of those given a high or medium priority in California, more than 100 have agricultural operations, grazing, or dairy operations identified as a pollutant source. The three most common pollutant types associated with those sources are sedimentation, nutrients, and pesticides. Not counting the urbanized San Francisco and Los Angeles regions, 53 of 107 high priority TMDL designations throughout the other seven regions of the state are attributed to agriculture and have TMDLs scheduled to be completed by the end of 2004 or sooner (Fig. 1). The TMDLs must be set at levels that will meet applicable water quality standards, account for seasonal variation, and allow a margin of safety.

As outlined in §303(d) of the CWA, states are required every even-numbered year to submit to the EPA a list of all water bodies in the state that do not meet established water quality standards, after technology-based controls have been implemented. California's final 2002 list has a 30% increase in listings over the 509 WQLS and 1400-plus segment-pollutant combinations identified in the prior EPA-approved list. Although the listing requirement is every even-numbered year, the previous EPA-approved list from California dates back to May 1998 because the EPA suspended the listing requirement for 2000.

For specific information regarding the 2002 list, including changes from the 1998 list, TMDLs completed, or the current lists and priorities, please visit the SWRCB website, *http://www.swrcb.ca.gov/303dupdate.html*.

For a more detailed discussion of TMDL legislation and the history of the TMDL regulatory process, please see the Winter 2003 issue of ***WaterWise***.

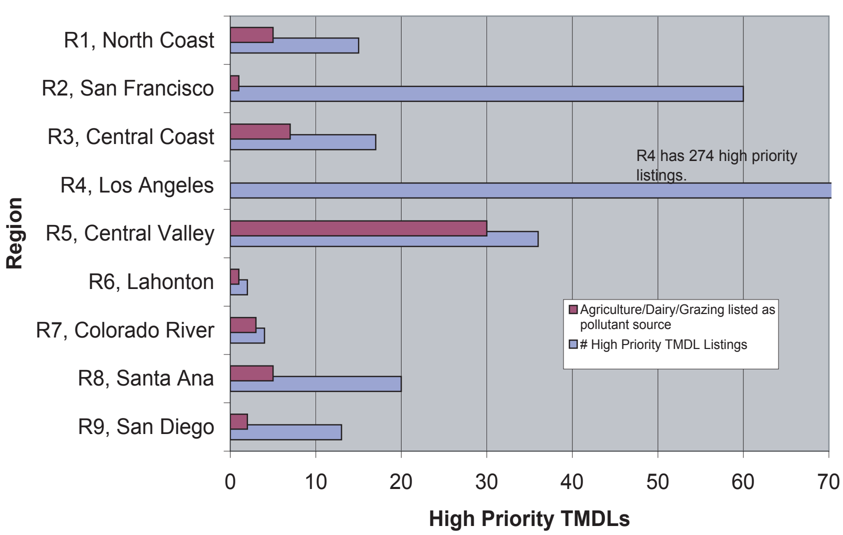

Fig. 1. Number of high priority TMDLs in California broken down by water quality region. (See SWRCB website for details, www.swrcb.ca.gov/303dupdate.html)

Incentive-Based Regulations for TMDLs

W. Bowman Cutter, Water Resource Management Specialist

The water quality goals in TMDL regulations will require that local government, industry, agriculture, and households reduce water pollution. However, it is difficult to determine, prior to implementation, which sectors can reduce pollution at least cost. Economists tend to favor decentralized and incentive-based approaches to achieve least-cost pollution reduction.

Three incentive-based approaches that could be applied to the San Diego Creek sediment TMDL are discussed. These examples do not take into account the full complexity of the San Diego Creek TMDL; instead, they highlight the types of incentive-based solutions that water resource economists have proposed to solve the pollution reduction allocation problem:

- **Cap and trade systems**
- **Pollution taxes**
- **Fee and credit systems**

Load Reduction Regulations

TMDLs set overall pollution load targets in a water body to achieve water quality standards, which are based on the designated beneficial uses of the water body. Pollution reduction plans are a state responsibility. In California, the Regional Water Quality Control Boards (RWQCBs) set the load allocations, which determine the pollution-reduction responsibility of each sector (agriculture, local government, etc.). Nationwide, states and localities set load reductions through a variety of methods. One method is to assign equal *percentage* reductions to each source. Another option is to require equal load reductions from each source. Neither method relies on cost data to assign load reduction and therefore would not be expected to minimize the cost of meeting water quality standards.

