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Economic Incentives and Nonpoint Source Pollution
A Case Study of California's Grasslands Region

by Chelsea H. Congdon, Terry F Young, and Brian E. Gray

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A much more detailed and technical version of this Article was published by the Environmental Defense Fund under the title, "PLa-M: Mnc, Gu.,;o EIE;e: TES TO CO:.t.OL WATE PcuOmOu RO'.AZr uLTuz Cop:es of this technical report are available for $20 postpaid from:

Nonpoint Source Pollution Report—1994
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We dedicate this Article to the memory of John Krautkraemer. John was a gifted lawyer, a devoted colleague, and a good friend. We miss him.


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I. INTRODUCTION

For over a decade, the problem of effectively controlling water pollution from agricultural drainage on the west side of California’s San Joaquin Valley has challenged and frustrated regulators, farmers, and environmentalists alike. Drainage discharges have caused, and continue to cause, significant environmental damage to one of California’s major river systems, as well as to extensive portions of the Central Valley wetlands that are the backbone of the Pacific Flyway. Although there exists a broad consensus that the solution to this problem lies in improved irrigation efficiency at the individual farm level, an effective method to accomplish this goal has not been identified.

In several important respects, problems associated with agricultural pollution in the San Joaquin Valley are representative of a nationwide challenge. Agricultural drainage is, in regulatory language, a “nonpoint source” of water pollution. In contrast to “point source” pollution—the readily identified and monitored discharges from individual factories and water treatment plants—“nonpoint source” pollution includes runoff from agriculture, logging, construction, urban development, and mining. Even though pollution from these sources—particularly agricultural pollution—is now known to be the principal cause of contamination in lakes, rivers, and streams nationwide, little progress has been made in creating effective programs to control it. This is due in large part to the perceived enormity and inefficiency of the regulatory task. Characteristic of many nonpoint source pollution problems, agricultural runoff is comprised of countless independent sources, each of which must be addressed if an overall program of pollution control is to be successful.

Indeed, traditional methods of regulation have seemed inappropriate to industries such as agriculture because of the sheer number and diversity of sources. Issuance of individual permits that limit the amount of pollutants that each farm may discharge has been considered too cumbersome a program to administer, and this approach thus far has been rejected by federal, state, and local legislatures and regulatory agencies. On the other hand, requiring farmers to adopt “Best Management Practices,” a regulatory approach that avoids the need for individual permits by requiring all sources to use a specified pollution-control technology, would present its own set of shortcomings when applied to a highly diverse group of individual farms. This combination of factors—a significant, uncontrolled source of environmental pollution and...
imperfect tools for regulating it—has led policymakers to seek to identify new, more workable strategies to control agricultural pollution.

At the same time, private sector concerns over regulatory costs and intervention in business decisions have generated a growing interest in incentive-based pollution control programs. The theoretical advantages of these programs—cost-effective pollution control, maximum flexibility to the regulated community, and reduced informational and bureaucratic requirements for regulators—have been widely discussed in the policy literature. Yet incentives have rarely, if ever, been given more than cursory consideration as the primary means of pollution control where pollution problems are attributable solely to nonpoint sources.

The agricultural drainage crisis in the Grasslands region of California’s Central Valley provides an excellent case study for testing the advantages and disadvantages of both incentive-based programs and traditional regulatory programs. The crux of the problem in the Grasslands is representative of agricultural pollution problems generally. Hundreds, perhaps thousands, of sources must be made accountable for the pollution they generate. Yet, these sources traditionally have resisted regulation out of concern that they will lose control of their farming operations to state or federal regulators and that mandates to reduce drainage would be unduly expensive. Thus, decentralized decision-making and cost-effectiveness are key elements to any reform effort. Indeed, cost is particularly important in the Grasslands region, where over 50 percent of employment in the affected counties is farm-related.

The Grasslands region is particularly suited to this type of approach to pollution control because the foundation for analysis has already been laid. The nature of the pollution problem is understood; the pollution sources, while numerous, have been identified; and options for controlling drainage discharges at the farm level are available and generally affordable. In addition, many of the legal and institutional mechanisms necessary for implementing a regulatory solution already exist.

Above all, the crisis in the Grasslands demands attention. Agricultural pollution in the Grasslands region has continued unabated for years, threatening ecosystems that provide critical remnant habitats for the many fish and wildlife species in the region.

This study examines the feasibility of using economic incentives to control pollution from irrigated agriculture in the Grasslands. In the process, it presents a model for moving from theoretical discussion of new regulatory strategies to practical applications. While the primary result of the study is a specific proposal for a regulatory system in the Grasslands, the analytic model itself is just as important. Parts or all of it may be useful in any region where agricultural or other nonpoint source pollution problems persist.

II. AN OVERVIEW OF THE PROBLEM OF NON-POINT SOURCE POLLUTION

A. Nonpoint Source Pollution: The National Context

Two decades ago, the nation embarked on an ambitious agenda to restore the quality of water in our rivers, lakes, and estuaries. The primary objective of the Federal Water Pollution Control Act Amendments of 1972—which form the basis of the modern CWA—was "to restore and maintain the chemical, physical, and biological integrity of the Nation’s waters." Although considerable improvements in water quality have been achieved to date, many surface waters in the United States still do not support designated uses. The primary cause of these continuing water quality problems is pollution from nonpoint sources.

Agricultural runoff is the single largest contributor to nonpoint source pollution and is the primary source of all water pollution in quality-impaired rivers, lakes, and streams. In the West, where...
approximately 50 million acres of land are devoted to irrigated agriculture. Low river flows can exacerbate the problem. In these relatively arid environments, agricultural runoff and drainage often provide a significant proportion of river flows and may dominate flows during periods of drought and seasonal low flows.

Agricultural drainage poses a direct threat to fish and wildlife habitats and the species that depend on them. In a recent study, the United States Fish and Wildlife Service (hereinafter "FWS") documented extensive damage to aquatic habitats due to toxic concentrations of pollutants in surface and subsurface drainage discharges from irrigated lands. Significantly, agricultural return flows are the most common source of pollution of national wildlife refuges. Many refuges depend on agricultural drainage flows for some portion of their water supplies, and many areas that receive contaminated drainage water serve as habitat to one or more federally listed endangered or threatened species. Adverse effects on waterfowl populations include reduced reproductive success and survival of young birds. While less information is available about the effects of agricultural drainage on species other than waterfowl, a National Fishery Survey conducted by the United States Environmental Protection Agency (hereinafter "EPA") and FWS found that agricultural runoff adversely affected fish populations in 29 percent of the waters studied.

One reason that nonpoint sources, including irrigated agriculture, are such a prominent cause of continuing pollution is that the Clean Water Act has focused regulatory efforts and expenditures almost exclusively on municipal and industrial point sources. Until the Act was amended in 1987, the primary program for addressing nonpoint source pollution was the requirement in section 208 that the states develop comprehensive water quality management plans. The "208 Plans" were largely ineffective, however, because federal law does not require that they be implemented.

Another, less obvious reason that nonpoint sources have been overlooked is the regulatory bias embodied in the CWA. Since 1972, technology-driven effluent standards have been the principal tool for controlling pollution. In 1987, Congress amended the Act to emphasize pollution control requirements based on water quality, thereby increasing the pressure on states and localities to regulate the dischargers responsible for most of the pollution—including nonpoint sources.

The CWA now requires states to identify waters that, "without additional action to control nonpoint sources of pollution, cannot reasonably be expected to attain or maintain applicable water quality standards or the goals and requirements of this Act." It also directs each State to identify specific categories and subcategories of nonpoint sources as part of this process and, for each such source, to develop a detailed management plan to address the pollution problem, including both regulatory and non-regulatory programs. In addition, nonpoint sources must be factored into the calculations that allocate pollution reduction responsibilities among dischargers for each water body that does not meet water quality standards.

Although this emphasis on water quality-based regulation has turned the spotlight on nonpoint source pollution, the CWA still does not require states to implement nonpoint source regulatory programs. Nor does it authorize the EPA to promulgate a federal program in the absence of an adequate state program. In sum, while Congress has
expressed the clear intent to address nonpoint source pollution,17 the language of the CWA fails to ensure effective nonpoint source pollution control.18

The need to improve the federal legal and policy structure for controlling nonpoint source pollution, particularly agricultural pollution, is now widely recognized. In some watersheds, nonpoint source dischargers produce most of the pollution. Yet, these sources have not invested in pollution control and are not required to take even the most affordable steps to decrease discharges. At the same time, point source dischargers in the same watershed generate significantly less pollution, have substantially reduced their discharges and are now being required to invest in pollution control measures with relatively high marginal costs. Because of this imbalance, point source dischargers are seeking relief from these requirements and are urging the states and the federal government to begin to regulate nonpoint sources.

Environmental interests, as well as state and local agencies responsible for water pollution control, also recognize the importance of controlling nonpoint sources of pollution, agricultural sources.19

The 103rd Congress debated significant amendments to the nonpoint source provisions of the CWA.20 Recent changes in other federal laws also demonstrate the growing interest in nonpoint source regulation. For example, the Coastal Zone Management Act was amended in 1990 to require certain states to develop a Coastal Nonpoint Pollution Control Program.21 The Central Valley Project Improvement Act, enacted in 1992, contains a number of significant reform measures for federal water management in California. These include requirements that water districts and individuals who use federally supplied water assume responsibility for control and management of drainage discharges generated within their respective boundaries in order to comply with all state and federal water quality standards.22

B. The Grasslands: A Test Case For Nonpoint Source Pollution Control

On the west side of the San Joaquin Valley, in a 93,000-acre region known as the Grasslands region (Figure 1), subsurface drainage from irrigated agriculture contains high concentrations of trace elements and salts.23 These elements occur naturally in the area's soils but pose problems when they are mobilized and transported by irrigation water. Several contaminants (notably selenium, boron, arsenic, and molybdenum) are of particular concern because of their potential harm to fish and wildlife, or because of their adverse effects on agricultural productivity in areas downstream. Toxic concentrations of trace elements in drainage discharges also pose a threat to public health by contaminating game species.

Widespread irrigation of the west side San Joaquin Valley's saline soils requires importation of water into the region on a large scale and a program to "leach" the salts out of the soils and to drain the lands of excess water following the irrigation of...
Figure 1.
Water, Irrigation, and Drainage Districts in the Grasslands Region
crops. Without drainage facilities to carry away excess water and salt, irrigation would lead to widespread "waterlogging" of clay soils, trapping dissolved salts and trace elements within the root zone.

In the 1960s, farmers on the west side of the San Joaquin Valley began to install subsurface drains and drainage canals to collect, transport, and dispose of saline drainage water. The long-term plan, conceived as a partnership among state, federal, and farming interests, was to construct a 188-mile concrete drain in the trough of the San Joaquin Valley to carry drainage water to the Sacramento-San Joaquin River Delta. Construction of a segment of this San Luis Drain began in 1968 and included a regulating reservoir in the Kesterson National Wildlife Refuge. When construction of the San Luis Drain was halted in the mid-1970s because of financial and political problems, Kesterson Reservoir became its terminus.

By 1983, approximately 7,000 acre-feet of drainage, primarily from subsurface drains in the Westlands Water District, was being delivered to Kesterson each year. Shortly thereafter, biologists from the FWS discovered unusually high rates of embryonic deaths and deformities among birds in the area. Of the nests under study at Kesterson, almost 20 percent contained deformed birds, and over 40 percent contained at least one dead embryo. Only one species of fish, the hardy gambusia (mosquito fish), could be found. The biologists attributed these shocking findings to elevated concentrations of selenium present in subsurface agricultural drainage water in the San Luis Drain. Selenium had accumulated in invertebrates and plants in the food chain, leading to severe effects on the birds that fed on them.

The discovery of the effects of selenium in agricultural drainage was unanticipated in this irrigation and reclamation plan for the region would be contingent upon the installation of drainage facilities. The San Luis Unit of the Central Valley Project began to bring water to the region from the San Francisco Bay-Delta in a large aqueduct.

One significant natural limitation to widespread agricultural production remained, however. Much of the west side contained clayey soils which make percolation of irrigation water very slow. Once in the shallow groundwater, downward percolation is further limited by the Corcoran Clay Member of the Tulare Formation, which divides the upper, semi-confined aquifer from the confined aquifer beneath it. As a result of these restrictions to downward percolation, the semi-confined aquifer operates much like a bathtub. If water flows in faster than it drains out the bottom—an average of about 0.3 acre-feet/acre per year through the Corcoran Clay—then the water level rises. In this respect, farming on the saline soils on the west side is restricted in much the same way as in other western regions which do not have a convenient outlet to the sea, such as Stillwater, Nevada and the Salton Sea region of California. While the details of these geological limitations were not fully understood at the time, the drainage problem was widely recognized by the 1960s. The irrigation water from the aqueduct (particularly when used in abundance to leach excess salts) was expected to build up in the shallow groundwater table, encroach on the root zone of the crops, and decrease yields.

In anticipation of this problem, the San Luis Unit authorization included plans for a drainage system to remove the excess subsurface water from nearly 300,000 irrigated acres. The plan envisioned a system of subsurface drains in the affected farmlands, which would collect the contaminated drainage water and eventually convey it to a natural watercourse flowing to the ocean.

Unanticipated in this irrigation and reclamation plan was the environmental damage that would result from disposal of drainage in the wetlands, the river, and the estuary due to selenium and other trace elements. The discovery of deformed birds at Kesterson Reservoir in 1983 inaugurated the search for environmentally acceptable irrigation and drainage disposal practices.

24 Congress decided that the federal irrigation project planned for the region would be contingent upon the installation of drainage facilities. The San Luis Unit of the Central Valley Project (hereinafter "CVP"), which serves the Grasslands, was authorized in 1959. San Luis Act of 1959, Pub L No 92-453, 74 Stat 193 (1960).

25 An acre-foot of water, approximately 326,000 gallons, is enough water to cover one acre of land one foot deep and to meet the average annual (domestic) water needs of a family of five.


27 Selenium is essential to human and animal health in small quantities, but it can be toxic when it is ingested in large quantities, leading to reduced reproduction, reduced survival, reduced growth and deformities in fish and wildlife species.
cultural drainage at Kesterson was serendipitous. Several factors converged to allow researchers to detect its adverse effects. Kesterson was a federally protected national wildlife refuge, and biologists were frequently working in the field. Documentation of actual deaths and deformities might not have occurred in an unprotected area. Moreover, the effects of selenium toxicity were clearly observable in young birds, while sublethal effects in adult birds would have been more difficult to identify. In addition, Kesterson was located in a closed basin with no other water source, which accelerated the rate of accumulation of selenium and other elements to harmful levels. Where drainage is disposed of in open, flowing water bodies, the effects of selenium are far more difficult to detect.

In 1986, the California State Water Resources Control Board ordered the United States to close the San Luis Drain and Kesterson Reservoir. Closure of these facilities did not resolve the problem of managing and disposing of contaminated agricultural drainage, however, and selenium in drainage water continues to threaten biological resources in the San Joaquin Valley. Much of the agricultural drainage in the region now flows directly into the San Joaquin River. Elsewhere in the San Joaquin Valley, evaporation ponds are still widely used for drainage disposal. The ponds are known to attract migratory waterfowl and other aquatic birds, posing a significant risk to these populations. Currently, there are approximately 7,000 acres of evaporation ponds in the San Joaquin Valley; plans have been made to build between 10,000 and 20,000 additional acres of ponds.

Before the closure of Kesterson, private wetlands in the Grassland Water District had been receiving as much as 29,000 acre-feet of similarly contaminated drainage as a water supply for duck habitat. Because the drainage water was mixed with relatively clean water in the Grasslands wetlands, contamination was not as severe as at Kesterson. In 1985, following the discoveries at Kesterson, the Grasslands Water District stopped using the drainage water and, through a series of temporary conveyances, it was routed to the San Joaquin River. Since that time, the river consistently has exceeded selenium standards. Resulting damage to fish populations has been difficult to detect, however, due to a lack of baseline information.

In response to the sudden degradation of the San Joaquin River and the continuing risk to the wetlands, the California State Water Resources Control Board sponsored a two-year study of the agricultural drainage problem in the Grasslands region. Searching for practical solutions, state and regional officials found that most of the drainage problem could be solved affordably by using readily available, more efficient irrigation methods to reduce the amount of drainage produced.

The findings of the state report were confirmed and supplemented in 1990 by the conclusions of a $20 million study undertaken by the joint federal-state San Joaquin Valley Drainage Program (hereinafter “SJVPD”). The SJVPD also produced a detailed management plan based on the same fundamental recommendations put forward by the state study: First, to decrease the amount of drainage generated, growers in the region must improve irrigation efficiency and selectively retire land (i.e., permanently fallow) highly contaminated farmland. Second, they must recycle and dispose of strictly limited quantities of drainage. Third, farmers must employ technological “fixes,” as necessary, to ameliorate the remaining problem.

While the SJVPD’s management plan was widely accepted by government agencies, the agricultural community, and the public, its recommendations have not yet been implemented. For example, the RWOCB neither has set specific limits on drainage discharges to the San Joaquin River nor has enforced any other requirements for drainage reduction or land retirement. Instead, it has relied


29. During the 1970s and 1980s until the disaster at Kesterson Reservoir, up to 50% of the water used in wildlife areas in the Grasslands region consisted of agricultural drainage and other “surplus” waters. Id.


In December of 1994, Judge Oliver W. Wangler of the United States District Court for the Eastern District of California ruled that the Bureau of Reclamation is required by the San Luis Act to complete the San Luis Drain. Judge Wangler issued a permanent injunction that compels the United States to “take all reasonable and necessary actions to apply for a discharge permit for the drain” Summer Peck Ranch, Inc. v. Bureau of Reclamation, Nos. CV-F-91-048 OW & CV-F-91-634 OW, slip op. at 47 (E.D. Cal. 1994).


32. SAN JOAQUIN VALLEY DRAINAGE PROGRAM, A MANAGEMENT PLAN FOR AGRICULTURAL SUBSURFACE DRAINAGE AND RELATED PROBLEMS ON THE WESTSIDE, SAN JOAQUIN VALLEY. FINAL REPORT (1990) (hereinafter “DRAINAGE PROGRAM FINAL REPORT”).
AGRICULTURAL PROFILE OF THE GRASSLANDS REGION

Agriculture is the principal economic activity in the Grasslands region and accounts for over 50 percent of the employment in the three counties that encompass the Grasslands region (Fresno, Madera, and Merced). Other land uses in the area include private, state, and federal wildlife areas, and municipal and industrial uses associated with the towns of Los Banos, Gustine, and Firebaugh. The majority of the irrigated agricultural lands in the region is divided among 20 irrigation, water, and drainage districts.

In the Grasslands, nearly 70 percent of the farms are owned by individuals and the average farm size is 400 acres. The land owners are not necessarily the farm "operators," however. Approximately 50 percent of the farms are operated by full owners, with part owners accounting for about 30 percent of the farms, and tenant operators accounting for the remainder. Nor are the boundaries of the farms and the farm operations necessarily the same. For example, farm operators may lease land on more than one farm. The mix of owners and operators, combined with the fact that farm operation boundaries may change from year-to-year as a result of changes in leasing arrangements, underscores the importance of piggybacking the reporting system for a pollution control program onto existing district recordkeeping activities.

The principal crops grown in the region are cotton, field crops (e.g., feed grains, hay, wheat, sugar beets, dry beans, oilseeds), and tomatoes. Cotton accounts for approximately 40 percent of the acreage in the region. Cotton and grains (which are grown in rotation with cotton) together account for approximately 60 percent of the total farmed acreage. Other crops include cantaloupes, dry onions, lettuce, carrots, and garlic. Fruit and nut trees are grown in those portions of the region where salinity is not limiting.

Neither this mix of crops nor the scale of farming in the region would be possible without a reliable supply of irrigation water, because rainfall is insufficient to meet crop water requirements, even during wet years. Irrigation water sources include surface water deliveries from the Central Valley Project, groundwater, and recycled tailwater. Although the proportion of total irrigation water supplied by each of these sources varies among water districts (because of water contract provisions) and varies from year-to-year (due to hydrologic conditions), by far the largest share is supplied by the federal aqueduct. Overall, more than 80 percent of the irrigated acreage in the region is supplied by these surface water deliveries. Surface water is delivered to districts under "take-or-pay" contracts (i.e., districts must pay for the full amount of water covered by the contract whether or not it is delivered to the district). Districts in turn sell water to individual farmers. A single farm or farm operation may be located in more than one district. In addition, farmers may obtain surface water from other districts.

The average water allotment from surface water supplies is 2.68 acre-feet. This allotment is sufficient to supply the amount of water required by a cotton crop (approximately 2.25 acre-feet) and about 1.5 times the amount of water actually consumed by a tomato crop in this region. The average price paid by farmers in the Grasslands region for delivered surface water in 1990 was $13.25 to $14.25 per acre-foot. The range of prices for surface water is far greater ($5.00/af to $90.00/af), depending on district pricing policies and surcharges. The average cost of water also varies for individual farmers based on the degree of reliance on groundwater, which may cost $60.00/af or more to pump. Retail water prices for surface water have increased since 1990 as a result of water shortages caused by drought and other supply reductions.

Water prices and availability influence farm-level decisions regarding the type of crop grown, area under cultivation, and the installation and management of irrigation systems. Indeed, water price and supply are likely the dominant factors influencing farm operations, and, by extension, the economic profile of the region.

soley upon voluntary cooperation by water districts and farmers to limit drainage discharges, even though California law provides ample authority to regulate agricultural pollution. To date, this voluntary approach has failed to ensure that water quality objectives are met in the river and appears unlikely to do so in the future.

C. A New Look At Agricultural Nonpoint Source Pollution Control

An important first step in controlling nonpoint sources is to dispel the misperception that nonpoint source pollution is necessarily diffuse and therefore difficult or impossible to manage or regulate. This perception is embodied in the language of the CWA and has resulted in an approach to nonpoint source control, both by EPA and the states, that is limited to planning and voluntary implementation of pollution abatement measures.

In fact, many categories of nonpoint source pollution are comprised of numerous individual sources that can be identified and monitored. This is particularly true in the case of irrigated agriculture where many engineered ditches, canals, and drains convey drainage waters to an ultimate point of discharge. These conveyances make the sources of pollution identifiable. Moreover, the quantity of drainage generated is a direct function of water application and water use efficiency, both of which can be measured and controlled.

The real challenge of controlling agricultural nonpoint source pollution is to design an approach that is sufficiently flexible to address myriad individual sources, yet still achieves the environmental goals. Flexibility is best achieved through a decentralized decision-making process so that farmers can adapt control technologies to site-specific conditions. In this way, farmers also will be able to minimize the costs of pollution control. The desire for flexibility, however, cannot override the need to ensure that the program achieves water quality goals. Accordingly, institutional mechanisms must be established to shift responsibility for pollution control to the farmers, just as point source dischargers are accountable for their discharges. Finding a method to provide this accountability in a practical way has been the missing link in nonpoint source pollution control.

33 See discussion infra Part V.
34 See Clean Water Act §§ 402(11) & 502(14) (categorical exemptions for discharges of irrigation return flow from the NPDES permit system and from the definition of point source, respectively).
1. Best Management Practices
To date, direct regulation of agricultural sources generally has been based on Best Management Practices (hereinafter “BMPs”).\(^\text{35}\) BMPs usually prescribe the use of specific technologies or management measures designed to decrease pollution from runoff. In irrigated agriculture, for example, BMPs may consist of particular irrigation technologies and land management practices, such as land leveling. In rarer cases, BMPs have specified the goal to be achieved—for example, reduced erosion—rather than the practices to be used. In these cases, BMPs have established general goals instead of quantitative effluent limits.\(^\text{36}\)

While BMPs are the customary tool, there are two reasons why establishment of BMPs is not necessarily the optimal method for controlling agricultural pollution. First, BMPs tend to be general. Therefore, while they may be relevant to a broad range of conditions, they do not impose sufficient accountability on the discharger. Moreover, the amount of pollution reduction that will be achieved is difficult to predict. This undermines the potential for effective and enforceable environmental improvements. Even in cases where relatively fine-tuned BMPs can be prescribed, variations in site-specific physical conditions (e.g., soil type, soil uniformity, depth to groundwater) will result in different levels of performance at different locations for a given BMP.