W. Bowman Cutter

San Diego Creek Sediment TMDL

The San Diego Creek sediment TMDL seeks to limit the quantity of sediments that enter Newport Bay and degrade the bay ecosystem. The goal of the Santa Ana RWQCB is to reduce sediments entering San Diego Creek by 50% by 2008. Specific sediment ton limits are set for open space, agricultural land, construction sites and urban areas. For example, Resolution No. 98-101 (Attachment p.2) specifies "no more than 13,000 tons per year discharged to San Diego Creek and its tributaries from construction sites."

It is noteworthy that the specified allocations may not correspond to the least-cost pollution reduction alternative. Perhaps sediment reduction from agricultural land is much cheaper than reduction from construction sites or vice versa. Also, within each sector, the cities and counties are largely responsible for formulating sediment reduction plans. However, some cities may have sources of sediment reduction that are lower-cost than others. Water resource economists have proposed cost-effective methods for complying with the mandated regulations, such as the San Diego Creek TMDL rules that would assign pollution-reduction responsibility to the least-cost source of pollution reduction.

Three Incentive-Based Regulations

Economists have proposed three alternative methods for solving this pollution reduction allocation problem. The first two options – cap and trade systems and pollution taxes – require costly monitoring of individual polluters. The third method – fee and credit systems — is less monitoring intensive and may be more applicable in the case of the San Diego Creek sediment TMDL.

Cap and Trade Systems. A cap and trade system for sediment reduction would first determine the total allowable pollution, which is 125,000 tons/year in this case. Sediment permits totaling 125,000 tons would be issued or sold to sediment-dischargers. The dischargers could trade permits among themselves. Those with high sediment-reduction costs would have an economic incentive to buy permits and those with low sediment-reduction costs would sell. Sediment reduction would be concentrated among sectors with low costs of pollution reduction.

Pollution Taxes. A sediment tax would first set a per-ton fee for all sediment dischargers in the San Diego Creek watershed. An initial analysis would estimate the fee level that would attain the goal of 125,000 tons of sediment. If, after the fee is imposed, the sediment load is still too high, the fee would be raised. If the sediment load is too small, the fee could be lowered. Similar to the cap and trade system, pollution reduction would be implemented by the low-cost pollution reduction sources. Those with high costs would choose to pay the tax, instead of reducing sediment. Those with low costs would reduce sediment, instead of paying the tax. Policymakers may see the uncertainty concerning the amount of pollution reduction as a disadvantage of pollution taxes. However, a pollution tax would also provide funding for necessary government spending, while permits are usually distributed free of charge and generate no revenue.

Please see ***TMDLs****, page 7*

BMPs Developed To Mitigate Pesticide Runoff at Nurseries

Jay Gan

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Orange County Farm Advisors and Cooperative Extension Water Specialists at the University of California, Riverside have reduced pesticide and nutrient runoff by more than 90 percent at a large Southern California commercial nursery by implementing three inexpensive BMPs.

The BMPs include the following:

- Polyacrylamide (PAM) delivery into the runoff stream
- Installation of an in-line sediment trap and a settling pond
- Development of a vegetative strip in the discharge channel

The three BMPs work in concert to cause maximal removal of suspended solids from the runoff flow and are based on the results of on-site research into the causes of pesticide contamination at commercial nurseries.

The study focused on bifenthrin, but the developed BMPs may also work well with other pesticides and in runoff situations other than nurseries, because the BMPs are based on general principles of pesticide movement. Tests with additional pesticides and at other locations are planned, pending budgetary constraints.