Second, BMPs do not account for differences in pollution-control costs among farms. Thus, while a given irrigation technology or management practice may be well-suited for one farm, it might not be the most cost-effective approach for another, with the result that total pollution-control costs for the regulated farm community are higher than necessary. As with the physical differences among farms, this economic heterogeneity makes the process of defining appropriate BMPs time-consuming and expensive.

2. Incentive-Based Programs
Awareness of the potential shortcomings of BMPs, coupled with growing concerns over the costs of environmental regulation, have fueled a strong interest in alternative approaches to pollution control such as economic incentives.\(^\text{37}\) The chief appeal of economic incentives over traditional regulatory approaches is the potential cost savings to the regulated agricultural community and to society as a whole.\(^\text{38}\) Economic incentives communicate a “price” of pollution, which reflects the cost of environmental damage (or, alternatively, the value of the environmental resources at risk). In this way, incentive programs shift the costs of polluting to the polluters. As a result, each farmer is encouraged to seek out technologies or practices to reduce pollution and thereby to minimize the costs of doing business.

Among economic incentives, market-based programs provide the greatest potential for cost savings, because they provide the greatest flexibility for farmers to take advantage of differences in pollution-control costs among different farming operations. As a result, the ultimate distribution of pollution-control activities within the industry as a whole is more cost-effective, because those who can least expensively reduce pollution assume more of the abatement responsibility, and those with higher costs assume less.

The burden on regulators to determine the available pollution-control technologies and associated costs also can be minimized under incentive-based programs. While some information is required to design the proper incentives, once the program is in place, the choice of control strategies rests with the farmers. Regulators are left with the

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35. This also is true for voluntary pollution control programs for agriculture. California’s Nonpoint Source Management Plan, for example, encourages the use of BMPs. State Water Resources Control Board (Division of Water Quality, Nonpoint Source Program), Nonpoint Source Management Plan (1988).

36. The EPA’s Guidance for Implementation of the Coastal Zone Act Reauthorization Amendments of 1990 distinguishes between “management measures,” which state a performance goal in non-quantitative terms, and “management practices,” which may be used to achieve these goals. The guidance does not preclude states from identifying alternative management measures, including market-based approaches such as trading of pollution credits. U.S. Environmental Protection Agency & U.S. Department of Commerce, Coastal Nonpoint Pollution Control Program—Program Development and Approval Guidance (1991).


more appropriate task of monitoring and enforcing compliance with the pollution limits.

At least two additional factors make incentive programs attractive. First, they encourage innovation by providing direct financial rewards for creating better and cheaper pollution control methods. Second, because incentive programs are based on decentralized decision making, they can conform to the characteristics of the farm industry and preserve the flexibility desired by farmers for responding to changes in economic, environmental, and technological conditions. Therefore, incentive-based approaches also increase the likelihood of compliance on the part of the regulated community.

While there is a substantial body of literature on incentive-based programs, including tradable discharge permits, opportunities for employing incentives have only just begun to be tapped. A prominent example is the Clean Air Act Amendments of 1990, which established an emissions trading program for stationary air pollution sources and encouraged states to adopt flexible, incentive-based options in other areas. In the area of water quality, incentive-based programs have primarily relied on water pricing strategies, the reduction of water subsidies, and the creation of water markets in several western states. In addition, pollution trading programs between regulated point sources and nonpoint sources that are subject to BMPs have been initiated at Dillon Reservoir, Cherry Creek Reservoir, Fox River Wisconsin, and the Tar-Pamlico River Basin. The potential for relying solely on economic incentives (in lieu of BMPs) to control agricultural pollution has received little attention, however.

D. Economic Incentives in the Grasslands

The Grasslands problem is well-suited to the use of economic incentives, because incentives offer a means for addressing economic differences among farmers and for providing flexibility for farm-level decision making to an industry that is traditionally independent-minded and diverse. Among incentive systems, a system of tradable discharge permits is particularly attractive because:

- The nature of the pollution problem requires a pollution cap or ceiling;
- The characteristics of the regulated community are conducive to a flexible system of cost-sharing; and
- Monitoring and enforcement of discharges are possible.

The principal obstacle to using tradable permits (or any other economic incentives) to regulate agricultural pollution seems to be based on the following assumptions:

- Farmers cannot be made individually accountable for pollution control because individual farms and drains are too numerous;
- Agricultural pollution cannot be controlled or monitored, which precludes the use of trades or fees;
- Incentives provide less environmental protection than BMPs;


41. See e.g., Reclamation Reform Act of 1932, 43 U.S.C. §§ 390a-22-1, CVP-A § 3404 (limitation on contracting and contract reform) & § 3405 (water transfers, improved water management, and conservation).


• Trading of toxic substances in river basins will cause pollutants to become concentrated in one location;

• Tradable permits will not be cost-effective when the marginal costs of pollution control do not differ dramatically among regulated sources; and

• The calculation of a pollution cap (a prerequisite for a trading program) is excessively complicated for rivers with highly variable flows.

Many of these assumptions do not pertain to the Grasslands region. Moreover, several of these beliefs must be addressed if any agricultural nonpoint source program is to be successful. A demonstration of how tradable discharge permits (and other economic incentives) can be used to address agricultural pollution problems in the Grasslands may provide a model for analyzing the usefulness of these tools in other regions where agricultural or other nonpoint source pollution problems persist.

III. ESTABLISHING POLLUTION REDUCTION GOALS

The first step in designing a water pollution control program is to identify specific environmental objectives and the reductions in pollution loads necessary to meet them. After these reductions are defined, the optimum program for achieving them can be determined.

Establishment of pollution reduction goals generally involves three tasks:

• defining “safe” levels of pollution in the water body;

• calculating the amounts of pollutants the region can discharge without exceeding these “safe” levels; and

• allocating the allowable pollution loads (or load reductions necessary to achieve them) among the region’s responsible parties.

A. Defining “Safe” Levels of Pollution

Agricultural drainage in the Grasslands region threatens the local wetlands, the San Joaquin River, and the river’s tributaries. Current drainage discharge practices have concentrated this threat on the river itself, however, and on two upstream tributaries—Salt Slough and Mud Slough. These tributaries flow through and provide water supplies (when uncontaminated) for state, federal, and private wildlife refuges. As a result, the primary pollution control efforts in the region are focused on these water bodies.

The California State Water Resources Control Board (hereinafter “SWRCB”), the Central Valley Regional Water Quality Control Board (hereinafter “RWQCB”), and the EPA have adopted numeric water quality standards that define “safe” concentrations of major agricultural pollutants in the river and the two tributaries. Of these pollutants, the RWQCB has identified selenium—the trace element responsible for the bird deformities which plagued Kesterson Reservoir—as the primary pollutant of concern. The RWQCB reached this conclusion because of the severe adverse effects of selenium on fish and wildlife and because the reductions in subsurface farm drainage necessary to meet the selenium standard also will reduce the loads of other high-priority pollutants. Currently applicable selenium standards are shown in Table 1. Concentrations of selenium often exceed applicable selenium standards for the San Joaquin River. In some tributaries—particularly Salt and Mud Sloughs—the standards are consistently exceeded during the pre-irrigation and irrigation seasons (Figure 2). Subsurface drainage discharges from irrigated agriculture in the Grasslands region account for over 80 percent of the selenium load in the San Joaquin River and sloughs.

The water quality monitoring and compliance points chosen by the RWQCB to represent San Joaquin River quality downstream of the agricultural drainage discharges is Crows Landing (Figure 3). The Crows Landing station is located 22 miles downstream from the area where drainage actually is discharged to the river, and is below the San Joaquin’s confluence with the Merced River, a source of substantial dilution flows. The specific


Table 1
Water Quality Standards for the Protection of Aquatic Life in the San Joaquin River and its Tributaries

<table>
<thead>
<tr>
<th>Location</th>
<th>Selenium (μg/l)</th>
</tr>
</thead>
<tbody>
<tr>
<td>San Joaquin River</td>
<td></td>
</tr>
<tr>
<td>From the mouth of the Merced River to Vernals</td>
<td>5c</td>
</tr>
<tr>
<td>San Joaquin River</td>
<td></td>
</tr>
<tr>
<td>From Sack Dam to the mouth of the Merced River</td>
<td>20c</td>
</tr>
<tr>
<td>Mud Slough; Salt Slough</td>
<td></td>
</tr>
<tr>
<td>Wildlife Refuge Supplies</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2e</td>
</tr>
</tbody>
</table>

a "Criterion continuous concentration" is the four day average concentration not to be exceeded more than once every three years on average, unless otherwise noted.
b "Criterion maximum concentration" is the one-hour average concentration not to be exceeded more than once every three years on average, unless otherwise noted.
c Promulgated by the U.S. Environmental Protection Agency 1992b.
d "Maximum" concentration adopted in the applicable Basin Plan (see State Water Resources Control Board 1990); this objective was not superseded by the Inland Water Plan (State Water Resources Control Board 1991a) or the federal rulemaking (U.S. EPA 1992b).
e Monthly mean concentration, applicable to water diverted from Mud Slough, Salt Slough, and smaller channels for use in the Grasslands Water District, San Luis Wildlife Refuge, and Los Banos State Wildlife Area (measured in any water used by subject area for waterfowl habitat); this objective was not superseded by the Inland Waters Plan (State Water Resources Control Board 1991a) or the federal rulemaking (U.S. Environmental Protection Agency 1992b).

Accordingly, this study assesses the pollution load limits necessary to achieve the established selenium standard: 5 micrograms per liter (μg/l) as a four-day average concentration, not to be exceeded more than once every three years in the San Joaquin River, measured at Crows Landing. Because drainage discharges convey significant loads of other high-priority pollutants (e.g., boron and salt), efforts to reduce selenium loading from this region also will help to achieve compliance with standards for these pollutants. The pollution loading requirements calculated in this study do not reflect the additional decreases that may be required to comply with antidegradation requirements.

B. Translating "Safe" Levels into Allowable Pollution Loads

The standard method for determining allowable pollution loads for water bodies that do not meet water quality standards is dictated by the CWA, which requires that water quality standards (expressed as the acceptable concentration of pollutants in a water body) be translated into "Total Maximum Daily Loads" (hereinafter "TMDLs"). The TMDL first establishes the allowable pollution load from all of the pollution sources in the region, based on the capacity of the "receiving water"—in this case, the San Joaquin River and its tributaries. This method is reinforced by section 303(d) of the 1937 Clean Water Act Amendments. California has adopted similar requirements.

Federal antidegradation policy (see 40 CFR 131.12 (1994)) was reinforced by section 303(d) of the 1937 Clean Water Act Amendments. California has adopted similar requirements.

46. The regional load allocation derived in this study is based on a direct conversion of a water concentration standard. In the future, load allowances (or mass emissions limits) may be derived independent of water concentration standards, based on the capacity of an ecosystem to safely absorb pollutants as measured in sediments or plant and animal tissues. If so, the methods for deriving the TMDL will be different, but the implementation issues will be much the same as discussed here.

47. Federal antidegradation policy (see 40 CFR 131.12 (1994))
Figure 2.
Figure 3.
Location of Water Quality Monitoring Points for the San Joaquin River and Tributaries.
this case the San Joaquin River—to dilute the pollution to a safe concentration. The TMDL procedure then allocates the total load among all of the relevant point sources, nonpoint sources, background loads, and a margin of safety (Figure 4). This allocation allows each category of discharger to be held accountable for its own contribution to excess pollution loads. California has identified the San Joaquin River as a quality-impaired water body for which a TMDL calculation is required.49

The first step in the Grasslands TMDL—which defines the pollution load that can be discharged into the river without violating the 5 µg/L water quality objective for selenium—is determined by the dilution capacity of the river, which in turn is a function of the flow regime in the river. In other words, the concentration-based standard is converted to an allowable load (measured in pounds) according to the standard formula:

\[
\text{Dilution Capacity (or TMDL) = Water Quality Standard x River Flow}
\]

Prediction of the flow regime is difficult for western rivers, such as the San Joaquin, because flows may vary by orders of magnitude across seasons and years. Also, flow data often are limited or are not representative of current conditions. To address this problem, a simple method was developed to account for the varying river flows that are typical in developed river basins in the irrigated West. This generic method was then used to derive a TMDL for selenium for the middle reach of the San Joaquin River.50 This screening-level TMDL51 was developed in conjunction with the RWQCB.52

The next step of the TMDL procedure allocates the allowable regional pollution load among responsible parties according to the standard formula:

\[
\text{TMDL = wasteload allocation + load allocation + margin of safety} \quad 53
\]

The resulting monthly load allocations for the agricultural community in the Grasslands region as a whole are shown in Tables 2a-c, column 12.54 Corresponding final daily load allocations are shown in column 13.

49. The 1991 Water Quality Assessment prepared by the RWQCB catalogs the quality of water bodies pursuant to section 304(f) of the CWA. Water bodies listed under this section, including a 130-mile stretch of the San Joaquin River, are those affected by both point and nonpoint pollution sources and which are not expected to meet water quality standards even with effective point source controls. CENTRAL VALLEY REGIONAL WATER QUALITY CONTROL BOARD, WATER QUALITY ASSESSMENT (1991).

50. TERRY F. YOUNG & CHELSEA H. CONGDON, FLOWING NEW GROUND (1994).

51. See U.S. ENVIRONMENTAL PROTECTION AGENCY, OFFICE OF WATER REGULATIONS AND STANDARDS, GUIDANCE FOR WATER QUALITY-BASED DECISIONS: THE TMDL PROCESS (1991). The EPA generally accepts a phased approach to TMDLs involving nonpoint sources and where there is considerable uncertainty about the characteristics of the pollutant (e.g., its persistence, pathways, interaction with other pollutants). A screening-level TMDL is the first step of a phased TMDL. A phased approach also includes a monitoring program and pre-determined schedule for reassessing the TMDL and allocation. This option allows a state to implement water quality-based control measures where beneficial uses are known to be impaired but the resource is not being regulated for lack of adequate data.

52. See Karkoski et al., Development of a Selenium TMDL for the San Joaquin River, IN MANAGEMENT OF IRRIGATION AND DRAINAGE SYSTEMS (1993). Substantial assistance was also provided by EPA Region IX and EPA Headquarters. See YOUNG & CONGDON, supra note 50, at Appendix B (detailing the calculations).

53. The wasteload allocation is the portion of the TMDL attributable to point sources, and the load allocation is the portion of the TMDL attributable to nonpoint sources and natural background sources. The margin of safety is provided to account for uncertainties in the data or analysis. U.S. ENVIRONMENTAL PROTECTION AGENCY, OFFICE OF WATER, TECHNICAL SUPPORT DOCUMENT FOR WATER QUALITY-BASED TOXICS CONTROL (1991) (hereinafter "TECHNICAL SUPPORT DOCUMENT"). In the case of the San Joaquin River, there are no contributions from point sources, so the wasteload allocation is zero. The load allocation is comprised of background loads (from the main stem of the San Joaquin River, the Merced River, and additional selenium loads from the managed wetlands in the region) and drainage discharges from agricultural operations in the Grasslands region. The margin of safety was allotted ten percent of the total load, which is considered minimal given the uncertainty in the input data and the bioaccumulative and other exposure characteristics of selenium.

54. The load was not subdivided among irrigation districts or farmers at this stage. Options for district and farmer allocations are discussed in the next section.
<table>
<thead>
<tr>
<th>Month</th>
<th>WQS</th>
<th>Crows</th>
<th>TMDL</th>
<th>Flow</th>
<th>Conc</th>
<th>Flow</th>
<th>Conc</th>
<th>Flow</th>
<th>Conc</th>
<th>Elgred</th>
<th>Load</th>
<th>Load</th>
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<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td>lb/mo</td>
<td>µg/l</td>
<td></td>
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<tr>
<td>Sep</td>
<td>5</td>
<td>8,371</td>
<td>114</td>
<td>3,351</td>
<td>0.2</td>
<td>55</td>
<td>0.5</td>
<td>1,600</td>
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<td>5</td>
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<td>0.5</td>
<td>1,600</td>
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<tr>
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<td>1,700</td>
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<td>2,519</td>
<td>0.2</td>
<td>85</td>
<td>0.5</td>
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<td>21</td>
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<td>54</td>
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<tr>
<td>Aug</td>
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<td>67</td>
<td>870</td>
<td>0.2</td>
<td>50</td>
<td>0.5</td>
<td>2,500</td>
<td>1</td>
<td>7</td>
<td>7</td>
<td>54</td>
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</tbody>
</table>

Table 2a: Screening-Level TMDL for the San Joaquin River at Crows Landing

**Water Quality Standard**

<table>
<thead>
<tr>
<th>Critically Dry Years</th>
<th>Merced</th>
<th>San Joaquin at Lander</th>
<th>Wetlands</th>
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<tbody>
<tr>
<td></td>
<td>Flow</td>
<td>Conc</td>
<td>Flow</td>
</tr>
<tr>
<td></td>
<td>µg/l</td>
<td></td>
<td>µg/l</td>
</tr>
<tr>
<td></td>
<td>cl/mo</td>
<td>lbs/mo</td>
<td>cl/mo</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Column 1:** Water quality standard for selenium, as a four-day average concentration not to be exceeded more than once in three years, on average.

**Column 2:** Design flow of the San Joaquin River at Crows Landing.

**Column 3:** Monthly sum of total maximum daily loads = Col. 1 x Col. 2 x 0.00272 lb-lb-µg-af.

**Column 4:** Flow of the Merced River (U.S. Geological Survey 1992) which corresponds to the month and year represented by the design flow.

**Column 5:** Concentration of selenium in the Merced River (Central Valley RWQCB 1999c).

**Column 6:** Flow of the San Joaquin River at Lander Avenue (California Department of Water Resources, unpublished) which corresponds to the month and year represented by the design flow.

**Column 7:** Concentration of selenium in the San Joaquin River at Lander Avenue (Central Valley RWQCB 1999b).

**Column 8:** Flow from the area wetlands (Swain 1991).

**Column 9:** Selenium concentration of wetland discharged in 1992 (Central Valley RWQCB 1993). (Central Valley RWQCB 1993b).

**Column 10:** Background selenium load in the San Joaquin river at Crows Landing = (Col. 4 x Col. 5) = (Col. 6 x Col. 7) + (Col. 8 x Col. 9)) x 0.00272 lb-lb-µg-af.

**Column 11:** Margin of safety = 0.1 x Col. 3.

**Column 12:** Monthly load allocation for agricultural dischargers = Col. 13 - Col. 10 - Col. 11.

**Column 13:** Daily load allocation for agricultural dischargers = Col. 12 + 28, 30, or 31 days/month.
### Table 2b

Screening-Level TMDL for the San Joaquin River at Crows Landing

**Water Quality Standard**

| Month | WQS | Crows Flow | TMDL Flow | Merced Concentration | San Joaquin at Lander Concentration | Wetlands Concentration | Dry and Below Normal Years | WQS of lbs/mo | TMDL of lbs/mo | Flow of lbs/mo | Flow of lbs/mo | Flow of lbs/mo | Flow of lbs/mo | Flow of lbs/mo | Flow of lbs/mo | Flow of lbs/mo | Flow of lbs/mo | Flow of lbs/mo | Flow of lbs/mo | Flow of lbs/mo | Flow of lbs/mo |
|-------|-----|------------|-----------|----------------------|-------------------------------------|------------------------|--------------------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|
| Sep   | 5   | 20,202     | 274       | 15,909               | 0.2                                 | 1,328                  | 0.5                      | 16             | 27             | 231            | 8              |                |                |                |                |                |                |                |
| Oct   | 5   | 20,202     | 274       | 15,909               | 0.2                                 | 1,328                  | 0.5                      | 19             | 27             | 228            | 7              |                |                |                |                |                |                |                |
| Nov   | 5   | 20,202     | 274       | 15,909               | 0.2                                 | 1,328                  | 0.5                      | 19             | 27             | 228            | 8              |                |                |                |                |                |                |                |
| Dec   | 5   | 25,822     | 351       | 14,398               | 0.2                                 | 1,704                  | 0.5                      | 19             | 35             | 297            | 10             |                |                |                |                |                |                |                |
| Jan   | 5   | 25,822     | 351       | 14,398               | 0.2                                 | 1,704                  | 0.5                      | 19             | 35             | 297            | 10             |                |                |                |                |                |                |                |
| Feb   | 5   | 18,555     | 252       | 7,595                | 0.2                                 | 869                    | 0.5                      | 44             | 25             | 182            | 7              |                |                |                |                |                |                |                |
| Mar   | 5   | 18,555     | 252       | 7,595                | 0.2                                 | 869                    | 0.5                      | 44             | 25             | 182            | 6              |                |                |                |                |                |                |                |
| Apr   | 5   | 18,555     | 252       | 7,595                | 0.2                                 | 869                    | 0.5                      | 26             | 25             | 200            | 7              |                |                |                |                |                |                |                |
| May   | 5   | 18,555     | 252       | 7,595                | 0.2                                 | 869                    | 0.5                      | 20             | 25             | 207            | 7              |                |                |                |                |                |                |                |
| Jun   | 5   | 13,175     | 179       | 14,414               | 0.2                                 | 293                    | 0.5                      | 15             | 18             | 144            | 5              |                |                |                |                |                |                |                |
| Jul   | 5   | 13,175     | 179       | 14,414               | 0.2                                 | 293                    | 0.5                      | 13             | 18             | 148            | 5              |                |                |                |                |                |                |                |
| Aug   | 5   | 13,175     | 179       | 14,414               | 0.2                                 | 293                    | 0.5                      | 3              | 18             | 158            | 5              |                |                |                |                |                |                |                |

**Column 1:** Water quality standard for selenium, as a four-day average concentration not to be exceeded more than once in three years, on average.
**Column 2:** Design flow of the San Joaquin River at Crows Landing
**Column 3:** Monthly sum of total maximum daily loads=Col.1 x Col.2 x .00272 lb-l/μg-af.
**Column 4:** Flow of the Merced River (U.S. Geological Survey 1992) which corresponds to the month and year represented by the design flow.
**Column 5:** Concentration of selenium in the Merced River (Central Valley RWQCB 1990c).
**Column 6:** Flow of the San Joaquin River at Lander Avenue (California Department of Water Resources, unpublished) which corresponds to the month and year represented by the design flow.
**Column 7:** Concentration of selenium in the San Joaquin River at Lander Avenue (Central Valley RWQCB 1993b)
**Column 8:** Flow from the area wetlands (Swain 1991)
**Column 9:** Selenium concentration of wetland discharged in 1992 (Central Valley RWQCB 1993b)
**Column 10:** Background selenium load in the San Joaquin river at Crows Landing = (Col. 4 x Col. 5) = (Col. 6 x Col. 7) + (Col. 8 x Col. 9) x .00272 lb-l/μg-af.
**Column 11:** Margin of safety = 0.1 x Col. 3.
**Column 12:** Monthly load allocation for agricultural dischargers - Col.3 - Col. 10 - Col. 11.
**Column 13:** Daily load allocation for agricultural dischargers = Col. 12 + 28, 30, or 31 days/month.