How Pesticides Get into Nursery Runoff

To determine how pesticides get into nursery runoff, samples of surface soil were collected throughout a 100-acre nursery in Orange County, California and the samples were analyzed for their pesticide concentrations. The sampling sites were located next to various runoff paths. It was visually observed that the soil at most locations contained wood chips that originated from potting mix, suggesting that potting mix spills occurred commonly during the transportation, handling, and/or watering of plant containers.

Pesticide residue analysis showed that there was a clear relationship between pesticide concentrations and the content of wood chips in the surface soil. Therefore, it may be concluded that potting mix is the primary "vector" for pesticide contamination at nursery sites. It appears that daily operations cause spills of pesticide-treated potting mix, and runoff water from irrigation washes pesticides into the runoff flow. Knowing this chain of events is very useful, because it suggests that a fundamental approach to reducing pesticide runoff at nursery sites is "clean" operations that do not allow potting mix to spill all over the place.

Mitigation Strategies

Once pesticides are in the runoff water, what can commercial nurseries do to prevent pesticides from leaving the nursery site and entering an adjacent stream? To answer this question, one needs to understand the different forms in which pesticides may move in runoff. Conceptually, pesticides can move in nursery runoff in two forms: (1) adsorbed to suspended solids and (2) dissolved in water. Because nursery runoff typically contains high levels of solids, pesticides tend to move in runoff by association with (adsorbed to) suspended solids in the runoff. Therefore, management practices that cause separation of solids from the runoff flow should also decrease the pesticide load in the runoff.

On the other hand, it is important to realize that pesticide load in runoff is the product of runoff volume and pesticide concentration, and an essential step in mitigating pesticide

*Please see **BMPs**, page 6*

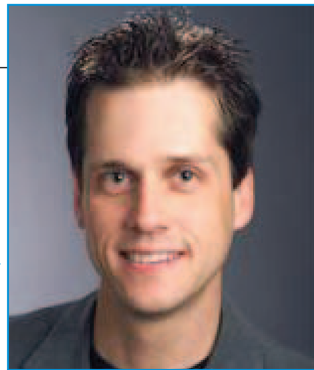
Table 1. Reductions in Bifenthrin Concentration in Nursery Runoff by BMPs

Position in Runoff Path	May 2002		June 2002	
	Concentration (ppb)	Removal (%)	Concentration (ppb)	Removal (%)
Before PAM	10.56	-	3.18	-
Sediment Pond	1.41	-86.7	0.93	-70.7
104 m (vegetative strip begins)	9.27	-12.2	1.11	-65.0
166 m	4.26	-59.6	0.55	-82.8
187 m	2.83	-73.2	0.43	-86.6
210 m	1.68	-84.1	0.95	-70.2
240 m (vegetative strip ends)	0.87	-91.8	0.28	-91.3
340 m	0.96	-90.9	0.30	-90.7

Nitrogen Mineralization:

UC Workgroup Develops Factors To Reduce Pollutant Load and Correct for Temperature Effects

David M. Crohn, Biosystems Engineering Specialist and Chair, Waste Management Workgroup



David M. Crohn

The UC Cooperative Extension Waste Management Workgroup is developing a technique that adjusts mineralization rates to reflect local temperature conditions throughout California, which will reduce the risk of over-application of organic fertilizers and amendments, resulting in greater source control of both surface and ground water pollutants.

The conversion of unavailable organic nitrogen to plant-available ammonium nitrogen (NH_4^+), known as ***mineralization,*** occurs when bacteria and fungi living in the soil decompose soil organic matter. To plan efficacious land application rates of fertilizers and amendments, growers must estimate the rate at which the mineralization process occurs.

Laboratory and field experiments can be used to determine mineralization rates for different materials in a *particular* location, but such experiments are time-intensive and costly. Furthermore, the response of decomposer microbes to climate makes generalization of results from such studies inappropriate, without correction for the effects of temperature, which the Waste Management Workgroup has undertaken.

Mineralization rates depend on a number of factors, but the most important are:

- Soil temperature
- Soil moisture conditions
- Chemical structure of the applied organic amendment

Soil Temperature

Temperatures affect decomposition rates dramatically. A rule-of-thumb is that decay rates roughly double for every 18°F (10°C) change in temperature. This means that mineralization rates determined experimentally for one location should not be used in another location without correcting for temperature. Consider, for example, a laboratory experiment conducted at a constant 68°F. Figure 1 shows correction factors needed to convert laboratory results to values appropriate for soil temperatures in four California locations, spanning different temperature regimes during the growing seasons in northern, central and southern regions throughout the state. The correction factors vary seasonally, which is an important consideration when several crops are grown annually. For example, in Imperial County, summer applications would release far more nutrients than

Please see ***Mineralization****, page 5*

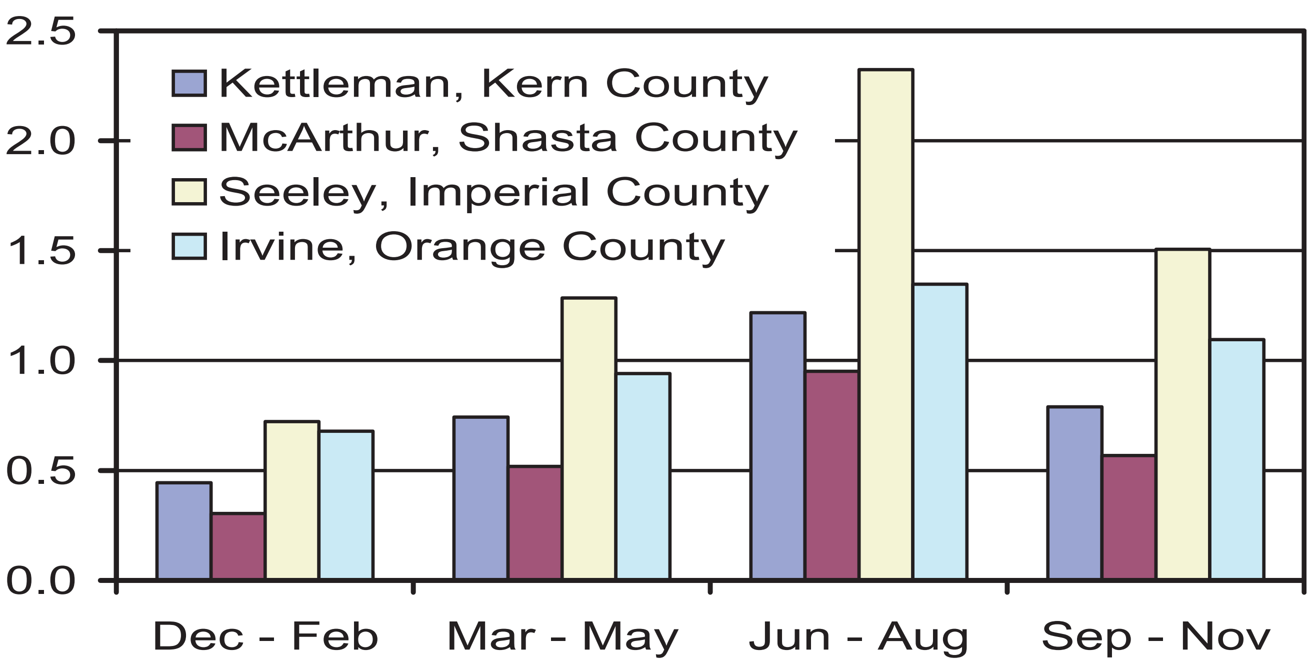


Fig. 1. Factors for correcting laboratory (68°F) mineralization rates for four California locations. **(Source: UC Cooperative Extension Waste Management Workgroup)**

Risks of Over-Application

Whether farmers and landscapers choose to apply nitrogen fertilizers in organic or inorganic form will determine their need to focus on mineralization rates. Inorganic fertilizers, such as ammonium nitrate, can be immediately taken up and metabolized by plants, so knowing the plant-available amount in comparison to the applied amount poses little problem for growers. However, before the nitrogen in organic fertilizers and amendments can be used, it must be converted first to inorganic forms (mineralized).