Total 2,504
Table 2c
Screening-Level TMDL for the San Joaquin River at Crows Landing

<table>
<thead>
<tr>
<th>Water Quality Standard</th>
</tr>
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<td>Above Normal and Wet Years</td>
</tr>
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<table>
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<tr>
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<th>WQS Crows Flow</th>
<th>Merced Flow</th>
<th>San Joaquin at Lander Flow</th>
<th>Wetlands Flow</th>
<th>Flowed Kg</th>
<th>MOS Lac</th>
<th>Local Lac</th>
<th>Local Lac</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>µg/l</td>
<td>cf/mo</td>
<td>lbs/mo</td>
<td>µg/l</td>
<td>cf/mo</td>
<td>µg/l</td>
<td>cf/mo</td>
<td>µg/l</td>
</tr>
<tr>
<td>1</td>
<td>Sep 5 8,371</td>
<td>114</td>
<td>3,351 0.2</td>
<td>55 0.5</td>
<td>1,900 1 7</td>
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<td>114</td>
<td>3,351 0.2</td>
<td>55 0.5</td>
<td>3,300 1 11</td>
<td>11</td>
<td>91</td>
<td>3</td>
</tr>
<tr>
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<td>Nov 5 8,371</td>
<td>114</td>
<td>3,351 0.2</td>
<td>55 0.5</td>
<td>3,300 1 11</td>
<td>11</td>
<td>91</td>
<td>3</td>
</tr>
<tr>
<td>4</td>
<td>Dec 5 13,983</td>
<td>190</td>
<td>4,999 0.2</td>
<td>15 0.5</td>
<td>3,200 1 11</td>
<td>11</td>
<td>169</td>
<td>5</td>
</tr>
<tr>
<td>5</td>
<td>Jan 5 13,983</td>
<td>190</td>
<td>4,999 0.2</td>
<td>15 0.5</td>
<td>3,200 1 11</td>
<td>12</td>
<td>159</td>
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<td>Feb 5 30,869</td>
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<td>9,571 0.2</td>
<td>4,457 0.5</td>
<td>14,400 1 50</td>
<td>42</td>
<td>327</td>
<td>12</td>
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<tr>
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<td>Mar 5 30,869</td>
<td>419</td>
<td>9,571 0.2</td>
<td>4,457 0.5</td>
<td>14,400 1 50</td>
<td>42</td>
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<td>Apr 5 30,869</td>
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<td>4,457 0.5</td>
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<tr>
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<td>1,324 0.5</td>
<td>4,409 1 18</td>
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<td>212</td>
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<tr>
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<td>Jul 5 18,877</td>
<td>256</td>
<td>7,347 0.2</td>
<td>1,324 0.5</td>
<td>4,409 1 18</td>
<td>26</td>
<td>212</td>
<td>7</td>
</tr>
<tr>
<td>12</td>
<td>Aug 5 18,877</td>
<td>256</td>
<td>7,347 0.2</td>
<td>1,324 0.5</td>
<td>3,900 1 16</td>
<td>26</td>
<td>212</td>
<td>7</td>
</tr>
</tbody>
</table>

*Total 2,598

*Total of Column 12 may vary slightly due to rounding of monthly figures

Column 1: Water quality standard for selenium, as a four-day average concentration not to be exceeded more than once in three years, on average.

Column 2: Design flow of the San Joaquin River at Crows Landing

Column 3: Monthly sum of total maximum daily loads = Col.1 x Col.2 x .00272 lb-µg-af.

Column 4: Flow of the Merced River (U.S. Geological Survey 1992) which corresponds to the month and year represented by the design flow.

Column 6: Flow of the San Joaquin River at Lander Avenue (California Department of Water Resources, unpublished) which corresponds to the month and year represented by the design flow.

Column 7: Concentration of selenium in the San Joaquin River at Lander Avenue (Central Valley RWQCB 1993b)

Column 8: Flow from the area wetlands (Swain 1991)

Column 9: Selenium concentration of wetland discharged in 1992 (Central Valley RWQCB 1993b)

Column 10: Background selenium load in the San Joaquin River at Crows Landing = (Col. 4 x Col. 5) = (Col. 6 x Col. 7) + (Col. 6 x Col. 9)] x .00272 lb-µg-af.

Column 11: Margin of safety = 0.1 x Col. 3.

Column 12: Monthly load allocation for agricultural dischargers = Col.1 - Col. 10 - Col. 11.

Column 13: Daily load allocation for agricultural dischargers = Col. 12 + 28, 30, or 31 days/month.
C. Allocating Allowable Loads Among Responsible Parties

To be effective, a pollution control program must assign responsibility for pollution load reductions to the appropriate parties. In the case of the Grasslands region and other regions of irrigated agriculture, opportunities for pollution reduction stem from irrigation improvements at the farm level and, to a more limited extent, from operational changes at the water district level. Therefore, an effective program to reduce agricultural drainage must establish accountability and incentives for pollution control at the farm level, by allocating the regional pollution load (defined by the TMDL) among contributing farmers. This farm-level allocation may either be calculated directly from the regional pollution load, or be calculated in a two-step process which first allocates the regional pollution load among districts and then allocates the district load among farmers. The choice between a one-step and a two-step process depends upon the type of pollution control program desired.

For example, the allowable pollution load assigned to each water district provides the basis for regulatory programs that hold districts accountable for pollution control. District allocations could define effluent limits for a traditional discharge permit program at the district level—an option that currently exists for regulating agricultural dischargers under California law. Alternatively, with a system of tradable discharge permits, the initial district allocations would provide the basis for subsequent market-based adjustments among districts. Similarly, district-level effluent fees would be based on district pollution targets.

Farm-level allocations provide the targets for farm-level accountability and incentives. The method for determining farm-level allocations may be the same for the entire region or may vary from district to district. Farm-level targets could serve as the basis for prescribing BMPs or for assigning effluent fees or tiered water prices to farmers within the region or within individual districts.

The precision with which the allocations must be determined, as well as the implications of different allocation options for "fairness" or equity among the regulated parties, will vary under the different regulatory approaches. Estimates of both the district- and farm-level allocations thus help to inform decisions about the most appropriate regulatory program for a given area. Similarly, preliminary estimates of both district and farm-level allocations provide an important basis for pollution control planning and investments by the regulated community.

1. District-Level Allocation

Two of the most commonly used methods for allocating pollution reductions are: (1) to require each source to make equal progress towards reducing pollution through equal pollutant-removal efficiencies or equal increments of removal; and (2) to require each source to achieve a fixed level of pollution control per unit of production through equal final pollutant concentrations, regardless of the necessary level of pollutant-removal efficiency. When applied to pollution load allocations among the Grasslands districts, these approaches would result respectively in: (1) allocations that are proportional to historical drainage outputs, expressed as either drainage volume or selenium load; and (2) allocations that are proportional to irrigated acreage, drained acreage, or selenium-contaminated acreage within the district.

In the Grasslands region, the historical record of district-level drainage discharges (Table 3) is adequate to support a legitimate estimate of district allocations using most of these methods. Estimates of the district allocations that would result from using historical drainage outputs, irrigated acreage, and drained acreage, as well as one weighted combination of these three factors are shown in Tables 4 through 7.

Besides the choice of allocation method, district allocations will depend on the number of districts or other entities included in the overall distribution. While it is generally assumed that the number of water districts that discharge to the San Joaquin River will not increase in the future, the allocation can be calculated to include other poten-

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55. In this respect, agricultural drainage problems differ from many other types of wastewater problems, such as municipal wastewater discharges, which are more amenable to a single, regional treatment facility.

56. This allocation step is often included as part of the standard TMDL calculation. It is presented as a separate procedure here to emphasize the variety of options available.

57. See discussion infra Part V.

58. TECHNICAL SUPPORT DOCUMENT, supra note 53.

59. Initial allocations may also be determined by auction.

60. The purpose of this section is explore various allocation methods rather than choose a particular method and assign effluent limits. With this in mind, several simplifying assumptions were made. For example, EPA-recommended methods for translating a wasteload allocation (or load allocation) into maximum daily or average monthly permit limits were not used. Effluent variability also was not taken into account. In general, such calculations would tend to reduce district load allocations relative to the allocations presented in this section. Similarly, it is assumed that all of the selenium load discharged by each district actually reaches the river without being used by farmers downstream, or taken up by biota en route.
## Table 3
Baseline Data for Pollution Allocations

<table>
<thead>
<tr>
<th>District</th>
<th>Historical Selenium Discharge</th>
<th>Irrigated Area</th>
<th>Drained Area</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>lb/yr</td>
<td>% of subtotal</td>
<td>% of total</td>
</tr>
<tr>
<td>Panoche</td>
<td>4,698</td>
<td>43</td>
<td>39</td>
</tr>
<tr>
<td>Firebaugh</td>
<td>2,222</td>
<td>20</td>
<td>19</td>
</tr>
<tr>
<td>Charleston</td>
<td>945</td>
<td>9</td>
<td>8</td>
</tr>
<tr>
<td>Pacheco</td>
<td>1,016</td>
<td>9</td>
<td>8</td>
</tr>
<tr>
<td>Broadview</td>
<td>1,774</td>
<td>16</td>
<td>15</td>
</tr>
<tr>
<td>CCID-13</td>
<td>195</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Widren</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td><strong>SUBTOTAL</strong></td>
<td>10,850</td>
<td>100</td>
<td>90</td>
</tr>
<tr>
<td>Other</td>
<td>1,160</td>
<td>10</td>
<td>-</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td>12,010</td>
<td>100</td>
<td>100</td>
</tr>
</tbody>
</table>

aAverage annual selenium discharge for water years 1986-1988.
bTotal irrigated area within each district (Central Valley Regional Water Quality Control Board 1989c).
cTotal drained area within each district (Broadview Water District 1989; Charleston Drainage District 1990; Panoche Water District 1989; State Water Resources Control Board 1987e; Chedester, S., Porter, M., personal communication).
dReserved for additional lands which are not incorporated within existing districts or for portions of Westlands Water District.
eAverage annual discharge for water years 1987 and 1988 from the Camp-13 area of the Central California Irrigation District (Central California Irrigation District 1993).
fLands within Widren Water District have been fallowed in recent years; baseline data are unavailable.
gAssumes the same average per-acre selenium discharge as the 93,390 acres included in the subtotal.
hPercentage adjusted to accommodate rounding errors.

Drained acreage estimated as follows: (subtotal drained acres + subtotal irrigated acres) x (Widren or subtotal irrigated acres).
Table 4
Selenium Discharge Allocations for Districts

SCENARIO 1: HISTORICAL DISCHARGES

A: Current Dischargers Only

<table>
<thead>
<tr>
<th>District</th>
<th>Water Quality Standard</th>
<th>Internm Goal</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Critical</td>
<td>Dry and Below Normal</td>
</tr>
<tr>
<td></td>
<td>lbs/yr</td>
<td>%</td>
</tr>
<tr>
<td>Panache</td>
<td>503</td>
<td>11</td>
</tr>
<tr>
<td>Firebaugh</td>
<td>238</td>
<td>11</td>
</tr>
<tr>
<td>Charleston</td>
<td>101</td>
<td>11</td>
</tr>
<tr>
<td>Pacheco</td>
<td>169</td>
<td>11</td>
</tr>
<tr>
<td>Broadview</td>
<td>150</td>
<td>11</td>
</tr>
<tr>
<td>CCID-13</td>
<td>21</td>
<td>11</td>
</tr>
<tr>
<td>Widenc</td>
<td>0</td>
<td>11</td>
</tr>
<tr>
<td>TOTALd</td>
<td>1,163</td>
<td>11</td>
</tr>
</tbody>
</table>

B: Allowance Reserved for Additional Dischargers

<table>
<thead>
<tr>
<th>District</th>
<th>Water Quality Standard</th>
<th>Internm Goal</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Critical</td>
<td>Dry and Below Normal</td>
</tr>
<tr>
<td></td>
<td>lbs/yr</td>
<td>%</td>
</tr>
<tr>
<td>Panache</td>
<td>455</td>
<td>10</td>
</tr>
<tr>
<td>Firebaugh</td>
<td>215</td>
<td>10</td>
</tr>
<tr>
<td>Charleston</td>
<td>91</td>
<td>10</td>
</tr>
<tr>
<td>Pacheco</td>
<td>98</td>
<td>10</td>
</tr>
<tr>
<td>Broadview</td>
<td>172</td>
<td>10</td>
</tr>
<tr>
<td>CCID-13</td>
<td>19</td>
<td>10</td>
</tr>
<tr>
<td>Widenc</td>
<td>0</td>
<td>10</td>
</tr>
<tr>
<td>SUBTOTALd</td>
<td>1,050</td>
<td>10</td>
</tr>
<tr>
<td>Other</td>
<td>112</td>
<td>10</td>
</tr>
<tr>
<td>TOTALd</td>
<td>1,163</td>
<td>10</td>
</tr>
</tbody>
</table>

Note: Discharge allocation (lbs/yr) are calculated as follows: (total discharge allocation) x (district's drained acreage, Table 3) + (subtotal or total drained acreage, Table 3).

a. The interim goal assumes a once-in-five month excursion rate.
b. Allocation as a percentage of historical discharge.
c. Baseline data on Widren's historical discharges were not available.
d. Sums may reflect rounding errors.
### Table 5
**Selenium Discharge Allocations for Districts**

#### SCENARIO 2: DRAINED ACREAGE

#### A: Current Dischargers Only

<table>
<thead>
<tr>
<th>District</th>
<th>Water Quality Standard</th>
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<th></th>
<th>Water Quality Standard</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Critical</td>
<td>Dry and Below Normal</td>
<td>Above Normal and Wet</td>
<td></td>
<td>Critical</td>
<td>Dry and Below Normal</td>
<td>Above Normal and Wet</td>
</tr>
<tr>
<td></td>
<td>lbs/yr</td>
<td>%b</td>
<td>lbs/yr</td>
<td>%b</td>
<td>lbs/yr</td>
<td>%b</td>
<td>lbs/yr</td>
</tr>
<tr>
<td>Panache</td>
<td>519</td>
<td>11</td>
<td>1,118</td>
<td>24</td>
<td>1,160</td>
<td>25</td>
<td></td>
</tr>
<tr>
<td>Firebaugh</td>
<td>264</td>
<td>12</td>
<td>569</td>
<td>26</td>
<td>591</td>
<td>27</td>
<td></td>
</tr>
<tr>
<td>Charleston</td>
<td>85</td>
<td>9</td>
<td>163</td>
<td>19</td>
<td>190</td>
<td>20</td>
<td></td>
</tr>
<tr>
<td>Pascoo</td>
<td>84</td>
<td>8</td>
<td>180</td>
<td>18</td>
<td>187</td>
<td>18</td>
<td></td>
</tr>
<tr>
<td>Broadview</td>
<td>154</td>
<td>9</td>
<td>331</td>
<td>19</td>
<td>343</td>
<td>19</td>
<td></td>
</tr>
<tr>
<td>CCD-13</td>
<td>47</td>
<td>24</td>
<td>102</td>
<td>52</td>
<td>105</td>
<td>54</td>
<td></td>
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<tr>
<td>Widren</td>
<td>10</td>
<td>na</td>
<td>21</td>
<td>na</td>
<td>22</td>
<td>na</td>
<td></td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td>1,163</td>
<td>11</td>
<td>2,594</td>
<td>23</td>
<td>2,598</td>
<td>24</td>
<td></td>
</tr>
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</table>

#### B: Allowance Reserved for Additional Dischargers

<table>
<thead>
<tr>
<th>District</th>
<th>Water Quality Standard</th>
<th></th>
<th></th>
<th></th>
<th>Water Quality Standard</th>
<th></th>
<th></th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Critical</td>
<td>Dry and Below Normal</td>
<td>Above Normal and Wet</td>
<td></td>
<td>Critical</td>
<td>Dry and Below Normal</td>
<td>Above Normal and Wet</td>
</tr>
<tr>
<td></td>
<td>lbs/yr</td>
<td>%b</td>
<td>lbs/yr</td>
<td>%b</td>
<td>lbs/yr</td>
<td>%b</td>
<td>lbs/yr</td>
</tr>
<tr>
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<td>1,110</td>
<td>22</td>
<td>1,048</td>
<td>22</td>
<td></td>
</tr>
<tr>
<td>Firebaugh</td>
<td>239</td>
<td>11</td>
<td>514</td>
<td>23</td>
<td>533</td>
<td>24</td>
<td></td>
</tr>
<tr>
<td>Charleston</td>
<td>77</td>
<td>8</td>
<td>165</td>
<td>17</td>
<td>172</td>
<td>18</td>
<td></td>
</tr>
<tr>
<td>Pascoo</td>
<td>76</td>
<td>7</td>
<td>163</td>
<td>16</td>
<td>169</td>
<td>17</td>
<td></td>
</tr>
<tr>
<td>Broadview</td>
<td>139</td>
<td>8</td>
<td>299</td>
<td>17</td>
<td>310</td>
<td>18</td>
<td></td>
</tr>
<tr>
<td>CCD-13</td>
<td>43</td>
<td>22</td>
<td>92</td>
<td>47</td>
<td>95</td>
<td>49</td>
<td></td>
</tr>
<tr>
<td>Widren</td>
<td>9</td>
<td>na</td>
<td>19</td>
<td>na</td>
<td>20</td>
<td>na</td>
<td></td>
</tr>
<tr>
<td><strong>SUBTOTAL</strong></td>
<td>1,050</td>
<td>10</td>
<td>2,262</td>
<td>21</td>
<td>2,347</td>
<td>22</td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td>112</td>
<td>10</td>
<td>242</td>
<td>21</td>
<td>251</td>
<td>22</td>
<td></td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td>1,163</td>
<td>10</td>
<td>2,504</td>
<td>21</td>
<td>2,598</td>
<td>22</td>
<td></td>
</tr>
</tbody>
</table>

Note: Discharge allocation (lbs/yr) are calculated as follows: (total discharge allocation) x (district's drained acreage, Table 3) + (subtotal or total drained acreage, Table 3).

a. The interim goal assumes a once-in-five month excursion rate.
b. Allocation as a percentage of historical discharge.
c. Baseline data on Widren's historical discharges were not available.
d. Sums may reflect rounding errors.
Table 6
Selenium Discharge Allocations for Districts

SCENARIO 3: IRRIGATED ACREAGE

A: Current Dischargers Only

<table>
<thead>
<tr>
<th>District</th>
<th>Water Quality Standard</th>
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<th>Internm Goal</th>
<th></th>
<th></th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Critical</td>
<td>Dry and Below Normal</td>
<td>Above Normal and Wet</td>
<td>Critical</td>
<td>Dry and Below Normal</td>
<td>Above Normal and Wet</td>
</tr>
<tr>
<td></td>
<td>lbs/yr</td>
<td>%</td>
<td>lbs/yr</td>
<td>%</td>
<td>lbs/yr</td>
<td>%</td>
</tr>
<tr>
<td>Panache</td>
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<td>26</td>
<td>1,252</td>
<td>27</td>
</tr>
<tr>
<td>Firebaugh</td>
<td>279</td>
<td>13</td>
<td>601</td>
<td>27</td>
<td>623</td>
<td>28</td>
</tr>
<tr>
<td>Charleston</td>
<td>54</td>
<td>6</td>
<td>115</td>
<td>12</td>
<td>120</td>
<td>13</td>
</tr>
<tr>
<td>Pacheco</td>
<td>73</td>
<td>7</td>
<td>158</td>
<td>16</td>
<td>164</td>
<td>16</td>
</tr>
<tr>
<td>Broadview</td>
<td>112</td>
<td>6</td>
<td>241</td>
<td>14</td>
<td>250</td>
<td>14</td>
</tr>
<tr>
<td>CID-13</td>
<td>75</td>
<td>8</td>
<td>161</td>
<td>82</td>
<td>167</td>
<td>86</td>
</tr>
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<td>na</td>
<td>21</td>
<td>na</td>
<td>22</td>
<td>na</td>
</tr>
<tr>
<td>TOTALd</td>
<td>1,163</td>
<td>11</td>
<td>2,504</td>
<td>23</td>
<td>2,598</td>
<td>24</td>
</tr>
</tbody>
</table>

B: Allowance Reserved for Additional Dischargers

<table>
<thead>
<tr>
<th>District</th>
<th>Water Quality Standard</th>
<th></th>
<th></th>
<th>Internm Goal</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Critical</td>
<td>Dry and Below Normal</td>
<td>Above Normal and Wet</td>
<td>Critical</td>
<td>Dry and Below Normal</td>
<td>Above Normal and Wet</td>
</tr>
<tr>
<td></td>
<td>lbs/yr</td>
<td>%</td>
<td>lbs/yr</td>
<td>%</td>
<td>lbs/yr</td>
<td>%</td>
</tr>
<tr>
<td>Panache</td>
<td>506</td>
<td>11</td>
<td>1,090</td>
<td>23</td>
<td>1,131</td>
<td>24</td>
</tr>
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<td>543</td>
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<td>563</td>
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<td>Charleston</td>
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<td>Pacheco</td>
<td>66</td>
<td>7</td>
<td>143</td>
<td>14</td>
<td>148</td>
<td>15</td>
</tr>
<tr>
<td>Broadview</td>
<td>101</td>
<td>6</td>
<td>218</td>
<td>12</td>
<td>226</td>
<td>13</td>
</tr>
<tr>
<td>CID-13</td>
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<td>8</td>
<td>145</td>
<td>75</td>
<td>151</td>
<td>77</td>
</tr>
<tr>
<td>Widren</td>
<td>9</td>
<td>na</td>
<td>19</td>
<td>na</td>
<td>20</td>
<td>na</td>
</tr>
<tr>
<td>SUBTOTALd</td>
<td>1,050</td>
<td>10</td>
<td>2,262</td>
<td>21</td>
<td>2,347</td>
<td>22</td>
</tr>
<tr>
<td>Other</td>
<td>112</td>
<td>10</td>
<td>242</td>
<td>21</td>
<td>251</td>
<td>22</td>
</tr>
<tr>
<td>TOTALd</td>
<td>1,163</td>
<td>10</td>
<td>2,504</td>
<td>21</td>
<td>2,598</td>
<td>22</td>
</tr>
</tbody>
</table>

Note: Discharge allocation (lbs/yr) are calculated as follows: (total discharge allocation) x (district’s drained acreage, Table 3) + (subtotal or total drained acreage, Table 3).

a. The interim goal assumes a once-in-five month excursion rate.
b. Allocation as a percentage of historical discharge.
c. Baseline data on Widren’s historical discharges were not available.
d. Sums may reflect rounding errors.
### Table 7
Selenium Discharge Allocations for Districts

**SCENARIO 4: WEIGHTED COMBINATION**

#### A: Current Dischargers Only

<table>
<thead>
<tr>
<th>District</th>
<th>Water Quality Standard</th>
<th>Interim Goal&lt;sup&gt;a&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Critical</td>
<td>Dry and Below Normal</td>
</tr>
<tr>
<td></td>
<td>lbs/yr</td>
<td>lbs/yr</td>
</tr>
<tr>
<td>1.123</td>
<td>1,165</td>
<td>25</td>
</tr>
<tr>
<td>549</td>
<td>569</td>
<td>26</td>
</tr>
<tr>
<td>184</td>
<td>190</td>
<td>20</td>
</tr>
</tbody>
</table>

#### B: Allowance Reserved for Additional Dischargers

<table>
<thead>
<tr>
<th>District</th>
<th>Water Quality Standard</th>
<th>Interim Goal&lt;sup&gt;a&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Critical</td>
<td>Dry and Below Normal</td>
</tr>
<tr>
<td></td>
<td>lbs/yr</td>
<td>lbs/yr</td>
</tr>
<tr>
<td>1,015</td>
<td>1,053</td>
<td>22</td>
</tr>
<tr>
<td>496</td>
<td>515</td>
<td>23</td>
</tr>
<tr>
<td>166</td>
<td>172</td>
<td>18</td>
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<td>183</td>
<td>189</td>
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<tr>
<td>314</td>
<td>326</td>
<td>18</td>
</tr>
<tr>
<td>89</td>
<td>83</td>
<td>42</td>
</tr>
<tr>
<td>11</td>
<td>10</td>
<td>52</td>
</tr>
</tbody>
</table>

Note: Discharge allocation (lbs/yr) are calculated as follows: (total discharge allocation) x (district's drained acreage, Table 3) + (subtotal or total drained acreage, Table 3).  

a. The interim goal assumes a once-in-five month excursion rate.  
b. Allocation as a percentage of historical discharge.  
c. Baseline data on Widren's historical discharges were not available.  
d. Sums may reflect rounding errors.
tial discharging entities. Accordingly, two alternate calculations of district load allocation have been made for each of the scenarios described in Tables 4 through 7. These two calculations appear in the tables as Alternative A, which assumes that only known and monitored discharging entities are included in the distribution, and Alternative B, which assumes that a fraction of the allowable pollution load is reserved for additional dischargers.

a. Scenario 1: Allocation Based on Historical Discharge Levels

Under this method, each district is required to reduce selenium discharges by the same percentage relative to its historical discharges. In other words, if the regional agricultural load must be reduced to eleven percent of the historical regional load, then each individual district must reduce its discharges to eleven percent of its historical discharges.

The years 1986-89 represent the pollution loading baseline. According to this baseline (expressed in the average annual number of pounds of selenium discharged), the district-level drainage reductions necessary to meet the selenium concentration standard during critical, dry/below normal, and above normal/wet water years are as shown in Table 4. This table also shows the drainage reductions required to meet a possible interim goal in each year type.

An allocation based on historical selenium loads implicitly addresses inequities among districts due to physical factors beyond the farmers' control. Specifically, by relying on historic discharge levels, the varying degrees of soil contamination within the districts are accounted for along with the quantities of drainage produced. Without detailed maps of shallow groundwater quality or selenium contamination of soils, this allocation method is the best available approach for taking soil quality into account when assigning pollution control responsibility.