Organic fertilizers and amendments are commonly produced from manures, municipal biosolids, composts, green wastes, and food processing residuals. When they are applied as fertilizers, the materials must supply enough nutrients to assure plant growth, but over-application can pollute both surface and ground waters with excess nutrients. Over-application also introduces unnecessary contaminants, such as heavy metals, pathogens, weed seeds, or pesticides, if they are present. Best management practices supply nutrients from organic fertilizers at rates just sufficient to meet plant demands. When organic amendments such as composts are used, their nutrient contribution potential should be used to adjust overall fertilization schedules, which often also include inorganic fertilizers.

WASTE MANAGEMENT WORKGROUP

Cooperative Extension's (CE)Waste Managment Workgroup is one of more than 90 workgroups within the UC's Division of Agriculture and Natural Resources (ANR), which collaboratively plan and coordinate research and extension activities throughout California. The 90-plus workgroups are organized into four umbrella program areas: natural resources, agricultural productivity, agricultural policy and pest management, and human resources.

The workgroups are a primary mechanism for accomplishing ANR's high priority research and extension goals through grassroots leadership. Workgroups bring together CE and Agricultural Experiment Station personnel along with non-ANR partners to work on emerging and continuing priority issues.

The Waste Management Workgroup is one of 15 statewide that focus on natural resources issues. Among the high priority issues addressed by the Waste Management Workgroup are measuring nitrogen mineralization rates statewide, educating the public about compost use, and conducting research into the use of composts in arid-zone agriculture.

Mineralization,
continued from page 4

plants could assimilate while winter crops would not receive enough nutrients to meet their needs.

Soil Moisture Conditions

Moisture is important because microbes live in the thin water layers surrounding soil particles. If there is too little water in the soil, the microbes have nowhere to grow and if there is too much water, as occurs in a saturated soil, microbes have difficulty getting the oxygen they need to digest organic matter efficiently. Fortunately, irrigated soil moisture conditions used to support plants are also ideal for soil microbial development.

Chemical Structure

Different amendment types break down at different rates. Manures and biosolids decompose readily. Because composts are pre-stabilized, they release nutrients much more slowly and are not normally used as fertilizers, unless they are fortified in some way. Mulches are selected for resistance to decay and may even tie up nitrogen temporarily as they break down.

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BMPs, *continued from page 3*

runoff is to reduce runoff volume. Reduction of runoff volume may be achieved by adopting sensor-based irrigation systems, by properly grouping crops with similar water needs, and by using porous surfaces, among other practices.

Three Successful BMPs

The BMPs installed by UC Cooperative Extension in collaboration with a nursery grower in Orange County are based on the principle of separating solids from runoff water. All of these BMPs worked in concert to cause maximal removal of suspended solids from the runoff flow. The BMPs included the following:

- **PAM delivery into the runoff stream**. Polyacrylamide (PAM) is a powerful flocculent. Addition of PAM into the runoff effluent caused aggregation of fine suspended solids, which dropped out under gravity.

- **In-line sediment trap and pond.** Installation of a sediment trap and settling pond slowed down the runoff flow, allowing a large fraction of the suspended solids to settle out. The sides of the sediment trap and pond may also act as physical barriers to stop and trap suspended solids.

- **Vegetative strip in the discharge channel**. The vegetative strip was first developed in 2000 and contained canna lilies grown in plastic mesh baskets or crates submerged in water. The variety of canna lily ('Tropicanna') develops a large root system, which helps to further slow down the flow to cause settling and physical trapping of suspended solids.

To evaluate the effective-ness of these BMPs, runoff samples were collected on a monthly basis at different locations along the runoff path. These samples were analyzed for their content of suspended solids as well as pesticide concentrations. It was observed that the upstream runoff at the nursery site contained extremely high levels of solids.