The historical discharge allocation method also takes into account physical limitations on irrigation efficiency, because the quantity of drainage is a function of both controllable factors such as irrigation technologies and practices and uncontrollable factors such as soil uniformity. Finally, the historically based allocations avoid penalizing those districts and landowners who have significantly reduced pollution since 1988.

b. Scenario 2: Allocation Based on Drained Acreage

This method reflects a policy assumption that only the acreage underlain with subsurface drains should be included in the load distribution. Selenium load allocations would be apportioned without respect to the degree of soil selenium contamination. Using this method, the district-level allocations shown in Table 5 differ significantly from those derived from the historical baseline.

c. Scenario 3: Allocation Based on Irrigated Acreage

A different policy assumption underlies this approach—the notion that all irrigated land within the Grasslands region contributes to the regional selenium loading problem, since all irrigated land contributes to the elevation of the region's shallow groundwater table. As shown in Table 6, however, an allocation based on total irrigated acreage has the effect of granting districts with larger land areas greater shares of the river's dilution capacity, regardless of the distribution of subsurface drains and soil selenium contamination.

d. Scenario 4: Allocation Based on a Weighted Combination of Factors

Each of the first three scenarios has certain advantages and disadvantages from a regulatory perspective, and different distributional (i.e., equity) implications for individual districts. The advantages of the various options can be captured, and the disadvantages partly ameliorated, by allocating pollution loads according to a weighted combination of factors. Table 7 shows the allocation that results...
from assigning a 50 percent weight to historical selenium discharges and a 25 percent weight each to the amount of irrigated and drained acreage.

Each of the four district allocation scenarios presented here would satisfy the primary regulatory goal of defining district-level pollution reduction requirements sufficient to meet selenium water quality standards in the San Joaquin River. Each scenario also offers the additional benefits of reducing the loads of other pollutants of concern and increasing water conservation. Moreover, none of the allocation options poses a significant administrative burden on local agency officials, because each can be calculated using existing data and district-level allocations (unlike farm-level allocations) can be readily monitored and enforced under existing conditions. Each of the district-level allocation methods therefore would be acceptable from the perspective of the regulator.

The critical issue in selecting among the allocation methods is the fairness of the distribution of pollution control responsibility as perceived by the water districts and their farmers. Scenarios 1, 2, and 3 reflect different policy choices, result in substantially different allocations among districts, and therefore would result in differences in the distribution of compliance costs. Such equity concerns could be addressed by allowing the agricultural community (represented by the districts or a regional entity) to identify a preferred allocation method. If no consensus can be reached, the local regulatory agency could adopt a weighted formula similar to that presented as Scenario 4.65

2. Allocation Among Farmers

Any regulatory program designed to reduce drainage discharges from irrigated agriculture ultimately must address farm-level irrigation and water management practices. This is true regardless of whether the regulatory agency chooses to deal with individual farms directly or with larger entities such as water or drainage districts (which, in turn, would deal with the individual farms). In either case, conversion of the regional pollution load (or the district load allocation) into a farm-level goal or allocation allows farmers and regulators to assess the magnitude and affordability of pollution control requirements. The process of calculating farm-level pollution goals (i.e., the ease or difficulty of the calculation due to data constraints) also affects the choice of pollution control program, because different programs may require different levels of accuracy about discharges at the farm and district levels.

The most direct method for establishing a farm-level goal is to divide the allowable regional selenium load among the subsurface drainage sumps, weighted by acreage.66 This allocation can be problematic, however, because of the difficulty in establishing farm-specific contributions to each sump. In recognition of this problem, previous drainage management plans have recommended that drainage reduction targets be applied to all irrigated lands rather than focusing solely on the drained acreage.67

Under this allocation method, an average selenium or drainage allowance per acre is determined, regardless of existing drain systems. The results of this calculation appear in Table 8.69 As shown in Table 8, compliance with existing water quality standards and the corresponding regional load allocations would require farmers to reduce drainage to little more than the amount of excess irrigation water necessary to maintain the salt balance in the soil. This is particularly true for critically dry years. Farm-level drainage generation would be limited to approximately 0.1 to 0.2 acre-feet of "adjusted deep percolation"69 (hereinafter "ADP") per irrigated acre per year (af/ac/yr). The interim goal would allow about 0.2 to 0.4 af/ac/yr of ADP. In practice, these farm-level goals may be adjusted upward if district recycling of drainage water increases.70

The level of irrigation efficiency implied by the calculations in Table 9 would require a high rate of uniformity of water application. This, in turn, would

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65. The district allocation options presented in Tables 4 through 7 show annual load allocations for the sake of simplicity. The San Joaquin River TMDL defines allowable loads which differ, however, for different months. See Tables 2a-c. Similarly, final district-level pollution load allocations must specify allowable loads for each month of each year type. These would be calculated by applying the same formulas used to create the annual load allocations in Tables 4 through 7.

66. See Young & Congdon, supra note 50.

67. Central Valley Regional Water Quality Control Board, Water Quality Control Plan (1989); SWRCB REPORT, supra note 31; Drainage Program Final Report, supra note 32.

68. See Young & Congdon, supra note 50.

69. For purposes of this Article, "adjusted deep percolation" is equal to the amount of water that moves downward past the root zone (deep percolation) minus 0.3 af/ac/yr (which is assumed necessary to maintain a salt balance in the soil). Consequently, the amount of water moving downward out of the confined aquifer (where farm drains are located) and through the Corcoran clay layer is about 0.3 af/ac/yr on average. Drainage Program Final Report, supra note 32.

70. Most, if not all, districts are able to recirculate drainage water, mixing it with incoming water deliveries or groundwater for reuse within the district (or transfer to other districts). Therefore, the average efficiency of water use in the region is higher than the efficiency of the average farm, and less drainage is discharged into the river than is actually produced at the farm level.
Table 8

Farm-Level Selenium Discharge Allocation Based on Drained Acreage

<table>
<thead>
<tr>
<th>Year type</th>
<th>Regional Load Allocation</th>
<th>Current Farm-Level Load Allocation</th>
<th>Future Farm-level Load Allocation</th>
<th>Current Average Farm-Level Drainage</th>
<th>Future Average Farm-Level Drainage</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(lbs Se/yr)</td>
<td>(lbs Se/ac/yr)</td>
<td>(cf/af/yr)</td>
<td>(af/ac/yr)</td>
<td>(af/ac/yr)</td>
</tr>
<tr>
<td>Water Quality Standard</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Critical</td>
<td>1,163</td>
<td>11</td>
<td>.75</td>
<td>.08</td>
<td>.05</td>
</tr>
<tr>
<td>Dry/Below Normal</td>
<td>2,504</td>
<td>23</td>
<td>.75</td>
<td>.17</td>
<td>.11</td>
</tr>
<tr>
<td>Above Normal/Wet</td>
<td>2,598</td>
<td>24</td>
<td>.75</td>
<td>.18</td>
<td>.12</td>
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<tr>
<td>Intern Goal</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Critical</td>
<td>3,060</td>
<td>28</td>
<td>.75</td>
<td>.21</td>
<td>.14</td>
</tr>
<tr>
<td>Dry/Below Normal</td>
<td>3,737</td>
<td>34</td>
<td>.75</td>
<td>.26</td>
<td>.17</td>
</tr>
<tr>
<td>Above Normal/Wet</td>
<td>5,463</td>
<td>50</td>
<td>.75</td>
<td>.38</td>
<td>.25</td>
</tr>
</tbody>
</table>

**Column 1:** Regional load allocation necessary to meet the water quality standard or an interim goal that corresponds to a once-in-five-month excursion rate.

**Column 2:** (Column 1) + (baseline drained acreage of 49,273 acres; Table 3).

**Column 3:** (Column 1) + (predicted future drained acreage of 54,000 acres: San Joaquin Valley Drainage Program 1990a).

**Column 4:** (Column 2) + (average selenium concentration of 150 µg/l or 0.408 lb Se/af; San Joaquin Valley Drainage Program 1990a).

**Column 5:** (Column 3) + (average selenium concentration of 150 µg/l or 0.408 lb Se/af; San Joaquin Valley Drainage Program 1990a).
<table>
<thead>
<tr>
<th>Year type</th>
<th>Load Allocation (lbs Se/yr)</th>
<th>% Reduction from Historical Discharges</th>
<th>Historical Drainage Discharges (af/ac/yr)</th>
<th>Drainage Allocation (af/ac/yr)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Water Quality Standard</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Critical</td>
<td>1,163</td>
<td>11</td>
<td>.75</td>
<td>.08</td>
</tr>
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<td>23</td>
<td>.75</td>
<td>.17</td>
</tr>
<tr>
<td>Above Normal/Wet</td>
<td>2,598</td>
<td>24</td>
<td>.75</td>
<td>.18</td>
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<tr>
<td>Interim Goal</td>
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<td>5,463</td>
<td>50</td>
<td>.75</td>
<td>.38</td>
</tr>
</tbody>
</table>

**Column 1:** Regional load allocation necessary to meet the water quality standard or an interim goal that corresponds to a once-in-five-month excursion rate.

**Column 2:** Percent selenium load reduction required to meet the regional load allocation, calculated as \((\text{Column 1)} - (\text{historical discharge, water years 1986-1988}) \times 100\).

**Column 3:** Historical drainage discharges (roughly equivalent to adjusted deep percolation) during the same period, derived from the San Joaquin Valley Drainage Program (1990a).

**Column 4:** Drainage allocation, calculated as \((\text{Column 2)} \times (\text{Column 3}) + 100\).
require farmers to install more efficient irrigation equipment or use current equipment more efficiently. For example, cotton farmers would have to practice very effective management of quarter-mile furrow systems with tailwater return or install more advanced technologies such as surge systems and linear-move sprinklers.

3. Implications for Program Design

The San Joaquin River TMDL has several implications for the choice of a regulatory program for the Grasslands. First, the TMDL indicates that selenium loads must be significantly decreased in order to meet water quality standards. For example, compliance with the existing 5 \( \mu g/l \) standard for selenium in critical water years requires selenium load reductions of more than 80 percent from 1991 levels (a critical year with curtailed water deliveries), and reductions of 89 percent from 1986-1988 levels. Since the required load reductions are substantial, and because selenium is both toxic and bioaccumulative, the pollution control program should be designed to comply with the regional load allocation or pollution “cap” as closely as possible. Excess discharges of selenium will have unacceptable environmental impacts, but overly stringent load restrictions could cause farmers to incur significant and unnecessary costs.

The pollution load calculations for the San Joaquin River also demonstrate that the perceived difficulty of deriving a pollution cap can be overcome. The required load reductions both for the Grasslands region as a whole and for individual districts can be estimated using minimal resources. Yet, the estimates would be sufficiently reliable to initiate effective water quality regulation and to generate substantial environmental benefits.

In contrast, the task of allocating the regional load among individual farmers is technically complex. Although the regional average farm-level goals presented here are accurate enough to design a pollution abatement program, more precise farm-level goals could be calculated within individual districts.

The relative difficulty of calculating farm-level allocations within districts—combined with the fact that district allocations are easier to calculate than farm-level allocations—suggests that it may be appropriate for a regional pollution abatement program to combine specific load limits at the district level with more flexible programs at the farm level.

IV. REGULATORY OPTIONS FOR ACHIEVING POLLUTION CONTROL OBJECTIVES

To meet the pollution-control objective for the Grasslands region, substantial decreases in agricultural drainage are required. The key to accomplishment of these reductions is improved irrigation management at each individual farm. Thus, achievement of the regional load limits ultimately depends upon the creation of a program that holds individual farmers responsible for pollution control.

A. Regulatory Options for the Grasslands

As discussed above, states that have attempted to control agricultural pollution problems generally have used programs based on the voluntary adoption of BMPs. Continuing water quality problems associated with agricultural pollution indicate that these voluntary programs must be improved or replaced with formal regulatory programs.

In theory, programs for regulating agricultural drainage can be divided into two categories—traditional “command-and-control” programs and incentive-based programs. In practice, the distinctions between the two categories often becomes blurred. For example, an incentive-based tradable permit program may be premised on discharge permits (for point sources) and BMPs (for nonpoint sources). By the same token, a traditional BMP program may stipulate the use of an incentive program such as tiered input pricing.

A pollution control program for the Grasslands region could combine components of two or more of the regulatory options described below. And,

71 Even assuming a more lenient excursion rate as an interim goal (i.e. once in five months rather than once in three years), the actual 1991 discharge levels would exceed allowable loads in all year types. Moreover, these annual load reduction figures do not reflect the monthly variations in load limitations. Greater drainage reductions would be required during the months of the pre-irrigation and irrigation seasons than during other times of the year. Figure 2. Finally, the calculated drainage load allocation is derived for the Crows Landing compliance point where readings, as explained earlier, underestimate pollution farther upstream. Stricter limits on drainage discharges would be necessary to meet existing water quality standards in the tributaries and in the river upstream from its confluence with the Merced River.

72 The focus on farm-level reductions has been recommended by several agencies, because the methods are well understood and available and do not require substantial financial commitments by the government. Where on-farm source reduction is not sufficient to attain environmental objectives, drainage recycling and/or selective land retirement at the district level also may be undertaken. See, e.g., DRAINAGE PROGRAM FINAL REPORT, supra note 32, SWRCB REPORT, supra note 31.

73 The term “command-and-control” generally refers to regulatory programs that rely on technology-based effluent limits which are enforced through site-specific permits. The term also is used more broadly to refer to any program where specific effluent limits or pollution-control technologies are prescribed. This more general meaning is adopted here.
these programs could be applied at either the dis-
trict or the farm level. Indeed, because of the sig-
nificant role of local districts in irrigation and drainage
management, the optimal regulatory system may
well be two-tiered, using one type of program at the
district level and a different type of program within
each district to reach the farm level.76

1. Best Management Practices

Under existing nonpoint source policy, states
are expected to develop comprehensive programs
that identify technology-based BMPs for a wide
range of land uses, including irrigated agriculture.
In most states, implementation of BMPs is volun-
tary. BMPs for irrigated agriculture generally pre-
scribe the use of irrigation scheduling, water meter-
ing, efficient water application systems, land con-
touring, tailwater (surface runoff) recovery, and
drainage control. These BMPs are, of necessity,
less specific than technology-based requirements
for point sources and are intended to allow for site-
specific adaptation. As the basis for a regulatory
program in the Grasslands, BMPs probably would
take the form of mandatory, uniform, technology-
based requirements for all farmers.77

Under a mandatory BMP program, the respon-
sible regulatory agency translates the regional pol-
lution goal into a technology requirement for all of
the farmers within the region.78 Farmers are respon-
sible only for using the prescribed technology,
although the use of more efficient technologies is
allowed. Although these factors in turn require a con-
siderable amount of information about farm-level
conditions and day-to-day management of irriga-
tion technologies. Moreover, the implementation of
a BMP often is difficult to verify. For example, the
manner in which an irrigation system is operated
cannot practically be monitored or verified. How
often and how well a farmer performs maintenance
on equipment also is difficult to assess. Conse-
quently, a BMP usually specifies only physical
components. To estimate the actual resulting pollu-
tion output, the regulator must make some as-
sumption about the level of management.

Once a BMP is chosen, its verifiable compo-
nents can be monitored at the farm level by the reg-
ulatory entity or the water district. Fees or penalties
are used to enforce compliance. At the district level,
BMPs may stipulate certain practices including
installation of irrigation water recycling systems,
adoption of tiered water pricing, and development
of a land retirement program for farmers within the
district. Such programmatic requirements generally
do not specify performance, however, and therefore
do not ensure that the desired level of water con-
servation or participation will be achieved.

2. Traditional Permits

Permits are familiar in the context of point
source regulation. Effluent limitations set forth in
National Pollutant Discharge Elimination System
(herewith "NPDES") permits generally set forth
the amount, the concentration, and the frequency
of pollutant discharges allowed for individual
sources.79 Under California law, the SWRCB has
authority to issue permits to various agricultural
sources: farmers engaged in irrigated agriculture;
existing water or drainage service districts; and
regional entities that represent larger groups of ser-
vice districts.80

Ultimately, a permit-based system for drainage

74. See discussion infra Part V.

75. A number of possible incentive-based options, including a
performance bond, are not evaluated here. The Environmental
Defense Fund proposed a performance bond for agricultural
sources in the Grasslands region during negotiations (1990-1991)
over the terms and conditions for the proposed reopening of the
San Luis Drain to collect and convey drainage for disposal in the
San Joaquin River. The RWQCB also proposed a performance bond
to help meet waste-discharge pollution load objectives and
the accuracy with which compliance can be verified. Knowledge of
these factors in turn requires a considerable amount of informa-
tion about farm-level

76. The EPA's Guidance for Implementation of the Coastal Zone Act
Reauthorization Amendments of 1990 provides the most recent and
comprehensive example of how national policy for nonpoint source
pollution control is evolving. See U.S. ENVIRONMENTAL PRO-
TECTION AGENCY, GUIDANCE SPECIFYING MANAGEMENT MEASURES
FOR SOURCES OF NONPOINT POLLUTION IN COASTAL WATERS (1993).

77. Alternatively, BMP programs can be performance-based.
For example, a BMP program could be adopted requiring no more
than 0.2 acre-feet of drainage (ADP) output. Because the character-
istics of a performance-based BMP program are substantially the
same as a permit program which assigns effluent limits, the per-
mance-based BMP is not discussed separately here.

78. Theoretically, the mandated BMP might be different for
different crops, since the performance of each technology/mana-
gement regime varies with different crops.

79. These limitations are set forth in individual permits issued
and administered by state or federal agencies under the NPDES.
Other types of permits include general permits (e.g., storm water
permits) that do not specify effluent limits.

80. See discussion infra Part V. In the early 1980's, the State
Water Resources Control Board was preparing to issue such a per-
mit for agricultural discharges at the terminus of the San Luis
Drain. The process was cut short when the disaster at Kesterson
occurred. See STATE WATER RESOURCES CONTROL BOARD, INTERIM
GUIDANCE ON POSSIBLE WASTE DISCHARGE REQUIREMENTS FOR THE
PROPOSED SAN LUIS DRAIN (1983).
regulation depends on the ability of regulators to identify monitorable discharge points and to assign responsibility for discharges from those points to districts or individual farmers. Today, discharges from districts in the Grasslands are monitored pursuant to requirements imposed by the RWQCB. Monitoring discharges from individual farms is both more expensive and more difficult.\textsuperscript{81} Irrigation water inputs can be used as a surrogate for drainage outputs at the farm level, however, because irrigation water deliveries are easily monitored, and selenium loads in drainage water are a function of the amount of irrigation water inputs. Thus, if the relationship between water inputs and selenium outputs can be predicted, water inputs can be used as an alternate measure of pollution load.\textsuperscript{82}

Because selenium loads are the product of both the concentration of selenium in the drainage water and the quantity of drainage water produced, both parameters must be addressed in order to derive the surrogate measurement. The relationship between irrigation water inputs and the concentration of selenium in the drainage water has been determined with sufficient accuracy to derive an input surrogate.\textsuperscript{83} Selenium concentrations in drainage water vary significantly in different areas, however. Much of this difference can be predicted from location (for example, land on an ephemeral fan or at the edge of an alluvial fan), depth of groundwater, and from selenium concentrations in shallow groundwater. Other variables that cause differences in selenium concentrations on different farms include the age of the drainage system, the length of time the land has been irrigated, and other factors.\textsuperscript{84} If field-to-field precision in selenium concentrations is necessary, the easiest method to establish the surrogate would be to survey the selenium concentrations in drainage from various fields. In some districts, these data are already available.\textsuperscript{85}

The predicted selenium concentration in drainage water is then used to calculate the amount of drainage water that can be produced and still comply with the allowable pollution load. To derive the input surrogate, the remaining step is to relate the amount of drainage produced to the amount of irrigation water used. This relationship is conceptually straightforward: using less irrigation water creates less drainage water. Quantitatively, an average relationship between the allowable quantity of drainage water and the corresponding amount of irrigation water that can be applied during the growing season can be derived for each crop.

Once calculated, the input surrogate is relatively straightforward to use. Surface water deliveries to farmers are already metered (or soon will be) at the farm or field level. If groundwater prices become competitive with those for surface water, groundwater use also should be accounted for. Although few districts currently require formal reporting of groundwater use, recent changes in state groundwater policy\textsuperscript{86} allow districts to adopt groundwater management programs that may require such reporting.

Although the input surrogate can be derived for each farm or field, using the surrogate at the district level in conjunction with traditional permits, effluent fees, or tradable discharge permits at the farm level generally would not require such precision. Rather, the average relationship within a district or the region could be used as a basis for farm-level limits. The use of a district-wide average considerably simplifies the calculation of the surrogate, because variations in drainage flows and selenium

\textsuperscript{81} Measuring the amount of drainage water that is collected by the subsurface farm drains is relatively straightforward technically and can be accomplished by using flow meters at sumps, electrical records of sump pump operation, flumes equipped with measurement gauges in gravity-flow drains, and/or saddle meters on pipelines. Installation of these devices and periodic recording of these measurements would, however, be a new and perhaps significant expense.

To determine the selenium loads exiting the drains, the concentration of selenium (which varies by at least two orders of magnitude across the region) must also be measured. Although several factors influence the concentration of selenium in drain water from a particular field at a particular time, the average concentration of selenium in drain water from a single field or farm would not be expected to vary significantly over time and could be characterized by relatively few concentration measurements.

\textsuperscript{82} See Young & Congdon, supra note 50, at Appendix A (discussing the methodology for calculating an input surrogate for drainage outputs).


\textsuperscript{86} See CAL. WATER CODE §§ 10750-10767 (West 1984).
concentrations are attenuated when all of the individual sources are combined.\(^7\)

Finally, an "input surrogate" provides a mechanism for incorporating farms without drains into the regulatory system. Accordingly, the RWQCB presently could issue a waste discharge requirement (hereinafter "WDR")\(^8\) to districts or individual farmers and establish an enforcement fine or penalty.

3. Tradable Discharge Permits

Under a system of tradable discharge permits, the regulatory agency establishes the total allowable pollution load, or "cap," and allocates this "cap" among districts or farmers in individual permits.\(^9\) For purposes of this study, the allocation is assumed to be assigned, or "grandfathered," to districts according to one of the allocation scenarios presented in Part III. Farm-level allocations could be assigned regionwide to a similar method or they could be assigned by the individual districts.

After the initial allocation, districts and farmers may buy and sell allocations (or portions thereof). Water districts and farmers that face lower pollution control costs or that choose to control pollution beyond the level specified in the allocation may reduce their own pollution more than initially required and then sell excess allocations. Districts and farmers with higher abatement costs have the option of buying allocations rather than investing in pollution control. The price and ultimate distribution of pollution permits (and therefore abatement responsibility) is determined through these market transactions. In essence, the market provides an opportunity for cost-sharing\(^1\) between districts (or between farmers) that face different marginal pollution control costs. Total permitted discharges may not exceed the pollution cap, however, and any expansion in irrigated acreage would be accommodated through purchases of existing allocations.

To enable the trading system to function smoothly, limitations on trades and regulatory interference in trading transactions must be kept to a minimum.\(^9\) In the Grasslands region, rules for trading would primarily pertain to temporal restrictions to ensure compliance with yearly and seasonal load limits. For example, a wintertime allocation could not be purchased for use in summertime. Nor could an allocation for one year be purchased for use in a different year.\(^9\)

Regulatory oversight of district and farm pollution discharges is similar under tradable permit and traditional permit systems, because the ability to monitor and enforce pollution discharge limits is central to each. This can be accomplished by monitoring pollution load outputs at the district level or monitoring irrigation water inputs (as a surrogate) at the farm level in the manner described above for traditional permits.

4. Fees

The types of fee programs that could be used to regulate drainage in the Grasslands include both effluent and input fees, inasmuch as both drainage outputs and irrigation inputs can be monitored and enforced, and both are directly correlated with drainage generation. Water pricing requires monitoring water supply or water use and establishing a relationship between water inputs and drainage outputs. Effluent fees require monitoring effluent quantity and quality. Effluent fees also could be based on an "input surrogate," making them substantially equivalent to input fees, as well as enforceable as a pollution control requirement.

Effluent fees would be levied on agricultural drainage discharges at the farm or district level based on measurements at an identified ditch, sump, or other discharge point. As noted above, measurements of district discharges already are available and either could be instituted for individual farms or could be estimated based on a surrogate measurement. The fee could be imposed on pollutant loads (e.g., pounds of selenium) or drainage flows, although the latter requires the determination of a relationship between flows and loads. District-level fees would be set by the regulatory agency; farm-level fees would be set either by

87. Devenel et al., supra note 84.

88. WDRs are the state equivalent of NPDES permits under federal law pursuant to which the federal EPA or state agencies assign pollution control responsibility to point sources. See discussion infra Part V.

89. Alternatively, a regional entity such as a Regional Drainage District could perform the allocations. See discussion infra Part V.

90. This use of the term "cost-sharing" occurs in the literature on tradable permit systems. See supra, supra note 39. It does not refer to cost-sharing between the federal government and state or local agencies.

91. A number of additional factors are important in determining the feasibility of using tradable discharge permits, including a clear definition of the nature of permits to be traded, the "thickness" of the market (e.g., the number of players), and market structure and operation. A discussion of these factors is presented later in this chapter in relation to a proposed tradable permit system among water districts in the Grasslands region.

92. These restrictions are required in the Grasslands as a result of the variable flows of the San Joaquin River. It is likely that similar temporal restrictions would apply to other regions adopting trading programs where the wasteload allocation varies with river flow.
the regulatory agency or by the districts.\textsuperscript{93}

The level of the effluent fee initially would be based on estimates of the additional cost necessary to cause water districts and farmers to reduce pollution loads enough to meet environmental goals. The fee level could be adjusted if the load reductions affected by the initial fee was insufficient to meet the pollution objective, if the number of irrigated acres in the region increases, or if changes in other economic factors caused farmers to use more or less water.

Input fees would be levied by the responsible agency and correlated with the pollution limits to be regulated.\textsuperscript{94} To make an input fee program most effective, groundwater (which currently is not metered) would have to be accounted for. Similarly, because water transfers play an increasing role in the distribution of agricultural water supplies in California, this source of water inputs also would have to be considered. To date, these water substitutes have not been price-competitive with scheduled surface water deliveries.

Input and effluent fees may be imposed either as a flat fee or as a block-rate (or "tiered" fee) that increases with the size of the pollution load. In effect, increasing block-rate fees are a graduated tax, with higher end-rate surcharges compensating for lower initial-block rates. Compared to a uniform, across-the-board surcharge, tiered fees are a less efficient incentive. With a uniform surcharge, the marginal cost of pollution (or marginal benefit of water conservation) is equal across all farms. With tiered water rates, the marginal benefit varies according to the level of use, with the result that some farmers have less incentive than others to adopt equally efficient conservation measures.

Another issue critical to the use of fees is the ultimate disposition of the revenues collected through the fee system. Fees collected by a government agency typically do not remain within the community. Alternatives for returning revenues back to the community (according to a formula that does not negate the incentive) might increase the acceptance of a fee-based program. For example, districts could use revenues to fund a "bank" that guarantees loans for capital-intensive improvements in irrigation systems, to finance land falling or to provide environmental enhancement or mitigation. Some portion of the fees also could be used to fund the operation of a Regional Drainage District.\textsuperscript{95}

B. Comparison of Regulatory Options

A successful pollution control program for the Grasslands region must meet two goals: (1) Pollution reduction targets must be achieved. (2) The regulatory system should be easy to implement and to administer. These goals, and by extension the interests of each of the major stakeholders, can be formalized into a set of criteria that provide a framework for evaluating regulatory options:

- ability to meet the environmental goal;
- cost-effectiveness;
- compatibility with the regulated community;
- equity;
- verifiability; and
- ease of administration.

Evaluation of the regulatory options discussed above on the basis of these criteria demonstrates that a system of tradable discharge permits offers the best means of addressing the drainage problem in the Grasslands region.

1. Ability to Meet the Environmental Goal

In the Grasslands region, and in other areas where water quality standards currently are not met, the dominant regulatory objective is to comply with a specific load allocation, or pollution "cap." Among the options considered in this Article, only the traditional permit and tradable permit programs are explicitly designed to meet a loading cap. BMPs and fees enforce a cap indirectly by altering irrigation practices. The ability of these programs to meet the specific target depends, however, on the accuracy of the program design. Unfortunately, such accuracy is difficult to achieve, because of the physical heterogeneity (in the case of BMPs) and economic heterogeneity (in the case of fees) of the farming industry.

Meeting the cap with BMPs or fees is rendered ever more difficult by the nature of the pollution abatement options. Pollution is reduced by increasing irrigation efficiency. The efficiency of irrigation practices depends, however, both on the technology (equipment that is verifiable) and on how the technology is used and maintained (factors that are not readily verifiable). The wide variation in

\textsuperscript{93} Again, assignment and collection of fees can also be performed by a Regional Drainage District. See discussion infra Part V.

\textsuperscript{94} The importance of water pricing as a tool for correcting drainage-related water quality problems is corroborated by several studies and, to a lesser extent, by district practices. A study on irrigation-induced water quality problems by the National Research Council concluded that "the most pervasive economic issue contributing to irrigation-related water quality problems and affecting the choice and success of solutions is the cost of water." NATIONAL RESEARCH COUNCIL, IRRIGATION-INDUCED WATER QUALITY PROBLEMS: WHAT CAN BE LEARNED FROM THE SAN JOAQUIN VALLEY EXPERIENCE (1989)

\textsuperscript{95} See discussion infra Part V.
drainage output that results from using the same equipment at different management levels (see Figure 4) makes it difficult to choose a BMP or fee to meet a specific target. For example, a regulator might require a relatively affordable BMP or fee and risk exceeding the pollution cap by a dramatic margin. Alternatively, the regulator might require a more sophisticated technology to increase the probability of meeting the pollution cap, which would significantly increase the costs of pollution control.

In short, reliance on BMPs or fees to achieve pollution goals poses an implicit trade-off between affordability and effectiveness. This trade-off, which is clear in the Grasslands, refutes the widespread assertion that tradable discharge permits necessarily compromise environmental protection and that BMPs and fees are a preferable means to accomplish pollution reduction.

Under a system of tradable permits, meeting the environmental goal would not be as problematic. Permit programs are explicitly designed to guarantee that the pollution cap is met (assuming the program is enforced), so they do not depend on predictions of how a technology will be managed or on estimates of the effects of fees. They also do not require farmers to implement any specific technology, but instead allow them to select among all of the available irrigation technology and management options. The farmer therefore has the flexibility to choose the system best suited to site-specific conditions and to operate it in accordance with changing circumstances.

In the case of trading programs between point and nonpoint sources, it has been argued that trades involving nonpoint sources compromise pollution control because of the uncertainties inherent in regulating these sources. This observation pertains only to situations where specific effluent limits (for point sources) are "traded" for BMP implementation (for nonpoint sources), however, and the performance of BMPs varies according to site-specific conditions and implementation. See Bartfeld, supra note 16.

Figure 4. Adjusted Deep Percolation* of Irrigation Technologies Used for Cotton

* ADP = total deep percolation - 0.3 af/acre average leaching requirements. In the case of Surge-4Drip, Linear, and LEPA technologies at high management levels, negative ADP indicates that applied water is less than the sum of crop requirements and leaching requirements.

96. More specifically, in the Grasslands a BMP program designed to meet an average farm-level goal of 0.25 af/acre of ADP might require cotton farmers to use surge irrigation with quarter-mile furrows (Surge-4) and risk exceeding the pollution cap by as much as 250%. Alternatively, a regulator might require linear-move sprinklers (a more sophisticated and expensive technology), be fairly sure of meeting the pollution cap, and nearly double the cost of pollution control.

97. In the case of trading programs between point and nonpoint sources, it has been argued that trades involving nonpoint sources compromise pollution control because of the uncertainties inherent in regulating these sources. This observation pertains only to situations where specific effluent limits (for point sources) are "traded" for BMP implementation (for nonpoint sources), however, and the performance of BMPs varies according to site-specific conditions and implementation. See Bartfeld, supra note 16.
ing wet and dry year pollution-reduction goals. Individual dischargers also have the option to buy and to sell pollution discharge allocations, provided that the sum of the allocations (and therefore discharges) remains unchanged. With this flexibility, a tradable permit program avoids the trade-off between environmental effectiveness and cost-effectiveness.

A common criticism of tradable permit systems arises, however, where pollution discharges from one source are more damaging to the environment than are discharges from another source, because of proximity to a sensitive receptor. Under these circumstances, a trading system might result in the reallocation of pollution discharges to areas where the pollution is more damaging. In river basins, this often is referred to as the “upstream-downstream” problem. Environmental harm and injury to public health also could result from trades if pollutants became concentrated at one location, or pollution “hot spot.”

Under these conditions, tradable permits could meet an overall pollution cap but would not provide the same amount of environmental protection as a traditional permit system. Such problems could be minimized by appropriately defining the geographical boundaries for trading, by assigning weighting factors to account for upstream-downstream locations, and by restricting trades quantitatively to avoid hot spots.

In the Grasslands, these problems do not arise, however, because all of the drainage from the region is collected into one or two channels well upstream of where they enter the San Joaquin River. Thus, trading among agricultural dischargers upstream of the points of discharge to the river would not alter the effects of the discharge on the river.

2. Cost-Effectiveness

The costs of a regulatory program can be measured either in terms of the costs to the regulated community or the total costs to society (which also include the costs of administering the regulatory program and the costs to other affected parties). In practice, however, the costs to the regulated community are most often the principal determinant of public acceptance of a given program. Accordingly, the appropriate cost criterion for comparing regulatory options for the Grasslands region is the cost to the regulated community of achieving the pollution cap.

Incentive programs such as tradable permits and fees are cost-effective, because they encourage each discharger to control pollution to the point at which the marginal cost of abatement is equal to the marginal benefit. Within the industry as a whole, pollution control costs are distributed according to the response of individual dischargers to the market signals or fees.

With a tradable permit system, farmers with low pollution control costs are encouraged to abate more than the average amount required and benefit from selling excess allowances; farmers with higher pollution control costs are allowed to abate less than the average amount required and to purchase the necessary additional allowances. By allowing farmers with the lowest costs to abate the most, the tradable permit system, in effect, “buys” the desired level of pollution control at the lowest possible price.

Theoretically, fee-based systems also take...
advantage of marginal cost differences. Here, farmers with low pollution control costs are likely to abate more in order to avoid paying fees, while farmers with higher pollution control costs likely will abate less and pay greater fees. Again, the aggregate pollution control costs for the community should be minimized.

In practice, however, tradable permit systems are more likely to result in cost-effective regulation than fee-based systems. This is true because pollution allowance trading allows the separation of "who pollutes" and "who pays" in a regional system of cost-sharing, which improves the chances that the theoretical cost savings will be realized. Moreover, under a fee-based system, farmers pay both for pollution control and for pollution. Only if revenues from pollution fees were rebated as a lump sum to the community (without undermining pollution control incentives) would the total cost to the regulated community of fees and tradable permits be comparable.105

In contrast, uniform pollution abatement requirements such as BMPs do not distinguish among the costs to individual dischargers, nor do they allow pollution control costs to be redistributed among dischargers. Consequently, BMPs cost the regulated community more than a comparable incentive-based program for achieving any pollution goal.106

The differences in marginal pollution control costs among dischargers are the source of cost savings under all incentive-based systems; the magnitude of potential cost savings is a function of the magnitude of the marginal cost differences among dischargers. Thus, significant cost savings have been predicted in the point/nonpoint source permit trading programs studied to date, where industries facing very high control costs (the point sources) are expected to trade with unregulated nonpoint source industries that have not yet made any pollution control investments and, therefore, still face relatively low marginal pollution control costs.107 In the Grasslands region, however, all of the sources to be regulated are in a single industry. Therefore, significant cost savings can be expected, not as a result of dramatic cost differences among industries, but as a result of aggregating a large number of relatively small cost differences within the regulated community.108

To determine whether these cost savings would be significant, it is necessary to compare the costs of using tradable discharge permits and BMPs to achieve a regional pollution control objective. Because drainage abatement is accomplished by improving irrigation efficiency, irrigation system costs are used to compare pollution-control costs under the programs. As a result, some of the costs attributed to the two regulatory systems are actually routine costs of farming and do not represent the costs due to environmental regulation.

The results indicate that use of tradable discharge permits or fees among districts can yield savings of up to twenty-three percent, depending on the pollution-control target. Application of these economic incentives both among districts and within districts may yield even greater savings, again depending upon the particular pollution target (Figure 5). Regardless of the pollution goal chosen, however, BMPs always appear to be less cost-effective than the economic incentive options. (Figure 6)109

3. Compatibility with the Regulated Community

The tradition of independence in farming argues for a regulatory approach that is flexible and decentralized. Moreover, the agricultural industry is diverse and is influenced by a number of external and variable factors, including crop market conditions (e.g., prices and contracts); climate; water supply, quality, and cost; energy prices; interest rates; and regulatory requirements. From the farmers' point of view, therefore, the optimum regulatory program would allow decisions about pollution control to be made in conjunction with other production decisions related to these variables.

All of the incentive-based options discussed above would allow farmers and water districts flexibility to adjust pollution control decisions to respond to changing conditions. This is because economic incentives rely on price signals to determine when and how much to reduce discharges; yet they also allow farmers to decide the optimal method of compliance. Thus, the preservation of flexibility under an incentive-based program does not imply a compromise in effective pollution control. Pollution control can be achieved without

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105. The indirect costs of the two systems might still differ, depending upon, for example, the need to adjust the fee in response to changes in economic conditions.

106. Tietenberg, supra note 100; Stavins & Whitehead, supra note 38; Hahn & Noll, Year 2000, supra note 39.

107. Bartfeld, supra note 16; Yandle, supra note 39; APoGEE Research, Inc., supra note 37; APoGEE Dillon, supra note 42; APoGEE:

108. The actual savings with trades may be limited by the capital constraints on farmers in the short term. In the long term, however, actual savings will be greater as capital constraints are overcome. Tietenberg, supra note 39.

109. For a more detailed analysis, see Young & Conzob, supra note 50.
Figure 5.
Regionwide Pollution-Control Costs

Figure 6.
Regionwide Pollution-Control Costs
"telling farmers how to farm."

In contrast, a centralized program of mandatory BMPs is unlikely to satisfy the farmers' preference for flexibility and independence and still be effective in meeting the environmental goal. The common perception that BMP programs are flexible is due mostly to the use of broadly-defined BMPs. Where requirements are general enough to be adaptable to a wide range of conditions, however, they also tend to undermine the ability of BMP programs to meet pollution control objectives. If more specific requirements are employed (e.g., mandated technological improvements), BMPs are likely to be objectionable to farmers for two reasons. First, they do not take into account the significant physical and economic differences among farms. Second, they may inhibit the ability of farmers to respond to changing economic, environmental, or technological conditions because of "sunk" capital costs.

Incentive-based programs also provide a direct financial incentive (e.g., avoided costs of effluent or input fees or supplemental income gained from the sale of discharge permits) to reduce discharges below the required level or to invest in improved control technologies. In contrast, technology-based BMPs could discourage experimentation with new technologies, because successful demonstration of more efficient controls might lead to a new, more stringent standard.

4. Equity

The goal of an equitable regulatory program is to ensure that each polluter is responsible for his or her share of the required level of pollution abatement. In the Grasslands, disagreements over the sources of subsurface drainage could lead to a perception that pollution control assignments are unfair. The problem arises from the common assumption that unmeasured quantities of subsurface drainage water migrate downslope. Although experts dispute the significance of this lateral migration, the potential for perceived inequities must be accounted for when allocating responsibility for drainage management among water districts and individual farmers.

Programs that rely on direct measurement and enforcement of farm-level drainage outputs will appear inequitable if the quantities of subsurface drainage collected from a given field or farm do not correspond to the amount of drainage generated in that location. Effluent fees and tradable discharge permits can use water inputs as a surrogate for drainage outputs, however, and thereby avoid this problem. Similarly, either farm-level BMPs or farm-level input fees can avoid penalizing farmers who may be the recipients of others' pollution. Any of the regulatory programs implemented at the district level also can compensate for an "upslope-downslope" problem by using historical (unregulated) discharges as the basis for assigning pollution control responsibility.

"Equity" also can be achieved by equalizing the costs of pollution abatement for dischargers. Uniform, technology-based BMPs appear to be equitable, because all regulated parties must invest in the same control measures. In practice, however, a system of mandatory BMPs may have significantly different economic effects on individual farmers because of variations in other production factors, in

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110. A frequently cited advantage of incentive programs is that they encourage the discovery of more effective and less costly abatement technologies and/or practices by the dischargers who have the best knowledge of and experience with abatement options, and who stand to gain from such innovations. See M. Cropper & W.E. Dates, Environmental Economics: A Survey, 30 Journal of Economic Literature 675 (1992); Tiernan, supra note 39. This advantage was demonstrated when the recent drought and changing economic conditions caused some farmers in the Central Valley to innovate. For example, in 1985, most farmers in the Grasslands region used half-mile furrows at a low management level to irrigate row crops such as cotton. By 1992—after six years of drought, during which water deliveries eventually were reduced by more than half and districts adopted tiered water pricing and other conservation-oriented programs—90% of the farmers growing cotton in Broadview Water District had adopted quarter-mile furrows, 28% percent were irrigating alternate furrows, and most had reduced pre-irrigation. Similar changes were observed for tomato and melon farmers in the district. These innovations are similar to measures taken by farmers in the other districts in response to the 1986-92 drought. Other responses included crop switching, improved irrigation scheduling at the farm level, and changes in district water delivery schedules. N. MacDougall et al., The Economics of Agricultural Drainage (1992); S. Archibald, An Economic Analysis of Water Availability in California Central Valley Agriculture, Testimony to the State Water Resources Control Board During the Consideration of Interm Water Rights Actions (June 26, 1992).

111. The principal concern about equity is the question of "who pays" for pollution control. The issue can be defined more broadly to include potential impacts on consumers and farm-related industries as well as on the agricultural community. To the extent that changes in drainage management result in substitutions in irrigation practices or otherwise increase the "costs of doing business," these costs may be passed on to consumers or related businesses.

112. Disputes over drainage generation between the upslope lands within the Westlands Water District and downslope lands within the several low-lying districts of the Grasslands region have been the subject of various and ongoing legal proceedings.

113. To some extent, the "upslope-downslope" problem can also be addressed through institutional means. For example, the downslope districts in the Grasslands have organized themselves informally as the "Grassland Basin Drainers" for purposes of participating in various drainage management projects. The institutional capacity for addressing this and other perceived sources of inequity among dischargers would be enhanced with the creation of a regional drainage district composed of all the contributing sources in the region. Institutional considerations are the subject of Part V.

114. See discussion supra Part III.

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physical conditions, and in profit margins. Incentive-based programs, by contrast, tend to equalize marginal costs but enable dischargers to adopt different levels of pollution control.

Among incentive-based programs, one of the primary equity considerations involves the transfer of wealth out of the community. For fee-based programs, the ultimate disposition of revenues collected is often at issue. Typically, effluent and input fees result in a net transfer of wealth out of the community in the form of payments to the government. If a program were designed in which the fees were imposed on farmers by the water district, then the revenues would remain within the regulated community.

Because pollution sources in the Grasslands region currently are unregulated, the initial allocation of discharge permits represents a significant assignment of wealth. Whether this wealth remains with the regulated community or is transferred out of the community to a regulatory agency would depend on the program design. Allocation methods that involve no net transfer of wealth to the government include: (1) revenue-neutral auctions, in which the proceeds collected from the initial auction of discharge permits are redistributed to the community in one way or another; and (2) "grandfathering"—a method of distributing allowances according to acreage or historical patterns of discharge. The latter option is more likely to be supported by the existing agricultural dischargers in the Grasslands region. Indeed, an initial allocation based on historical discharges would mean that few, if any, of the dischargers would have to assume costs for pollution abatement greater than the costs they would face under a traditional permit program or fee system.

Once the initial allocation is complete, the revenues from a trading program automatically stay within the community and are transferred among participating farmers or districts as a form of cost-sharing. Regionwide, all sources participate in financing pollution control, but some are buyers and some are sellers of permits.

5. Verifiability

An essential component of a successful regulatory program of any kind is the ability to verify that farmers and districts are complying with pollution control requirements. Verification of farm-level BMPs is relatively simple, because BMPs usually consist of prescribed technologies or farm management techniques. In contrast, traditional permit programs, tradable discharge permits, and other incentive-based programs must provide some collateral means of measuring and verifying farm-level pollution.

In the Grasslands region, verification of compliance with a permit or fee program would require direct measurement of drainage outputs or indirect measurement using water inputs as a surrogate. In this region, subsurface drainage is collected in sumps that correspond to several fields or farms. The drainage then flows to collector drains and is subsequently discharged from the district at an identifiable point. Most surface drainage (i.e., tailwater) is collected and recycled at the farm level, but some surface drainage (which contains little selenium) is blended with the subsurface drainage within the districts. District discharges then flow through a labyrinth of ditches before they are conveyed to the San Joaquin River via Mud Slough and Salt Slough.

A monitoring and metering system is in place to measure the combined surface and subsurface drainage outputs, both at the district discharge points and at the points of discharge to the two sloughs and the San Joaquin River. The current monitoring system makes it possible to verify drainage outputs (including selenium loads) at the district level. Indeed, monitoring data have been collected on a monthly basis at district outlets since 1985.

Drainage outputs are not measured at the individual farm level in most districts. To determine drainage outputs from farms, improved drainage collection and monitoring could be installed, but only at considerable expense. A far easier and

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115. Potential equity problems also may arise with performance-based BMPs in the Grasslands where returns to farm-level and management vary because of high water table effects. See D. Wichelns & M. Weinberg, Economics of Agricultural Drainage Policies, 44 CAL. AGRICULTURE 8 (1990).

116. See discussion supra Part III (regarding equity effects of allocation options).

117. See Tietsenberg, supra note 39 (discussing the distribution of financial burdens).

118. Most if not all districts in the Grasslands require farmers to employ tailwater return systems as a matter of district policy.

119. See discussion supra Part II; see also Young & Congdon, supra note 50.

120. GRASSLAND WATER TASK FORCE, GRASSLAND AREA MONITORING REPORT (1989) (hereinafter "GRASSLAND 1989 REPORT").

121. Presently, approximately one half of the acreage in the Grasslands region is underlain by subsurface tile collection systems that convey drainage by gravity to sumps serving several fields and/or farms. Distinguishing the discharges of individual farms would require either reconfiguration of the collection systems with sumps for each field (or farm) or drainage flow measurements at each farm boundary.
less expensive option for farm-level metering would be to use water inputs as a surrogate for drainage outputs.\textsuperscript{122} Many districts already meter water inputs at the field level, and recent federal and state policies for improved water management include metering requirements.\textsuperscript{123} Monitoring of surface water deliveries would have to be combined with monitoring of groundwater use to account for all irrigation inputs.\textsuperscript{124}

In sum, the monitoring and enforcement requirements of any program could be met at the district level under existing conditions. BMPs and input fees would be readily verifiable at the farm level, as well. A tradable permit or effluent fee program would be verifiable with improvements in farm-level drainage metering capacity. If groundwater were metered, however, measurement of water inputs as a surrogate for drainage discharges would be preferable at the farm level.

6. Ease of Administration

Agricultural pollution cannot be regulated effectively unless individual farmers become responsible for pollution control. This requirement gives rise to the most frequently cited obstacle to any system of regulation of agricultural pollution—viz. the administrative difficulty of tracking and enforcing hundreds or thousands of individual discharges. Just as an incentive-based program is more compatible with the needs of the regulated community, administrative burdens also would be minimized under a regulatory program that provides incentives to farmers to make independent decisions that collectively meet the environmental goal.\textsuperscript{125}

Both tradable permits and fee-based systems equate the farmer's economic self-interest with environmental protection by providing financial rewards for reducing pollution. By motivating farmers to comply with pollution reduction requirements, incentive systems should minimize the enforcement burden.\textsuperscript{126} In contrast, BMP and traditional permit programs rely solely on threat of enforcement to assure compliance.