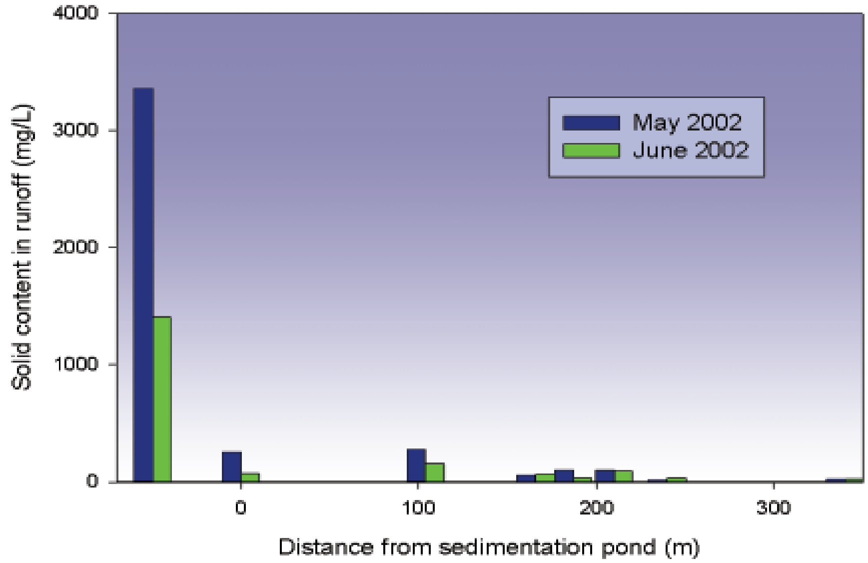

Fig. 1. Decreases in suspended solid concentration in runoff flow

Figure 1 shows decreases of suspended solid content in runoff along the runoff path for 05/16/2002 and 06/16/2002. It is clear that the suspended solid content rapidly decreased when the runoff traveled downstream through the sediment trap (-40 m), sediment pond (0 m), and finally the vegetated channel (104-240 m). On both sampling dates, the greatest decrease in suspended solid content occurred between the PAM delivery point (-50 m) and the pond, or after the sediment trap.

When the PAM delivery point was used as the reference point, the suspended solid removal after the sediment trap was >90% for both sampling dates. When the runoff reached the end of the vegetative strip (240 m), the overall suspended solid removal was >97%.

The pesticide concentrations in the runoff generally decreased as the runoff moved through the sediment trap, pond, and the vegetated channel. For instance, on 05/16/2002, the initial bifenthrin level in runoff before the PAM release point was 10.56 ppb, which decreased to 0.87 ppb at the end of the vegetative strip. On 06/16/2002, the initial bifenthrin level was 3.18 ppb, which decreased to 0.28 ppb after the vegetative strip. Using the concentration before the PAM release point as the reference point, the reduction in bifenthrin concentration in the runoff was 91.8% on 05/16/2002, and 91.3% on 06/16/2002 (Table 1, page 3).

The greatest decrease for bifenthrin occurred after the sediment trap, but further decreases occurred through the vegetated channel. The pesticide removal was apparently correlated with the removal of suspended solids caused by the various BMPs along the runoff path. Very similar patterns were also observed for another synthetic pyrethroid insecticide (permethrin, data not shown).

Overall, removal of suspended solids by these BMPs approached 97-99%, and the reductions of bifenthrin and permethrin were consistently >90%. Again, the main reason that these BMPs are effective in mitigating the runoff of these pesticides is that they "knock out" suspended solids from the runoff water. These BMPs are of low cost and low maintenance and may be easily adopted by other nursery growers or other end users.

TMDLs, *continued from page 2*

Individual pollutant monitoring of all potentially significant dischargers, or the equivalent, would be necessary to enforce permits or charge the tax. For sediment, it would probably be enormously expensive to monitor all the many construction sites, agricultural parcels, or urban areas that might be significant sediment sources. One possible alternative would be to use a model-based estimation procedure. A model would estimate the sediment load from, for example, a construction site, and determine the tax due or permits needed.