Another key to reducing the administrative burden is to build on existing institutions and existing programs as much as possible.\textsuperscript{127} Existing water supply and drainage districts are a logical choice to administer any of the proposed drainage regulatory programs, because they already perform similar administrative functions and have well-developed relationships with individual farmers.\textsuperscript{128} In addition, much of the necessary legal authority for undertaking these pollution control responsibilities is already in place.\textsuperscript{129} Districts also could implement BMPs or input fees at the farm level with comparative ease.

In contrast, effluent fees would require additional monitoring and perhaps the development of an input surrogate. Tradable permits at the farm level would be more cumbersome to administer because of the additional reporting requirements and the need to coordinate and oversee transactions among farmers.

Implementation by the RWQCB of any of the district-level regulatory programs discussed here would be fairly simple given the limited number of entities involved and the ease of monitoring both drainage outputs and water inputs.\textsuperscript{130} Administration of a system of tradable discharge permits, record-keeping and enforcement system run by another agency.

122. The surrogate does not account for the relative selenium contamination of drain water from different fields, unlike a direct measurement of drainage flow and selenium concentration. However, average shallow groundwater contaminant levels could be used to weight the water input measurements. See discussion of input surrogates earlier in this Part.

123. Section 3405(b) of the CVPIA requires measurement of water deliveries for all surface water delivery systems within a contracting district's boundaries. At the state level, agricultural districts have been negotiating a Memorandum of Understanding (hereinafter "MOU") for improved water management that includes metering of water deliveries. CAL. WATER CODE § 1003 (West Supp. 1995).

124. Groundwater is used by farmers in every water district to supplement surface water deliveries and can readily be monitored based on direct flow measurements or electricity use at pumping locations.

125. Other requirements for establishing accountability at the farm level are discussed in Part V.

126. For the same reasons, incentive systems arguably speed the initial compliance with the regulatory limits. See Tietzenberg, supra note 39.

127. For example, the nce herbicide control program in the Sacramento Valley of California is "piggybacked" on an existing record-keeping and enforcement system run by another agency.

128. Existing drainage districts and water districts currently have varying degrees of authority over and involvement in drainage management. Most of these public entities have some drainage policies in place, including mandatory tillage water recycling at the farm-level, moratoria on district financing of additional subsurface drainage systems, annual drainage management fees, and metering of water inputs. A number of districts are managing drainage far more intensively than others. For example, Broadview Water District has developed a data management system to keep track of farm-level water use, drainage quantity and quality at individual sumps, and crop production. BROADVIEW WATER DISTRICT, supra note 84. This system is compatible with the monitoring requirements of the incentive-based pollution control programs. Similarly, farmers are required to submit annual crop plans to the district prior to the pre-irrigation season. The plans currently are used to inform farmers of the practices and efficiencies of their neighbors in order to encourage greater efficiency district-wide. This approach could be broadened to include reporting of irrigation technologies, with a schedule for district verification, under a BMP program.

129. See discussion infra Part V.

130. The drainage operation plans already required of each water district could provide a framework for administering district-level programs. Drainage operation plans might have to be amend-
however, could require additional regulatory involvement, depending upon the program design. The critical issues for designing an effective tradable permit program are discussed in the following section.

C. A Tradable Discharge Permit System for the Grasslands

As shown in Table 10, a district-level tradable discharge permit program would best satisfy each of the criteria described at the outset of this section:

- The allocation of tradable permits among districts would be based on a predetermined pollution cap to ensure that the water quality objectives for selenium in the San Joaquin River are met in different water-year types and irrigation seasons.
- The cost-effectiveness of this program stems from the reliance on incentives to encourage a cost-minimizing allocation of pollution control responsibility among districts (using tradable permits) and farmers (using input fees).
- The decisionmaking flexibility afforded by this program, including the opportunity for each district to determine the most appropriate system of tiered water prices, conforms to the characteristics and preferences of the regulated community.
- Equity issues related to the “upslope-downslope” migration of subsurface drainage and to differences in past investments in pollution control would be addressed through the initial allocation of

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<th>CRITERIA</th>
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<th>Input Fees</th>
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Table 10
Comparison of Regulatory Options
permits among districts and the opportunities for cost-sharing among districts and, by extension, among their farmers.

- Compliance with the water quality standard in the river and with the district load limits established through trades is verifiable with the existing monitoring system in the Grasslands. At the farm level, monitoring of water deliveries (which can be correlated with drainage discharges) is widely practiced and is likely to increase in response to other legal requirements and policies.

- While the introduction of any regulatory program would create new responsibilities for the regulatory agency, the incentive structure of the proposed program, its compatibility with existing agricultural programs and policies, and the familiarity of regulators with permit systems and tiered water pricing all work to minimize the burden on regulators and districts. The creation of a regional drainage district to oversee the program would further ease the administrative burden.131

How the trading system would function in practice, or whether it would work at all, depends of course on how the program is implemented and administered. An extensive body of literature describes the conditions required for an effective tradable permit program.132 In terms relevant to the Grasslands, they are:

1. a defined environmental goal;
2. a potential for cost savings based on differences in marginal pollution control costs among farmers;
3. the capability to identify and quantify agricultural pollution sources;
4. the ability accurately to monitor discharges.

ed to include more specific and mandatory reporting guidelines. From the districts's perspective, many of the administrative requirements of a drainage management program could be integrated with existing activities, such as water contract renewals and water conservation planning requirements for water districts served by the CVPIA §§ 3403 & 3405(e), or they could be implemented as part of the proposed MOU for agricultural water suppliers regarding the implementation of Efficient Water Management Practices. Cal. Water Code § 10903 (West Supp. 1995).

131. See discussion infra Part V.


133. The significance of transaction costs for the performance of pollution markets is discussed in the literature. Analyses of the Fox River pollutant trading program cite high transaction costs and uncertainty over the future value of permits as the primary reasons for the program's failure. See Hahn, supra note 38; Bartfeld, supra note 16. By contrast, the combination of minimal administrative requirements and general familiarity with trading partners is cited as the reason for the high number of trades and overall success of EPA's 'inter-refinery averaging' taxed gasoline trading program. See Cropper & Oates, supra note 110.

134. In general, the reliance on a market-maker also hastens the market permit price towards its equilibrium by facilitating a sufficient number of early transactions. Hahn & Noll, Market Design, supra note 39; H Taylor, Experimental Economics: Putting Markets under the Microscope, in BUSINESS REVIEW 15 (1933).

to ensure compliance with permit transactions and with the regional pollution cap;
5. knowledge of the relationship between effluent discharges and water quality consequences so that the problems of "upstream-downstream" effects and "hot spots" can be avoided;
6. market structure and market operation that minimize transaction costs;
7. a sufficient number of participants for a fluid market; and
8. a competitive market.

The first five requirements are met in the Grasslands, as demonstrated by the analysis in the preceding section. The remaining conditions for a functioning market must be addressed in the design of the proposed regulatory program.

1. Minimizing Transaction Costs133

In a trading program for the Grasslands region, transaction costs would be voluntarily incurred. If the initial allocation of discharge permits is generally equitable and acceptable to the regulated districts, few transactions will occur, and market participants will be no worse off under the tradable permit system than they would have been under a mandatory program to reduce drainage discharges. If districts choose to undertake market transactions to adjust their permit allocations, the magnitude of the transaction costs will be a function of the availability of information and program administrative requirements. Therefore, measures to streamline the flow of information should be incorporated into the design of the permit market.

There is a history of cooperation among water district managers in the Grasslands region that would facilitate dissemination of information about permit trading. Search and negotiation costs could be reduced further by relying on brokerage services to identify potential trades and to facilitate transactions.134 In addition to private brokers, a regional drainage district or similar entity could help to
reduce transaction costs by serving as a clearinghouse for information on trading opportunities and terms, by maintaining a periodic schedule for compliance review, and by providing a clear definition of the basis for determining violations and penalties for non-compliance.

Permits also should be freely tradable, both through purchases and leases. Under the proposed trading program, permit leases may be easier to negotiate and therefore result in lower transaction costs than purchase transactions. This is likely to be the case for two reasons. First, the permit holders (i.e., the districts) do not generate or directly control the pollution that is discharged. As a result, the districts would be more likely to negotiate short-term leasing arrangements than commit to the permanent transfers of farmers’ pollution allocations. Second, the variability in the allowable pollution load and the likely reliance on short-term management practices to control pollution would tend to increase the number of short-term transactions.

From the regulator’s perspective, the major transaction cost of a trading program is the administrative cost of approving individual trades. In the Grasslands, however, there is little need for approval of individual trades, because discharges are well-mixed during conveyance in regional drains and are indistinguishable at the point of discharge to the San Joaquin River. Thus, the rules for trading should limit disapproval of trades to instances where the temporal restrictions in the permit have been violated.

2. Market Size
In theory, if a market has too few players (what economists call a “thin” market), transactions may be few and infrequent, leading to higher and more variable permit prices. In a thin market, adverse market behavior by one or more districts also can result in fewer trades and higher transaction costs for each trade.

A trading program among water districts in the Grasslands would involve a minimum of seven participants—the water districts that currently discharge to the San Joaquin River via Mud Slough and Salt Slough. While a market of this size generally is considered thin, seven participants probably is a sufficient number to achieve a cost-effective distribution of pollution control. Moreover, because transactions at the district level would be a function of the actions of a far greater number of farmers, the potential for adverse market behavior would be minimized.

3. Market Competitiveness
Price competitiveness is the sine qua non of a functioning market. To be efficient, the market rules and the value of permits traded in it must be well-established. Uncertainty about allowable pollution loads, for example, would erode the value of the permits traded and undermine credibility in the market. In the Grasslands, however, the variations in river flows and effluent flows are taken into account in the regional loading analysis and would be reflected in the terms of each permit, thus minimizing insecurity over the value of allocated permits.

There are several ways to preserve the value of permits yet let the permit market reflect changes in the allowable pollution loads according to water-year type and irrigation seasons. First, yearly adjustments in the total allowable load (and hence the total number of permits) could be accomplished through the annual participation of the RWQCB in the market. The Board could sell pollution allowances during non-critical water-years to increase the total number of permits to conform with the increased allowable load. Revenues could be rebated to the market participants to preserve the cost-effectiveness of the trading system.

Alternatively, the permits could be allocated according to three classifications—one that would allow continuous uninterrupted discharges, and two that allow discharges only during the appropriate year-type. Priority 1 permits would correspond to the critical-year allocation and would represent discharges that could occur on an uninterrupted basis during the appropriate month regardless of the type of water year. Priority 2 and Priority 3 permits would correspond to discharges that could

135. TiETENBERG, supra note 39.

136. HAHN & NOLL, MARKET DESIGN, supra note 39.

137. Personal Communication with L. Goulder, Professor, Department of Economics, Stanford University (1992); Personal Communication with I. Merrifield, Professor, Division of Economics, University of Texas, San Antonio (1993); Personal Communication with D. Mussatti, Economist, U.S. Environmental Protection Agency, RTP NC (1993) See also YANDLE, supra note 39 (suggesting that market size is less important to market success than the scarcity and security of the tradable permits).

138. In general, the number of players in the market may be larger than the number of permit holders if parties that do not participate in the initial allocation nevertheless participate in the market. A farm-level trading program—which would involve all farmers within the boundaries of the Grasslands region or farmers within individual districts—would result in a substantially larger market, with potentially more than 1000 participants. In the case of the Grasslands region, the market could be expanded to include additional players, such as the Grasslands Water District (a water supplier to private wetlands), unincorporated agricultural lands, portions of the Westlands Water District, or other entities.
take place during more favorable hydrologic conditions. The determination and announcement of the annual allowable load should be timed to coincide as closely as possible with the farmers' crop planning and investment schedule, as well as with district operations.

The competitiveness of the market also is affected by the distribution of power within it. If one or a small number of participants controls the majority of permits, as either buyers or sellers, there is an incentive to behave non-competitively, thereby driving up the permit price. The ability of market participants to influence the market is principally a function of the method of the initial permit allocation. While no single method of allocation is recommended, a distribution rule could be selected that would be acceptable to the participating districts and thus minimize the potential for adverse market behavior. If these concerns are accounted for in its design, a tradable permit market among water districts in the Grasslands would be feasible, effective, and less costly than a more traditional regulatory approach.

In past projects related to drainage treatment and disposal and in their participation in an informal water market, the districts in the Grasslands have shown themselves capable of the level of cooperation a new market would require.

V. THE REGIONAL DRAINAGE DISTRICT

A Regional Drainage District would be the best means of implementing a tradable permit system for the discharge of drainage in the Grasslands region. Although such a system could be directly imposed on the existing water supply and drainage districts by the RWQCB, the creation of a new, regional drainage agency would offer the twin advantages of local autonomy and greater administrative accountability.

Any nonpoint source pollution control program—whether based on technology standards, performance standards, or economic incentives—must have the institutional capacity to make individual sources accountable for the pollution they generate. The presumption that nonpoint sources cannot be held individually accountable for specific pollution control requirements lies behind the exemption in the federal CWA for agricultural drainage and other nonpoint sources from direct regulation and has contributed to the lack of institutional mechanisms to bring about this accountability. This presumption also is at the heart of the present regulatory stalemate in the Grasslands, where individual sources of agricultural pollution have not been regulated despite clear authority in California law to do so.

The regulatory challenge therefore must be redefined. Legal authority must be adequate to allow each of these sources to be regulated directly when necessary, and the regulatory agency must have an effective mechanism for doing so. From the regulator's perspective, the system should be efficient, with as few regulated entities to administer and monitor as possible. From the perspective of the regulated agricultural community, the program should ensure maximum flexibility to take account of farm-level conditions affecting pollution control.

As a practical matter, accountability also will be enhanced if the regulatory system contains an incentive structure that encourages compliance, and if it is implemented through institutions over which the farmers have substantial influence—viz. water and drainage districts. Finally, the regulatory structure should be consistent with the regional nature of the pollution problem to be solved, because subsurface drainage flows are not necessarily confined to the boundaries of a given farm or water district.

These requirements suggest the need for a regulatory framework that includes an intermediate entity (or entities) to provide a link between numerous individual pollution sources and the responsible regulatory agency. The intermediate entity should be directly accountable to the regulatory agency and have clear enforcement authority over the regulated community. At the same time, this entity should be controlled by (or otherwise responsive to) the regulated community. In this way, the need for centralized authority at the state or regional level to ensure compliance is balanced with the efficacy of decentralized, site-specific planning and management.

In the Grasslands region, a Regional Drainage District should be created to serve as such an intermediate entity. The Regional Drainage District would function essentially as a consortium of existing water agencies and drainage districts. The Regional District would have the authority to represent the Grasslands water agencies and farmers.
before the RWQCB and to administer the programs needed to achieve compliance with the environmental objectives for the San Joaquin River. With this arrangement, the Board would not be required to attempt the Herculean task of enforcing effluent limits for hundreds of individual sources. Rather, the Regional Drainage District (in concert with water agencies and drainage districts) would bridge the regulatory "gap" between the RWQCB and farmers.

Figure 7 depicts the institutional roles proposed for the existing regulatory agency (the RWQCB), the Regional Drainage District, the existing water and drainage districts, and the individual farmers in the proposed system. The bold lines represent the primary and expected paths of supervisory and enforcement power. The light lines represent the fallback means of supervision and enforcement. For example, if an existing water or drainage district or individual farmer should fail to implement the required effluent reductions, the Regional Drainage District (or, if necessary, the RWQCB) could impose appropriate sanctions on the agency or on the individual farmer.141

The advantages of this institutional approach are significant. First, the RWQCB would have a better chance of bringing the agricultural sources in the aggregate into compliance with water quality standards because it could concentrate its regulatory efforts on a single entity. The Regional Drainage District would be responsible for complying with the load limits set by the RWQCB to achieve the ambient water quality standards. Second, farmers would remain accountable to the same district managers with whom they work on a daily basis, as well as to one another. In a sense, the Regional Drainage District would be analogous to municipal, publicly owned wastewater treatment works, except that farmers would be both accountable to the Regional District and in control of it through their membership in participating water districts. This arrangement would enhance the incentive for the farm community to cooperate with the regional pollution-reduction program. Moreover, the Regional Drainage District would provide a forum in which the water districts could buy and sell discharge allowances if a tradable discharge permit system were adopted.142

A. The Legal Basis for Regulation of Agricultural Pollution

Since the enactment of the modern CWA in 1972, the principal focus of the nation’s water pollution control efforts has been on the regulation of "point sources" through an elaborate and expensive set of technology-based effluent limitations.143 The "centerpiece" of these effluent controls is the NPDES system, pursuant to which the EPA or state water quality boards may issue permits to dischargers of pollutants into the surface waters of the United States.144 In California, the SWRCB has been granted authority to administer the NPDES permit system through the nine regional water quality control boards.145

141. A regulatory program also could be implemented without direct regulatory involvement by the Grasslands water and drainage agencies (e.g., if adequate legal authority were lacking) or without a regional drainage district (e.g., if a new district is not formed). In any case, it is essential that clear legal authority for implementation and enforcement of pollution control requirements exist between the pollution control agency and the regional and local agencies, as well as each of these and the farmers. See Greg A. Thomas & Michelle T. Leighton-Schwartz, Legal and Institutional Structure for Managing Agricultural Drainage in the San Joaquin Valley: Designing a Future (1993). A. Randall, Alternative Institutional Arrangements for Controlling Drainage Pollution, in The Economics and Management of Water and Drainage in Agriculture (A. Dinar et al. eds., 1991).

142. If a Regional Drainage District is not formed, the RWQCB itself could assign discharge allocations to each of the local districts in the Grasslands region. As described earlier, the contribution of each district that provides drainage service to the farms is already monitored. Since most of the selenium-laden drainage is discharged by seven districts, and there are only fourteen drainage agencies in the region, it should be administratively feasible for the RWQCB to hold the districts individually responsible for meeting the allowed pollution loads. This option would require the RWQCB to establish separate effluent limitations for each district, to monitor each district’s point(s) of discharge, and to enforce the limitations against each district.


144. Clean Water Act § 402.

145. CAL. WATER CODE §§ 13160 & 13370-13389 (West 1992). The NPDES permits issued by the regional boards are known as “waste...
The NPDES program covers all "point sources" of water pollution, which Congress has defined broadly as "any discernible, confined, and discrete conveyance[s]." Thus, the term "point source" includes discharges through pipes, ditches, and channels, and "embraces the broadest possible definition of any identifiable conveyance from which pollutants might enter the waters of the United States." The NPDES permit program does not apply to "nonpoint sources," which (for lack of a better definition) are all sources of water pollution other than point sources.

The exemption of nonpoint source pollution from the NPDES permit system traditionally has been justified on the theory that it is "diffuse"—i.e., it does not enter the surface water system at a discrete and discernible location. This in turn creates two problems. First, the scattered nature of the pollution renders it impractical to establish effluent limitations. Second, it is difficult, perhaps impossible, to trace the pollution back to its numerous sources. Accordingly, it would be unduly expensive to attempt to regulate each source through a permit-based, effluent control system.

Neither of these explanations for the exemption of nonpoint sources is applicable to the Grasslands region. Virtually all of the return flow from irrigated lands in the region enters the San Joaquin River through an elaborate system of tile drains, pipes, canals, and sloughs that easily qualify as "discernible, confined, and discrete conveyance[s]" of the pollution. Although thousands of individual farms generate this tailwater, there are but fourteen local agencies that provide drainage services to these farmers. With almost all irrigation return flow captured in identifiable conveyance facilities before discharge, it would not be difficult to impose effluent limitations on each source at the "point" at which it discharges into the San Joaquin River system. Moreover, with only fourteen agencies with which to deal, it would not be prohibitively expensive to impose VDRs on each agency that provides drainage services. The RWQCB has exempted irrigation return flows in the Grasslands region from the NPDES program and instead has elected to control drainage indirectly through its water quality planning authority.

In its 1989 Water Quality Control Plan for the Central Valley Basin, the Regional Board established ambient water quality objectives for a variety of pollutants, including selenium, and announced an array of actions that it and other agencies may take to achieve those objectives. Among the proposals included in the Basin Plan were:

1. A "favored option" of exporting agricultural drainage out of the basin through completion of the San Luis Drain or another "valleywide drain."

2. Imposition of BMPs, which the RWQCB identified as "principally water conservation measures...applicable to the control of agricultural subsurface drainage."

3. "Annual submittal and approval of drainage operation plans...from all those discharging or contributing to the generation of agricultural subsurface drainage from 1989 through 1993."

4. "As a last resort and where the withholding of irrigation water is the only means of achieving significant improvements in water quality," a request to the SWRCB "to use its water rights authority to preclude the supplying of water to specific lands."

The RWQCB also stated that it would consider establishment of "waste discharge requirements ... to control agricultural subsurface drainage discharges containing toxic trace elements, if water quality objectives are not achieved" by certain dates. Moreover, the Regional Board observed that a "waste discharge requirements" Cal. Water Code § 13374 (West 1992), 146. Clean Water Act § 502(14).


148. See ROGERS, supra note 143, at 147. The California Court of Appeal has stated that "nonpoint sources are defined by obverse inference from the definition of point sources." Tahoe-Sierra Preservation Council v. State Water Resources Control Board, 210 Cal. App. 1421, 1425 n.2 (1989).

149. See ROGERS, supra note 143, at 147; Davidson, supra note 141.


151. See CAL. WATER CODE §§ 13240-13247 (West 1999).

152. CENTRAL VALLEY REGIONAL WATER QUALITY CONTROL BOARD,


153. Id. at IV-5 to IV-22.

154. Id. at IV-8.

155. Id. at IV-18.

156. Id.

157. Id. at IV-15.

158. Id. at IV-18. The dates were January 1939 for molybdenum; October 1970 for selenium in the water supply channels for the Grasslands Water District and for state and federal wildlife refuges; October 1991 for selenium and boron in the San Joaquin River between its confluence with the Merced River to Vernalis; and October 1993 for selenium and boron in Salt Slough, Mud Slough, and the remainder of the San Joaquin River. Id.
that "[i]f fragmentation of the parties that generate, handle and discharge agricultural subsurface drainage jeopardizes the achievement of water quality objectives," it would consider petitioning the Legislature "for the formation of a regional drainage district." 159 Although the Regional Board has not yet acted on these pronouncements, they mark a significant first step toward resolution of the drainage problem in the Grasslands region. For the Regional Board has signaled its willingness to move beyond traditional ambient water quality and nonpoint source regulation, and to use the tools of the NPDES program to create a workable system to control irrigation runoff.

The SWRCB approved the Basin Plan in 1990,160 and one year later incorporated the Regional Board's suggestion that WDRs be considered as regulatory option to address the drainage problem. In the "Inland Surface Waters Plan," the State Board established numerical ambient water quality objectives for a variety of pollutants to protect both human health and freshwater aquatic life.161 Then, pursuant to its authority under both the CWA and the Porter-Cologne Act, the State Board directed the Regional Boards to devise "water quality-based" effluent standards for those waters for which the existing WDRs are inadequate to achieve the new water quality standards.162 The purposes of the latter are to determine the TMDL of each regulated pollutant that may be discharged into the watercourse without impairing the ambient standards and to limit discharge of pollutants by each source so that aggregate discharges do not cause a violation of the ambient standards.163

Of the three categories of watercourses for which the SWRCB ordered the establishment of water quality-based effluent standards, two are present in the Grasslands region. The first is Category B watercourses, which the SWRCB defined as "[n]atural water bodies, or segments thereof, that...are dominated by agricultural drainage."164 The second, designated Category C watercourses, includes "[w]ater bodies, or segments thereof, that...have been constructed for the primary purpose of conveying or holding agricultural drainage and were not natural water bodies which supported aquatic habitat beneficial uses."165 For point source dischargers into Category B watercourses, the State Board ordered the Regional Boards to incorporate the numerical ambient water quality objectives into their existing WDRs. Thus, each permit will be amended to ensure that the aggregate TMDLs for each watercourse are not exceeded.166 For nonpoint sources, however, the SWRCB took a different approach. Instead of creating a permit system for agricultural drainage and other nonpoint source discharges, it directed the Regional Boards to implement the ambient water quality standards through the use of "performance goals." The State Board then defined performance goals for nonpoint sources by reference to its existing plan for nonpoint source management that it adopted in accordance with section 319 of the CWA.167

The "Nonpoint Source Management Plan" is a three-step process for regulating agricultural drainage. First, farmers and other sources are given the opportunity to devise and to adopt BMPs to reduce the amount of irrigation return flow. Second, if these "voluntary" practices do not achieve the TMDLs necessary to comply with the ambient water quality standards, or if there is insufficient response, the Regional Boards shall "encourage" the adoption of BMPs by threatening to impose WDRs on individual sources.

Third, if drainage is still not reduced to the levels required to achieve the ambient water quality standards, the Regional Boards have authority to issue WDRs that "establish effluent limitations or discharge prohibitions."168 The SWRCB also set out a timetable for implementation of this nonpoint source management program.169

The authority of the State and Regional Boards

159. Id. at IV-16.
160. RESOLUTION 90-28, supra note 44. Pursuant to its authority under section 303(c) of the CWA, the EPA has disapproved portions of the Basin Plan—viz., the critical year water quality standards and the ambient standards for Mud and Salt Sloughs.
161. INLAND SURFACE WATERS PLAN, supra note 44.
162. Clean Water Act § 303(d); CAL. WATER CODE § 13263(a) (West 1992).
164. INLAND SURFACE WATERS PLAN, supra note 44, at 6.
165. Id.
166. Id. at 7.
168. INLAND SURFACE WATERS PLAN, supra note 44, at 22.
169. Id. at 22-23. EPA has disapproved portions of the Inland Surface Waters Plan. The vetoed portions include: (1) the State Board's deferral of immediate protection under the numerical ambient water quality standards for water bodies in all three categories established by the Plan, and (2) its decision to exempt all watercourses in Category C from the numerical water quality standards. EPA acknowledged that

[for] those constructed drains that are not "waters of the United States" [and therefore not governed by the Clean Water Act], we can appreciate the State Board's desire to exempt them from Clean Water Act regulations. Nevertheless, the State Board's exemption from category (c) water bodies is drafted so broadly and imprecisely that it could be interpreted as applying to certain constructed drains that are clearly conveying waters of the
to impose WDRs on dischargers of irrigation return flows—that is, to treat nonpoint sources as though they are point sources—was confirmed by the landmark decision in *Tahoe-Sierra Preservation Council v. State Water Resources Control Board*.170 In that case, the Court of Appeal upheld the Lake Tahoe Basin Water Quality Plan, which requires the use of WDRs to regulate nonpoint source pollution from residential and commercial development around the lake. The SWRCB adopted this permit-based pollution control strategy after concluding that the conventional methods of addressing nonpoint source pollution—in this case through ambient water quality standards promulgated by the Lahontan Regional Water Quality Control Board and land use regulations issued by the United States Forest Service and the Tahoe Regional Planning Agency—had failed to prevent erosion of the surrounding land and sedimentation of the lake.171 As the Court explained, "surface runoff of water carrying soils into the lake is the principal source of pollutants which induce the growth of algae in the lake."172 In turn, the algae impairs both the quality and the exceptional clarity of Lake Tahoe. "If the trend continues, the lake’s translucent blue color will be altered."173

In sustaining the Plan, the Court of Appeal denied the claims of developers (who were made subject to the WDRs) that the State Board exceeded its statutory authority to regulate nonpoint sources. The plaintiffs contended that two provisions of the Porter-Cologne Act required the Board to adhere to the federal law of nonpoint source pollution control, which would preclude the imposition of permit requirements on the developers' land use activities and the consequent surface water runoff. First, section 13373 of the Water Code states that "point sources” as used in this chapter shall have the same meaning as in the Federal Water Pollution Control Act and acts amendatory thereof or supplementary thereto.174 Second, section 13374 defines “waste discharge requirements” as "the equivalent of the term 'permits' as used in the Federal Water Pollution Control Act, as amended."175 In turn, the CWA categorically excludes “return flows from irrigated agriculture” from the definition of point sources176 and prohibits EPA from requiring an NPDES permit “for discharges composed entirely from irrigated agriculture.”177 The plaintiffs argued that, since erosion caused by development is treated as nonpoint source pollution under federal law, and because “under the federal act federal permits are not used for regulation of nonpoint sources of pollution,” California may not require WDRs “by resort to its own authority.”178

The Court rejected this argument on grounds that now support the imposition of WDRs on all nonpoint sources of water pollution, including agricultural dischargers. It held that the Porter-Cologne Act requires equivalency with federal law “only for purposes of state compliance with the minimum requirements of the federal mandate. The federal law does not preclude the state from utilizing its broader authority to regulate nonpoint sources of pollution by means of its waste discharge permit system.”179 Indeed, the Court concluded, federal law mandates state regulation of nonpoint sources by means of the state’s choosing.”180 Thus, the exemption of nonpoint sources from the NPDES system as directed by federal law does not preclude permit-based regulation of nonpoint sources under California law. The federal definition of point sources—including its categorical exclusion of return flows from irrigated agriculture—is simply irrelevant to the administration of California’s water quality laws.

In light of the successful defense of WDRs for nonpoint sources in *Tahoe-Sierra Preservation Council*, it is surprising that the SWRCB chose to back away from permit-based regulation of agricultural dischargers in the Inland Surface Waters Plan and to continue to rely primarily on the use of “voluntary” and “encouraged” BMPs to meet ambient water quality goals for California’s other streams, rivers, and lakes. This “preferred” approach has failed in the Grasslands region and other parts of the San Joaquin Valley for several reasons. First, BMPs (vol-

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171. Id. at 1427-29.
172. Id. at 1427.
173. Id.
175. CAL. WATER CODE § 13374 (West 1992).
177. Id. § 402(l) (Section 402(l) also states that the Administrator may not “directly or indirectly require any State to require such a permit").
179. Id. at 1431 (emphasis in original).
180. Id. (emphasis in original).
unitary or otherwise) can be expensive and generally do not afford farmers any flexibility to comply in a least-cost manner or in an alternative way that is better tailored to individual circumstances. Second, without certain economic or regulatory inducements, farmers are unlikely to make the investments in water conservation and drainage reduction necessary to comply with the BMPs. Third, the requisite regulatory certainty is lacking in a setting in which a single administrative agency must deal with thousands of individual sources. The Regional Board simply does not have the resources to enforce the BMPs against all of the farmers who contribute to the drainage problem in the Grasslands region and other parts of the San Joaquin Valley. Nor will it be able to set effluent limitations in the form of WDRs for the thousands of individual sources of irrigation return flow.

In short, the “preferred” regulatory approach established by the SWRCB is unlikely to succeed both because the sources of pollution are not individually responsible for their actions and because it will be difficult (if not impossible) for the RWQCB to ensure that collectively they do not exceed the TMDL for selenium that is established for the region. What is needed in place of the Inland Surface Waters Plan strategy is a regulatory regime that addresses the drainage problem on a regional level, holds the sources of the drainage accountable for the external costs of their practices, and gives the sources a modicum of economic and farm management flexibility to comply with their legal duties in ways that minimize the costs of moving from an unregulated environment to a managed drainage basin.

B. Establishment of a Regional Drainage District

The vexing problem of nonpoint source pollution in the San Joaquin Valley is attributable in large measure to institutional distance—specifically, the regulatory gap between the ambient water quality standards for selenium and other pollutants in the San Joaquin River system and the individual sources of those pollutants at the farm level. In the Grasslands region, however, it is not necessary to attempt the Herculean task of translating an ambient water quality standard (or an aggregate TMDL) into BMPs or WDRs for thousands of individual sources. Rather, in the Grasslands region (and, indeed, throughout the San Joaquin Valley), the water agencies and drainage districts that serve the farmers could play a significant role in bridging the regulatory gap. As described in Part III, although it is prohibitively expensive today to measure the irrigation tailwater generated by each individual farm in the Grasslands region, the contribution of each agency that provides drainage service to the farms can be calculated. And, because there are only fourteen drainage agencies in the region, it would not be administratively impracticable for the Regional Board to hold the agencies individually responsible for meeting the collective TMDL for discharges from the Grasslands region into the San Joaquin River.

Once the decision was made to regulate at the agency level, the RWQCB would have two options. It could simply assign TMDLs to each of the individual agencies. This option would require the Regional Board to establish separate effluent limitations for each agency or for each location at which the agency’s drainage enters a conduit in which it could be accurately measured. The Board then would be responsible for monitoring and enforcing these limitations against each agency. Alternatively, the RWQCB could focus its standard-setting, monitoring, and enforcement efforts on the resource it is charged with protecting. Under this approach, the Board would set a single TMDL for selenium entering the San Joaquin River system from the combined points of discharge within the Grasslands region. The Board would then defer to the local agencies’ determination of how to apportion the limitation on drainage required by the TMDL among themselves and their members. The Regional Board would be responsible for monitoring and enforcing the aggregate TMDL for the Grasslands region, but would (initially, at least) look to the local agencies to enforce the individual drainage limitations among themselves and their members.

Either option would offer an improvement over the current situation in which the water quality standards for the San Joaquin River are effectively unenforceable because of the vast number of sources of subsurface drainage. The RWQCB would have a better chance of implementing the standards simply because it would have a manageable number of entities to regulate. From the perspective of the Board, the second option offers the advantage of enabling it to focus on a single entity—the collective of Grasslands area water supply and drainage agencies—that would be responsible for complying with the TMDLs set by the Board to achieve the ambient water quality standards.

Under both options, the farmers and other water users within the region who are required to reduce their generation of pollution to meet the TMDLs would be accountable to the same water managers with whom they work on a daily basis, as well as to one another, through the local agencies regulated by the Regional Board. From the water
users' vantage point, the second option affords an additional, significant benefit: By designating a single entity to be responsible to the RWQCB for the Grasslands region's aggregate discharge of drainage water into the San Joaquin River system, there would exist a forum in which the producers of the drainage could buy and sell discharge allowances as a means of meeting their individual regulatory obligations in a flexible, least-cost manner.

The best means of creating a single regional entity that would be responsible to the RWQCB for the aggregate discharge of pollution from the Grasslands region would be through the formation of a Regional Drainage District. Indeed, both the Basin Plan and the Inland Surface Waters Plan identify the formation of a Regional Drainage District as one means of coming to grips with the problem of nonpoint source pollution in the San Joaquin Valley. Moreover, the creation of a Regional Drainage District is a condition for the proposed plan by the Grasslands water districts to collect and convey drainage from the region in the San Luis Drain for discharge into the San Joaquin River downstream of the Merced, and it is stipulated as a criterion for implementation of federal water conservation requirements.

1. The Role and Authority of a Regional Drainage District

In the regulatory framework proposed here, the Regional Drainage District would provide the institutional capacity to address the drainage problem on a regional level. This entity would hold the sources of the drainage discharges (districts and the farmers within each district) accountable for the environmental costs of their practices, while at the same time giving them flexibility to decide how to comply with load reduction requirements in ways that minimize the costs of moving from an unregulated environment to a regulated one.

To this end, the Regional Drainage District would have three essential duties. First, it would be responsible to the RWQCB for compliance with the ambient water quality standards and pollution load limits for the San Joaquin River. The RWQCB would assign to the Regional Drainage District a single WDR for the drainage discharged from all of the districts (and therefore farms) in the Grasslands region that currently discharge into the river. This drainage permit would be similar to WDRs for point sources and would specify permissible pollutant loads for different water-year types and different seasonal flow conditions. The RWQCB would retain its existing authority to monitor all effluent discharges from the Grasslands region and to enforce the terms of the WDR against the Regional Drainage District through cease and desist orders, fines, civil penalties, injunctive relief, and other remedies. The RWQCB also would retain the option of issuing permits to individual districts and farmers.

Second, the Regional Drainage District would have authority to allocate the regional allowable pollution load among its member districts and to ensure that each district complies with its assigned load allocation. The Regional Drainage District would have primary responsibility for monitoring and enforcement vis-a-vis the member agencies. As a default, the RWQCB would retain its existing power to take action against the districts (or, if necessary, against individual farmers) to enforce the water discharge requirements for the Grasslands region.

Third, the Regional Drainage District would be charged with administering the system of tradable discharge permits or another district-level regulatory program approved by the RWQCB. If a program of tradable permits were chosen, the Regional Drainage District would supervise and facilitate trades to ensure that, following the transactions, the parties did not exceed their respective discharge entitlements. The Regional District also could serve as a clearinghouse for relevant information about the market, such as the names of sellers and potential purchasers, prices, quantities of the offers and the requests, and predicted variations in the aggregate WDR applicable to the Grasslands region as a whole.

181. PRIOR PLAN, supra note 152, at IV-16; INLAND SURFACE WATERS PLAN, supra note 44, at 22.
184. Unincorporated irrigated lands that are not within the boundaries of a water district would be included within the jurisdictional boundaries of the Regional Drainage District.
185. See discussion supra Part III
187. The owners or operators of farms on unincorporated lands that are not within the boundaries of a water district would be assigned individual load allocations or permits.
188. If a different regulatory approach were chosen, the Regional Drainage District would perform a comparable administrative role. For instance, it would set, collect, and adjust effluent and input fees, monitor implementation of BMPs, or monitor compliance with traditional discharge permits. Similarly, if the chosen regulatory approach were to involve farm-level regulation based on
To accomplish these duties, a Regional Drainage District would need the following powers:

- jurisdiction over all of the land and over the local agencies that supply water and provide drainage services to the Grasslands area;
- authority to represent the agencies and the farmers and other users in the Grasslands region to the RWQCB, the State Board, the EPA, and other relevant state and federal regulatory agencies, as well as in court;
- power to assign drainage discharge allocations to each member agency;
- authority to monitor and to evaluate irrigation practices and drainage management and discharges in all conveyance facilities in the Grasslands region and to monitor discharges from each member agency;
- authority to construct and operate regional drainage collection, storage, treatment, or disposal facilities based on fees collected from member agencies;
- enforcement power (including power to levy fees or assessments) over member agencies and individual farmers to ensure compliance with effluent limits set forth in their drainage discharge allocations;
- responsibility for administering requirements of a given regulatory program at the district or farm levels;
- ability to provide technical and financial assistance to member agencies and to individual farmers to assist them in meeting the drainage reduction requirements set forth in their drainage discharge allocations; and
- contracting authority with other entities including neighboring water districts.

2. Implementation Options
There are two ways to establish a new regional entity with these powers. Either the array of existing local agencies could establish the Regional Drainage District through a joint powers agreement, or a new entity could be established by legislation. Fourteen local agencies currently provide drainage services within the Grasslands region, and twelve agencies supply water to Grasslands area farmers and other water users. Six of these agencies engage in both water supply and drainage. These entities are listed

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<td>Camp 13 Study Area</td>
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<td>Charleston Drainage District</td>
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in Table 11 and are shown in Figure 1.

As Table 11 indicates, an organizational analysis of the Grasslands region is a complex task. Not only do several water districts provide both water and drainage services to their members, but a number of agencies also have overlapping jurisdictions. For example, the Central California Irrigation District (hereinafter “CCID”) is divided into several subareas within the Grasslands region, and the lands to which it delivers water are drained by six different drainage districts. The Charleston Drainage District serves both CCID and the San Luis Water District. And the Panoche Drainage District includes four water districts. Moreover, the presence of four different types of water agencies—California water districts, irrigation districts, drainage districts, and mutual water companies—means that water supply to and drainage from the Grasslands area is governed by the four separate statutes that authorize the creation and operation of these separate agencies.

This complex array of local water agencies has little relation to hydrology or efficient resource management. Rather, the existence of twenty agencies to serve the Grasslands region can be explained only by history. Much of the organizational complexity of the Grasslands region may be put aside, however, in favor of one essential point: All of the agencies have the existing authority to take the actions needed to manage drainage and water supplies on a regional, collective basis to ensure that aggregate discharges to the San Joaquin River do not violate either the ambient water quality standards or the load allocations established by the RWQCB. Consequently, the Grasslands agencies may enter into a joint powers agreement to form a Regional Drainage District.92

A. Joint Powers Agreement

The twenty agencies that comprise the Grasslands region individually have the authorities necessary for an effective regional drainage institution. Each is authorized to enter into contracts with other agencies to carry out its functions, including the provision of drainage services to its members.93 While the concept of assigning load allocations and administering regulatory programs for drainage reduction may be new, each agency has the power to perform all acts necessary to fulfill its other statutory duties.94 This broad functional authority should enable the agencies to devise innovative means of providing drainage services in a manner that complies with applicable state and federal water quality laws. Inasmuch as economic incentives generally, and tradable discharge permits specifically, are reasonable means of fulfilling this objective, all of the Grasslands agencies that provide drainage services to their members have the authority to implement such programs.

The agencies currently measure and monitor the drainage generated by farmers within their service areas and report those data to the RWQCB.95 They also have the power to promulgate rules and regulations governing water distribution and use (including subsurface drainage and surface return flows).96 Pursuant to this authority, some of the agencies have enacted a farm-level allocation of the allowable regional pollution load, see supra Part II, that the Regional Drainage District would work with member agencies to establish load limits, oversee compliance with regulatory requirements, and monitor discharges. Direct farm-level monitoring of drainage discharges could be achieved through installation of additional drains, flow-meters, etc. Alternatively, a calculation based on water inputs could be used as a surrogate for individual farm discharge levels.

189. Omitted from this list is the Westlands Water District, a portion of which is located in the Grasslands region.

190. The drainage districts were formed originally to drain wetlands in the area to enable the land to be farmed. Later, these same districts began to provide drainage services to their members, carrying excess irrigation water off the farmlands and into the drainage systems. The irrigation and water districts were created to distribute water that previously had been controlled by the Miller and Lux Corporation and to bring additional water supplies into the Grasslands area. Later, a number of these agencies contracted with the CVP to purchase water from the Delta-Mendota Canal and San Luis Reservoir, and some began to provide drainage along with water service. See N.D. COHN, AGRICULTURAL DRAINAGE MANAGEMENT ORGANIZATIONS IN THE DRAINAGE PROBLEM AREA OF THE SAN JOAQUIN VALLEY (1989) (giving a detailed description and history of the local water supply and drainage agencies in the Grasslands area).

191. Public agencies are permitted to "jointly exercise any power common to the contracting parties" (CAL. GOV'T CODE § 6502 (West Supp. 1995)). The joint powers agreement may create a new entity, "which is separate from the parties to the agreement and [which] is responsible for the administration of the agreement." CAL. GOV'T CODE § 6503.5 (West 1973). The joint powers agency may exercise the authority conferred upon it by the parties over the geographical area that represents their common interests. CAL. GOV'T CODE § 6502 (West Supp. 1995). Thus, although each participating agency may not expand the types of powers beyond those that it shares with the other contracting agencies, it may expand the geographic scope of those powers beyond its individual service area to include the area in which the common interests of the parties are affected. In this case, the joint powers agreement would apply to the entire Grasslands region.


194. See GRASSLANDS 1939 REPORT, supra note 120, GRASSLAND 1950 REPORT, supra note 120.

agencies in the Grasslands region have adopted tiered water pricing as an incentive to increase water conservation by their members. Others have adopted drainage fees as well.\textsuperscript{196}

The enforcement authority of the agencies is limited, however. The authorizing legislation for existing districts does not explicitly grant them authority to enforce compliance with water quality standards and implementation measures. California water districts and irrigation districts may levy nominal fines for violations of agency bylaws,\textsuperscript{197} and they have some authority to withhold water or drainage services for failure to pay service charges or for inadequate maintenance of irrigation and conveyance facilities.\textsuperscript{198} The enforcement powers of the drainage districts are less certain, however. Although these agencies do not have express statutory authority to penalize members for violations of bylaws or regulations, they do have the ability to include in those rules limited sanctions for abuse.\textsuperscript{199} For mutual water companies, the statutes are silent on the subject of enforcement powers.\textsuperscript{200}

While existing agencies lack a full range of enforcement powers, collectively they have a variety of authorities that would be sufficient for effectively implementing regional water quality standards and individual pollution discharge allocations. As described above, water and irrigation districts may condition water and drainage service upon payment of charges or other requirements. They also might condition such services on the farmers' implementation of drainage reduction measures necessary for achieving compliance with district-level load limits. The requisite authority to enforce water pollution control measures therefore could be articulated in district-level rules and regulations and incorporated into the authority of the joint powers agreement.

The efficacy of this approach ultimately depends on the districts' interpretation of their authority and on the cooperation of districts and farmers. Water agencies are effectively "pass through" agencies, created to serve member farmers who elect the governing board. As public agencies, all of their costs are passed along to member farmers. Thus, in practice, the final measure of an agency's authority depends in large part on its board's interpretation of its mandate as articulated through district policy and regulations. To the extent that the elected board does not perceive its authority to include powers of enforcement, it is unlikely that those powers would be exercised, even where they legitimately could be. By the same token, the member farmers and the other districts included in the joint powers agreement must concur and cooperate with such an interpretation of district authority. Disagreement about the limits of district authority to enforce regulatory requirements against individual farmers would undermine the effectiveness and the potential authority of the joint powers agreement.

b. Legislation

Because joint powers authorities can exercise only those powers that are common to all parties to the agreement, and because a joint powers agreement cannot be used to expand the members' individual powers, it might be desirable to create the new Regional Drainage District by legislation. Such legislation not only could vest in the Regional District enforcement authority that some of the participating agencies currently lack, it also could confer on the Regional District the full panoply of enforcement powers required to accomplish the task of providing integrated drainage management to the Grasslands region.

Moreover, a legislative mandate for a Regional Drainage District would be consistent with the statutory basis for existing districts. The language of the implementing legislation can be written as a blueprint for the authorization of other regional entities with similar regulatory and administrative responsibilities. A model statute for creation of a Regional Drainage District is provided in the Appendix to this Article.

C. Operation of the Regional Drainage District

As set forth either in a joint powers agreement or in legislation, the Regional Drainage District would include all water supply and drainage agencies in the Grasslands region that contribute to the aggregate pollution load in the San Joaquin River. Farmers would be members of the Regional Drainage District by virtue of their membership in their respective water agencies.

The Grasslands Regional Drainage District would be administered by a board of directors, which would exercise the powers described above.

\textsuperscript{196} See \textit{e.g.}, \textit{San Luis Canal Company, Drainage Operation Plan of 1991} (1990); \textit{Central California Irrigation District, Drainage Operation Plan of 1992} (1991); \textit{Broadview Water District, supra note 85}.
\textsuperscript{197} \textit{Cal. Water Code} \textsection 35304 (West 1984) (California Water Districts); \textit{Cal. Water Code} \textsection 22089 (West 1984) (Irrigation Districts).
\textsuperscript{199} See \textit{Cal. Water Code App.}, \textsection 8-14 (West Supp 1995)
Directors would be elected by the member agencies. An important issue is how to structure the voting rights of the various agencies. One option would be simply to assign one vote to each agency. In view of the differences in the size of the Grasslands agencies, however, a system of "one agency, one vote" might not fairly represent the interests of the water users within the region. Thus, an alternative would be to weight each agency's voting power to reflect its relative size. As with the allocation of the total allowable pollution load for the region, this allocation of voting power by size could be based on the amount of drainage generated by each agency as a percentage of the aggregate drainage produced in the Grasslands region, or on the amount of irrigated or drained land within each agency as a percentage of the total irrigated or drained land in the region. To ensure a diversity of views on the board, it would be appropriate to stipulate that no more than one director may come from a single agency.

The board of directors should be of a manageable size. Five directors would meet this criterion and would provide one director for every four of the participating agencies. Directors should be elected on staggered terms and should serve for no longer than four years. Once elected, the board would appoint a chairman or chairwoman, an executive officer, a financial officer, a chief counsel, and other necessary officers and employees. The executive officer would be principally responsible for the day-to-day administration of the Regional District, for ensuring that the district complies with its drainage discharge requirements, for monitoring and enforcing the individual discharge allocations held by the member agencies, and for overseeing and facilitating regulatory measures taken by member agencies and, as necessary, by individual farmers. These, and other organizational issues, would be spelled out in the governing by-laws for the district.

In carrying out its duties, the Regional Drainage District would have different responsibilities in relation to member water and drainage districts and to entities outside of the Regional District. Under a tradable permit program, for example, where all permit holders are members of the Regional Drainage District, the Regional District would serve as the primary regulatory link between the regulated community (i.e., districts and farmers receiving an initial allocation) and the RWQCB. If permit trades involve other entities that are not members of the Regional Drainage District, the enforcement authority of the Regional District vis-à-vis non-member agencies would be limited. This problem could be addressed by having the RWQCB issue a separate discharge permit to any non-member agency whose drainage flows into the Grasslands area. In that case, the Regional Drainage District and its individual members would have the opportunity to participate in the hearings conducted by the RWQCB on these discharge permits. If a non-member agency exceeded the discharge allowance set forth in its permit, the Regional Drainage District would be able to petition the RWQCB to take enforcement action against the non-member agency.