Fee and Credit Systems. A fee and credit system may achieve most of the cost-reduction benefits of a cap and trade system or pollution taxes without the monitoring difficulties. Sediment-dischargers would be offered the alternative of paying a fee, again based on estimated sediment discharges, or installing BMPs to decrease sediment. Instead of individual monitoring, BMPs would earn a standard percentage credit against the sediment fee. A variant of this system has been used in city stormwater utilities in which property owners pay a fee based on estimated stormwater runoff and may earn credits against the fee for installing stormwater-retention ponds and other BMPs.

The advantage of a fee and credit system relative to a permit/tax system is lower monitoring costs. The disadvantage is that the incentives for pollution reduction are not as individually-tailored in the fee and credit system as in a permit/tax system. This means that the fee and credit system probably will not be as efficient at finding low-cost pollution reduction as a cap-and-trade or pollution tax approach.

WaterWise is published quarterly by Dr. W. Bowman Cutter, University of California Cooperative Extension (UCCE) Water Resource Management Specialist and Editor; Dr. David M. Crohn, UCCE Biosystems Engineering Specialist and Chair, Waste Management Workgroup; Dr. Jay Gan, UCCE Water Quality Specialist; Dr. Laosheng Wu, UCCE Water Management Specialist; and Dr. Marylynn V. Yates, UCCE Groundwater Quality Specialist and Associate Executive Vice Chancellor, University of California, Riverside. The newsletter is edited by Dr. Bo Cutter and Deborah Silva and designed by Jack Van Hise, graphic artist, UCR Printing and Reprographics. The intent of the publication is to disseminate summaries of research results and topics of interest in water management and environmental sciences to UCCE Farm Advisors and Specialists, UC faculty, personnel in government agencies, and industry clientele. Additional copies are available upon request. Please address comments and correspondence to Dr. Bo Cutter, **WaterWise** Editor, via e-mail (*bowmanc@citrus.ucr.edu*), by telephone (909-787-2088), by fax (909-787-3993), or by mail addressed to him in the Department of Environmental Sciences, University of California, Riverside, CA 92521. **WaterWise** is issued in furtherance of Cooperative Extension work, Acts of May 8, 1914 and June 30, 1914, in cooperation with the United States Department of Agriculture, W. R. Gomes, Director, UCCE. The University of California prohibits discrimination against or harassment of any person on the basis of race, color, national origin, religion, sex, physical or mental disability, medical condition (cancer-related or genetic characteristics), ancestry, marital status, age, sexual orientation, citizenship, or status as a covered veteran (covered veterans are special disabled veterans, recently separated veterans, Vietnam-era veterans or any other veterans who served on active duty during a war or in a campaign or expedition for which a campaign badge has been authorized) in any of its programs or activities or with respect to any of its employment policies, practices, or procedures. University policy is intended to be consistent with the provisions of applicable State and Federal laws. Inquiries regarding the University's nondiscrimination policies may be directed to the Affirmative Action/Staff Personnel Services Director, University of California, Agriculture and Natural Resources, 300 Lakeside Drive, 6th Floor, Oakland, CA 94612-3550, (510) 987-0096.

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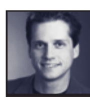

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Dr. Laosheng Wu is a Cooperative Extension Water Management Specialist in the UCR Department of Environmental Sciences whose current research focuses on irrigation, water, and salinity management, water quality issues, and interaction of soil physical and chemical properties. He also serves as the Associate Director of the UC Center for Water Resources, a systemwide center based in Riverside.

Dr. Marylynn V. Yates is a Cooperative Extension Groundwater Quality Specialist in the UCR Department of Environmental Sciences. Her research area involves studying the transmission of disease through water. Activities that involve the disposal or reuse of reclaimed water or biosolids have the potential to contaminate the environment with disease-causing microorganisms. Her work involves examining ways to minimize the potential for microorganisms to contaminate potable water supplies. She also serves as UCR's Associate Executive Vice Chancellor.