The success of any program to regulate agricultural drainage requires unambiguous lines of authority between the responsible regulatory agency and the individual dischargers. Existing or new institutions can be employed to this end. In the Grasslands, however, the need for accountability would best be satisfied at the regional level through a regional entity such as a Regional Drainage District. Such an intermediate entity would serve the critical function of closing the regulatory "gap" between regulators and a large number of small, variable pollution sources that comprise the non-point source pollution problem. The Regional

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201. The constitutionality of deviating from the general principle of "one person, one vote" and of weighting voting power over the administration of local water agencies is now well-established. In Ball v. James, 451 U.S. 355 (1981), the Supreme Court upheld an Arizona state statute that (1) limits the right to vote in the election of the board of directors of a water reclamation district to the owners of the land within the district, and (2) apportions voting power according to the amount of land held by each voter. Earlier, in Sayler Land Co. v. Tulare Lake Basin Water Storage District, 410 U.S. 719 (1973), the Court ruled that a California law that limits the franchise to landowners and which apportions voting power according to the assessed valuation of the property does not violate the equal protection rights of district residents who do not own land. Under the California Constitution, however, a restriction that makes only landowners eligible to serve as members of the board of directors would be unconstitutional. Choudhry v. Free, 17 Cal. 3d 660 (1976).

202. An example of how such organizational issues might be articulated is provided by The San Luis-Delta Mendota Water Authority, a Joint Exercise of Powers Agreement among the water agencies which receive water supplies from and are otherwise served by the facilities of the federal CVP. The Agreement spells out the purposes, powers, organization, financing, accounting, property rights, liability, and terms of termination for the Agreement. San Luis and Delta Mendota Water Authority, Amended and Restated Joint Exercise of Powers Agreement (1972).

203. See CAL. WATER CODE §§ 13350-13351 (West 1992 & Supp. 1995). If no Regional Drainage District is formed, a system of tradable permits (or other regulatory program) could be implemented by the RWQCB. The RWQCB could issue individual permits to districts and to individual farmers or groups of farmers in unincorporated areas, as necessary. The districts would retain primary responsibility for implementing programs to effect farm-level drainage reduction sufficient to comply with permit limits. Although the enforcement authority of some districts is limited, all of the existing water supply and drainage districts in the Grasslands region have authority to control aggregate drainage discharges through price incentives such as tiered water rates and drainage service.

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Drainage District also would enable an integrated, basin-wide approach to pollution control, consistent with the environmental and operational boundaries of the pollution problem.

VI. A PROPOSED REGULATORY SYSTEM FOR THE GRASSLANDS

The proposed regulatory program for the Grasslands region is a two-tiered system that combines tradable discharge permits at the district level with tiered water pricing within districts. Combination of the two incentive-based approaches establishes accountability for pollution control at the farm level, where most drainage reduction must occur, and optimally satisfies the criteria for an effective pollution control program. As a result, the system responds to the principal concerns of the major affected interests while meeting the environmental objective.

A. The Role of the Regulatory Agency

Under the proposed system, the RWQCB would initiate the program by specifying the TMDL for selenium in the San Joaquin River. The screening-level TMDL presented in Part III can be used for this purpose. The allowable monthly loads for different types of water years and for different irrigation seasons presented in Part III underscore the undisputed need for significant reductions in pollution loads compared to historical discharge levels. While the allowable loads might be refined in the future (using improved predictions of river flow changes and water diversions), any substantial increases in calculated allowable loads will depend on information that is not available in the short term. In any case, the TMDL calculations provide a reliable basis for establishing pollution reduction goals. To implement the proposed program, however, the RWQCB might adopt interim drainage reduction goals based on a more lenient excursion rate as part of a compliance schedule. The TMDL model used for the San Joaquin River is designed to allow calculations for such alternative scenarios.

With the pollution load objectives determined, the RWQCB would issue one waste discharge requirement for the agricultural community's share of the allowable load. This area permit would be assigned to a Regional Drainage District. In the absence of a Regional Drainage District, the RWQCB would assign individual permits to each of the water districts in the region under the same authority.

The RWQCB would retain the authority to establish water quality goals. At the same time, its administrative and enforcement requirements would be streamlined by reducing the number of permitted dischargers to one. Limitation of the number of individual sources that must be directly monitored and enforced also would minimize the potential for litigation or implementation delays and increase the likelihood that environmental goals will be achieved.

B. The Role of the Regional Drainage District

The Regional Drainage District would assume responsibility for meeting the discharge limits specified by the waste discharge requirement and for implementing the measures and programs necessary to do so. One task would be to administer the tradable discharge permit program. In this capacity, the Regional Drainage District would determine the initial allocation of the total allowable pollution load among the contributing water and drainage districts. Leaving this allocation to a locally controlled entity would ensure that equity concerns among neighboring districts are addressed. Options for allocating the total allowable pollution load among the districts include an allocation based on historical discharge levels, irrigated acreage, drained acreage, or some weighted average of these factors. The equity implications of alternative allocation methods for the individual districts are significant, as demonstrated in Tables 4 through 7.

The trading program would provide an additional opportunity to adjust load allocations. Through permit trades, districts could achieve a cost-effective distribution of pollution control responsibility, which may change from year to year, and resolve remaining equity disparities. The Regional Drainage District would assist member districts by identifying potential trades, recording transactions, and enforcing permit limits.

The district-level allocation, formalized by permits assigned to individual districts, would stipulate allowable discharge levels for different months and water-year types, consistent with the TMDL and the waste discharge requirement issued to the Regional Drainage District. To meet the needs of the agricultural community for predictability in planning irrigation improvements and negotiating permit transactions, the allocations could be implemented using an "episode" permit system which assigns priorities to discharge permits. Priority 1 permits would correspond to the critical-year allocation and represent discharges that could occur on an uninterrupted basis during the appropriate month, regardless of year-type changes. Priority 2 and 3 permits would correspond to additional discharges that could occur only during more favorable
hydrologic conditions—i.e., dry/below-normal years and above-normal/wet years, respectively.

The rules for trading would conform to the temporal limits on discharges. Given the monthly and yearly variations in the dilution capacity in the San Joaquin River, trades across months and years would be prohibited. For example, an April allocation could not be traded and used for a July discharge; nor could an allocation for July of one year be saved or traded to allow additional discharges in July of a later year. If the total allowable load for different year types and seasons is known well in advance, this restriction on banking or storing permits should not inhibit market activity.

Allocations could be traded either for a limited period, after which the allocation would revert to the original holder (a permit lease) or could be traded in perpetuity (a fee simple purchase). The proportion of leasing transactions relative to fee purchases would likely be higher in the Grasslands region than in areas where the allocations remain constant over time.

C. The Role of Water Districts and Farmers

Under the system of tradable permits, each district would secure the appropriate number of permits of each priority designation necessary to accommodate its discharges. The highest priority permits (Priority 1) would have a greater market value since they would provide for reliable, baseline discharges. The quantity of lower priority permits would be determined by the district's ability to make short-term adjustments to changes in the total allowable load through improved management of existing irrigation systems by farmers or through short-term land fallowing.

To comply with the final discharge allocations, water districts in the Grasslands would adopt programs to encourage or to require farmers to improve irrigation efficiency and thereby to reduce drainage generation. Water districts in the region currently have the authority to implement such programs as a function of their powers to manage water supply as well as drainage. To minimize the costs and the administrative burden to the districts (and, by extension, to their member farmers), districts could employ an incentive-based program for improving farm-level irrigation efficiency—and one that is consistent with the district's existing monitoring and administrative activities.

Based on these considerations, water districts might elect to adopt a system of tiered water prices (block rates in which unit prices for water increase with the volume of water purchased) to encourage more efficient use of irrigation water supplies and decreased drainage generation by farmers. Tiered water pricing would be consistent with existing district practices. Moreover, the water management provisions of the Central Valley Project Improvement Act require tiered water pricing as a condition of water contract renewals for districts receiving federal water supplies, including those in the Grasslands region.

Theoretically, water rates could be calculated to reflect estimated avoided drainage costs. In practice, because of the limited number of drainage management options other than on-farm irrigation efficiency improvements, this would equate to a fee that encourages water use consistent with the average per acre drainage output necessary for the district to meet its pollution load allocation. Because water districts are legally prohibited from making a profit on the water they sell to farmers, excess revenues might be rebated to farmers on a per acre basis.

Alternatively, districts could adopt effluent fees or tradable discharge permit programs for farm-level source reduction. Because of the current limited extent of subsurface drainage monitoring at the farm level, however, water inputs probably would be used as surrogates for discharges under these programs.

Tiered water prices encourage drainage reduction, but do not assure achievement of a specific district pollution load limit. As a consequence, water districts probably would use recirculation systems to assure that discharges comply with actual permit limits. Over the past several years, many districts have constructed systems to capture, blend, and recirculate surface (and in some cases, subsurface) drainage to augment irrigation water supplies. This capability would be particularly useful on a short-term basis and in critical or dry year conditions, when it would allow farmers to produce more than the target level of subsurface drainage yet still comply with overall pollution load limits.

Finally, to enhance source control measures, districts and farmers might employ other drainage management techniques for reducing pollution levels. The options for improving drainage manage-

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204. Many advocates of tradable permit systems argue that the ability to "bank" permits for future use is a necessary condition for an efficient permit market. See, e.g., Hahn & Noall, 1990, supra note 39. In the case of the San Joaquin River and other western rivers, the preservation of water quality cannot be ensured where discharge permits can be "banked" for future use.

205. CVPIA § 3405(d).

206. The importance of farm-level drainage targets is discussed in Part III.

207. See Thomas & Lechten-Schwartz, supra note 141.
ment in the Grasslands region, as in other areas where irrigation drainage poses water quality problems, include selective land retirement, treatment and reuse, and water transfers.208 All of these options could be implemented within the framework recommended by this study.

D. Putting Economic Incentives to Work

The incentive-based system proposed for the Grasslands optimally satisfies the concerns of both regulators and the regulated farm community, while still achieving environmental goals. Specifically, the program is designed to:

- meet the pre-determined allowable pollution load or cap;
- minimize the costs of pollution control to the regulated community;
- accommodate the preference of farmers for flexibility and independence through a decentralized program;
- address equity concerns of farmers and districts by allowing a locally-controlled entity to perform the initial allocation of the allowable pollution load, by allowing subsequent adjustments to the allocations, and by promoting cost-sharing;
- enable verification of compliance with little change in existing monitoring systems, and
- impose few new enforcement or general administrative tasks on existing agencies and further minimize these by creating a Regional Drainage District.

The proposed program responds to the two primary constraints imposed by the TMDL, or pollution load limit. First, the significance of potential pollution control costs, combined with the properties of the pollutant in question, argue for a program that neither exceeds nor falls short of the pollution goals by any significant margin. In other words, conditions defined by the pollution load limits clarify the need for a program design which incorporates a predetermined pollution cap while maximizing cost-effectiveness. Both are features of a tradable permit program. Second, the program must be amenable to changes in the allowable pollution loads and other modifications that arise over the long term (as TMDL calculations are revised), without requiring a fundamental restructuring of the program design. Again, the tradable permit system, combined with farm-level price incentives, meets this need.

The two-tiered incentive system also accommodates the technical difficulty of determining accurate farm-level pollution load allocations. A system that makes districts responsible for achieving specific load limits, combined with farm-level financial incentives that do not require calculation of precise individual load allocations, is preferable. The regulatory approach also tends to ameliorate inequities attributed to ground water migration and other physical factors by using input fees and by providing a mechanism to adjust discharge allocations.

Most importantly, the proposed program establishes accountability for pollution control at the farm level, where the vast majority of pollution reductions must take place, yet does not "tell farmers how to farm." The two-tiered program relies on strict district-level accountability in exchange for greater flexibility at the farm level. Tiered water prices make farmers responsible for the pollution they generate, but do not deprive them of the opportunity to determine the most cost-effective methods of pollution control. This arrangement also is consistent with the established roles and responsibilities of water districts and their farmers.

VII. CONCLUSION

The incentive-based, tradable discharge permit system developed in this Article provides an opportunity to address the agricultural drainage problem that has plagued the Grasslands region and other areas that suffer from essentially unregulated non-point source pollution. In the first step, the pollution reduction goal and an initial allocation of pollution control responsibilities are defined. The second step uses this information to analyze various types of programs according to criteria representing the concerns of the principal stakeholders, the regulated community, the administrative agencies, and the environment. Determination of the advantages and disadvantages of each type of program from these perspectives not only helps to clarify the most acceptable approach; it also provides insights

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208. DRAINAGE PROGRAM FINAL REPORT, supra note 32; SWRCB REPORT, supra note 31; NATIONAL RESEARCH COUNCIL, supra note 94; UNIVERSITY OF CALIFORNIA COMMITTEE OF CONSULTANTS ON DRAINAGE WATER REDUCTION, OPPORTUNITIES FOR DRAINAGE WATER REDUCTION (1988); UNIVERSITY OF CALIFORNIA COMMITTEE OF CONSULTANTS ON DRAINAGE WATER REDUCTION, ASSOCIATED COSTS OF DRAINAGE WATER REDUCTION (1988); UNIVERSITY OF CALIFORNIA COMMITTEE OF CONSULTANTS ON DRAINAGE WATER REDUCTION, SAN JOAQUIN VALLEY AGRICULTURE AND RIVER WATER QUALITY (1988).
about the hybrid systems that might be constructed to take maximum advantage of different program characteristics. The final step defines any institutional adjustments required to implement the preferred program.

The results of this study also suggest that much of the conventional wisdom that has pretermitted consideration of economic incentives for addressing nonpoint source pollution problems can be challenged. Establishment of accountability—by making dischargers individually responsible for the pollution they generate—is central to the success of any pollution control program. The first step is to redefine agricultural drainage more accurately as "a large collection of independent, monitorable and controllable" discharges. This characterization, in turn, provides a point of departure for developing an effective regulatory system. Redefinition of the pollution problem also underscores the advantages of economic incentive programs—viz, flexibility in meeting pollution reduction requirements, enhanced accountability for individual sources, and increased likelihood of compliance and enforcement.

Two environmental concerns have inhibited consideration of incentive programs and tradable permits in the context of nonpoint source pollution control. First is the belief that the use of tradable discharge permits will result in less environmental protection than more traditional forms of regulation. This presumption is based primarily on proposals that would involve trades between point sources (which are subject to specific effluent load limitations) and nonpoint sources (which would be subject to BMPs). In this case study, the proposed trading system is premised on specific, enforceable load limitations for nonpoint sources—viz, the Grasslands water and drainage districts. As a result, the trading program results in a higher degree of environmental protection than a traditional BMP program, without sacrificing cost-effectiveness. To the extent that similar programs can be used in other regions, environmental protection can be enhanced by the use of tradable permit programs.

Similarly, economic incentives often have been overlooked as a viable option where there is a single regulated industry, on the assumption that similarity in marginal costs precludes opportunities for significant cost savings compared to traditional programs. Although economic data for individual farm sources generally are limited, the Grasslands case suggests that cost savings can be realized when small marginal cost differences among a large number of sources are aggregated.

The technical difficulty of deriving a defensible regional pollution load limit (or TMDL) also has inhibited consideration of alternatives to the traditional BMP approach. As pointed out in this Article, however, an estimate of the regional pollution load allocation (or screening-level TMDL) is a prerequisite for designing any effective program. For the San Joaquin River, the TMDL provides a simple, affordable, and reliable method by which to calculate an initial load allocation among contributing members, and to initiate an appropriate nonpoint source control program.

Economic incentives thus are an important option for controlling nonpoint source pollution, particularly in agricultural areas such as the Grasslands region. While incentive-based approaches and tradable permit systems will not be optimal in every situation, increased knowledge and experience with incentive programs will enhance the overall capacity of policy makers, regulators, and dischargers to improve and protect water quality.
APPENDIX

THE GRASSLANDS REGIONAL DRAINAGE DISTRICT: A MODEL STATUTE

Section 1: Policy Declarations and Findings

The Legislature finds and declares as follows:

a. The Grasslands Region of the San Joaquin Valley is a productive and valuable component of California's agricultural economy and is home to some of the last and most important wetlands in the state. The Grasslands Region also is a principal source of water supply for the lower reaches of the San Joaquin River.

b. There exists in the Grasslands Region a serious problem of irrigation drainage. These problems include:

(1) high levels of groundwater, which can saturate the root zone of the crops grown in the region;

(2) contaminated irrigation runoff and drainage from farms in the region, which has caused harm to crops, fish and wildlife, waterfowl, and public health, and which has degraded the quality of water in both the San Joaquin River and the aquifer that underlies the region; and

(3) the absence of a safe and effective means of disposing of the agriculture drainage water that is produced by farms in the region.

c. The pollutants in the drainage water that pose the greatest risk to crops, public health and welfare, fish and wildlife, waterfowl, and water quality are arsenic, boron, molybdenum, selenium, and other salts.

d. The continued discharge of contaminated drainage water at present concentrations of pollutants is unacceptable; and past reliance on nonpoint source pollution controls and ambient water quality standards to address the problems caused by excessive drainage from the Grasslands Region are inadequate.

e. Solution of these problems requires:

(1) integrated, regional management of water use and drainage in the Grasslands Region;

(2) greater individual accountability among existing water supply and drainage agencies for their members' irrigation and drainage practices; and

(3) creation of a system of tradable discharge permits for the drainage and pollution generated by irrigation within the region.

Section 2: Membership

a. The Grasslands Regional Drainage District is comprised of the following members:

(1) Broadview Water District;

(2) Camp 13 Study Area;

(3) Central California Irrigation District;

(4) Charleston Drainage District;

(5) Dos Palos Drainage District;

(6) Eagle Field Water District;

(7) Firebaugh Canal Water District;

(8) Grasslands Water District;

(9) Gustine Drainage District;

(10) Mercy Springs Water District;

(11) Newman Drainage District;

(12) Oro Loma Water District;

(13) Panoche Drainage District;

(14) Panoche Water District;

(15) Pacheco Drainage District;

(16) Pacheco Water District;

(17) Poso Canal Company;

(18) San Luis Canal Company;

(19) San Luis Water District; and

(20) Widren Water District.
b. With the unanimous consent of the member agencies, other local water or drainage service agencies may be added to the Grasslands Regional Drainage District.

Section 3: Board of Directors

a. The Grasslands Regional Drainage District shall be administered by a Board of Directors comprised of five representatives of the member agencies. Each director shall serve for a term of four years, except that in the first election of directors, the terms shall be staggered as set forth in section 4.

b. The Board of Directors shall administer the Grasslands Regional Drainage District and shall have all powers granted to it under this statute.

c. The Board of Directors shall act on the basis of a majority vote of the directors present and voting at each meeting. Three directors shall constitute a quorum.

d. The Board of Directors shall elect a Chair, who shall serve for no longer than one year.

e. The Board of Directors shall appoint an Executive Officer, and Chief Financial Officer, a General Counsel, a Chief Engineer, and other employees. The Board also may retain non-employee consultants to assist the District with its responsibilities under this statute.

f. The Board of Directors shall meet at least once each quarter. All meetings shall be conducted in public, except for discussions concerning personnel and matters protected by the attorney-client privilege.

Section 4: Election of Board of Directors

a. Elections for the Board of Directors shall be held once every two years.

b. In the first election, two directors shall be elected for terms of two years, the other three directors shall be elected for terms of four years. In all subsequent elections, directors shall be elected for terms of four years.

c. If a vacancy should occur before the end of a term, the remaining directors shall elect a replacement, who shall serve for the balance of the term.

d. Each member agency may nominate one candidate for election to the Board of Directors.

e. In the election of directors, each member agency shall vote for one candidate for each open position on the Board of Directors. The number of votes cast by each member agency shall be proportionate to the percentage of irrigated land within the Grasslands Region served by the agency. For purposes of this section, "irrigated land" includes land served by irrigation water or drainage for wetlands purposes.

e. No director may serve for a term longer than four years, and no member agency may have more than one representative on the Board of Directors at any time.

Section 5: Powers and Responsibilities

a. The Regional Drainage District shall be responsible to the Central Valley Regional Water Quality Control Board, the California State Water Resources Control Board, the United States Environmental Protection Agency, and all other federal and state agencies with authority over water quality and natural resources in the San Joaquin Valley for complying with all laws governing the discharge of drainage and other effluent into the San Joaquin River and its surface and subsurface tributaries.

b. The Regional Drainage District shall have authority over its member agencies, and over all uses of water and discharges of drainage that occur within its member agencies, to ensure that the District and its member agencies comply with all applicable laws regarding water quality, pollution control, and natural resources management. This authority shall include the following:

(1) Based on waste discharge requirements, effluent limitations, or other water quality standards established under state or federal law, the District shall determine the aggregate pollution load for each pollutant governed by such law. This aggregate pollution load is the maximum amount of each regulated pollutant that may be discharged from all sources located within the
District into the San Joaquin River and its tributaries. The aggregate pollution load may be established for any period up to one year.

(2) The District shall ensure that the aggregate discharge of pollution from all sources within the District does not exceed the aggregate pollution load.

(3) The District shall apportion the aggregate pollution load among its member agencies according to fair and equitable criteria established by the Board of Directors. In establishing these criteria, the Board of Directors shall consider:

(a) the total irrigated acreage within each member agency;

(b) the average quantity of drainage produced by each member agency in the form of surface runoff, return flow, and percolation following irrigation during the ten years immediately preceding the apportionment;

(c) the average quantity of water applied for the purpose of irrigating crops within each member agency during the ten years immediately preceding the apportionment; and

(d) drainage reduction and management methods that are applied by, or are potentially applicable to, water supply, distribution, irrigation, drainage, and other water uses within each member agency.

For purposes of this section, “irrigation” and “irrigated land” include land served by irrigation water or drainage for wetlands purposes.

(4) The District shall quantify each member agency’s apportionment of the aggregate pollution load and issue a discharge permit to each agency based on that apportionment.

(a) The discharge permit for each member agency shall define the quantity of drainage water that each agency is entitled to discharge from all sources into the San Joaquin River and its tributaries, into the groundwater basin, or into any drain or other conveyance facility that flows into the San Joaquin River or its tributaries or into the groundwater basin.

(b) The Board of Directors shall issue discharge permits that define the quantity of drainage water and the quantity of pollutants that each member agency may discharge over any period up to one year.

(c) The allowances to discharge drainage water and pollution established by the discharge permits may be transferred among member agencies and individual sources of drainage water and pollution.

(d) The allowances to discharge drainage water and pollution established by the discharge permits do not constitute property protected under the California Constitution, the United States Constitution, or any other law.

(5) The District shall supervise and manage the transfer of discharge allowances. No member agency may transfer a discharge allowance without the prior approval of the Board of Directors. The Board shall establish criteria to define acceptable trades and to govern its review transfer proposals.

(6) The District shall monitor and evaluate water supply, irrigation, and drainage practices within each member agency to ensure that each agency complies with the terms of its discharge permit.

(7) The District shall collect from each member agency a reasonable fee to pay for the District’s costs of implementing this statute, including but not limited to the payment of all salaries, administrative expenses, rent, capital and improvement costs, attorneys’ and consultants’ fees, and monitoring and enforcement costs.

(8) The District shall levy fines and other penalties for the violation of the discharge permits. The Board of Directors shall establish
a hearing procedure to govern the administration of such fines and penalties and shall promulgate a schedule of fines and penalties applicable to violation of the discharge permits. The amount of the fine and the severity of any other penalty shall double with each successive violation.

(9) The District shall provide technical and financial assistance to member agencies and to individual water users within the member agencies to assist them in meeting the drainage reduction requirements set forth in their discharge permits.

c. The District shall represent its member agencies, and the interests of water users within the member agencies, before the Central Valley Regional Water Quality Control Board, the State Water Resources Control Board, the United States Environmental Protection Agency, and other relevant state and federal regulatory agencies, as well as in court.

d. Notwithstanding any other provision of this statute, the District shall comply with all waste discharge requirements, effluent limitations, and other water quality standards established under state or federal law.

Section 6: Other Authority

a. The Board of Directors shall have the authority to promulgate regulations as it deems appropriate to carry out its responsibilities under this statute.

b. The Board of Directors shall have the authority to enter into contracts as needed to carry out its responsibilities under this statute.